SMARTeST

Guideline for implementation of flood resilience construction, technology and systems

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The SMARTeST Project

The SMARTeST project was funded under the European Union's FP7 Research Programme, in the area Technologies for improved safety of the built environment in relation to flood events (ENV.2009.3.1.5.1).

The extent and consequences of recent flood events in Europe and worldwide have shown that existing flood defence structures do not guarantee sufficient protection for people and properties. Due to climate change and rapid urbanisation the situation is likely to become more severe. In this unfavourably changing environment, a substantial rethinking of existing strategies and a paradigm shift from the traditional approaches is required in order to cope with future flooding in an adequate way.

The SMARTeST project (Smart Resilient Technologies, Systems and Tools) was conceived in order to address many of the issues of integration of flood resilience (FRe) technology into the overall approach to flood risk management. The project has developed and disseminated knowledge to help facilitate flood resilience across Europe. It has identified challenges to the design and integration of FRe technologies and isolated opportunities for their promotion. The project was designed to improve the road to market for FRe technologies, particularly those with innovative or 'smart' FRe features. These features rely less upon human intervention for their deployment, although correct use, installation and maintenance are critical to improving their overall effectiveness. Beyond innovative technologies, the project has also developed FRe modelling and decision-making, again with an ultimate aspiration to promote the growth of more resilient societies. The emphasis is on cost effective solutions to flood resilient systems in the urban environment.

The project has achieved the following:

- Development of guidance for standards makers on FRe technology;
- Understanding of FRe systems intended to incorporate FRe technology;
- Development of a series of models and tools that support integration;
- Understanding stakeholder needs for the integration of FRe technology, systems and tools;
- Production of guidance for professionals and individuals.

The project has been coordinated by the Building Research Establishment of the UK, and has involved 10 European research institutes. It has been supported by National Support Groups in each country and an International Application and Implementation Group (see www.floodresilience.eu for details).

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SMARTeST

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Other SMARTeST reports

Flood Resilience Technologies

Guidance for Flood Resilience Systems

Integration of Flood Resilience Technologies, Systems and Tools

Executive Summary

The increase of frequency and intensity of floods as well as the increase of flood vulnerability due to an accumulation of values needs innovative solutions which improve the resilience of the built environment. In this context the SMARTeST project has the overall aim to improve the Road to Market of innovative solutions and to reduce the deficiencies and obstacles within the implementation process. Thereby this document acts as a guideline for the implementation of FRe construction, technology and systems. It considers both the implementation strategies within the FRe Management as well as the models and tools which support decision making process by the implementation of FRe measures. Both aspects use the case study approach, which serve as a basis for the following:

- to consider the different national and local context;
- to detect constrains and opportunities in the FRe management process;
- to give examples for good practice when dealing with innovative FRe measures;
- to demonstrate the performance and to support the application of the models and tools;
- to build capacity of public and professional stakeholders in order to understand and implement the SMARTeST outcomes;
- to improve the dissemination of the SMARTeST results.

Within the different European SMARTeST case studies, the work done was only possible by supporting of SMARTeST partners as well as the involvement of the national and local experts and support groups.

The case study approach and the two mentioned main aspects result in three main parts of the guideline. The Part I is the core element of the guideline, which bring together the findings of the case studies (Part II and III) and fits the results into the context of other SMARTeST outcomes, work packages, and deliverables.

Flood resilience (FRe) is to be addressed regarding spatial – ecologic, structural, social and risk management levels. It needs appropriate strategies to achieve the overall objective to reduce flood risks integrating prevention, protection, preparedness, and emergency response, recovery and monitoring. Thereby the different management levels require defined indicators to evaluate the success. It leads to a FRe rating matrix that expresses priorities as an important element to evaluate the success of the FRe management process. Using a case example the Chapter I-1 shows also development opportunities for capacity building in this process.

In addition, the implementation process within FRe management requires specialised models and tools for an improved understanding and implementation of innovative FRe Construction and Technologies. With that in mind, a SMARTeST modelling toolkit has been generated, which bring together all the developed and extended SMARTeST models and tools. The SMARTeST toolkit with its components focuses on the different requirements within the FRe management process in terms of scope, objective target, scales, technology and target groups. The components of the toolkit are already described in detail in the within it. It is complemented by previous research which has focused on the simulation of the effects of FRe construction and technology using damage models like HOWAD-Prevent. The application of the models, as described in **Error! Reference source not found.**, is an important research pillar for Chapter I-2 within the Guideline.

The far-reaching opportunities of the developed components and tools have been applied at different case study areas such as the following:

- HOWAD-Prevent in Germany (Dresden), Netherland, Spain, and UK;
- FLORETO / FLORETO-Kalypso in Cyprus, Germany (Hamburg), Greece, and UK;
- Multi-hydro and VAT in France;
- Rains in the Netherland;
- Basic Barrier in Cyprus.

The site-specific application of the SMARTeST models and the achieved results within selected case study areas reflects **Error! Reference source not found.** of the guideline.

Error! Reference source not found. gives an insight into constraints and opportunities of capacity building in SMARTeST involved nations to effectuate a transfer process from the current situation to FRe systems. With that in mind, a questionnaire was designed in order to get short and comparable information to this issue as fundamental for the analysis in the chapter I-1.

In summary, the guideline represents an important contribution to capacity building in stakeholders and institutions as well as support and shape the transfer process from the current situation to FRe systems.

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1 Introduction

1.1 Background and objective of the guideline

The acceptance of smart models and tools for simulating the performance of innovative FRe technologies depends decisively on the availability of comprehensive and profound knowledge about their functionality, their outputs, their data requirements, and their ability to facilitate the uptake of FRe technologies. Besides, their broad acceptance and application require capacity building with key stakeholders in order to disseminate common knowledge about model and tool development and improvement.

Therefore, the primary objective of this guidance is to support stakeholders in implementing FRe technologies. To achieve the stated objective, this guidance, first, covers a methodological framework on methods for integrating FRe technologies in flood damage modelling and, second, summarises relevant constraints and opportunities for capacity building in each study area to effectuate the transfer process from the current situation to FRe systems.

The methodological framework specifies major principles for the development and implementation of tools for flood risk analysis and describes a general approach on how the performance of FRe technologies can be integrated in this process. This methodological framework builds upon research findings that have already been undertaken in the SMARTeST project.

The summary of constraints and opportunities for capacity building provides information on the national and local scale, drawing on information developed through a national analysis, as well as by the local case study workshops and on the case study itself. A survey of different European (administrative) planning procedures supports the detection of FRe implementation strategies and the determination of needs for enhancement and adaptation to accomplish full integration of flood resilience systems and constructions in urban development plans by regulations, restrictions and planning constraints. The guide provides examples on how intensive stakeholder involvement builds capacity and enhances the uptake of FRe technologies using the case study approach, with contributions of different national and local contexts and from different flood types.

1.2 Users of the guideline

Flood resilience need to be considered in a comprehensive fashion involving the legislature, government agencies on the national and local level, the construction industry, the insurance industry, FRe manufacturers, professional associations, NGO environmental groups, individual property owners as well as the research community.

1.3 Contributions of partners to the guidelines

SMARTeST project partners provided comprehensive contributions for this guidance, to achieve its overall objective to build capacity in professional stakeholders to support effective implementation of FRe technologies. The SMARTeST project partners have undertaken a survey of stakeholders and institutions to support and shape the transfer process from the current situation to FRe management. It gave the basis for the questionnaire in Part III.

The results and outcomes of applied SMARTeST models and tools support decision-making processes to explore appropriate flood risk management strategies. Part II of this guideline covers documentation and detailed findings of the application of the models and tools within six selected case studies considering diverse local contexts and different flood types.

Part I: Fundamentals of FRe Measures Implementation

I-1 Implementation strategies for FRe management

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I-1.1 Fundamental considerations for implementation strategies

Climate change today is causing more frequent and more intensive storms. There has also been increased population growth in cities causing more run-off from paved surfaces, and increased floodplain development in settings where land is scarce. These factors combine, leading to catastrophic flood losses throughout Europe and around the globe. The EU Floods Directive and the EU Water Framework Directive are forcing us to take a new look at flood defence. In the past levies and flood control structures were designed to control design storms with known frequencies of occurrence that now are eligible to overtopping, causing flood damage in areas thought to be protected. We have become accustomed to rely almost exclusively on physical infrastructure improvements for flood risk management. Now there is a realisation that there is a need for flood resilience, the wisdom of “living with floods”, planning for a minimisation of damage and a speedy recovery.

Flood damage is a social issue that calls for a social response. We have learned that flood resilience not only involves structural aspects but also contains social and city planning problems that requires “capacity building” and “social capital” to be addressed comprehensively[1] requiring an educated and committed constituency in communities. It requires (1) spatial/ ecologic, (2) structural, (3) social, and (4) risk management levels of planning. Planning for resilience is bound to fail when it ignores any one of those components. What do those levels of planning entail?

1) SPATIAL PLANNING - refers to the way we locate and arrange land uses (Preferably not on floodplains). It also refers to how we manage run-off from surfaces that cause flash flooding in cities. Peak flows depend not only on the intensity of storms but to a great extent on the run-off-coefficient of surfaces.[2] Cities like Washington and New York are making efforts to introduce green

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1 http://en.wikipedia.org/wiki/Social_capital accessed 9/12/2012

2 Rational Run-off Equation Q = ciA whereby Q = Peak discharge, cfs; c = Rational method run-off coefficient; i = Rainfall intensity, in/hour; A = Drainage area/ acres

roofs, porous pavement and other sustainable drainage (SUD) measures that maintain the natural water cycle.

2) STRUCTURAL PLANNING - for flood defence is not the exclusive responsibility of governments but also needs private action. Permanent, demountable, and temporary measures can be built by private owners (to keep basements dry), by transportation authorities (to keep facilities from flooding), by utility companies (flood-proofing) and by other stakeholders.

3) RISK MANAGEMENT - is aided by the availability of flood insurance to compensate for loses and by the public availability of information about measures that can be taken to reduce risks.

4) SOCIAL PLANNING - includes flood warning, emergency planning and stakeholder participation by public agencies, and most importantly the building of "social capital" an educated constituency with a network of connections between individuals and representatives.

In the US cities like Washington DC, Philadelphia and New York are pursuing a resilience strategy, strengthening their ability to weather the effects of serious flooding and recovering from it. To achieve flood resilience the *New York Times* reports progress on the four levels of resilience planning, mentioned above, but quotes a city official as saying "We're behind in consciousness building and disaster planning".[3] The storm "Sandy" later proved this to be true. This deficiency in capacity building also applies to many European cities, which should be reminded to take an approach that keeps all four response options on the table when dealing with flood risk responsibilities.

Constraints and opportunities for the implementation of FRe have been explored through the SMARTeST project in a National Review, through workshops in case study areas and through case studies in the cities of Hamburg, Rotterdam, Dresden, Greater Manchester, Valencia, Cyprus, Paris, Athens and the Washington D.C. area. A further case study including a questionnaire about opportunities and constraints for capacity building for flood resilient systems (FRe) has been applied to six case study areas and is presented in the following chapter. It is looking at capacity building (1) on the national level, and (2) on the local scale. On the national level this considers: 1.1 national laws, 1.2 nation state programs, 1.3 the construction industry, 1.4 insurance industry, 1.5 FRe manufacturers, and 1.6 professional associations. The level of experience is the local scale. It identifies constraints and opportunities shown by 2.1 city governments and municipalities, 2.2 educational institutions, 2.3 local environmental groups and NGO's and 2.4 individual property owners.

The workshops found a higher level of professional and public awareness of FRe in most northern countries (UK, Germany, France and the USA) as compared to southern and Mediterranean countries. Southern EU member states have been described repeatedly as having customs of natural resource management that make reforms difficult.[4] It can be said in all European countries there is a need to create an educated constituency that understands a holistic approach to reach flood resilience, which will then interact with decision makers. This can be achieved through "learning and decision alliances" involving stakeholders. Stakeholders are more than citizens' groups and involve units of government, the construction industry, insurance industry, FRe manufacturers, professional associations, municipalities,

3 Navarro, M. New York is Laging as Seas and Risks Rise, Critics Warn. The New York Times, 9/11/2012

4 Priedham, G. National Environmental Policy Making in the European Framework: Spain, Greece, and Italy in Comparison, in Jordan, A. (ed) Environmental Policy in the European Union: Actors, Institutions and Processes, Earthscan, London, 2002

universities, and last but not least the property owners themselves. These are the units addressed in this document.

It is being concluded that capacity building with stakeholders is holding the key for a successful “road to market”, leading to a transfer from the current situation to the use of FRe systems, coping with flooding and showing ability to recover from flooding. The document interpreting the results of workshops in case study areas (D5.2) examines how obstacles and reluctance to implement FRe can be overcome, how to progress in the design of holistic systems, the development of decision support tools, lending backing for a Europe-wide flood risk management policy of “Living with water” and “Living with risk”. The EU Floods directive is calling for such a comprehensive view, asking for a threesome of prevention, protection, and preparedness.[5]

The National Review of workshops and case studies concluded that the road to implementation of FRe requires a linking of technologies, systems and tools leading to (1) an integration of FRe technical responses, (2) integration of FRe into the wider system, (3) integration of FRe into decision making tools, and (4) integration of FRe into implementation processes.. Vertical integration refers to scales of influence, from the EU level to the Nation States, from cities and municipalities and also from the grass root level up. Horizontal integration applies to stakeholder ranging from environmental groups to the construction industry, as well as from FRe manufacturers, insurance companies, environmental groups and the general public. Figure I.1-1 illustrates this integrative approach. It has further been reasoned that the use of FRe could be supported if it were linked with other concerns, systems and decision-making tools on the horizontal and vertical levels to create beneficial synergies.

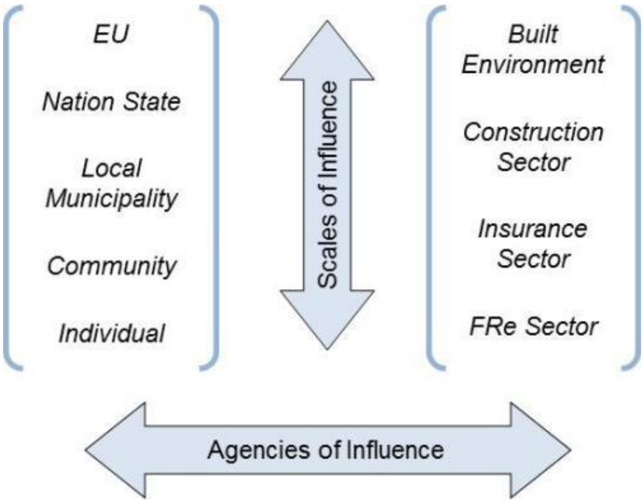

Figure I.1-1: Agencies of influence for the horizontal and vertical integration of flood resilience [6]

[5] European Union. Directive 2007/60/EC: On the Assessment and Management of Flood Risk. EC, Brussels, 2007

[6] Source Ibid

Citizens are accustomed to flood control being the responsibility of government, acting entirely on technical reasons. Flood resilience realises that it requires spatial, structural, social, and risk management levels of planning. Today there is an international trend towards fiscal austerity, limiting fiscal expenditures throughout Europe and the U.S. This is being applied from the top down, limiting national and state expenditures, and has implications on the bottom level, spreading responsibility for flood risk management to include communities, voluntary associations and the general public. Flood risk management involves performance aspects of land use, requiring cooperation among all stakeholders and an educated public. To manage flood risks effectively and in a responsible manner cannot be achieved overnight but will be a process that requires time. The option of not to engage in such a route is unacceptable, as the price in lost life, public health impairments, damages to property and costs to the economy are unacceptable.

I-1.2 Indicators of success

What is success in flood resilience, and what are the indicators of success? Success implies the achievement of objectives. Prior to the emergence of the flood resilience concept, success in flood control and flood defence could be relatively easily declared. The planning of flood defence systems usually involved a cost-benefit analysis, were the costs for levies, floodwalls, flood control dams and the deepening and hardening of river channels were compared with the value of damage reduction achieved.

Adverse environmental impacts were usually ignored. In the US for example, the US Army Corps of Engineers (USACE) would deepen river channels and dispose of the dredged fill in wetlands on the river floodplains. It took the passage of a range of environmental laws and a lawsuit by the Environmental Defence Council to force the USACE to stop those practices and in a reversal of roles become a custodian of wetlands. Similarly there has been a change in the legal landscape of EU countries, having to adhere to the Water Framework Directive (WFD), which is asking to achieve the “highest ecological potential”, even for “heavily modified water bodies”.

Flood resilience is more complex than conventional flood control because it has multiple aspects. It also is more precise than the concept of sustainability because each of the resilience aspects- spatial, structural, social, and risk management can be measured. It is this measurement and quantifying ability that defines success when compared to pre-improvement conditions and to goals and objectives set in a plan.

Following is a matrix of indicators of success that makes users take a comprehensive approach by looking at all necessary aspects of flood resilience. Indicators of success can be (1) formulated and used for project guidance to define and adjust the course of an assignment and (2) used as a post-implementation assessment to define what has been accomplished. Utilisation of indicators has multiple benefits. It will force the setting of clear goals and objectives early in a project, increase transparency, establish stakeholder participation, and increase manageability for decision making bodies.[7] A post- implementation assessment is vital to permit professionals to learn from projects and to improve the state of the art for future endeavours. It should involve the setting of measurable criteria (indicators of success) and permit the measurement of effects, effectiveness and efficiency of a project. Effects are the outcomes of a project, effectiveness relates to goals and measures taken, and efficiency relates to the resources spent to achieve those effects. For reasons of costs and because of an often missing transparency there is a wide spread deficiency in the number of post-project appraisals that are being carried out. An examination of nearly 100

[7] Nijkamp, P. and Ouwerslooth, A Decision Support System for Regional Sustainable Development: The Flag Model, in Theory and Implementation of Sustainable Development Modelling, Eds, van den Berg et al, Dordrecht, 1998

river and flood alleviation projects in the UK, for example, showed that only five had conducted a post-project appraisal.[8]

1. Indicators of success criteria

Flood resilience should be defined on four FRe levels as follows:

1) SPATIAL-ECOLOGICAL FLOOD RESILIENCE implying the management of land by floodplain zoning, urban greening and management to reduce storm run-off through depression storage and by practicing Sustainable Urban Drainage (SUD's), Best Management Practices (BMP's), or Low Impact Development (LID). Ecologic processes and cultural elements are included.
2) STRUCTURAL FLOOD RESILIENCE referring to permanent flood defence structures such as levies, demountable structures that are partially installed, temporary structures that are removable, as well as dry- and wet flood-proofing of structures to meet construction standards to deflect or resist pressure without breaking.
3) SOCIAL FLOOD RESILIENCE referring to the building of robust institutions (including NGO's) and governance systems that underpin our capacity to prepare for and cope with uncertainty, change, and disasters when they occur.
4) FLOOD RISK RESILIENCE implies the ability to withstand and recover from crises through financial insurance assistance and through assistance by governmental institutions, including the communication of information on flood-proofing steps that individuals can take on their own.

These considerations are criteria that should be present in flood resilient projects, acting as indicators of success.

2. Indicators of success for project guidance

Consideration of indicators helps to define and fine-tune a project and helps to set priorities. Projects in different locations may place different emphasis on the four FRe Levels. A project in a Dutch polder, for example may place more emphasis on structural planning than on run-off management. It is recommended that all criteria be considered, but that a weighted rating is applied. In certain situations FRe Level II - Structural Planning may receive an emphasis as height as 60%, compared to other levels of resilience, which could then divide up the remaining 40%. This sort of priority rating can be called the Weighted Sum Method. It should be noted that weights should be assigned as percentages and that they always have to add up to 100%.

The Weighted Sum Method was used with a stakeholder participation project for the City of Grimma, in Saxony, Germany, where in 2002 the historic downtown area had been flooded to a depth of more than six feet. Here the threat of a repeated flood provided the "glue" that brought a citizen's group together in a

[8] Holmes, N. Post-Project Appraisals of Environmental Enhancement. Draft Report to the National Rivers Authority, Thames Region, Reading, UK. 1991

learning and planning process that lead to a plan for permanent and demountable flood barriers integrated into civic design.[9]

Table I.1-1 shows how stakeholders expressed priorities in ratings on a matrix that considered existing conditions and formulated goals leading to concepts. The Weighted Sum Method expressed priorities assigned as percentages. The sum of all weights had to equal 100%. Weights were assigned to main values and to a division of weights assigned to related implementation concepts. Here a high priority rate was assigned to Flood defence needs (40 %), but even higher was the combination of Compatibility with historic preservation (25%) and Visual appearance of the city (25%), as well as Use of the waterfront (10%).

Table I.1-1 Value Matrix used in stakeholder meetings in the City of Grimma, Germany, leading to an agreement on flood barriers compatible with stakeholder values

Value Concepts	Rating	Existing conditions			Goals	Rating
		Oppor-tunities	Con-straints	Situation		
Flood defence needs	40%				1. ……… 2. ……… 3. ………	25% 10% 5%
Compatibility with historic preservation	25%				1. ……… 2. ………	5% 20%
Visual appearance of city	25%				1. ………. 2. ………. 3. ……….	10% 5% 10%
Use of waterfront	10%				1. ………. 2. ……….	8% 2%
Sum in total	100%					100%

Table I.1-2 shows a Weighted Ratings Matrix that express priorities within different FRe Levels shown above and their categories. It is similar to the City of Grimma example permitting ratings four FRe Levels and of individual FRe categories, having to add up to 100%. Table I.1-2 can be used as a way to set planning priorities with stakeholders by considering existing conditions, to formulate goals and to develop concepts. A clear formulation of goals is an essential first step in the planning process. Clear goals are a pre-requisite for the monitoring of performance. Only when you set clear goals at the beginning, In order to evaluate to what extent goals and objectives have been met at the end of a project they need to be set clearly at the beginning. A clear setting of the intent of projects is often neglected as Projects in different locations may place different emphasis on the four FRe Levels. The Sligo Creek Basin project in Washington D.C., for example placed high emphasis on stormwater quality, yet did not ignore social planning and risk management aspects. It is recommended that all criteria be considered, but that a weighted rating is applied. In certain situations FRe Level II - Structural Planning may receive an emphasis

[9] Will, T., J.T. Tourbier. Forschungs- und Entwicklungsprojekt "Städtebauliche Einordnung des Hochwasserschutzes für Grimma, integrierte landschafts- und hochbauliche Fachplanung für einen nachhaltigen und denkmalverträglichen Hochwasserschutz". Für die Landestalsperrenverwaltung Sachsen, 2005

as height as 60%, compared to other levels of resilience, which could then divide up the remaining 40%. It should be noted that when using the Weighted Sum Method to express priorities, weights assigned as percentages always have to add up to 100%.

The matrix works well for stakeholder involvement, which has been recognised as the important step on the "road to market", leading to the use of FRe measures. It helps to reduce "silo thinking"[10], or the "entrapment effect"[11] when influential members in stakeholder groups try to advocate what traditionally had "worked best". All stakeholders, including policy makers, should be involved in an active policy process, which has been called "a learning and action alliance to build capacity for flood resilience"[12].

3. Indicators of Success for a Post-Implementation Assessment.

The matrix can further function as an indicator of success for a post-implementation assessment. Table I.1-3 shows an amendment and simplification of the matrix to indicate whether a project had (a) Criteria fully met, (b) Criteria partially met, or (c) Criteria not achieved.

Table I.1-3 shows an application of this matrix as a Post-implementation assessment of the Sligo Creek area in the Anacostia River Basin of the Washington D.C. Case Study. The Sligo Creek basin turns out to have few examples of flood defence structures (demountable and temporary) and few examples of flood-proofing (elevation, wet flood-proofing, dry flood-proofing, levees and floodwalls). In all other respects the adherence to flood resilience is remarkable.

It is recommended that communities apply the Table I.1-2 or Table I.1-3 matrix to evaluate to what extent they are taking a comprehensive approach to flood resilience. It should not be used to make a community resentful of deficiencies, but to discover how they could open up their mind to a comprehensive view, to initiate decisions and to engage in capacity building with its stakeholders.

[10] Newman, R. Ashley, F. MacTaggert, S. Gillon, A. Cashman, G. Martin, S. Molyneux- Hdgson. Using non-structural responses (NGS) to better manage flood risk in Glasgow. 11th International Conference on Urban Drainage, Edinburgh, Scotland, UK, 2008

[11] Walker, W. Entrapment in large technology systems: Institutional commitment and power relations. Research Policy, 29,883-847. 2000

[12] Ashley, R.M., J. Blanksaby, R. Newman, B. Gersonius, A. Poole, G. Lindley, S. Smith, S. Ogden, R. Nowell. Learning and Action Alliance to Build Capacity for Flood Resilience. Journal of Flood Risk Management. 2011

Table I.1-2 Weighted Ratings of FRe Levels and FRe Categories

FRe Levels	Rating	FRe Categories	Existing condition			Goals	Con-cepts	Rating
			Situation	Opportunities	Constraints			
I. FRe Level - Spatial planning								
		I.1 On-site run-off management - retention, detention, infiltration, erosion control, water quality protection						Rating .....%
		I.2 Off-site stormwater management – polders and flood compartments, floodplain enlargement and river restoration						Rating .....%
		I.3 Conveyance - spillways, flood-ways						Rating .....%
		I.4 Ecologic processes and cultural heritage elements						Rating .....%
	Level I Rating							Level I Rating .....%
II. FRe Level – Structural planning								
		II.1 Flood defence structures – Permanent, Demountable and Temporary						Rating .....%
		II.2 Flood-proofing – Elevation, Wet flood-proofing, Dry flood-proofing, Levees and floodwalls and Relocation						Rating .....%
		II.3 Technical flood-proofing advice						Rating .....%
	Level II Rating							Level II Rating .....%
III. FRe Level - Social planning								
		III.1 Flood warning – location specific						Rating .....%
		III.2 Flood depth information on the 10 year frequency, 100 year frequency, and extreme flood						Rating .....%
		III.3 Municipal flood emergency planning – private and public						Rating .....%
		III.4 Stakeholder participation						Rating .....%
		III.5 Monitoring performance compared with goals						Rating .....%
	Level III Rating							Level III Rating .....%
IV. FRe Level - Risk Management								
		IV.1 Availability of flood insurance						Rating .....%
		VI.2 Public availability of information on FRe measures and flood-proofing						Rating .....%
	Level IV Rating							Level IV Rating .....%
Sum in total	100%							100%

4. Resilience Rating Matrix

Table I.1-3 A Post-implementation assessment of Sligo Creek in the Anacostia River Basin, Washington D.C. Case Study

	(a) Criteria fully met	(b) Criteria partially met	(c) Criteria not achieved
I. FRe Level - Spatial planning			
I.1. On-site run-off management - retention, detention, infiltration, erosion control, water quality protection	x		
I.2. Off- site stormwater management – polders and flood compartments, floodplain enlargement and river restoration	x		
I.3. Conveyance - spillways, flood-ways,	x		
I.4. Ecologic processes and cultural heritage elements	x		
II. FRe Level - Structural planning			
II.1. Flood defence structures – Permanent, Demountable and Temporary			x
II.2. Flood-proofing – Elevation, Wet flood-proofing, Dry flood-proofing, Levees and floodwalls and Relocation		x	
II.3. Technical flood-proofing advice	x		
III. FRe Level - Social planning			
III.1. Flood warning – location specific	x		
III.2. Flood depth information on the 10 year frequency, 100 year frequency and extreme flood	x		
III.3. Municipal flood emergency planning – private and public	x		
III.4. Stakeholder participation	x		
III.5. Monitoring performance compared with goals	x		
IV. FRe Level - Risk Management			
IV.1. Availability of flood insurance	x		
VI.2. Public availability of information on flood resilience measures and flood-proofing	x		

I-1.3 Decision support for Public Authorities

EU governments have designated Public Authorities to carry out water resources management programs that have been formulated by public representatives. Laws passed in EU countries are providing the legal framework. Water related laws such as the EU Floods Directive and the Water Framework Directive provide guidance for subsequent laws on the state level. These laws are still relatively new and sometimes entail conflicts. FRe measures and implementation projects are carried out on a site specific scale, primarily in urban areas. Public authorities involved are the City Planning Commission, Sewer, Water and Drainage Authority, City Engineering, Open Space and Recreation Department, Utility Commission and others. One of these agencies traditionally is assigned to take the lead in flood resilience planning and implementation.

Past flood defence projects have mostly been led by engineering firms and usually been justified by a cost-benefit analysis that compares the cost of structures with the value of protected property. The flood resilience approach is more holistic, comprehensive, and interdisciplinary. It thus has a higher need for input from various disciplines.

The EU directives see stakeholder identification and stakeholder participation as a component of the planning process, not to be the “after the fact” public participation review of completed plans as practiced in the past. Instead, stakeholders should be involved, starting with the definition of goals and objectives up to the formulation of a plan and post project evaluation of outcomes. Support may come through the involvement of multi-disciplinary stakeholder committees, forming “learning and action alliances”.

Behavioural scientists, public health specialists, commercial interests, lawyers and other professional organisations, and resident- and interest groups can be participants in stakeholder groups. Multi-disciplinary planning will always be a learning process for some of the participants. Today with the help of computer technologies, there are unparalleled opportunities for information and communication. There are opportunities for both modelling and communications with technology transfer in the planning process under stakeholder participation.

Computer assisted planning and education aids can be targeted at the needs of different stakeholder groups.[13] Computer based user-interactive decision support tools seem to be ideal to help the personnel of agencies who have a diverse educational background cope with interdisciplinary tasks and to assist stakeholder committees. Their potential is immense.

Decision Support Systems (DSS) are a relatively new computerised development to support organisations in decision making. A DSS is an interactive software based system designed to help decision makers compile useful information from raw data, personal knowledge and simulation models to identify and solve problems and make decisions.[14] Having started with the study of organisational decision making at the Carnegie Institute of Technology in the early 1960s DSS became a discipline on its own in the 1990’s with data warehousing and online analytical processing. There has been a differentiation between passive, active, and cooperative DSS. The latter allows decision makers to modify and refine decisions offered by the program and to send them back for re-evaluation. Benefits of DSS that have been defined are: improves personal efficiency, expedites problem solving, facilitates interpersonal communication, promotes learning or training, increases organisational control, generates new evidence in support of a decision, encourages exploration and discovery on the part of the decision maker, and reveals new approaches to thinking about a problem.[15]

There has been research and advances in flood decision support system architecture considering remote sensing, GIS, and hydrologic models (Figure I.1-2). Prof. E. Pasche and N. Manojlovic of the SMARTeST team have presented papers addressing capacity building of spatial planners for flood risk management in

[13] Tourbier, J.T., Ashley R.M. Aquaterra Conference, “Integrative Teaching and Learning Modules for the Application of On-Site Urban Flood Resilience Planning”. Amsterdam, pp. 85-102. ISBN 978-3-937693-06-8, 2007

[14] http://en.wikipedia.org/wiki/Decision_support_system accessed 12/9/2008

[15] Ibid

urban environments through Decision Support Systems and Interactive Learning[16]. For the EU Interreg IIIb project FLOWS, they developed a DSS and computer model that determined flood probability, depth of inundation, assessment of damage, as well as a scenario-analysis including conflict analysis, flood risk assessment, mitigation plans, efficiency analysis, and decisions. The program considered redesign of options and optimisation opportunities. As FLORETO the model has been developed further as a three tier advisory system to assist cities to adhere to Awareness, Assistance, Alleviation and Avoidance permitting: (1) risk assessment, (2) resilience adaptation and (3) implementation and review. The TU Hamburg-Harburg has now developed the FLORETO-Kalypso model for SMARTeST to analyse and evaluate the performance of FRe technology in terms of damage reduction, to develop preferred options through data mining, and to extend the existing DSS to multi-criteria analysis and other planning aspects. Planned outcome will be a support for decision-makers on the level of professional stakeholders. The Model was applied in Hamburg-Wilhelmsburg, on Cyprus, and elsewhere.

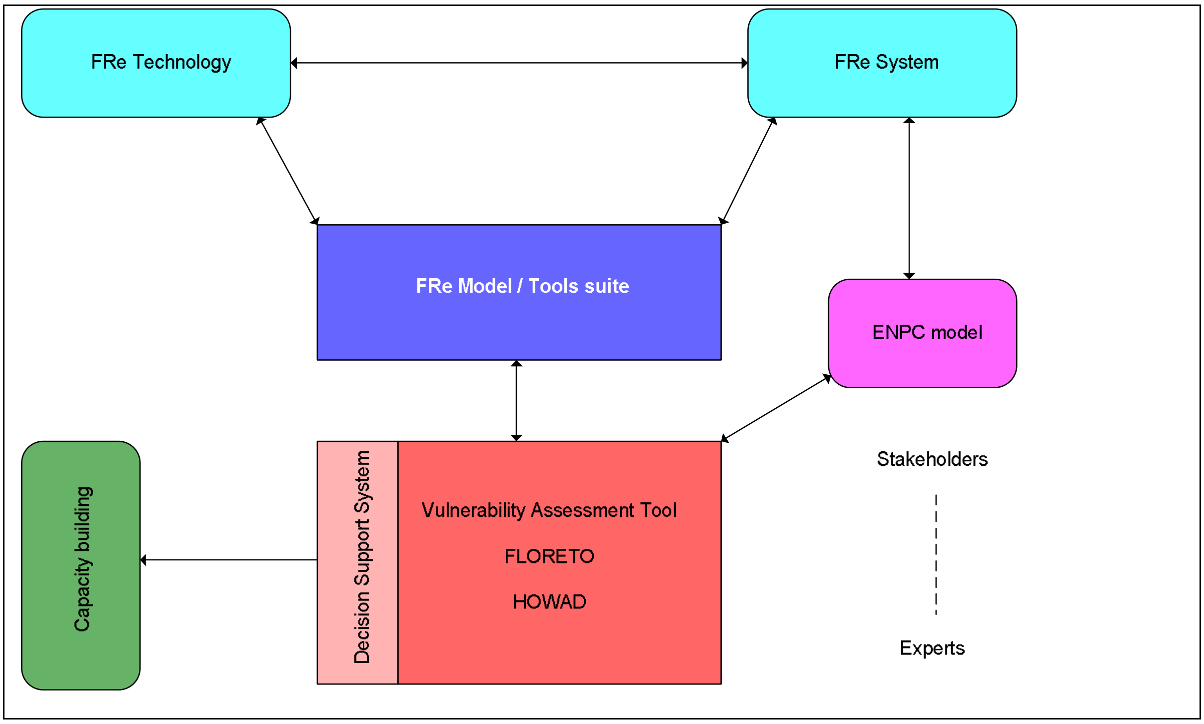

Figure I.1-2: Functions of the DSS FLORETO and HOWAD

Another program is the HOWAD-Prevent model. It was developed by of the Leibniz Institute of Ecological Urban and Regional Development, Dresden (IOER) and has been advanced the HOWAD approach as a SMARTeST tool for the implementation of FRe technologies[17]. The IOER used the forerunner of this model as a participant in FLOODsite, a 5-year EU research project involving 13 countries. HOWAD-Prevent

[16] Pasche, E., Ch. Kuepferle, N. Maojojlocvic. Capacity building of Spatial Planners for Flood Risk Management in Urban Environment through Decision Support Systems and Interactive Learning. International Symposium on New Directions in Urban Water Management, UNESCO, Paris 2007

[17] Neubert, M. and Schinke, R. (2012): Tutorial of the HOWAD-Prevent Demo Tool, unpublished

calculates flood damage to buildings and the effects of FRe Construction and Technologies using building types and site-specific, synthetic depth-damage functions. Outcomes with high spatial resolution are on the property level and can then be aggregated for districts of interest. The effects, changes of the flood hazard, changes of urban structure and changes of vulnerability through dry flood-proofing and wet flood-proofing as flood resilience measures can be simulated. The model was applied in Heywood Greater Manchester (United Kingdom, Chapter II-5), Valencia (Spain, Chapter II-6), Pendrecht Rotterdam (The Netherland, Chapter II-3), and Dresden Kleinzschachwitz (Germany).

Other models developed through the SMARTeST project are Multi-Hydro, RAINS, VAT, and SMARTeST Barrier. A summary presentation of FLORETO-KALYPSO and the HOWAD-Prevent model at the strategic and local level workshops in Washington D.C. was viewed with interest and considered for use at the professional level. Computer generated information is generally trusted, though it is being realised that the quality of output depends on the accuracy of input. It is being understood that computer based decision support systems and models will undoubtedly play an increasing role as a planning aid and as a facilitator of informed decisions. DSS can be used for seminars at universities or in continuous education courses taught by academics offered at professional association continuous education courses. DSS can further be used on a professional level assisting in stakeholder participation and in the work of learning and action alliances formed to assist projects. DSS is an important tool for decision support in stakeholder participation and in the work of public authorities.

I-1.4 Development opportunities for Capacity Building – a case study example

The chapter contains (1) a description of case study areas I-1.4.1), (2) capacities and performance in case study areas (I-1.4.2), and (3) implementation strategies (I-1.4.3) that result from the above.

Capacity building refers to the creation of enabling settings and policy and legal frameworks for the implementation of FRe systems.[18] This requires the strengthening of managerial systems, human resource development, and participation of all stakeholders (government and non-governmental organisations).[19] Capacity building has been defined as the "process of developing and strengthening the skills, instincts, abilities, processes and resources that organisations and communities need to survive, adapt, and thrive in the fast-changing world."[20] Implementation of the EU Floods Directive requires capacity building with all stakeholders. It implies Institutional Development to enable organisations and agencies to enhance their capacities; Organisational Development involving processes and procedures within and management between different sectors such as public, private and community; and Human Resource Development, equipping individuals with the skills, access to information, training and knowledge enabling them to act effectively.[21]

Flood risks have increased in a time of climate change, and population increases in urban areas. Capacity building gives variability, flexibility and functionality to enable organisations to adapt to changing needs. Capacity building is more than training, though it is impossible to achieve it without an educated constituency.

[18] Definition: Flood resilience combines spatial – ecologic, structural, social and risk management levels, integrating prevention, protection, preparedness, and emergency response, recovery and monitoring.

[19] http://en.wikipedia.org/wiki/Capacity_building accessed 12/9/2008

[20] Philbin, Ann, Capacity building in Social Justice Organizations. Ford Foundation, 1996

[21] http://en.wikipedia.org/wiki/Capacity_building accessed 12/9/2008

I-1.4.1 Description of case study areas

Part III shows a questionnaire and answers from case study areas in the United Kingdom, Germany, United States, Spain, Cyprus, and Greece. Characteristics of those case study areas vary.

The UK case study area is the community of Heywood in the city of Manchester. This area was developed during the 19th century. The location and condition of much of the sewer system and of many private drains is unknown. Considerable additional urban development during the last 50 years is stressing the capacity of the sewer system, which caused flooding in 2004 and 2006.

The German case study area is Dresden-Kleinzschachwitz, which together with Dresden-Laubegast had been severely flooded in 2002 and in 2006. Both are privileged, primarily residential districts, located in the upstream portion of the city, surrounded by filled in, old oxbow meanders of the River Elbe. In Kleinzschachwitz damage is caused by fluvial flooding, ponding and through raised groundwater levels.

In the US Washington D.C. area the Sligo Creek drainage basin was studied. It contains 11 square miles in the western portion of the Anacostia river catchments area, abutting the District of Columbia. The Sligo Creek area is a classical suburban development. Impervious surface amounted to approximately 34 %. In 2005 Congress initiated a program to use the Anacostia area as a national stewardship model. A total of 84 future stormwater retrofit installations have been proposed.

In Spain, the case area is the city of Valencia, which as an autonomous community has its own regional government. The residential district is subject to riverine flooding. A catastrophic flood occurred here in 1982. Flood control in the past placed emphasis on up-stream prevention. The HOWAD-Prevent computer model was applied here.

In Cyprus, the waterfront of the city of Paphos (Poseidon Avenue), experiences coastal flooding due to wave overtopping approximately twice a year. In a case study the software FLORETO was applied and cost estimates for alternative flood barriers were prepared.

In Greece, the case study area Nea-Philadelphia is located in the prefecture of Attica. The area was last subject to a catastrophic flood in 1994. The FLORETO model to assess flood risk was applied here.

I-1.4.2 Capacities and performance in case study areas

A questionnaire sent to the participating case study areas outlined above contained questions concerning capacity building on the following levels:

1. Capacity Building on the national level

1.1 EU member countries and the US
1.2 Regions and States
1.3 Construction industry level
1.4 Insurance industry level
1.5 FRe manufacturers level
1.6 Professional association level

2. Capacity Building on the local scale

2.1 City Government and municipal level
2.2 Educational institution level
2.3 Non-Government organisation level
2.4 Individual property owner level

The following paragraphs describe capacity building efforts that can be implemented on each of those levels and make recommendations for the future.

1. Capacity Building on the national level

1.1 Capacity Building on the level of EU Member countries and the US

The question put forth was how national laws constrain the implementation of FRe and what opportunities are being offered. It can be generally said that Southern EU participants are making efforts to meet the requirements of the Floods Directive (FD). Northern participants, in this case the UK and Germany, do that also but go beyond basic requirements, particularly in respect to property-level flood resilience measures.

Laws in Spain, Cyprus and Greece do not encourage the practice of FRe. The Spanish contribution reported that Royal Decree 903/2010, Article 11.4 states that "Flood risk management plans shall encompass all the aspects involved in the management of the risk of flooding," which is more comprehensive than past laws and programs. In Greece, legislation does not fully harmonise with European legislation yet, but relevant ministries are taking actions to implement FD related programs. There are small variations in regional programs in Spain. In Cyprus regions with separate laws and programs do not exist. Constraints to the implementation of FRe technologies put forth by the Spanish contribution are a lack of experience and governmental expertise on the regional level. In all three Southern countries past laws and programs had concentrated on traditional flood defence.

Catastrophic flood events in the UK (2007) and in Germany (2002, 2005) preceded the passage of the FD and set an early stage for laws and programs that made attempts to be more comprehensive. After the 2007 flood, the UK Government followed a Pitt recommendation, passing the Flood & Water Management Act (2010). There are also Flood Risk Regulations (2009). The Flood and Water Management Act of 2010 requires the Environment Agency (EA) to "develop, maintain, apply and monitor a strategy for flood and coastal erosion risk management in England". Every planning application for land use is required to file a Flood Risk Assessment (FRA). The EA is offering guidance through a document (*Prepare Your Property for Flooding)*, and through a technical document on groundwater flooding.

A 2002 flood set the stage for an effort in Germany to revise water laws and to implement flood defence strategies, leading to the 2005 Federal "Act to Improve Preventive Flood Control" preceding the Floods Directive. After passage of the FD its implementation in Germany was facilitated through the 2007 Federal Regional Planning Act, the 2007 Federal Building Code, and through the 2009 Federal Water Resources Act.

In both the UK and Germany, private and municipal investments in FRe measures are constrained by the perception that flood defence is the responsibility of the State government. In Germany, this perception was deepened by the generosity of the federal, state, and private disaster relief, which in the past permitted reconstruction of flood damaged properties without implementation of FRe technologies. This will hopefully change in the future as the German 2009 Federal Water Resources Act for the first time requires that individuals take protective measures on their own to guard against risks, to lower flood losses, and to adjust uses of flood-prone properties. The mapping of flood-prone areas has been made mandatory. Both the UK and Germany have supplemented the Floods Directive with additional programs. In Germany, the States of Rhineland Pfalz and Baden-Wuertenberg, have developed knowledge partnerships for risk assessment, awareness, damage reduction, and emergencies.[22] These are examples of the vertical integration of programs (see Figure I.1-1).

The Washington D.C. case study illustrates two advances that have been made in the US. Both address flood risk management on the property-level. The first advance is flood proofing of individual structures, and secondly there are stormwater Best Management Practices (BMP's) on the property level to lessen run-off volumes and peaks, and to reduce run-off pollution. Both are required through regulations and supported by technical assistance programs offered by units of government. Equivalents to the EU Floods Directive in the US are the Flood Control Act of 1932 and its amendments. The US counterpart to the Water Frameworks Directive is the Clean Water Act of 1972. The early passage of both laws gave the US a considerable time advantage in experimenting with implementation approaches and in defining programs under public participation.

The US Corps of Army Engineers (USACE) has assisted in the practice of elevating and flood-proofing (dry or wet) since the 1930s. A report "Flood-proofing Regulations" was initially published in 1972, addressing permits; inspection; waterproofing; structural requirements; closure of openings, walls, buildings and structures; and protection of electrical and mechanical facilities. It puts forth minimum building safeguards "regulating and controlling the design, construction, and quality of materials". The National Flood Insurance Program (NFIP) makes communities eligible for flood insurance only when they practice floodplain zoning, restricting floodplain uses and requiring that new structures be elevated to a level above the 100-year frequency flood and flood-proofed. Flood Risk Management Programs by the Federal Emergency Management Agency (FEMA) put forth flood damage resilient design standards calling among others for pre-construction flood-proofing certificates, detailed plans, elevations and design details. FEMA requirements and certification cover flood warning time, safety and access, evacuation routes, flood velocities and flood depth, and flood emergency operations planning. It keeps a continuously updated website with a description of programs, guidelines and regulations for flood-proofing.[23] Stormwater management through the Clean Water Act has led to the systematic lessening of storm run-off through surface management, retention and infiltration, run-off detention and slowed release at pre-development rates, creation of wetlands and the restoration of streams. This is being achieved through stormwater management ordinances, making practices mandatory.

These US achievements are not without critique. During recent flood events National Flood Insurance reimbursements (with low premium incomes) and Federal Disaster Relief have repeatedly exceeded budgetary capacities and required additional funding through acts of Congress. There have been calls for more integrated flood risk management that would involve the public in "on site flood risk management" and give owners of floodplain properties a higher financial share in mitigation. It has been stated that it would be in the interest of the US to formulate a new strategy on flood resilience. The fact that several programs already exist and a currently dysfunctional US Congress make such actions unlikely.

[22] Deutscher Städte- und Gemeindebund (DStGB) Vorbeugender Hochwasserschutz – eine Querschnittaufgabe von Bund, Ländern und Gemeinden, 2010

[23] www.fema.gov/plan/prevent/floodplain/.../floodproofing.shtm accessed 9/18/2011

A comparison between the US and the EU shows differences in capacities, performance and levels of engagement, with the US having an advance, due to longer experience in implementing laws and programs that were formed much earlier than in the EU. There are also great differences in the implementation of the FD between EU member countries, with Northern countries showing a higher level of engagement than Southern countries. EU Member countries have a considerable amount of discretion in how they want to implement EU directives. Unfortunately, there are sizable differences in implementation having led to reports in literature about an "implementation gap" and "pathology of non-compliance" in some EU countries.[24] [25]

EU directives like the Water Framework Directive and the Floods Directive set, as the term implies, a framework that needs to be filled with content by the countries involved. There is however a tendency in member countries to establish minimalist aspects of the law as checkpoints to be marked off as "mission accomplished", rather than establishing substantial programs to implement the intent of the Floods directive. The FD is a substantial endeavour and a sister directive to the Water Framework Directive (WFD) using the same units of management (river basins), an identical six year cycle of planning, and a requirement to coordinate implementation of the two directives. To combine that with property level FRe measures to combat the effects of climate change is a task big enough to warrant national attention.

It is therefore recommended that EU Nations sponsor conferences bringing together experts to focus media attention on solutions to problems that require a transformation of institutions and planning processes. Funds spent in information and knowledge- development and dissemination are bound to generate benefits many times the value of the money invested. It is further recommended that R & D funding and accreditation of FRe products be conducted on a national level.

1.2 Capacity building on the level of regions and states

Within EU countries there are regions and states with an independent layer of government. Examples of such independent regions are the individual states of the US; England, Wales, Northern Ireland and Scotland in the UK; the Basque Region in Spain; and Saxony and Bavaria in Germany. In Cyprus and in many other Southern EU countries such a division does not exist. Regions with separate levels of government offer the benefit of representation and capacity building by additional layer of government. States in the US, the UK and Germany have conducted studies and issued publications that advocate the benefits of property-level and owner implemented FRe measures.

In the UK a commendable effort is being made. In England, the Flood and Water Management Act of 2010 requires that every planning application for land use file a Flood Risk Assessment (FRA). The Environment Agency (EA) is offering guidance through a document (*Prepare Your Property for Flooding)*, and through a technical document on groundwater flooding. The UK publication "Flooding: Engineering Resilience"[26] offers technical advice.

[24] Barnes, P.M, and Barnes, I. Environmental Policy and the European Union, Edward Elgar, Cheltenham, 1999

[25] Jordan, K. Environmental Policy in the European Union: actors, Institutions and Processes, Earthscan, London, 2002

[26] Ashley, R. et al. Pennine Water Group, Flooding: Engineering Resilience, Sheffield, for the Institution of Civil Engineers, 2008

In Germany, the Ministry of the Environment of the State of Saxony is now placing emphasis on measures taken by individual property owners (Eigenvorsorge)[27] to reduce flood risks. Information is communicated through websites, brochures and publications. An "Information and Advise Centre for Flood Resilience" was formed in Rhineland Pfalz in 2010, constituting a voluntary alliance of municipalities[28] which become voluntary members and exchange information. The information centre can further issue documents, host exhibits and provide information over the Internet.

German region-states are utilising the Internet to inform about flood risks through maps and by offering information about FRe measures. Special educational movies and slide shows can also use the Internet. Starting in the 1990s States here began issuing Best Practice Documents (Hochwasserfibel[29]) available over the Internet, describing and illustrating examples of flood risk management including flood-proofing steps that municipalities and homeowners could take. An example is the State of Nordrhein-Westfalen, having issued a manual on flood proofing.[30] The State of North Rhine Westphalia has issued an advisory report on FRe techniques including flood-proofing and construction materials on floodplains to be used at the city planning scale including matrices of measures to be used for new developments and for the retrofitting of existing developments[31].

In some places, such as Dresden, exemplary installations have been made that can function as a model for potential users. Another exemplary project with funding by the State of Saxony was a historic preservation/urban design project for flood proofing the centre of the City of Grimma, Saxony along the flood prone Mulde River.[32]

Some States have advised municipalities to assist property owners in the preparation of "building passports" for individual structures that contain information relevant to flood management including location, age, entranceways, cellar-floors, groundwater level, drainage, water supply, gas, oil, electric, and levels of past flooding. When buildings are being sold this information would be available to the new owners.[33]

States in Germany, under multiple funding are carrying out exhibits and fairs. An example is the International Construction Exhibit (IBA) and International Garden Fair (IGA) and State Garden Fair (Landesgartenschau). Currently, an IBA in Hamburg Wilhelmsburg is featuring Floatable housing as a FRe measure. State governments are conducting planning studies required by the Floods directive and carry out flood abatement project after major floods. States could pass a "Flood Resilience Policy Objective" and

27 Freistaat Sachsen, Staatsministerium fuer Umwelt und Landwirtschaft. – Hochwasser geht uns alle an! Hochwassermanagement im Freistaat Sachsen. 2013

28 Deutscher Städte- und Gemeindebund (DStGB) Vorbeugender Hochwasserschutz – eine Querschnittsaufgabe von Bund, Ländern und Gemeinden. 2010

29 Hochwasserfibel – Bauvorsorge in Hochwassergefährdeten Gebieten. Ministerium für Umwelt, Raumordnung und Landwirtschaft des Landes Nordrhein-Westfalen, 1999

30 Hochwasserfibel – Bauvorsorge in Hochwassergefährdeten Gebieten. Ministerium für Umwelt, Raumordnung und Landwirtschaft des Landes Nordrhein-Westfalen, 1999

31 Hochwasserfibel – Bauvorsorge in Hochwassergefährdeten Gebieten. Ministerium für Umwelt, Raumordnung und Landwirtschaft des Landes Nordrhein-Westfalen, 1999

32 Will, T. J.T. Tourbier. Forschungs- und Entwicklungsprojekt "Städtebauliche Einordnung des Hochwasserschutzes für Grimma, - integrierte landschafts- und hochbauliche Fachplanung für einen nachhaltigen und denkmalverträglichen Hochwasserschutz". Für die Landestalsperrenverwaltung Sachsen, 2005

33 UN/ECE, "Best Practice Document "Best Practices on Flood Prevention, Protection and Mitigation" UN/ECE Athens, 2003

conduct competitions in which towns could participate to construct and evaluate to what extent flood resilience objectives are being achieved.

In the United States, most state governments have achieved the practice of stormwater management on the property level. The State of Maryland, similar to other US states internalises responsibilities for stormwater management, having those who cause problems pay for mitigation measures. In the Sligo Creek Area, the Maryland Stormwater Management Act of 2007 and its "Design Manual" with 2009 revisions, establish guidelines for "Environmental Site Design (EDS)".

Questionnaire respondents in all participating countries answering to various type questions pointed to a general lack of knowledge about FRe measures. It has been recognised early that best practices of risk management should be defined in manuals. As early as 2003 a "Best Practice Document" on flood risk management was issued (EU UN/ECE, Section H).[34] Property-level flood risk management requires that stakeholders be educated about measures. The first steps taken in the US to initiate stormwater management in the 1970s were the development of Best Management Practices (BMP) manuals on a state-wide basis. They will be essential for learning alliances between stakeholders and planners. Planners will increasingly need to communicate ideas through a learning process, leading to recognition of risks and risk reduction, gaining public confidence and winning consensus among stakeholders.

It is recommended that Region-State governments publish FRe manuals and construction handbooks that relate to geographic, demographic and political characteristics of regions and offer information dissemination to build social capacity for stakeholder participation. In light of the increasing impacts of flood events and currently shrinking budgets of governments it is opportune to maximise benefits through multiple use planning, combining water quality (WFD) and volume control (FD) in facilities built. Region-State governments should develop FRe demonstration shows in conjunction with garden fairs as a competition among professionals, offering prizes, and constructing demonstration projects. Media coverage of competition, prizes, and festive openings of fairs would assist in the dissemination of information. Region- State governments should further establish "Flood Resilience Information and Advice Centres" to inform the public about flood risk management options, to exhibit demonstration projects and to place policy directives, advisory documents and Decision Support Systems on the Internet.

1.3 Capacity building on the construction industry level

Cities like New York in the US are considering codes to require retractable flood barriers, floodgates in building openings and other flood-proofing devises for new structures, but have not yet passed such requirements. Ben Chu, a water-policy analyst of the Natural Resources Defence Council noted that there is concern about angering developers.[35] The National Association of Home builders (NAHB) who represent the housing industry in the US, states in their *Policies for Environment*[36] that their priority is "housing affordability, availability and choice" and that regulations "while well intended often impact on availability by increasing the cost of homes and reducing the supply of land and materials for homes or both". In the US, the construction industry is a powerful lobby, and developers usually take the initiative when it comes to new development.

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34 UN/ECE, 2003 - Best Practice Document "Best Practices on Flood Prevention, Protection and Mitigation" UN/ECE Athens, 2003

35 Navarro, M. New York is Lagging as Seas and Risks Rise, Critics Warn. The New York Times, 9/11/2012

36 http://www.nahb.org/reference_list.aspx?sector accessed 8/4/2012

New construction in flood prone areas will however not be eligible for flood insurance unless flood-proofing measures are applied. When stormwater management BMP's were required by code the construction industry was pacified with the argument that such regulations were applied equally, and that as a result no competing developer was enjoying an undue advantage.

The Spanish response to the questionnaire states "A mandatory use of FRe technologies that increases building costs will not be seen favourably" .The Greek response though, sees FRe technologies as a challenge and an opportunity for new jobs in the construction industry.

In Dresden Kleinzschachwitz, Germany, and its lowlands the flood proofing of individual structures is an opportunity. FRe measures are services that offer new and additional profit opportunities. FRe practices permit mitigation of flooding, opening up sites to development that would have otherwise been unsuitable. This is particularly applicable to urban centres and historic districts that have traditionally concentrated along waterfronts. In other cities, such as Hamburg, Germany such building codes have been passed and are being accepted by the development industry as a price to develop in HafenCity Hamburg[37], a privileged waterfront development district in the city centre. Codes require elevated emergency access roads, elevated catwalks for building evacuation and permanent floodgates on structures, among others. HafenCity and Wilhelmsburg Hamburg had experienced catastrophic historic floods. Their memory has been kept alive in the public conscience by city agencies. Procurement of building designs in HafenCity takes place through competitions that call for flood-proofing measures.

For the UK it was reported that some members of the construction industry view FRe measures as a commercial opportunity. The subject however is not yet mainstream. Opportunities lie in the use of the recently published BRE Digest (Garvin, 2012).[38] There also is the opportunity to expand energy efficiency requirements and ECO funding through the Energy Act of 2010 to include climate change adaptations to cover FRe. In the UK, there has been a considerable initiative through the "Construction Industry Research and Information Association (CIRIA)" which is advocating Sustainable Drainage Systems (SUDS) and sustainable development through news announcements, research and project initiatives, publication releases, conferences, events and training sessions.[39]

Historic city centres developed along waterfronts for water, energy and transportation. Waterfronts such as Georgetown in Washington D.C.; Sydney, Australia; Boston, MA; Rotterdam, Holland; and HafenCity Hamburg, Germany continue to be prime real estate. Flood-proofing provides the technology that expands the availability of land for development. FRe thus is highly desirable to the construction industry. Under these circumstances special building codes such as those issued for HafenCity Hamburg[40] and voluntarily practiced for waterfront development in Georgetown in Washington DC, will most likely be accepted by the construction industry.

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37 Landesbetrieb Strassen, Bruecken und Gewaesser, Freie Hansestadt Hamburg. Informationen zum Flutschutz in der HafenCity Hamburg. Stand: 22.12.2009

38 BRE Digest 523, Flood resilient construction, Parts 1 and 2, (2012), brebookshop.com.

39 CIRIA's Flood resilience and resistance for critical infrastructure http://www.ciria.org/service/knowledgebase/AM/ContentManagerNet/ContentDisplay.aspx?Section=knowledgebase&ContentID=15520 http://www.ciria.org/service/ciria/_news/AM/ContentManager/ContentDisplay.aspx?Section=ciria_news&ContentID=22763 accessed 9/11/2012

40 Landesbetrieb Strassen, Bruecken und Gewaesser, Freie Hansestadt Hamburg. Informationen zum Flutschutz in der HafenCity Hamburg. Stand: 22.12.2009

Initiatives such as those taken by the “Construction Industry Research and Information Association (CIRIA)” of the UK are commendable as a capacity building effort and should be actively pursued in all member countries of the EU.

Uniform building codes, applicable to all sites subject to inundation by a 100 year frequency storm should be passed to be applicable equally to all developments on such sites.

1.4 Capacity building on the insurance industry level

The insurance industry has opportunities for capacity building through policy provisions, and through financial incentives in premiums charged. All questionnaire participants, except for the US, reported that the insurance industry limits the application of FRe by providing insufficient incentives for their utilisation. A study by the University of Manchester [41] found that the better the flood insurance coverage, the lesser the incentive for the practice of flood resilience measures. In France, the Netherlands, and Spain readily available insurance and low premiums were seen as a deterrent to the practice of FRe.

In the UK, a “no betterment” clause prevents insurance companies from offering after claim assistance in the financing of FRe products. Insurance companies have serious problems with FRe, due to lack of trust in products, concerns about on-going maintenance, quality of installations, and the ability of homeowners to use measures correctly. Flood coverage as a standard feature for households and small business in the UK is most likely to change. An Association of British Insurers (ABI) statement of principles notes that standard flood coverage will only extend until 2013, and not be renewed unless government increases the amount of money for flood protection. This cancellation is most likely to happen. As a consequence there will be a serious impact on availability and cost of flood insurance.

There are opportunities for improvement. UK insurers could use the excess/deductible of their policies to share risks with the insured, providing an incentive for the use of FRe. The insurance industry could also become pro-active, assisting in the development of products, and work with banks and mortgage providers to encourage FRe uptake and could jointly, with government and utility companies, kick-start schemes to protect groups of structures. They could also share confidentially held data about past flood events. The ABI has made a good start; publishing two reports about flood resilient repairs and resistance measures

In Germany, insurance companies also are not very effective in encouraging awareness of flood risks, and in pro-action to mitigate losses. The insurance industry there provides little or no incentives to those policyholders who implement flood proofing and other flood resilience measures.

It is in the interest of the insurance industry to reduce flood losses and related claims. This holds particularly true at a time of climate change and ever increasing frequency and intensity of flood events and related high losses. Insurance industry reinsurers (Rueckversicherung) are expected to take initiatives in the future

In the US, the “National Flood Insurance Program” (NFIP) provides remarkable incentives for the practice of FRe. A 2009 study published in the University of Miami International and Comparative Law Review however, found that the NFIP is doing better than flood insurance programs in the UK, France, Germany and the Netherlands. This is because the NFIP actively aims to share the burden of flood risks between individuals, insurance companies, and the Government. It denies coverage to municipalities that do not

[41] Lawson, Nigel, The Insurance Industry, unpublished paper, University of Manchester, 2011

practice flood risk assessment, enact building restrictions (floodplain zoning) and encourages flood proofing of structures.[42]

The NFIP further offers building standards. It offers a Community Rating System (CRS) that gives credit points for community activities that: (1) reduce flood losses, (2) facilitated an accurate risk rating for insurance purposes, and (3) promote an awareness of the availability of flood insurance. Communities are being evaluated and placed into a CRS class between 1 and 10, with class 10 receiving the largest premium reduction (amounting to a 45% premium reduction).

Homes built in compliance with NFIP building standards have been found to suffer less flood damage than those who did not follow such standards. In a study, the Multi-hazard Mitigation Council found that each dollar spent on mitigation saves society an average of four dollars.[43]

Residents of the Sligo Creek basin in the Washington DC case study area received a 25 % reduction in flood insurance rates. This has been made possible, because Prince George's County in the US State of Maryland participated in a program by NFIP designed to encourage and recognise community floodplain management efforts. Most of the 1200 communities who participate are in the Class 8 and 9 categories, receiving a 5-10 % premium reduction. A community in the Class 1 would receive a 45% premium reduction.

In Spain, a state controlled consortium of 50% insurers and 50% State (the "CONSORCIO") has set up a fund for flood insurance. Policies and insurance rates consider predicted risks of flooding for the country as a whole.

The Cyprus contribution points out that FRe should be seen as a system that requires proper implementation, maintenance, and operation. Such a system does not yet exist and is not yet recognised by the insurance industry. The Greek contribution holds that future insurers may encourage FRe, but only after measurable benefits have been demonstrated.

Private insurance companies in EU countries view themselves as a business only, but should be encouraged to include stewardship for risk reduction into their future programs (advertisement, policies, premiums and compensation payments). Insurance companies should provide more incentives for the practice of FRe, provide information about property-level installation and "become pro-active" in the development of FRe products".[44] This would be in their own interest, as flood losses are bound to rise with climate change.

1.5 Capacity building on the FRe manufacturers level

FRe manufacturers are taking a risk in the hope of future profits. Concern about this risk is particularly pronounced in Southern EU countries. In Cyprus it was pointed out that there is a lack of suppliers/manufacturers of FRe technologies. There is a limited demand and practically no supply, particularly as the island has no tradition of technology manufacturing. Similarly there is little demand in Spain where it was pointed out that if FRe measures were more widely specified in project plans, there

[42] Toothill, J., N. Catford. "Flood management in Central Europe" RISKTRANSFER, Magazine Volume 2, Issue 5, Oct. 2004

[43] http://www.fema.gov/business/nfip/crs.shtm

[44] Lawson, Nigel, The Insurance Industry, unpublished paper, University of Manchester, 2011

would be more opportunities for their manufacturers. In Greece, limitations are being seen in a lack of initiative, financial limitations, limited responsibilities and red tape.

In the UK, FRe technology manufacturing is a relatively new industry with generally small or medium sized enterprises. Up-front test and certification of a FRe product will cost a minimum of £ 30,000. Certification of measures has been conceived as a way to winning public trust for FRe measures. Flood protection products that keep floodwaters from entering buildings are being awarded a British Standards Institute (BSI) Kitemark after complying with requirements for designation, testing, factory production control, installation documentation and marketing for different types of flood protection products.[45] The related PAS1188 refers to groups of measures as a: (1) Building aperture product; (2) Temporary products; (3) Building skirt systems; and (4) Demountable products. A British manufacturer has estimated that additionally for every £1 spent on product development and certification, £10 needs to be spent on marketing. Manufacturers have pointed out that current government practices to permit floodplain development without doing anything to protect buildings is a problem. It is being felt that requirements for FRe should be aligned with the granting of building permits.

The UK government is also creating opportunities for FRe products, by providing grants for their use. A property level flood protection grant scheme (£ 5.6 million) has been set up to assist properties in areas of high flood risk that do not benefit from community level defences. It provides up to £ 7,500 for the costs of FRe measures per household.

In Germany, FRe technology manufacturers range from giants, like Thyssen Steel of the Ruhr Valley, to upstart companies in Dresden using plywood and plastic sheeting. A wide range of FRe products on the market demonstrates that German manufacturers see export opportunities. A lack of uniform building codes for flood proofing though constrains domestic sales, and so is the reluctance of the insurance industry to reduce flood insurance premiums for individuals who install measures on private properties.

Paragraph 5, Section 2, of the German 2009 Federal Water Resources Act, that requires that individuals take measures on their own to lower flood losses offers opportunities for the manufacture of FRe. The “Plan Hochwasservorsorge Dresden” offers aid, having produced a flyer and web page outlining measures for individual property owners. Temporary and demountable flood barriers (through State funding) at various locations in Dresden help to showcase FRe technologies.

In the US, the “National Flood Insurance Program” (NFIP) offers financial assistance for the implementation of flood-proofing measures as “Increased Cost of Compliance”, paying up to $30,000 toward the cost of making an insured structure compliant flood-proofing is required. This illustrates how government funding can aid the manufacturing of FRe products.

As flood events increase with climate change, it is in the interest of US and EU governments to encourage the manufacturing of property- level flood abatement measures that can be purchased and installed by private property owners. Grants by the EU government and by the insurance industry should fund the development and manufacturing of temporary and demountable flood protection measures, partially- and fully pre-installed barriers, floodgates and other FRe. This should involve fully automated (smart) and semi-automated measures. Locally developed and installed measures tend to be best adapted to meet the special needs of different European countries. R&D funding and accreditation for FRe products should be assisted by national governments to help to overcome reservations held by property owners and the insurance industry.

[45] http://shop.bsigroup.com/en/ProductDetail?pi accessed 9/17/2012

1.6 Capacity building on the professional association level

Members of professional associations, particularly “built environment associations” are involved in the practice of FRe. In addition, there are professional associations of doctors, accountants, merchants, and businessmen and other professional groups who yield great influence in local decision-making. Their members may not design a flood control scheme, but may equally importantly decide on the type of flood risk management a community chooses. These groups should be carefully scrutinized in a stakeholder analysis and be subject of a capacity building process.

Flood risk assessment and management planning will bring together a wide range of professional groups: civil engineers, city planners, architects, landscape architects, economists, social and behavioural scientists, public health specialists, commercial interests, lawyers and other professional organisations, and resident- and interest groups organised in NGO’s.[46] Professionals such as civil engineers, city planners, architects and landscape architects are increasingly the leaders and mediators of flood risk management teams. This requires skills in mediation, which need to be acquired. Professional associations can communicate those skills by offering special courses.

There is a need for risk communication and more knowledge exchanges through professional bodies and membership based societies by hosting meetings and conferences. In addition, there should be continuous teaching and learning opportunities on the professional level specifically aimed at urban flood risk management. The Best Practice Document [47] (UN/ECE 2003) already pointed to a need for education and exchange of knowledge and Advanced Study Courses (ASC) on topics related to flood management and “training for professional engineers, scientists, technologist, economists, ecologists” as well as professional bodies that require an annual program of Continuing Professional Development (CPD) as part of a registration.

Civil engineers, architects, landscape architects and spatial planners are registered, or licensed and are members of professional associations. Without such license and membership they are not permitted to practice. This is the case in Southern and Northern EU countries and in the US. It has been recognised that issues, subject matter and educational content changes over time. It is for this reason that professional associations have initiated continuous education programs. In order to remain registered members have to attend a set minimum of daylong continuous education classes. FRe should become a required course.

In the UK, the Association of British Insurers (ABI), and the Royal Institute of Chartered Surveyors (RICS) promote usage of FRe. The Royal Institute of British Architects (RIBA) developed a guide “Design for Flood Risk” aimed at architects, urban designers and landscape architects. Other associations such as flood risk management consultants, the utility industry and fire services could be encouraged to promote FRe. If FRe became a mandatory consideration professional associations would have to take it into account.

In Germany, it has been reasoned that professional associations have an obligation to keep their members informed about advances in their field, such as FRe, and if they neglect to do so are hindering applications indirectly, implying that such measures are not worthwhile. The DWA Sachsen/Thueringen,[48] with its office in Dresden, is offering courses in preventive flood risk management since 2008. This includes modules on

[46] Tourbier, J.T., Ashley R.M. Aquaterra Conference, “Integrative Teaching and Learning Modules for the Application of On-Site Urban Flood Resilience Planning”. Amsterdam, pp. 85-102. ISBN 978-3-937693-06-8, 2007

[47] UN/ECE, “Best Practice Document ”Best Practices on Flood Prevention, Protection and Mitigation” UN/ECE Athens, 2003

[48] DWA Deutsche Vereinigung fuer Wasserwirtschaft, Abwasser und Abfall e.V. Landesverband Sachsen/Thueringen

(a) theory and (b) practice. They are designed for a class size of 10-20 participants.[49] Other professional associations, such as the Chamber of Architects [50] of Saxony have offered courses on the innovative protection of drainage courses and soil bioengineering. A further group is the State Work Association Water (LAWA).[51]

In the US, it has been recognised that it is essential for professionals to enrol in continuous education courses. The American Society of Landscape Architects (ASLA) has offered courses and lectures on stormwater management for credit points to be accumulated. [52] The American Society of Civil Engineers offers courses on property-level stormwater management including instructions on computer software to size detention basins, infiltration beds and conveyance.

In Spain, professional associations are considered to be neutral, as they are not hindering application of FRe, and presentation of the results of SMARTeST is viewed as a possibility.

In Cyprus designers of purpose built FRe construction must be registered with the Cyrus Chamber of Professional Engineers (ETEK). There is no hindrance and no special courses.

For Greece the concept was considered not applicable.

It is recommended that professional associations of civil engineers, architects, landscape architects, city planners and other professions related to flood risk management that require member participation in a program of Continuing Professional Development (CPD) offer a course on FRe. It is further recommended that flood resilience be addresses in professional association meetings and conferences.

2. Capacity Building on the local scale

On the Local Scale constraints and opportunities are being considered as follows:

2.1 Capacity Building on the city government and municipal level

City and municipal governments usually hold “home-rule” powers concerning land use and building codes. They often administer a detailed review and approval process that involves details of construction and performance of a proposed development and have a significant ability to influence the use of FRe. In Northern EU countries (and in the USA) city governments and municipalities hold the key for the implementation of FRe technologies and have the “power to deal”, establishing conditions for issuing a building permit.

In countries with “home rule power” cities and municipalities are free to adopt their own rules concerning land use and flood risk management. This is a benefit when a city has educated and honest decision makers who realise the benefits of flood resilience, rather than reliance on outdated flood defence. It has been recommended to formulate learning coalitions of stakeholders to facilitate implementation of flood risk

[49] www.dwa-st.de (Menuepunkt Kurse)

[50] Architektenkammer Sachsen, Dresden

[51] Länderarbeitsgemeinschaft Wasser (LAWA) “Hochwassergefahr, Vorbeugen, Schäden vermeiden”, Berlin 1996

[52] ASLA annual meeting San Francisco, CA, Oct.8. 2007. J.T. Tourbier course “Sustainable Drainage and Flood Control”.

management planning, placing the planner into the role of mediator. It is only through such awareness and participation that citizens will support flood resilience planning projects, understand that they may need to take their own flood prevention measures and learn how to act during flood events. Unfortunately citizens are accustomed to flood control being the responsibility of government agencies acting primarily on technical merit. The new EU directives widen areas of concern for flood risk management to include nature protection, recreation and management of land use that relate to a wide range of public interests. Flood risk assessment and management planning will further bring together a wide range of professional groups that are related to land use questions and resident- and interest groups organised in NGO's.[53]

The so called "home rule power" is not the case in some Southern EU countries where centralised government prevails. The Cyprus case study[54] reports that here land use and building codes are being set on the national level, giving municipalities only the duty to enforce and implement them. Spanish city-regions such as Valencia yield considerable power. Some of Valencia's local councils have used their "administrative power to bargain" calling for special FRe measures before granting building permits. General Valencia's Regional Government Regulations are looking for "adaptations in buildings and infrastructures at flood risk". There is a call for the granting of financial aid and the development of technical norms for buildings and for the protection of infrastructure from defined frequency storms (PATRICOVA, Section II, Articles [25; 29]). For example, roofs must be accessible from the inside. Major garages may be asked to have low-level floor obstacles and there are meant to be signs with warnings of flood risks. Additional special conditions can be imposed as deemed fit.

In the UK, efforts are being on the city planning scale to overcome a combination of factors to the practice of FRe (lack of acceptance by insurers, trust in performance, insufficient funding). In Heywood, the Manchester case study, about 50% of properties affected by the 2004 and 2006 storms received grants for flood-proof doors, non-return valves, pumps, automatic airbrick covers and flood resistant coatings. Grants were primarily received in areas most able to lobby local politicians. Finances were obtained through a 2007 UK, £5.6 million grant for property level resilience measures. In 2013, Heywood received a £250,000 grant for two years, focusing on capacity building. The Department for Environment, Food and Rural Affairs (Defra) has provided £5million to fund thirteen communities across England to research and develop innovative projects.[55]

In Dresden, Germany catastrophic flood events of 2002 and 2006 led to much soul searching by its City Council. In 2004 it decided to embark on a long-range "Flood Control Plan"[56] that included a component of flood-proofing through property owners [57], stakeholder information, and flood warning and planning for exceedence flows in sewers. Measures planned, and partially implemented, along the River Elbe have a cost of 79.6 million EUR.

Flood-proofing through property owners is being advocated through brochures and the Internet. Stakeholder information has been expanded into a stakeholder capacity building program with learning alliances. In 2009, the City Council decided to initiate a participatory stakeholder involvement process for

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[53] Tourbier, J.T., Ashley R.M. Aquaterra Conference, "Integrative Teaching and Learning Modules for the Application of On-Site Urban Flood Resilience Planning". Amsterdam, pp. 85-102. ISBN 978-3-937693-06-8, 2007

[54] Toumazis, A. Cyprus Case Study

[55] See the website "The Communities and Local Governments Guidance on Flood Resilient Construction" www.planningportal.gov.uk/uploads/br/flood_performance.pdf

[56] Landeshauptstadt Dresden, Geschaeftsbereich Wirtschaft, Umweltamt. Plan Hochwasservorsorge Dresden, in progress

[57] Bauvorsorge und Objektschutz durch die Eigentuemer

planning District 17 that includes Kleinzschachwitz.[58] A document [59] describes the process in a summary of protocols, diagrams of design options and related correspondence. The stakeholder process started in 2010 [60] involving about 200 participants formulating goals, defining tasks to be completed, and formulating concepts.

It has been found to be advantageous when cities exchange information. The German Association of Cities and Communities reports that some municipalities are forming partnerships to meet flood risks. A good example is a communal Flood Risk Partnership of Baden-Wuertenberg and a voluntary alliance of municipalities concerning flood risks that formed in Rhineland Pfalz in 2010.[61]

In the US Washington D.C. case study area, FEMA and the National Flood Insurance Program (NFIP) actively support local efforts. In fiscal year 1995 alone Prince George's County provided funding for the acquisition or flood-proofing of 23 homes at a cost of $ 2.7 million.[62] Between the mid-1980's and 2005 a total of 62 residences have been flood-proofed with Prince George's County funds, primarily through site grading and floodwalls around entrances. Almost all flood-proofing projects have received some form of public/financial assistance. The Anacostia Watershed Restoration Partnership prepared the 2008 Sligo Creek "Provisional Restoration Project Inventory ".[63] One of the objectives is the reduction of stormwater flows and associated pollutants. 87 property-level stormwater management measures already existed in the Sligo Creek basin at the time of the beginning of that project in 2007.

Flood-proofing is being advocated by local planning agencies, but is not very popular with property owners. With FEMA funding, Prince George's County, MD offered flood-proofing assistance to about 90 commercial properties. Only about a dozen took advantage of this offer. At the SMARTeST Washington DC Workshops FRe hindering forces were listed as old school attitudes; lack of understanding; public education; public acceptance; institutional barriers; inflexibility of the NFIP; lack of funds or willingness to pay.

EU directives see stakeholder identification and stakeholder participation as a component of the planning process, not to be the "after the fact" public participation review of completed plans as practiced in the past. Instead, stakeholders should be involved, starting with the definition of goals and objectives up to the formulation of a plan and post project evaluation of outcomes. [64] A prerequisite for capacity building with stakeholders on the city and municipal level is public education and a realisation of benefits. Public participation requirement of EU directives are still a novelty and a challenge for most EU countries and the agencies involved. It is however also an opportunity for the preparation of better plans and for a more likely implementation.

Most cities and municipalities do not know their level of preparedness for flood events. It is recommended to apply the SMARTeST indicator of success Matrix to define their flood risk management priorities and to

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58 Landeshauptstadt Dresden, Geschaeftsbereich Wirtschaft, Umweltamt. Plan Hochwasservorsorge Dresden, Betrachtungsgebiet 17, Zschieren, Leuben, Laubegast. Stand 06. 2011

59 Dresden – Laubegast Leben mit dem Fluss, Beteiligungsprozess zur Vorbereitung von Massnahmen zum Schutz vor Hochwasser der Elbe, Positionen und Empfehlungen, Ergebnisdokument, 30.05.2011

60 www.urbaneprojekte.de.download/806/download/ accessed 3/20/2013

61 Deutscher Städte- und Gemeindebund (DStGB) Vorbeugender Hochwasserschutz – eine Querschnittsaufgabe von Bund, Ländern und Gemeinden. 2010

62 http://www.princegeorgescountymd.gov/government/agencyindex/der/ppg/floodplains.asp accessed 6/20/2011

63 Galli, J., P. Trieu, A. Maynard, K. Choi. Department of Environmental Programs, Metropolitan Washington Council of Governments. Sligo Creek Subwatershed: Provisional Restoration Project Inventory, 2008, upgraded 2009

64 Ibid

evaluate their status. It is further recommended that communities form voluntary alliances and partnerships with other communities for the coordination of efforts such as flood warning and emergency programs, interpretation of flood risk maps, knowledge about FRe measures, public awareness as well as risk reduction through insurances and creation of financial reserves. On the city scale emphasis should be placed on learning alliances of stakeholders working with voluntary associations. Ad-hoc disaster relief seems an inefficient use of government funds. Instead communities should consider a strategy of flood resilience that involves private property owners in programs of flood preparedness. Foundation funding for community programs could become a form of life-saving philanthropy.

2.2 Capacity building on the educational institution level

The Cyprus reply noticed that educational institutions currently constrain the transfer of knowledge about the practice of FRe since coursework and textbooks concentrate on the design of networks of storm drainage systems for a given design storm. How to deal with situations where the storm exceeds design conditions is usually not being dealt with at the university level. The Spanish reply noted that at universities structural solutions under governmental control are being considered to be more effective than FRe products. In Greece, a lack of funding and structures for testing FRe practices was noted. Funded research projects, involving case studies, were felt to lead to dissemination of results. This, to a certain degree holds true throughout Europe and the US.

In the UK, the Environment Agency (EA) found that it has a problem in finding technically competent staff and has commissioned an engineering foundation degree in river and coastal engineering in partnership with a university. They have only had 120 students since 2004 and as such the EA are now seeking to address this poor rate of attendance.

Institutions such as the Chartered Institute of Water and Environmental Management (CIWEM), the Royal Institute of Chartered Surveyors (RICS) and the Construction Industry Research and Information Association (CIRIA) provide seminars on various aspects of FRe for which they issue Certificates of Continued Professional Development (CPDs) but these seminars do not necessarily address FRe in any depth.

The BRE Trust has funded the development of a course on flood resilient planning and construction aimed at those in both the construction industry and the flood management field. However, take up of the training has not been good. Low attendance is seen as a result of the refusal of government to implement Pitt Report recommendations on building regulations.

The German government encourages universities to establish a special profile. The Dresden University of Technology has conducted special activities in the practice of FRe and sustainable drainage. This involved the Faculty of Architecture, Institute for Landscape Architecture, having conducted special teaching and research seminars involving neighbourhood representatives, students and other faculties in Germany, Slovenia and the USA. The Faculty of Architecture also conducted a pilot project for the City of Grimma, including urban design of FRe measures and is currently planning an international conference on “Flood Protection and Heritage Conservation” in 2014. In addition the Department of Hydro-Sciences has initiated a Master’s program on integrated flood risk management with the name “Hydro Sciences and Engineering”. The program has a modular structure and is aimed at international students. The Leibniz Institute of Ecological and Regional Development (IOER) is highly active in flood risk management research. Conventional approaches continue to prevail, in spite of these efforts.

In the US, prominent educational institutions charge tuition of $ 30,000 to $ 60,000 per year (or higher). Prof. Dr Ritter of the University of Delaware, and adviser to SMARTeST, noted that students tend to select courses that permit them to graduate as soon as possible. Flood resilient technology still is at the fringe of future coursework. Stormwater management though has become an educational standard. An example is a textbook prepared by the Water Environment Federation (WEF, sponsor of the SMARTeST Strategic Workshop in Washington DC) and by the American Society of Civil Engineers (ASCE).[65]

Competition for student enrolment though entices universities to attempt to be on the forefront in research and course offerings. Stormwater management is part of the coursework offered at the University of Maryland and at other universities in Washington D.C. Computer based decision support systems can be a great help as a teaching tool. Over the last four decades US Universities have played a pivotal role in research, conferences, courses and seminars on flood topics. Flood catastrophes like the Katrina and Sandy events hopefully will bring flood resilience related education to the forefront.

The Best Practice Document [66] (UN/ECE 2003) already pointed to a need for education and exchange of knowledge, stating that the “integration of knowledge into graduate and post-graduate education programs is essential”. It further states that this should include Advanced Study Courses (ASC) on topics related to flood management and “training for professional engineers, scientists, technologist, economists, ecologists” and professional bodies that require an annual program of Continuing Professional Development (CPD).

Property- based stormwater management experience gained in the US showed that its practice lies primarily on the level of land use planning. The same applies to the practice of FRe. This means that it offers teaching and learning experience in the university fields of architecture, landscape architecture, city planning, regional planning, civil and environmental engineering, natural sciences and geography.

It offers particular opportunities for what has been called “urban design” involving the design professions in the enhancement of urban areas, shaping the infrastructure and built environment of urban areas. Urban design enhances downtown areas and improves the image of a city (Kevin Lynch) [67] while considering multiple uses. Flood defence structures in the past have had the tendency to be visually intrusive and aesthetically unpleasing. This does not need to be the case. There are many examples of functional urban design applications. After the 9/11 attacks in the US, Washington D.C. faced the need to incorporate structures against terror attacks into the city. It issued planning guidance to design security barriers against terrorism that promote vistas, open spaces, streetscape enhancement and public realm beautification.[68] Similarly FRe technologies can be made subject to urban design principles. It can involve hardened streetscapes such as knee walls separation barriers, balustrades, curbs, street dividers, retaining walls and landscaped earth forms acting as levies. Open spaces secured through soil-bioengineering techniques may be used as surface elements. Hardened urban parks with non-erosive surfaces, pedestrian ways, plazas, parking lots and raised minor roads can act as flood-ways to direct and convey floodwaters.

Urban design needs to incorporate strategic thinking about multi-functional approaches for natural disasters and stakeholder participation. It can engage students in problem-solving exercises that link concerns, systems and decision making tools to create a beneficial synergy where the sum turns out to be greater

65 ASCE, WEF, Design and Construction of Urban Stormwater Management Systems. New York City, 1992

66 UN/ECE, “Best Practice Document ”Best Practices on Flood Prevention, Protection and Mitigation” UN/ECE Athens, 2003

67 Lynch, K. Image of the City – Das Bild der Stadt. Braunschweig/Wiesbaden, 2001

68 Jon Coaffee, Paul O'Hare and Marian Hawkesworth. The Visibility of (In)security: The Aesthetics of Planning Urban Defences Against Terrorism. The John Rylands University Library, The University of Manchester, 2009

than the parts, permitting problem solving where expenditures can be written off to multiple uses, leading to money savings. Educational institutions should take a lead in conveying such information.

It is recommended that educational institutions integrate knowledge about FRe into graduate and post-graduate education programs for professions that relate to land use involving architecture, landscape architecture, city planning, regional planning, civil and environmental engineering, natural sciences, geography as well as scientists, technologist, economists, and ecologists. There further should be Advanced Study Courses (ASC) on topics related to flood management.

2.3 Capacity building on the NGO level

Non- Government organizations hold a key role in achieving flood resilience. Capacity building and social capital relate to personal development, organisational skills, and advocacy and leadership development in dealing with catastrophes on a social level.[69] It has been reasoned that the density and strength of social networks determine neighbourhood resilience after catastrophic events, rather than wealth, education, or culture.[70] It has been found that neighbourhoods that build social capital through civic and voluntary activities fare much better during catastrophes than those who do not. Thus, people power, not just physical infrastructure, should be the focus on enhancing resilience in the field of disaster recovery.

The Washington D.C. case study is an example of the power of NGOs. The Anacostia Watershed Society (AWS) sued the Washington D.C. Water and Sewer Authority (WASA) in 1999 for permitting untreated stormwater to flow into the river. WASA agreed in a settlement to invest $ 40 million in related improvement including public notices of overflows.[71] More than 10 voluntary and semi-public associations are active in the Anacostia River Basin. Through a combined effort they succeeded in having the Anacostia declared a model for the nation**.** The Anacostia Watershed Initiative Act of 2005' was passed by Congress as an amendment to the Clean Water Act as model of urban river restoration and stewardship. Under strong local involvement the Anacostia Watershed Restoration Partnership entered into a Federal cost-sharing agreement with the U.S. Army Corps of Engineers to prepare an Anacostia Watershed Restoration Plan.

NGO's are a primary political driver, seeing to it that state governments are doing their job. NGO's such as the Anacostia Watershed Society have been referred to in previous EU projects, demonstrating the use of the Internet to communicate the performance of government in achieving targets that it had previously set. Figure I.1-3 below shows a "performance meter" displayed on the Internet, showing an excellent, good, fair, or poor performance. Such a form of transparency through on-going-project evaluation is feared by insufficient governments and can be used to enhance a functional democracy.

NGO's develop social networks through meetings, social events, newsletters and other forms of communications. The Internet plays an important role in developing social capital. Social networking sites, such as Facebook, MySpace and Twitter create virtual networks that enhance communications.

A UK example of a successful NGO and flood victim support groups is the National Flood Forum (NFF) http://floodforum.org.uk/. The NFF is a charity run by flood victims, providing support and advice to communities and individuals. It is a successful lobbying group that emerged in response to larger-scale

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69 Linnell, Deborah. Evaluation of Capacity Building: Lessons from the Field, Washington D.C. Alliance for Non-profit Government, 2003

70 Aldrich, Daniel P. How to Weather a Hurricane, New York Times, 08/29/2012

71 http://en.wikipedia.org/wiki/Anacostia_River, accessed 07/12/2011

flooding in predominantly middle class towns where it was felt that the entirety of flood abatement is the responsibility of government. Some feel that it connects less with the needs of vulnerable urban centres. There is some anecdotal evidence that many groups prevent FRe uptake in the hope that large-scale projects will be funded.

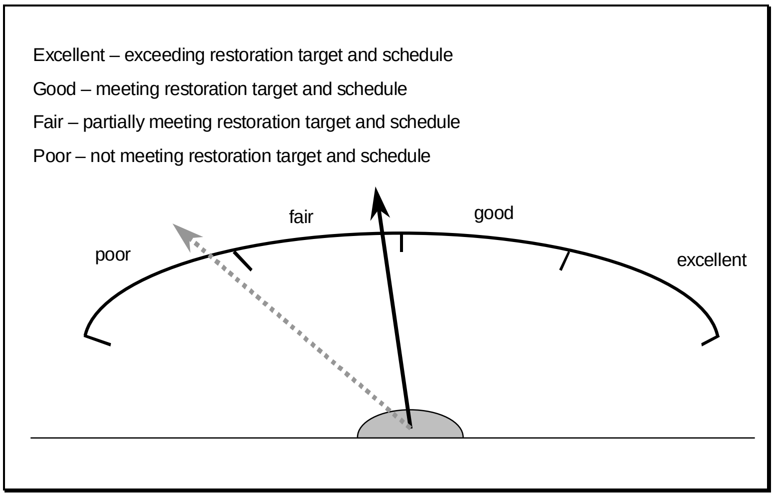

Figure I.1-3: The "performance meter" used on the Website for the Anacostia Project.

In Dresden, Germany it was the political engagement of NGOs in Laubegast that helped to convince the Dresden City Council to allocate funding for a stakeholder involvement process. Stakeholder participation here grew out of a perceived problem, issues, and differences of opinions that provided political glue that brought people together. Dresden NGO's offered the benefit of understanding networks of decision makers, knowledge about processes, realisation of funding opportunities and organisational skills to exert political pressure.

The Spanish questionnaire response pointed out that most NGOs are in need of capacity building, prior to distributing information and supporting the use of FRe. The Cyprus response noted NGOs and environmental groups could play a key role. Massive drainage systems and flood protection infrastructure call for large capital investment with adverse environmental impacts. Contrary to that FRe technology at local levels is associated with low capital investments and limited adverse environmental impacts.

In Greece local communities have started to establish relevant citisen bodies to permit active participation of stakeholders. Such groups have organised workshops on civil protection and on environmental education for students. An example is the Hymettus Protection and Development Association (representing 1.2 million citizens) that plays a role in flood risk management. Citizens' groups are meant to conduct studies and push forward measures for their areas of interest. Their activities though require to be approved by the supervising Ministry of Environment, Energy and Climate Change. Often approval arrives late or not at all. Given the economic circumstances of Greece such projects have hardly been scheduled lately.

It is recommended that governments encourage NGOs to promote civic engagement, local events, volunteerism, and citizens' participation in decision-making and collaborative governance.[72]

2.4 Capacity building on the individual property owner level

Many property owners know little about the history of the property they own. A survey of property owners found that 59% of the households affected by the River Elbe Flood of 2002 stated that they did not know they lived in a flood prone area. [73] Similarly it is not commonly understood that a 100 year frequency flood implies a 1% chance of reoccurrence, every year, rather than having to wait 100 years. There can be no meaningful stakeholder participation effort, unless there is an educated set of participants.[74]

Property-level FRe can obviously not be implemented without the consent of property owners, making it more difficult to implement than large-scale flood defence works.

Opinions voiced at the UK Manchester case study area are similar to other areas in the EU and the US. Principal issues in the UK and elsewhere are a lack of knowledge about what is available, lack of finances; trust in efficiency, ease of use, and product aesthetics and public communication of undesirable messages. Property owners generally feel that protection against flooding is the responsibility of government agencies or their insurer. The answer is information and communication. Public agencies have been promoting opportunities through publications and internet reports. They may not reach a predominantly working class urban neighbourhood such as Manchester/Heywood but the effort is commendable. Examples are BRE Digest 523, Flood Resilient Construction, Parts 1 and 2; BRE Repairing Flooded Buildings; the ABI Flood Resilient Homes fact sheets at www.abi.org.uk/Information/consumers/General/15274.pdf; RAAB Consultants Homeowners Guide to Flood Resilience; and Defra/EA's research and development concerning Flood Resilience and Resilience Solutions.

In Dresden, Germany, lack of knowledge about flood risk and about abatement measures is also a constraint. In a survey of more than 1200 households, 59% of those affected by the River Elbe Flood of 2002 stated that they did not know they lived in a flood prone area, only 11% had used and furnished their house in a flood adapted way and only 6% had flood adapted building structures.[75] The government continues to be viewed as being responsible for flood risk management and its costs. The stakeholder participation process in Dresden-Laubegast demonstrated how property owners and other interested parties can be involved in planning optimal solutions. This was aided by the promise of the City of Dresden to wait for citizen's recommendations in its formulation of plans.

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[72] Aldrich, Daniel P. Building Resilience: Social Capital in Post-Disaster Recovery. Chicago and London, The University of Chicago Press, 2012

[73] Kreibich, H., A. H. Thieken, Th. Petrow, M. Müller, B. Merz. Flood loss reduction of private households due to building precautionary measures – lessons learned from the Elbe flood in August 2002. Natural Hazards and Earth System Sciences, 2005

[74] Tippett J., Griffiths E,J. New approaches to flood risk management – implications for capacity building, in Advances in Urban Flood Management, edited by A. Vassilopoulod, R. Ashley, C. Zevenbergen, E. Pasche, and S. Garvin. Taylor & Francis, 2007

[75] Kreibich, H., A. H. Thieken, Th. Petrow, M. Müller, B. Merz. Flood loss reduction of private households due to building precautionary measures – lessons learned from the Elbe flood in August 2002. Natural Hazards and Earth System Sciences, 2005

The Spanish response note that property owners are the main beneficiaries of measures and that they would welcome incentives through the reduction of municipal fees and taxes for properties where FRe have been installed.

In Cyprus it was felt that property owners tend to ignore the benefits of flood protection as they feel secured through flood insurance. Increasing frequency and depth of flooding is expected to lead to more flood awareness helping to create a market for flood resilience products that benefit property owners.

In Greece a lack of information, a lack of initiative and a lack of funding are seen as essential constraints.

In the US it has been recognised that implementation of FRe depends heavily on property owners and stakeholders. A strategy for their involvement has been put forth by FEMA. It is a multi-objective management approach called M-O-M reasoning that a single-minded approach will no longer lead to solutions. M-O-M reasons to: (1) keep the effort locally based, (2) understand the problem and its relationship to the catchment area, (3) think broadly about possible solutions, (4) identify other community concerns that could be related to the flood problem, (5) obtain expert advice from government and private organisations, (6) build a partnership among individuals, private and public groups. Successful implementation of property-level stormwater management practices (BMPs) in the Washington area case study reflect 40 years of practical experience.

Capacity building for property owners can be achieved through advancements in planning strategies and strong stakeholder involvement programs that offer opportunities for individuals to participate in learning and action alliances.

It be in the interest of property owners to see to it that strategies similar to the FEMA M-O-M approach be applied in planning for their community**.** Property owners should seek contact with voluntary associations and alliances of municipalities to build up “social capital” through a network of connections to assist, inform, and educate.

I-1.4.3 Implementation strategies

As an implementation strategy the following recommendations should be applied:

1. Capacity Building on the national level

RECOMMENDATIONS 1.1 FOR EU MEMBER COUNTRIES

It is recommended that EU nation members sponsor conferences bringing together experts to focus media attention on solutions to problems that require a transformation of institutions and planning processes. Funds spent in information and knowledge-, development and dissemination are bound to generate benefits many times the value of the money invested. It is further recommended that R&D funding /accreditation of FRe products be conducted on a national level.

RECOMMENDATIONS 1.2 FOR REGIONS AND STATES

Region-State governments should publish FRe manuals and construction handbooks that relate to geographic, demographic and political characteristics of regions and offer information dissemination to build social capacity for stakeholder participation. It is considered opportune to maximise benefits by combining water quality (WFD), volume control (FD) and multiple uses in facilities built. Region-State governments should develop FRe Demonstration Shows. Media coverage would assist in the dissemination of information. Region- State governments should further establish “Flood Resilience Information and Advise Centres” to inform the public about flood risk management options, to exhibit demonstration projects and to place policy directives, advisory documents and Decision Support Systems on the Internet.

RECOMMENDATIONS 1.3 FOR THE CONSTRUCTION INDUSTRY LEVEL

Initiatives such as the “Construction Industry Research and Information Association (CIRIA)” of the UK are commendable as a capacity building effort on the construction industry level and should be actively pursued in all member countries of the EU.

RECOMMENDATIONS 1.4 FOR THE INSURANCE INDUSTRY LEVEL

Private insurance companies in EU countries view themselves as a business only, but should be encouraged to include stewardship for risk reduction into their future programs. Insurance companies should provide more incentives for the practice of FRe, provide information about property-level installation and “become pro-active” in the development of FRe products”[76].

RECOMMENDATIONS 1.5 FOR THE FRe MANAUFACTURERS LEVEL

EU member countries and the insurance industry should fund research and development of locally produced FRe products. EU member countries should sponsor testing, adherence to uniform standards and accreditation of FRe products.

RECOMMENDATION 1.6 FOR THE PROFESSIONAL ASOCIATION LEVEL

It is recommended that professional associations of civil engineers, architects, landscape architects, city planners and other professions related to flood risk management that require member participation in a program of Continuing Professional Development (CPD) offer a course on FRe. It is further recommended that flood resilience be addressed in professional association meetings and conferences.

2. Capacity Building on the local scale

RECOMMENDATION 2.1 FOR THE CITY GOVERNMENT & MUNICIPAL LEVEL

It is recommended to apply the SMARTeST indicator of success Matrix to cities and municipalities define their flood risk management priorities and to evaluate their status. It is further recommended that communities form voluntary alliances and partnerships for the coordination of efforts and creation of financial reserves. Emphasis should be placed on learning alliances of stakeholders working with voluntary associations. Communities should consider a strategy of flood resilience that involves private property owners in programs of flood preparedness.

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[76] Lawson, Nigel, The Insurance Industry, unpublished paper, University of Manchester, 2011

RECOMMENDATIONS 2.2 FOR THE EDUCATIONAL INSTITUTION LEVEL

Educational institutions should integrate knowledge about FRe into graduate and post-graduate education programs for professions that relate to land use involving architecture, landscape architecture, city planning, regional planning, civil and environmental engineering, natural sciences, geography as well as scientists, technologist, economists, and ecologists. There further should be Advanced Study Courses (ASC) on topics related to flood management.

RECOMMENDATIONS 2.3 FOR THE NGO LEVEL

It is recommended that governments encourage NGOs to promote civic engagement, local events, volunteerism, and citizens' participation in decision-making and collaborative governance.

RECOMMENDATIONS 2.4 ON THE INDIVIDUAL PROPERTY OWNER LEVEL

It is in the interest of property owners that strategies similar to the FEMA M-O-M approach should be applied in planning for their community. Property owners should seek contact with voluntary associations and alliances of municipalities to build up "social capital" through a network of connections to assist, inform, and educate.

I-1.5 Contribution to project objectives

The investigation of development opportunities for capacity building and above recommendations should help to implement SMARTeST project goals. The scale and wide distribution of areas affected by climate change make it impossible to protect all areas by structural flood defence works. For this reason it is essential to adopt an integrated approach that includes property-level measures.

There is a need to practice vertical integration of stakeholders in a "top-down" and "bottom up" approach and horizontal integration including "built environment professionals, land managers, the construction sector, the development and finance sector, the insurance sector, the public and those companies who design and sell FRe technology".[77] A Flood Resilience Alliance (FRA) for capacity building should be formed. Learning & Action Alliances have been pursued in previous EU projects to overcome "silo thinking" of established agencies and interest groups.[78] It is recommended that such alliances be formed to be specific to address problem areas, since problems provide the social glue and incentive to ensure active participation of representatives of stakeholder groups.

Implementing the floods Directive and the Water Framework Directive can only be achieved by a stronger horizontal integration and involvement of all the stakeholders mentioned above. This is placing the planner in the role of a mediator and can turn planning into a learning and action alliance. It is well advised to address the seven categories (TRICEPS) that have been identified in the SMARTeST project, covering the

[77] White, I., P. O'Hare, N. Lawson, A. Barker, J. Tippett. Principles of Integration, SMARTeST - D.5.1, University of Manchester, 2011

[78] Ashley, R., J. Blanksby. Learning and Action Alliances in Relation to Urban Water and Flood Risk Management. MARE, The InterregIVB, North Sea Region Programme. University of Sheffield, 2009

themes of (1) **T**echnical, (2) **R**egulatory and **L**egislative, (3) **I**nstitutional, (4) **C**ultural, (5) **E**conomic, (6) **P**olitical, and (7) **S**ocial aspects.[79]

It has also been found that "Flood resilience combines spatial, structural, social and risk management levels of flood preparedness" and that using communities as indicators of success can apply a Weighted Rating Matrix. This can lead to a setting of clear goals, stakeholder participation, monitoring of results and transparency. Flood resilience is a more encompassing concept than "sustainable development"[80], offering an opportunity to consider thresholds and limits to recovery.

The review of six case studies shows that it is not only important for states to set a legal framework, but that the primary emphasis of flood resilience lies on the community level. Land use planning and construction involves individual property owners, city government and municipalities. Local decision-making is influenced by professional associations, the insurance industry, educational institutions and by non-governmental associations. Heavily centralised state decision-making tends to be inept in dealing with Complex Adaptive Systems such as flood risk management. The northern case study areas in the UK, Germany and in the US offered the highest level of opportunities and least constraint for the practice of flood resilience. Advanced FRe systems were found here. An example of a city initiative is the recent $20 billion resilience plan (PlaNYC) put forth by the mayor of New York City.[81] In the EU the Floods Directive alone will not bring about flood resilience unless there is a financial commitment, good governance and capacity building on the local level.

[79] White, I., P. O'Hare, N. Lawson, A. Barker, J. Tippett. Principles of Integration, SMARTeST - D.5.1, University of Manchester, 2011

[80] Ross, A. Modern Interpretations of Sustainable Development. Journal of Law and Society 36 (1). 32. 2008

[81] United States/ You're going to get wet. The Economist, 06.15.2013

I-1.6 Appendix: Summary – documentation of case studies in Capacity Building for stakeholders

United Kingdom	Germany	United States	Spain	Cyprus	Greece	Findings, Results, and Recommendations
1. Constraints and opportunities for capacity building on the national level.						
1.1 Laws in your Country						
1. 1a How do national laws and the national interpretation of the EU Floods Directive constrain implementation of FRe technologies and related programs?						
After the 2007 flood the UK Government followed a Sir Pitt recommendation, passing the Flood & Water Management Act (2010). There also are Flood Risk Regulations (2009). The Environment Agency (EA) has a strategic oversight role in England and Wales. Directly responsible for flooding is the Local Authority (LA), and not the EA. Euro –scepticism is constraining interpretation of the EU Floods Directive. There is an anti-governmental regulation climate currently prevailing in the UK. The New Coalition Government has cut flood defence spending by 8% annually from 2011.	German states have been given the mandate to revise water laws and to implement flood defence strategies through passage of the 2005 Federal "Act to Improve Preventive Flood Control". After passage of the 2007 EU Floods Directive its implementation in Germany was facilitated through the 2007 Federal Regional Planning Act, the 2007 Federal Building Code, and through the 2009 Federal Water Resources Act. National laws and interpretation of the EU Floods directive do not constrain implementation of FRe Technologies. The local perception that flood defence is the responsibility of the State government is an excuse to constrain private and municipal investments in FRe measures. A further deterrent was the generosity of the federal, state, and private disaster relief, which in the past permitted reconstruction of flood damaged properties without implementation of FRe technologies.	Equivalents to the EU Floods Directive in the US are the Flood Control Act of 1932 and its amendments. The US counterpart to the Water Frameworks Directive is the Clean Water Act of 1972. The early passage of both laws gave the US a considerable time advantage in experimenting with implementation approaches and in defining programs under public participation. Some feel that an early monopoly in flood control given to the U.S. Army Corps of Engineers, USACA has encouraged a narrow focus on structural solutions that runs contrary to flood resilience as a comprehensive approach. There have been calls for more integrated flood risk management that would involve the public in "on site flood risk management" and give owners of floodplain properties a higher financial share in mitigation. During recent flood events National Flood Insurance reimbursements (with low premium incomes) and Federal Disaster Relief have repeatedly exceeded budgetary capacities and required additional funding through acts of Congress. This is bound to be repeated as climate change causes more frequent catastrophic flood events. It would be in the interest of the US to formulate a new strategy on flood resilience. The fact that two laws already exist (of 1932 and 1972), their implementation through three separate agencies (USACE, FEMA and USEPA), and the recent political climate of the US Congress will make this highly unlikely.	Royal Decree 903/2010, Article 11.4 does not mention FRe directly, but states that "Flood risk management plans shall encompass all the aspects involved in the management of the risk of flooding," Flood control planning in the past has concentrated on preventive measures for run-off reduction, control reservoirs dams, levies and river bed modifications like in Valencia city. A lack of experience and governmental expertise on the regional level in implementing comprehensive aspects of the Floods Directive can be a temporary constraint.	National laws do not encourage implementation of FRe technologies.	The implementation of the EU Floods Directive and relevant Greek legislation is underway. There has been no specific reference to FRe uptake.	EU countries have passed laws following the recently enacted Floods Directives and Water Framework Directive. Comparable laws in the U.S. are the Flood Control Act, passed as early as 1932 and a Clean Water Act, in place since 1972. It would be appropriate for the EU and its member countries to make an effort to study and benefit from implementation experiences of other countries in the EU and in the United States. An anti-governmental regulation climate is currently prevailing in the U.K. and in the U.S. The economic recession and a lack of experience is a particular constraint in southern countries of the EU.
1.1 b What opportunities are being offered by the interpretation of the EU Floods Directive?						
Following EU Floods Directives the EA and local Authorities are creating flood risk reports, flood hazard and flood risk maps.	The German response to the EU Floods Directive has set the stage for a new approach of flood resilience and	The interpretation of the US Flood Control Act of 1932 and its amendments has offered opportunities through the development of (1) Flood Proofing Programs, enactment of the	Opportunities lie in the comprehensive interpretation of Article 2b of the	Implementation of the EU Floods directive will produce flood risk maps and will inform the	Greek legislation does not fully harmonise with the European legislation, but	Since 1972 the U.S. has been making commendable progress in advocating property-level abatement measures. Best

United Kingdom	Germany	United States	Spain	Cyprus	Greece	Findings, Results, and Recommendations
United Utilities has made budgetary provisions for measures. The Government sees Local Authorities (LA) in a future leadership role.	speedy recovery that is different from the past reliance on flood defence structures. Federal ministries provide assistance. An example is the "Federal Ministry for Traffic, Construction and City Planning" that issued an update to its technical report "Flood Protection Manual" addressing flood proofing and flood resilient construction. It addresses measures to waterproof buildings, dry and wet flood proofing, flooding through sewers, flood proofing of utility and heating systems, protection from pollutants, flood warning, flood preparedness, risk management and stakeholder involvement. The 2009 Federal Water Resources Act, for the first time requires that individuals take protective measures on their own to guard against risks, to reduce flood losses, and to adjust uses of flood-prone properties. The mapping of flood-prone areas is mandatory.	(2) National Flood Insurance Program, and through (3) flood risk management programs by the Federal Emergency Management Agency (FEMA). The Clean Water Act has been the basis of a comprehensive, Stormwater Management Program administered through the USEPA. (1) FLOOD PROOFING. - The USACE is one of the first government agencies that assisted in the practice of elevating and flood-proofing (dry or wet) private structures on flood-ways. Numerous publications on implementation are available free of charge. The US Corps of Army Engineer's report "Flood-proofing Regulations" was initially published in 1972, addressing permits; inspection; waterproofing; structural requirements; closure of openings, walls, buildings and structures; and the protection of electrical and mechanical facilities. It puts forth minimum building safeguards "regulating and controlling the design, construction, and quality of materials of all buildings and structures located on the 100-year floodplain. Regulations apply to the construction, alteration, and repair of buildings or part of buildings or structures in flood hazard areas. Uses in flood risk areas shall not be expanded, changed, enlarged, or altered in any way, which increases their nonconformity. (2) THE NATIONAL FLOOD INSURANCE PROGRAM (NFIP), - regulates development on mapped floodplain areas. Communities are eligible for flood insurance only when they practice floodplain zoning, restricting floodplain uses and requiring that new structures be elevated to level above the 100-year frequency flood and flood-proofed. (3) FLOOD RISK MANAGEMENT PROGRAMS by the Federal Emergency Management Agency	Floods Directive, asking: "to reduce negative consequences of floods on the health and safety"…."the environment"…"cultural heritage, economic activity and infrastructure". Initiation of an "Automatic Hydrological Information System (SAIH)" including a "Decision Support System (DSS)" and off-line storage of storm sewers are being seen as opportunities.	public about the potential and risk of flood damage. This awareness and information about FRe technologies will open a road to market and opportunities for implementation.	relevant ministries have taken action to implement the EU Floods Directive, activating a National Program of Flood Risks Management, providing the preliminary flood risk assessment, flood hazard maps, flood risk management maps and management plan.	Management Practices (BMP's) for lessening flood peaks through run-off control, detention, infiltration and run-off quality control have been widely accepted. Experiences made here on the "road to market" for property-level measures hold a lesson for the EU. Germany and the U.K. are pursuing a similar direction though Sustainable Drainage Systems (SUDS) and by advocating a range of FRe measures through government and "Local Authorities" in the U.K.

United Kingdom	Germany	United States	Spain	Cyprus	Greece	Findings, Results, and Recommendations
		(FEMA) put forth flood damage resilient design standards calling among others for: Pre-construction flood-proofing certificates; detailed plans; elevations and design details; FRe manufacturers specification sheets and catalogue cuts. FEMA requirements and certification for non-residential place emphasis on: Flood warning time; safety and access; pedestrian stability in flood flow conditions; vehicular roads to be used as evacuation routes; flood velocities and flood depth; and flood emergency operations planning, considered to be critical when flood-proofing involves human intervention or optional operations during power failure. A plan must include: (4) STORMWATER MANAGEMENT THROUGH THE CLEAN WATER ACT (NPDES). - This program has led to the systematic lessening of storm run-off through surface management, retention and infiltration, run-off detention and slowed release at pre-development rates, creation of wetlands and the restoration of streams. This is being achieved through stormwater management ordinances, making practices mandatory.				
1.2 In many countries Nation States and regional provinces exercise autonomy in government. How do the following apply to the case study area:						
1.2.a How do Nation State program interpretation of the EU floods Directive constrain implementation of FRe technologies and related programs?						
Interpretations in England, Wales, Scotland and other areas of the UK are slightly different. There is no direct constraint to the implementation of FRe technologies.	State interpretation of the EU Floods Directive does not impair implementation of FRe Technologies.	Programs by the USACE, USEPA and FEMA should not constrain the implementation of FRe. Structural solutions constructed by the USCAE at public expense though are being favoured for flood risk management.	Several autonomous Regions have adopted them to their own legislation, but there are few variations from the national law passed by Royal Decree in 09/2008. Implementation is tied to heavier workloads for agencies and to	Cyprus is a small country and does not contain regional provinces with autonomy. Constraints-N/A	No constraints	There is no direct constraint to the implementation of FRe. An indirect constraint in all countries, including the U.S. is flood disaster relief funding with no strings attached permitting re-construction without practicing FRe. Governments also hold a preference for major engineering works constructed by central agencies.

United Kingdom	Germany	United States	Spain	Cyprus	Greece	Findings, Results, and Recommendations
			additional bureaucratic processes.			
1.2.b What opportunities are being offered by the Nation State interpretation of the EU Floods directive?						
The Floods Directive set the stage for an integrated approach. The Flood and Water Management Act of 2010 requires the Environment Agency (EA) to "develop, maintain, apply and monitor a strategy for flood and coastal erosion risk management in England". Every planning application for land use is required to file a Flood Risk Assessment (FRA). The EA is offering guidance through a document (*Prepare your property for flooding)* , and through a technical document on groundwater flooding.	States must now prepare flood risk reports, flood risk maps and flood risk management plans. A new provision for stakeholder participation is changing planning and aiding in the uptake of FRe measures. In brochures and publications the Ministry of the Environment for the State of Saxony is now placing emphasis on measures taken by individual property owners (Eigenvorsorge) to reduce flood risks.	The State of Maryland, similar to other US states internalise responsibilities for stormwater management, having those who cause problems pay for mitigation measures. In the Sligo Creek Area. The Maryland Stormwater Management Act of 2007 and its "Design Manual" with 2009 revisions, establish guidelines for "Environmental Site Design (EDS)".	Regional governments have the opportunity to implement the "State Plan for Civil Protection Against the Risk of Flooding", approved by the Council of Ministers in 2011.	N/A	Municipalities or inter-municipal bodies may suggest FRe measures to later be financed by regional authorities or the Ministry of Environment, Energy & Climate Change. The regions Department of Water, in cooperation with the Directive of Civil Protection will develop management plans.	Climate change is increasing flooding and is raising the cost of conventional flood risk management for states. At times of fiscal constraints this poses a problem. The EU Floods Directives are setting the stage for property-level measures, stakeholder information- and participation. For the Washington D.C. area design manuals for BMP's and design standards for flood-proofing are in place. In Germany and in the UK States are using the Internet and brochures to inform the public.
1.3 The Construction Industry is a special stakeholder in FRe. They may view it as a burden or as an opportunity for development						
1.3.a What constraints to the practice of FRe are being raised by the construction industry?						
Small and medium sized companies dominate the construction industry in the UK. In the Heywood case study area there is a general lack of knowledge by surveyors, designers and builders about what constitutes FRe technologies. Inundation areas are not shown on flood maps and there is no FRe requirement by code. Homeowners are reluctant to invest in flood proofing and the only road to market is through publicly funded programs. The Sir Pitt	In Germany the construction industry is more regulated than in many other countries. Cities and municipalities control shape and performance of urban developments (Bebauungsplan). Builders will not practice FRe unless required by code and specified by an architect. The absence of code requirements for FRe is a constraint in many places.	In the US the construction industry is an influential lobbyist. One of its representatives is the National Association of Home Builders (NAHB), "focusing on housing affordability, availability and choice". The NAHB policy for the Environment states that: "Federal laws and regulations.... while well intended often impact availability ... by increasing the cost of homes and reducing the supply of land and materials for homes or both". Requests for additional FRe measures that would increase costs will not be accepted lightly, particularly as the housing industry has been negatively impacted by the current economic slump.	FRe structures on a building scale are generally not stipulated in building codes. Builders in Spain tend to be neither a source of innovation nor a constraint, as they depend on client demands. A mandatory use of FRe technologies that increases building costs will not be seen	There is a lack of awareness and a lack of experience in the implementation of such technologies.	Construction of flood defence is viewed as a responsibility of government. Responsibilities for roads and hydraulic works have been passed on to a newly established organisation, the Decentralised Region's Management of Construction works. A wide timeframe for the implementation of national legislation	The construction industry in most of the participating EU countries and in the U.S. would not look favourably at a mandatory use of FRe technologies that would increase building costs.

United Kingdom	Germany	United States	Spain	Cyprus	Greece	Findings, Results, and Recommendations
report (2008) recommended that flood resilience become part of the building code, however this has not been implemented.			favourably.		and EU directives, red tape and organisational problems are creating obstacles.	
1.3.b What opportunities does the construction industry see in the practice of FRe?						
Some members of the construction industry view FRe measures as a commercial opportunity. The subject however is not yet mainstream. Opportunities lie in the use of the recently published BRE Digest (Garvin, 2012). There also is the opportunity to expand energy efficiency requirements and ECO funding through the Energy Act of 2010 to include climate change adaptations to cover FRe. If this be realises the construction industry would need to invest in necessary training. A positive step are seminars for various aspects of FRe (and SUDS) offered by the Construction Industry Research and Information Association (CIRIA), issuing Certificates of Continued Professional Development (CPDs).	FRe measures are services that offer new and additional profit opportunities. FRe practices permit mitigation of flooding, opening up sites to development that would have otherwise been unsuitable. This is particularly applicable to urban centres and historic districts that have traditionally concentrated along waterfronts. In Dresden Kleinzschachwitz and its lowlands the flood proofing of individual structures is an opportunity.	Historic city centres developed along waterfronts continue to be prime real estate sites. Flood-proofing provides the technology that expands the availability of land for development. FRe thus is desirable for the construction industry. Under these circumstances special building codes such as those issued for HafenCity Hamburg and voluntarily practiced for waterfront development in Georgetown in Washington DC will most likely be acceptable.	Individual and collective flood defences, elevated structures, flow back valves and use of sump pumps offer business opportunities.	The construction industry is welcoming new products that improve safety and functionality of buildings and infrastructure. FRe technologies are a challenge and an opportunity for new jobs. There is a potential for export to other countries.	A future committee should compile a single flood regulation	All participants pointed out that members of the construction industry view FRe measures as a commercial opportunity. It was also seen that FRe could mitigate flood problems at historic urban centres and permit construction along waterfronts that would have otherwise been unsuitable.
1.4 The Insurance industry has a direct relationship to the practice of FRe.						
1.4 a Describe how the insurance industry limits the implementation of FRe?						
The Association of British Insurers (ABI) statement of principles notes that flood coverage as a standard feature for households and small business will only extend until 2013, and not be renewed unless government increases the	Insurance companies in Germany are generally not very effective in encouraging awareness of flood risks, and pro-action to mitigate losses. The insurance industry here provides little or no incentives to those	FloodsafeUSA", a manufacturer of flood-proofing measures states that: "at the time, there are no insurance premium reductions available for flood-protected residences". This may be viewed as a temporary situation, related to provisions of the National Flood Insurance Program (NFIP). It is being viewed as a drawback by manufacturers.	The insurance industry currently is not offering any incentives for the implementation of FRe. It is not possible to lower insurance rates in response to	No reduced premiums are being offered to properties that practice FRe.	The insurance industry barely takes FRe systems under consideration, as they are not commonly used in Greece.	EU participants found that the insurance industry has serious problems in recognising benefits of FRe practices, and does not reduce premiums reflecting their use. There also is not a clear insistence on using FRe measures in repairs after

United Kingdom	Germany	United States	Spain	Cyprus	Greece	Findings, Results, and Recommendations
amount of money for flood protection. This is most likely to happen. As a consequence there will be a serious impact on availability and cost of flood insurance. Insurance companies have serious problems with FRe, due to lack of trust in products, concerns about on-going maintenance, quality of installations, and the ability of homeowners to use measures correctly.	policyholders who implement flood proofing and other flood resilience measures. Insurance companies are concerned about the maintenance and effectiveness of privately owned and operated FRe measures.		the implementation of FRe, though this may be possible in the future if the use of FRe shows good results.			claims for flood damage have been paid out. The insurance industry holds a general distrust in the performance, maintenance and operation of FRe.
1.4.b What opportunities does the insurance industry offer to encourage FRe?						
Insurers could use the excess/deductible of their policies to share risks with the insured, providing an incentive for the use of FRe. The insurance industry could become pro-active, assisting in the development of products, and work with banks and mortgage providers to encourage FRe uptake and jointly with government and utility companies kick-start schemes to protect groups of structures. They could also share confidentially held data about past flood events. The ABI has made a good start; publishing two reports about flood resilient repairs and resistance measures.	It is in the interest of the insurance industry to reduce flood losses and related claims. This holds particularly true at a time of climate change and ever increasing frequency and intensity of flood events and related high flood losses. Insurance industry reinsurers (Rückversicherung) are expected to take initiatives in the future.	The National Flood Insurance Act was passed in 1968 to provide financial aid to property owners while guiding away development from flood hazard areas and to require that buildings minimise flood damage (Flood-proofing). A 2009 study in the University of Miami International and Comparative Law Review found that the NFIP is doing better than flood insurance programs in the UK, France, Germany and the Netherlands, because it actively aims to share the burden of flood risks between individuals, insurance companies, and the Government. It denies coverage to municipalities that do not practice flood risk assessment, enact building restrictions (floodplain zoning) and encourages flood proofing of structures. Residents of the Sligo Creek drainage basin in the Washington DC case study area received a 25 % reduction in flood insurance rates, having participated in a Community Rating System (CRS) and been given credit points for community activities that: (1) reduce flood losses, (2) facilitated an accurate risk rating for insurance purposes, and (3) promote an awareness of the availability of flood	A state controlled consortium of 50% insurers and 50% State (the "CONSORCIO") has set up a fund for flood insurance. Policies and insurance rates consider predicted risks of flooding for the country as a whole.	FRe should be seen as a system that requires proper implementation, maintenance, and operation. Such a system does not yet exist and is not yet recognised by the insurance industry.	Flood insurance is part of property insurance and rates are dependent on an individual risk assessment by insurers. In the future insurers may encourage FRe, but only after measurable benefits have been demonstrated.	The U.K. insurance industry has stated that flood coverage as a standard attachment in policies will not be extended after 2013 unless government increases funding for flood protection projects. This is unlikely, neither in the U.K. nor in other EU countries. The problem for the insurance industry is that flood losses are mounting with climate change. This offers an opportunity for the recognition of FRe by insurers and stressed re-insurers. The Association of British Insurers (ABI) has made a start, publishing two reports about flood resilient repairs and resistance measures. In the U.S. National Flood Insurance (NFI) in conjunction with government agencies (FEMA, USCAE) provide financial aid for the flood-proofing of structures. They require floodplain zoning by municipalities and have

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		insurance. Communities may receive up to 45% premium reductions.				established a rating system for FRe related community activities that can lead to an up to 45% reduction in insurance premiums.
1.5 FRe manufacturers are taking a risk in hope of future profits.						
1.5.a What are the constraints for FRe technology manufacturers?						
FRe technology manufacturers in the UK are a relatively new industry and generally small and medium sized enterprises. Test and certification of a FRe product will cost a minimum of £ 30,000. A manufacturer has estimated that for every £1 spent on product development, £10 needs to be spent on marketing. Manufacturers have pointed out that current government practices to permit floodplain development without doing anything to protect those buildings is a problem. They pointed out that it would help if the provision of FRe would be aligned with the granting of building permits.	FRe technology manufacturers in Germany range from giants, like Thyssen Steel of the Ruhr Valley to upstart companies in Dresden, using plywood and plastic sheeting. A lack of uniform building codes for flood proofing constrains sales, and so is the reluctance of the insurance industry to reduce flood insurance premiums for individuals who install measures on private properties.	FloodsafeUSA, a manufacturer and installer of flood-proofing measures states that the current policy for federally subsidised flood-proofing does not include dry flood protection measures for residential structures. This is considered a drawback.	A lack of trust in FRe measures, and a related lack of business opportunities offer constraints for FRe manufacturers.	A FRe market is currently non-existent in Cyprus. Furthermore, the island does not have a tradition for technology manufacturing. New manufacturers would have to train new personnel for new products.	A lack of initiative, financial limitations, responsibility limitations and red tape are seen as limitations.	FRe manufacturers in participating EU countries are a relatively new industry, facing the constraints of developing and marketing new products. This includes financial constraints of research/ development, certification and advertisement. An additional constraint is a lack of acceptance of product performance, and maintenance and absence of code requirements and a lack of incentives for their use that could be offered by government and the insurance industry.
1.5.b What are the opportunities for FRe technology manufacturers?						
A property level flood protection grant scheme (£ 5.6 million) has been set up to assist properties in areas of high flood risk that do not benefit from community level defences. It provides up to £ 7,500 for the costs of FRe measures per household.	Increases in flood events and the 2009 Federal Water Resources Act (Section 5, Paragraph 2) require that individuals integrate measures on their own to reduce flood losses. It needs the offer of opportunities for the use of FRe. The “Plan Hochwasservorsorge Dresden” as an example of city related management of	The “National Flood Insurance Program” (NFIP) offers financial assistance for the implementation of flood-proofing measures as “Increased Cost of Compliance”, paying up to $30,000 toward the cost of making an insured structure compliant with the local flood damage prevention ordinance. This shows that government assistance that is also helping manufacturers.	If FRe measures were more widely specified in project plans, then there would be more opportunities for their manufacturers.	As an EU member Cyprus is part of a very large market. Globalisation and e-commerce enable promotion and sale of new products all over the world.	A new market for FRe products in Greece and a new market in the Eastern Mediterranean region are being seen as an opportunity.	Government in the U.K. is experimenting with property-level flood protection grants. In Germany a federal law now requires that individuals take actions on their own to lower flood losses. This offers opportunities for the use of FRe. The city of Dresden has produced a flyer and Web page informing about measures for private properties. Temporary

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	flood prevention with its additional information (flyer and Web page) outlining FRe measures for individual property owners. Temporary and demountable flood barriers that help to showcase FRe technologies (financed by the State of Saxony) have been installed at various locations in Dresden. A wide range of FRe products on the market demonstrate that German manufacturers see export opportunities.					and demountable flood barriers have been built here throughout the city, showcasing measures. EU countries are seeing export opportunities for such new products.
1.6 Professional associations register and control the practice of their members.						
1.6.a How do professional associations hinder the application of FRe?						
Local Authorities (LA) and the Lead Local Authority (LLA) who through recent legislation are in a leadership role in the application of FRe use construction/ engineering consultancies to carry out work. Not all those consultancies have a highly skilled and knowledgeable modelling staff. Bids for Surface Water Management plans (SWMPs) are being made by less skilled companies with antiquated modelling software or lack of robust input data. There is some evidence that there is a tendency to advocate larger scale heavy engineering solutions where small-scale FRe would be more appropriate. There are concerns about the	It can be reasoned that professional associations have an obligation to keep their members informed about advances in their field, such as FRe, and if they neglect to do so are hindering applications indirectly, implying that such measures are nor worthwhile. In Dresden continuous education courses are being offered, though many registered members of associations are more familiar with conventional engineering practices.	"Flood Control" used to be the exclusive responsibility of civil engineers. Many civil engineers in practice in senior positions were educated at a time when levies and dams were the preferred answer to flood problems. Civil engineers are organised in professional associations and still are preferably the lead agency in flood risk management.	The role of professional associations in Spain can be considered to be neutral, as they are not hindering the application of FRe.	Designers of purpose built FRe construction must be registered with the Cyrus Chamber of Professional Engineers (ETEK). No hindrance.	N/A	The German response reasons that professional associations have an obligation to keep their members informed about advances in their field and if they neglect to inform about FRe are indirectly hindering application by implying that such measures are not worthwhile.

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efficiency of FRe products, and concerns about surveys, installations and maintenance.						
1.6 b How could professional associations offer opportunities for the practice of FRe?						
The Association of British Insurers (ABI) and the Royal Institute of Chartered Surveyors (RICS) promote usage of FRe. The Royal Institute of British Architects (RIBA) developed a guide "Design for Flood Risk" aimed at architects, urban designers and landscape architects. Other associations such as flood risk management consultants, the utility industry and fire services could be encouraged promote FRe. If FRe became a mandatory consideration professional associations would have to take it into account.	The DWA Sachsen/Thueringen (Deutsche Vereinigung fuer Wasserwirtschaft, Abwasser und Abfall e.V.), with its office in Dresden, is offering courses in preventive flood risk management since 2008. This includes modules on (a) theory and (b) practice. Other professional associations, such as the chamber of architects of Saxony have offered courses on the innovative protection of drainage courses and soil bioengineering.	Civil engineers, architects, landscape architects and spatial planners are registered, or licensed and are members of professional associations. It has been recognised that issues, subject matter and educational content for professions change over time. It is for this reason that professional associations have initiated continuous education programs. In order to remain registered members have to attend a set minimum of daylong education classes. FRe could become a required course, just like sustainable urban drainage education (BMP's) has been.	Dissemination of the results of projects (like SMARTeST) can facilitate the training of members of professional associations.	Professional associations can raise the awareness of engineers, increasing their opportunities to be engaged in an emerging new market.	N/A	In the U.K. the association of British Insurers ((ABI), and the Royal Institute of Chartered Surveyors (RICS) promote usage of FRE, and the Royal Institute of British Architects (RIBA) developed a guide on "Design for Flood Risk". In Germany the Association for Water- and Waste Management (DWA) is offering courses in preventive flood risk management.
2. Constraints and opportunities for capacity building on the local scale						
2.1 City government and municipalities traditionally hold power over land use and building codes that relate to the implementation of FRe programs. Summarise what is happening in your case study city:						
2.1.a Are you aware of constraints to the practice of FRe technologies and related programs?						
The Heywood case study area was developed during the 19th century. Location and condition of much of the sewer system and of many private drains is unknowns. Considerable additional urban development during the last 50 years is stressing the capacity of the sewer system having caused flooding in 2004 and 2006.	Dresden-Kleinzschachwitz together with Dresden-Laubegast had been severely flooded in 2002 and in 2005. Both are privileged, primarily residential districts, located in the upstream portion of the city, surrounded by filled in, old oxbow meanders of the River Elbe. In Klein-zschachwitz damage is caused by ponding of floodwater, and through	The Sligo Creek drainage basin of 11 square miles in the western portion of the Anacostia river catchments area, abutting the District of Columbia was used as the Washington DC case study area. Approximately 81,950 people here in a suburban setting, amounting to a population density of 7,081 persons per square mile. Impervious surface amount to approximately 34 %. In 2005 Congress initiated a program to use the Anacostia area as a national stewardship model. A total of 84 future stormwater retrofit projects have been	Valencia's Regional Government and some others have adopted Flood Risk Special Plans in 1010 and before. A depth/damage curve applied by HOWAD for the case study of Valencia is considered insufficient within Spanish NSG since it	Poseidon Avenue is the waterfront of the city of Paphos in the southwest of Cyprus and is experiencing coastal flooding due to wave overtopping approximately twice a year. In a case study the software FLORETO was applied and cost estimates for alternative flood	The case study area, Nea -Philadelphia, is located in the prefecture of Attica. The area was last subject to a catastrophic flood in 1994. The FloReTo model to assess flood risk was applied here, but no action has been taken by city government.	Seven case studies reflect conditions unique to their geographic and demographic conditions in the EU and in the U.S. Participating EU municipalities are facing similar constraints in the practice of FRe. There is a general lack of knowledge about options, lack of qualified companies for construction, lack of trust in installation,

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Constraints to the practice of FRe are a combination of factors, including a lack of acceptance by insurers, lack of trust in their performance and efficiency, lack of trust in their installation, on-going maintenance, and insufficient funding on the local level. A lack of flood warning about timing and intensity is also an issue. Less skilled companies, claiming that they can undertake Surface Water Management Plans (SWMP) (1.6a above) contribute to the problem.	raised groundwater levels. The City of Dresden has prepared a "Flood Control Plan" that is considering Kleinzschachwitz together with Laubegast and Zschieren as a planning district. As a part of the planning process considerable efforts are being made in land use control, flood preparedness, contingency building of stakeholders. Flood control for Dresden used to be the primary responsibility of the State Reservoir Administration of Saxony (LTV), administering flood control dams, first built in the early 19-hundreds. During the communist era floodwater diversion courses (Flutrinnen) in Dresden were permitted to be filled with allotment garden colonies as well as an ice skating hall. Conventional engineering in the past constrained the practice of flood resilience.	proposed for the Sligo Creek area. With FEMA funding, Prince George's County, MD offered flood-proofing assistance to about 90 commercial properties. Only about a dozen participated took advantage of this offer. Flood-proofing is being advocated by local planning agencies, but is not very popular with property owners. At the SMARTeST Washington DC Workshops FRe hindering forces were listed as follows: Old school attitudes; lack of understanding; public education; public acceptance; institutional barriers; lack of good life cycle analysis and benefit information data; inflexibility of National Flood Insurance; lack of funds or willingness to pay.	cannot be generalised to be applied to all basins/ zones. Some of Valencia's local councils have used their "administrative power to bargain" calling for special FRe measures before granting building permits. No constraints other than their limited promotion	barriers along the Paphos promenade were prepared. In Cyprus land use and building codes are governed on the national level and not by municipalities. Paphos has the authority and duty to enforce and implement regulations and codes when issuing and implementing building permits The main constraint is a lack of awareness and a lack of suppliers/manufacturers of FRe technologies. The implication is that there is a limited demand and practically no supply.	Constraints N/A	operation, maintenance performance, and little funding for property-level measures. Conventional flood defence measures implemented by central agencies are generally preferred. In the U.S., where funding for property-level FRe measures is available such offers are not widely accepted. Hindering forces mentioned are old school attitudes, lack of understanding and a lack of good life cycle analysis and benefit information data.
2.1.b What special opportunities exists to*Educational institutions are conveying knowledge and influence the mind-set of our future decision makers.*						
In Heywood about 50% of properties affected by the 2004 and 2006 storms received grants for flood-proof doors, non-return valves, pups, automatic airbrick covers and flood resistant coatings. Grants were primarily received in areas most able to lobby local politicians. Finances were obtained through	Flood events of 2002 and 2006 in Dresden led to much soul searching by its City Council. In 2004 it was decided to embark on a long-range "Dresden Flood Prevention Plan" that included components of flood-proofing through property owners,	A FEMA floodplain mapping has been completed for the Washington DC area and all municipalities have implemented floodplain zoning. FEMA and the National Flood Insurance Program actively support flood-proofing and stormwater management. Almost all flood-proofing projects have received some form of public/financial assistance. Between mid-1980's and 2005 a total of 62 residences have been flood-	General Valencia's Regional Government Regulations are looking for "adaptations in buildings and infrastructures at flood risk". There is a call for the granting of financial aid and	There is a potential opportunity for a demonstration project, utilising targeted funding for innovative products.	N/A	In the UK government agencies are initiating grant programs aimed at flood-proofing on the property-level and to develop innovative projects. In Germany State funding to municipalities, such as Dresden permitted preparation of a "Flood Control Plan", a stakeholder participation program and the

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a 2007 UK, £5.6 million grant for property level resilience measures. In 2013 Heywood received a £250,000 grant for two years, focussing on capacity building. The Department for Food and Rural Affairs (Defra) has provided £5 million to fund thirteen communities across England to research and develop innovative projects. A Website "The Communities and Local Governments Guidance on Flood Resilient Construction" www.planningportal.gov.uk/uploads/br/flood_performance.pdf offers assistance.	stakeholder information, flood warning, and planning for exceedance flows in sewers. Measures planned, and partially completed along the River Elbe have a cost of 79.6 million EUR. Stakeholder information has been expanded into a stakeholder capacity building program with learning alliances. In 2009 City Council initiated a participatory stakeholder involvement process for planning District 17 (including Laubegast und Kleinszchachwitz). A document describes the stakeholder process started in 2010 involving about 200 participants to formulate goals, defining tasks, and formulating concepts.	proofed with Prince George's County funds, primarily through site grading and floodwalls around entrances. At the SMARTeST Washington DC Workshops a listing of FRe supporting forces included: The crisis of climate change coupled with run-off increases; increasing risks and economic losses; regulations and permit requirements; incentives such as lowering insurance rates.	the development of technical norms for buildings and for the protection of infrastructure from defined frequency storms (PATRICOVA, Section II, Articles [25; 29]). For example roofs must be accessible from the inside. Major garages may be asked to have low-level floor obstacles and there are meant to be signs with warnings of flood risks. Additional special conditions can be imposed for buildings in flood hazard zones.			construction of innovative measures. In Spain local councils have used their "administrative power to bargain", calling for FRe measures before granting building permits. On Cyprus a limited demand and practically no supply of measures summed up the constraints.
2.2 Educational institutions are conveying knowledge and influence the mind-set of our future decision makers.						
2.2.a To what extend do educational institutions constrain the transfer of knowledge about the practice of FRe practice FRe in your case study city?						
Specialist courses in FRe are not part of the curriculum at universities or other educational institutions. This contributes to a lack of knowledge and expertise. A lack of interest is deemed to be the refusal of the UK government to implement Pitt Report recommendations on building regulations.	Rigid and outdated education constrains the transfer of knowledge. This is not a problem in Dresden.	Prominent educational institutions in the US charge tuition of $ 30,000 to 60,000 per year (or higher) Students tend to select courses that permit them to graduate as soon as possible. Flood resilient technology still is at the fringe of future coursework.	No constraints, though structural solutions under governmental control are being considered to be more effective than FRe products.	Coursework and textbooks concentrate on the design of networks of storm drainage systems for a given design storm. How to deal with situations where the storm exceeds design conditions is usually not being dealt with at the university level.	No constraints identified. Research and educational institutions make significant efforts to import innovative practices, however a lack of funding and structures for testing limit the transfer of knowledge about FRe practices.	Specialist courses for the planning and construction of FRe are not part of the general curriculum of universities in the EU. A constraint in the U.S. is high tuition rates at universities compelling students to avoid "non-essential" courses to graduate as fast as possible.
2.2 b How can educational institutions offer opportunities for the practice of FRe?						
An engineering foundation degree in river and coastal	The Dresden University of Technology has acted as a	Competition for student enrolment forces universities to be on the forefront in research	The study of resilient approaches and of	Students should be taught how to address	Funded research projects, involving	Competition for student enrolment in the U.S. is

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engineering at a university has been commissioned by the Environment Agency (EA), but has only had 120 students since 2004. Efforts are being made to increase attendance. The Chartered Institute of Water and Environmental Management (CIWEM), the Royal Institute of Chartered Surveyors (TICS), and the Construction Industry Research and Information Association (CIRIA) are offering seminars leading to Certificates of Continued Professional Development (CPDs). The Trust of the Building Research Establishment Ltd (BRE) has funded development of a course on flood resilient planning and construction.	centre advocating the practice of FRe and sustainable drainage practices. This involved the Faculty of Architecture, Institute for Landscape Architecture, having conducted special teaching and research seminars involving neighbourhood representatives, students and other faculties in Germany (TU Hamburg Harburg), Slovenia and the USA. The Faculty of Architecture also conducted a pilot project for the City of Grimma, including urban design of FRe measures and is currently planning an international conference on "Flood Protection and Heritage Conservation" in 2014. The Leibniz Institute of Ecological Urban and Regional Development (IOER) is highly active in flood risk management research.	and course offerings. Stormwater management is part of the coursework offered at the University of Maryland and in other universities in Washington D.C. Computer based decision support systems can be a great help as a teaching tool in continuous education courses. Over the last four decades Universities have played a pivotal role in research, conferences, courses and seminars on flood topics.	applicable technologies could become part of the curricula for academic degrees that relate to flood risk management.	consequences of exceeding design conditions. This especially applies to urban areas where flood risks are constantly increasing and where living with floods is becoming a new reality.	case studies, could lead to the dissemination of results.	motivating universities to want to be on the forefront in course offerings. Government programs directing universities in Germany hold incentives for the creation of elite universities. Special efforts in coursework development and research (IOER) have been made in Dresden, Germany. In the U.K. special courses addressing FRe have been developed through funding by government agencies and private institutes.
2.3 Local environmental groups and NGO's have been hailed as the real movers and shakers in a democracy.						
2.3.a Have local environmental groups and NGO's offered constraints on the practice of FRe						
It is being felt that FRe are the responsibility of government. There is some anecdotal evidence that many groups prevent FRe uptake in the hope that large-scale projects will be funded.	Environmental groups in Dresden have opposed the construction of certain levies and floodwalls.	Local environmental groups do not offer constraints to the practice of FRe, but generally oppose new development on the floodplain including the construction of levies and floodwalls.	No constraints as a general rule. The use of FRe technologies should not be an excuse for building on floodplains.	Environmental groups and NGO's have not presented any constraints to the implementation of FRe. During floods FRe protects both, the natural- and the built environment.	Citizen's groups are meant to conduct studies and push forward measures for their areas of interest. Their activities require to be approved by the supervising Ministry of Environment, Energy and Climate Change.	NGO's with successful lobbying capabilities in the U.K. have been accused to try to secure funding for large-scale projects, rather than property-level FRe. Environmental groups in Germany are known to oppose flood defence with adverse environmental impacts. The Spanish contribution points out

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					Usually approval arrives late or not at all. Given the economic circumstances of Greece such projects have hardly been scheduled.	that most NGO's are in need of capacity building for themselves, prior to distributing information and supporting FRe.
2.3.b Have local environmental groups and NGO's created opportunities for the practice of FRe?						
Victim support groups such as the National Flood Forum (NFF) http://floodforum.org.uk/ offer opportunities. The NFF is a charity run by flood victims, providing support and advice to communities and individuals. It is a successful lobbying group that emerged in response to larger-scale riverine flooding in predominantly middle class towns. Some feel that it connects less with needs of vulnerable urban centres.	It was the political engagement of NGO's in Laubegast that helped to convince the Dresden City Council to allocate funding for a stakeholder involvement process. In all of these cases stakeholder participation grew out of a perceived problem, issues, and differences of opinions that provided political glue that brought people together. NGO's here offered the benefit of understanding networks of decision makers, knowledge about processes, realisation of funding opportunities and organisational skills to exert political pressure.	Stormwater management for water quality is actively embraced by environmental groups and by NGOs. It is a particular interest of environmental groups formed for the protection of stream catchment areas. Numerous voluntary and semi-public associations in the Washington DC area play an outstanding role in "capacity building". Stakeholder participation here is an effort to build consensus, through learning and convincing, gaining confidence and winning agreement. NGO's here have made contributions that influenced the course of water resources management throughout the U.S.	Most NGO's are in need of capacity building, prior to distributing information and supporting the use of FRe.	NGO's and environmental groups could play a key role. Massive drainage systems and flood protection infrastructure call for large capital investment with adverse environmental impacts. Contrary to that FRe technology at local levels is associated with low capital investments and limited adverse environmental impacts.	Local communities have started to establish relevant citizen bodies to permit active participation of stakeholders. Such groups have organised workshops on civil protection and on environmental education for students. Associations like the Hymettus Protection and Development Association (representing 1.2 million citizens) play a role in flood risk management.	NGO's in the Dresden, Germany case study area used their organisational skill and knowledge of political process to secure funding for a stakeholder involvement program. In the U.S. NGO's were instrumental in promoting adoption of property-level stormwater management practices (BMP's).
2.4 Individual property owners play an expanded role in implementing and managing FRe technologies and programs.						
2.4.a What are the constraints offered by property owners?						
Principal issues in Haywood and elsewhere include a lack of knowledge about what is available, lack of finances, trust in efficiency, ease of use, product aesthetics and public communication of undesirable	Lack of knowledge about flood risk and about abatement measures are a constraint. In a survey of more than 1200 households, 59% of those affected by the River Elbe Flood of 2002	Flood-proofing of homes can receive substantial public assistance, yet there is low interest in practicing it. Participants of the Washington DC workshops stated that government involvement after accepting public assistance and limited control over appearance of measures act as a constraint.	Property owners are likely to make attempts to avoid compulsory FRe technologies as they increase constructions costs.	Property owners tend not to be aware of FRe technologies. They tend to forget the risk of flooding. They further tend to ignore the benefits of flood	A lack of information, a lack of initiative and a lack of funding are essential constraints	Implementation of property-level measures in the EU is constrained by a lack of knowledge about what can be done, lack of trust in measures and a lack of available finances. In the U.S. where some

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messages. Property owners generally feel that protection against flooding is the responsibility of government agencies or their insurer.	stated that they did not know they lived in a flood prone area, only 11% had used and furnished their house in a flood adapted way and only 6% had flood adapted building structures. Government continues to be viewed as being responsible for flood risk management and its costs.	There also was a concern that evidence of flood-proofing on structures may scare off potential buyers.		protection when they feel secured through flood insurance.		government funding is available there were concerns about limited control over the appearance of measures and their effect on resale value.
2.4 b What are the opportunities for property owners?						
Agencies have been promoting opportunities through publications and Internet reports. They may not reach a predominantly working class urban neighbourhood such as Heywood but are commendable. Examples are BRE Digest 523, Flood Resilient Construction, Parts 1 and 2; BRE Repairing Flooded Buildings; the ABI Flood Resilient Homes fact sheets at *www.abi.org.uk/Information/-consumers/General/15274.pdf*; RAAB Consultants Homeowners Guide to Flood Resilience; the *www.knowyourfloodrisk.co.uk/pdf/protection-guide.pdf*, and Defra/EA's research and development concerning Flood Resilience and Resilience Solutions.	The stakeholder participation process in Dresden-Laubegast demonstrated how property owners and other interested parties could be involved in planning of optimal solutions. Eventually property owners are expected to agree that private flood risk management is in their own interest.	Implementation of FRe depends heavily on property owners and stakeholders. A strategy for their involvement that has been put forth by FEMA. It is a multi-objective management approach called M-O-M reasoning that a single-minded approach will no longer lead to solutions. M-O-M reasons to: (1) keep the effort locally based; (2) understand the problem and its relationship to the catchment area; (3) think broadly about possible solutions; (4) identify other community concerns that could be related to the flood problem; (5) obtain expert advice from government and private organisations; (6) built a partnership among individuals, private and public groups. Successful implementation of property-level stormwater management practices (BMP's) in the case study area reflects 40 years of practical experience.	Property owners are the main beneficiaries of measures. They would welcome incentives through the reduction of municipal fees and taxes for properties where FRe have been installed.	Increasing frequency and depth of flooding and will lead to more awareness after flood events will help to create a market for flood resilience products that benefit property owners.	Property owners see the protection property, livelihood and risk- and damage mitigation as opportunities.	Property owners and governments that represents their interests are expected to realise that property-level flood risk management is more beneficial for them than a sole reliance on large-scale flood defence works bound to be overtopped at times. The most important stakeholders are property owners. This can only succeed when there is a participatory decision- making and learning process for capacity building. In the U.S. a strategy for stakeholder involvement has been advocated by FEMA. The multi-objective management approach (M-O-M) reasons that a single-minded approach wills no longer lead to solutions. The U.S. further is a good example of the successful implementation of property-level stormwater management practices (BMP's).

I-2 Models and tools for the implementation of FRe constructions and technologies

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I-2.1 Introduction

The targets of this chapter are, first, to demonstrate the performance of models and tools that have been enhanced within the SMARTeST project to facilitate the uptake of FRe technologies (s. section I-2.2) and, second, to describe an approach on building capacity in stakeholders to strengthening their skills, competencies, and abilities to develop a better understanding of opportunities and constraints in flood risk modelling (s. section I-2.3).

The SMARTeST toolkit contains all models and tools that have been evolved to assess flood damage to the built environment and to support resilient planning on different scales. The toolkit introduces the scope of application, the methodology, the SMARTeST enhancements as well as the general results and outcomes of each model and tool. Hence, section I-2.2 places more emphasis on the integration of FRe technologies in flood risk modelling and describe how the SMARTeST models and tools deal with that issue.

It is obvious that the acceptance of innovative FRe technologies requires capacity building with stakeholders in order to understand and implement the transfer process from the traditional flood defence to flood resilient cities. An approach on building capacity on SMARTeST models and tools is addressed in section I-2.3.

I-2.2 Integration of current technologies in flood risk modelling

I-2.2.1 Current state of research in flood damage assessment

In recent years several tools for flood damage assessment have been developed. An over-view is given by the review reports of Messner *et al*. (2007) as well as by Merz *et al*. (2010). Although flood damage assessment is an essential part of flood risk management, as it supplies crucial information for decision-making processes, it has not received much scientific attention. For the assessment of economic flood damage most of the available models and tools use absolute or relative damage functions to quantify the flood vulnerability of elements at risk. Knowledge about these elements at risk is necessary for the assessment of the effects of flood resilience measures. Most of the existing tools are not sufficient as they cannot simulate the damage reduction potential and do not offer the possibility to quantify direct tangible damage to buildings and constructed assets and to deter-mine the impacts of measures concerning vulnerability mitigation.

Flood damage models usually use the concept of damage functions to describe the degree of damage to elements at risk depending on different water levels. These specific damage functions represent the flood vulnerability of each element. The review report of Merz *et al*. (2010) has covered two main approaches to develop flood damage models: empirical approaches which use damage data collected after flood events (ex-post analyses) and synthetic approaches which analyse damage processes including refurbishment measures ex ante (Neubert *et al*., 2012; Naumann *et al*., 2009).

An example for the first approach is the German flood damage data base HOWAS (Merz *et al*., 2004), from which the damage functions of MURL (MURL, 2000) and Hydrotec (Em-scher Genossenschaft & Hydrotec, 2004) were derived. Examples for synthetic approaches are the damage functions for United Kingdom (Penning-Rowsell *et al*., 2005) and HOWAD-Prevent (Neubert *et al*., 2012). It is possible to combine both approaches, e.g. to extend empirical data with synthetic data which was done by the US Army Corps of Engineers (USACE, 2006), in Australia (NRE, 2000; NR&M, 2002) and Germany (ICPR, 2001) or to evaluate synthetic models with empirical data. Table I.2-1 indicates the advantages and dis-advantages of both approaches.

Table I.2-1: Advantages and disadvantages of empirical and synthetic flood damage models (Merz et al., 2010 modified)

	Advantages	Disadvantages
Empirical damage models	Real damage information possesses apparently a greater accuracy than synthetic data (Gissing and Blong, 2004).	Detailed damage surveys after floods are uncommon, so that models may be based on poor quality data (Smith, 1994).
e.g. RAINS	Effects of damage mitigation measures can be quantified and taken into account in damage modelling (Kreibich *et al*., 2005; Thieken *et al*., 2008a).	Statistical data about flood damage is often available only for coarse statistical units (e.g. German federal states). Hence, the data are often vague and have a high range of variability.
	Variability within one category and water depth is reflected by the data and uncertainty can be quantified (Merz *et al*., 2004).	Paucity of information about floods of different magnitude and often a lack of damage records with high water depth require extrapolations (Smith, 1994; Gissing and Blong, 2004).
		Transferability in time and space is difficult due to differences in warning time, flood experience, building type and contents (Smith, 1994).

	Advantages	Disadvantages
Synthetic damage models e.g. HOWAD-Prevent, FLORETO-KALYPSO	In each building, damage information for various water levels can be retrieved (Penning-Rowsell and Chatterton, 1977). Approach does not rely on information from actual flood events and can therefore be applied to any area (Smith, 1994). Higher level of standardisation and comparability of damage estimates	High effort is necessary to develop detailed data bases (inventory method) or undertake large surveys (valuation survey method) to achieve sufficient data for each category/building type (Smith, 1994). What-if analyses are subjective, resulting in uncertain damage estimates (Gissing and Blong, 2004; Soetanto and Proverbs, 2004) Premises within one classification can exhibit large variations which are not reflected by the data (Smith, 1994).

I-2.2.2 SMARTeST Toolkit

The SMARTeST toolkit has been developed in order to support flood risk assessment and flood resilient planning on different spatial scales. Therefore, the toolkit is composed of several models and tools, which support different planning phases being risk assessment and development of a resilient plan for the built environment (Manojlovic, 2013; see Figure I.2-1). An overview of the developed models and tools with their functionalities, their classification in terms of the key targeted users, their considered spatial scale and flood typology, their integration in flood resilient planning processes and their technical features is given in Table I.2-2. In addition, the application of the model approaches in the SMARTeST project is shown in Table I.2-3.

Figure I.2-1: Components of the SMARTeST toolkit. (Source: Manojlovic, 2013)

Table I.2-2: Overview of the model approaches within the SMARTeST toolkit

Tool	Multi-Hydro	HOWAD-Prevent	FLORETO/ F-KALYPSO	RAINS	FVAT	Basic Barrier
Project partner	ENPC	IOER	TU-HH	TUD	ENPC	DTA[82]
Model approach						
Rainfall-run-off & Hydrodynamic modelling	+					
Empirically Damage & Risk assessment				+		
Synthetically Damage & Risk assessment		+	+			
Indicator based vulnerability assessment					+	
FRe Barriers dimensioning						+
Description of the Urban structure						
Building geometry	+	+	+	+		
Building classes (Land use)					+	
Structure type approach		+	+			
Building type approach		+				
Vulnerability approaches						
Vulnerability Indicators					+	
Depth-Damage Curves for Building types		+				
Depth-Damage Curves for single Buildings			+			
Empirical approach (insurance data)				+		
Flood types						
Pluvial	+	+	+	+	+	
Fluvial	+	+	+		+	+
Groundwater		+				
Coastal		+	+			+
Flood Resilient planning						
Flood resilient planning	+	+	+		+	+
Effects of object related FRe C & FRe T		+	+			
Effects of area related FRe T	+	+				
Dimensioning of FRe Barriers						+
Cost-Benefit Analysis (CBA)		+	+			
Multi-Criteria Analysis (MCA)			+			
Support of the decision making process	+	+	+		+	
Scale of modelling						
Building / property	+		+			
Neighbourhood / Districts	+	+	+		+	+
City / Region / Catchment areas	+	+	+	+	+	+
Target groups						
Water Management/ Hydraulic Engineers	+	+	+	+	+	+
Consultants (civil engineers, architects)	+	+	+	+	+	+
Public authorities, Decision makers		+			+	
Environmental agencies	+	+			+	
Insurance & reinsurance industry		+		+	+	
Private users (homeowners, dwellers)			+		+	
Other professionals (e.g. spatial planners)		+			+	

[82] Dion. Toumazis & Associates (Nicosia)

Table I.2-3: Application of the model approaches within the SMARTeST case studies

Tool	Multi-Hydro	HOWAD-Prevent	FLORETO/ F-KALYPSO	RAINS	FVAT	Basic Barrier
Case studies						
Villecresnes, Kodak, Bievre, France	+				+	
Dresden, Germany		+				
Valencia, Spain		+				
Rotterdam, The Netherlands		+		+		
Paphos, Cyprus			+			+
Athens, Greece			+			
Greater Manchester, Heywood, UK	+	+				
Hamburg, Germany			+			

A key criterion for the implementation of flood resilience construction and technologies is having sufficient evidence about their level of performance. Therefore, within the SMARTeST project a set of innovative and smart flood resilience technologies has been identified and tested by experimental studies. Following Samuels & Gouldby (2010) performance is defined as the degree to which a process or activity succeeds when evaluated against some stated aim or objective. Performance indicators for FRe T are their reliability and efficiency.

Reliability is understood as the capability of FRe T to perform to their required functions under stated conditions. Based on harmonised test methods, consistent reliability studies were conducted for selected FRe T within the SMARTeST research project in order e.g. to analyse their capacity to withstand hydrostatic and hydrodynamic flood actions (failure) or to determine their intrinsic parameters such as the leakage rate . Efficiency generally relates the positive effects (benefits) to the expenditures (costs) of FRe T implementation in monetary terms. The resulting benefit-cost ratio is an indicator that serves as a basis for the selection of most efficient FRe T alternatives to improve flood resilience. However, there is currently a significant uncertainty of FRe T efficiency due to a lack of scientific data of their positive effects (benefits).

To overcome this obstacle models and tools that have already been developed and approved by project partners were extended and enhanced to analyse the potential of FRe T implementation. The SMARTeST toolkit supports (i) the assessment of singular FRe T or the combination of several FRe T options, (ii) permits the derivation of optimised FRe T alternatives, and (iii) supports decision-making processes.

The models and tools of the SMARTeST toolkit have been tested in selected European study sites to analyse their functionality considering various flood types as well as different national and local contexts. The case study approach is used to demonstrate and to compare the effects of different FRe T implementation alternatives at a preferably high spatial and contextual resolution.

Moreover, the SMARTeST toolkit supports the improvement of the flood resilient system design. Following the SMARTeST document ‘Guidance for Resilience Systems’, a ‘system’ is an assembly of elements (e.g. buildings, infrastructure) including their interconnections that may be exposed to various flood scenarios (e.g. fluvial, pluvial, coastal, groundwater). The system approach embraces all flood management elements on various spatial and time scales. As resilience is a system property, it should be applied to flood risk management by adopting a systems approach. Basically, resilience is defined as the ability and the ease by which a system can recover from flooding. The resilience of a system can be assessed through qualitative or quantitative means. For example, the enhancement of flood damage simulation models (e.g. HOWAD-Prevent) can be used to provide information on the extent and costs of damage to properties after flooding. The impacts of FRe technology can result in the reduction in physical damage and reduce repair costs for a property.

Flood risk systems describe the complex interacting processes that influence the magnitudes and patterns of flood events and their adverse consequences. They provide a sound basis for a broad understanding of systems behaviour. The conceptualisation of flood risk systems is a major challenge and comprises the identification of relevant system elements, processes and structures depending on the functional and spatiotemporal extent as well as on the applied scales in space and time (Luther and Schanze, 2009).

The source-pathway-receptor-consequence (SPRC) concept is widely accepted as a simple interrelation representing the risk generating process. Sources (S) indicate the flood generation due to heavy rainfall, snowmelt, storm surges; pathways (P) mean the flood propagation in the river network or at the coastline including the inundation processes; receptors (R) are all physical entities exposed to flooding, such as human beings, buildings, infrastructure or sensitive ecosystems (e.g. in terms of flood pollution); negative consequences (C) specify the adverse physical, social, institutional, economic or environmental effects of flooding (Schanze 2006, see Figure I.*2-2*).

In terms of flood risk sources and pathways represent the flood hazard, whereas receptors and negative consequences state the flood vulnerability. Sources, pathways, receptors and consequences are not only closely connected but also spatially and temporally overlaid. Thus, the division between sources, pathways and receptors is not strict and depends upon the scale and context of the research (Hall *et al*. 2003).

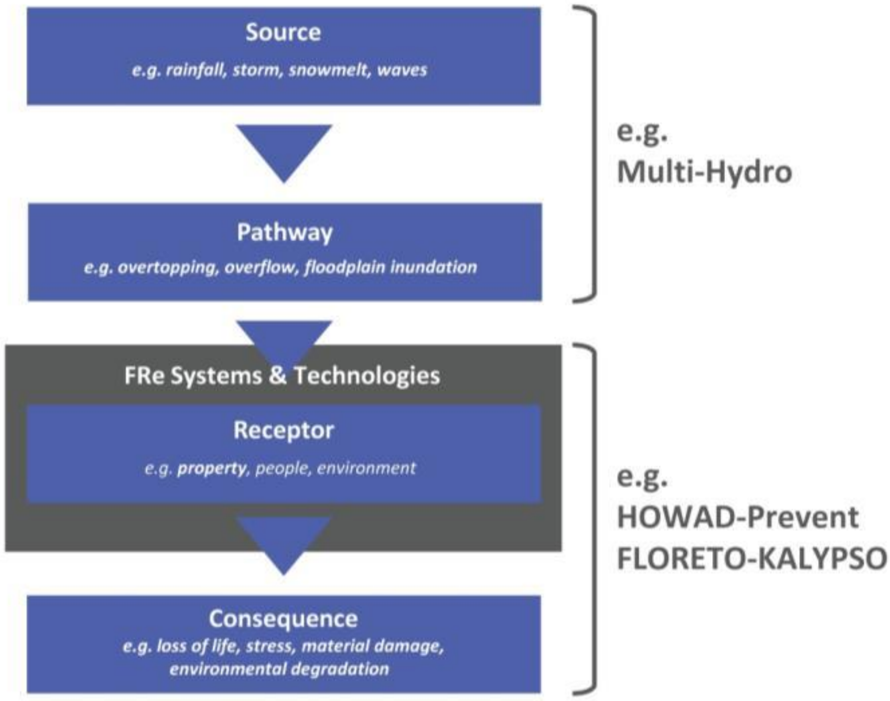

Figure I.2-2: Assignment of SMARTeST models and tools to the SPRC-concept.

The analysis of an entire flood risk system requires the linkage of various approaches. The flood damage simulation model HOWAD-Prevent can be embedded in comprehensive flood risk modelling methodology to analyse potential economic damage to buildings and constructed assets and to assess the impacts of FRe technologies.

I-2.2.3 Coupling of SMARTeST models and tools

A report produced by Luther and Schanze (2009) has covered the issue of analysing a flood risk system for the Elbe River. The authors argue that the coupled modelling of entire flood risk systems with the large number and particularities of processes involved especially on larger scales provide a basis for analysing the system behaviour, but exceeds the traditional disciplinary perspective of flood research. It requires linking methods for hydro-meteorological flood hazard determination with social science approaches of flood vulnerability analysis since risk comprises social, economic and environmental aspects. It is also a specific challenge to deal with the lack of complete information. Linking various approaches is a challenge because of the widespread modelling concepts. However, hard and soft coupling of individual models are common ways of trying to comprehensively simulate flood risk systems. A unique model for simulating the entire flood risk system would currently be a challenging endeavour because of complexity and reduced methodological flexibility.

Figure I.2-3: Coupling models and tools for flood probability assessment and flood damage assessment to assess flood risk

Principal modules for the representation of the flood risk system are already indicated in the methodological framework for decision support in flood risk management by McGahey *et al*. (2009). The modules relate to the description of sources, pathways, receptors and consequences and to the risk analysis. There are numerous tools available for modelling these compartments of the flood risk system. They bear upon different mathematical and technological solutions. Thus, the simulation of a flood risk system requires a choice of appropriate models. This may be influenced by the personal preferences and possibilities of the investigators and also by previous work and results. Beyond modelling the physical processes and the resulting consequences uncertainty of the flood recurrence needs to be tackled by involving stochastic approaches.

The SMARTeST toolkit is no all-in-one tool, as a broad range of complex processes need to be considered in flood risk assessment. Hence, selected SMARTeST models and tools are coupled to analyse flood risk in particular case studies. For example, an approach on linking methods for hydro-meteorological flood hazard determination (Multi-Hydro) with methods for flood vulnerability analysis (HOWAD-Prevent) to support decision making processes was tested within the case study Heywood (s. Figure I.2-4).

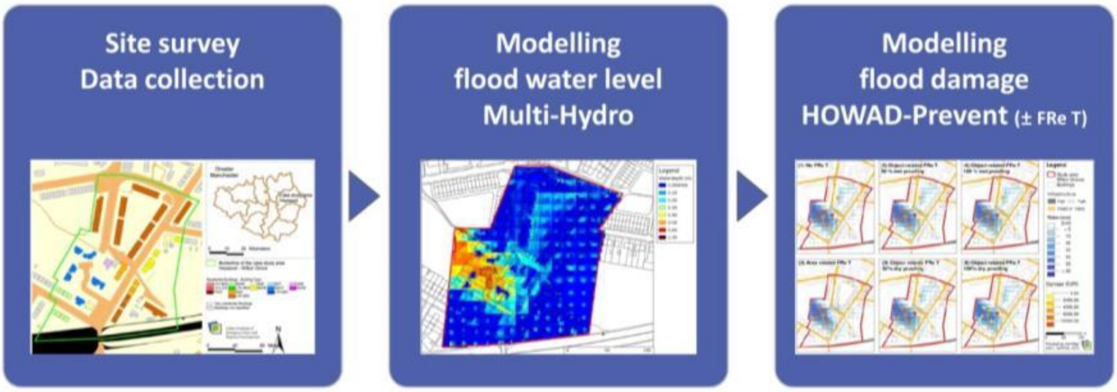

Figure I.2-4: Modelling the effects of selected FRe T regarding vulnerability mitigation considering different flood scenarios and various levels of FRe implementation using the case study Heywood/Greater Manchester (UK).

I-2.2.4 Considered categories of FRe T

Basically, flood resilient technologies (FRe T) are specified as any methods, products or materials that improve the resilience properties of the built environment (Lawson 2011). The SMARTeST project has identified a broad variety of FRe T and assigns them to four predefined categories, as follows:

- Perimeter technologies;
- Infrastructure technologies;
- Building aperture technologies;
- Building technologies.

A comprehensive database was established that provides access to relevant information about available FRe T (http://tech.floodresilience.eu).

On urban scale particularly perimeter technologies such as mobile flood barrier systems, which are installed at some distance from groups of buildings, provide flood protection to specific locations up to a certain threshold. Infrastructure technologies provide protection to roads and railways using surfacing materials, membranes or automatic barriers to maintain their functions. It should be noted that both FRe T categories are outside the scope of this paper, as it pays emphasis to the effects of FRe T at the property level.

On an individual building scale the set of FRe T comprises, first, building aperture technologies for the temporary watertight closure of façade openings such as doors, windows or ventilation elements and, second, building technologies that address either resilient building components or resilient engineering solutions for potentially flood affected building assemblies.

In general, the implementation of both building aperture technologies as well as resilient building components intends to keep floodwater out of the building up to a defined design level. It is obvious that this dry proofing strategy is limited by the individual strength of the particular external wall constructions to withstand flood actions e.g. hydrostatic pressure without structural failure.

Resilient building components include materials for the temporary or permanent sealing of the building envelope; anti-corrosive products that prevent triggering destructive processes or smart domestic flood warning systems that operate automatically flood barriers.

In contrast, resilient engineering solutions are related to the wet proofing strategy. Although building aperture technologies and resilient building components are available in the market that can help avoid floodwater entering a building, there can nevertheless be a significant risk that building assemblies in flood-prone areas have to cope with floodwater, e.g. due to overtopping or failure. Hence, resilient engineering solutions provide advice on how to design new or how to modify existing building assemblies, e.g. external wall or floor constructions, in order to enhance cleanability, to promote fast drying and to minimise the extent of necessary repair works in case of flood water is entering the building. The recommendation of resilient engineering solutions considers material interactions in composite building constructions as well as their structural integrity and inherent resilient characteristics. Laboratory tests to determine the resilience properties of building assemblies have also been conducted e.g. by Escarameia*et al*. (2006), Gamerith & Hoefler (2006), Bowker *et al*. (2007), Escarameia *et al*. (2007), Gabalda *et al*. (2012), and Garvin *et al*. (2012).

I-2.2.5 Selected results from case study analyses

The analyses of different case studies are an important instrument for testing and enhancing the model approaches. The regional characteristics may influence the methodology and hence require an adaptation in generating input data for the models and tools. This is a helpful process in generalisation and enlargement of the particular methodologies. The results of the investigation are detailed information about the study area and a basis for modelling other areas of the region. The case study approach provides the following:

- in-depth experience;
- facilitates knowledge discovery;
- is used to demonstrate and to compare the interrelation between the structural design of building types and their specific vulnerability considering various flood types and different national and local contexts;
- provides a sound basis for the simulation of damage reduction through flood resilience technology (FRe T);
- enables the gathering of high quality digital geo-datasets, which contain, among other things, information about expected flood levels, the topography and the building stock.

Table I.2-4: Selected results from case study analyses.

Case study	Selected results
Valencia, Spain	The investigation within the case study Valencia demonstrates the applicability of the HOWAD-Prevent approach in Spain. The derivation of a country specific, characteristic building type matrix allows the appropriate differentiation of the investigated settlement areas. In evaluation of the mapped building types, it was derived site specific, synthetic depth-damage functions for all predominant building types in consideration of recommended object-related FReT. The target-oriented derivation of model scenario is an extended refinement of the recommendations for individual buildings due to the object related exposure information. The application of the Monte Carlo approach clarifies the possibilities of a detailed consideration of FReT and it validates the weight function method. The overall results emphasis the pilot character of the study and give an important insight in effects of FRe Technologies. The study provides the basis for the application of the model approach in other Spanish areas considering different flood types and damage types.
Villecresnes, France	The results show that all scales should be taken intoaccount when evaluating system performance. The simulations concern four options considered independently that have impacts on the whole area. These results are helpful to specify the functions of the FM/FRe system. The implementation of these measures is something really complex and difficult in the Paris area. Indeed, as it shown during the recent local workshop with different actors of the flood resilience, these protections are from the responsibility of different level of the decisional pathway. As shown in this study, the problem of the implementation of a protection measures ask many questions about the efficiency, the cost and the management... All these questions need to be taken into account before the choice of the protection strategy. A tool as Multi-Hydro can provide some precision about the effect of a given implementation and can pro-vide a support to explain the problem to the concerned people.
Rotterdam, The Netherlands	One of the strengths of HOWAD-Prevent is that the model can be successfully used for pluvial flood damage assessment. The model assigns water level depths for every building polygon with 10 cm steps allowing detailed calculation. The other strength, which at the same time can be weakness, is the detailed approach by using fine water grid and disaggregating buildings into polygons. Weakness stems from the great efforts in data collection and uncertainty in input data, which propagates to the final damage estimate. The uncertainty sources of the HOWAD-Prevent are the input data– water level, building stock classification and depth-damage curves. While building classification has the least influence on the uncertainty, both water level and depth-damage curves have the most influence. Specifically for this study, great uncertainty source was the digital elevation model and the method of filling

Case study	Selected results
	the voids. The HOWAD model approach using a statistical analysis of the damage relevant water levels. It calculates the minimum, mean, and maximum water level for each building polygon using all grid cells surrounding by the corresponding building polygon. The three values give an insight for the statistical distribution of the calculated water levels. The differences of the statistical water level values could be relevant for large buildings and small investigation areas.
Paphos, Cyprus	With the barrier system mounted during the storm, the impact on the road and shops is reduced. Water run up is reduced and the water level does not reach the shops. Sea weeds, pebbles and debris are stopped by the barrier and some of them are deposited at the foot of the mounted barrier. The road is closed for four hours, during the storm and returns to traffic use soon after the end of the storm. The direct damage cost is only associated with the cleaning of the barrier. The cost of the installation of the barrier is about €100,000 and the cost of mounting, cleaning, demounting the barrier is estimated to be about €5,000 per event. The cost-benefit analysis suggests that a capital investment of 100 000 € and a maintenance cost of about €5,000 have a potential reduction in flood damage of €380,000 thousand per flood event with a flood level of 0.2 m. The risk of flood damage is increasing with time due to climatic conditions, namely higher sea level and extreme events being more frequent.
Athens, Greece	FLORETO damage assessment model was implemented in two different building blocks. The suggested resilient plan for the studied blocks included the following measures: a) Controlled flooding of a basement (installing a pump with a sump), b) Wet-proofing of the building fabric, c) Encapsulation of services (wiring and heating), d) Protection from backwater by a non-return valve and e) Horizontal sealing of the walls in the ground floor. Controlled flooding could in effect assist in dealing with long periods of recovery in the context of infrastructure and building restoration. The cost of selected measures for the given parameters were accumulated to 5.000 € per building while benefits per building were indicated in a range of 220.020 € - 440.400 € (min-max). In Greece and in Nea Philadelphia in particular, direct damages are recorded in the basement or ground floor of a building, in the majority of flood events. This is owed mainly to two reasons: a) no predictive methods for flood water removal, for economic reasons in the construction or b) due to bad design-construction. Despite the flood risk in some areas, there is no provision for installing a pump to remove flood water from basements, but only rarely and after a flood event. Until the mid-1980's, in residential areas like Nea Philadelphia, particularly of

Case study	Selected results
	low and moderate income, illegal configuration of basements in residences took place in order to fully exploit the property. Even today, in areas with garden patches, the entrance of the building (houses, shops) is placed as low as 60 cm below the road level, in order to fully exploit the total allowable height and number of floors of the building.
Heywood/Greater Manchester, UK	The enhanced flood damage simulation model HOWAD-Prevent was successfully tested within the Heywood case study. It became obvious that the expert model's strengths is its usability even for small scale flood damage assessments considering different flood types. Moreover, it could be demonstrated how to determine the effects of FRe technologies concerning physical flood vulnerability mitigation. The flood damage assessment considered various scenarios that comprised different types and levels of FRe technology implementation. The modelling results provide a sound basis for stakeholders to find most appropriate resilient options.

I-2.3 Capacity Building on SMARTeST models and tools

Basically, the capacity building approach aims at strengthening the skills, competencies, and abilities of stakeholders to develop a better understanding of opportunities and constraints in flood risk modelling. The engagements of all concerned stakeholders, who are involved in flood risk modelling issues, encourage effective decision making in flood resilient planning for the built environment. It is evident that the acceptance of smart models and tools in flood risk management requires the availability of comprehensive and profound knowledge about their functionality, their outputs, their data requirements, and their ability to facilitate the uptake of FRe technologies.

Capacity building on flood risk modelling addresses at least two different levels, first, the individual level and, second, the organisational level. At the individual level, capacity building typically covers knowledge and skills exchange, via training and other mechanisms such as learning-by-doing, participation and the exercise of ownership. At the organisational level capacity building involves strengthening performance and functioning capabilities through developing tools, guidelines, and decision support systems. Of course there may be links between the individual and the organisational level that need to be strengthened as well.

Capacity building on the SMARTeST toolkit needs to be addressed to a broad range of stakeholders to achieve the purposeful implementation of smart models and tools in resilient planning processes. If there is to be substantial benefit it is obvious to increase expertise at least to the following target groups to achieve a resilient culture:

- Professionals in spatial planning and architects;
- Administration (local authorities);
- Civil engineers (R&D, consultants, practitioners);
- Insurance industry;
- Private users (homeowners, dwellers).

Regarding the targeted groups of stakeholders a range of strategies would appear to have the potential for capacity building, as follows:

- To provide teaching and information material e.g. for the chamber of architects or for the chamber of civil engineers as a basis for professional training and further education;
- To maintain internet platforms on flood resilient technologies and on models and tools for flood damage assessment and flood resilient planning, e.g. the SMARTeST model platform;
- To supply a methodological framework for the selection of the most appropriate model or tool for particular purposes;
- To publish research findings in journals, newspapers and to distribute knowledge on television programs;
- To provide open-access or web-based demonstration versions of the developed tools
- To run training sessions and workshops;
- To design and erect a model house that exhibits the range of appropriate FRe technologies as well as the potential of FRe implementation.

Basically, FRe technologies have to be implemented in complex organisational contexts that may vary significantly depending on local or national policies, e.g. building regulations, restrictions or planning constraints and depending on societal practice. The case study approach that has been selected in the SMARTeST project allows in-depth explorations of these organisational contexts within eight European study sites. These explorations provide information on both national and local scale, drawing on information developed through national analysis and on local case study workshops. The comparative presentation of the results and outcomes of the case study analyses serve as a further profound basis for building capacity in stakeholders. Moreover, part III of this guideline contains comprehensive analyses of constraints and opportunities for capacity building for each case study area to effectuate a transfer process from the current situation to FRe systems.

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Part II: Findings and documentation of SMARTeST case study results

The SMARTeST models and tools have been applied in European case studies to test their functionality considering various organisational, local contexts as regional characteristics may influence the methodology and hence require an adaptation in generating input data for the models and tools. The following chapter reflects overall results of case study research and specifies research questions to reach convincing evidence grounding. The case study approach is described in section I-2.2.5 and is used to demonstrate the different models and tools as well as to compare the effects of different FRe T implementation alternatives at a preferably high spatial and contextual resolution.

Case study areas are:

- Villecresnes/Paris (France) Chapter II-1
- Paphos (Cyprus) Chapter II-2
- Pendrecht/Rotterdam(The Netherlands) Chapter II-3
- Nea Philadelphia (Greece) Chapter II-4
- Heywood/Greater Manchester (United Kingdom) Chapter II-5
- Ensanche/Valencia (Spain) Chapter II-6

The following chapters reflect the overall results of the work done within the case study.

II-1 Case study – Villecresnes (France)

Authors:

Agathe Giangola-Murzyn, Abdellah Ichiba, Ioulia Tchiguirinskaia, Daniel Schertzer,

École Nationale des Ponts et Chaussées (ENPC)

II-1.1 Description of the case study: Villecresnes

Villecresnes is a town of 9639 citizens, located in the south east of the Paris region (Figure II.1-1). Being a part of the Val-de-Marne department, it covers an area of 5.62 km². As most of the cities in the Paris region, Villecresnes has undergone a huge urbanisation during recent years, which resulted in a significant decrease of green areas and an important soil sealing.

The city of Villecresnes was heavily affected by several pluvial flood events in 2009. The July 22 event was recognised as a 'natural catastrophe event' according to the French law. The flooding of the gymnasium of Villecresnes is an example of the recorded damages. The ground-floor, occupied by the main room for sport activities, was covered with more than 20 cm of water. The dojo located in the basement, was damaged after this event. Water infiltrated through the ceiling slab. The floor, the tatamis, and the ceiling were damaged.

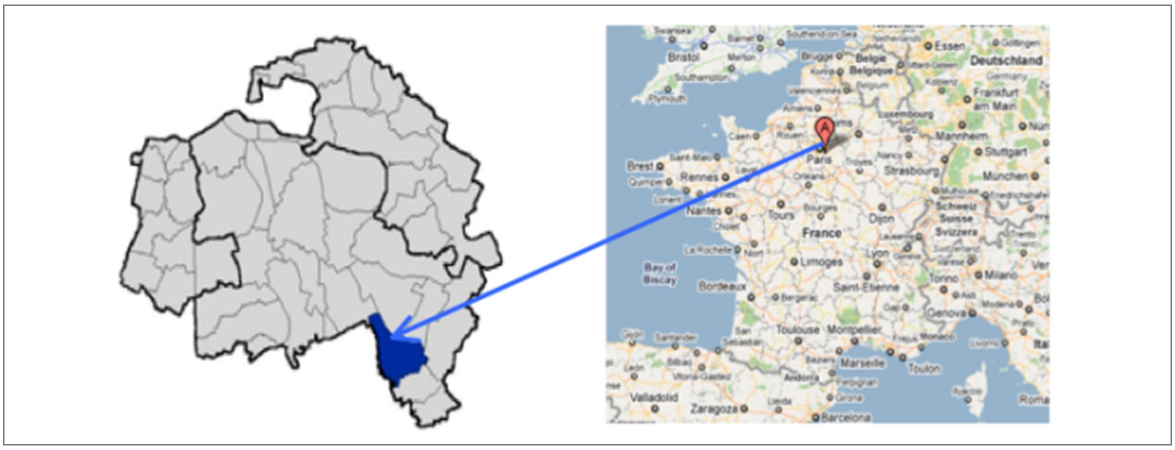

Figure II.1-1: Location of the Villecresnes city

The sport equipment which was not damaged was moved to another location to be used by other cultural associations. The 'sharing of the space with floods' has been difficult because sport activities require a lot of space.

The flood damages could have been reduced by using an existing pumping system. But the users of the gymnasium ignored the existence of this pump, which was moreover not well maintained and could not work correctly. Finally, the decision was taken to move the gymnasium exposed to one in a year flood. A new gymnasium was built outside the flood risk area.

Since 2009 the city has been involved in the national strategy for sustainable development and its Local Plan of urbanisation promotes collective housing, aiming to protect green areas. After the floods of July 22, 2009 the city has also adopted a policy of flood protection and risk management.

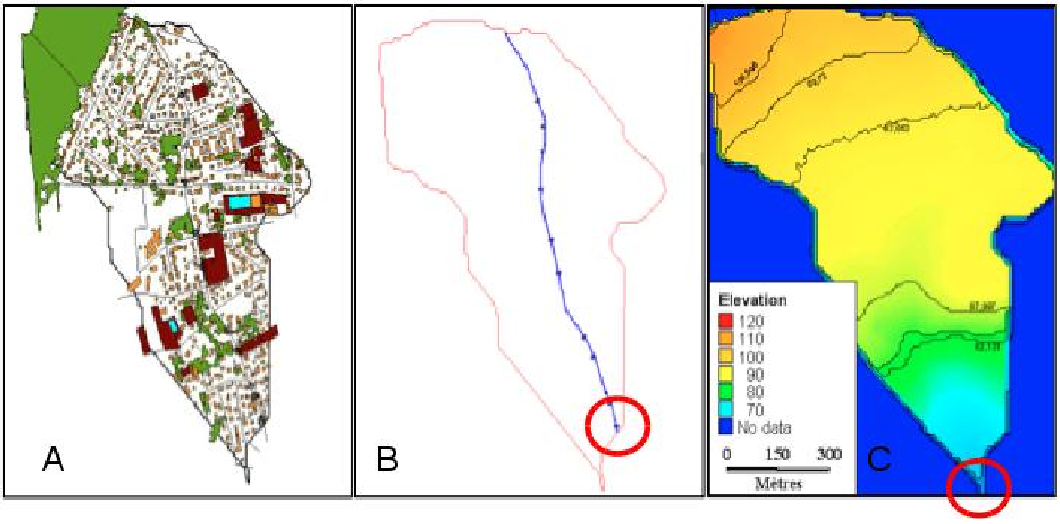

Figure II.1-2: Land use (A), sewer system (B) and elevation (C) maps for the modelling domain. The red circle indicates the location of the outlet of the sewer system on picture B and the outlet of the surface run-off on picture C

The modelled area is located on the East side of the city. Its surface is 7200 m² (72 ha) and its elevation ranges from 120m in the North to 50 m in the South with a constant gradient slope. The land use is characterised by eight classes (see Figure II.1-2). However, roads, houses, greenhouses, and tennis courts have similar parameters.

The sewer system is defined by a linear concrete pipe the diameter of which is 40 cm on the northern third and 60cm on the southern two-thirds. In this case study, four scenarios have been tested using Multi-Hydro model. For each of these scenarios, the objectives will be presented and the results will be discussed. The rainfall pattern (Figure II.1-3) is the same for each scenario: it is a constant (in space and in time) rainfall of 22 mm during 80 minutes. It corresponds to a return period of 10 years.

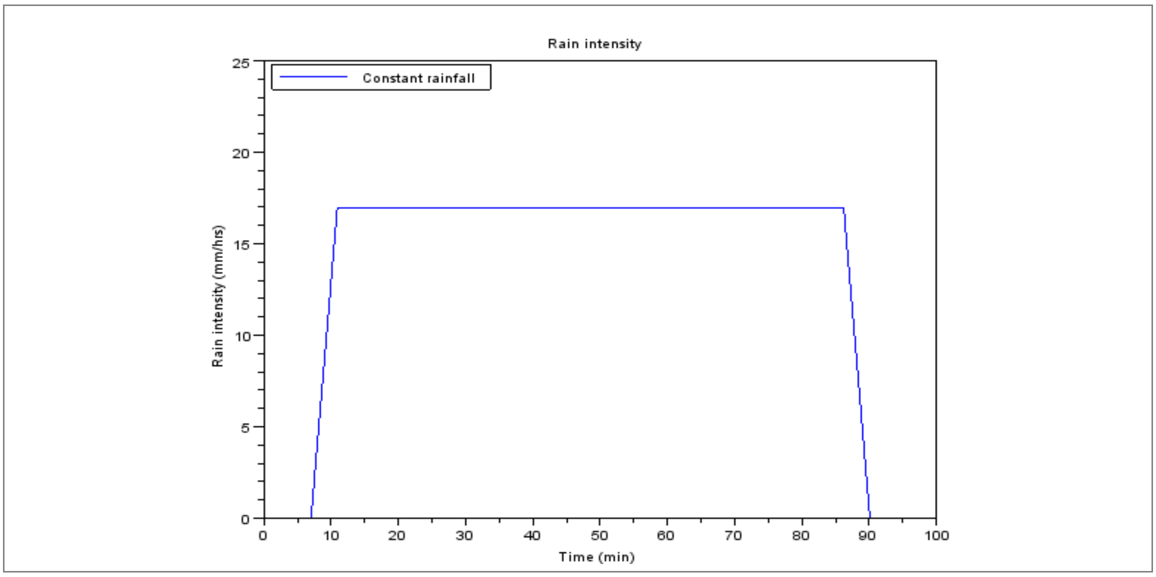

Figure II.1-3: Rainfall event used in this study

II-1.2 Background

Multi-Hydro is a fully distributed physically based model developed at the Ecole des Ponts ParisTech. It is built on the four open source software developed separately and widely used in the scientific world.

With its modular structure, Multi-Hydro can be easily adapted to the need of each case study. As it is GIS based and it doesn't need to be calibrated, Multi-Hydro is easily transportable to a case study to another one. The GIS data are quickly assimilated with the help of MH-AssimTool, an open source software developed at the Ecole des Ponts ParisTech.

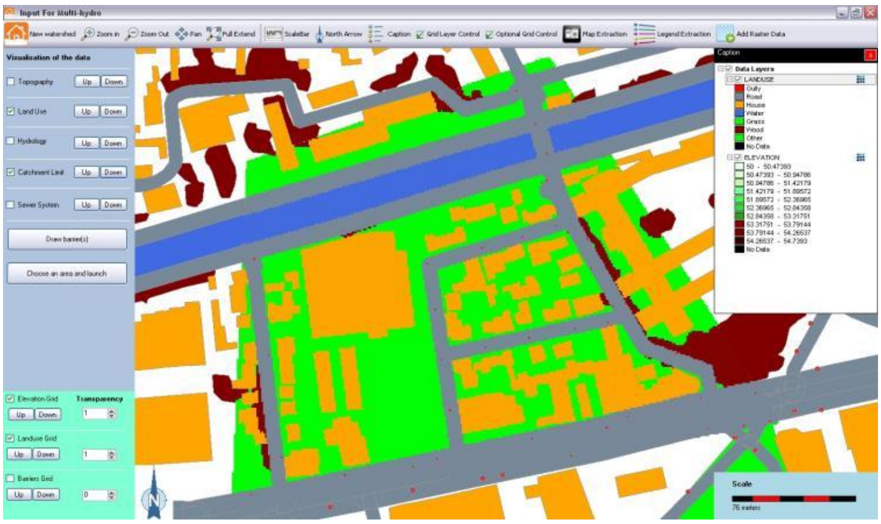

Figure II.1-4: User interface of the MH-AssimTool software

II-1.3 Research approaches/methodology

The Multi-Hydro Surface Component (MHSC) models the surface run-off and relies on TREX, which was developed by HydroQual Incorporate and the Colorado State University (Velleux *et al*., 2011). It uses spatially distributed data (hydrological network, land use, type of soil, elevation, overland storage depth and the initial conditions) to model the behaviour of the catchment.

The Multi-Hydro Ground Component (MHGC) models sub-surface processes and relies on the VS2DT model, which was developed by the U.S. Geological Survey (Lappala *et al*., 1987). It uses finite differences to compute the pressure head, the total head, the moisture contents and/or the saturation and the mass balance, with the help of the law of conservation of fluid mass and a non-linear form of the Darcy equation. It takes into account the structure and the composition of the soil, the amount of water entering in the system, the temperature and the initial conditions.

The Multi-Hydro Drainage Component (MHDC) models flows in sewer systems and relies on SWMM, which is developed by the United States Environmental Protection Agency and the Camp Dresser & McKee incorporation (Rossman, 2010). The model basically relies on 1D Saint-Venant equations, which are used to dynamically simulate sewer flow. The sewer system is described in details (pipe, node, shape, length, slope, initial head, Manning's coefficient).

The Multi-Hydro Rainfall Component (MHRC) enables to downscale rainfall data. Indeed the usual C-band radar resolution of 1 km * 1 km * 5 min does not enable to fully take advantage of the high resolution distributed hydrological model (10 m). The space-time downscaling is performed with the help of universal multi-fractals cascades (Schertzer and Lovejoy, 1987). More details about the multi-fractal analysis and downscaling of this process can be found in Gires *et al*. (2011).

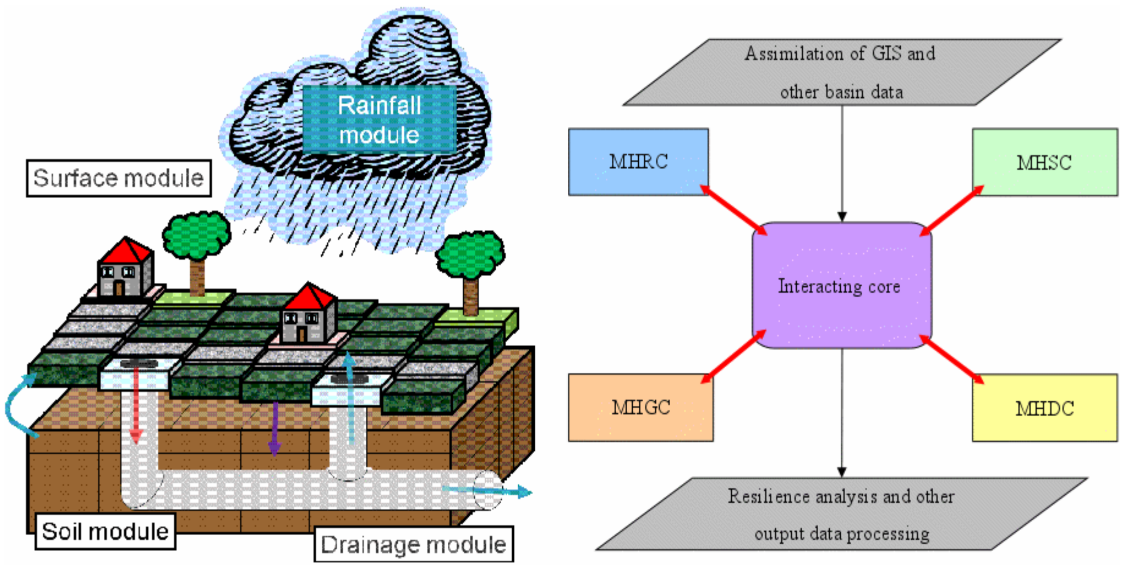

Figure II.1-5: Multi-hydro model description and organisation of the interaction between each component of the Multi-Hydro model

II-1.4 Implementation strategies

Multi-Hydro can be used to model the hydrological behaviour of a catchment under different scenarios, of rainfall and changes of land use.

As the time of computation is relatively short (around 10 minutes for three hours of event on a catchment of 1 km² with a resolution of 10 m), it is easy to produce different scenarios. Here, we will show four scenarios of land use modifications to illustrate the abilities of the model. The scenarios are as follows:

- Channelling roof collected water to drainage network;
- Applying FRe technology;
- Tennis court used as a retention basin;
- Implementation of a peripheral barrier.

These options were considered only for simulation purposes.

A. Channelling roof collected water to drainage network

For peri-urban watershed, water from the roofs of buildings represents an important volume and has a great influence on the surface run-off. Storing water in order to prevent it to directly run off the streets has been the subject of several recent scientific researches. Several storage techniques have been tested: underground reservoirs, wells and green-roofs.

The Multi-Hydro model has simulated the impact of channelling water collected by roofs directly to the sewage system, so as to avoid this volume of collected rain water to participate in the run-off process. In this scenario, both the impact of this change on surface run-off and the possible impact on the sewer system will be analysed.

B. House protection using FRe technologies

Protecting houses, public buildings and electrical installations against water penetration during the storm event is a crucial step to decrease their vulnerability. It may also be helpful to increase resilience.

The SMARTeST project highlighted the great variety of available protection products. The most commonly used are the flood barriers. According to their design, these barriers may be flexible and easy to install after flood alert diffusion.

The department of Val-de-Marne has adopted a protection strategy after the catastrophic floods of 1910 and 1920 and a risk management unit was established. The primary task of this unit is to secure and seal the most vulnerable buildings and important facilities such as electrical installations (see Figure II.1-6).

For simulation purposes, protections around buildings were described as 5m high barriers. This height is of course totally unrealistic. But, in term of numerical simulation and in the context of the scenarios studied, protections needed to be efficient in all case, hence this size of protection of 5m.

Figure II.1-6: Example of techniques used in Val-de-Marne to protect installations (Source: Snapshots from the video: 'Ohval! 18 Spécial crue centennale' http://www.cg94.fr/webtv/term/1061#19442)

C. Tennis court used as a retention basin

Alternative techniques have become today the most widely used tools for storm water management in cities. These techniques enable the storage of rainwater during the storm event. This stored water infiltrates the soil or maybe injected into the drainage network through a flow regulator after the event.

Great efforts have been done during the last few years to integrate such water storage in the urban landscape and make their presence acceptable for the population. In the Paris region, the Seine-Saint-Denis department is one of the leaders in this field. This department can demonstrate an important know-how after 30 years of research on these techniques.

Retention basin with double function is one of the techniques being used and tested in Seine-Saint-Denis. A football ground was for instance laid out so as to ensure a rainwater storage capacity during rain period and return to its normal condition after the event.

In this case study, it was attempted to simulate the same things with a tennis court, the location of which is shown in Figure II.1-7. This is obtained by excavating the ground so as to lower the tennis court surface by 2 metres. In the Multi-Hydro model, this scenario was modelled to assess the impact of this decision on the water run-off in the watershed.

Figure II.1-7: Location of the tennis court in the studied watershed.

D. Implementation of a perimeter barrier (FRe technology)

According to the results of the simulation on the unprotected catchment, a group of houses will be protected with a peripheral barrier of a type displayed on Figure II.1-8. The location of this protected area is shown in Figure II.1-9.

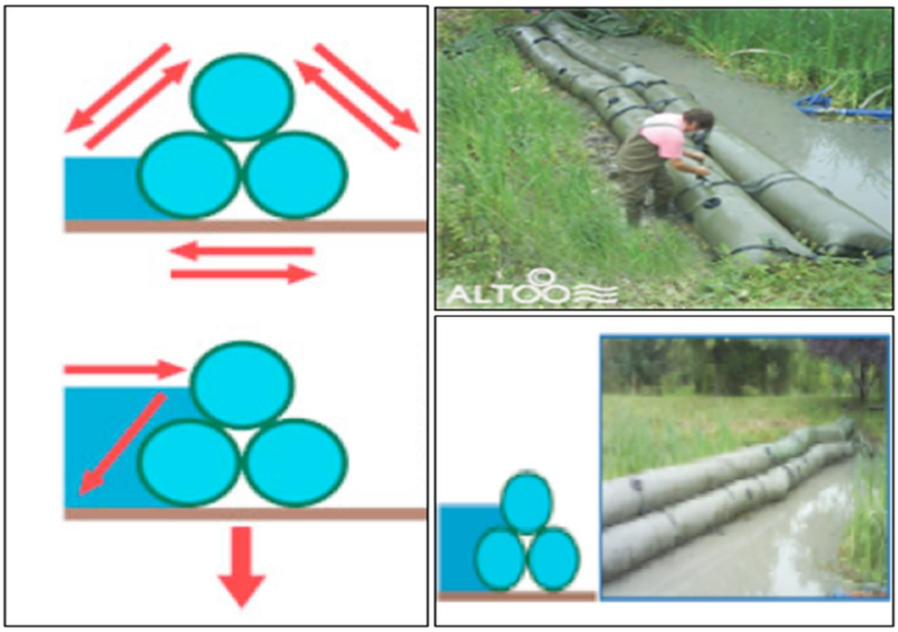

Figure II.1-8: System of barrier used in this case study. (source: www.altoo-protec-flood.fr)

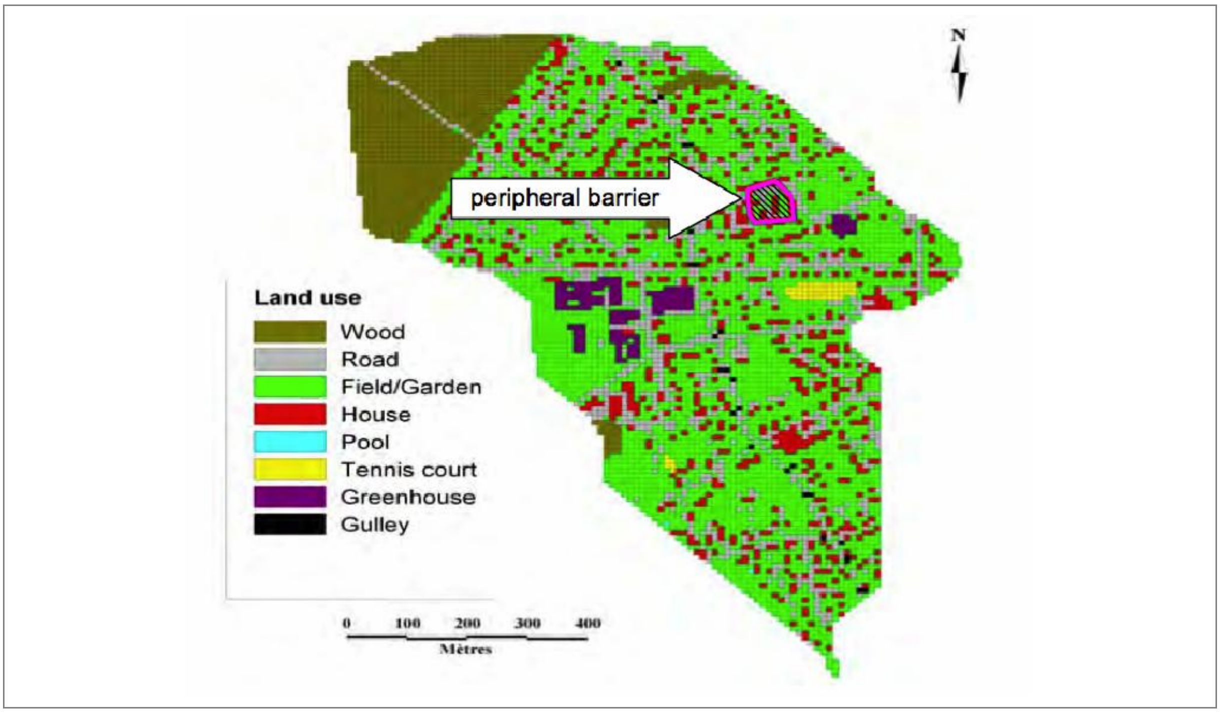

Figure II.1-9: Location of the area being 'virtually' protected by a peripheral barrier

II-1.5 Results

A. Channelling roof collected water to drainage network

To evaluate the impact of the connection of each property of the studied area to the drainage system on the hydrological behaviour of the catchment, the house's pixels were virtually disconnected and connected to the drainage system. The results are given in the Figure II.1-10 for the surface discharge (Figure II.1-10 A) and for the drainage discharge (Figure II.1-10 B).

Figure II.1-10 (A) shows that connecting properties to the sewer system decreases the surface run-off by $0.19m^3/s$, which present 30% of the initial run-off whilst Figure II.1-10 B shows that the sewer system discharge was increased by $0.21m^3/s$ (43% of the initial value).

With this simulation, we show that the connection of the properties to the drainage system has an important impact of the hydrological behaviour of the catchment by decreasing the surface run-off and increasing the discharge in the drainage system pipes.

This decrease of the water run-off does not rely on any FRe technology but on decisions concerning the water drainage system in the city. It may then rather be considered as a 'sustainable development' measure. Further reflections have nevertheless to be carried out in order to assess the possible negative effects (drainage overflow, overpressure).

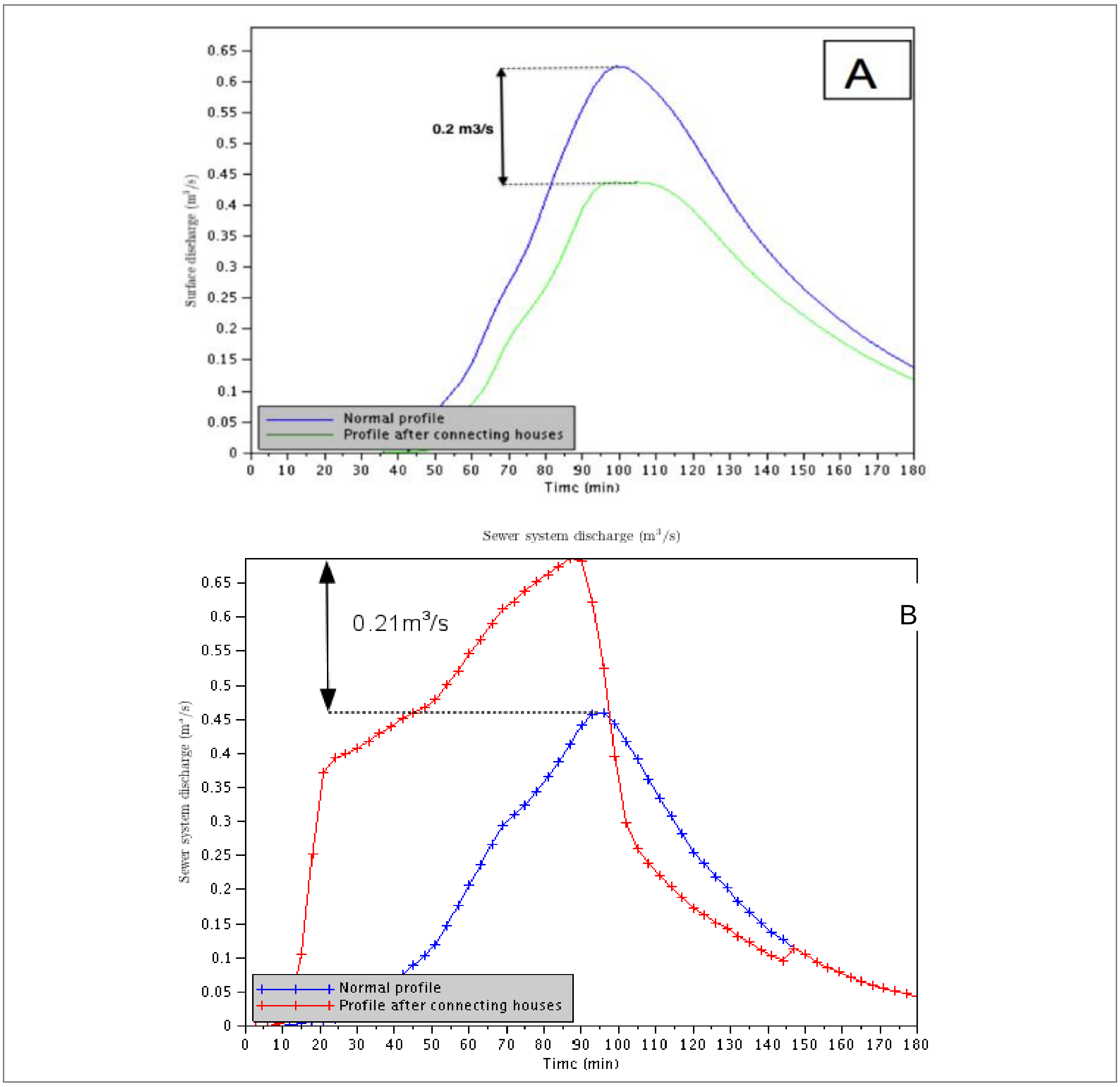

Figure II.1-10: The impact of connecting houses to the sewer system:
(A) on the surface run-off
(B) on sewer system discharge (m^3/s)

B. House protection using FRe technologies

In this option, a 1-in-10 year storm event has been modelled with protecting all openings of houses and buildings. In this case, it is considered that the protections are completely efficient and so, there is no possibility of protection overflows.

The distribution of run-off resulting from the simulation is shown in Figure II.1-11. Gardens, parks and roads are flooded.

In reality, it is difficult to efficiently protect all houses against any flood water depths. The question will be to evaluate which are the houses to protect and for which height, keeping in mind the potential risk to flood an important access roads (access for hospital, evacuation of people).

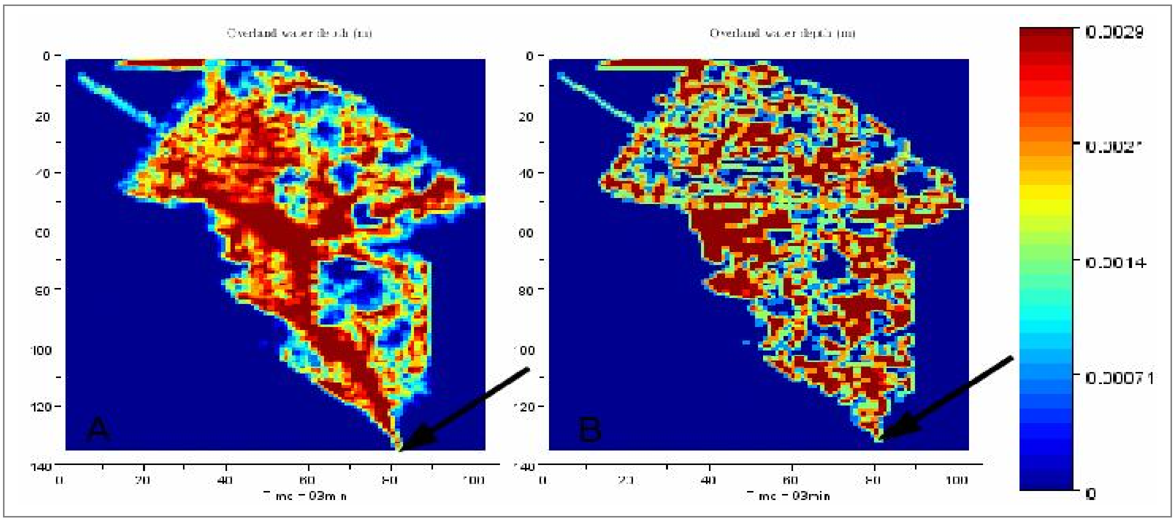

Figure II.1-11: The overland water depth before (A) and after (B) protecting houses at the end of the rainfall event (80min of rainfall, 22mm)

C. Tennis court used as a retention basin

One of the most common measures of land planning in Ile de France is to create areas with a double use. During dry periods, these areas are places of relaxation, such as parks, sports fields and green spaces. In the case of heavy rain, these areas become storage tanks for rainwater and run-off and can be completely flooded without damages.

In this study, the tennis courts were modelled as a potential retention basin to evaluate the effect of this change on the hydrological behaviour of the study area. The location of the tennis courts is given in Figure II.1-7.

Figure II.1-12 shows the impact of this change on the run-off rate at the outlet. The implementation of this modification reduced by 0.2m^3/s the peak flow at the surface.

These results need to be analysed as a series of maps centred on the tennis court area to evaluate the effect of this measure on the hydrological behaviour in the neighbourhood of the tennis courts.

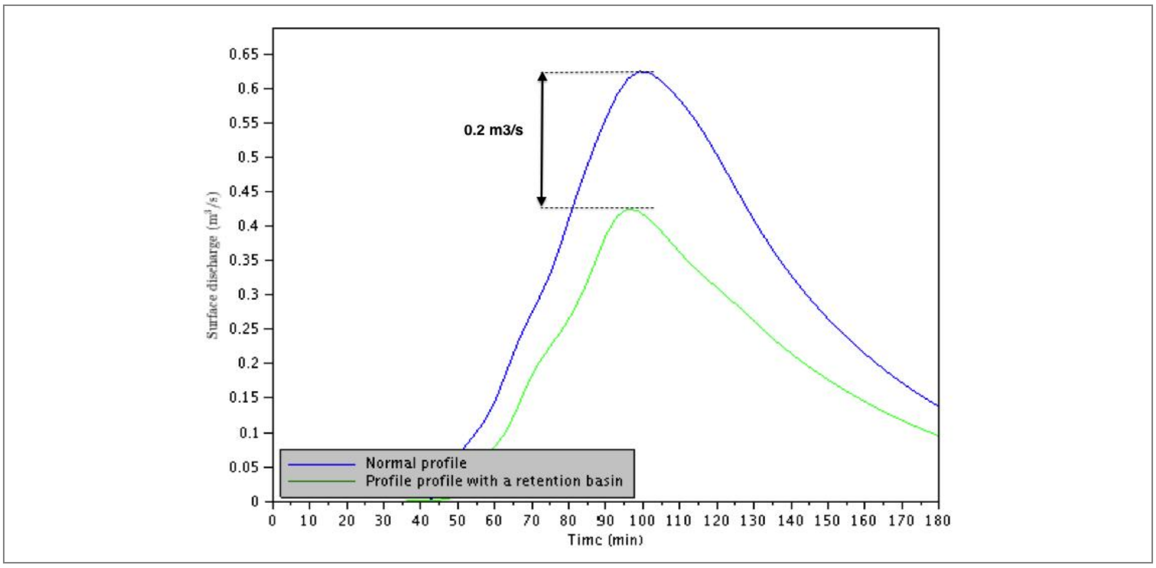

Figure II.1-12: Effect of a retention basin on the surface discharge at the outlet of the catchment

D. Implementation of a perimeter barrier

The simulation taking into account a perimeter barrier provides some indications on the effects of this kind of protection on the hydrological behaviour of the catchment.

The results of the simulation of the unprotected catchment show that a group of houses is vulnerable to the flood risk (pink circle) (Figure II.1-13 left). This area shows an overland water depth of 50 cm.

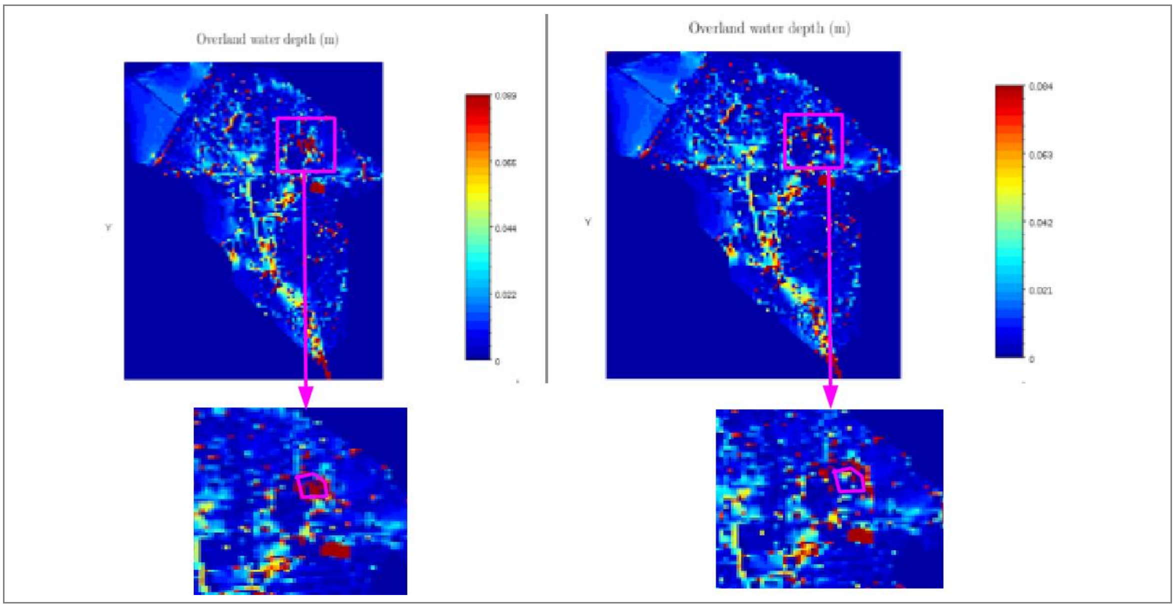

Figure II.1-13: Effect of a peripheral on the overland water depth before (left) and after (right) protecting the area

This area is 'virtually' protected by a peripheral barrier as shown previously in Figure II.1-10. The situation of the protected area looks to be improved (Figure II.1-13 right).

The overland water depth is only of 10 cm inside of the protected area, also a decrease of the water depth of 80%. Moreover, the situation in the neighbourhood does not worsen after implementing the barrier, i.e. roughly 20 cm of water in both cases.

The discharge at the surface outlet and drainage system outlet (Figure II.1-14 and Figure II.1-15) is not modified by the implementation of the barrier. This protection device has a beneficial effect on the vulnerable area without too many negative effects neither on the neighbourhood nor on the behaviour of the catchment.

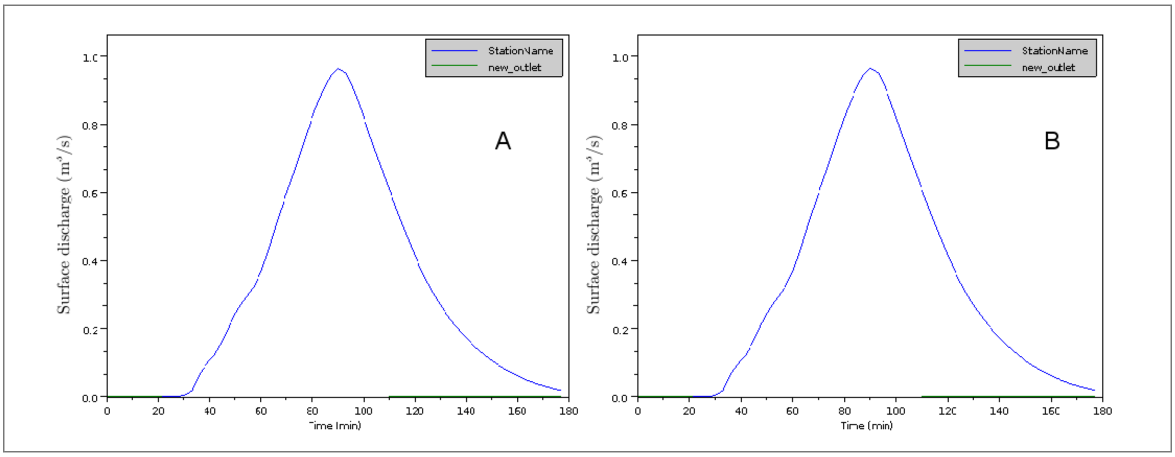

Figure II.1-14: Effect of a peripheral on the overland water depth before (A) and after (B) protecting the area

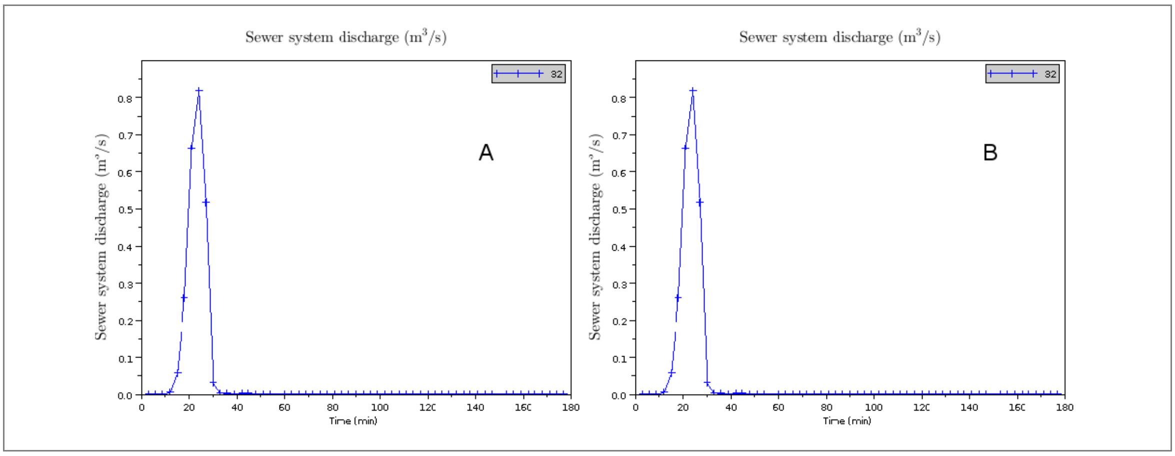

Figure II.1-15: Sewer system discharge before (A) and after (B) protecting the area

II-1.6 Short summary

The results presented in the previous paragraphs show that all scales should be taken into account when evaluating system performance. The simulations concern four options considered independently that have impacts on the whole area. These results are helpful to specify the functions of the FM/FRe system.

The implementation of these measures is something really complex and difficult in the Paris area. Indeed, as it shown during the recent local workshop with different actors of the flood resilience, these protections are from the responsibility of different level of the decisional pathway.

As shown in this study, the problem of the implementation of a protection measures ask many questions about the efficiency, the cost and the management. All these questions need to be taken into account before the choice of the protection strategy. A tool as Multi-Hydro can provide some precision about the effect of a given implementation and can provide a support to explain the problem to the concerned people.

II-1.7 References

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II-2 Case Study – Paphos (Cyprus)

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II-2.1 Introduction

Paphos sea front is experiencing coastal flooding (approximately twice a year) due to wave overtopping. This problem is expected to be worsening due to climate change (rising sea level and more frequent extreme events), more intensive land use and more valuable materials in the flood prone areas. Flood resilience models and tools may be implemented in this area in order to assess the potential damage due to various flood scenarios, implement tools to minimise the flood consequences and return to business as usual at the least possible time. Living with the floods, is achievable by employing FRe technologies and FRe systems.

This report presents the background of the case study of Paphos sea front. The potential flood damage is assessed for various flood levels, using the software tool FloReTo. The cost of installing suitable flood barriers along Paphos promenade is estimated and a cost benefit analysis is performed.

The flood resilience system is presented and discussed. A key unknown in this system is the determination of duties and authorities to stakeholders. The sea front is a public area and there is confusion regarding the allocation of duties for flood protection. This is discussed in this report.

II-2.2 The case study area

Cyprus is an island geographically located in the Eastern Mediterranean (Figure II.2-1), an area characterised by its semi-arid climate. Despite its long history of extended periods of drought that led to water shortage, major floods have affected the island in recent years causing extensive damage to the built environment. Three types of floods threaten the island: (a) pluvial floods in the densely built urban areas, (b) overflow of streams/rivers and of (man-made) storm drainage system, and (c) floods from sea waves. All three types can be disastrous to properties. Floods from the sea are expected to become more frequent as the global climate is changing, with higher sea level and increased frequency of storm events. There is therefore an imminent need to take action in protecting lives and properties potentially threatened by wave induced floods. The sustainable and effective management of floods demands a holistic approach, bridging technical advancements with socioeconomic development.

Figure II.2-1: Location of island Cyprus in the Mediterranean Sea

Paphos, a coastal city in the southwest of Cyprus (Figure II.*2-2*), is one of the major areas experiencing the impact of climate change with coastal floods becoming an increasingly acute problem. The coastal zone of Paphos is of primary importance as most urban development and economic activity takes place in that region.

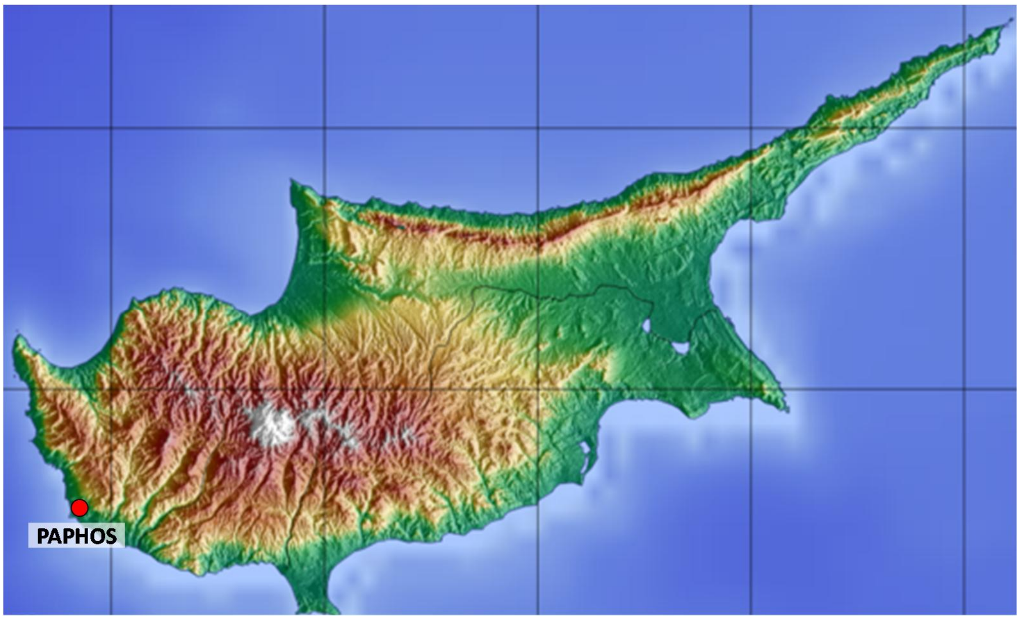

Figure II.2-2: Map of Cyprus – Location of Paphos, the case study area.

The study area is the low ground elevation region of the coastal road of Poseidonos Avenue, in Paphos as indicated in Figure II.2-3. Poseidonos Avenue is effectively the city’s sea front/ promenade where locals and tourists gather and enjoy the sea.

Figure II.2-3: Satellite map (Google Earth) of the study area (Poseidon Avenue is indicated within the red line).

Poseidonos avenue is susceptible to flooding from the sea due to climatological, geomorphological and anthropogenic factors. As shown in Figure II.2-4, the study area is approximately flat and on an elevation of about 1.3 m above sea level.

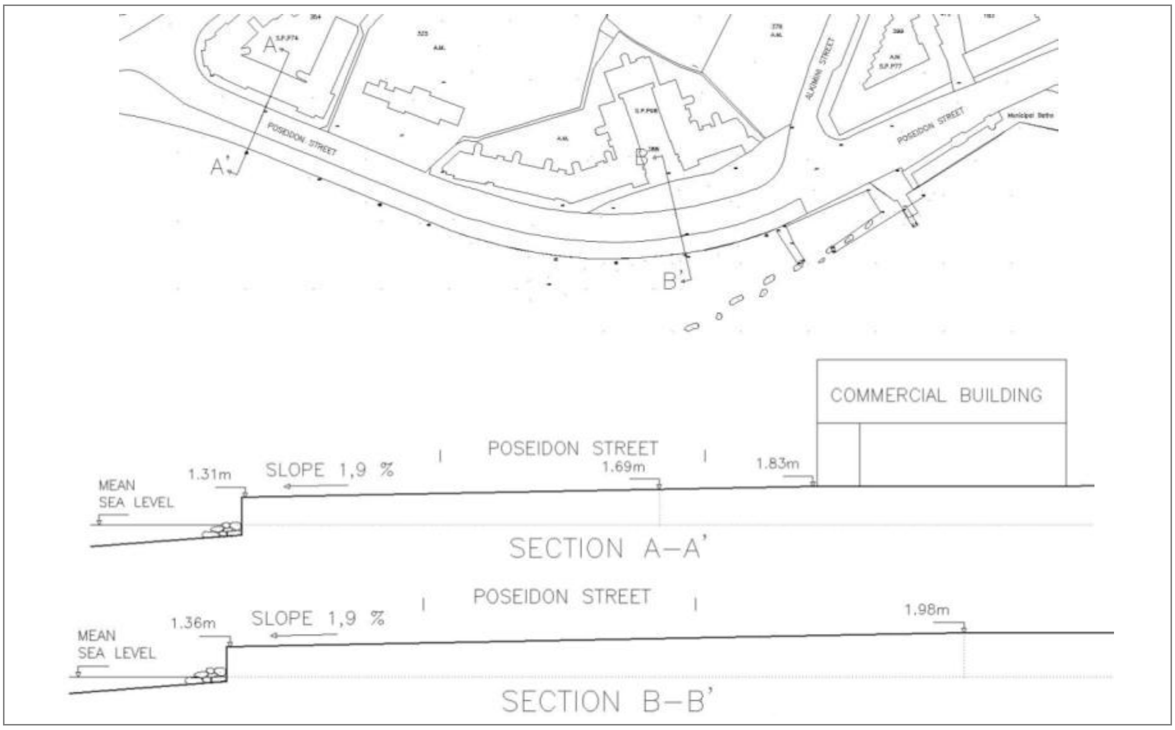

Figure II.2-4: Profiles across Poseidonos Avenue.

The entire coastal road of Poseidonos Avenue has a slope towards the sea of about 2%. The study area is densely developed which reflects its high economic importance and touristic nature. Kato Paphos, which is built around the medieval castle and ancient harbour, accommodates most of the hotels and the tourism infrastructure of the city. The coastal area of Kato Paphos generates large household income, houses major activities and concentrates most of the recent urban development. Many cultural events take place in the area in front of the castle, close to Poseidonos Avenue. On September of each year, the Paphos Aphrodite Festival is staged around the castle, which hosts world-renowned operas. Off Poseidonos Avenue and about 300 metres from Paphos Castle there are the Municipal Baths which are a major attraction.

Poseidonos Avenue is a commercial road with intense economic activity. It is an open-air, pedestrian-friendly shopping destination featuring convenience stores, ice cream stores, jewelleries, opticians, selected local merchants and restaurants. Moreover, pictures of the inventory of structures in the floodplain area were also taken. Figure II.2-5 and Figure II.2-6 illustrate the use of the area. The residents of the properties were contacted and asked to provide information regarding the value of structures, inventory, and equipment.

Figure II.2-5: Satellite (Google Earth) image of the study area.

Figure II.2-6: Photographs of the shops at Poseidonos Avenue.

II-2.3 Background of the coastal flooding problem

A serious problem for the study area is wave overtopping. An up-stand short sea wall along the Paphos sea front main road was demolished as part of the renovation of the area (Figure II.2-7).

Figure II.2-7: The up-stand wall (left) the area with the wall removed (right).

During recent floods structures and properties were damaged and some basic facilities of the Paphos port were also affected. The process of remediation involved decontamination, cleaning and drying, repair of shops and restoration of the economic activity took days to complete.

II-2.4 Damage assessment

II-2.4.1 Building construction type

Reinforced concrete is one of the most widely used construction material for residential, and commercial construction in Cyprus. Typically, the structural frame is reinforced concrete, and the walls are in-fill hollow brick non-structural elements. The walls are insulated, rendered, decorated. This type of construction is commonly found in both rural and urban areas.

The floors are typically composed of several layers which include concrete screed and laminate flooring or ceramic (or terrazzo) tiles. In some cases floors are carpeted (in bedrooms). The ceilings of the structures are usually composed of spatula coatings and coatings of emulsion paint. The doors of the main entrances are commonly made of wood and the doors leading to the verandas as well as all the windows are aluminium framed, double-glazed glass windows. Regarding services, many buildings are equipped with solar heater panels and piping installations for cold and hot water supply, and there is also a connection, or at least a provision, to the town's sewerage system. Finally, electrical installations are built in accordance to European standards as approved by the Cyprus Electricity Authority. In general, many buildings are wet-proof.

II-2.4.2 FloReTo modelling

In order to assess the flood damage of the properties, typical buildings are modelled utilising the web-based software application Flood Resilience Tool (FloReTo). The damage assessment tool facilitates estimation of potential losses in case of a flood event for input property data. The overall damage is exported in terms of damage to fabric and to contents having its practical advantage in planning of measures and better transparency in damage analysis.

The model simulates flood damage based on geographic and economic data describing structures within the affected area considering different flood events. Utilising this software with effective visualisation capabilities typical building and its elements has been drawn on the screen similar to the drawing board while size, location and structural characteristics of the elements has been assigned. Maps obtained from the Department of Lands and Surveys showing the location of each building (Figure II.2-8) were used to develop the relevant information.

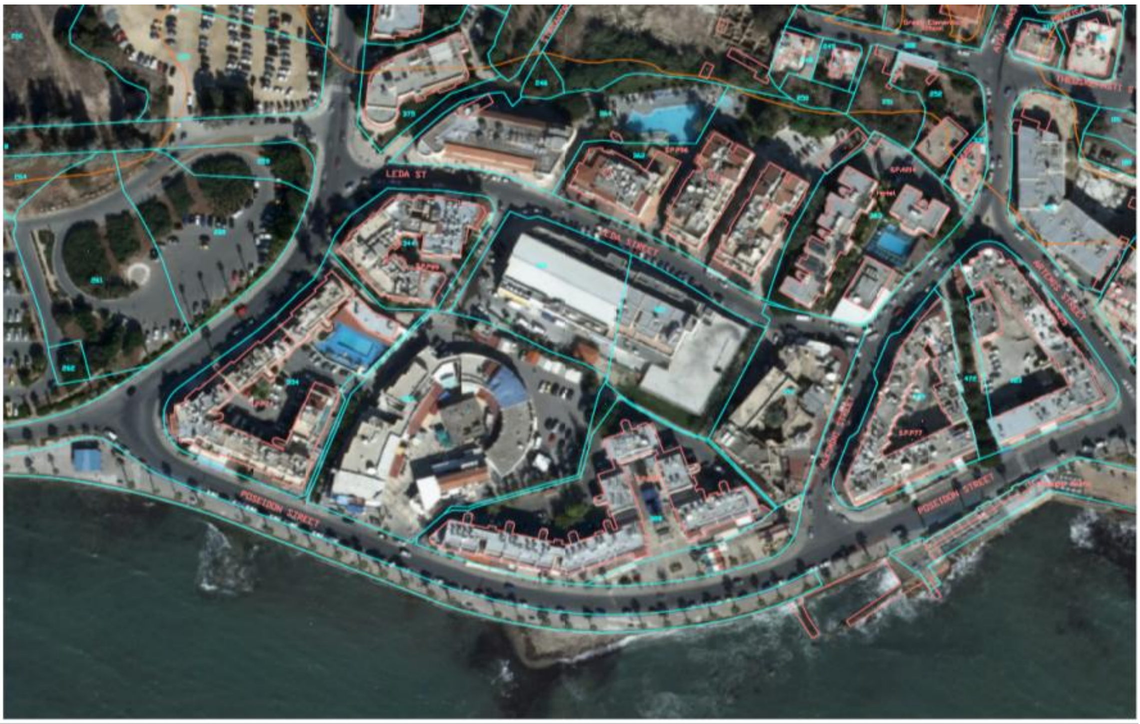

Figure II.2-8: Map of plot boundaries (Department of Lands and Surveys).

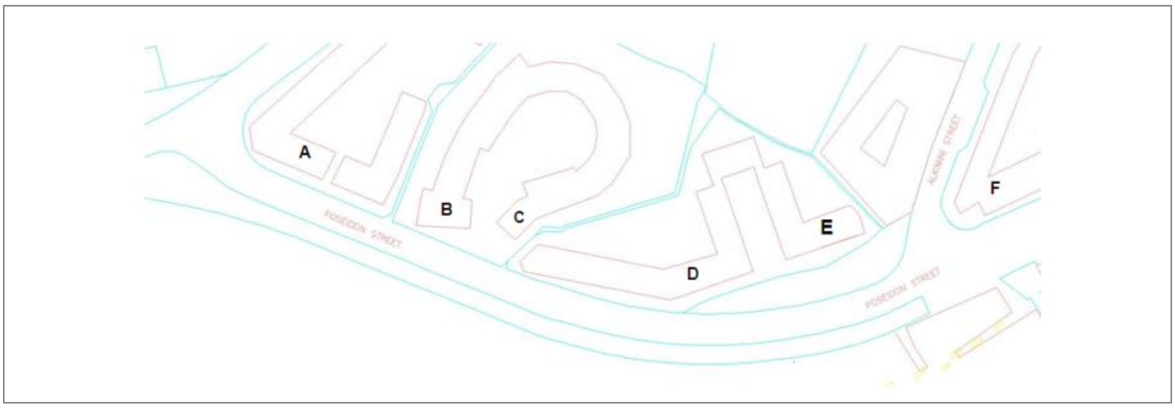

Figure II.2-9: The flood prone area – subdivided in building blocks.

Figure II.2-10: The property uses in each block.

All buildings within the study area are categorised as commercial, residential, or public. All the properties at ground level fall into the category of commercial uses. The commercial properties were further classified into occupancy types based on the type of business occupying the structure. The structures were subdivided by considering the bay opening. Table II.2-1 lists the number of category of the commercial building considering the structure inventory.

Table II.2-1: Commercial Property Categories.

Damage Function Category	*Units*	*Bays*
Souvenir Shop	8 (20.0%)	14 (21.2%)
Jewellery	7 (17.5%)	12 (18.2%)
Restaurant - Cafe	7 (17.5%)	12 (18.2%)
Opticians	5 (12.5%)	9 (13.6%)
Real Estate Office	4 (10.0%)	5 (7.6%)
Ice-cream	3 (7.5%)	3 (4.5%)

Damage Function Category (Cont.)	*Units*	*Bays*
Leather Goods	2 (5.0%)	6 (9.1%)
Bank	1 (2.5%)	1 (1.5%)
Clothing	1 (2.5%)	1 (1.5%)
Food store	1 (2.5%)	2 (3.0%)
Vacant	1 (2.5%)	1 (1.5%)

FLORETO was applied for all property types (Figure II.2-11) and flood damage curves were obtained for various flood depths (Figure II.2-12).

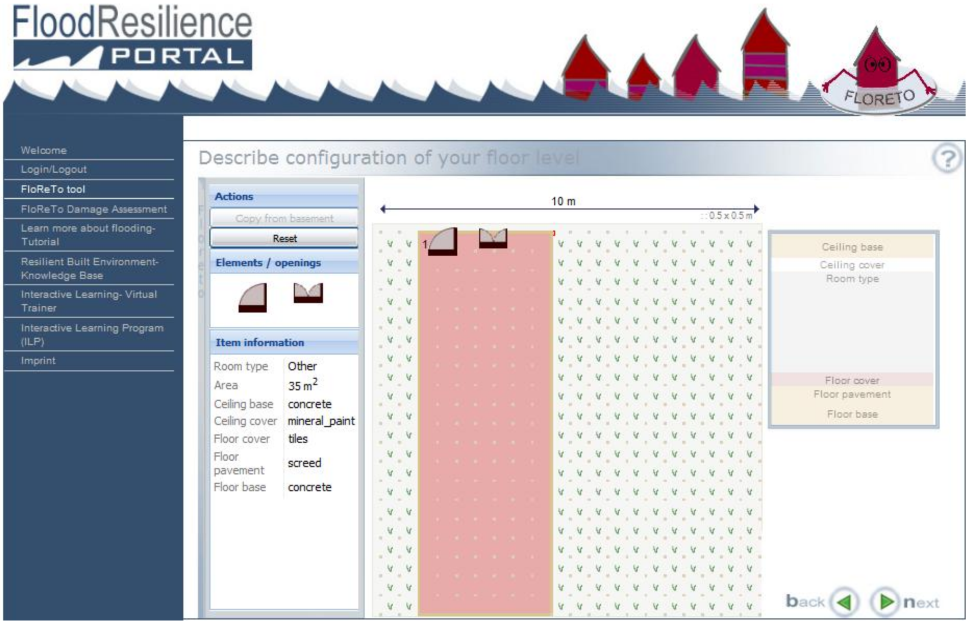

Figure II.2-11: FLORETO input file for typical bank.

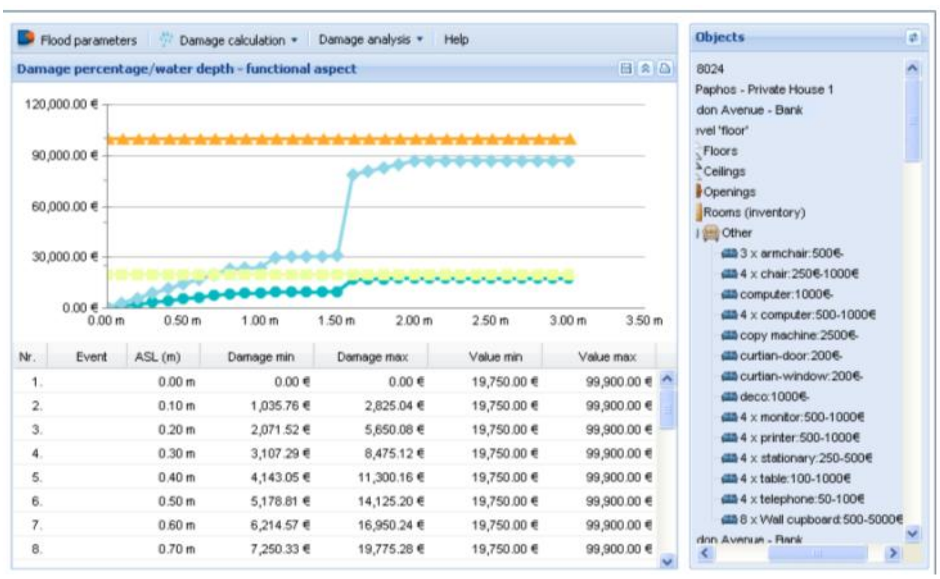

Figure II.2-12: Flood damage curves for a property type.

The flood damage curve was then assessed for all types of properties. Based on the number of property types and the number of bays of each property the cumulative or total flood damage curve is derived (Figure II.2-13).

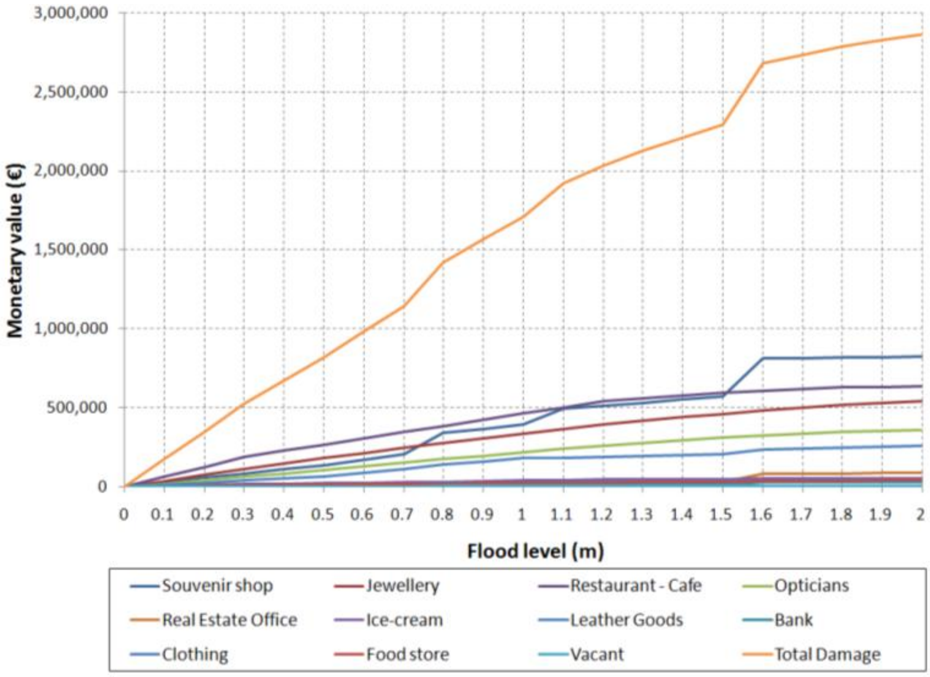

Figure II.2-13: Cumulative Flood damage curves for all properties.

As inferred from these results, the total direct damage to property for a flood level of 0.2 m is about €300 000 and for a flood level of 0.3m it is about €500 000.

II-2.5 FRe application

Flood resilience technology, e.g. flood barriers, is available mainly in northern and central European countries and in North America. This technology consists of numerous off-the-shelf products which are ready to install (http://tech.floodresilience.eu/). An attempt was made to select demountable perimeter barriers that fit the particular site requirements. Off-the-shelf products mainly address river/ rainfall induced floods, which have different characteristics from wave overtopping induced floods. In the former case, flood level is relatively stationery for some time and water-tightness is a critical barrier requirement, whereas in the coastal flood case water impact is intermittent, loads (including waves' dynamic effects) are higher and water tightness may not be so critical, since water may return back to the sea in-between extreme wave impacts.

There is technology available in specialist companies which may provide solutions to this problem on a turn-key basis, namely they can design and build the barrier in accordance with the project requirements. However, these companies need prior appointment for providing their designs and quotations for the cost of the flood barriers. There is therefore a need to design and estimate the cost of the flood resilience system for various scenarios/ options. These options need to be discussed with stakeholders, licensing authorities, funders of projects prior to proceeding with the final construction drawings.

The road to market of flood resilience technology, systems and tools is a challenge for this case study as there is no off-the-shelf product available. A research task to develop a barrier that can be designed by many companies and manufactured by different companies was undertaken, by the partner of SMARTeST Dion. Toumazis & Associates. The outcome of this task is a new design tool that enables the dimensioning of the barrier by consultants. This design tool enables consultants to develop various flood barrier designs, specific to particular project requirements, derive the dimensions and cost estimate of various system options. It is a basic flexible tool which can be adapted by industry to fit particular needs. A prototype flood barrier designed using this design tool was built and exhibited during the SMARTeST international conference and exhibition in Athens in September 2012. Figure II.2-14 presents a cross section of the barrier designed and developed on the basis of particular project requirements such as wave characteristics, pavement material, mounting system, degree of automation, traffic load and durability requirements.

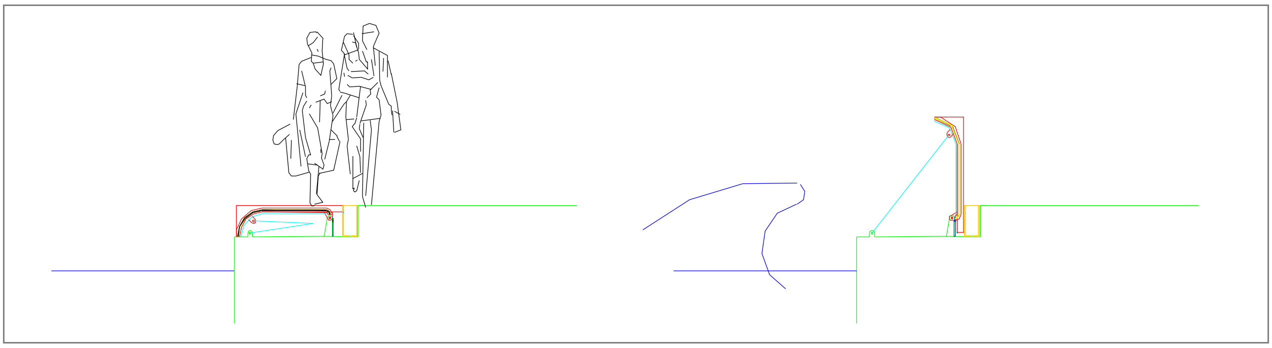

Figure II.2-14: Principle of the demountable flood barrier.

More information can be found at: www.diontoumazis.com/Barrier. Components from various suppliers may be used by different manufacturers to construct flood barriers (Figure II.2-15 and Figure II.2-16).

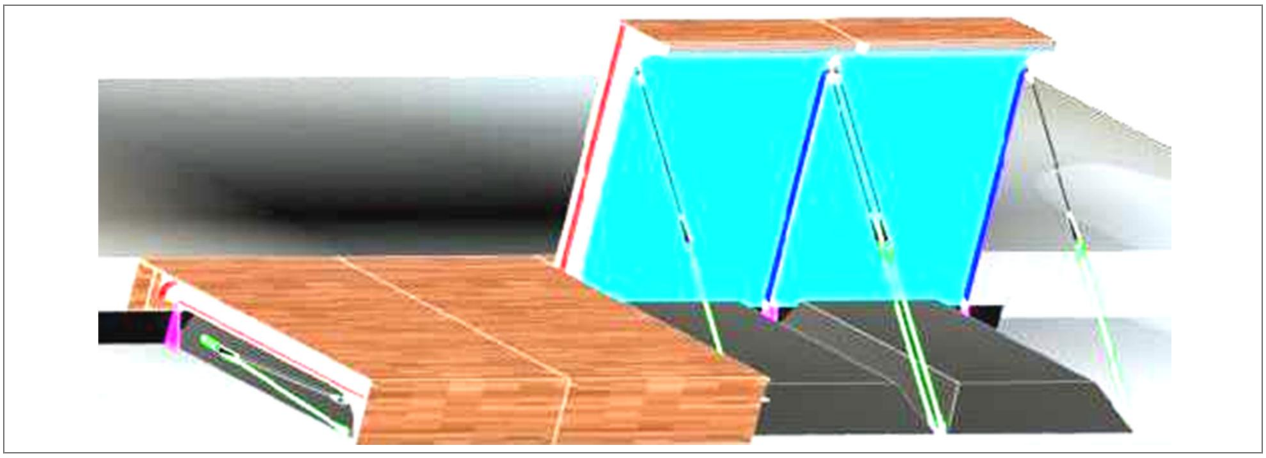

Figure II.2-15: 3-D model of flood barrier. Left during normal conditions, right mounted.

*Figure II.2-16: The barrier under development.
Left: Prototype under construction. Right: Exhibition during the SMARTeST conference in Athens (2012-09).*

The flood barrier was developed so that it is a resilient system itself (Jackson S. 2010) by employing redundant structural components, additional water-tightness lines, fall-back manual deployment methods when automatic deployment equipment fails. The cost of the flood barrier varies depending on the type and value of the materials used, the method of mounting embodied, the degree of automation selected, the traffic load and the characteristics of the incident wave on the barrier. In the case study of Paphos the cost of the flood barrier 0.6m in height for the various options of technology-materials is shown in Table II*2-2*.

Table II.2-2: Cost of Flood Barrier

Option	***Description***	***Cost per metre length in Euros***
1	Stainless steel structural components	270
2	Carbon steel structural components + paint	175
3	Aluminium structural components	185
4	Manual mounting	-
5	Automatic deployment	+200

For stainless steel components, the cost of the barrier, including breaking up of the existing pavement and making good is about €300 per metre. For a 300 m barrier the cost is about €100 000, including unforeseen costs. In order to assess the effectiveness of the FRe system a virtual situation/scenario is examined and the consequences are assessed with and without the FRe system. Paphos experiences simultaneously a storm and a high tide. The duration of the storm is four hours.

Without the FRe system, the waves overtop the sea front and damages the shops up to a level of 20cm, sea weeds, pebbles and other debris are deposited on the coastal road. The road remains closed for two days, whilst cleaning the road takes place. The direct property damage suffered is estimated to be about 300 000 €.

The consequential damage for the road being closed for two days is estimated as valued 80 000 € (2 days x 40 units @ 1000 € per day). This is a rough estimate since the damage depends on the time of the year the storm occurs. If the storm occurs during the peak tourist period this damage can be much higher, whilst if it happens during off-peak tourist period it is much less. The damage to the image of the area cannot be quantified. The adverse publicity given to such events has a long term cost, with people tending to keep away from 'dangerous' areas. It is also assumed that there is no injury or casualty due to flooding. In summary the quantifiable damage is about 380 000 €.

The assumed FRe system consists of a perimeter barrier, 0.6m high, with marine timber surface when closed, capable of taking heavy traffic load and wave loading. The barrier is normally closed and people and traffic pass over the barrier. The meteorological service issues weather forecasts which are received by the Fire Service. When there is a storm forecast and a prediction of coastal flooding, then the fire service mounts the barrier. When the storm starts the road is closed by the traffic police. After the end of the storm, the fire service cleans the barrier and demounts the barrier.

With this FRe system in place and the barrier mounted during the storm, the impact on the road and shops is reduced. Water run up is reduced and the water level does not reach the shops. Sea weeds, pebbles and debris are stopped by the barrier and some of them are deposited at the foot of the mounted barrier. The road is closed for four hours, during the storm and returns to traffic use soon after the end of the storm. The direct damage cost is only associated with the cleaning of the barrier.

The cost of the installation of the barrier is about 100 000 € and the cost of mounting, cleaning, demounting the barrier is estimated to be about €5 thousands per event. The cost-benefit analysis suggests that a capital investment of 100 000 € and a maintenance cost of about €5 thousands have a potential reduction in flood damage of 380 000 € thousand per flood event with a flood level of 0.2 m. The risk of flood damage is increasing with time due to climatic conditions, namely higher sea level and extreme events being more frequent.

II-2.6 References

Jackson S., (2010). *Architecting Resilient System:* accident avoidance and survival and recovery from disruptions. Wiley series in systems engineering and management. New Jersey.

II-3 Case Study – Pendrecht, Rotterdam (The Netherlands)

Authors:

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Department of Water Management

II-3.1 Background

So far, considerable research has been done and progress has been made on damage data collection, data analysis and model development regarding damage assessment of fluvial and coastal floods (Merz*et al*., 2010). Very few methodologies have focused on local floods in small urban watersheds that occur due to pluvial flooding. Some reasons behind this fact are the complexity of the flooding processes in urban areas (Freni *et al*., 2010) and a high number of stakeholders involved.

The focus of this case study is on pluvial flooding in urban areas. Existing damage assessment models tend to focus on damage due to river flooding. They are also applied to pluvial flood damage, even though models have not been explicitly designed for this purpose. Pluvial floods do occur relatively frequently (frequencies of once per one to 30 years) in urban areas and the damage assessment related to this type of flooding is important. Pluvial flood events with relative small flood volumes and extensions can produce considerable damage in the long run due to its high frequency of occurrence (Freni *et al*., 2010; Ten Veldhuis, 2011).

The flood damage simulation model HOWAD-PREVENT was applied in this study. The modelling approach spatially interlinks the simulated water levels with urban structure types. The main relationships included in the model (flood level used as input to depth-damage functions) are common to other damage assessment models. The main characteristic that makes this model different from others is the high spatial resolution and detailed building type classification and analysis.

Case study description

Rotterdam is partly built in a low-lying polder area with ground levels down to six meters below the sea level, from which the water is pumped out to surrounding surface waters. Rotterdam is threatened not only by tidal surges from the North sea and river floods from the river Rhine, but also by pluvial floods. The neighbourhood Pendrecht in the south of Rotterdam was chosen for the application of HOWAD for damage assessment, because 1) the area has a homogeneous composition of buildings types (predominantly residential buildings), 2) the area had less than 1000 building polygons, reducing the time to collect essential input data and 3) there had been some events related to pluvial flooding (water on a street, water in basement, water in house) reported by the citizens.

Pendrecht is situated south of the river Rhine in Rotterdam, the size of the investigation area (see Figure II.3-1) is around 0.28 km^2 (approx. 1/3 of the neighbourhood) with 630 building polygons. The area is located -2 meter below mean sea level. Based on the information provided by the Municipality of Rotterdam, The Department for Urban Planning and Housing, this area has been developed starting in 1990s, and the latest buildings have been erected as recent as in 2010. The predominant building types are low and tall terraced houses as well as multi-family in row standing buildings.

Figure II.3-1: Study area location in Rotterdam

There are four different building types present in the study area as follows:

1) Low terraced houses (LTH) (see Figure II.3-2 left);
2) Tall terraced houses (TTH) (see Figure II.3-2 right);
3) Multi-family in row standing houses (open block) (MRO);
4) Other (garages, shops, children day care, churches).

Every building in the study area has been assigned a specific sub-type. There are 10 sub-types present as shown in Figure II.3-3.

Figure II.3-2: Predominant building types in Pendrecht: low and tall terraced houses (left), multi-family in row standing buildings (right).

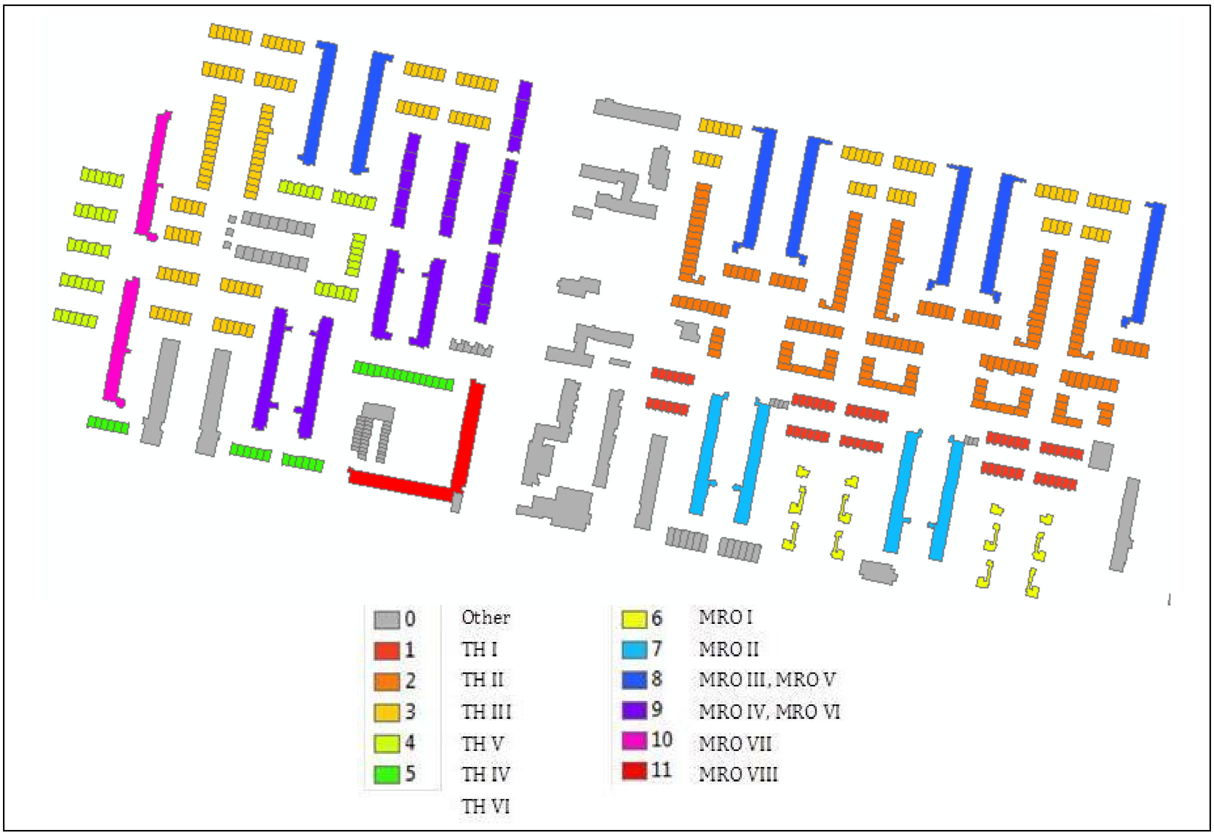

Figure II.3-3: Building sub-types in the study area.

As the height of the building and the number of storeys is negligible for pluvial flooding because of the low water levels (assumed to be < 1 m), tall terraced houses and low terraced houses have been aggregated to one type – terraced houses. Majority of the multi-family houses have been built as adapted building – the ground floor is not at the street level, but raised approx. 0,5 – 1,0 m above street level, so the entrance was also above the street level. On the other hand, most of these buildings have a basement, so the basement and its contents might suffer in the case of a flood. Majority of the terraced houses have the entrance level 0.1 – 0.15 m above street level, so these buildings are subject to inundation if there is significant water level on the street.

Objective

This study was carried out with the main objective to test the flood damage assessment model HOWAD-PREVENT in a case study in Rotterdam and to evaluate the uncertainty and sensitivity of this model. The objective includes a detailed review of the input data and model uncertainties.

II-3.2 Research approaches/methodology

Scope

The scope of this study is limited to residential buildings only. For a building, the most crucial water entry points are located at the height of 0 m to 0.3 m – ventilation gaps in the building wall, possibly leaking small basement windows, unsealed doors and large windows. The presence or absence of a doorstep and its height is of utmost importance when it comes to the possibility of water to enter the building.

For this study, a HOWAD-PREVENT demo version was available, which could calculate damage for 100 building polygons and for four building types which increased the modelling time, since the study area had to be divided into several separate files. The modelling using HOWAD-PREVENT toolbox in ArcMap software is straightforward. After the relevant datasets have been created, the model runs and provides the calculation results. The relevant datasets necessary for modelling are listed below:

1) Water level dataset (GRID)
2) Building dataset (polygon shape file .shp)
3) Precaution measure area selection (polygon shape file, if applied)
4) Depth damage functions for each building type (table in Excel .xlsx)

Data sources

Table II.3-1 shows the sources used for building type classification, their availability and reliability.

Water levels have been obtained using Digital Elevation Model (DEM) for Rotterdam which has +/- 7cm accuracy (Veldhuis C., Gemeente Rotterdam, pers. com.). The DEM has been constructed from data acquired by the ‘Light Detection And Ranging[83]’ (LIDAR) method. The resolution of the original DEM file was 0.5 x 0.5 m with filtered terrain layer – all the buildings, trees, cars have been extracted and in these areas the map has blank spaces without any information regarding the elevation. A Kriging method using ArcMap 10.0 was applied in order to fill these voids with values. A study from Reuter *et al*. (2007) suggests this method to be used in flat areas. Four water level depth raster files were created by adding a certain

[83] LIDAR – optical remote sensing technology that can measure the distance to, or other properties of a target by illuminating the target with light, often using pulses from a laser (Wikipedia).

water depth (0.3m, 0.5m, 0.6m, and 0.7m) to the deepest point in the study area which, based on the elevations, was -1,80 m (canal banks) (see Figure II.3-4).

Table II.3-1: Building type classification information sources

Map/Action	*Source*	*Application, availability*
Aerial maps	Google maps	Help in area selection, building classification. Most recent maps available for Rotterdam (2012)
Postal code areas	Municipality of Rotterdam	Boundaries for the study area
Building polygons	Municipality of Rotterdam, GBK: Large-scale basic data, *grootschalige basis kaart*	Building polygon shape file (Feb 2012)
Building function (zoning) plan	GIS Web Rotterdam, Bestemmingsplannen	Help in area selection, available with access to Rotterdam GIS Web (http://www.gis.rotterdam.nl/gisweb2/default.aspx)
Building types	Google maps, field survey, http://www.bouwkostenkompas.nl/	Building type categorisation based on field survey, building types taken from Bouwkostenkompas and categories proposed in HOWAD
Construction year	Municipality of Rotterdam, Archive	Not readily available in a map as an attribute to building polygon. Partly available on old building construction maps, where every building has a code: yy-aaaa-bb (y for year), not 100% reliable
Blueprints (plans, cross-sections)	Municipality of Rotterdam, Archive	Only hard copies available. Not all of the required information present (the most absent – wall and floor materials and their thickness)
Ground area	Arc Map 10.0	Calculation in ArcMap
Basement	Field survey, blueprints	
Foundation type		Not available
Building floor, wall material and thickness	Not available	Not available, assumed using the most likely from www.paroc.com catalogue. Other sources: experienced architect, building engineer
Building height	3D Stadsmodel > Rotterdam 3D (gebouwhoogten)	Rotterdam 3D, for homogeneous area selection and DEM validation, additional information

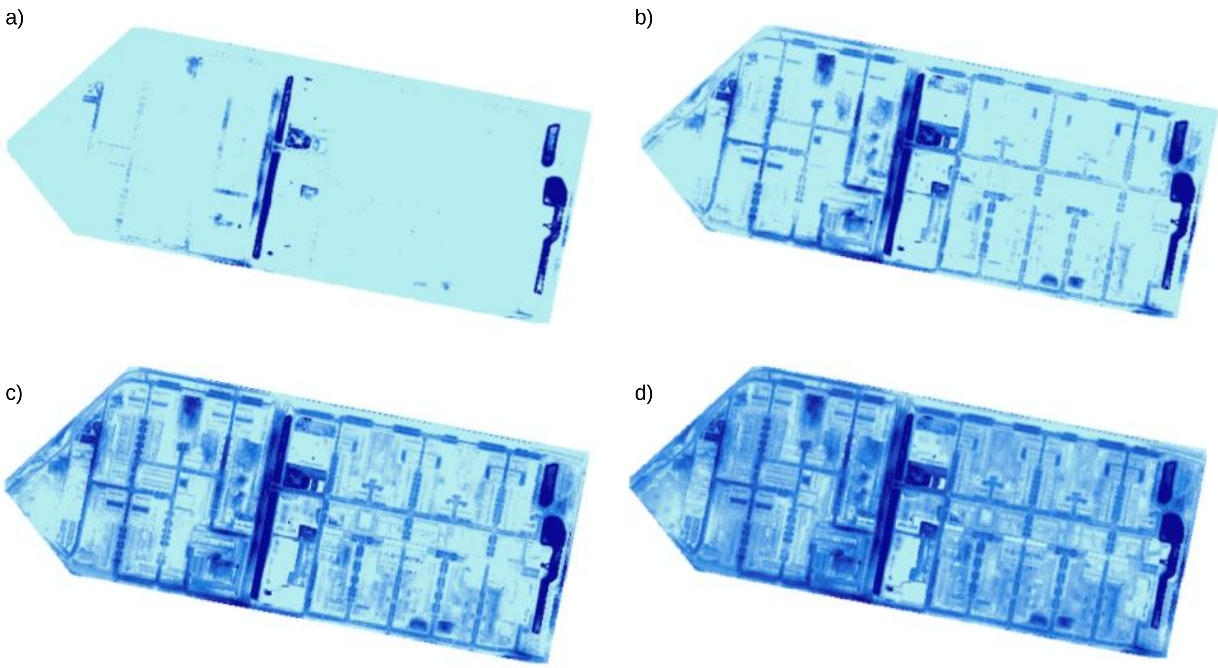

*Figure II.3-4: Four water level situations in the study area:
a) +0,3 m, b) + 0,5 m, c) +0,6 m, d) +0,7 m*

Depth-damage curves for the modelling have been taken from the HOWAD-Prevent report for the UK case study in Heywood. The curves in this project are created by taking only two relevant points (h=0 m and h=1 m) and the values in between have been linearly interpolated (see Figure II.3-5). The building contents damage is not included in this calculation.

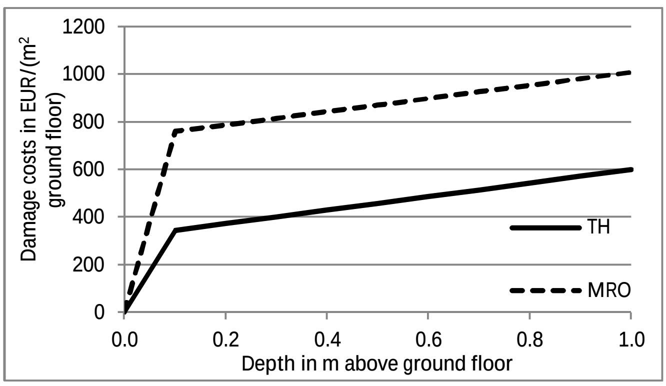

Figure II.3-5: Depth-damage curves used in this study (adapted from a case study in Heywood)

II-3.3 Sensitivity analysis

Sensitivity of the damage calculation to a certain component in the damage assessment model is presented as a factor, representing variation in damage outcomes as a result of variation in the particular model component. This factor is calculated by dividing the highest by the lowest damage estimate resulting from the variation in the component, keeping the other components equal. This factor shows how far off an estimate can be due to uncertainties in model input data. The following method will be used for the model evaluation and sensitivity analysis; the model performance will be assessed by testing three water level and two building type combinations:

1) All water levels will be combined with a shape file, which has two building types (484 TH and 85 MRO), and consequently uses two different depth-damage curves. The curves have two points containing real values, and the points in between have been linearly interpolated.

2) All water levels will be combined with a shape file, which has one building type (539 TH), and consequently uses one depth-damage curve.

II-3.4 Results/findings

The acquired modelling results are presented in Table II.3-2. It has to be taken into account that the total damage presented in column No. 3 does not represent the real values for the case study area, since the selected depth-damage curves have not been created for this specific study area. The water level +0.3m scenario was discarded as it did not cause any flooding. Figure II.3-6 shows the assigned water level for damage calculation for each building polygon indicating the flooded buildings for each water level scenario.

Table II.3-2: Modelling results combining two building type and three water level combinations

Run No.	Number of building types	Water level [a)]	Total damage [b)] [EUR]	Number of flooded buildings [c)]
1	1	+ 0,5 m	1 517 310	17
2	1	+ 0,6 m	7 245 290	198
3	1	+ 0,7 m	17 764 435	511
4	2 [d)]	+ 0,5 m	3 147 430	17
5	2	+ 0,6 m	12 267 497	198
6	2	+ 0,7 m	27 847 908	511

a) The deepest ground level point in the study area + x m (x =0.5, 0.6 and 0.7).
b) Total calculated damage for all building polygons in the study area.
c) Out of 539 building polygons in total. Flooded – mean water level for the building polygon is 0.1 m and higher.
d) 484 building polygons of type TH, 85 building polygons of type MRO.

Results show that there is significant increase in the number of flooded buildings and consequently the damage with a water level increase of each 0.1 m steps meaning that the model estimates are sensitive to water level changes. As expected, there is a difference in damage estimates, if two different depth-damage curves are used.

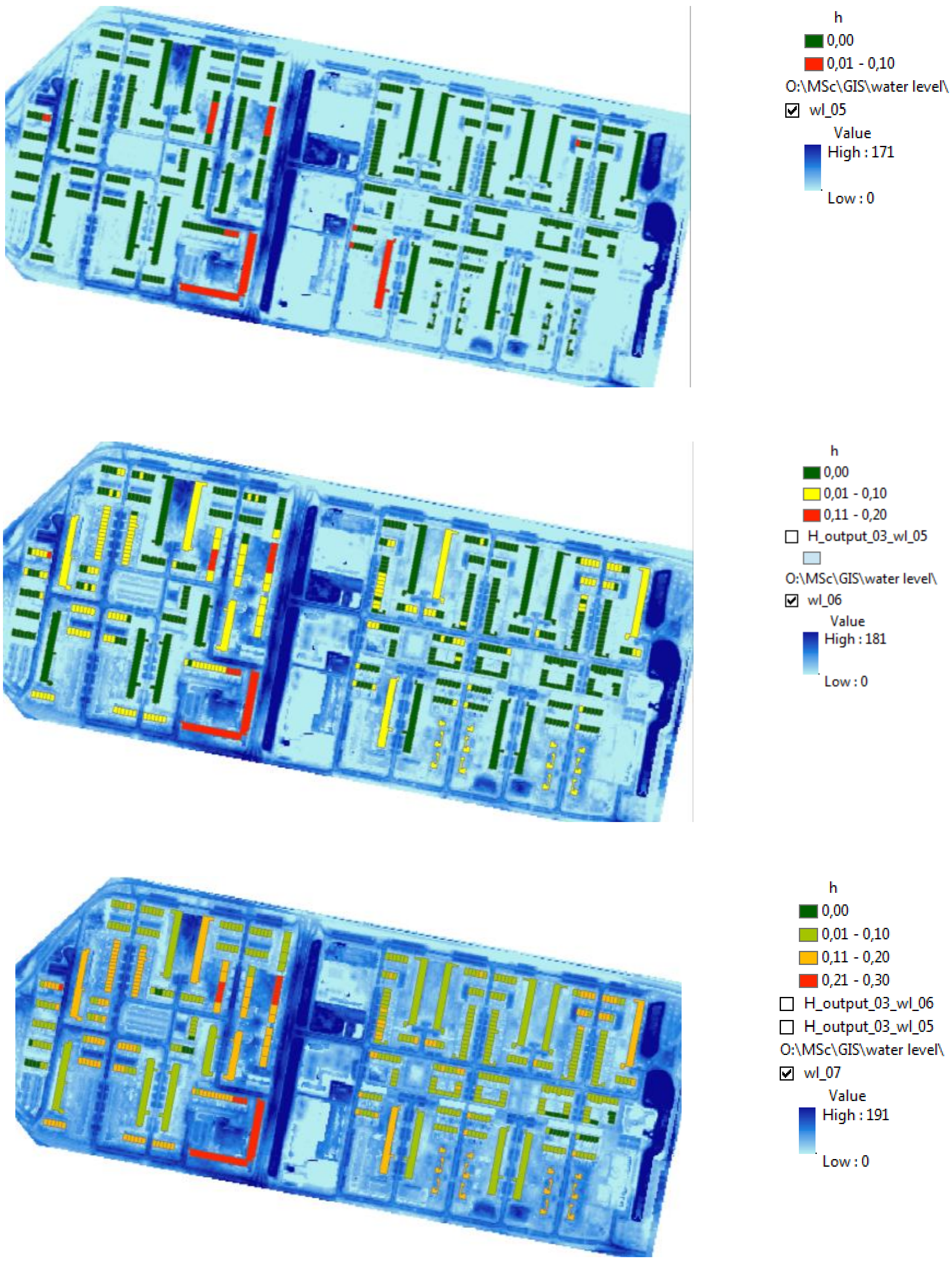

Figure II.3-6: Assigned water levels for each building polygon [h in meters]. Top: +0.5m (run no. 1), middle: +0.6m (run no. 2), bottom: +0.7m (run no. 3).

Model and data input uncertainty

All three input data sets (water level, building types and depth-damage curves) have been found to be a source of uncertainty each having a different order of magnitude. An additional uncertainty source is how the model calculates the mean water level per building polygon. Uncertainty quantification is described below.

Uncertainty in water level

Uncertainty in the digital elevation model is ±7 cm, thus the model input can deviate from reality and overestimate or underestimate the results. The large uncertainty occurs for building polygons with a flood level of 0.1 m, because the model starts to assign damage to a building polygon from 0.1 m water level upwards. In this study case, damage assigned to a building with 0.1 m water level is 345 euro. For buildings with mean water levels > 0,1 m, sensitivity to water level variations is smaller (each next step is around 30 euro more in damage). From the results, water level rise of 0.1 m gives 10x more flooded building polygons, water level rise of 0.2 m gives 25x more flooded building polygons.

Uncertainty in building classification

There can be two sources of uncertainty in building type classification: 1) wrong classification due to the lack of information or too extensive information collection (large areas, no possibility for a field visit) and/or 2) wrong classification due to the uniqueness of a building that does not belong to any category. Depending on the size of the study area, the uncertainty in the model input could be in the range of 1-5 %. Regarding this study, the building classification can be assumed to be fully correct.

Uncertainty in depth-damage curves

While the buildings were classified correctly, the depth-damage curves were taken from a case study in the UK and thus did not represent the building types in the study area. Depth-damage curves from Neubert*et al*. (forthcoming) gave absolute damage values in the range of -15 – +35% for different building types (345 euro as lowest value and 760 euro as highest value for water level of 0,1 m and 600 euro as lowest and 1010 euro as highest value for water level of 1 m). The developed depth-damage curves are applicable to be used for pluvial flood events, but great uncertainty is introduced since the curves use only few points with damage values and the relevant values were only at water levels 0.1 and 1 m.

Model uncertainty

The model calculates a minimum, mean, and maximum water depth value for each building polygon based on the water depth values as attributes for the 2 x 2 m grid cells that touch the building polygon (both perimeter and area under the polygon). An uncertainty is introduced when for larger building polygons, one side can be flooded, but the other side is dry (water level = 0), and if the mean water level is less than 0,05 m, then the model determines that the building is not flooded at all (see example in Figure II.3-7).

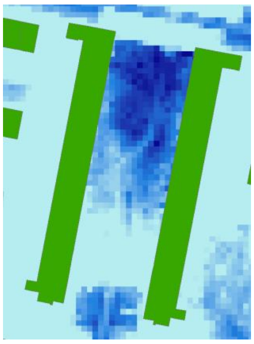

Figure II.3-7: Water level calculation in HOWAD-PREVENT (green – no damage)

II-3.5 Conclusions

One of the strengths of HOWAD-Prevent is that the model can be successfully used for pluvial flood damage assessment. The model assigns water level depths for every building polygon with 10 cm steps allowing detailed calculation. The other strength, which at the same time can be a weakness, is the detailed approach by using fine water grid and disaggregating buildings into polygons. Weakness stems from the great efforts in data collection and uncertainty in input data, which propagates to the final damage estimate.

The main uncertainty sources of the HOWAD-Prevent are the input data sources – water level, building stock classification and depth-damage curves. While building classification has the least influence on the uncertainty, both water level and depth-damage curves have the most influence. Specifically for this study, great uncertainty source was the digital elevation model and the method of filling the voids. This combined together with the model concept (of using the mean water level value from all grid cells surrounding the building polygon and the cells under the polygon) might have caused some buildings to be assigned as flooded, when they should have not been flooded and vice versa.

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II-4 Case Study – Kephisos Basin, Municipality of Nea Philidelphia (Greece)

Authors:

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II-4.1 Introduction

Kephisos river basin springs from Parnitha mountain range, north of Athens, crosses the Athenian basin and discharges in Faliro bay, to a depth of 9.5 m. Kephisos river covers an area of about 381 km^2 and has a length of 22 km, of which 14 km are located inside residential areas. It is the main recipient of pluvial water of the Athenian basin.

In general, Athens is characterised by a dry climate, with average rainfall of 400 mm and show high evaporation rates. However, the area experiences high intensities of precipitation due to short pluvial events. Some of the major issues that are identified in the area are the condensed river networks, the presence of residential, commercial and industrial areas around the river banks, the arbitrary constructions on river beds and the continuous reduction of green areas and parks. Furthermore, flood protection and drainage networks are underdeveloped, damaged or even obsolete flood protection.

The history of urban development around Kephisos River dates back to 1922, when following the defeat of the Greek Army by Kemal Ataturk, the area received a massive influx of refugees fleeing the Greek cities of Asia Minor. Many refugees moved to Attica looking for better living prospects and settled in the western, less urbanised part. A new wave of immigration followed the end of the Civil War (1945-1949) and continued for decades, drastically changing the profile and outlook of Athens. The urbanisation of western Attica, primarily by refugees and internal immigration, resulted in a socio-economic segregation of the population of Athens, which still evident, to some extent, even today.

The intense development of the wider Athenian urban complex, led to the degradation of many tributary streams. Although the Kephisos River preserved its flow to the sea by discharging 70% of the drainage basin, it suffered much due to a significant decrease in its width as a result of illegal dumping of rubbles and solid waste. The river's degradation was also accelerated due to illegal construction and haphazard industrial development on its banks.

The initial arrangements on Kephisos river started about 35 years ago and were only accomplished, in part, in 2004. The problems appear mainly from the inner Athens area disposition, down to the river-mouth and the adjacent areas of the southern suburbs. Surface waters deluge the lower altitude areas on both sides of Kephisos and overflow towards the areas of southern lowlands (Renti, Kaminia, Neo Phalero, Votanikos, Kallithea and Moschato), currently characterised as closed basins.

In this framework, Nea Philadelphia was selected as the study area. Nea Philadelphia has suffered from floods, several times in the past, with a repetition pattern of approximately two decades. Events are known to have occurred in 1934, 1961, 1977, and 1994, with the last one well documented. The 1994 event affected the greater Athens area. Areas like Tavros, Moschato and Neo Phalero experienced extensive flooding when the Kifissos River overflowed. The Ministry declared a state of emergency in Athens, while Army units joined to contribute to the rescuing operations. In Nea Ionia, Nea Philadelphia, Chalkidona, Perissos, Kalogreza, Rentis, Ano Liosia, Marousi and Chalandri, dozens of homes and stores were flooded, and many cars they were swept along by water. Eleven deaths were reported, while nine of them occurred in the greater Athens area (Evelpidou *et al*., 2009).

Data were collected from two building blocks (**Error! Reference source not found.**) in Nea Philadelphia and were imported into the FloReTo platform. The two building blocks consist of 22 buildings, with 15 buildings on the south block and seven buildings on the north one.

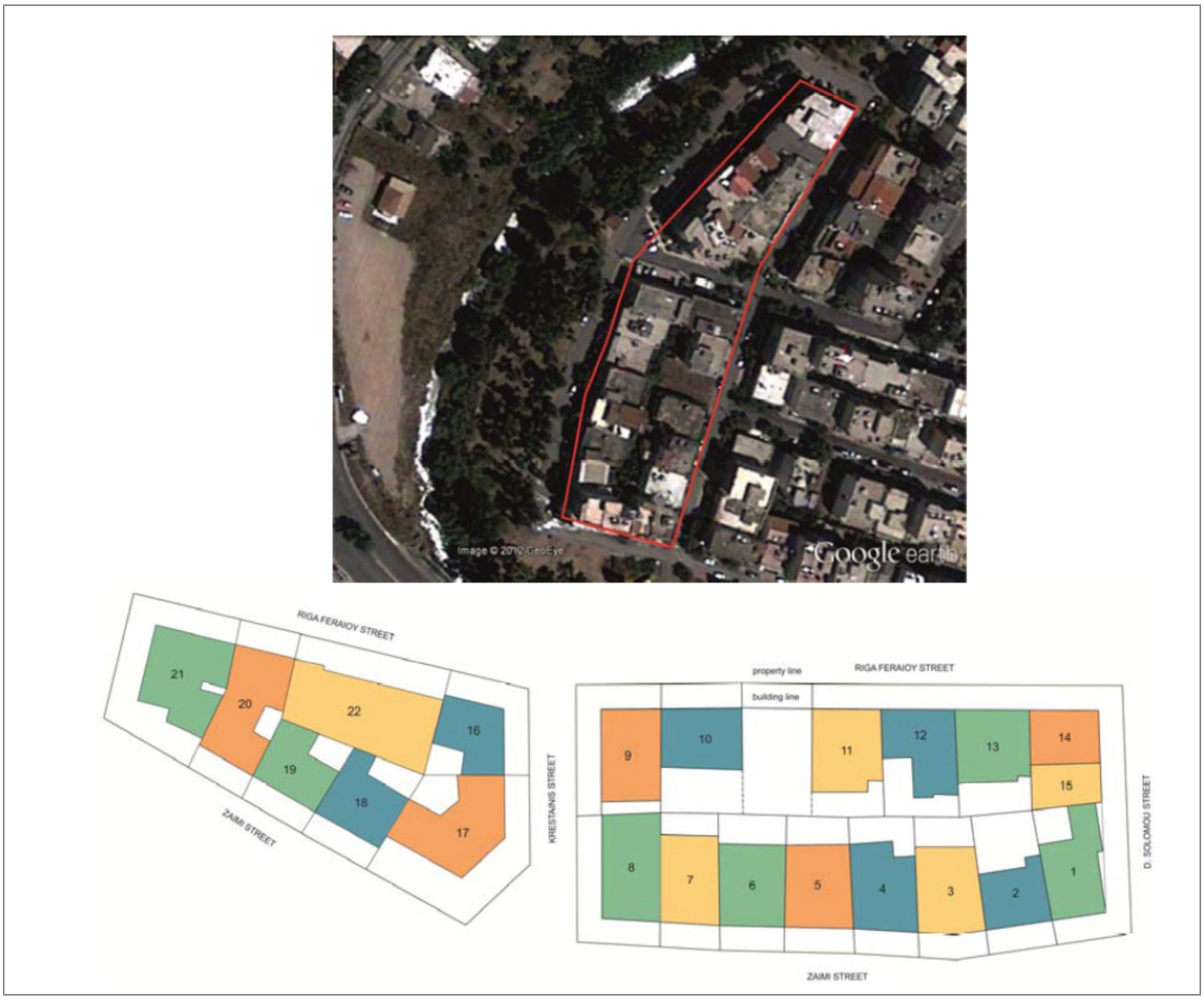

Figure II.4-1: The two building blocks in satellite image and in drawing

In the north block, from the seven buildings in total, three are four-storey, two are three-storey, one two-storey and one six-storey. Three of the buildings are of mixed use, with business units in the lower floors and residents on the higher levels, while the rest are private for residential purposes. Additionally, three of the buildings do not have basements. Those with basements, have the floor level ranging from -1.60 m to -1.00 m and the roof level up to +1.50 m. In this block, all structures are built from the 90s and beyond.

For the south block, two buildings are business units and the rest are private buildings for residential purposes, while they can be characterised as new since they are built from the 80s and beyond. The building system is continuous, with a garden patch of approximately 4.00 m width. The majority of the buildings have a basement, with the floor level ranging from -1.60 m to -1.00 m and the roof level up to +1.50 m. Most of the residential buildings have an underground garage. In total, there are nine three-storey, five two-storey and one six-storey building.

Concerning the materials for all buildings, the basic structure is reinforced concrete, the basement walls consist of reinforced concrete and the floor walls of masonry brick. The floor coatings are mostly ceramic tiles. The doors and windows consist of aluminium or wood, externally and of wood, internally.

II-4.2 Background

The study area, Nea Philadelphia, is located in the prefecture of Attica, in the northern suburbs. Nea Philadelphia neighbours to Kephisos River, which springs from Parnitha's mountain range.

Kephisos River is part of the National Forest and is included in the 'Natura 2000' protected sites. The river, which is the major recipient of the Athenian rainfall run-off, covers an area of 381 km^2, while its length is 22 km (of which 14 km are within residential areas) (Evelpidou *et al*., 2009).

Figure II.4-2: Location of Nea Philadelphia and overview of the studied building blocks (red square).

Nea Philadelphia has suffered from floods, several times in the past, with a repetition pattern of approximately two decades. Events are known to have occurred in 1934, 1961, 1977, and 1994, with the last one well documented and described below.

Nea Philadelphia suffered from a severe flood event in 1994, along with other areas neighbouring to Kephisos River (Tavros, Moschato and Neo Phalero), when the river overflowed. During the night of the 20th of October 1994, a cold front passed over Greece, provoking heavy precipitation and consequently catastrophic floods in many areas. In some of the affected areas, the precipitation height was equivalent to 140 mm, while in the centre of Athens precipitation height exceeded 140 mm (Evelpidou *et al*., 2009). The Greater Athens area experienced one of the most devastating flood events in years, during which nine deaths were reported along with severe damages in the transportation, telecommunication and energy infrastructure (Evelpidou *et al*., 2009). Dozens of homes and stores were flooded, a considerable number of cars was destroyed, three buildings collapsed and hundreds of people remained trapped in cars and buildings for several hours (Evelpidou *et al*., 2009).

II-4.3 Research approaches/methodology

The case study follows the FloReTo approach. For each of the studied buildings, a new profile was developed in the platform. For each building the user needs to define the type of property – presence of basement, house type, other characteristics (garage, fence, balconies, garden; see Figure II.4-3).

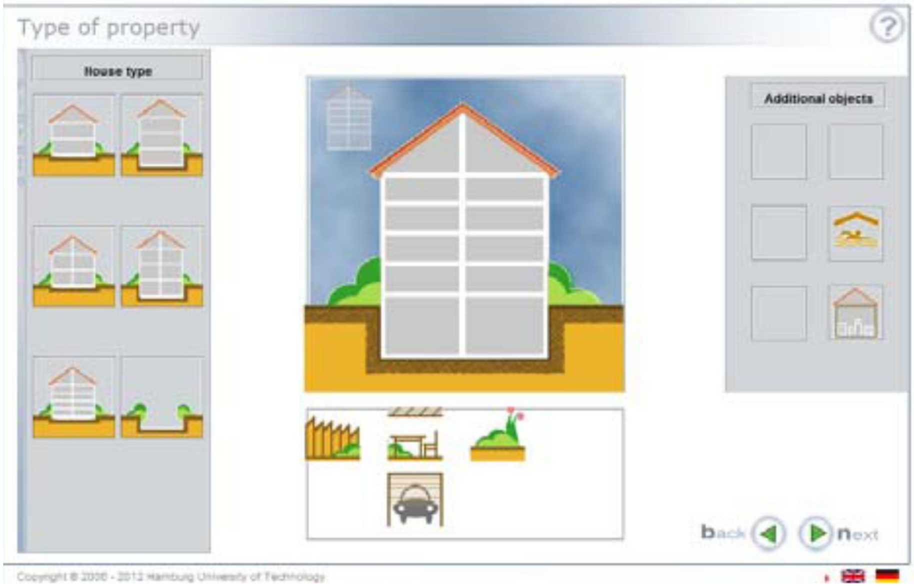

Figure II.4-3: The House type is Multi with basement, with garage, garden, fence and balconies (buildings 3, 6, 7, 14, 16, 19 and 22).

In the next step, the user has to define the basic building characteristics (elevation of the first floors, type of foundation, building condition, use type; see Figure II.4-4).

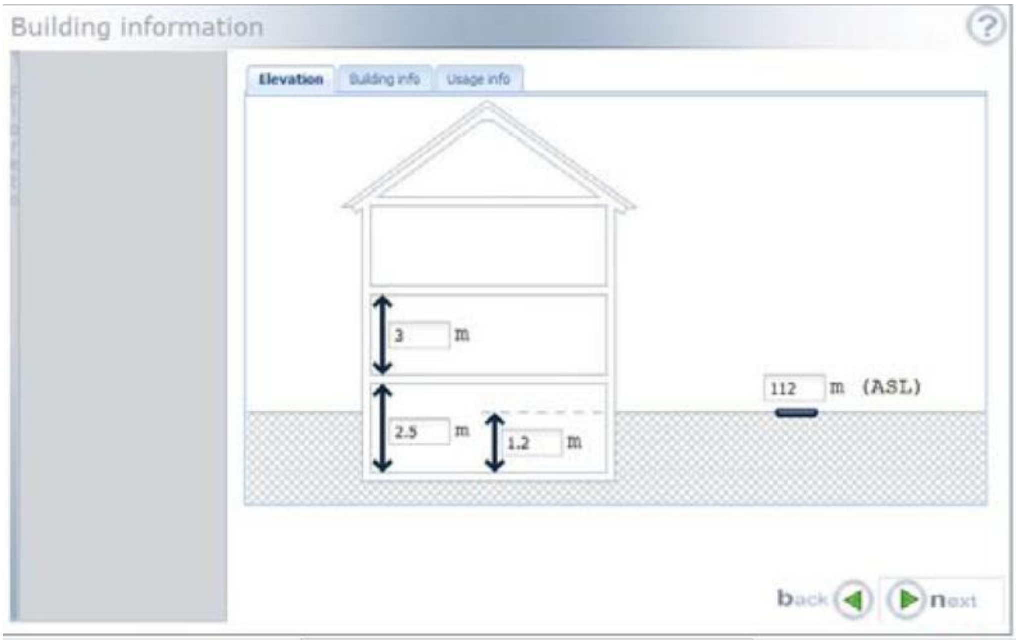

Figure II.4-4: Two storey house, with the level of the basement at -1.2 m. The foundation is reinforced concrete, as in all the studied buildings. This image corresponds to building 6.

In the next tab, the user is requested to provide a schematic representation – configuration of each floor (basement, if there is one and ground floor; see Figure II.4-5).

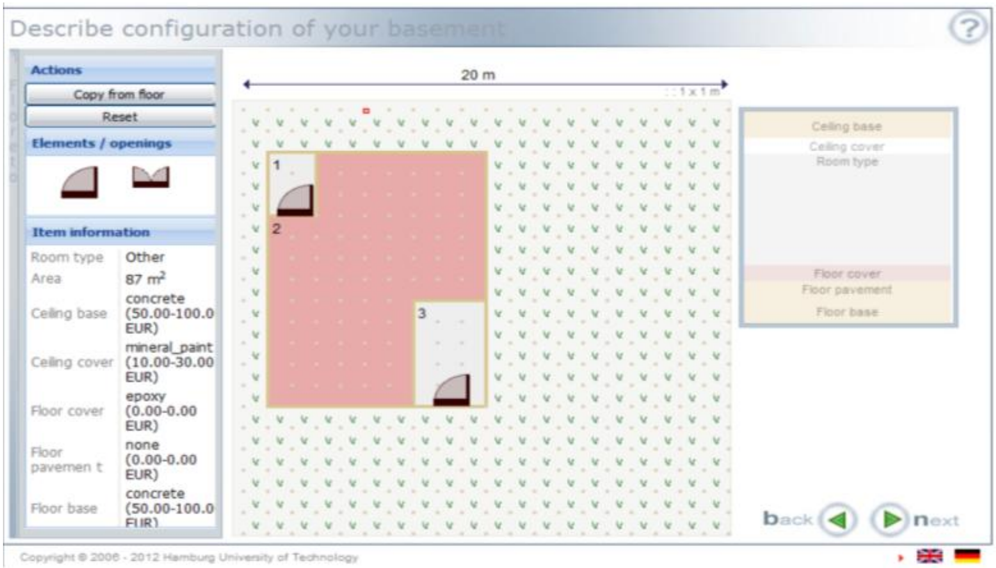

Figure II.4-5: Configuration of the basement – definition of each room type and building materials.

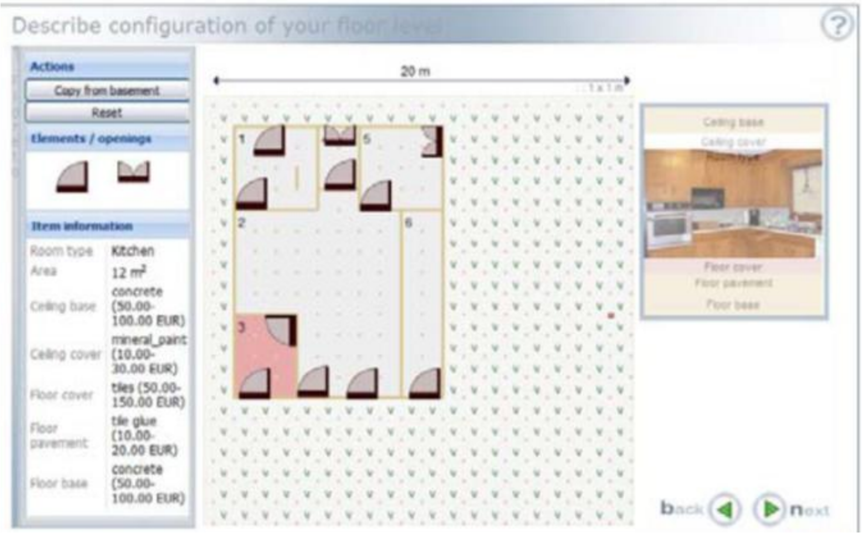

Figure II.4-6: Configuration of the ground floor for building 6 – definition of each room type and building materials.

The platform also requires the definition of an inventory on the recorded floors (Figure II.4-6). This is done by selecting the items of each room and by specifying their price range.

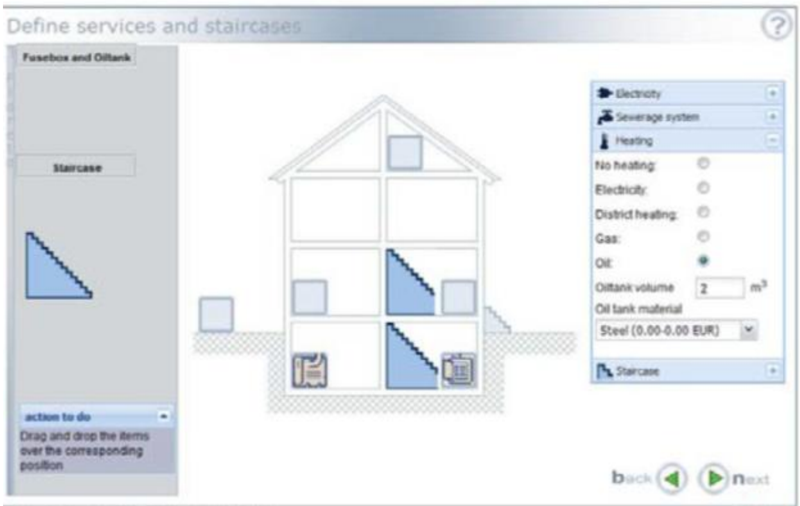

Figure II.4-7: The final imported data before the results. In all the studied buildings the central heating was oil.

The final data requested by the platform include information about the services of the building, which include the heating, electricity and sewerage system (Figure II.4-7).

The last step requires the user to define the water depth and then the platform provides the suggested resilience measures and a cost/benefit analysis.

II-4.4 Results/findings

The results of FloReTo are presented in the following table (Table II.4-1), where two values for the water depth were examined for the suggested resilience measures. The minimum value for the water depth was 0.4 m and the maximum value was 1.5 m.

Table II.4-1: FloReTo results from the studied buildings

Building No	No of Floor levels	Base-ment	FloReTo resilience plan			
			water depth = 0.4 m		water depth = 1.5 m	
			C3-controlled flooding of the basement	C6-controlled flooding and shielding		C6-controlled flooding and shielding
1	6	no		+		
2	3	yes	+			
3	3	yes	+			+
4	3	no		+		
5	3	yes	+			+
6	2	yes	+			+
7	2	yes	+			+
8	3	yes	+			+
9	2	no		+		
10	2	no		+		
11	2	no		+		
12	3	no		+		
13	3	no		+		
14	3	yes	+			+
15	4	no		+		
16	2	yes	+			+
17	6	no		+		
18	4	no		+		
19	3	yes	+			+
20	4	yes	+			+
21	4	no	+	+		
22	4	yes	+			+

FloReTo assigns a number (C1, C2 …C18) to the suggested solutions which relate to the resilience strategies that are presented in the tool. For example, C3 is a resilience plan where it is recommended to allow flooding of a basement level, to prevent the upper floors from flooding.

When a basement exists, the suggested measures from FloReTo are ‘C3-controlled flooding’, if the water depth reaches 0.4 m. These include installing a pump with a sump, wetproofing of the building fabric, encapsulation of services, protection from backwater by a non-return valve and horizontal sealing of the walls in the ground floor. If the water depth reaches 1.5 m, the suggested measures are ‘C7- Controlled flooding and sealing or shielding’. These include the shielding of the ground floor.

In the case of buildings with no basement, the suggested measures from FloReTo depend on the water depth. If the water reaches 0.4 m, the measures are ‘C16 - Shielding or sealing of the ground floor’, and they include the following: shielding of the ground floor applying movable barriers or flood protection products; or sealing of the building fabric in the ground floor which implies horizontal sealing of the walls in ground floor and vertical sealing of exterior walls (8500.00 euro) and sealing of openings with demountable barriers for openings.

If the water reaches 1.5 m then the measures are ‘C18 - Wetproofing and removing inventory 2’ and they include the following: wetproofing of the building fabric on the ground floor including walls, floors and staircase services.

The suggested measures from FloReTo and the cost/benefit analyses confirm that as in every natural disaster, in urban flood events, it is better to prevent rather than ‘cure’. The cost of preventive work, both from the government and the citizens/individuals is significantly lower than the cost of repairing damages after an urban flood.

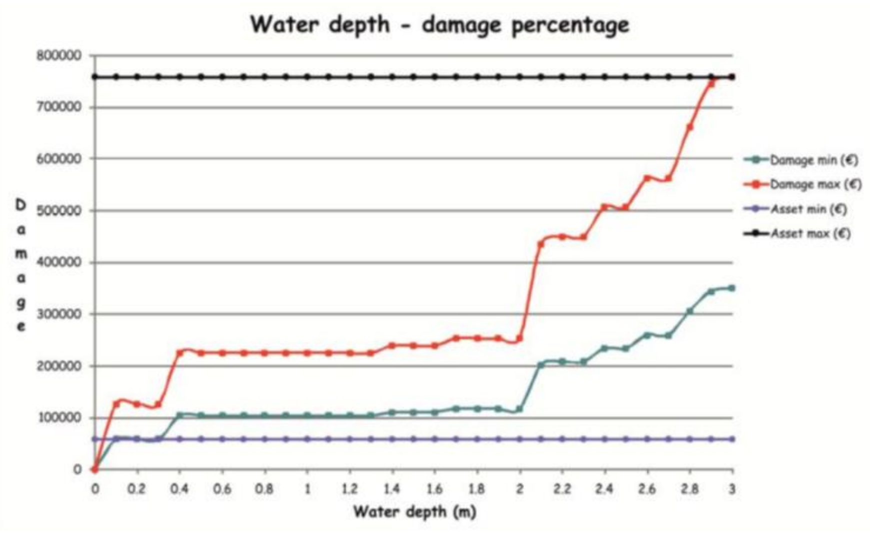

Figure II.4-8: Diagram of water depth and damage percentage estimation for a house with a basement. In this case, the level of the basement is 1.2 m below the level of the road. When the water depth reaches 2 m, the damages increase rapidly.

It is worth noting that, especially in Greece, direct damages are recorded in the basement or ground floor of a building, in the majority of flood events. This is owed mainly to two reasons: a) no predictive methods for flood water removal, for economic reasons in the construction or b) due to bad design-construction. Despite the flood risk in some areas, there is no provision for installing a pump to remove flood water from basements, but only rarely and after a flood event.

Additionally, until the mid-1980's, in residential areas, particularly of low and moderate income, illegal configuration of basements in residences took place in order to fully exploit the property. Even today, in areas with garden patches, the entrance of the building (houses, shops) is placed as low as 60 cm below the road level, in order to fully exploit the total allowable height and number of floors of the building.

II-4.5 Summary

- FLORETO damage assessment model was implemented in two different building blocks.
- The suggested resilient plan for the studied blocks included the following measures:
  a) Controlled flooding of a basement (installing a pump with a sump),
  b) Wet-proofing of the building fabric,
  c) Encapsulation of services (wiring and heating),
  d) Protection from backwater by a non-return valve and
  e) Horizontal sealing of the walls in the ground floor.
- Controlled flooding could in effect assist in dealing with long periods of recovery in the context of infrastructure and building restoration.
- The cost of selected measures for the given parameters were accumulated to 5.000 € per building while benefits per building were indicated in a range of 220.020 € – 440.400 € (min-max).
- In Greece and in Nea Philadelphia in particular, direct damages are recorded in the basement or ground floor of a building, in the majority of flood events. This is owed mainly to two reasons: a) no predictive methods for flood water removal, for economic reasons in the construction or b) due to bad design-construction. Despite the flood risk in some areas, there is no provision for installing a pump to remove flood water from basements, but only rarely and after a flood event.
- Until the mid-1980's, in residential areas such as Nea Philadelphia, particularly of low and moderate income, illegal configuration of basements in residences took place in order to fully exploit the property. Even today, in areas with garden patches, the entrance of the building (houses, shops) is placed as low as 60 cm below the road level, in order to fully exploit the total allowable height and number of floors of the building.

II-4.6 References

Evelpidou, N., Mamassis, N., Vassilopoulos, A., Makropoulos, Ch., Koutsoyiannis, D., 2009. Flooding in Athens: The Kephisos River flood event of 21-22/10/1994; Proceedings of International conference on Urban Flood Management, 25-27 November 2009, UNESCO, Paris

II-5 Case Study – Heywood, Greater Manchester (United Kingdom)

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II-5.1 Background

Objective

In close collaboration with the University of Manchester, the study area Heywood/Greater Manchester was selected to test the flood damage assessment model HOWAD-Prevent and to assess the effects of FRe technologies. The Heywood area represents a typical heavily urbanised area with inadequate surface drainage which remains very vulnerable to pluvial flooding.

Flood experience

Prior to 2004, Heywood, Rochdale, Greater Manchester had almost no history of flooding. The area was only experienced by minor, highly localised flooding in the past (Douglas*et al*., 2010). There is solely some evidence of regular (annual) flooding of road surfaces in one small housing estate. However, in 2004 and 2006 short duration, high intensity, summer thunderstorms[84] induced serious pluvial flooding at six distinct locations within the township (Figure II.5-1). The 2006 event resulted in over 200 homes being inundated with up to 900 mm of sewage contaminated water for up to three hours and around 90 properties had to be evacuated for varying time-spans whilst renovation was taking place.

All six areas which experienced substantial flooding are located along two urban streams[85] that have been previously culverted (Figure II.5-2). Some reaches of these streams are still part of an inadequate combined sewer system that is used to drain surface run-off as well as waste water. Besides the heavy

[84] The thunderstorms produced high rain intensities. The 24-hour totals at the four nearest rain gauges ranged from 27.4 to 4.9 mm in the 2004 event and from 58 to 14 mm in 2006. Return periods: 15 mm in 30 minutes is about 1 in 10 years and 58 mm/day is 1 in 9.83 years. Lack of rainfall records actually in the township of Heywood makes it difficult to estimate the severity of the storms and the flood return period more accurately.

[85] Two streams run through Heywood and drain into the River Roch in the north of the town. Wrigley Brook in the west is completely covered; Miller's Brook in the south east is partly covered. Neither Miller's Brook nor Wrigley Brook is included in the Environmental Agencies (EA) Register of Critical Ordinary Watercourse. This means flooding along them is not in the EA's area of responsibility.

precipitation, restricted sewer capacity was responsible for flooding on both occasions. Pluvial flooding in Heywood is caused by sewer overflow due to hydraulic overload.

None of the affected residential buildings was charted on the Environment Agency's floodplain map, because of the high uncertainty in quantifying pluvial flood risks. The climate change induced increased severity and frequency of storm events makes the area highly vulnerable to pluvial flash floods.

Case study description

Heywood is a town located in North West England within the Metropolitan Borough of Rochdale in Greater Manchester at an elevation of around 130 m above mean sea level. It lies about 11.9 km north of the city of Manchester and has a population of around 28,000.

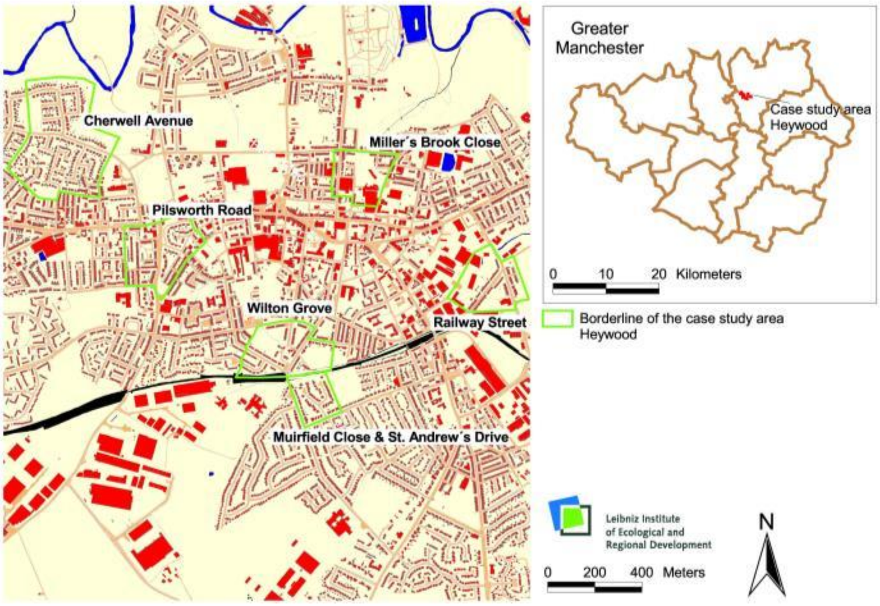

Figure II.5-1: Heywood area; six locations potentially exposed to pluvial flooding

Heywood has been developed on the south bank of the River Roch and is flanked by the Pennine hills in the north and east. The study area is drained by two partly covered streams Wrigley Brook and Miller's Brook flowing into the River Roch. The main urban area is a high-density residential and industrial site, originally developed between 1750 and 1900. Since 1960 many open areas and brownfield sites, both within the town and on it southern margins have been occupied by new housing and new low-rise, large warehouses on a new distribution centre.

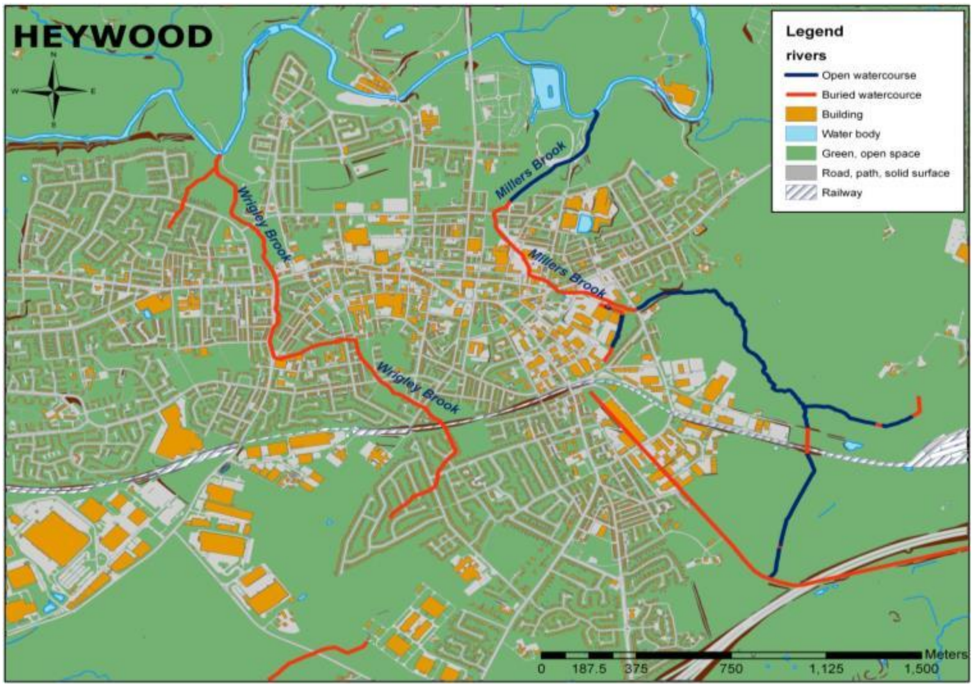

Figure II.5-2: Heywood area; open and historically culverted watercourses. Source: Bubel 2008.

II-5.2 Research approaches/methodology

Scope

The flood damage simulation model HOWAD-Prevent was applied in the Heywood urban area to analyse flood damage to buildings for selected scenarios. These scenarios comprised, first, different heavy rain events resulting in diverse flood water depths in certain township areas and, second, different levels of FRe technology implementation resulting in a dissimilar extent of flood damage. Based on these analyses, the effects of FRe technology implementation concerning damage reduction can be verified to support decision making processes in flood resilient planning.

The HOWAD-Prevent approach spatially interlinks the flood water depths of various scenarios to buildings and their respective synthetic depth-damage functions in order to calculate the damage costs. The application of the object-based approach with a high contextual and spatial resolution not only permits a detailed assessment of the impacts of the current flood hazard but also the simulation of future risks for different scenarios (climate change, socio-economic development) and strategic alternatives. In addition the method enables ex-ante analyses of effects of risk reduction measures (FRe measures). The modelling results can be visualised using maps or analysed within statistics.

Based on Heywood case study the potential of coupling SMARTeST models for risk assessment has been demonstrated considering alternative types of FRe technologies on different scales. In this case the SMARTeST model Multi-Hydro provided flood water depths for selected areas within Heywood caused by certain heavy rain events. Then, these water depths were linked to the flood damage simulation model HOWAD-Prevent to calculate flood damage to buildings.

Data requirements/data sources

The GIS-based flood damage simulation model HOWAD-Prevent requires certain input data to determine flood damage to buildings and constructed assets as well as to assess the potential of flood resilient technologies concerning vulnerability mitigation. The relevant datasets necessary for modelling are:

1) Water level dataset (GRID)
2) Building dataset (polygon shape file)
3) Synthetic depth-damage functions for each building type (original state without implemented FRe technologies) (table in Excel)
4) Synthetic depth-damage functions for each building type (modified state with implemented FRe technologies) (table in Excel)

The following Table II.5-1 contains obligatory data for the flood damage assessment tool.

Table II.5-1: Sources of required data for flood damage assessment using HOWAD-Prevent

Dataset	*Source*	*Application, availability*
Flood water depths	SMARTeST model Multi-Hydro	Multi-Hydro provided flood water depths for selected heavy rain scenarios based on hydraulic modelling.
Aerial images	Google maps	Aerial images support the identification and classification process of building types in the Heywood study area.
Building types	Field survey	Based on field surveys all relevant building types got finally identified and classified
Building dataset	Ordnance Survey Mastermap	Digital OS Mastermap provides a topography layer and building polygons (GIS-data, shape-file)
Building information	Literature analyses, expert interviews, field survey	Based on several sources, specific information about building types like drawings (e.g. floor plans, sectional drawings), planning documents (e.g. building specifications) were gathered
FRe technologies	Literature analyses, expert interviews, field survey	

II-5.3 Results/findings

Water level

The analyses of flood risk systems often require the linkage of various modelling approaches. Hard and soft coupling of individual models are common ways of trying to comprehensively simulate entire flood risk systems. Input data for the HOWAD-Prevent tool are geo-referenced flood water levels based on hydraulic modelling results. The applied methodology for hydro-meteorological flood hazard determination was developed at the Ecole des Ponts ParisTech and implemented as an open source software tool named Multi-Hydro.

Flood water levels were simulated for certain precipitation scenarios within 'Wilton Grove' (Figure II.5-2), a flood-prone urban area in the south of Heywood that experienced severe flooding in the past. One selected precipitation scenario covers an event of 58.5 mm of rainfall in two hours. This scenario simulates a severe rainfall event that took place at August 3rd 2004. As there are no rain gauges in Heywood[86], the scenario is based on British Atmospheric Data Centre's NIMROD[87] radar data for the Heywood area[88]. The methodology of Multi-Hydro for the determination of flood water levels is described comprehensively in the SMARTeST document 'Guidance for Flood Resilience Systems'. This guidance places emphases on flood damage assessment.

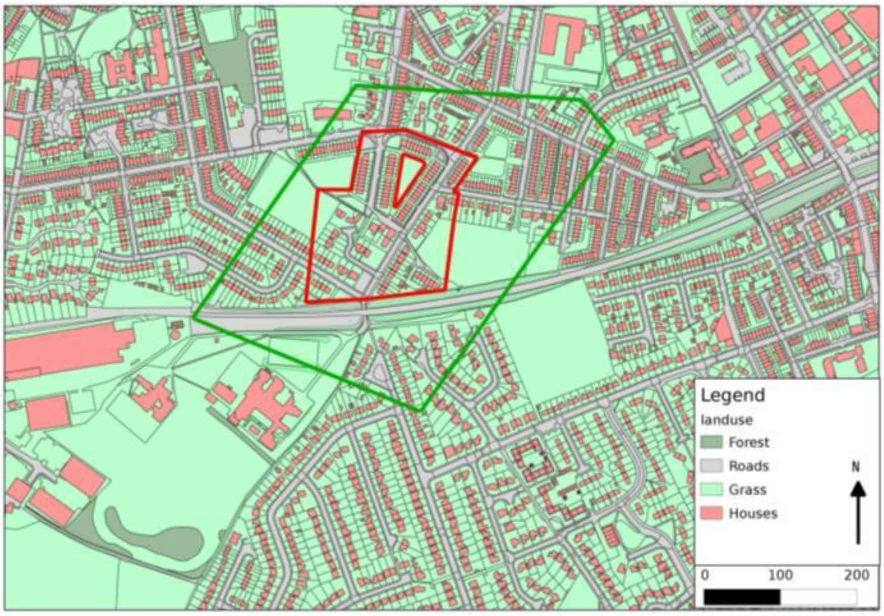

Figure II.5-3: Heywood area; 'Wilton Grove'. Green line: large catchment boundary (to evaluate the lateral inflow for the small catchment). Red line: small catchment boundary. Source: ENPC 2012.

Resulting flood water levels were determined considering several drainage effects, surface and sub-surface run-off processes as well as sewer flow actions. In contrast, impacts of any flood resilient measures were not included in the simulation process to obtain flood water levels for the initial (unprotected) state. Results

86 Robust precipitation data are available in surrounding areas of between 3.25 km and 6km distance from the locations which were flooded.

87 Nimrod is a fully automated system for weather analysis and nowcasting based around a network of C-band rainfall radars. This dataset has the fine-resolution analyses of rain rate for the UK and Europe.

88 NIMROD radar data provide the best estimation of precipitation data (up to 117 mm in 30 minutes and 287 mm in 90 minutes).

of Multi-Hydro modelling for the characterised rainfall scenario are visualised in Figure II.5-4. Flood water levels rise up to 60 cm in the 'Wilton Grove' area. Based on these results potentially affected buildings and constructed assets were detected.

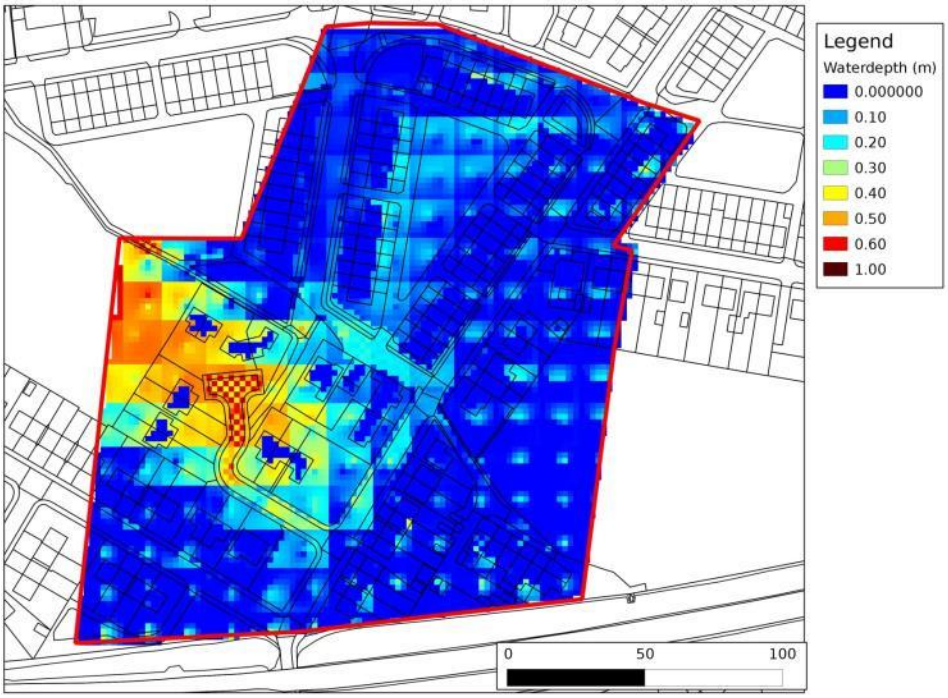

Figure II.5-4: Heywood area; 'Wilton Grove'.
Hydraulic modelling results (flood water levels) for a certain rainfall scenario based on Multi-Hydro simulations.
Source: ENPC 2012.

Building types

The analysis of the flood vulnerability for each location initially relates to the quantitative and qualitative pattern of the distribution of housing. The entire building stock in the Heywood study area was identified and classified using high resolution aerial images, the Ordnance Survey Mastermap® topography layer including building polygons as well as findings from field surveys. Then, all data were integrated into a Geographic Information System (e.g. ArcGIS) to enable spatial allocation of flood vulnerability.

As mentioned in section I-1.1 high intensity summer thunderstorms induced serious pluvial flooding at six distinct locations within the Heywood township. Each of these six locations is mainly characterised by homogeneous developed residential sites, dominated by three quantitative relevant structure types:

- Low terraced houses;
- Semi-detached houses;
- Detached houses.

The explored building typology that is presented in Figure II.5-5 links the indentified structure types to predefined construction periods and thus provide an overview of most dominant building types. It became obvious that particularly terraced houses from Late Victorian / Edwardian era (1870-1918) are the most common and widespread type of high-density residential housing in this area, comparable with numerous other industrial districts in the United Kingdom.

Building type		Structure Type				
		LTH-SE Low terraced house - no or small extension	LTH-LE Low terraced house - large extension	TTH Tall terraced house	SDH Semi-detached house	DH detached house
Construction period	1 Historic to end Georgian era until 1840					
	2 Early and Middle Victorian era 1840 - 1870					
	3 Late Victorian / Erdwardian era 1870-1918					
	4 Interwar period 1918-1945					
	5 Post war period 1945-1965					
	6 1965-1980					
	7 1980 - 1995					
	8 after 1995					

Figure II.5-5: Typology of residential buildings for the case study area Heywood.
Legend of the coloured elements:
Dark grey: no occurrence.
Light grey: building types with less quantitative relevance.
Yellow: building types with high quantitative relevance.
Orange: building type(s) with most quantitative relevance.
Source: IOER 2012.

It is obvious that the specific flood vulnerability of the analysed building types varies significantly, as building materials, building constructions, and building technologies with different flood susceptibilities were commonly used during their construction period. For example, detached houses built after 1995 in

Heywood are often engineered timber frame constructions with masonry outer cladding, whilst terraces from Victorian era usually have solid masonry walls. Section II-5.6 provides a more detailed characterisation of each quantitative relevant building type, which was identified in the Heywood study area. This characterisation comprises the main architectural and structural attributes that may effect the phsical flood vulnerability of the building types. Hence, those characteristics are a substantial basis for the calculation of damage costs due to flooding and for the derivation of synthetic depth-damage functions.

Both Figure II.5-6 as well as Figure II.5-7 depict the classified building types for two flood-prone areas in Heywood, first, for 'Pilsworth Road' and, second, for 'Wilton Grove'. Particularly the built structure in 'Pilsworth Road' document the homogeneous real estate development in different time periods. For example, in Figure II.5-6 terraced houses from 1870 until 1918 are marked in red colour, in contrast yellow coloured buildings represent semi-detached houses constructed between 1965 and 1980.

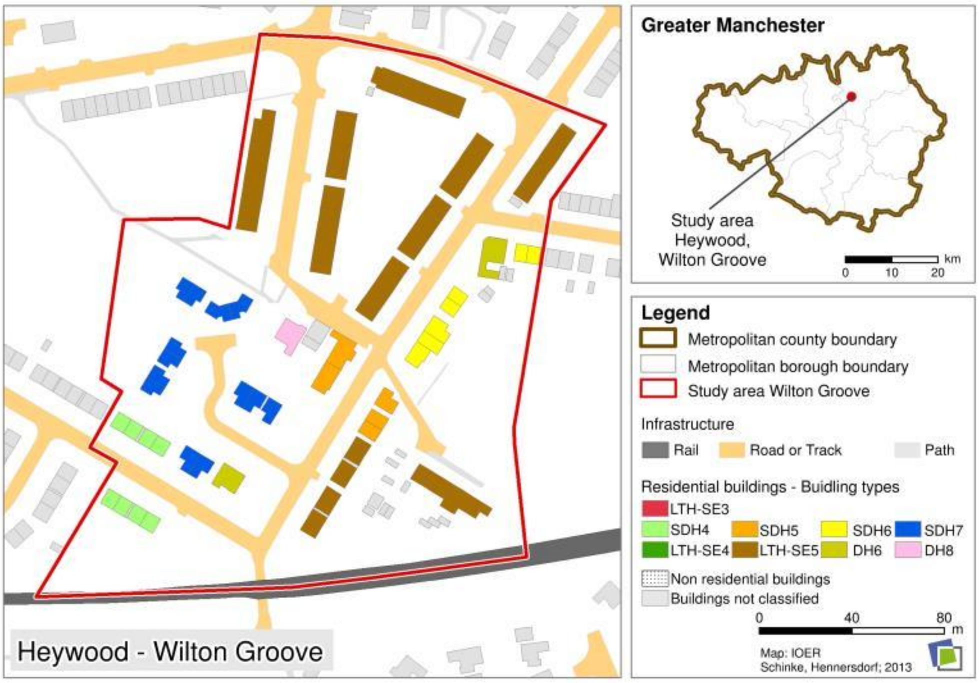

Figure II.5-6: Heywood area. Classified building types for 'Wilton Grove'. Source: IOER 2012. (Data source: Ordnance Survey Mastermap)

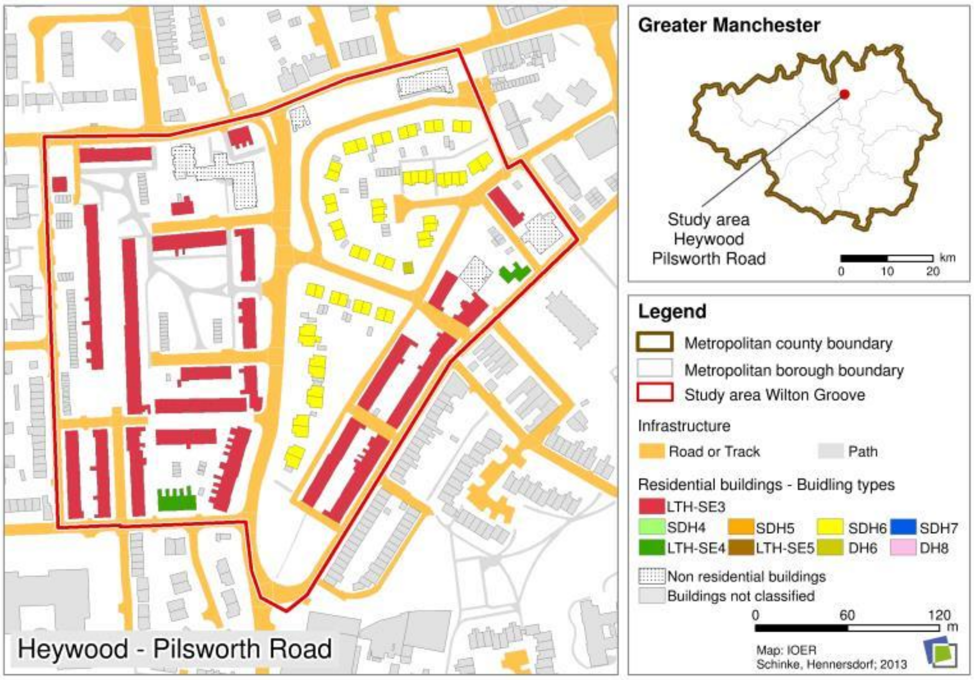

Figure II.5-7: Heywood urban area. Classified building types for 'Pilsworth road'. Source: IOER 2012. Data Source: Ordnance Survey Mastermap.

Results of calculation

All examinations were focused mainly on the analyses of opportunities and constraints of wet and dry flood proofing measures that enhance the resilience properties of flood-prone buildings. Therefore, the tasks were, first, to elaborate the characteristics of 'English' building constructions and, second, to demonstrate exemplary the effectiveness of selected flood resilience measures. This is to extend the scope of the flood damage simulation tool HOWAD-Prevent and to provide a significant contribution for capacity building.

Experts from ENPC in Paris, in co-ordination with colleagues from the University of Manchester, simulated the impacts of certain heavy rainfall scenarios for a selected section of the Heywood urban area. They used the developed Multi-Hydro tool and determined flood water levels for the study area 'Wilton Grove'. The resolution of these resulting flood water levels is decimetre altitude. Then, ENPC also explored the effects of selected area-related FRe T&S regarding altered flood water levels. In the case of 'Wilton Grove' the effects of a rain water retention basin and perimeter flood barrier systems were analysed.

However, the results of the ENPC's calculations comprise notably irregularities, which may be due to numeric issues and or problems with data homogeneity or data quality. One crucial reason for this may be the insufficient resolution of the available digital terrain model that uses a grid size of only 10x10 m. This grid size is inadequate for the intended micro scale investigations carried out in Heywood's 'Wilton Grove'. Therefore, it is assumed that the calculations of flood water levels contain considerable uncertainties. The presented general considerations lead beyond the site-specific issues. Therefore, the used flood water levels are solely reference values, which serve mainly to compare the established results.

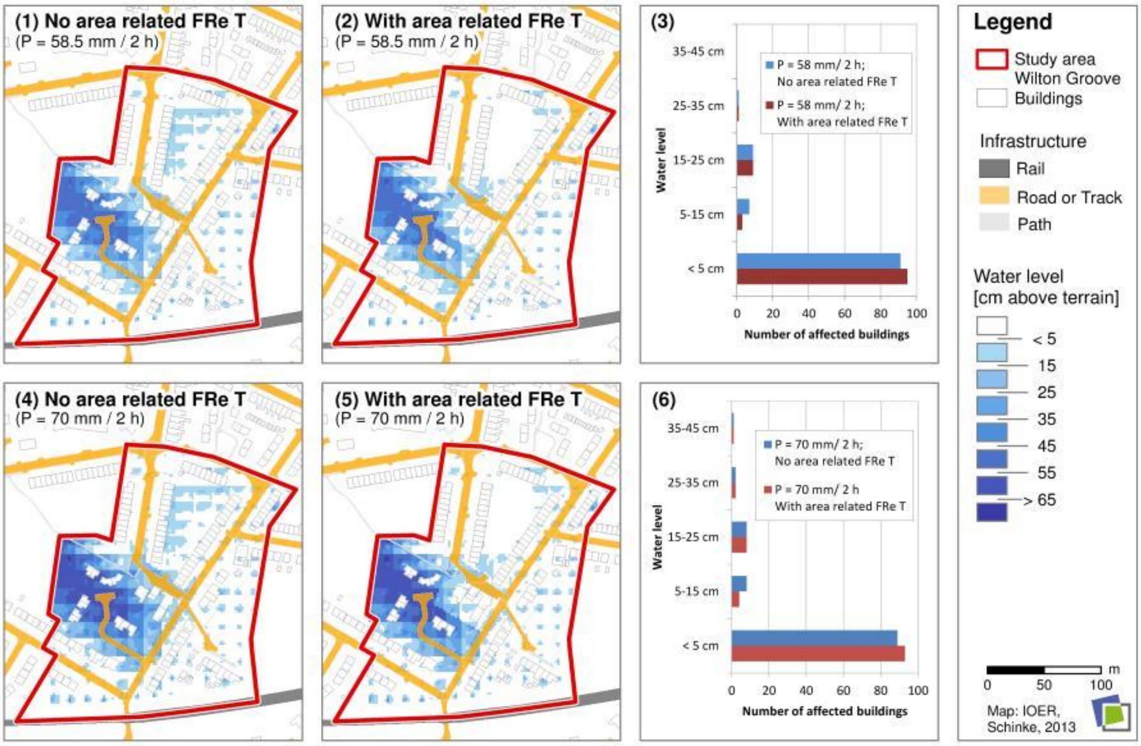

Figure II.5-8: Flood scenarios and the effects on building related water level (Source: IOER); data source: water level ENPC 2012)

The results of hydrodynamic simulations, which were determined with the Multi-Hydro tool and used for the damage modelling, are presented in Figure II.5-8. The differences in flood water level through the implementation of area-related FRe measures in the study area 'Wilton Grove' (here: water retention basin and/or perimeter flood barriers) are relatively marginal and therefore barely recognisable on the maps. Thus, complementary histograms were prepared that should clearly specify the differences of building-related flood water levels (Figure II.5-8 No. (3) and No. (6)). It became apparent that particularly those buildings benefit from area-related FRe measures, which are exposed to low flood depths (range 5-15 cm).

The diagram shown in Figure II.5-9 provides the percentage of total damage to buildings for altogether 14 calculated scenarios. The used flood water levels are based on two different heavy rainfall events: (a) 58.5 mm / 2 h and (b) 70.2 mm / 2 h. Both extreme events represent the bandwidth of maximum precipitation values within a certain time period. The average precipitation value serves as a basic value (100% see for Figure II.5-9 (No. 1)) for the following comparative studies.

Flood damage to buildings was calculated for each scenario using the HOWAD-Prevent tool. It should be noted that different implementation levels for building-related FRe measures (dry and wet flood proofing measures) were considered within damage simulations: (i) 0% = no building-related FRe measures were implemented, (ii) 30% = realistic value for the implementation level of FRe measures, (iii) 100% = optimistic value that indicates the potential of the completely implementation of FRe measures regarding flood damage reduction in the area 'Wilton Grove'.

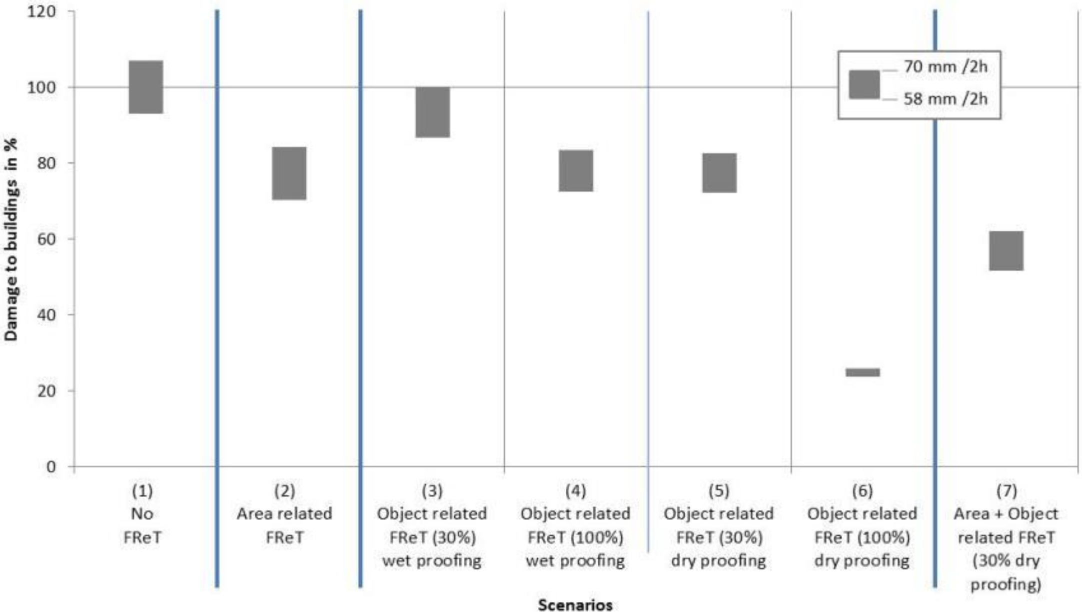

Figure II.5-9: Results of the calculation for the case study area Wilton Grove

It became evident that dry proofing measures (Figure II.5-9 (No. 6)), particularly for the low flood depths, are highly effective to reduce significantly flood damage to buildings in ‘Wilton Grove’. However, to take advantage of the high potential of dry proofing measures, it is needed to ensure that a high level of implementation is achieved, so that their applicability in case of flooding is guaranteed.

Comparing area-related (No. 2 in Figure II.5-10) and object-related (No. 4 in Figure II.5-10) FRe technologies regarding their potential for damage reduction, it became obvious that in this case both types of technologies reach nearly the same level. However, the potential of damage reduction appears to be low considering a realistic level of FRe technology implementation. But it should be noted that particularly wet flood proofing measures (object-related FRe technologies) are effective at any time regardless of any flood warning time, personal efforts, potential operating errors, and leakage rates. Therefore, wet proofing measures should be incorporated in relevant regulations to support their implementation.

Figure II.5-10 provides selected damage maps for the heavy rain event of 58 mm / 2 hours. The potential of FRe technologies concerning damage reduction became evident comparing the initial state (No. 0) and the scenario (No. 6), which depict the case that 100% dry-proofing measures are implemented. However, one building in the centre of the map remains with relatively high flood damage (red coloured). This building is assigned to the building type DH 8. The implementation of FRe technologies is not feasible due to its timber frame construction.

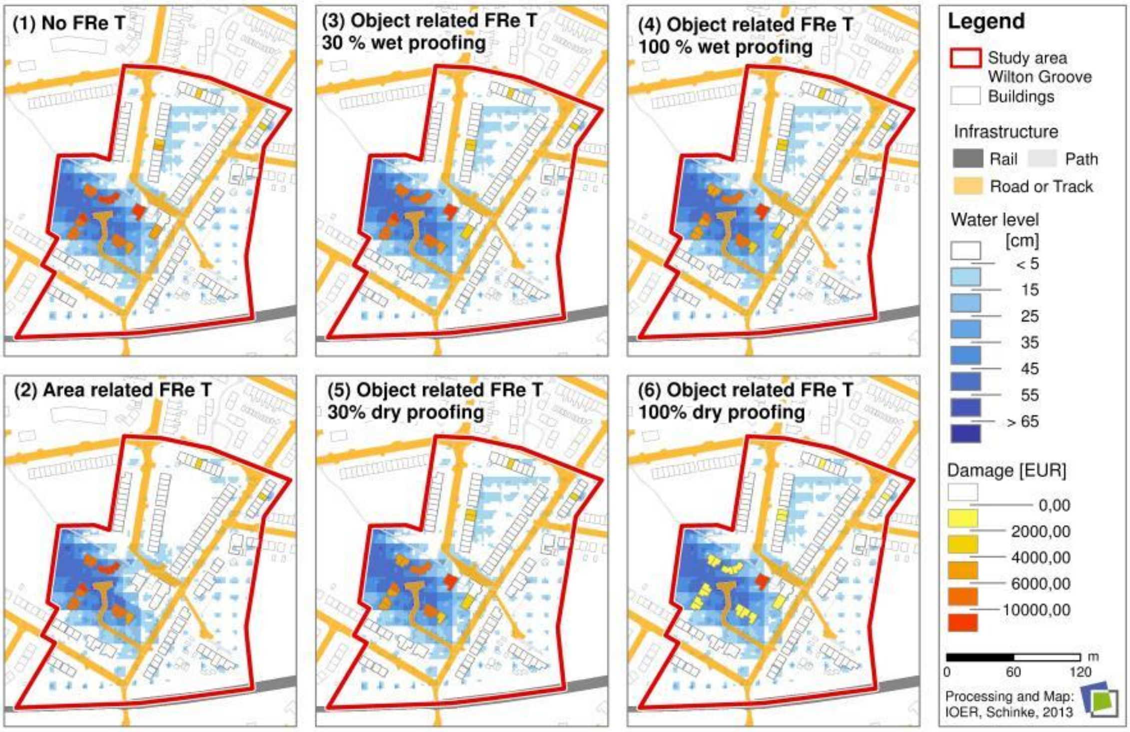

Figure II.5-10: Damage maps for the case study area Heywood, Wilton Groove based on rainfall event 58.5mm/2h (Source: IOER 2013; Data sources: (a) Water levels: ENPC, (b) Building polygons: Ordnance Survey Mastermap).

II-5.4 Summary

The enhanced flood damage simulation model HOWAD-Prevent was successfully tested within the Heywood case study. It became obvious that the expert model's strengths is its usability even for small scale flood damage assessments considering different flood types[89].

Moreover, it could be demonstrated how to determine the effects of FRe technologies concerning physical flood vulnerability mitigation. The flood damage assessment considered various scenarios that comprised different types and levels of FRe technology implementation. The modelling results provide a sound basis for stakeholders to determine most appropriate resilient options.

II-5.5 References

Douglas I, Garvin SL, Lawson N, Richards J, Tippett J & White I (2010). Urban pluvial flooding: a qualitative case study of cause, effect and non-structural mitigation. Journal of Flood Risk Management, 3 (2), 112-115.

[89] As mentioned Heywood is vulnerable to pluvial flooding.

II-5.6 Appendix: Overview of relevant building types in Heywood

DH 6: Muirfield Close, Heywood/Greater Manchester

Urban structure type: **Detached House** (DH)
Period of construction: 1965-1980 (6)

Fig. 1: Row of detached houses. Source: Google Earth.

Fig. 2: Detached house. air brick detail. (2010)

Fig. 3: Detached house. (2010)

Fig. 4: Detached housing estate, aerial photography. Source: Google Earth.

Characteristics:

- Unit (without garage): approx. 7,.5 x 7.5 m
- no cellar, two full storeys, unfinished attic storey
- gable-end onto street
- garage directly connected with the building
- [unknown ceiling construction]
- [unknown wall cross section]
- façade: facing brickwork, partial plaster
- façade is less ornamented: here only vertical whitely plastered band
- masonry bond: stretcher bond
- windows with glazing bars
- plastic frame casement windows
- low pitched gable roof, current roof cladding: concrete roofing tiles

DH 7: Millers Brook Close, Heywood/Greater Manchester

Urban structure type: **Detached House** (DH)
Period of construction: Modern housing 1980-1995 (7)

Fig. 1: Detached house estate. (20th October 2010)

Fig. 2: Detached house, front view. (20th October 2010)

Fig. 3: Masonry detail. (20th October 2010)

Fig. 4: Detached housing estate, aerial photography. Source: Google Earth.

Characteristics:

- unit: approx. 9.00 m x 9.00m
- no cellar, two full storeys, unfinished attic storey
- side-gabled
- three window axis, centred entrance
- garage is integrated in the building
- [unknown ceiling construction]
- [unknown wall cross section]
- façade: facing brickwork, no plaster
- building's façade is less ornamented
- wooden porch above entranced door
- masonry bond: stretcher bond
- plastic frame casement windows to front and back elevation
- 1st floor: upper edge of windows = eaves
- gable roof, current roof cladding: concrete roofing tiles

DH 8: Tangmere Avenue, Heywood/Greater Manchester

Urban structure type: **Detached House** (DH)
Period of construction: Recent years since 1995 (8)


Fig. 1: Detached house. Source: Google Maps 2010


Fig. 2: Detached house. Source: Google Maps 2010


Fig. 3: Window detail. Source: Google Maps 2010


Fig. 4: Detached housing estate, aerial photography. Source: Google Earth.

Characteristics:

- unit: approx. 9.00 m x 9.00 m
- no cellar, two full storeys, unfinished attic storey
- three window axis, centres entrance
- side -gabled
- [unknown ceiling construction]
- cavity wall
- brick outer leaf
- internal leaf: timber framed
- construction with phenolic insulation
- façade: facing brickwork, no plaster
- masonry bond: stretcher bond
- façade is moderate ornamented: here accented corners (pilaster strips) with natural stones as well as straight arched window lintels with accented crown stones in the ground floor
- plastic frame casement windows with glazing bars to front and back elevation
- gable roof, current roof cladding: concrete roofing tiles

SDH 4: Kingsley Avenue, Salford/Greater Manchester

Urban structure type: Semi **Detached House** (SDH)
Period of construction: Interwar period 1918-1939 (4)

Fig. 1: Semi-detached house. (21st October 2010)

Fig. 2: Semi-detached house. Source: Google Maps 2010.

Fig. 3: Semi-detached house, masonry and window detail. Source: Google Maps 2010.

Fig. 4: Semi-detached housing estate, aerial photography. Source: Google Earth 2010.

Characteristics:

- units: 8.75 m x 7.50 m
- large ground area
- houses have mirrored floor plans, thus two houses share one chimney, additional each houses has an own second chimney
- no cellar, two full storeys, unfinished attic storey
- [unknown ceiling construction]
- [unknown wall cross section]
- façade: facing brickwork, no plaster
- masonry bond: stretcher bond
- façades are less ornamented an decorated: here only small fascia between ground floor and 1st floor and slightly accented window lintels
- arched windows
- plastic frame pivot hung windows
- large bay window in the ground floor
- low-pitched hipped roof, current roof cladding: slate roof cladding

SDH 5: Cherwell Avenue, Heywood/Greater Manchester

Urban structure type: Semi Detached House (SDH)
Period of construction: Post war period 1945-1965 (5)

Fig. 1: Semi-detached house, front view. (21st October 2010)

Fig. 2: Semi-detached house. Source: Google Maps 2010.

Fig. 3: Semi-detached house, detail of the dormer. Source: Google Maps 2010.

Fig. 4: Semi-detached housing estate, aerial photography. Source: Google Earth 2010.

Characteristics:

- units: approx. 5.60 m x 8.00 m
- two houses have mirrored floor plans, thus two houses share one chimney
- no cellar, one full storey, finished attic storey, unfinished garret
- [unknown ceiling construction]
- [unknown wall cross section]
- façade: facing brickwork, no plaster
- façade is less ornamented
- masonry bond: stretcher bond
- large dormers with timber decking
- wide windows with pivot hung fanlight windows
- emphasis of horizontals
- steeply pitched gable roof, current roof cladding: concrete roofing tiles

SDH 6: Millbank Street, Heywood/Greater Manchester

Urban structure type: Semi Detached House (SDH)
Period of construction: 1965-1980 (6)

Fig. 1: Semi-detached house, front view. (21st October 2010)

Fig. 2: Semi-detached house. Source: Google Earth 2010.

Fig. 3: Semi-detached house, façade detail. Source: Google Earth 2010.

Fig. 4: Semi-detached housing estate, aerial photography. Source: Google Earth 2010.

Characteristics:

- unit: approx. 5.00 m x 5.00 m
- the houses have mirrored floor plans
- no cellar, two full storeys, unfinished attic storey
- short front extension, porch
- [unknown ceiling construction]
- [unknown wall cross section]
- front façade: facing brickwork, no plaster, timber decking
- façades are not ornamented
- masonry bond: stretcher bond
- geometry of windows accentuate the horizontals of the house
- plastic frame casement windows
- low-pitched gable roof
-

SDH 8: Millbank Street, Heywood/Greater Manchester

Urban structure type: Semi Detached House (SDH)
Period of construction: since 1995 (8)

Fig. 1: Semi-detached house, front view. (21st October 2010)

Fig. 2: Semi-detached house. Source: Google Earth 2010.

Fig. 3: Half of the semi-detached house. Source: Google Maps 2010.

Fig. 4: Semi-detached housing estate, aerial photography. Source: Google Earth 2010.

Characteristics:

- units: approx. 6.,00 m x 8.00 m
- houses have mirrored floor plans
- no cellar, two full storeys, unfinished attic storey
- [unknown ceiling construction]
- [unknown wall cross section]
- façade: facing brickwork, no plaster
- façades are less ornamented: here only accented window and door lintels
- masonry bond: stretcher bond
- plastic frame casement windows
- low-pitched gable roof, two transverse gables, current roof cladding: concrete roofing tiles

LTH-SE 3: Gloucester Street, Salford/Greater Manchester

Urban structure type: Low **Terraced House** with small or no extension (LTH-SE)
Construction period: Late Victorian era/ Edwardian era 1870-1910 (3)

Fig. 1: Terraced housing estate. (21st October 2010)

Fig. 2: Two terraced houses with mirrored front view. (21st October 2010)

Fig. 3: Terraced house, rear back with small two-storeyed extensions. Source: Google Earth.

Fig. 4: Terraced housing estate, aerial photography. Source: Google Earth.

Characteristics:

- entire terrace of 30 houses
- small houses (breadth approx. 4.0 m)
- 2 bedroom house?
- mid and end terrace properties are at the same size
- two neighbouring houses have **mirrored floor plans**, thus two houses share one short rear extension as well as one chimney
- mostly no cellar, maximum two full storeys, predominantly unfinished attic storey
- façade: brickwork, no plaster
- façades are less ornamented: here only small fascia between ground floor / 1st floor, accented window, and door lintels in the ground floor
- masonry bond: three stretcher courses, one header course
- arched windows in the 1st floor
- wooden frame sash windows to front and back elevation
- low-pitched roof, current roof cladding: concrete roofing tiles

LTH-SE 3: Pilsworth Road, Heywood/Greater Manchester

Urban structure type: Low Terraced House with small or no extension (LTH-SE)
Construction period: Late Victorian era/ Edwardian era 1870-1910 (3)

Fig. 1: Terraced housing. (20th October 2010)

Fig. 2: Terraced house LTH-SE 3, front view. (2010)

Fig. 3: Terraced house, rear back, no extensions. (20th October 2010)

Fig. 4: Terraced housing estate, aerial photography. Source: Google Earth.

Characteristics:

- entire terrace of six houses
- small houses (breadth approx. 4.50 m)
- no back extensions
- 2 bedroom house?
- mid and end terrace properties are at different sizes
- two neighbouring mid houses have identical floor plans, thus two houses share one chimney
- mostly no cellar, maximum two full storeys, predominantly unfinished attic storey
- [unknown ceiling construction]
- [unknown wall cross section]
- façade: brickwork (front), plaster/brickwork (back)
- façades are less ornamented: here only accented window and door lintels
- masonry bond: three stretcher courses, one header course
- arched windows
- wooden frame casement windows to front and back elevation
- low-pitched roof, current roof cladding: concrete roofing tiles

LTH-SE 5: Wilton Grove, Heywood/Greater Manchester

Urban structure type: Low **Terraced House** with small or no extension (LTH-SE)
Period of construction: Post war period 1945-1965 (5)

Fig. 1: Terraced house, front view end house. (20th October 2010)

Fig. 2: Terraced house, detail of access to back space. (20th October 2010)

Fig. 3: Terraced house, front view (20th October 2010)

Fig. 4: Semi-detached housing estate, aerial photography. Source: Google Earth 2010.

Characteristics:

- unit: approx. 5.00 m x 8.00 m
- the two houses in the mid have mirrored floor plans, thus they share on chimney
- no cellar, two full storeys, unfinished attic storey
- 4 bedroom house?
- small gap to the court
- [unknown ceiling construction]
- [unknown wall cross section]
- façade: facing brickwork, plastered masonry in the 1st floor
- façades are not ornamented
- masonry bond: stretcher bond
- large bay windows in the ground floor
- plastic frame windows
- low pitched roof

LTH-SE 7: St Bartholomew's Drive, Salford/Greater Manchester

Urban structure type: Low Terraced house with small or no extension (LTH-SE)
Construction period: Modern Housing 1980-1995 (7)

Fig. 1: Terraced housing estate. (21st October 2010)

Fig. 2: Terraced house, front view. Source: Google Earth 2010.

Fig 3: Terraced housing, rear back. (21st October 2010)

Fig 4: Terraced housing estate, aerial photography. Source: Google Earth 2010.

Characteristics:

- unit breadth approx. 6.00 m
- neighbouring houses have **identical floor plans**
- no back extensions
- 3 bedroom house?
- mostly no cellar, maximum two full storeys, unfinished attic
- [unknown ceiling construction]
- [unknown wall cross section]
- façade: facing brickwork, no plaster
- façades are not ornamented
- wooden porch above entrance door
- masonry bond: stretcher bond
- plastic frame casement windows to front and back elevation
- low-pitched gable roof, current roof cladding: concrete roofing tiles

LTH-LE 3: Rudman Drive, Salford/Greater Manchester

Urban structure type: Low **Terraced house** with larger extension (LTH-LE)
Construction period: Late Victorian era/ Edwardian era 1870-1910 (3)

Fig. 1: Terraced housing. Source Google Earth 2010.

Fig. 2: Terraced house, front view. Source: Google Earth 2010.

Fig 3: Terraced house, rear back with larger one-storied extensions. Source: Google Earth 2010.

Fig 4: Terraced housing estate, aerial photography. Source: Google Earth 2010.

Characteristics:

- entire terrace of 30 houses
- small houses (breadth approx. 4.0 m)
- neighbouring houses have identical floor plans, thus each house has one back extension and an own chimney
- mostly no cellar, maximum two full storeys, developed attic storey (typical construction period feature?)
- [unknown ceiling construction]
- [unknown wall cross section]
- façade: brickwork, no plaster
- façades are less ornamented: only small fascia between ground floor and 1st floor; accented window and door lintels in the ground floor
- masonry bond: three stretcher courses, one header course
- arched windows in the 1st floor
- wooden frame sash windows to front and back elevation
- low-pitched roof, current roof cladding: concrete roofing tiles

TTH 3: Coronation Street, Salford/Greater Manchester

Urban structure type: Tall Terraced House (TTH)
Construction period: Late Victorian era/ Edwardian era 1870-1910 (3)

Fig. 1: Terraced housing. (21st October 2010)

Fig. 2: Terraced houses with mirrored front view. (21st October 2010)

Fig. 3: Terraced house, rear back with two-storeyed extensions. Source: Google Earth

Fig. 4: Terraced housing estate, aerial photography. Source: Google Earth.

Characteristics:

- tall three+ storeyed terrace
- house breadth approx. 4.50 m
- two neighbouring houses have mirrored floor plans, thus two houses share one rear extension as well as one chimney
- mostly no cellar, more than two storeys, developed attic storey
- [unknown wall cross section]
- [unknown ceiling construction]
- façade: brickwork, no plaster
- façade division: transverse gable, less ornamented, porch roof with elaborate timber brackets
- bay windows in the ground floor
- masonry bond: three stretcher courses than one header course
- wooden frame sash windows to front and back elevation
- low-pitched roof, current roof cladding: concrete roofing tiles

II-6 Case Study – Valencia (Spain)

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II-6.1 Introduction

Valencia is one of the greatest cities in Spain. It is the capital of the 'Autonomous Community of Valencia' (Spanish: Comunidad Autónoma de Valencia) and has approximately 1.3 million inhabitants in the administrative city limits and about two million people in the whole metropolitan region, respectively.

The city has a long and eventful history starting with the foundation in 138 BC as a Roman colony. It is situated on the bank of the Turia River, at the east coast of the Iberian Peninsula. The city was often affected by floods of the Turia River. The floods are reported since about the thirteenth century. In 1957 the greatest flood occurred with a discharge of around 3,700 m^3/s and flow peaks up to 4,200 m^3/s which lead to high loss of lives (officially 81 deaths, 52 within the city area (Source: Town and Country Planning Directorate, 2002) and heavy loss of properties. It had corresponded with an average recurrence interval (ARI) of 100 – 500 years.

The reason of this flood was a specific meteorological event called 'cold drop' (in Spanish: 'gota fría'), which is a relatively frequent phenomenon in different magnitudes on the Spanish Mediterranean coast. The typical conditions for its development exists in autumn, when the Mediterranean Sea has a high water temperature and the air is humid and warm. Combining them with an overtopping polar jet stream of cold air, the condition forming the 'cold drops'. The circumstances lead to thunderstorms with heavy downpours and hail (seldom snow) as well as high wind speeds.

Due to the 1957 'cold drop' event and the resulting big flood in Valencia, the authorities decided to divert the river towards the south of the city in 1960’s. It is called 'South Plan' and the capacity of the riverbed is dimensioned for about 5000 m^3/s, which matched with a 500 year ARI event. However, it shall be assumed that the South Plan has currently a capacity of only 4200 m^3/s, comparable with the 1957 event.

However, the Valencia Metropolitan area has been growing southward to the new Turia riverbed. Jucar is the main river in the Valencia plain and is linked to the Turia basin through the ‘Albufera’ littoral lagoon. Therefore Valencia’s urban area may be considered submitted to flood risks by a double source/path (Diez *et al.*, 2013).

In view of the foregoing and additional circumstances, the competent authorities were afraid of further threats to several city areas. It focuses on areas which are;

- close to the old Turia riverbed in case of pluvial and fluvial floods;
- close to the Mediterranean Sea in case of coastal and pluvial floods.

The purpose and goal of the studies in Spain are directed to the characterisation of FRe Technologies effects using the damage model HOWAD-Prevent with its high resolution modelling of the damage to buildings. Thereby, the case study Valencia with its country specific investigation results should serve as a first example of the application in Spain. This represents an important basis for applying the methodology in further Spanish investigation areas.

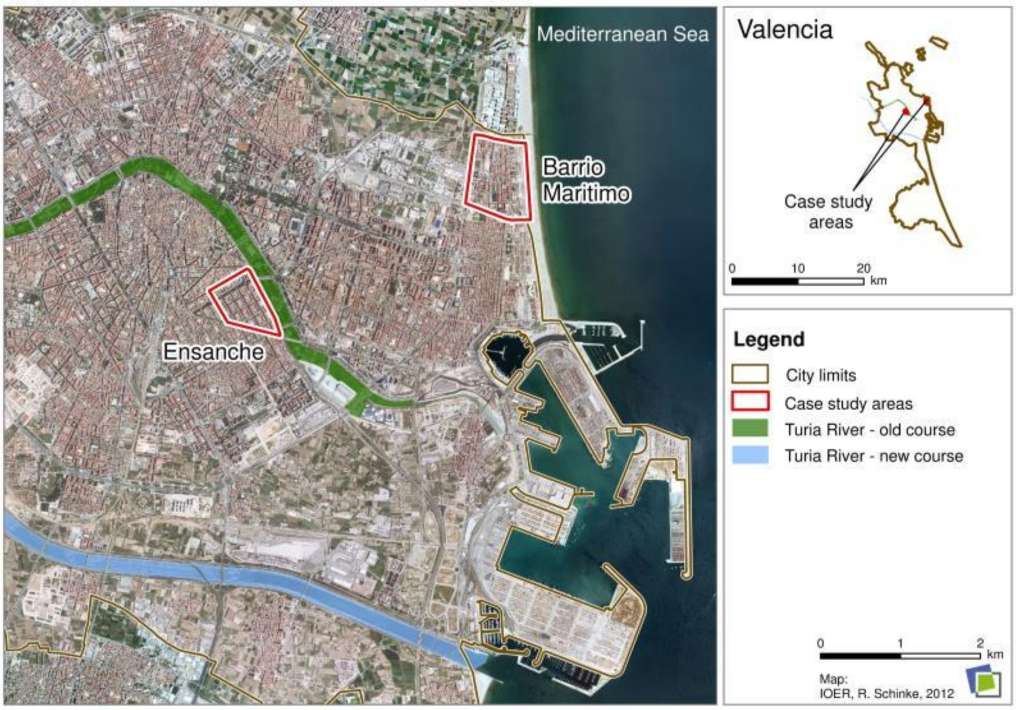


Figure II.6-1: Valencia with the study areas 'Ensanche' and 'Barrio Maritimo'

In view of the threats, the Spanish case study has two different investigation sites which are characterised by different urban structures and urban developments. Figure II.6-1 shows the two locations in a map. The first area named 'Ensanche' is close to the historic city centre and covers an area of about 39 hectares (0.39 km^2). It is located on the old Bank of the Turia River and a relatively homogeneous heavy built up area with around 550 residential buildings. Due to the nearby old River bank, the competent authorities expect a further threat of this city area. The second area, named 'Barrio Maritimo', is close to the coast of the Mediterranean Sea and covers an area about 69 hectares (0.69 km^2) with around 740 residential buildings. The area contains mixed urban structures such as detached, open and closed urban structures. There is a risk of coastal flooding due to the low terrain level of the investigation area combined by a backwater/river flooding of a nearby tributary.

II-6.2 Research approach/methodology

The focus of the case study Valencia is targeted on the first application of the high-resolution damage modelling with HOWAD-Prevent in Spain. The methodology and model approach are described in detail in Schinke *et al*. 2012 and Neubert *et al*. (forthcoming). With that in mind, it was to test the applicability of the associated methodology and model approach to assess damage to buildings considering the effects of FRe Technologies under typical Spanish conditions. The challenge was the:

- Derivation of a Spanish building typology with distinctive construction periods;
- Investigation of different, characteristic buildings (representatives) with regard to the identification and systematisation of the typical building constructions;
- Assessment of the country specific repair techniques;
- Site specific formulation of the depth-damage curves considering the effects of FRe Technologies.

The detailed investigations in Valencia are the basis for a problem adequate analysis of the risks and the effects of FRe Technologies. The size of the investigation areas are optimised with regard to the pilot character of the study. Both study areas are small enough for a detailed and in depth analysis and large enough to show the effects of integrated, object related FRe Technology. Due to these aspects it is possible to transfer and to generalise outcomes and support the applicability of the approach in different spatial scales (local and regional scale).

II-6.3 Results of the investigation

II-6.3.1 Assessment of the water level

The characterisation of the hazard with its flood water levels is one of the major preconditions for precise damage modelling. It is necessary to understand the sources of the flood event with regard to the meteorological conditions, the possible pathways as well as the interaction of all relevant compartments of the hydrologic balance. It needs an in depth analysis of the hydrodynamic conditions using numerical tools.

Due to the huge effort, the necessary local experience, and the specific, science background, the modelling is the task of a parallel, local financed project in Spain. This project and the necessary investigations are still in progress. In consequence of this, the results of these analyses are not available for the SMARTeST project.

In terms of the SMARTeST objectives, it was possible to estimate the water levels using a simplified way. The results contain numerous uncertainties; however, they serve only as reference values to demonstrate the methodologies and to characterise the effects of FRe Technologies. The estimated water levels focus on the 1957 flood event without FRe Technologies and they should approximately correspond with a worst case scenario.

II-6.3.2 Building typology for the case study, Valencia

The derivation of construction periods for the Spanish case study follows the building type approach. The relevant time-depend, gradual development of the country is shown in Figure II.6-2. Based on that, the construction periods could be defined, which are comparable with architecture/construction periods of Fran

Bretones (1990) and Serrano Lanzarote (2012). The derived construction periods and the structure types generate the building type matrix as a basis to characterise the urban structure in Spanish study areas.

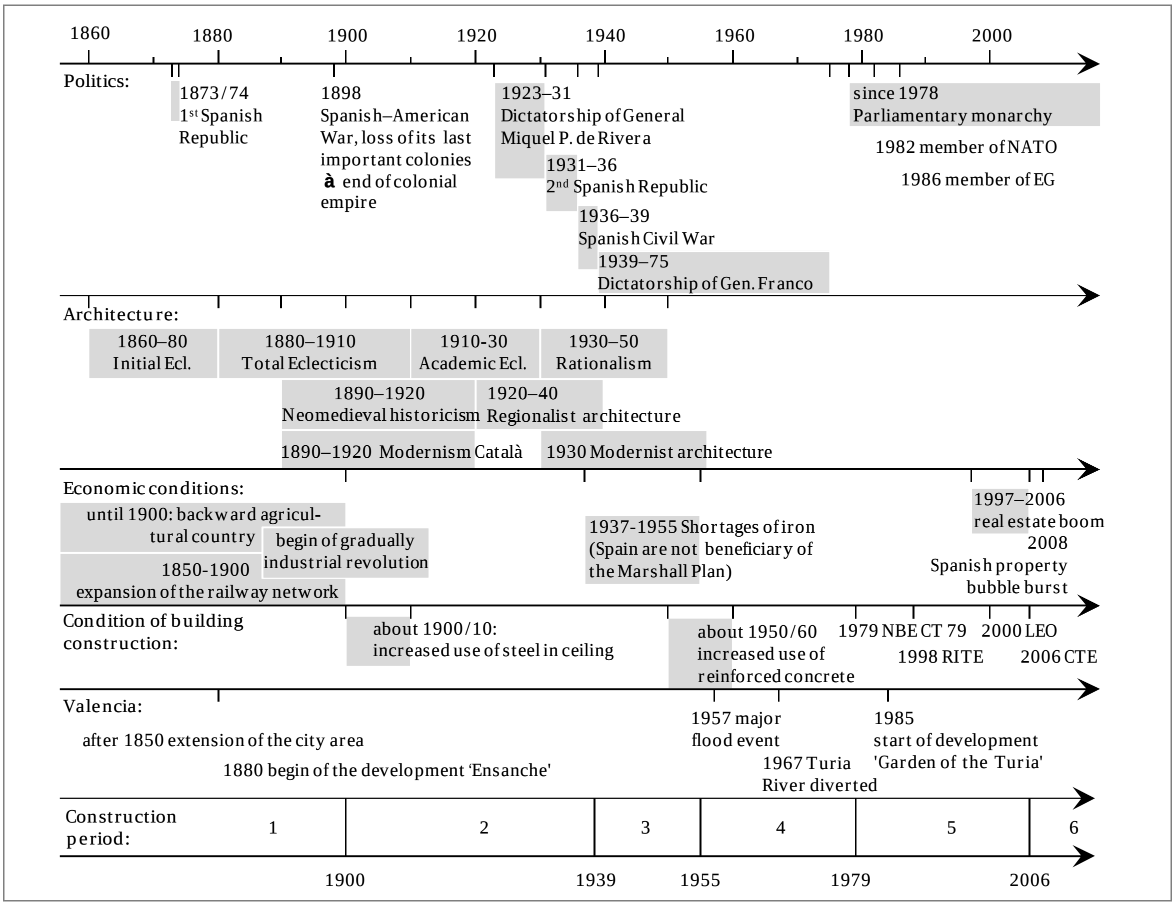


Figure II.6-2: Derivation of construction periods for the case studies in Valencia (Spain)

The derived construction periods combined with the structure types leads to characteristic Spanish building types. The resulting building type matrix is the basis for analysing the settlement structure within the study areas. The challenge of the analysis lies especially in the estimation of the construction periods for every single building. The best insights and most accurate results usually are obtained by field surveys. The applicability is given only for smaller study areas because of the required, high staffing resources.

The field survey in Valencia was aimed to get more familiar with the characteristics of Spanish building construction. The findings of the analysis are important for the study areas themselves and for any further application of the method in Spain. In addition to the field survey, the following datasets were useful for the analysis in the case study, as follows:

- *Aerial photographs/topographic map:*
  - Digital orthographic map 'ODCV 10', flight 2008, scale 1:5000
  - Institute of Cartography Valencia (in Spanish: Instituto Cartográfico de Valencia)

- *GIS-layer with building polygons (footprints)*:
    - GIS-layer and database including additional information like address, number of basement storeys, number of storeys, erection time, for every storey: type of use and different area types, and address.
- *Additional data*:
    - Central land registry (in Spanish: Sede Electrónica del Catastro)
    - Historical maps, and
    - Historical photographs.

In contrast to the experience in Germany, additional attributes are available such as 'erection time' and 'number of basement levels'. It leads to reduced uncertainties of the input data for the damage modelling. The detailed analysis with site specific outcomes is presented in Figure II.6-3 for both investigation sites. The figure shows the building type maps as well as the building type matrix including the fraction of building footprints for every building type. Therefore, it is possible to compare the urban development of both study areas.

The history of both areas is quite different. The study area 'Ensanche' is part of the second urban enlargement zone of Valencia. The urban development of the area started during the gradual industrialisation (about 1880's) in the northwest, close to the city centre and was extended stepwise in the southeast direction, away from the city centre. The built up area comprises attached multi-unit residential and a few non-residential buildings such as, schools, churches and commercial building complexes. The main development phase of the area ended before the 1980's.

The study area 'Barrio Marritimo' was formerly a suburb of Valencia. The area was characterised by small and relatively deep residential buildings along the coastline. During the city expansion, the Marritimo area was incorporated in the Valencia city area. The existing settlement was replaced and extended from the 1950's. The development is characterised by open and closed attached multifamily buildings but also with single family terraced buildings. Today there is a multifarious settlement structure with few fallow lands.

Legend
Fraction of building footprint
- > 15 %
- 5 - 15 %
- 1 - 5 %
- < 1%
- not relevant

Ensanche Structure Type						Barrio Maritimo Structure Type						Construction period	
Detached buildings			Attached and semi detached buildings			Detached buildings			Attached and semi detached buildings				
single unit		multi unit	single unit	multi unit		single unit		multi unit	single unit	multi unit			
SF	SFV	MF	ST	MTO	MTH	SF	SFV	MF	ST	MTO	MTH		
					0,5				0,2		0,2	before 1900 Pre-industrial period	1
					46	0,7	1,4		5,9	0,1	1,7	1900-1939 Gradually industrialisation	2
					19				1,1	1,9	6,4	1939-1955 Post-war period	3
					27				0,5	0,2	24	1955-1979	4
					7,8	0,5	0,2		2,2	19	26	1979-2006 New construction standards	5
					0,5	0,1		1,2	5,6	0,3	0,2	after 2006	6

Figure II.6-3: Building type map and the Building type matrix of the study areas Ensanche and Barrio Maritimo as a result of the building type mapping (data source: aerial photographs: Institute of Cartography Valencia; building polygon layer: Valencia City Council

II-6.3.3 Building vulnerability and the effects of object related FRe technologies

The derivation of site specific depth-damage curves is based on the synthetic method, which is described in Naumann *et al*. 2009.One special feature of the applied procedure is the detailed vulnerability analysis of characteristic, real existing buildings. The first step in the procedure is the identification of the building representatives for all relevant building types. The Figure II.6-4 shows appropriate, characteristic buildings (representatives) of predominate building types in the study areas of Valencia.

The detailed vulnerability analysis based on the virtual flooding of the building in stages. It requires an in depth analysis of the selected building representatives regarding building materials, structural design, and building services using especially building specification and construction drawings. The necessary data source was collected from the following sources:

- Historical Archive of School of Architecture of the Technical University of Valencia (in Spanish: Archivo Histórico de la Escuela de Arquitectura de la UPV);
- City Archive (in Spanish: Ayuntamiento de Valencia, Archivo Municipal de Urbanismo), building documents after 1987;
- Historical city archive (in Spanish: Ayuntamiento de Valencia, Archivo Histórico Municipal), building documents before 1987;
- visual analysis;
- Architects, owners;
- Literature.

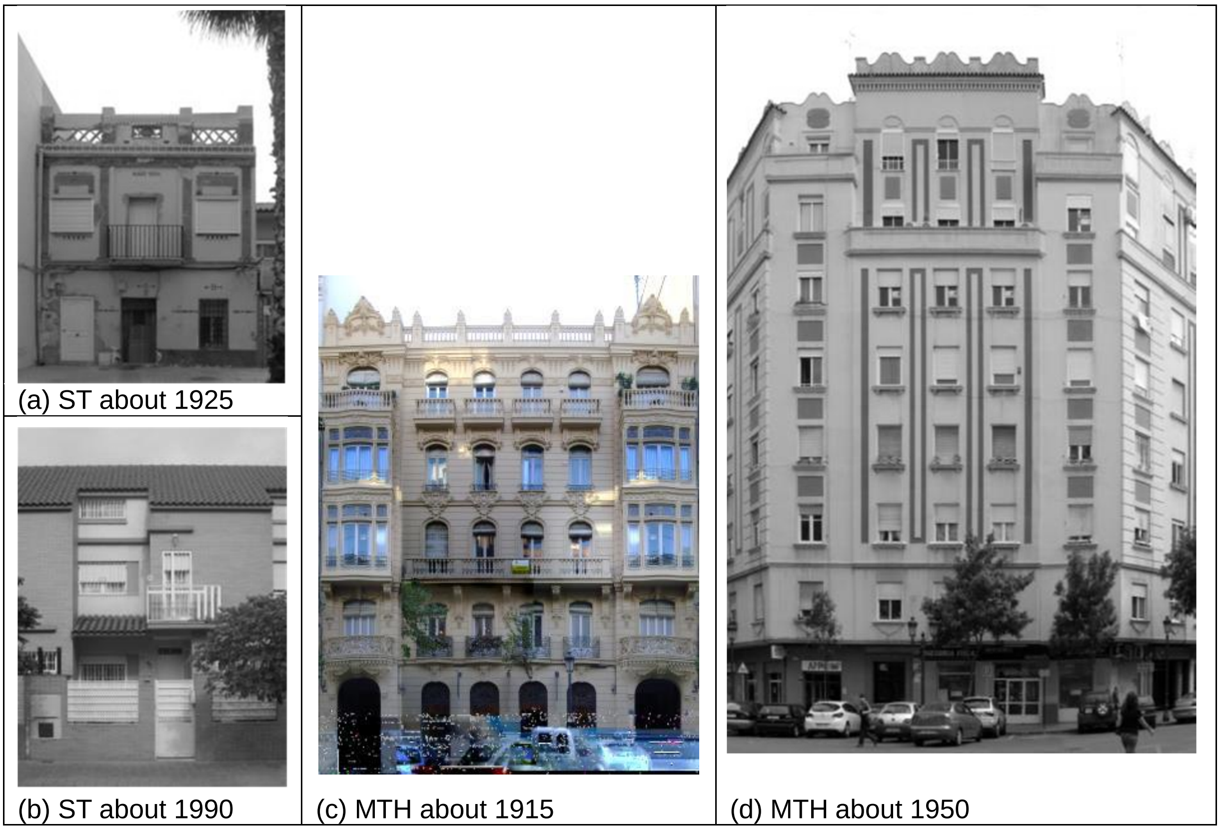


Figure II.6-4: Predominate building types of the study areas 'Ensanche' and 'Barrio Maritimo'
(a) single unit, attached house, about 1925 (ST2)
(b) single (two) unit, attached house, about 1990 (ST5)
(c) multi-unit, attached house about 1915 (MTH2)
(d) multi-unit, attached house about 1950 (MTH3)

Integration of FRe Technologies

In addition to the current state of the building vulnerability, the case study Valencia focuses especially on integration of object related FRe Technologies. These kind of measures need to be considered in the depth-damage curves. Based on the detailed expertise knowledge about the characteristic structural design and the typical use of building materials, the approach allows the well-founded selection and combination of appropriate FRe measures reducing the damage to buildings. It characterises a transferable solution of FRe T in terms of the investigated building type.

The description of the FRe T effects follows the overall synthetic method (Naumann *et al*. 2009). The renewed specification of repair techniques as well as the quantity determination and valuation consider the modification of the building representative. Due to this, the function reflects the effects of the implemented FRe T by a reduced depth-damage curve. In terms of the study area Ensanche, the following paragraphs give a brief overview with few aspects of the selected FRe - dry and wet proofing measures.

FRe - wet proofing measurements

The wet proofing measures supposed to reduce the damage to building by a modification of building construction and building services.

In Valencia, beam-column constructions are frequently used as supporting structures in Multi unit attached buildings (MTH/MTO)[90]. In consequence of this, the ground floor is relatively free of load bearing walls and allows a flexible floor plan design. This is the reason why in the majority of cases the measures focus on wall and floor finish layers as well as the relocation of central elements of building services. The relocation of highly vulnerable and cost intensive elevator machinery is an important point to reduce the flood damage to building. The diagrams in Figure II.6-5 present wet proofing measurement effects for two examples (the representatives of MTH3 and MTH5), marked by black rectangles and black dashed lines.

FRe - dry proofing measurements

Due the big openings in the ground floor level of the MTH, it is not useful to integrate building aperture technologies. The recommendations for the building owner focus on mobile flood protection systems with separate supporting structures and with separate building connections on the property boundaries. In consequence of this design, the selected technology is relatively independent of the neighbourhood and the building type. The flood protection elevation is set to 0.90 m. In comparison to building aperture technologies, the higher value is possible because of the separate supporting structures. The diagram in Figure II.6-5 presents the combination of dry and wet proofing measurement effects based on the selected and recommended FRe Technologies (red points with red dashed line).

[90] MTH – multi unit attached building within heavy built up areas

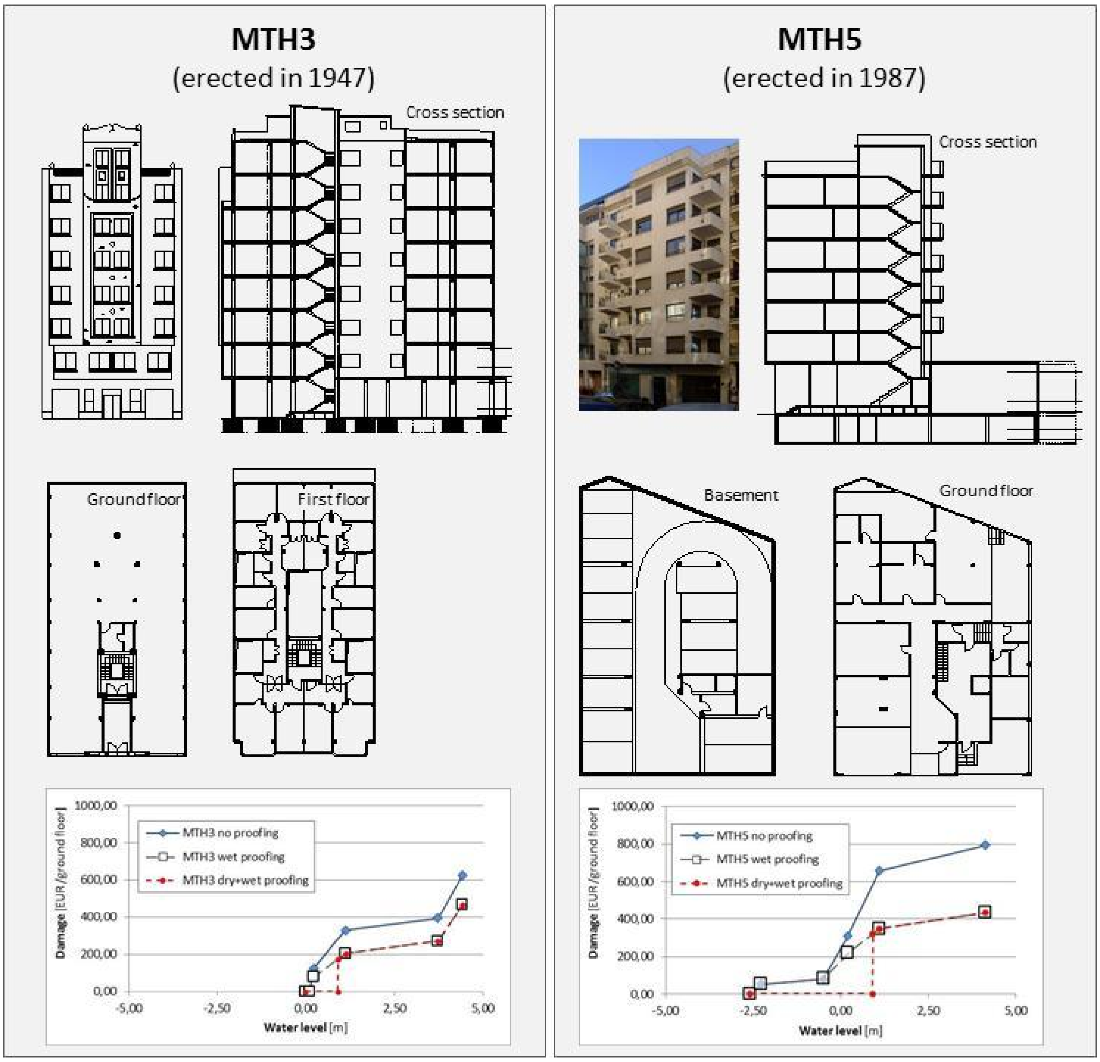
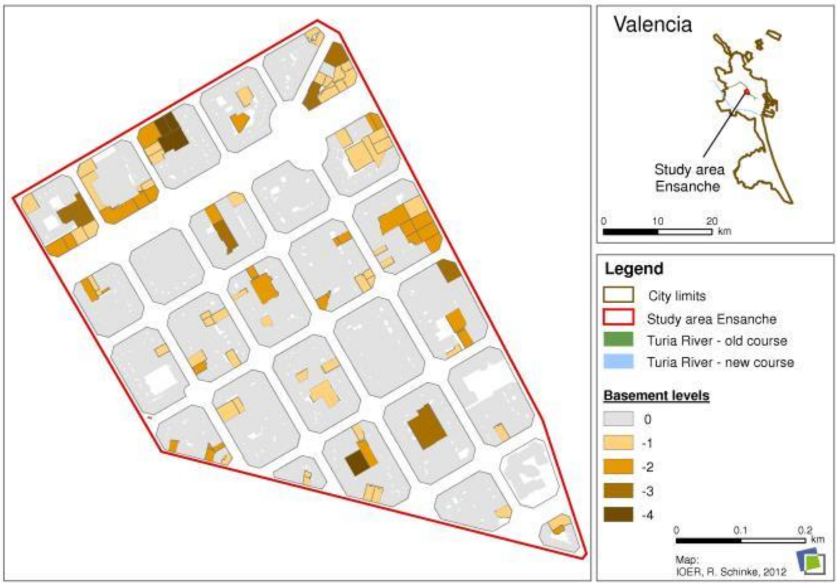


Figure II.6-5: Basic view of the fundamentals and the results of the synthetic vulnerability analysis for two relevant building types in the study area Ensanche, source: Kaidel 2012, modified

Consideration of damage dominating attributes

Additional, damage-relevant data will further reduce the uncertainty of synthetic depth-damage function. In the Valencia case, the land register (Sede Electrónica del Catastro) offers such information like the object-related, lowest basement level (see Figure II.6-6). It led to an adaptation of the functions regarding the variation of the basement levels. In Ensanche this adaptation was possible because of the comparable ground floor height as well as the absence and/or a relative independent location of building service. The Figure II.6-6 is showing the adapted function for the building type MTH2. With an extended nomenclature, the function could be allocated to the respective object within the damage model.



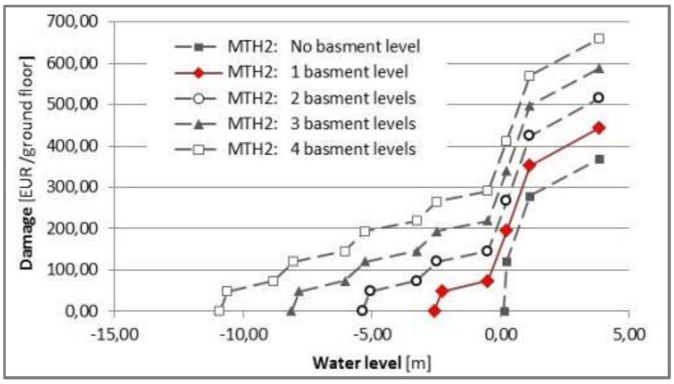


Figure II.6-6: Information to the basement levels in the study area Ensanche used for adaption of the depth-damage-functions shown for the example MTH2 (data source of basement levels: Sede Electrónica del Catastro)

II-6.3.4 Damage modelling

The chapter gives a brief insight into the formulation of possible and appropriate modelling steps as well as the result of the damage calculation with HOWAD-Prevent, based on the study area Ensanche. It especially focuses on the derivation of useful scenarios to specify the effects of the recommended FRe Technologies. The effects are illustrated by a comparison of different scenarios.

The starting point is the description of the design event, which is also referred to as the reference scenario and/or worst-case scenario of the study. It is characterised by the 1957 flood-event with its estimated water levels. It has been conflated with the depth-damage function of the residential building types without FRe Technologies.

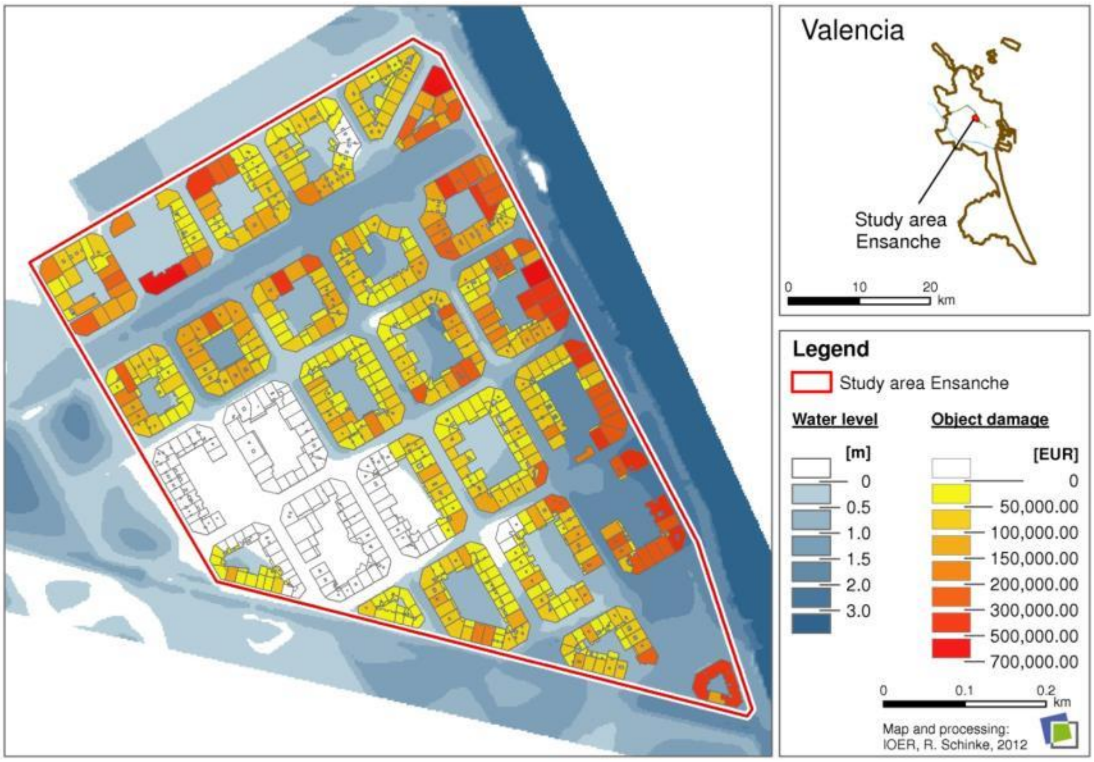


Figure II.6-7: Results of the reference scenario with object-related damage to residential buildings source: IOER 2012.

The target-oriented, spatial, and systematic selection and integration of recommended FRe Technology needs to consider the following major aspects:

(i) the exposure of the objects (reference water level on buildings);

(ii) the allocation of protection strategies; and

(iii) the consideration of the implementation level of FRe Technologies

The first aspect can be derived from the calculation results of the reference scenario. Due to the object based calculation of the damage, the statistical values of the water level Min, Mean, and Max are provided for every single building polygon. The suitable value to characterise the exposure zones is the highest water level (maximum value) because of the possible overtopping of recommended barriers.

In analysis of the water level values and recommended for technologies – which are included in the depth-damage functions – it was specified for three exposure zones (see Figure II.6-8 and Figure II.6-9). The three exposure zones lead to a fundamental decision about the scope of protection related to the object based measures. The exposure zone I characterize areas outside the flood area. In consequence of this, there are no requirements for implementation of flood protection measures. The exposure zone II is characterised by rated values up to 0.9 m. The focus is on dry proofing strategies to prevent the flooding of buildings in this area. The exposure zone III marked buildings with water levels which are higher than 0.9 m. The strategy dry proofing is insufficient here, because of the possible overtopping of the recommended object-related barriers. That is the reason why the scope of protection should include the dry and wet proofing measures. In case of an overtopping of the barrier, the damage to buildings is reduced due to an adaptation of the structural design, the building material, and the building services (see section II-6.3.3).

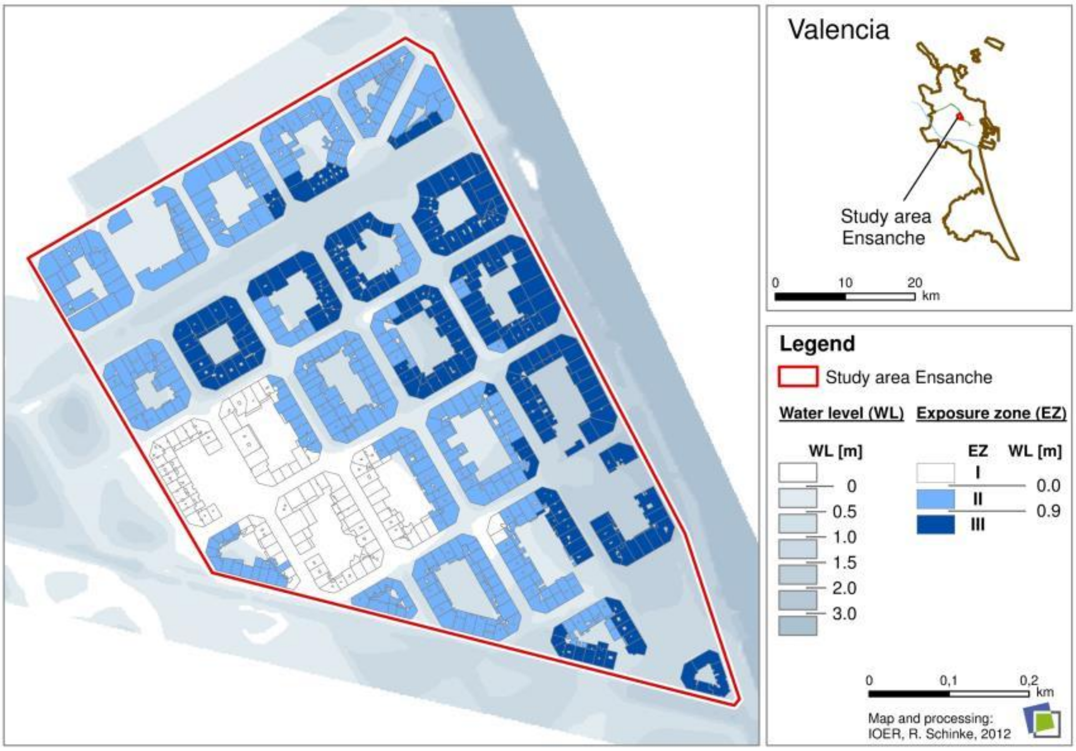


Figure II.6-8: Classification of the buildings in case of Ensanche with regard to the exposure based on the water levels of the reference scenario

Independent of the civil engineering based recommendations of appropriate FRe Technologies and the area related scope of protection, the individual implementation of the FRe Technologies themselves is a further and separate attribute. The determination of the parameter needs corresponding information to the investigation areas. The information can be specified directly using the building polygon or by statistical firm values. The first option is suitable for small case studies or adequate data supply. The second option is like in this case the more typical situation. It needs an estimate of the values or a specification by either of the following:

- field surveys using face to face interviews; or
- telephone calls with the home owners and home users.

Within the case study Valencia – Ensanche, there is no additional information and a data collection was not provided in the project. Therefore, the investigations show here the full range of possible levels of implementation (see Figure II.6-9). Within the study area Ensanche using a rough estimate with a range of possible implementation levels (IL). The following scenarios are calculated:

0 % **à** without any flood precaution measures

30 % **à** 30% of the objects using the recommended FReT

70 % **à** 70% of the objects using the recommended FReT

100 % **à** every object implement the recommended FReT,

whereby the range of 30% to 70% could be possible for an individual flood precaution in flood risk areas.

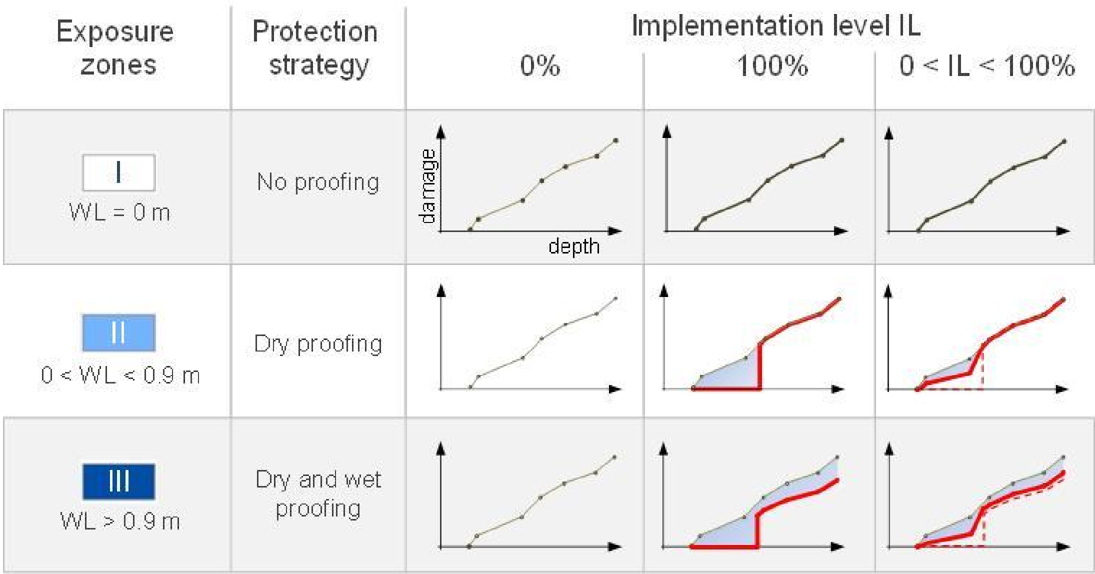


Figure II.6-9: Derivation of Scenarios to characterise the effects of FRe Technologies

The reflection of the IL parameter in the damage modelling can be achieved in two different ways, either through the use of weight (depth-damage) functions or Monte Carlo simulation.

The method to derive weight functions uses the initial calculated depth-damage functions with and without FReT (see section II-6.3.3). Qualitative results of this derivation are shown in Figure II.6-9. In case of the scenarios with IL = 0 % and IL = 100 %, the corresponding depth-damage function are directly useable without an adaption, because the functions characterise the associated implementation level.

The Monte Carlo simulation (MC) is used here to validate the results achieved with the weight function approach. The MC is a suitable method, because it is unknown here, which individual object will integrate the FReT. The allocation of the FReT was made by object based random numbers. Thereby, the entirety random numbers reflect the relationship of the IL. The results of every MC scenario are based on the statistical evaluation of 500 model runs.

The Figure II.6-10 shows selected calculation results for one quarter within the study area Ensanche. The quarter is located in exposure zone I. The buildings are affected with water levels less than 0.9 m. In consequence of this, there is no overtopping of the recommended barriers. The scenarios using weight functions lead to an average decreasing of the building losses by an increasing implementation level. The scenarios using MCA show only one single model run. Therefore, it is a result of a random allocation of the FReT. The objects with FReT reduce the damage to zero due to the installed barrier system. Thereby, the increasing implementation level leads to an increasing number of buildings with FReT. The objects without FReT have no loss changes.

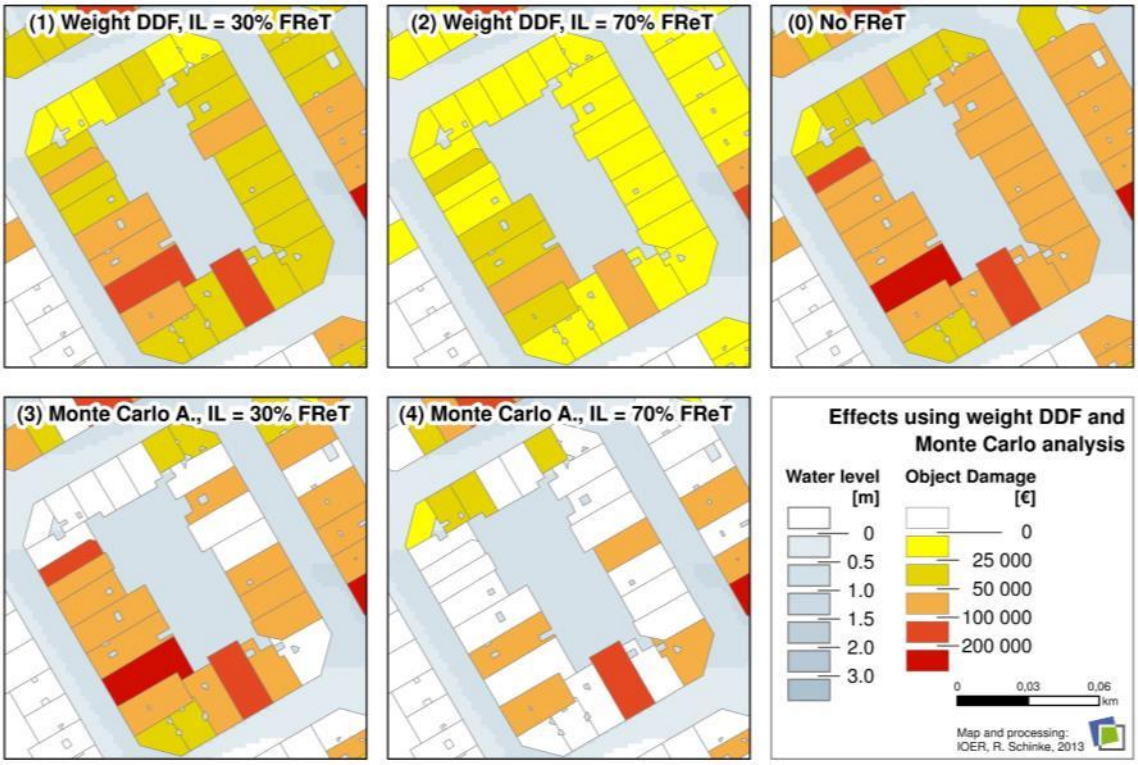


Figure II.6-10: Comparison of the scenario analysis using Weight DDF and Monte Carlo Simulation (example of one model run) for one quarter of exposure zone

The Figure II.6-11 contains a comparison of all scenarios with the view of the whole study area Ensanche. The results of the Monte-Carlo simulation are viewed as box-and-whisker plots. It gives an impression about the distribution of the different simulation runs. It makes clear that the bandwidth is relatively small and the uncertainty is low in consequence of the used approximation to allocate the FRe T. The mean values of the Monte Carlo analysis correlates with the results of the weight functions. Therefore, both ways appear to be suitable to characterise the effects of FRe Technologies.

In general, the results show decreasing damage up to 50 % by an increasing implementation of civil engineering selected and recommended FReT. This gives a basic insight in the opportunity of the private, object-related measures in the study area. In coordination with any other possible and public measures, it should lead to well founded and transparent decisions within flood risk management in particular with respect to the selection, location, and design of the different systems.

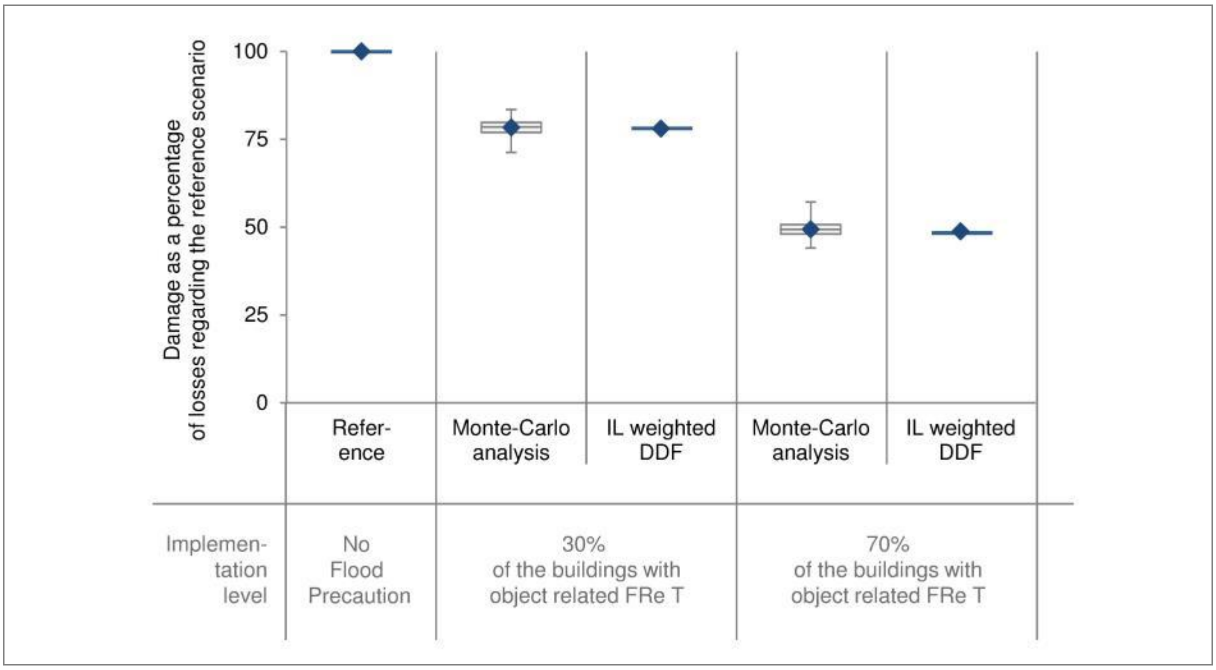


Figure II.6-11: Comparison of scenarios characterising the effects of FRe Technologies

II-6.4 Short summary

The investigation within the case study Valencia demonstrates the applicability of the HOWAD-Prevent approach in Spain. The derivation of a country specific, characteristic building type matrix allows the appropriate differentiation of the investigated settlement areas. In evaluation of the mapped building types, site specific, synthetic depth-damage functions were derived for all the predominant building types in consideration of recommended object-related FReT.

The application of the Monte Carlo approach clarifies the possibilities of a detailed consideration of FReT and it validates the weight function method. The overall results emphasise the pilot character of the study and give an important insight in effects of FRe Technologies. The study provides the basis for the application of the model approach in other Spanish areas considering different flood types and damage types.

II-6.5 Acknowledgements

The presented work would be not possible without a comprehensive support of our Spanish partners. The collection of data, accompaniment during field surveys, as well as establish of contacts to responsible authorities and professional experts have been very valuable for success of the work. We would like to thank:

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Technical University of Valencia

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Technical University of Madrid

- **José Santos López Gutiérrez, Jose Manuel Silvestre Sanz,** and **Jose Javier Diez** Technical University of Madrid (Universidad Politécnica de Madrid)

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[91] NSG - National Support Group of Spain in terms of the SMARTeST project
[92] AIG - Application and Implementation Group of the SMARTeST project

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Part III: Constraints and opportunities for Capacity Building on the national level

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The Part III of the guideline summarises relevant constraints and opportunities for capacity building for each nation and case study area in the SMARTeST project to effectuate a transfer process from the current situation to FRe systems. This summary should provide information on the national and local scale, drawing on information developed through the National Analysis, and on the local case study workshops. It should consider flood resilience[93] in a comprehensive fashion and should contain answers to the following questions, offering a full description. With that in mind, the following questionnaire was designed to offer short and comparable information to this issue.

1) <u>Constraints and opportunities for capacity building on the national level</u>.

1.1) Laws in your country and the interpretation of the EU Floods Directive influence the acceptance of FRe technologies and related programs. Please give a description.

a) *How do national laws and the national interpretation of the EU Floods Directive constrain implementation of FRe technologies and related programs?*

b) *What opportunities are being offered by the national interpretation of the EU Floods Directive?*

1.2) In many countries Nation States and regional provinces exercise autonomy in government. Pleas describe the following as it applies to your case study area:

a) *How do Nation State program interpretations of the EU floods Directive constrain implementation of FRe technologies and related programs?*

b) *What opportunities are being offered by the Nation State interpretation of the EU Floods directive?*

1.3) The Construction Industry is a special stakeholder in FRe. They may view it as a burden or as an opportunity for development. Please describe:

a) *What constraints to the practice of FRe are being raised by the construction industry?*

[93] Definition: Flood resilience combines spatial – ecologic, structural, social and risk management levels, integrating prevention, protection, preparedness, and emergency response, recovery and monitoring.

b) *What opportunities see the construction industry in the practice of FRe?*

1.4) The Insurance industry has a direct relationship to the practice of FRe.

a) *Describe how the insurance industry limits the implementation of FRe?*

b) *What opportunities does the insurance industry offer to encourage FRe?*

1.5) FRe manufacturers are taking a risk in hope of future profits.

a) *What are the constraints for FRe technology manufacturers?*

b) *What are the opportunities for FRe technology manufacturers?*

1.6) Professional associations register and control the practice of their members.

a) *How do professional associations hinder the application of FRe?*

b) *How could professional associations offer opportunities for the practice of FRe?*

2) <u>Constraints and opportunities for capacity building on the local scale</u>

2.1) City government and municipalities traditionally hold power over land use and building codes that relate to the implementation of FRe programs. Summarise what is happening in your case study city:

a) *Are you aware of constraints to the practice of FRe technologies and related programs?*

b) *What special opportunities exist to practice FRe in your case study city?*

2.2) Educational institutions are conveying knowledge and influence the mind-set of our future decision makers.

a) *To what extend do educational institutions constrain the transfer of knowledge about the practice of FRe?*

b) *How can educational institutions offer opportunities for the practice of FRe?*

2.3) Local environmental groups and NGO's have been hailed as the real movers and shakers in a democracy.

a) *Have local environmental groups and NGO's offered constraints on the practice of FRe.*

b) *How can local environmental groups and NGO's create opportunities for the practice of FRe?*

2.4) Individual property owners play an expanded role in implementing and managing FRe technologies and programs.

a) *What are the constraints offered by property owners?*

b) *What are the opportunities for property owners?*

III-1 Capacity Building related to the Paphos Case Study (Cyprus)

Author:

Antonis Toumazis

Dion. Toumazis & Associates, Nicosia (Cyprus)

1) Constraints and opportunities for capacity building on the national level

   1.1) Laws in your country and the interpretation of the EU Floods Directive influence the acceptance of FRe technologies and related programs. Please give a description.

   a) How do national laws and the national interpretation of the EU Floods Directive constrain implementation of FRe technologies and related programs?

National laws do not encourage the implementation of the FRe technologies. However, the implementation of the EU Floods Directive will produce flood risk maps and inform the public about the potential risk of damage due to floods. Indirectly, this awareness together with more FRe technologies will open the road to market for the implementation of FRe technologies.

   1.2) In many countries Nation States and regional provinces exercise autonomy in government. Please describe the following as it applies to your case study area:

   a) How do Nation State program interpretations of the EU Floods Directive constrain implementation of FRe technologies and related programs?

Cyprus is a small country and there are no regional provinces with autonomy.

   b) What opportunities are being offered by the Nation State interpretation of the EU Floods directive?

Many opportunities are offered in Cyprus by the interpretation of the EU Floods Directive. Local Authorities will need tools to assess the potential damage in flood risk areas. FLORETO-CALYPSO, HOWAD, VAT, MULTI-HYDRO are useful tools in assessing the damage and measures to minimise this damage. The appropriate FRe technology will then be selected and implemented.

1.3) The Construction Industry is a special stakeholder in FRe. They may view it as a burden or as an opportunity for development. Please describe:

a) *What constraints to the practice of FRe are being raised by the construction industry?*

The construction industry is welcoming new products which improve the safety and functionality of buildings and infrastructure. There is lack of experience in FRe construction yet due to lack of awareness and lack of implementation of such technologies.

b) *What opportunities does the construction industry see in the practice of FRe?*

FRe technologies are a challenge and a window for new jobs in the construction industry. There is potential for export of technology to other countries.

1.4) The Insurance industry has a direct relationship to the practice of FRe.

a) *Describe how the insurance industry limits the implementation of FRe?*

The Insurance industry does not provide reduced premiums to properties which implement FRe technologies. This happens because FRe technology on its own does not reduce the risk of flood damage. The whole system of proper implementation, maintenance, operation of FRe technology reduces the risk of flood damage.

b) *What opportunities does the insurance industry offer to encourage FRe?*

The insurance industry may reduce the insurance premium if there is assurance that an effective FRe system is in place. This assurance has to be provided by an independent body. Such a scheme will encourage the implementation of FRe technologies and systems.

1.5) FRe manufacturers are taking a risk in hope of future profits.

a) *What are the constraints for FRe technology manufacturers?*

The FRe market is currently non-existent in Cyprus. Furthermore, the island does not have a tradition for technology manufacturing in the construction industry. New manufacturers will have to train personnel for such new products.

b) *What are the opportunities for FRe technology manufacturers?*

Cyprus, being in the European Union is part of a very large market. Globalisation and e-commerce enable the promotion and sale of products all over the world.

1.6) Professional associations register and control the practice of their members.

a) How do professional associations hinder the application of FRe?

FRe technologies are considered as products and suppliers are not required to be registered by professional associations. Designers of purpose built FRe constructions must be registered with the Cyprus Chamber of Professional Engineers (ETEK).

b) How could professional associations offer opportunities for the practice of FRe?

Awareness of engineers through their professional associations offers opportunities for engineers to be engaged in this new market.

2) Constraints and opportunities for capacity building on the local scale

2.1) City government and municipalities traditionally hold power over land use and building codes that relate to the implementation of FRe programs. Summarise what is happening in your case study city:

Land use and building codes are governed at National level and not local level. Municipalities are consulted but they do not have the power to change the provisions of these regulations and codes. Paphos Municipality has the authority and duty to enforce or implement these regulations and codes when checking and issuing building permits. Currently FRe programs are not referred in the land use and building regulations.

a) Are you aware of constraints to the practice of FRe technologies and related programs?

The main constraint is lack of awareness and lack of suppliers/ manufacturers of FRe technologies in Cyprus. There is hence limited demand and practically no supply. Through SMARTeST there was public awareness and interest is developing.

b) What special opportunities exist to practice FRe in your case study city?

Targeted funding for innovative products is a current opportunity in Cyprus. There is a potential opportunity for a demonstration project in the case study area.

2.2) Educational institutions are conveying knowledge and influence the mind-set of our future decision makers.

a) *To what extend do educational institutions constrain the transfer of knowledge about the practice of FRe?*

At teaching level, university and student textbooks are generally addressing and teach students how to design storm drainage systems, focussing almost entirely on the design of networks for a given design storm. How one deals with the cases when the storm exceeds the design conditions is usually not dealt with at university level.

b) *How can educational institutions offer opportunities for the practice of FRe?*

By teaching students that one must address the consequences of exceeding the design conditions, then the damage to society will be reduced and FRe practice will increase. Especially flood risk in urban areas is increasing all the time and living with the floods is becoming a reality in many areas.

2.3) Local environmental groups and NGO's have been hailed as the real movers and shakers in a democracy.

a) *Have local environmental groups and NGO's offered constraints on the practice of FRe?*

Environmental groups and NGO's have not presented any constraints on the implementation of FRe. In the awareness campaigns through SMARTeST, FRe is assesses as an environmentally friendly solution, requiring nominal resources and energy and having minimum visual impact at normal conditions. During flood conditions, FRE systems protect the environment, both the natural and build environment.

b) *Have local environmental groups and NGO's created opportunities for the practice of FRe?*

Environmental groups and NGO's may have a key role in offering opportunities for FRe practice. Massive drainage systems, flood protection infrastructure works are commonly associated with large capital investment and adverse environmental impacts. Whereas, FRe technology at local level is associated with low capital investment and limited adverse environmental impacts.

2.4) Individual property owners play an expanded role in implementing and managing FRe technologies and programs.

a) *What are the constraints offered by property owners?*

Not all property owners are aware of the available technology in FRe. They tend to forget the risk of flooding. They do not appreciate the benefit of flood protection (when they are insured)

b) *What are the opportunities for property owners?*

Large market in flood prone areas. Awareness after a flood event.

III-2 Capacity Building related to the Dresden – Kleinzschachwitz Case Study (Germany)

Author:

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The following 'Findings and Documentation of the Dresden-Kleinzschachwitz Case Study' summarise constraints and opportunities for capacity building in Germany. After the II World War, the Constitution of Germany was written to place heavy responsibility for decision-making on individual States (Leander).

The Dresden-Kleinzschachwitz Case Study is located in the State of Saxony. A severe 2002 flood of the River Elbe helped set the precedence for the passage of the Federal Act to 'Improve Preventive Flood Control' which was adopted by the State of Saxony and followed by the City of Dresden.

Over the last decade, there have been improvements in social capacity building in flood risk management in Dresden, as well as in the case study area, leading to a wider involvement of the public. Dresden-Kleinzschachwitz together with Dresden-Laubegast had been severely flooded in 2002 and in 2005. Both are privileged, primarily residential districts, located in the upstream portion of the city. They are surrounded by filled in, old oxbow meanders (Alt-Elbarme) of the River Elbe. Their fate is inter-related as flood stages in Laubegast are lessened by the polder-type function of the 'Alt-Elbarme' around Kleinzschachwitz. Damage is caused by flow velocity, ponding and through raised groundwater levels.

The City of Dresden is preparing a 'Flood Preparedness Plan[94] that is considering Kleinzschachwitz together with Laubegast and Zschieren as a planning district. As a part of the planning process considerable efforts are being made in land use control, flood preparedness, contingency planning and capacity building of stakeholders.

1) <u>Constraints and opportunities for capacity building on the national level</u>.

 1.1) Laws in EU countries and the interpretation of the EU Floods Directive influence the acceptance of FRe technologies and related programs. A description:

States have been given the mandate to revise water laws and to implement flood defence strategies through passage of the 2005 Federal 'Act to Improve Preventive Flood Control'. After passage of the 2007 EU Floods Directive its implementation in Germany was facilitated through the 2007 Federal Regional Planning Act, the 2007 Federal Building Code, and through the 2009 Federal Water Resources Act.

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[94] Landeshauptstadt Dresden, Geschaeftsbereich Wirtschaft, Umweltamt. Plan Hochwasservorsorge Dresden, Betrachtungsgebiet 17, Zschieren, Leuben, Laubegast. Stand 06. 2011.

a) How do national laws and the national interpretation of the EU Floods Directive constrain implementation of FRe technologies and related programs?

National laws and interpretation of the EU Floods directive do not constrain implementation of FRe technologies. Implementation though lies on the local level, and the local perception that flood defence is the responsibility of the State government is a convenient excuse to constrain private and municipal investments in FRe measures.

A further deterrent was the generosity of the federal, state, and private disaster relief, which in the past permitted reconstruction of flood damaged properties without implementation of FRe technologies.

The EU floods directive does not contain requirement for an audit. Some feel that there will be no way to ensure that FRe systems and technologies planned will actually be implemented.

b) What opportunities are being offered by the national interpretation of the EU Floods Directive?

The German response to the EU Floods Directive (see 1.1 above) has set the stage for a new approach of flood resilience and speedy recovery that is different from the past reliance on flood defence structures. Federal ministries provide assistance. An example is the 'Federal Ministry for Traffic, Construction and City Planning' that issued an update to its technical report 'Flood Protection Manual' addressing flood proofing and flood resilient construction.[95] It addresses measures to waterproof buildings, dry and wet flood proofing, flooding through sewers, flood proofing of utility and heating systems, protection from pollutants, flood warning, flood preparedness, risk management and stakeholder involvement.

The 2009 Federal Water Resources Act[96], for the first time requires that; individuals take protective measures on their own to guard against risks, to lower flood losses, and to adjust uses of flood-prone properties. Flood warning, land use restrictions on floodplains and the mapping of flood-prone areas are mandatory.

1.2) In many countries Nation States and regional provinces exercise autonomy in government. Please do the following apply to the case study area:

a) How do Nation State program interpretations of the EU floods Directive constrain implementation of FRe technologies and related programs?

State interpretation of the EU Floods Directive does not impair implementation of FRe technologies.

[95] Bundesministerium fuer Verkehr, Bau, und Stadtentwicklung. Hochwasserschutzfibel – Objektschutz und bauliche Vorsorge. Issue 12.1010

[96] Paragraph 5, Section 2, Wasserhaushaltsgesetz (Federal Water Resources Act) 2009

b) *What opportunities are being offered by the Nation State interpretation of the EU Floods directive?*

States must now prepare flood risk reports, flood risk maps and flood risk management plans. A new provision for stakeholder participation is changing flood risk planning and aiding in the uptake of FRe measures. In brochures and publications the Ministry of the Environment for the State of Saxony is now placing emphasis on measures taken by individual property owners (Eigenvorsorge)[97] to reduce flood risks.

1.3) The Construction Industry is a special stakeholder in FRe. They may view it as a burden or as an opportunity for development.

a) *What constraints to the practice of FRe are being raised by the construction industry?*

In Germany the construction industry is more regulated than in most other countries. In Germany cities and municipalities control shape and performance of bigger urban developments through detailed construction plans (Bebauungsplan) often procured through architectural competitions that follow detailed specifications. Construction of individual houses need to involve architects. This is different from countries, like the U.S., where developers influence location, type and form of developments. Builders will not practice FRe unless required by code and specified by an architect. This is a constraint, but also an opportunity for the practice of FRe.

b) *What opportunities does the construction industry see in the practice of FRe?*

FRe measures are services by the construction industry that go beyond traditional practices, offering new and additional service and profit opportunities. FRe practices offer an opportunity to mitigate flooding, opening up sites to development that would have otherwise been unsuitable. This is particularly applicable to urban centres and historic districts that have traditionally concentrated along waterfronts. An example is Hafen City in Hamburg[98], Germany, containing prime real estate as a new-town site that is almost as big as the historic centre of town, but it is subject to flooding. Flood-proofing here and special building codes are the technology that expands the availability of land for development. FRe thus is highly desirable for the construction industry.

Dresden Kleinzschachwitz and its lowlands is being viewed as a polder area where flooding would reduce water levels in downstream Dresden Laubegast. Flood proofing of individual structures will be an opportunity for the construction industry.

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[97] Freistaat Sachsen, Staatsministerium fuer Umwelt und Landwirtschaft. – Hochwasser geht uns alle an! Hochwassermanagement im Freistaat Sachsen. 2013

[98] Landesbetrieb Strassen, Bruecken und Gewaesser, Freie Hansestadt Hamburg. Informationen zum Flutschutz in der HafenCity Hamburg. Stand: 22.12.2009

1.4) The Insurance industry has a direct relationship to the practice of FRe.

a) Describe how the insurance industry limits the implementation of FRe?

A 2009 study published in the University of Miami International and Comparative Law Review found limits to the effectiveness of flood insurance practiced in Germany, because it is not effectively sharing the burden of flood risks between individuals, insurance companies, and the Government.[99] In Germany the flood 'insurance penetration rate' is relatively low.

Insurance companies in Germany are generally not effective in encouraging awareness of flood risks, and pro-action to mitigate losses. The insurance industry here provides little or no incentives to those policyholders who implement flood proofing and other flood resilience measures. Insurance companies are concerned about the maintenance and effectiveness of privately owned and operated FRe measures.

b) What opportunities does the insurance industry offer to encourage FRe?

It is in the interest of the insurance industry to reduce flood losses and related claims. This holds particularly true at a time of climate change and ever increasing frequency and intensity of flood events and related high flood losses.

1.5) FRe manufacturers are taking a risk in hope of future profits.

a) What are the constraints for FRe technology manufacturers?

FRe technology manufacturers in Germany range from giants, like Thyssen Steel of the Ruhr Valley to upstart companies in Dresden, using plywood and plastic sheeting. FRe manufacturers offer different types of patented systems that vary in function, materials and design. Their development requires research and development funding and continuous marketing costs. A lack of uniform building codes for flood-proofing constrains sales, and so is the reluctance of the insurance industry to reduce flood insurance premiums for individuals who install measures on private properties.

b) What are the opportunities for FRe technology manufacturers?

Increases in flood events, due to climate change, and Paragraph 5, Section 2, of the 2009 Federal Water Resources Act[100], that requires that individuals take measures on their own to lower flood losses offer opportunities for the use of FRe measures. The 'Plan Hochwasservorsorge Dresden[101] has produced the flyer and Web page 'Eigenvorsorge - was muss und kann ich tun?' that outlines FRe measures for individual property owners.

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[99] Toothill, J., N. Catford. "Flood management in Central Europe" RISKTRANSFER, Magazine Volume 2, Issue 5, Oct. 2004

[100] Paragraph 5, Section 2, Wasserhaushaltsgesetz (Federal Water Resources Act) 2009

[101] Landeshauptstadt Dresden, Geschaeftsbereich Wirtschaft, Umweltamt. Plan Hochwasservorsorge Dresden, Betrachtungsgebiet 17, Zschieren, Leuben, Laubegast. Stand: 06.2011.

Temporary and demountable flood barriers can be in part pre-installed (flexible or rigid) or fully pre-installed sectional barriers (automatic and manual) as well as flood gates. Some have been installed in more than ten locations throughout Dresden since 2002 and help to showcase products of FRe technology manufacturers. These are technologies, though that are purchased and maintained by the city.

In planning district 17 within Laubegast temporary floodwalls have been considered. Manufacturers like Howatec[102] and 'Gesellschaft fuer operativen Hochwasserschutz'[103] (who have established offices in various European countries) demonstrate that German manufacturers see export opportunities.

1.6) Professional associations register and control the practice of their members.

a) *How do professional associations hinder the application of FRe?*

Professional associations that relate to construction, city planning and engineering, and do not make provisions to communicate information about FRe hinder its application. This is not the case in Dresden.

b) *How could professional associations offer opportunities for the practice of FRe?*

The DWA Sachsen/Thueringen[104], with its office in Dresden, is offering courses in preventive flood risk management since 2008. This includes modules on (a) theory and (b) practice. They are designed for a class size of 10-20 participants[105]. Other professional associations, such as the chamber of architects[106] of Saxony have offered courses on the innovative protection of drainage courses and soil bioengineering.

2) Constraints and opportunities for capacity building on the local scale

2.1) City government and municipalities traditionally hold power over land use and building codes that relate to the implementation of FRe programs. Summarise what is happening in your case study city:

a) *Are you aware of constraints to the practice of FRe technologies and related programs?*

Flood control for Dresden[107] used to be the primary responsibility of the State of Saxony Flood Control Dam Agency (LTV)[108], administering flood control dams, first built in the early 19-hundreds. The agency used to adhere to conventional flood control concepts. During the communist era, flood storage capacity in reservoirs was lost to water supply storage, and floodwater diversion courses (Flutrinnen) in Dresden were

102 http://howatec-online.com/ accessed 4/3/2013
103 http://www.goh.de/ accessed 4/3/2013
104 DWA Deutsche Vereinigung fuer Wasserwirtschaft, Abwasser und Abfall e.V. Landesverband Sachsen/Thueringen
105 www.dwa-st.de (Menuepunkt Kurse)
106 Architektenkammer Sachsen, Dresden
107 http://de.wikipedia.org/wiki/Hochwasserschutz_in_Dresden accessed 3/20/2013
108 Staatsbetrieb Landestalsperrenverwaltung des Freistaates Sachsen

permitted to be filled with allotment garden colonies as well as a regional ice skating hall[109]. Conventional engineering in fact constrained the practice of flood resilience.

b) What special opportunities exist to practice FRe in your case study city?

The Dresden catastrophic flood events of 2002 and 2005 led to much soul searching by its City Council. Initial desires to protect the River Elbe and tributaries (Weisseritz) with high levies were eventually dropped. In 2004 City Council decided to embark on a long-range 'Flood Preparedness Plan[110] that included a component of flood-proofing through property owners[111], stakeholder information, and flood warning and planning for exceedance flows in sewers. Measures planned, and partially implemented, along the River Elbe have a cost of 79.6 million EUR.

Flood-proofing through property owners is being advocated through brochures and the Internet. Stakeholder information has been expanded into a stakeholder capacity building program with learning alliances. In 2009 City Council decided to initiate a participatory stakeholder involvement process for planning District 17 that includes Laubegast und Kleinzschachwitz.[112] A document 'Dresden – Laubegast – living with the river – participatory process for the preparation of measures to protect against flooding of the River Elbe – opinions and recommendations'[113] describes the process in a summary of protocols, diagrams of design options and related correspondence. The stakeholder process started in 2010[114] involving about 200 participants formulating goals, defining tasks to be completed, and formulating concepts. The State of Saxony (LTV) still holds responsibility for implementing most measures.

2.2) Educational institutions are conveying knowledge and influence the mind-set of our future decision makers.

a) To what extend do educational institutions constrain the transfer of knowledge about the practice of FRe?

It is important for educational institutions to convey knowledge that helps to solve problems experienced by society and to convey knowledge and skills that makes their graduates employable in the future. Rigid and outdated education constrains the transfer of knowledge. This is not a problem in Dresden.

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[109] Flutrinne Ostragehege und Eislaufhalle

[110] Landeshauptstadt Dresden, Geschaeftsbereich Wirtschaft, Umweltamt. Plan Hochwasservorsorge Dresden, in progress

[111] Bauvorsorge und Objektschutz durch die Eigentuemer

[112] Landeshauptstadt Dresden, Geschaeftsbereich Wirtschaft, Umweltamt. Plan Hochwasservorsorge Dresden, Betrachtungsgebiet 17, Zschieren, Leuben, Laubegast. Stand 06. 2011

[113] Dresden – Laubegast Leben mit dem Fluss, Beteiligungsprozess zur Vorbereitung von Massnahmen zum Schutz vor Hochwasser der Elbe, Positionen und Empfehlungen, Ergebnisdokument, 30.05.2011

[114] www.urbaneprojekte.de.download/806/download/ accessed 3/20/2013

b) How can educational institutions offer opportunities for the practice of FRe?

As mentioned earlier, the Dresden flood of 2002 has acted as a wakeup call for the community. Since then the Dresden University of Technology (TU Dresden) and affiliated institutions have acted as a centre advocating the practice of FRe. This involved the Faculty of Architecture, Institute for Landscape Architecture, and its Teaching and Research Division for Landscape Construction. The Landscape Construction Division has conducted teaching and research seminars, looking into effects of climate change and Sustainable Urban Drainage Systems (SUDS) along Elbe tributary streams in the Kleinzschachwitz area, and along the Weisseritz [115] and the Kaitzbach. This involved neighbourhood representatives, students and the faculties of: Hydrologic Engineering of the University Hamburg-Harburg, Germany, TU Ljubljana, Slovenia and the Urban Design Centre, Kent State University, USA.

The Faculty of Architecture, Institute for Construction History, Architectural Theory and Heritage Conservation, together with the division of Landscape Construction, conducted a pilot project in flood defence for the nearby City of Grimma[116] which included stakeholder participation for policy determination. The project put forth a definition of tasks, and an urban design of FRe measures integrated into a design for the historic waterfront. The chair of Heritage Conservation is currently planning an international conference on ‘Flood Protection and Heritage Conservation’ in 2014.

The Leibniz Institute of Ecological and Regional Development (IOER) is affiliated with the Faculty of Architecture, is highly active in flood risk management research, and has developed a the HOWAD – Prevent Model, applied to Kleinzschachwitz to assess flood damage and to calculate detailed damage costs for individual buildings under different FRe scenarios.

Educational institutions in Dresden have advanced the practice of FRe through teaching, research and stakeholder involvement.

2.3) Local environmental groups and NGO’s have been hailed as the real movers and shakers in a democracy.

a) Have local environmental groups and NGO’s offered constraints on the practice of FRe.

Environmental groups in Dresden have opposed the construction of certain levies and floodwalls. Some NGO’s of businessmen have been in favour of those measures.

b) Have local environmental groups and NGO’s created opportunities for the practice of FRe?

The stakeholder participation efforts in Laubegast and in planning District 17 including Kleinzschachwitz are an example of successful capacity building for the practice of FRe.

[115] J.T. Tourbier, Erlebnis Fluss, Ein Neues Gesicht Fuer Die Weisseritz - a physical demonstration of stream-bed alteration and enhancement. TU Dresden, 27 pp. 2007

[116] Will, T., J. T. Tourbier. Forschungs- und Entwicklungsprojekt “Städtebauliche Einordnung des Hochwasserschutzes für Grimma, integrierte landschafts- und hochbauliche Fachplanung für einen Nachhaltigen und denkmalverträglichen Hochwasserschutz“. Für die Landes Talsperren Verwaltung Sachsen, 2005

It was the political engagement of the NGO's 'Buergerinitiative Laubegaster Ufer' (Citizens Initiative Laubegast Waterfront) and of the 'Interessengemeinschaft Laubegaster Ufer' that helped to convince the Dresden City Council to allocate funding for a stakeholder involvement process and the resulting document.[117]

Similarly it was the 'Buergerinitiative Plauen e.V.' along the River Weisseritz and a citizens group in the City of Grimma that initiated participatory planning efforts there.

In all of these cases stakeholder participation grew out of a perceived problem, issues, and differences of opinions that provided political glue that brought people together. NGO's offer the benefit of understanding networks of decision makers, knowledge about processes, realisation of funding opportunities and organisational skills to bring citizens to meetings and to exert political pressure on government representatives.

The positions and recommendations involving more than 200 stakeholders in a transparent process of 'capacity building' have been documented.[118]

2.4) Individual property owners play an expanded role in implementing and managing FRe technologies and programs.

a) *What are the constraints offered by property owners?*

In a survey of more than 1200 households, 59% of those affected by the River Elbe Flood of 2002 stated that they did not know they lived in a flood prone area, only 11% had used and furnished their house in a flood adapted way and only 6% had a flood adapted building structure.[119] Knowledge about flood risks has been spotty in the past, and individual property owners have taken little action. Government continues to be viewed as being responsible for flood risk management and its costs.

b) *What are the opportunities for property owners?*

The stakeholder participation process in Dresden-Laubegast demonstrated how property owners and other interested parties could be involved in planning optimal solutions. This was aided by the promise of the City of Dresden to wait for citizen's recommendations in its formulation of its plans.

Summary

In Dresden-Kleinzschachwitz, and in Germany in general, there has been a general increase in flood awareness as a step towards capacity building for flood risk management. This has been brought about by a 2005 federal 'Act to Improve Preventive Flood Control', through the passage of the 2007 EU Floods

117 Dresden – Laubegast Leben mit dem Fluss, Beteiligungsprozess zur Vorbereitung von Massnahmen zum Schutz vor Hochwasser der Elbe, Positionen und Empfehlungen, Ergebnisdokument, 30.05.2011

118 IBID

119 Kreibich, H., A. H. Thieken, Th. Petrow, M. Müller, B. Merz. Flood loss reduction of private households due to building precautionary measures – lessons learned from the Elbe flood in August 2002. Natural Hazards and Earth System Sciences, 2005

Directive and its implementation through the 2007 Federal Regional Planning Act, the 2007 Federal Building Code, and the 2009 Federal Water Resources Act.

Capacity building for flood resilience in Dresden could be summed up with a term that has also been used in other countries, 'good governance'.[120] The main driver in capacity building has been the federal, state and local government along with professional associations like the DWA[121] and educational institutions. Capacity building has responded to a government led effort, improving capacities in public knowledge, motivation, and by facilitating networks between actors.

The 'Flood Preparedness Plan'[122] by the city of Dresden that considers Kleinzschachwitz together with Laubegast and Zschieren as a planning district is advancing the state of the art of flood risk management. The plan considers structural, social and risk management levels.

The Dresden plan advances the practice of FRe, while demonstrating the importance of a functional government, as well as practicing capacity building with stakeholders as a component of a planning process.

[120] Defra (Department for Environment, Food and Rural Affairs). Managing space for water: Taking forward a new government strategy for flood and costal risk management in England. 2005

[121] DWA, Deutsche Vereinigung fuer Wasserwirtschaft, Abwasser und Abfall e.V., Landesverband Sachsen/Thueringen

[122] Landeshauptstadt Dresden, Geschaeftsbereich Wirtschaft, Umweltamt. Plan Hochwasservorsorge Dresden, Betrachtungsgebiet 17, Zschieren, Leuben, Laubegast. Stand: 06. 2011.

III-3 Capacity Building related to the Valencia Case Study (Spain)

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1) <u>Constraints and opportunities for capacity building on the national level</u>.

1.1) Laws in your country and the interpretation of the EU Floods Directive influence the acceptance of FRe technologies and related programs. Please give a description.

a) How do national laws and the national interpretation of the EU Floods Directive constrain implementation of FRe technologies and related programs?

The transposition of the European directive related to the assessment and management of flood risks, 2007/60/EC, into national law does not hinder the implementation of these technologies. At most it could be said that, unlike other anti-flood measures, it does not expressly mention the technologies directly applicable in the urban sphere to minimise the effects of flooding once it has already occurred.

Royal Decree 903/2010 on the assessment and management of flood risks (Article 11.4) cites them:

"Flood risk management plans shall encompass all the aspects involved in the management of the risk of flooding, focusing on prevention, protection and preparedness, including the flood forecasting and early warning systems, and taking into account the characteristics of the hydro-graphic basin or sub-basin. In addition, flood risk management plans may include the promotion of sustainable land use practices, measures for the hydrologic/agro-forestry restoration of basins, improvements in water retention, and the controlled flooding of selected areas in the event of flooding."

The transposition into domestic law of said Directive was carried out via Royal Decree 9/2008 of 11 January, which modified the Water Regulation with regards to its content concerning the 'Public Hydraulic Domain' (RD published in the Official State Gazette on January 16, 2008). At the same time, the Autonomous Communities and City Governments possess certain authorities in this area, limited in scope by their corresponding purviews. Some Autonomous Communities with their own authorities over basin management (Andalusia, Balearic Islands, Basque Country, Catalonia, Canary Islands and Galicia) could have adopted their own legislation, but not all seem to have done so, meaning that national law applies.

The Spanish tradition in this field, in short, is based on knowledge of actual, historical water flows to plan works designed to prevent, or at least reduce, damage in the most vulnerable areas. Although they may be very significant and inflict major damage, in Spain there have been relative few cases involving the flooding of urban areas by calm waters (e.g., Valencia in October 1957). In contrast, much more frequent are episodes of flooding under torrential conditions, in which, due to the flooding rapid development, the measures which may be taken during the floods themselves are limited. As a logical consequence, the work traditionally undertaken in Spain, featuring a wide variety of characteristics, mainly focuses on preventing and mitigating flooding of a torrential nature, usually consisting of prior prevention measures. These include the hydrologic/forestry modification of headwater areas, the construction of water levelling and spreading elements (regulation dams), and others for the channelling of river sections and gullies, case-specific or linear protection elements (defences and levees) against the danger of overflows ..., and in almost all cases a basic point is the definition of the zones to be protected due to their high vulnerability.

Only in more recent times have lines of action based on land-use planning been implemented, benefitting from general and systematic studies for the production of a cartography of floodable areas and, derived from it, the determination of territory usage limitations. Short, but very interesting, is the history of controlled floods in rural areas to protect urban areas downstream.

The short time period which has elapsed since the publication of RD 9/2008, at which point the work to implement the policy began, reduces the availability of governmental and technical experiences derived from the new stage of work initiated by the Directive. However, we can expect its implementation to confirm traditional policies, taking the same line followed in recent years, and to focus on optimal objectives and actions given our country's problems.

In summary: With regards to urban planning issues, restrictions for development do conform to prescriptions in the EU Flood Directive. However, development is a responsibility of the regional governments and these may introduce local specificities in the implementation of the Directive.

Beyond the EU Flood Directive, other regulatory drivers influence FRe system and technology uptake (for instance, the 'Decret 2508/1975 on flood damages forecasting', the *'Ley de Aguas, 1985 (LA)', and 'Reglamento del Dominio Publico Hidráulico', 1986 (RDPH)*, Water basin plans, building regulations, architectural standards and technological certification,)

b) *What opportunities are being offered by the national interpretation of the EU Floods Directive?*

The transposition permits the incorporation of this kind of technologies, as they are perfectly compatible with its objective. (Article 2):

"2. The objective of this regulation is:

(a) To obtain adequate knowledge about and an evaluation of the risks associated with floods.

(b) To bring about coordinated action by all Public Administrations and society to reduce the negative consequences of floods on the health and safety of persons and goods, as well as on the environment, cultural heritage, economic activity and infrastructures of the territories affected."

Implementation is being carried out well, with significant advances being made in accordance with the temporary provisions of the Directive. With the main aim of harmonising the different efforts undertaken to comply with the Directive, regular meetings attended by those responsible for its implementation in the different Member States are held. These meetings are coordinated by officials with the European

Commission (EC). Communications are also conducted in Spain with the other government offices involved. Resiliency-related measures are considered regardless of their inclusion in the Directive.

Although heeding those instructions thus received, the application in Spain of the Directive and Royal Decree is significantly influenced by the set of experiences assimilated in Spain with regards to hazard prevention and forecasting as a result of extreme events in which resilient measures were considered and applied. This circumstance is logical and acceptable, as the spirit behind the EU directives is the harmonisation of the regulations of the different EC countries, but with the logical adaptation to the special conditions of each. Unlike the process of transposition of Directive 2000/60 (framework Directive), the transposition of Directive 2007/60 has not produced relevant differences in criteria between the Kingdom of Spain and the EC as a whole.

Following the catastrophic floods in the year 1982 a new line of work was introduced to make possible the management of floods during their inception and development. These are what have been called the SAIH (AHIS, Automatic Hydrological Information Systems), which provide information on the genesis (precipitation) and evolution of floods (flows). The immediate improvement offered by these AHIS systems, which have already been developed and implemented, is their widespread inclusion of DSS computer elements (Decision Support Systems), based on hydrological algorithms. The information obtained during flooding episodes is shared immediately (even in real time) with the corresponding civil protection services responsible for taking the appropriate measures. It appears that their use in recent years has significantly reduced the number of victims and the material damage caused by floods.

Also of recent application in Spain has been the construction of what have been termed ‘storm tanks’, which provide a two-fold improvement in the operation of sewage systems by preventing many pollutant discharges while also facilitating the functioning of purification systems. These are also important in the facilitation, where relevant, of the evacuation of water (drainage) of flooded territories.

All these actions form an integral part of the territorial planning and flood reduction policies of the at-risk area, or, at least serve to reduce the flood frequency. And land use planning sets out development opportunities. 'Natural' handicaps may be totally/partially offset through FRe technologies

1.2) In many countries regional nation-states and provinces exercise autonomy in government. Please describe the following as it applies to your case study area:

National governance’s structure: Spain is a decentralised country, where the regions (called Autonomous Communities) have the responsibility on the land management, health services, civil protection and environment. In the national level, the State has only responsibility for coordination, support and water management in the interregional basin districts. The map below shows in colours the regions and in black lines the river basin districts. You could identify easily the interregional basin districts managed by the State.

Integration of governmental agencies (and stakeholders):

There are two main coordination systems, the National Civil Protection Commission, where the State and the Autonomous Communities coordinate their plans and responsibilities for Civil Protection, and the National Water Council, which represents all interests in water and rivers.

In general, all processes involve public information periods where the private sector and citizens can make claims to the plans. New proposals by the stakeholders are possible, which are analysed by the developer

Responsibilities/powers split and coordination:

Administration	Land planning	Rivers management	Civil Protection and health services
Central Government	Makes reports on development planning in flood-prone areas Regulates land use within the 100 meters on each side of the river.	Manages the Automatic Hydrological Information System produces hazard maps and flood risk coordinates the operation of all reservoirs	Coordination - Management in major emergencies of national importance - Management support of the Autonomous Communities with the police - Support to the Autonomous Communities with the Emergency Military Unit - gives financial aid to people affected
Autonomous Communities	Draft and approve regional plans for land use and sanction the local development plans	Report on environmental issues - Help State in hazard maps and flood risk - Help Local authorities in urban areas	Management in normal emergencies - are responsible for the health system - gives financial aid to people affected
Local authorities	Draft and approve local development plans	Responsible of rivers in urban areas	are responsible in urban areas

a) *How do nation-state program interpretations of the EU Floods Directive constrain the implementation of FRe technologies and related programs?*

The work of implementation is conditioned by the jurisdictional organisation of the Kingdom of Spain, in which the three main governmental administrations (national, regional and municipal) have significant competencies and responsibilities in these matters and in civil protection, making it necessary for them to coordinate their water and flood management activities.

No major political resistance has been encountered, since in Spain it was commonly assumed that the previous national 'Legal Water Framework' had hush up both concepts (flood risk and flood resilience)

Generally speaking, the Flood Directive has faced a mixed reception:

Negative: because its implementation will be tied to a heavy work load as well as many bureaucratic processes

Positive: since this Directive represents a powerful opportunity to harmonise flood management at a national scale, a matter of importance in States having opted for a complex national political structure

b) *What opportunities are being offered by the nation-state interpretation of the EU Floods Directive?*

Hardly any, as development issues are entirely in the hands of the Regional Governments, and the coordinated work of all these competent authorities is also guaranteed by the regulation (State Plan for Civil Protection Against the Risk of Flooding, approved by an Agreement of the Council of Ministers on 29 July 2011) and by the practice to be followed (administrations' coordination protocols, thoroughly verified by experience). Moreover, Spanish legislation currently in force also encompasses the articulation of water management projects with defence and civil protection projects, areas in which the different administrative levels also have authorities. The principle of subsidiarity is applied according to which all activity is to be undertaken by the level closest to the administrated parties, and that which may operate with the greatest efficiency. In any case there exists an express decision to fully implement the mandates of the Directives.

1.3) The Construction Industry is a special stakeholder in FRe. They may view it as a burden or as an opportunity for development. Please describe:

a) *What constraints to the practice of FRe are being raised by the construction industry?*

Builders do not tend to be source of innovation in terms of products and technologies, as they depend on other stakeholders in these activities, but they are not a source of constraints to their implementation.

Manufacturers are providing better FRe building solutions, but this usually means higher project costs and alterations to project plans, making builders and designers reluctant.

Meanwhile, the generalised approach to building in Spain is based on assuming that floods are going to happen and solving the problem by reducing the volume of flood waters after once they have already appeared. Trust is not placed in barriers and their effectiveness.

b) What opportunities does the construction industry see in the practice of FRe?

The adaptation of construction solutions, such as individual and collective defences, or even special materials, to hazardous situations yields effective and efficient lines of work. The construction of stilted housing proceeds from a historical adaptation adopted in territories prone to floods; the example can lead to the practice of leaving open a high percentage of the ground floors of buildings at risk.

Another important measure is to facilitate the evacuation of water after the flooding of urban spaces. For large areas these measures are addressed by hydraulic and urban management practices, but in smaller ones, though the need for them and their usefulness is evident, they are not expressly stipulated in legislation, and are sometimes forgotten by the owners of homes and housing developments; the use of one-way automatic gates is a resilient solution to drain small areas located directly adjacent to water flows after flooding incidents.

1.4) The Insurance industry has a direct relationship to the practice of FRe.

a) Describe how the insurance industry limits the implementation of FRe.

The insurance issue is an instrument that is dealt with in Directive 2007/60 itself. It is considered of high potential, but in the Spanish system the Consortium has little sway, as explained in other parts of this survey.

In Spain the function of insurance, with the Consortium, gives stability and security to the system; innovation only comes from the drivers. There is a positive assessment of the Consortium but there is scepticism regarding its innovative capacity. We think that insurance policies would be good drivers if differential premiums were set.

In short, there are no limitations on their implementation; in any case, perhaps there are no stimuli for their implementation from the point of view of Insurance.

b) What opportunities does the Insurance industry offer to encourage FRe?

A comprehensive system for the coverage of damage caused by flooding has been implemented, managed by a public Consortium and endowed with funds from all property insurance policies, regardless of the specific risks to which the different assets insured are exposed. This allocation mandatorily includes the forecasting of flooding effects in voluntary real estate insurance policies.

Insurance policies should encompass all flood effects. In the case of Spain, as there is a Consortium, this makes it a strategic issue that is not approached tactically, that is, for the immediate future. It goes beyond the insurance industry and affects the taxation of property, businesses and individuals.

Possibilities to negotiate lower insurance fees in exchange for resilience enhancement in structures are not pursued, so its current role can be considered neutral in relation to the promotion of FRe.

1.5) FRe manufacturers are taking a risk in hope of future profits.

a) *What are the constraints for FRe technology manufacturers?*

In our view, at least, after the three-year project meetings with the Spanish NSG, only the lack of business opportunities. However, waterproofing measures are already present in the construction of buildings, and when carrying out repairs to them, there is an effort to comply with these as part of project requisites.

b) *What are the opportunities for FRe technology manufacturers?*

Trust in FRe could be considered moderately high (60%) although it is not exactly known. Another issue is trust leading to their use. There is a major placement of trust in the Government, as well as the subsidiary bodies responsible for damages. Society, except in episodes of extensive flooding, pays little attention to this adverse phenomenon. It also believes that the government should provide these services, barring exceptional circumstances, and it has no opinion with regards to the methods used.

The manufacturers would apply better FRe solutions if FRe requirements were more widely specified in project plans.

1.6) Professional associations register and control the practices of their members.

a) *How do professional associations hinder the application of FRe?*

They do not hinder it in any concrete way. In fact, their role can be considered neutral.

b) *How could professional associations offer opportunities for the practice of FRe?*

By disseminating the results of projects like this (SMARTeST) and facilitating the training of these associations' professionals in the use of these types of technologies.

2) <u>Constraints and opportunities for capacity building on the local scale</u>

2.1) City government and municipalities traditionally hold power over land use and building codes related to the implementation of FRe programs. Summarise what is happening in your case study city:

Without any doubt there is a need to determine the vulnerability of buildings to flooding and the threat posed to people and their economic activities, as well as the causes of that threat, in order to develop a management system for each affected territory which reduces the hazard to levels acceptable to society, that is, to resilient limits. National, regional and local authorities actively cooperate to this end.

The Flood Risk Special Plan of the Valencia's Regional Government (Decree 156/1999, September the 17th) has been recently amended, in order to adapt it to the new circumstances, by Decree 81/2010, on May the 7th Valencia's Flood Legal framework is built up according to the following regulations (we believe a translation to English of those Legal Text catalogue can be misleading).

The assessment of damages has been based on depth/damage curves, extremely varied depending on construction typologies and not only associated with the different countries. It is difficult to generalise and apply them to territories different from those in the cases studied, but they are applicable to basins or, at least sub-basins, considered homogeneous. This may be relevant to the assessments made by insurance companies, which should take into account the effectiveness of technologies and materials in accordance with the construction typologies in each territory.

a) Are you aware of constraints to the use of FRe technologies and related programs?

No constraints other than their limited promotion.

Municipalities produce some local ordinance taking floods into account. Anyway, this is an uncoordinated normative action, depending on each local council.

Example of some FRe building regulations taken into account in some municipalities:

- To increase 1m the level of the 1st floor
- To transform building terraces in flood emergency escape routes
- To raise ceilings height
- In particular, the referred 'FRe garage ramps', despite not being legally enforceable, are often (in some Valencia's Local Councils) considered a pre-condition for the granting of building permits if this FRe measure is missing, the permit is not granted, and in subsequent project alterations, the developer is asked to integrate this FRe measure.

In within the PATRICOVA ('Plan de Acción Territorial de carácter sectorial sobre Riesgo de Inundación en la Comunidad Valenciana'), a few particular regulations can be founded regarding floods:

- In its Section II, Articles [25; 29] contains several norms aiming to the 'adaptation of buildings and infrastructures at flood risk'
- Article 25: about the promotion of adaptation measures: a) Valencia's Regional Government is made responsible to help financially the adaptation process for buildings and infrastructures at flood risk. b) Technological norms are asked to be developed
- Article 26: general conditions for the infrastructure adaptation:
- Incidence of superficial infrastructure on surrounding flood risk
- Return periods for infrastructures design:
- 500 years for strategically and highly vulnerable structures
- 100 years for medium vulnerable structures
- …

- Article 27: general conditions for the building adaptation
- In single level buildings, terraces (roof) must be accessible from inside by the mean of a staircase
- New buildings must be orientated according to the flood flow direction, in order to mitigate the barrier effect of the building
- …
- Article 28: additional conditions for constructions in 2,3 or 4 risk zones
- Article 29: signposting of flood risk

b) *What special opportunities exist to practice FRe in your case study city?*

Valencia, being a flood-prone area, has a special awareness of flood protection measures. Statutory planning regulations, introduced at the sub-regional level, are legally binding on local plans. The SMARTeST Technologies are of a local nature, focusing mainly on buildings. In this sense resilient measures would be applicable when a certain level of damage is inevitable, once territorial actions decreased the risks to acceptable levels for their application. From this perspective some NSGs consider very applicable tools based on the type of correlations used by the RAINS numerical model.

2.2) Educational institutions are conveying knowledge and influence the mind-set of our future decision makers.

Consciousness of Flood Prevention and Resilience is very great at the national level, and particularly in Valencia, representing the main factor favouring all FRe measure dissemination.

a) *To what extent do educational institutions constrain the transfer of knowledge about the practice of FRe?*

We think that no constraints can be expected from educational institutions, though FRe Systems, applicable more extensively and under institutional decisions, are generally considered by these institutions to be more effective than FRe products.

b) *How can educational institutions offer opportunities for the practice of FRe?*

In the case of university education it would contribute if institutions offered more widespread coverage of this type of problem. The study of resilient approaches and the applicable technologies could form part of the curricula for degrees directly related to the issue. The role of branch stakeholders may be meaning here.

2.3) Local environmental groups and NGO's have been hailed as the real movers and shakers in a democracy.

a) *Local environmental groups and NGO's have offered constraints on the practice of FRe.*

No constraints, as a general rule.

b) *How can local environmental groups and NGO's create opportunities for the practice of FRe?*

By distributing information on these technologies and supporting their use.

Most of them need to acquire previous capacity building.

2.4) Individual property owners play an expanded role in implementing and managing FRe technologies and programs.

a) *What are the constraints offered by property owners?*

Property owners/developers are moved by development costs. If these are higher due to the compulsory introduction of FRe technologies they will try to avoid them.

b) *What are the opportunities for property owners?*

They would be the main beneficiaries of any measures to be carried out, without entering into considerations of the measures' financing.

If municipal fees and taxes were contingent upon individual properties' levels of resilience, property owners might see FRe technologies as a bonus for their property market. A similar observation may apply to insurance policy premiums.

The Flood Directive also calls for public implication in flood risk management, and this will suppose a new challenge, and many initiatives have been used to help local people with the uptake of FRe as for example, the referred 'FRe garage ramps', despite not being legally enforceable, are usually (in some Valencia's Local Councils) used as a necessary condition for the granting of building permits, if this FRe measure is missing, the permit is not granted; and in subsequent project alterations, the developer is asked to integrate this FRe measure.

Short Summary

The use of FRe Measures that reduce damage to buildings can be very effective in reducing costs in the event of a flood - but this fact should not be allowed to promote laxer measures making it possible to locate new buildings in at-risk areas. The population is very vulnerable and only proper education can reduce the danger. If properly informed the population would know in advance about the consequences to which they would be exposed, and would voluntarily avoid inappropriate locations.

III-4 Capacity Building related to the Heywood Case Study (United Kingdom)

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The following information is a summary of constraints and opportunities for capacity building in the UK. Different legislation, regulation and guidance exist in Scotland, England, Wales and N Ireland due to the devolved nature of government in the UK. The devolved administrations of Scotland, Wales and N Ireland are responsible for the implementation of planning, building regulations and flood management legislations in those nations. In England, the Department of Environment, Food and Rural Affairs (Defra) of the UK government is responsible for flooding and Communities and Local Government (CLG) for planning and building regulations. Issues such as insurance and the nature of the construction industry are typically UK wide.

Heywood is located in Greater Manchester in the North of England and therefore capacity building in this area is linked to the situation in England primarily.

This section provides information on the national and local scale, drawing on information and text developed through a national analysis, as well as by the local case study workshops and on the case study itself. It is considering flood resilience in a comprehensive fashion and gives answers to the following questions:

1) Constraints and opportunities for capacity building on the national level.

1.1) Laws in your country and the interpretation of the EU Floods Directive influence the acceptance of FRe technologies and related programs. Please give a description:

Following disastrous flooding in 2007, the UK Government accepted recommendations of a review of flood risk management in the UK by Sir Michael Pitt (2008)[123] and many are implemented in the Flood and Water Management Act 2010.

Historically the split in responsibilities between local authorities and water companies has meant that there has not been a common approach to the management of drainage systems in urban areas. Following Pitt, this has been addressed in the Flood & Water Management Act (2010) which has given Lead Local Flood Authorities responsibility for the management of local flood risk, which includes surface run-off, groundwater and flooding from ordinary watercourses (smaller rivers and streams).

[123] http://webarchive.nationalarchives.gov.uk/20100807034701/http:/archive.cabinetoffice.gov.uk/-pittreview/thepittreview/final_report.html

Under the Flood Risk Regulations (2009), Lead Local Flood Authorities are also responsible for assessing, mapping and planning for local flood risk. Water companies and Lead Local Flood Authorities will need to work in partnership to manage surface water flooding.

The Environment Agency (EA) has a Strategic Overview role in England and a Strategic Oversight role in Wales for all types of flooding. In fulfilling this role the EA are working with local authorities to help them develop the knowledge and understanding of the areas at risk of flooding from surface water. (http://www.environment-agency.gov.uk/research/planning/109490.aspx).

a) How do national laws and the national interpretation of the EU Floods Directive constrain implementation of FRe technologies and related programs?

The EA is not directly responsible for surface water flooding which is the responsibility of the Local Authority (LA) and the water utility company. This split responsibility is a potential barrier to integrated flood risk management in urban environments. Despite earlier promises to the contrary, FRe will not escape cutbacks, the new coalition government have cut flood defence spending by 8% annually from 2011. Thus implementation of FRe technologies and related programs are likely to be severely constrained by a combination of the anti-regulatory climate currently prevalent in the UK, reduced governmental spending on FRe, cash constraints by LAs and lack of incentive for the water utility companies.

National interpretation of the EU Flood Directive is also constrained by the UKs euro-scepticism and the Coalition Government's *'Programme for Government'* states that the government will 'examine the case for a United Kingdom sovereignty legislation to make it clear that the ultimate authority remains with Parliament'.

b) What opportunities are being offered by the national interpretation of the EU Floods Directive?

Under the EU Floods Directive, the EA and Lead Local Authorities must now create preliminary flood risk reports and maps, flood hazard and flood risk maps and flood risk management plans. These plans must include measures relating to prevention and protection. The assumption is that better risk assessment increases uptake of FRe features. The EU Floods Directive is starting to influence FRe in the UK where the elected members of the Regional Flood Committees can agree a local levy paid by County and Unitary authorities to pay for works which do not attract a sufficiently high priority for funding by national government, but are nonetheless cost effective and of local importance. United Utilities, the water and drainage service provider for the North West of England, Business Plan 2010-2015 states that their investment programme will feature a major expansion in protecting properties at risk of flooding. The Government is consulting on how to give Surface Water Management Plans a stronger role in coordinating development and investment planning. The Government sees local authorities (LA) in a leadership role with the EA advising / quality-assuring the plans (Future Water p.58). However in the immediate future cutbacks in local authority budgets could also hinder uptake.

1.2) In many countries Nation States and regional provinces exercise autonomy in government. Please describe the following as it applies to your case study area:

a) *How do Nation State program interpretations of the EU Floods Directive constrain implementation of FRe technologies and related programs?*

See above. Interpretation of the EU Floods Directive by the UK Government does not directly constrain uptake of FRe technologies.

b) *What opportunities are being offered by the Nation State interpretation of the EU Floods directive?*

Opportunities for the implementation of FRe technologies in the UK offered by the Government are only directly influenced by the EU Floods Directive in so far as the Directive calls for integrated FRe. The Flood and Water Management Act 2010 requires the Environment Agency to 'develop, maintain, apply and monitor a strategy for flood and coastal erosion risk management in England'. Flood Risk Assessments (FRA) are required when a planning application is submitted and the requirement is set out in the Government's policy on development and flood risk as stated in the National Planning Policy Framework (NPPF) and are required to be completed according to Planning Policy Statement PPS 25: Development and Flood Risk. PPS 25 was designed to "strengthen and clarify the key role of the planning system in managing flood risk", and contribute to adapting to the impacts of climate change. It set out policies for local authorities to ensure flood risk is taken into account during the planning process to prevent inappropriate development in high risk areas and to direct development away from areas at highest risk.

The FRA takes into account the risk and impact of flooding on the site, and takes into consideration how the development may affect flooding in the local area. It also includes recommendations as to how the risk of flooding to the site can be managed. As well as assessing the risk to the site posed by fluvial flooding, FRAs should also consider flooding from other sources including fluvial, groundwater, surface water run-off and sewer flooding. Where necessary, they should be accompanied by a Surface Water Management plan (SWMP) to identify the flooding risk from all sources of surface water.

In addition, the EA offers guidance on the implementation of FRe via two guides, one simple and generic **(Prepare your property for flooding)** and one with more detail for groundwater flooding - see: http://www.environment-agency.gov.uk/homeandleisure/floods/31644.aspx

1.3) The Construction Industry is a special stakeholder in FRe. They may view it as a burden or as an opportunity for development. Please describe:

a) *What constraints to the practice of FRe are being raised by the construction industry?*

FRe technologies can be used to retrofit existing buildings or can be designed in as part of new construction. Resistance and/or resilience measures can be used in either situation, whilst for new construction avoidance measures may be more appropriate.

The construction industry is typified by a conservative approach with new technologies, products and approaches often needing years to be accepted. Research and development in the UK construction industry has always been poorly funded, but particularly in the current financial climate. The construction industry is also dominated by small and medium sized companies, and construction projects are delivered by main contractors/developers subcontracting design and specialist works to a number of subcontractors. All these factors impact on the implementation of FRe technologies.

In Heywood there is a general lack of knowledge and therefore capacity amongst local surveyors, designers and builders in what constitutes FRe technologies. As a result there is reliance for local people on the services provided by FRe technology manufacturers, suppliers and framework consultants responsible for grant scheme funded allocation.

In England building regulations do not consider flood risk to new development. Therefore, the issue is not generally considered by SME designers and contractors. Small construction works in Heywood would be undertaken without any recognition of the flood risk as the area does not appear on flood maps. Therefore, those involved in works such as extensions or one-off house construction would not have any recognition that flood should be considered.

The absence of flood requirements within the building regulation system means that any requirement set by planning conditions has no means of being verified. Therefore, the local builders are not exposed to technologies and building techniques that result in flood resilience. There is also no education of professionals or tradesmen in the construction area in flood resilience, either repair, retrofit or new build technologies. At present flood resilient construction is not part of college or university level education. Guidance that does exist often does not reach builders as a result of the 'make up' of the industry.

The construction industry is also restrained by the demands of its customers. Local builders involved in small construction works in Heywood would be reluctant to invest in training of operatives where there is no return. As homeowners are generally reluctant to invest in FRe technology the only route to market is through publicly funded programmes.

Builders and insurers are often reluctant or unable to install FRe technologies or measures after a property has been flooded (e.g. raised electricity sockets), even if it takes no longer and costs no more. If insurers were to invest as a matter of course in FRe measures after a flood, then this would have a resulting impact on the building industry; that would need to respond by investing in the necessary knowledge and training in FRe.

If Heywood floods, then the developers are not liable for any damages, and cannot be sued for such, so there is little incentive to spend more on resilience. In Scotland the developer and even planning authorities can be held liable and this acts as a disincentive to irresponsible development.

The lack of legislative drivers is significant. The Pitt Review (2008) recommended that flood resilience should become part of the building regulations. However, this recommendation has not been implemented and in the current circumstances it is unlikely to be taken forward. If flood resilience was included within building regulations then the industry would need to respond and improve its capacity in this area.

b) What opportunities does the construction industry see in the practice of FRe?

Currently the installation of FRe technologies and other measures is undertaken by specialist companies. Often the supplier of the technology (aperture technology or perimeter barriers) will have dedicated installation teams. Larger, one-off, contracts are often carefully supervised. However, property level work is more price restrained and supervision can be minimal. In this respect the industry sector is similar to any specialist activity such as window installation. Industry sectors, such as windows installation, have developed substantially over a period of 20 to 30 years. This has resulted in design and installation schemes for installers and a large number of British, European and industry standards. Technologies have developed and product quality has increased substantially, also in part driven by legislative changes and international competition. As such quality has been improved and the capacity of the industry has increased. At the same time price differentials exist between companies and this has a direct impact on quality.

The FRe technology industry generally welcomes the introduction of standards and is seeking means of improving quality of products and installation. This sector of the construction industry has the greatest potential to drive forward change, but as a small part of the industry it has limited impact.

Some parts of the wider industry have taken an interest in FRe measures and view it as a commercial opportunity. However, this group could be described as early adopters and the subject is not yet mainstream.

Publications in recent years have provided information to the construction industry. Reports such as the 2007 Communities and Local Government document, *'Improving the flood performance of new buildings: Flood resilient construction'* gives information to developers on flood resilience aspects of construction. However, the document can be viewed as confusing and in areas such as materials performance, the absence of clear test standards and their interpretation provide problems for specifiers. BRE has recently published BRE Digest 453 (Garvin, 2012) which sets out the background to flood, planning and building regulation in the UK as well as approaches to flood avoidance, resistance and resilience. Resistance and resilience measures would allow development in areas that are currently difficult to develop.

In Heywood, where surface water flooding is the main issue, the opportunity exists for those builders who invest in the knowledge, training and technology to exploit the market. The success will however depend on offering a quality product at a price that is affordable to homeowners.

At present, funding for energy efficiency measures is funded by CERT/SECP funding in the UK, which gives homeowners partial or full contribution to insulation and other measures. This is due to be replaced by ECO funding (the Energy Act 2010), which compels energy companies to contribute to energy efficiency with significant targets for investment being set by government. If climate change adaptation was to be included under ECO measures, then it would be transformational for the industry. As a result the industry would need to respond and invest in the necessary training. Schemes such as CERT/CESP are typically under-spent therefore climate adaptation measures could well be accommodated, even in a targeted approach to areas with previous history of flooding. Combining energy efficiency and adaptation measures would be a win-win situation for government and the construction industry.

1.4) The Insurance industry has a direct relationship to the practice of FRe.

a) Describe how the insurance industry limits the implementation of FRe?

In the UK, under the Association of British Insurers (ABI) Statement of Principles, insurers will provide flood cover as a standard feature of household and small business policies until 2013 for a) those properties defended to a minimum standard of 1 in 75 or b) for those properties where such defences are scheduled for completion within the next five years and premiums will continue to reflect different degrees of risk. The ABI has warned that the agreement to provide insurance up to 2013 will not be renewed unless the

Government increases the amount of money it spends on flood protection- and this is not going to happen. Post 2013 insurance against flood in high risk areas is unlikely to remain available as part of a standard household policy and provision of insurance will only become available from specialist flood risk insurers on an open market basis. This could seriously impact on the availability of insurance for many vulnerable households, but it could also open up the market for specialist surveys and for premiums linked to the provision of FRe. NB the UK government's Department for Environment, Food and Rural Affairs (Defra) interim report of the flood insurance working groups "Flooding and insurance: a roadmap to 2013 and beyond". http://www.defra.gov.uk/publications/files/pb13532-flooding-insurance.pdf

Insurers also have serious problems with FRe due to trust in the product and concerns about on-going maintenance, the quality of installation, and the ability of home owner to use FRe correctly. Additionally, the insurance industry is constrained in implementing FRe because most policies do not allow for betterment. In Heywood, evidence exists that the payments made to flood victims by several different insurance companies vastly exceed the cost of providing permanent resilience to homes in one particular area which continues to be at risk of further flooding.

b) What opportunities does the insurance industry offer to encourage FRe?

The Association of British Insurers (the ABI) has published a *resilient homes guide* www.abi.org.uk/Publications/ABI_Publications_ABI_Flood_Resilient_Repairs_and_Resistance_Measures_57a.aspx as have AVIVA Insurance www.floodresilienthome.com/.

However, there are further measures which the insurance industry could undertake to encourage the uptake of FRe. Insurers could follow the lead of the major re-insurers and use the excess/deductible to share the risk with the insured to incentivise investment in protection and resilience. Where this is done effectively and is certified by a professional surveyor, this should be rewarded with a reduction of the excess. The insurance industry could feasibly become pro-active and assist in the actual development of products. They could work more closely with banks and mortgage providers to encourage the uptake of FRe and could investigate ways of either working with other FRe providers such as the utility industry or the governmental authorities and/ or together with other insurance companies to finance (or to kick-start) schemes which will protect a group of houses or critical infrastructure. Insurance companies should ideally also co-operate in sharing data of past flood events. Unfortunately competition amongst insurers means that they always seek to protect their data and their investment in risk assessment processes, thus inhibiting many of these measures from actually happening.

In addressing some of these concerns, the ABI is collaborating in the development of the SMARTeST project aimed at providing trust in, and quality assurances for, FRe technology.

1.5) FRe manufacturers are taking a risk in hope of future profits.

a) What are the constraints for FRe technology manufacturers?

See also the section above on the construction industry. FRe technology manufacturers are a part of the construction industry in the same way that window makers or roof tile manufacturers interact with contractors and designers.

The FRe technology manufacturers in the UK are, in general, small and medium sized business enterprises. This is also a relatively new industry. In the UK, test/certification of a FRe product can cost at least £30,000 which is generally beyond the reach of small companies. However, the market place is not yet sufficiently mature to attract large companies thus resulting in a barrier to development; you need to prove that the product works to get funding but you need funding to prove that it works. A FRe technology manufacturer has estimated that for every £1 spent on the development of FRe products, £10 needs to be spent on marketing the product. FRe technology manufacturers also point out that the UK Government, via the planning system, has permitted building on flood plains but that the Government is not doing anything to protect these buildings and they propose that in future, the provision of FRe should be aligned to the granting of building permits.

b) What are the opportunities for FRe technology manufacturers?

A recent UK government property-level flood protection grant scheme (£5.6 million) to help properties in areas with a high risk of flooding that do not benefit from community-level defences, provided grants of up to £7,500 towards the cost of FRe measures to households previously flooded and still at risk of 1:20 flood. Grants for this scheme are distributed by the Environment Agency to local authorities. LAs were encouraged to discuss the scheme in detail with the communities concerned in order to determine the best approach to be adopted and to appoint surveyors. In Heywood, the LA originally appointed a consultant to undertake the scheme on their behalf but subsequently administered the scheme themselves. Also some doubt exists as to whether or not all properties which were severely flooded actually benefited from the scheme. There is evidence to suggest that those communities with the ability to be most vocal and active benefitted more than others.

1.6) Professional associations register and control the practice of their members.

a) How do professional associations hinder the application of FRe?

There is no evidence of professional organisations actually hindering the uptake of FRe. However, there is a history of a lack of cooperation between the various professional bodies entrusted with FRe in the UK, e.g. the EA, the utility industry and the LA although recent legislation seeks to address this problem by placing more responsibility with the Lead Local Authority (LLA). However, many LLAs now lack in-house expertise and need to use construction/engineering consultancies despite only a small number of consultancies actually possessing the highly skilled modelling staff. Because of their background there is some evidence that these consultancies have a tendency to advocate larger scale heavy engineering solutions where small-scale FRe and more pragmatic measures would be more appropriate. Further, there is now evidence that the process of assessing pluvial flooding, and thus informing on FRe, is constantly being undermined by less skilled companies claiming that they can undertake Surface Water Management Plans (SWMPs) with antiquated modelling software or lack of robust input data. It is also recognised that trust in the efficiency of the product and in its ability to actually work, as well as concerns about surveys, installation, on-going maintenance and the ability of home owners to use FRe correctly, all hinder the uptake of FRe.

b) How could professional associations offer opportunities for the practice of FRe?

Several organisations such as the Association of British Insurers (ABI) and the Royal Institute of Chartered Surveyors (RICS) discuss and promote the usage of FRe technology on their web sites and via guidance documents. The Royal Institute of British Architects' (RIBA) guide to Designing for Flood Risk aimed at practicing and student architects, urban designers and landscape architects takes a design-led approach to addressing flood risk. Other professional bodies such as flood risk management consultants, the utility industry, emergency services and the Fire Service could be encouraged to promote FRe. SMARTeST guidance on FRe technology will hopefully assist these, and other professional institutions, in the deployment of FRe. Also, if FRe became a mandatory consideration, planners and architects would have to take it into account.

2) Constraints and opportunities for capacity building on the local scale

2.1) City government and municipalities traditionally hold power over land use and building codes that relate to the implementation of FRe programs. Summarise what is happening in your case study city:

Heywood was heavily urbanised during the 19th century and much of the original drains and sewers still form part of the drainage system. The actual existence and the location and condition of many private drains remain unknown. The local drainage system of the area has been further compromised by considerable urban infill during the last 50 or so years without the provision of SUDS. Flood was not considered a hazard, and whilst there is some empirical evidence of small-scale flooding in one or two areas, there are no records of flooding in Heywood until approximately 100 properties suffered summer convective storm induced sewer infested internal flooding of up to 900 mm in August 2004 and again in July 2006.

a) Are you aware of constraints to the practice of FRe technologies and related programs?

The implementation of FRe technologies is constrained by lack of finance for FRe by local, governmental, and private organisations. A general lack of acceptance by insures of their capability to perform efficiently, lack of knowledge of what technologies are available, lack of trust in the efficiency of the products, lack of trust in their installation, on-going maintenance and of the ability of the homeowner to use them correctly are also constraining FRe uptake. The lack of a definitive SWMP (see 1.6a above) and the lack of adequate meteorological warning of the timing and intensity of convective storms is also an issue.

b) What special opportunities exist to practice FRe in your case study city?

In 2008, in response to the widespread flooding in the UK in 2007, the UK government provided £5.6 million in grants for property level resilience measures of up to £5000 per property. The grant was subject to bids by local authorities and then administered by them. Rochdale MBC employed a consultancy to undertake the initial surveys but the work was ultimately undertaken in-house by the LA. In Heywood some 50% of the properties affected in 2004 and 2006 received these grants for flood-proof doors, non-return valves, pumps, automatic air-brick covers and flood resistant coatings. In principle, properties in the better class areas received the grants whilst those in poorer areas did not and suspicion is that those most able to lobby local politicians were the most successful. A very few flood victims also successfully lobbied the utility company for financial assistance for FRe.

The grant scheme has now finished but the Department for Food and Rural Affairs (Defra) has indicated that, subject to finance, it will be extended.

2.2) Educational institutions are conveying knowledge and influence the mind-set of our future decision makers.

a) *To what extend do educational institutions constrain the transfer of knowledge about the practice of FRe?*

There is both a perceived and an actual lack of knowledge and expertise on FRe in the UK. Specialist courses in FRe are not part of the curriculum at universities or other further education institutes.

b) *How can educational institutions offer opportunities for the practice of FRe?*

The Environment Agency (EA) has accepted that it has a problem in sourcing technically competent staff and has commissioned an engineering foundation degree in river and coastal engineering in partnership with a university. They have only had 120 students since 2004 and as such the EA are now seeking to address this poor rate of attendance.

Some institutions such as the Chartered Institute of Water and Environmental Management (CIWEM), the Royal Institute of Chartered Surveyors (RICS) and the Construction Industry Research and Information Association (CIRIA) provide seminars on various aspects of FRe for which they issue Certificates of Continued Professional Development (CPDs) but these seminars do not necessarily address FRe at all, or in any depth.

The BRE Trust has funded the development of a course on flood resilient planning and construction. This is aimed at those in both the construction industry and the flood management field. However, take up of the training has not been good as the legislative drivers have not been sufficient to encourage attendance. In particular, the refusal of government to implement Pitt Report recommendations on building regulations.

2.3) Local environmental groups and NGO's have been hailed as the real movers and shakers in a democracy.

a) *Have local environmental groups and NGO's offered constraints on the practice of FRe?*

There is a lack of community buy-in for FRe in general because most feel the FRE is the responsibility of, and will be dealt with by, the state and institutions such as the EA, the LA, the utility company or even the insurer. There is also some anecdotal evidence that some groups prevent FRe uptake in the hope that bigger schemes will be funded.

b) *Have local environmental groups and NGO's created opportunities for the practice of FRe?*

The emergence of victim support groups does create opportunities for FRe. Principal amongst these groups is the National Flood Forum (NFF) http://floodforum.org.uk/ a charity run by flood victims, which provides support and advice to communities and individuals that have been flooded or are at risk of flooding. Other similar but perhaps less influential groups include the Morpeth Flood Action Group www.morpethflood-action.org.uk/ the Cockermouth Flood Action Group www.cockermouthfloodactiongroup.org.uk/ and Know Your Flood Risk campaign for increased awareness www.knowyourfloodrisk.co.uk/.

The NFF had certainly emerged as a successful lobbying group and are often quoted by governmental organisations. The NFF claims to be a collective, authoritative voice that aims to influence central and local government and all agencies that manage flood risk although some people do dispute this. These groups emerged in response to larger-scale riverine flood events in predominantly middle-class small town and semi-rural communities and they thus connect less well with vulnerable urban communities lacking sophisticated lobbying skills who are now subjected to the ever increasing predominance of repetitive smaller scale urban pluvial flooding. This means that these groups invariably concentrate in advocating and lobbying for large scale flood defences rather than for property level FRe.

2.4) Individual property owners play an expanded role in implementing and managing FRe technologies and programs.

a) *What are the constraints offered by property owners?*

The principal issues constraining the uptake of FRe by property owners in Heywood and elsewhere in the UK include lack of knowledge about what is available; lack of finance; lack of trust in the efficiency of the product; ease of use; product aesthetics and concerns that a deployed gate in advance of bad weather will notify potential burglars of their absence. Also property owners generally feel that protection against flooding is the responsibility of the government and its agencies or their insurer. NB also 2.1a and 2.3a above.

b) *What are the opportunities for property owners*

Several agencies encourage the uptake of FRe and provide guidance documents, such as for example:

- BRE Digest 523, Flood resilient construction, Parts 1 and 2, (2012), brebookshop.com.
- BRE, Repairing flooded buildings: an insurance industry guide to investigation and repair of flood damage to housing and small businesses, EP69 (2006), brebookshop.com
- The ABI's Flood Resistant Homes factsheets at www.abi.org.uk/Information/consumers/General/15274.pdf
- The Communities and Local Governments guidance on flood resilient construction www.planningportal.gov.uk/uploads/br/flood_performance.pdf

- CIRIA's Flood resilience and resistance for critical infrastructure http://www.ciria.org/service/knowledgebase/AM/ContentManagerNet/ContentDisplay.aspx?Section=knowledgebase&ContentID=15520 which is also promoted by the EA
- CIRIA, Standards for flood repair, 2005.
- AVIVA Insurances Flood Resilient Home http://www.floodresilienthome.com/
- Guidance by the NFF http://floodforum.org.uk/index.php?option=com_content&view=article&id=8&Itemid=4
- RAB Consultants Homeowners Guide to Flood Resilience (in conjunction with Mary Dhonau) www.knowyourfloodrisk.co.uk/pdf/protection-guide.pdf
- Defra/EA's Flood Resilience and Resilience Solutions R&D

However, whilst these initiatives are clearly dedicated to promoting opportunities for property owners to protect their homes, it is doubtful to what extent they are able to successfully communicate with, and influence, the average homeowner in a predominantly working-class urban area such as Heywood, Rochdale.

Summary

The Heywood case study demonstrates the problems in building capacity for FRe in a predominantly working-class urban area with no history of, or visually apparent risk, of ever being subjected to flood and which has after over 150 years of development suddenly found itself at great and regular risk of summer storm induced pluvial flood events. Yet even in Heywood where approximately 100 homes were inundated with sewer infested flood water in 2004 and 2006 memories are short, properties change hands, and flood risk is already low priority for both the authorities and also much of the general public. Thus, actually building capacity for FRe is difficult and is unlikely to be improved without much greater involvement and enablement by politicians and all concerned with FRe.

III-5 Capacity Building related to the Kephisos Basin Case Study (Greece)

Authors:

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1) Constraints and opportunities for capacity building on the national level.

1.1) Laws in your country and the interpretation of the EU Floods Directive influence the acceptance of FRe technologies and related programs. Please give a description.

a) *How do national laws and the national interpretation of the EU Floods Directive constrain implementation of FRe technologies and related programs?*

No such barriers can be identified at this point. The implementation of the EU Floods Directive and relevant Greek Legislation is underway and there has been no specific reference to FRe uptake so far.

b) *What opportunities are being offered by the national interpretation of the EU Floods Directive?*

Agencies adhere to the standards as established by the National legislation and Directives of the European Union. Environmental Agencies and Inter-municipal bodies ensure the implementation of the current (National and European) legislation for the protection of the environment in the area of responsibility and the monitoring of terms and restrictions implementation necessary for the preservation and enhancement of landscape and ecosystems.

Although the Greek legislation does not fully harmonise with the European legislation, the relevant Ministries have taken action into implementing the EU Floods Directive to its full length by activating a National Program of flood risk management, providing the preliminary flood risk assessment, flood hazard maps, flood risk management maps and management plans. In that context the FRe technology uptake is not compulsory but it is always taken into consideration (especially when the appropriate funding can be made available).

1.2) In many countries Nation States and regional provinces exercise autonomy in government. Pleas describe the following as it applies to your case study area:

a) *How do Nation State program interpretations of the EU floods Directive constrain implementation of FRe technologies and related programs?*

N/A – refer to 1.2 a.

b) *What opportunities are being offered by the Nation State interpretation of the EU Floods directive?*

Municipalities may opt to suggest FRe measures which will be later financed and implemented by either region authorities or the Ministry of Environment, Energy & Climate Change. Inter-municipal bodies may opt to suggest FRe measures which will be later financed and implemented by either region authorities or the Ministry of Environment, Energy & Climate Change. Forest service may opt to suggest FRe measures which will be later financed and implemented by either region authorities or the Ministry of Environment, Energy & Climate Change. The Regions' Department of Water, in cooperation with the Directorate of Civil Protection, develop management plans for flood risk concerning the areas identified as areas of potentially high-flood risk, based on hazard maps and flood risk maps.

Management plans take into account relevant factors such as costs and benefits, characteristics of the river basin or sub basin, covering all aspects of management, including flood forecasting and early warning systems, with emphasis on prevention, protection and preparedness.

1.3) The Construction Industry is a special stakeholder in FRe. They may view it as a burden or as an opportunity for development. Please describe:

a) *What constraints to the practice of FRe are being raised by the construction industry?*

From July 7, 2011 the responsibility of road and hydraulic works has passed from the Ministries to the Decentralised Regions' Management Control of Construction Works.

The wide timeframe of implementation of National legislation and the EU floods directive hinders the uptake of FRe technologies and products. Red line and lack of organisation in the newly established local authorities create additional obstacles.

b) *What opportunities see the construction industry in the practice of FRe?*

In the future there should be a committee with the purpose to compile a single flood regulation

1.4) The Insurance industry has a direct relationship to the practice of FRe.

a) Describe how the insurance industry limits the implementation of FRe?

The insurance industry doesn't limit the implementation of FRe nor reinforce it as it barely takes under consideration FRe systems' and products implementation. No such technologies are common to the Green Market.

b) What opportunities does the insurance industry offer to encourage FRe?

The flood insurance policy is incorporated in the key property sector and the automotive industry. Addressing this risk is different every time and proportional to the insured object, say a different approach to the security of a home and other insurance in a large business unit.

There is no such information or knowledge today, in terms of insurance industry encouraging FRe. In the future, and once there are measurable results and if only those results are important will there be an assistance in the FRe uptake.

1.5) FRe manufacturers are taking a risk in hope of future profits.

a) What are the constraints for FRe technology manufacturers?

In terms of Greece:

- Lack of initiative
- Budgetary limitations
- Responsibility limitations
- Red tape

b) What are the opportunities for FRe technology manufacturers?

- New national market
- New Eastern Mediterranean Market

1.6) Professional associations register and control the practice of their members.

a) How do professional associations hinder the application of FRe?

N/A

b) *How could professional associations offer opportunities for the practice of FRe?*

N/A

2) <u>Constraints and opportunities for capacity building on the local scale</u>

2.1) City government and municipalities traditionally hold power over land use and building codes that relate to the implementation of FRe programs. Summarise what is happening in your case study city:

Although the Greek legislation does not fully harmonise with the European legislation, the relevant Ministries have taken action into implementing the EU Floods Directive to its full length by activating a National Program of flood risk management, providing the preliminary flood risk assessment, flood hazard maps, flood risk management maps and management plans. In that context the FRe technology uptake is not compulsory but it is always taken into consideration (especially when the appropriate funding can be made available).

a) *Are you aware of constraints to the practice of FRe technologies and related programs?*

N/A

b) *What special opportunities exist to practice FRe in your case study city?*

N/A

2.2) Educational institutions are conveying knowledge and influence the mind-set of our future decision makers.

a) *To what extend do educational institutions constrain the transfer of knowledge about the practice of FRe?*

There is no such constraint identified. The Greek research and educational institutions, throughout their national and international collaborations, make significant efforts so as to import, technology and innovation practices into a new market, that of Greece and Eastern Mediterranean. However, lack of funding and appropriate structures for development and testing hinder the educational institutions involvement in the transfer of knowledge about FRe practices.

b) *How can educational institutions offer opportunities for the practice of FRe?*

Innovation is usually disseminated via research projects and relevant results. Those results are somewhat diffused via specific case studies, where applicable.

2.3) Local environmental groups and NGO's have been hailed as the real movers and shakers in a democracy.

a) *Have local environmental groups and NGO's offered constraints on the practice of FRe.*

The Local Government potential intervention has increased since local communities started establishing relevant citizen bodies which allow the active participation of citizens. Such bodies intend to push forward the appropriate and necessary measures for their area of interest, flood proofing especially after extended fire events, where applicable, by conducting studies and carrying out the respective necessary projects. Usually, the approval for the aforementioned activities either arrives too late or not at all. There are bodies such as the Hymettus Protection and Development Association representing an area of approximately 1.2 million citizens and do play a key role in flood risk management initiatives of communities. The way to promote such activities and citizens initiatives is to provide with timely decisions and measures implementation.

b) *How can local environmental groups and NGO's create opportunities for the practice of FRe?*

The above mentioned bodies frequently organise workshops on civil protection and environmental education for students, and informative events on the bodies' work and activities. Those activities require to be initially approved by the supervising Ministry of Environment, Energy & Climate Change.

Interventions relate to all civil protection and risk faced by urban areas from flooding. Municipalities have the responsibility to plan flood proofing projects which are later implemented with the support of the relevant Region. However, given the extraordinary economic circumstances, such projects are hardly scheduled for 2011 and 2012.

2.4) Individual property owners play an expanded role in implementing and managing FRe technologies and programs.

a) *What are the constraints offered by property owners?*

- Lack of funding
- Lack of initiative
- Lack of information

b) *What are the opportunities for property owners?*

- Property protection
- Livelihood protection
- Risk and damage mitigation

III-6 Capacity Building related to the Washington DC Case Study (USA)

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The following information in this chapter is a summary of constraints and opportunities for capacity building in the US to effectuate a transfer process from the current situation to FRe systems. This summary provides information on the national and local scale, drawing on information and text developed through a national analysis, as well as by the local case study workshops and on the case study itself. It is considering flood resilience[124] in a comprehensive fashion and gives answers to the following questions:

1) Constraints and opportunities for capacity building on the national level.

1.1) Laws in your country and the interpretation of the EU Floods Directive influence the acceptance of FRe technologies and related programs. Please give a description:

a) *How do national laws and the national interpretation of the EU Floods Directive constrain implementation of FRe technologies and related programs?*

Equivalents to the EU Floods Directive in the US are the Flood Control Act of 1932 and its amendments. The US equivalent to the Water Frameworks Directive is the Clean Water Act of 1972. The early passage of both laws gave the US a considerable time advantage in experimenting with implementation approaches and in defining programs under public participation. Some feel that an early monopoly in flood control given to the U.S. Army Corps of Engineers (80 years of responsibility, since 1932) has encouraged a narrow focus on structural solutions that runs contrary to flood resilience as a comprehensive approach.

There have been calls for more integrated flood risk management that would involve the public in "on site flood risk management" and give owners of floodplain properties a higher financial share in mitigation. During recent flood events National Flood Insurance reimbursements (with low premium incomes) and Federal Disaster Relief have repeatedly exceeded budgetary capacities and required additional funding through acts of Congress. This is bound to be repeated as climate change causes more frequent catastrophic flood events.

[124] Definition: Flood resilience combines spatial – ecologic, structural, social and risk management levels, integrating prevention, protection, preparedness, and emergency response, recovery and monitoring.

It would be in the interest of the US to formulate a new strategy on flood resilience and to initiate a comprehensive program similar to past initiatives, like urban planning Program under Section 701 of the Department of Housing and Urban Development or the Coastal Zone Management Program. The fact that two laws already exist (of 1932 and 1972) and their implementation through three separate agencies (USACE, FEMA and USEPA) and the recent political climate of the US Congress will make this highly unlikely. This assessment was voiced at the strategic 2012 workshop of SMARTeST in Washington DC and the opinion was expressed that the US Army Corps of Engineers would never get the budget needed to integrate flood risk management into community planning.

b) What opportunities are being offered by the national interpretation of the EU Floods Directive?

The interpretation of the US Flood Control Act of 1932 and its amendments has offered opportunities through the development of (1) Flood Proofing Programs, through the enactment of the (2) National Flood Insurance program, and through (3) flood risk management programs by the Federal Emergency Management Agency (FEMA). The Clean Water Act as an equivalent of the EU Water Framework Directive has been the basis of a comprehensive, FRe orientated (4) Stormwater Management Program administered through the USEPA implementing a National Pollution Discharge Elimination System (PDES).

(1) FLOOD PROOFING - The USACE is one of the first government agencies that assisted in the practice of elevating and flood-proofing private structures on flood-ways. Dry flood-proofing, wet flood-proofing and elevation are differentiated and numerous publications on implementation are available from the Government Printing Office free of charge.

The US Corps of Army Engineer's report "Flood Proofing Regulations" was initially published in 1972. Over 20 years of field experience, research and advances in engineering are reflected in its 1995 update[125], addressing permits, inspection, waterproofing, structural requirements, closure of openings, walls and ceilings, buildings and structures, electrical and mechanical facilities. The document puts forth minimum building standards and requirements that are applicable to safeguard public health and safety by "regulating and controlling the design, construction, and quality of materials of all buildings and structures which are or will be located in all lands shown within Special Flood Hazard Areas" (100-year flood). The Regulations apply to the 'construction, alteration, and repair of any buildings or part of buildings or structures in Special Flood Hazard Areas'. Uses in flood risk areas shall not be expanded, changed, enlarged, or altered in any way, which increases their nonconformity.

The US Army Corps of Engineers further recommend that local communities establish flood-proofing programs, and among other tools offered use a "Flood Damage Reduction Matrix" found at the web site of the National Non-Structural Flood-proofing Committee (NFPC)[126]. It rates flood-proofing techniques against flood depth, flood velocity, ice and debris flow, site location, soil type, structure foundation, structure condition, economic aspects, environmental aspects, recreation and social aspects.

(2) THE NATIONAL FLOOD INSURANCE PROGRAM (NFIP) - regulates development on mapped floodplain areas. Communities are eligible for flood insurance only when they practice floodplain zoning,

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[125] US Army Corps of Engineers, Flood Proofing Regulations. Washington D.C. Dec. 1995

[126] http://www.nwo.usace.army.mil/nfpc accessed 09/10/2011

restricting floodplain uses and requiring that new structures be elevated to level above the 100-year frequency flood and flood-proofed.

(3) FLOOD RISK MANAGEMENT PROGRAMS BY FEMA - The sections 1 and 2 above are linked to programs of FEMA, which have developed flood damage resilient design standards that have been incorporated into building codes adopted by states or municipalities.

Flood-proofing requirements issued by municipalities for both, residential and non-residential buildings may among others call for the following:

- Pre-construction flood-proofing certificates.
- Detailed plans including Base Flood Elevation (BFE) and elevation of flood-proofing.
- Design details of the flood-proofing measures.
- Manufacturer's specification sheets and catalogue cuts when measures (i.e. gates, shields) are ordered from catalogues.

FEMA has issued a document about requirements and certification for non-residential flood-proofing, applicable to commercial, industrial and public structures[127], placing emphasis on:

- WARNING TIME - with a community-based or regional flood warning system in place sufficient to successfully place flood-proofing components.
- SAFETY AND ACCESS - under consideration to pedestrian stability in flood flow conditions, and calling for all vehicular roads to be used as evacuation routes to remain passable.
- FLOOD VELOCITIES, FLOOD DEPTH, AND DEBRIES - generally considering sites with a flood velocity in excess of five feet per second or base flood depth in excess of three feet per second as unsuitable because the cost of dry proofing may be prohibitive.
- FLOOD EMERGENCY OPERATIONS PLANNING – considered to be critical when flood-proofing involves human intervention or optional operations during power failure. A plan must include:
    1. A chain of command and responsibilities for all aspects of the plan.
    2. A procedure for notification of necessary parties when flood warnings are issued. Personnel required should have a planned and safe rout of ingress, and alternates should be assigned.
    3. A list of specific duties assigned including the location of materials necessary to install flood-proofing components.
    4. An evacuation plan for all personnel. All possible ingress and egress routes must be identified.
    5. A periodic training and exercise program to keep personnel aware of their duties and responsibilities. Training drills are to be held at least once a year and should be coordinated with community officials.

[127] FEMA, Non-Residential Flood-proofing – Requirements and Certification for Buildings Located in Special Flood Hazard Areas in accordance with the National Flood Insurance Program. TB 3-93

- INSPECTION AND MAINTENANCE PLAN – Inspection and maintenance activities (to ensure that all flood-proofing components operate properly under flood conditions) must be defined in a plan. Necessary activities including inspection intervals must be defined for the following:

  1. Mechanical equipment such as sump pumps and generators.
  2. Flood shields and closures, to ensure a proper fit of gaskets and seals, labelling and storage according to plan.
  3. Walls and wall penetrations, for cracks and possible leaks.
  4. Levees and berms for excessive vegetation growth, cracks or leaks.

Both the Flood Emergency Operation Plan, and the Inspection and Maintenance Plan are necessary for a Flood-proofing Certificate. Before issuing a building permit communities often require that the owner sign an agreement stating that the plan be adhered to. In order to assure that inspection and maintenance activities will continue, regardless of changes in ownership, there should be appropriate deed restrictions.

- MINIMUM ENGINEERING CONSIDERATIONS - Building design, specifications, and plans must be certified by the design professional, registered professional engineer or architect with the following specifications:

  1. The building must be watertight to:

     a. Height of the flood-proof design elevation and minimum of a 1-foot freeboard.

     b. Walls must be “substantially impermeable to the passage of water” following the U.S. Corps of Army Engineers (COE) definition by “not permitting the accumulation of more than four inches of water depth during a 24 hour period if there were no devices provided for its removal. However sump pumps shall be required to control this seepage”. Flood-resistant materials, described in Technical Bulletin 2, “Flood-Resistant Material Requirements”, must be used in all areas where such seepage is likely to occur.

  2. UTILITIES AND SANITARY FACILITIES – Heating, air conditioning, electrical, water supply, and sanitary sewage facilities must be located above the BFE, completely enclosed with the buildings watertight walls, or made capable of resisting damage during flood events.

  3. All of the buildings structural components must be capable of resisting specific flood related forces. These are the forces that would be exerted upon the building as a result of floodwaters reaching the flood-proofing design level including the following:

     a. Hydrostatic Flood Force – as the force water exerts on any submerged object.

     b. Buoyancy – as the vertical force associated with the buildings tendency to float when surrounded by water.

     c. Hydrodynamic Force – as the force exerted on vertical surfaces exposed to moving floodwaters.

d. Debris Impact Force – associated with flood-borne debris striking the side of buildings.

Guidelines for calculating the above forces are provided in a FEMA document about requirements and certification for non-residential flood-proofing.[128] [129] Technical flood-proofing advice is further contained in the 290-page manual "Engineering Principles and Practices for Retrofitting Flood-Prone Residential Structures".[130]

FEMA keeps a continuously updated website with a description of programs, guidelines and regulations for flood-proofing.[131] Examples of certificates required for compliance shown are:

- ELEVATION CERTIFICATE – A community's permit file must have an official record that shows that new buildings and improvements in flood hazard areas are properly elevated.
- FLOODPROOFING CERTIFICATE – The documentation of certification by a registered professional engineer or architect that the design and method of construction of a non-residential building are in accordance with practices for meeting the flood-proofing requirements of the community's floodplain management ordinance. For insurance rating purposes a building's flood-proofed design elevation must be at least one foot above the baseline elevation (BFE) to receive full rating credit for flood-proofing.
- RESIDENTIAL BASEMENT FLOODPROOFING CERTIFICATE – to be used only in communities, which have been granted an exception by FEMA to allow construction of flood-proofed residential basements in flood hazard areas.
- NO-RISE CERTIFICATION FOR FLOODWAYS – Any project in a floodway must be reviewed to determine if the project will increase flood heights elsewhere. An engineering analysis must be conducted before a permit is issued. The communities permit file must have a record of the results of this analysis. Supporting technical data should be based on the standard step-backwater computer model used to develop the 100-year floodway.

Regulations and standards concerning flood-proofing are being applied through registered architects and engineers, interpreting building codes and using guidelines by the US Army Corps of Engineers, FEMA, and in the Washington DC area, the National Building Code of Building Officials and Code Administrators (BOCA).

4. STORMWATER MANAGEMENT THROUGH THE CLEAN WATER ACT AND THE USEPA ADMINISTERED NATIONAL POLLUTION DISCHARGE ELIMINATION SYSTEM (PDES). –

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[128] Ibid. Footnote 127

[129] For further calculation information see Appendix C of the FEMA „Design Manual for Retrofitting Flood-Prone Residential Structures"

[130] FEMA 259 Engineering Principles and Practices for Retrofitting Flood-Prone Residential Structures, Edition 2, June 2001

[131] www.fema.gov/plan/prevent/floodplain/.../floodproofing.shtm accessed 9/18/2011

The Clean Water Act's interpretation of stormwater management has led to the systematic lessening of storm run-off through surface management, retention and infiltration, run-off detention and slowed release at pre-development rates, creation of wetlands and the restoration of streams. This is being achieved through stormwater management ordinances, making these practices mandatory. All these measures are important components of FRe that are not yet practiced in many European countries

The above interpretation of laws and the related Best Practices aid in the implementation of FRe technologies and practices and may well be integrated into future guidelines by the European Community.

1.2) In many countries Nation States and regional provinces exercise autonomy in government. Please describe the following as it applies to your case study area:

a) How do Nation State program interpretations of the EU Floods Directive constrain implementation of FRe technologies and related programs?

Programs by the USACE, USEPA and FEMA do not constrain the implementation of FRe.

b) What opportunities are being offered by the Nation State interpretation of the EU Floods directive?

The State of Maryland, similar to other states in the union is following the approach to internalise responsibilities for stormwater management under the Clean Water Act, having those who cause problems pay for mitigation measures, rather than having all taxpayers foot the bill to solve problems. In the Sligo Creek area of the Anacostia drainage basin the legally binding base for action is the State of Maryland Stormwater Management Act of 2007 and the Maryland Stormwater Design Manual with its 2009 revisions, establishing guidelines for "Environmental Site Design (EDS)" [132] This Design Manual and its "environmental site design" are the end product of 39 years of evolution (since 1972), establishing standards for a combination of the equivalent of the European Water Framework Directive (WFD) and the 2007 EU Floods Directive[133] . The criteria are applicable to new developments and provide for (a) detention, (b) infiltration, (c) erosion control, and (d) water quality as described below.

In Maryland, the Stormwater Management Act of 2007 and the Stormwater Design Manual has a special provision for water quality. The equation for water quality volume (WQv) is

$$WQv = [(P)\ (Rv)\ (A)]/12,$$

whereby P = rainfall depth in inches is equivalent to 1.0", Rv is the volumetric run-off coefficient, and A is the area in acres. The first one inch of run-off from urban impervious surfaces has been found to be severely polluted. [134]

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[132] http://www.mde.state.md.us/programs/Water/StormwaterManagementProgram/MarylandS ... accessed 7/12/2011

[133] EU Flood Directive (2007) Guideline 2007/60/EG of the European parliament and the Council of October 23. 2007 concerning evaluation and management of flood risks. ABL.L 288 of 6.11.2007 pp. 27-34

[134] U.S Environmental Protection Agency, Results of the Nationwide Urban Run-off Program. Washington D.C: US Government Printing Office, 1982

1.3) The Construction Industry is a special stakeholder in FRe. They may view it as a burden or as an opportunity for development. Please describe:

a) What constraints to the practice of FRe are being raised by the construction industry?

The National Association of Home builders (NAHB) are representing the housing industry by "focusing on housing affordability, availability and choice". Under NABH policies for the Environment[135] it states that: "Federal laws and regulations…. while well intended often impact availability ... by increasing the cost of homes and reducing the supply of land and materials for homes or both". The NABH is accepting implementation of Best Management Practices (BMP's) for stormwater management through local controls. Requests for additional FRe measures that would increase costs will not be accepted lightly. The housing industry is being viewed as an indicator of the state of the economy of the US, and housing starts have been negatively impacted in the current economic slump.

b) What opportunities does the construction industry see in the practice of FRe?

Historic city centres developed along waterfronts for water energy and transportation. Waterfronts such as Sydney, Australia, Boston, MA, Rotterdam, Holland and Hafen City Hamburg, Germany continue to be prime real estate. Flood-proofing provides the technology that expands the availability of land for development. FRe thus is highly desirable to the construction industry. Under these circumstances special building codes such as those issued for Hafen City Hamburg[136] and voluntarily practiced for waterfront development in Georgetown in Washington DC will most likely be acceptable.

1.4) The Insurance industry has a direct relationship to the practice of FRe.

a) Describe how the insurance industry limits the implementation of FRe?

"Floodsafe USA", a manufacturer of flood-proofing measures states that: "at the time, there are no insurance premium reductions available for flood-protected residences".[137] This may be viewed as a temporary situation, related to provisions of the National Flood Insurance Program (NFIP), which encourages the flood-proofing of non-residential structures. It is being viewed as a drawback by manufacturers.

b) What opportunities does the insurance industry offer to encourage FRe?

The National Flood Insurance Act was passed in 1968 to provide financial aid to property owners while guiding away development from flood hazard areas and to require that improved buildings would minimise flood damage (Flood-proofing). The "National Flood Insurance Program" (NFIP) has been heavily scrutinised in the wake of the New Orleans flood catastrophe. A 2009 study published in the University of Miami International and Comparative Law Review however found that the NFIP is doing better than flood

135 http://www.nahb.org/reference_list.aspx?sector accessed 8/4/2012

136 Landesbetrieb Strassen, Bruecken und Gewaesser, Freie Hansestadt Hamburg. Informationen zum Flutschutz in der HafenCity Hamburg. Stand: 22.12.2009

137 http://www.floodsafeusa.com/faq.html accessed 8/12/2012

insurance programs in the UK, France, Germany and the Netherlands, because it actively aims to share the burden of flood risks between individuals, insurance companies, and the Government. It denies coverage to municipalities that do not practice flood risk assessment, enact building restrictions (floodplain zoning) and encourages flood proofing of structures.[138]

NFIP further offers building standards. Homes built in compliance with NFIP standards have been found to suffer less flood damage than those who did not follow such standards. In a study the Multi-hazard Mitigation Council found that each dollar spent on mitigation saves society an average of four dollars.[139]

Residents of the Sligo Creek drainage basin in the Washington DC case study area received a 25 % reduction in flood insurance rates. (This is contrary to the previous statement by Floodsafe USA). This has been made possible, because Prince George's County MD participated in a program by NFIP designed to encourage and recognise community floodplain management efforts. The program is being called Community Rating System (CRS) and gives credit points for community activities that: (1) reduce flood losses, (2) facilitated an accurate risk rating for insurance purposes, and (3) promote an awareness of the availability of flood insurance. Communities are being evaluated and placed into CRS class I to 10 with class 10 receiving the largest premium reduction. Most of the 1200 communities who participate are in the Class 8 and 9 categories, receiving a 5-10 % premium reduction. A community in the Class 1 would receive a 45 % premium reduction.

The NFIP provides remarkable incentives for the practice of FRe. Private insurance companies in EU countries view themselves as a business only, but should be encouraged to include stewardship for risk reduction into their programs.

1.5) FRe manufacturers are taking a risk in hope of future profits.

a) What are the constraints for FRe technology manufacturers?

Government subsidies in the implementation of flood-proofing measures improve the market for implementation and help to reduce financial risks taken by their manufacturers. FloodsafeUSA[140], a manufacturer and installer of flood-proofing measures states that the current policy for federally subsidised flood-proofing does not include dry flood protection measures for residential structures. This is considered a drawback.

b) What are the opportunities for FRe technology manufacturers?

The "National Flood Insurance Program" (NFIP) offers financial assistance for the implementation of flood-proofing measures as "Increased Cost of Compliance", paying up to $30,000 toward the cost of making an insured structure compliant with the local flood damage prevention ordinance when compliance through elevation or flood-proofing is required by a community. This shows that government assistance that is also helping manufacturers is available, provided that government guidelines are being adhered to.

[138] Toothill, J., N. Catford. "Flood management in Central Europe" RISKTRANSFER, Magazine Volume 2, Issue 5, Oct. 2004

[139] http://www.fema.gov/business/nfip/crs.shtm

[140] http://www.floodsafeusa.com/faq.html, accessed 8/12/2012

1.6) Professional associations register and control the practice of their members.

a) *How do professional associations hinder the application of FRe?*

"Flood Risk Management" used to be called "Flood Control", and be implemented through structural measures, being the exclusive responsibility of civil engineers. Many civil engineers in practice in senior positions and as decision makers today were educated at a time when levies and dams were the only answer to flood problems. Civil engineers are organised in professional associations and still are preferably the lead agency in any US project that involves flooding.

b) *How could professional associations offer opportunities for the practice of FRe?*

Civil engineers, architects, landscape architects and spatial planners are registered, or licensed and are members of professional associations. It has been recognised that issues, subject matter and educational content changes over time. It is for this reason that professional associations have initiated continuous education programs. In order to remain registered members have to attend a set minimum of daylong continuous education classes. FRe could become a required course.

2) Constraints and opportunities for capacity building on the local scale

2.1) City government and municipalities traditionally hold power over land use and building codes that relate to the implementation of FRe programs. Summarise what is happening in your case study city:

a) *Are you aware of constraints to the practice of FRe technologies and related programs?*

With FEMA funding, Prince George's County, MD offered a flood-proofing study to about 90 commercial properties. Only about a dozen participated and were offered partial protection through wet flood-proofing options (protecting critical equipment and utilities), or optimal protection (in most cases dry flood-proofing and floodwalls).

Flood-proofing existing structures on the 100-year floodplain is advocated by local planning agencies, but is not very popular with property owners.

At the two SMARTeST Washington DC Workshops a listing of FRe hindering forces included:

- Old school attitudes.
- Lack of understanding, public education, public acceptance.
- Institutional barriers, such as outdated codes, regulations, land use policies.
- Lack of good life cycle analysis and benefit information data.

- National Flood Insurance is not recognising some innovative flood-proofing devises without going through an official approval process.
- Lack of funds or willingness to pay.

b) What special opportunities exist to practice FRe in your case study city?

A FEMA floodplain designation has been made for the entire Washington DC area and all municipalities have implemented floodplain zoning. Municipal planning and zoning, FEMA and the National Flood Insurance Program actively support flood-proofing and stormwater management. Management through those FRe structures is being mandated for new developments, and widely accepted. The “Anacostia Watershed Initiative Act of 2005” was passed by Congress as an amendment to the federal Clean Water Act to act as a national model of urban river restoration and stewardship. In 1987 an “Anacostia Watershed Restoration Agreement” had been passed and a committee had been formed which later became the Anacostia Watershed Restoration Partnership, which enjoyed wide public support. In 2007 this partnership entered into a federal cost-sharing agreement with the U.S. Army Corps of Engineers to prepare an Anacostia Watershed Restoration Plan by 2009 The 2008 Sligo Creek Provisional Restoration Project Inventory evaluates existing stormwater drainage and control facilities and provides an outline of potential stormwater retrofit, stream restoration and wildlife habitat improvement projects.[141]

The Anacostia Watershed Restoration Partnership contracted with the Metropolitan Washington Council of Governments (COG) to prepare the 2008 Sligo Creek “Provisional Restoration Project Inventory “.[142] One of the objectives is the reduction of stormwater flows and associated pollutants and the project inventory provides a list of potential stormwater retrofits. The type and number of facilities that existed in the year 2007 is shown in Figure below.

[141] Ibid.

[142] Galli, J., P. Trieu, A. Maynard, K. Choi. Department of Environmental Programs, Metropolitan Washington Council of Governments. Sligo Creek Subwatershed: Provisional Restoration Project Inventory, 2008, upgraded 2009

Type of stormwater BMP's	No. of facilities
Dry Pond[143]	7
Extended Detention Wet Pond[144]	3
Wetland (non-Extended Detention and Extended Detention[145])	3
Infiltration (Trench or Basin)[146]	19
Oil Grit Separator[147]	22
Water Quality Inlet (e.g. Storm receptor, Bay Saver)[148]	9
Bio-retention/Rain Garden[149]	7
Green Street[150]	1
Bio-filtation Swale[151]	1
Sand Filter[152]	8
Underground Pipe Storage[153]	4
Other	3

Figure - Stormwater Management BMP's in existence in the Sligo Creek Basin in 2007 (Source[154])

143 A detention basin that falls dry after entire detained volume has been released

144 A detention basin with a permanent pool that detains run-off in addition for 72 hours to improve water quality

145 A shallow man-made wetland, or a wetland (extended detention) with a freeboard to detain run-off for 72 hours for additional quality enhancement (after 72 hours photosynthesis would be disrupted)

146 A trench or basin over soil suitable for infiltration

147 A subterranean multi-chamber container that separates lighter than water fluids from run-off

148 A stormwater inlet that diverts run-off into a panted infiltration and quality improvement bed

149 Bio-retention: A vegetated infiltration bed with three feet of infiltration media and under drainage Rain garden: A vegetated depression filled with infiltration media primarily used on private lots

150 A street where run-off is consumed by landscaping enhancements

151 A vegetated infiltration trench with three feet of infiltration media and optional under drainage

152 A space efficient sand-filled concrete box with high maintenance demands

153 A underground perforated pipe with high storage capacity and disposal through infiltration

154 Galli, J., P. Trieu, A. Maynard, K. Choi. Department of Environmental Programs, Metropolitan Washington Council of Governments. Sligo Creek Subwatershed: Provisional Restoration Project Inventory, 2008, upgraded 2009

FLOODPROOFING

Almost all flood-proofing projects in the Washington DC area have received some form of public/financial assistance. Property owner involvement in the planning process is deemed essential.

Prince George's County has developed a strategy to address flood problems. It takes the form of: (1) Evaluating mitigation and flood-proofing alternatives, (2) Recommending the most suitable alternative, (3) Performing a preliminary design for the solution, (4) Seeking Federal and State grants for construction. A public education program, a flood warning system, and a program to flood-proof structures or to purchase them is in place. In fiscal year 1995 Prince George's County provided funding for the acquisition or flood-proofing of 23 homes at a cost of $ 2.7 million.[155] Between mid-1980 and 2005 a total of 62 residences have been flood-proofed with County funds, primarily through site grading and floodwalls around entrances.

At the SMARTeST Washington DC Workshops a listing of FRe supporting forces included:

- The crisis of climate change coupled with run-off increases.
- Increasing risks and economic losses.
- Old drainage structures that have not been updated and cause flooding problems.
- Stream channel degradation.
- Public perception of problems.
- Regulations and permit requirements.
- Incentives, such as lowering insurance rates.
- FRe technologies can be integrated into "Urban Design" leading to waterfront enhancement.

2.2) Educational institutions are conveying knowledge and influence the mind-set of our future decision makers.

a) *To what extend do educational institutions constrain the transfer of knowledge about the practice of FRe?*

Prominent educational institutions in the US charge tuition of over $ 30,000 per year (some over $ 60,000). Courses for Civil Engineers, Spatial Planners, Architects and Landscape Architects are designed to reflect demands of the market. Prof. Dr Ritter from University of Delaware, and adviser to SMARTeST, noted that students would select courses that permit them to graduate as soon as possible. Flood resilient technology still is at the fringe of future coursework. Stormwater management though has become an educational standard. An example is a textbook prepared by the Water Environment Federation (WEF, sponsor of the SMARTeST Strategic Workshop in Washington DC) and by the American Society of Civil Engineers (ASCE).[156]

155 http://www.princegeorgescountymd.gov/government/agencyindex/der/ppg/floodplains.asp accessed: 6/20/2011

156 ASCE, WEF, Design and Construction of Urban Stormwater Management Systems. New York City, 1992

b) How can educational institutions offer opportunities for the practice of FRe?

Competition for student enrolment forces educational institutions to be on the forefront in research and course offerings. Dr Stuart Schwartz, University of Maryland Baltimore Campus and advisor to the SMARTeST project, is engaged in such research. Stormwater management is part of the coursework offered at the University of Maryland. Similarly the Cleveland Urban Design Centre of Kent State University has hosted seminars on innovative use of stormwater management practices. Over the last four decades Universities have played a pivotal role in research[157], conferences, courses and seminars as well as being on the forefront in capacity building for stormwater management, imbedding an understanding for it in American society. It is being felt that at a time of climate change the concept of flood resilience – living with floods – needs to be advocated in a similar fashion, in the US and in the EU.

A summary presentation of FLORETO-KALYPSO and the HOWAD-Prevent model at the strategic and local level workshops in Washington DC was viewed with interest and considered to be used at a professional level. Computer generated information is generally trusted, though it is being realised that the quality of output depends on the accuracy of input. It is being understood that computer based decision support systems and models will undoubtedly play an increasing role as a planning aid and as a facilitator of informed decisions. Computer based decision support systems are well suited to be used at seminars at universities or in continuous education courses taught by academics offered at professional association continuous education courses.

2.3) Local environmental groups and NGO's have been hailed as the real movers and shakers in a democracy.

a) Have local environmental groups and NGO's offered constraints on the practice of FRe?

Local environmental groups do not offer constraints to the practice of FRe, but oppose new development on the floodplain including the construction of levies and floodwalls. Instead a concept of more room for rivers and the preservation of natural stream valleys are being pursued.

b) Have local environmental groups and NGO's created opportunities for the practice of FRe?

Stormwater management for water quality is being actively embraced by environmental groups and by NGOs. It is a particular interest of environmental groups formed for the protection of stream catchment areas (Watershed Associations). In the Washington DC area case study private groups play an active role in "capacity building". The numerous voluntary and semi-public associations that are involved in the Sligo Creek basin are: (1) Friends of Sligo Creek (FOSC), (2) Watershed Society (AWS)– www.anacostiaws.org (301-699-6204) (3) Anacostia Wat www.fosc.org (301-345-6515), (4) Anacostia Watershed Citizens Advisory Committee ((AWCAC) – www.anacostia.net (202-962-3348), (5) Anacostia Riverkeeper - www.anacostia-riverkeeper.org, (6) Natural Resources Defence Council (NRDC) – www.nrdc.org (202-289-

157 Tourbier, J., R. Westmacott. Water Resources Protection Measures in Land Development - A Handbook, University of Delaware Water Resources Centre, 1974

6868), (7) Metropolitan Washington Council of Governments (COG) – www.mwcog.org (202-962-3200), (8) Earth Conservation Corps – www.ecc1.org – (202-545-1960), (9) Interstate Commission on the Potomac River Basin – www.potomacriver.org (301-984-1908), (10) Chesapeake Stormwater Network (CSN) www.chesapeakestormwater.net (40-608-7171). Some of these organisations, such as Metropolitan Washington Council of Governments have a sizable staff and are financially supported by the governments of the greater Washington area.

These organisations have made contributions that often went beyond Sligo Creek. The Natural Resources Defence Council (NRDC), a voluntary group of lawyers and scientists sued the U.S. federal government over disposal of dredge fill in marshes and won, hence turning the U.S. Army Corps of Engineers into the federally appointed custodian of all U.S. Wetlands. The Anacostia Watershed Society (AWS) sued the Washington D.C Water and Sewer Authority (WASA) in 1999 for allowing 7,600,000 cbm of combined sewage (stormwater) to flow into the Anacostia. In a settlement WASA agreed to invest $ 40 million in related improvements, including public notices of overflows[158]. The Chesapeake Stormwater Network (CSN) is advocating reforms of federal, state, and local laws and regulations to promote sustainable stormwater management in the Chesapeake Bay, including the Anacostia River Basin. It developed a spreadsheet for the review of stormwater designs. The Metropolitan Washington Council of Governments (COG) is an association of 21 local governments and has been an award winning national leader in city-and regional planning.

Stakeholder participation in the Sligo Creek watershed is being practiced with three levels of stakeholder groups in an effort to build consensus, through learning and convincing, gaining confidence and winning agreement.

2.4) Individual property owners play an expanded role in implementing and managing FRe technologies and programs.

a) What are the constraints offered by property owners?

Flood-proofing of homes can receive public assistance (up to $ 30,000), yet there is low interest in practicing it. Participants of the Washington DC workshops stated that government involvement after accepting public assistance is viewed by some as the reason for a low interest. Limited control over appearance of measures and special requirements of government agencies have been noted as a constraint at a DC Area workshop. There also was a perception that evidence of flood-proofing on structures may scare off potential future buyers, as they see flaws in a property indicating the threat of future flooding.

b) What are the opportunities for property owners

Implementation of FRe depends heavily on the involvement of environmental groups and on property owners. Advancements in planning strategies and strong stakeholder involvement programs offer opportunities.

A pre-requisite for capacity building with property owners is public education and a realisation of benefits. An example of an improved strategy to more actively involve people at the local level has been put forth by

[158] http://en.wikipedia.org/wiki/Anacostia_River, accessed 07/12/2011

FEMA. It is a multi-objective management approach called M-O-M[159] with reasoning that a single-minded approach will no longer lead to solutions for flood problems. Instead it brings together everyone with a concern or problem. M-O-M follows six guidelines: (1) KEEP THE EFFORT LOCALLY BASED - Making solutions acceptable to residents and others in an area, fitting in with local concerns and goal. (2) UNDERSTAND THE FLOOD PROBLEM AND ITS RELATIONS TO THE WATERSHED – Realising that the problem is not isolated and making certain that the solution does not cause a problem for somebody else, (3) THINK BROADLY ABOUT POSSIBLE SOLUTIONS TO REDUCE THE FLOOD PROBLEM – Realising that there are alternatives to floodwalls or other single purpose projects that conventional wisdom would suggest, (4) IDENTIFY THE OTHER COMMUNITY CONCERNS AND GOALS THAT COULD HAVE A BEARING ON THE FLOOD PROBLEM – Brainstorm possible solutions with stakeholders and select those that can reach more than one of their objectives, (5) OBTAIN EXPERT ADVICE AND ASSISTANCE FROM GOVERNMENT AGENCIES AND PRIVATE ORGANISATIONS – Identify and utilise the multiple funding options available, (6) BUILT A PARTNERSHIP AMONG THE PRIVATE AND PUBLIC GROUPS AND INDIVIDUALS THAT CAN BE ENLISTED TO WORK ON THE OBJECTIVES – More minds and hands increases opportunities for implementation. One reason why M-O-M has been getting good results is that when using it you treat the river's waterfront, floodplain and river basin as a resource.

Summary

The Washington DC Case study contributes to SMARTeST project goals by giving examples of how capacity building for the implementation of FRe has been enhanced over an extended time period. It demonstrates the following:

- Demonstrating that intensive stakeholder involvement builds capacity and brings about implementation. This includes the legislature, government agencies on the federal and local level, the construction industry, the insurance industry, FRe manufacturers, professional associations, NGO environmental groups, and individual property owners.
- Showing that water quality concerns can successfully be made part of flood risk management (as required by the EU WFD).
- Indicating the need for active government support programs.
- Presenting how flood insurance can play an active role and not only be a business.
- Showing that flood resilience can be a combination of the levels of spatial planning, structural planning, and social planning and risk management.

Level I - Spatial Planning - involves on-site stormwater management with (a) detention, (b) infiltration, (c) erosion control, (d) water quality. On-site stormwater management reduces combined sewer overflows and water pollution and surface conveyance in "naturalised" streams along with the restoration of wetlands and restoration of the ecologic continuity of streams.

Level II - Structural Planning - A high emphasis on technical flood-proofing advice and its practice as a government program. Structural planning is being closely linked to National Flood Insurance, making it

159 www.fema.gov/pdf/floodplain/nfip_sg_unit_10.pdf, accessed 09/7/2011

essential that the risk of flooding and flood depth is known, and that this is communicated to the public through flood hazard mapping. A deciding factor for the implementation of flood-proofing was found to be the availability of financial and technical assistance.

Level III - Social Planning - Flood warning is location specific and can be personalised upon request, using latest communication techniques. Floodplain delineation is complete and readily available to the public. Municipal flood emergency planning is being interpreted broadly by FEMA with emphasis on the community level, rather than on the state and federal level like in Europe. FEMA flood hazard management planning has a holistic approach different from Europeans emphasis on structural engineering, and a procedure in hazard mitigation set forth in M-O-M which runs contrary to a long cherished belief in relying on experts and centralised institutions.

Stakeholder participation is practiced extensively and has long been used as a model in Europe. The Internet is being widely used and enhances social planning. The monitoring of performance of institutions and their projects, compared with previously adopted goals is commendable.

Level IV - Risk Management - The availability of flood insurance through the NFIP is unique, because it not only provides a federally backed insurance to assist in a speedy recovery after disasters, but it also offers an incentive to communities to manage flood risks more effectively, and indeed practice flood resilience.

NFIP incentives are numerous. It is only available to communities who restrict further development of flood prone areas. Communities that rate high (CRS) in flood risk communication receive an up to 25% insurance premium reduction. NFIP “Building Standards for Flood Prone Buildings” reduce flood damage, and information on “Flood-resilient Material” is available. Financial assistance for the implementation of flood-proofing measures is available.

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http://floodresilience.eu