Development of a framework for integrated storm and surface water management

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1. Introduction

When it issued its first response to the autumn 2004 *Making space for water* consultation exercise (Defra, 2005), the Government Took "note of the views put forward in responses. So as to take forward thinking on future arrangements Defra will review ongoing best practice and pilot a range of different approaches to developing more integrated management of urban drainage. The proposal for such pilots in *Making space for water* received widespread support. Work will commence in summer 2006 and be completed in 2009. The best practice review will look at emerging findings and lessons learned from several ongoing voluntary approaches, including the Birmingham SMURF project, and the proposals for integrating storm and surface water management planning in the AUDACIOUS Project".

Defra has recently invited tenders for a scoping review, the aim of which is to inform the development of the pilot studies and its' specific objectives may be summarised as:

- The identification and summarising of completed and current projects which will contribute to the development of integrated proposals
- The identification of barriers and constraints to integrated urban drainage management and to suggest a framework within which this may be practiced
- Making recommendations for a range of procedural, institutional and technical alternatives and possible methodologies for Integrated Urban Drainage to be investigated through the Pilot Projects Teams.
- Preparing a draft questionnaire to be used to inform the subsequent selection of pilot schemes by Defra.

Comment: Date is not relevant for rhe longevity of the paper

Comment: Is summarisation a word?

At the same time there are proposals for a European Community directive on flood management and it is understood, that this directive will pass down issues of detail and timing to member states. If this becomes reality, then the outcome of Making space for water will, without external influence, form policy in England and Wales and will no doubt contribute to policy formulation in Scotland and Northern Ireland. Hence, it is important that Defra's commitment to "working with the Environment Agency, Sewerage Undertakers, Local Authorities and other responsible bodies, to investigate and demonstrate best practice for partnership co-operation to deliver Integrated Drainage Management for urban areas at high risk of flooding" is reciprocated.

Comment: It only mentions England

Comment: Scotland may well be ahead of England already!

The purpose of this paper is to explore some of the issues that will have to be dealt with in *Making space for water* and to summarise some of the experience already gained in AUDACIOUS, FRMRC and NORIS which are mentioned in the tender document for the scoping review, and other equally associated projects, some of which are being reported at this conference. The paper focuses on the barriers and constraints to integrated urban drainage and identifies some technical procedures that may help to overcome these. However, it should be noted that the contents are solely based on the experiences of the researchers and collaborating partners involved in AUDACIOUS and the urban aspects of FRMRC. These procedures have been evolving over the past three years and it is anticipated that they will continue to evolve. They may even be abandoned and replaced

Comment: To what?

as the *Making space for water* pilot projects progress. Nevertheless they are tendered to help to stimulate the debate that will take place over the coming years.

1. Urban flooding

Urban flood mechanisms are shown in Figure 1. There are major systems, comprising the watercourses, rivers, groundwater and surface flow pathways, and minor systems that are the networks of pipes and drains below ground. It is the interactions between these systems which is poorly understood and inadequately represented in models.

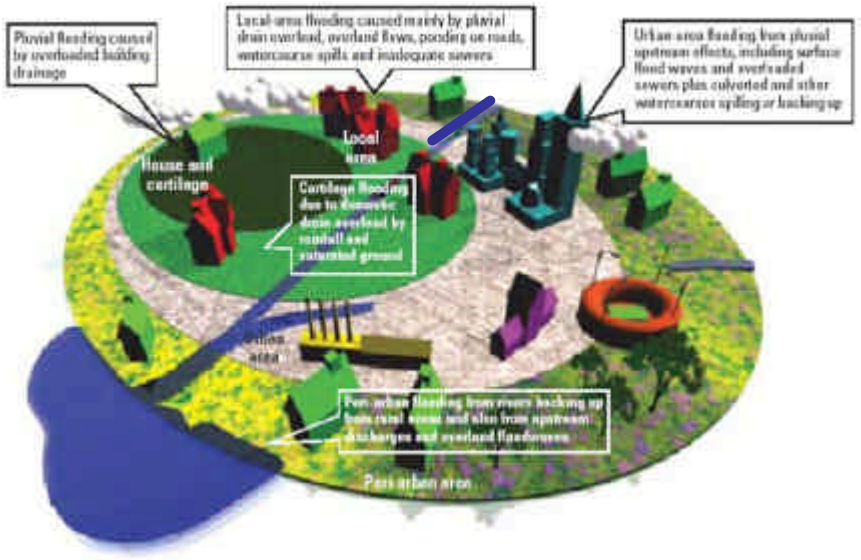

Figure 1: Urban flooding (OST, 2004)

The first Government response to the Making space for water consultation identified the different aspects of urban flooding and illustrated these in Figure 2.

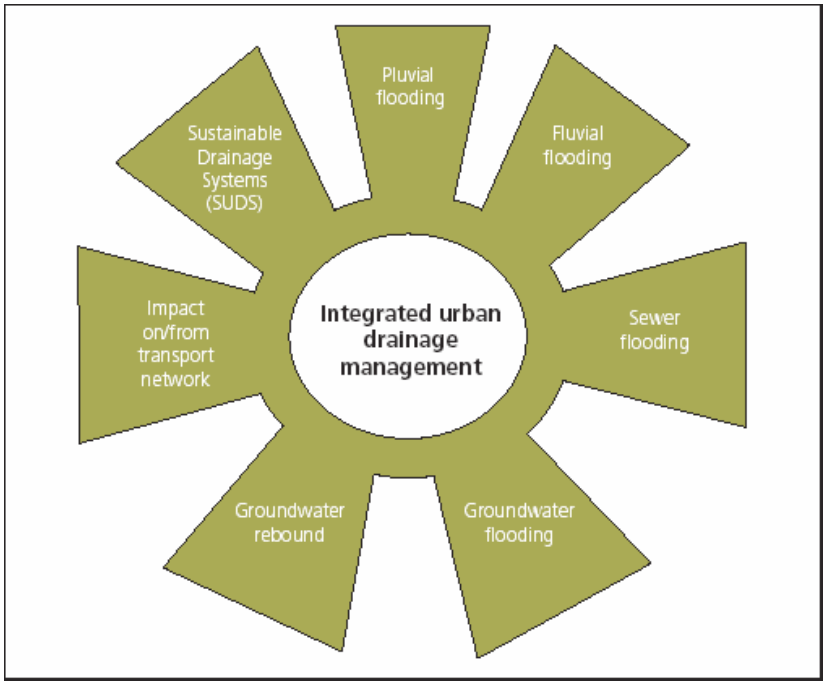

Figure 2: Aspects of urban flooding (Defra 2005)

Integrated urban drainage management covers urban drainage systems including ordinary watercourses draining urban and peri-urban areas. It does not cover main rivers or ordinary watercourses in rural areas. Specifically, it should encompass:

- the combined and surface water sewerage systems operated by the wastewater service provider.
- ordinary water courses including critical ordinary watercourses (COWS).
- surface pathways and receptors
- undeveloped land contributing run-off directly into the urban area
- developed land within the urban area
- open space within the open area
- the boundary with main rivers and coastal waters

2. Stakeholder communities

There are currently a number of different organisations responsible for managing flood risk. Responsibilities vary depending upon whether the system is major or minor and if the risk management is in:

- the planning stage (identifying, designing, building and maintaining to manage risk)
- during a flooding event (warning, emergency, preparation and evacuation)
- after an event (post-event restoration, diagnostics etc)

Responsibilities are unclear to many stakeholders. This is partly because the boundaries within which the Environment Agency operates (26 area offices) do not match with the political boundaries for local government or with the regional extent of each of the private sewerage undertakers, and partly because of the complex and interacting causes of flooding, particularly in urban areas.

The main organisations/functions are given in Table 1. However, depending on circumstances this list is not exhaustive.

Table 1: Outline of the functions of the principal organisations and stakeholders involved in water management in England and Wales (adapted from CIRIA, 2003)

Organisation	Function
Defra (Department for Environment, Food and Rural Affairs) *(Consultee on use of agricultural land)*	Policy in England and Wales including: • drinking water quality • water quality in rivers, lakes and estuaries • groundwater • reservoir safety • flood & coastal defence • sponsorship of Environment Agency and English Nature. Also have a regional engineer 'responsible for all water courses in each area'.
ODPM (Office of the Deputy Prime Minister) *Has powers to call in development plans and applications at all levels for review and determination*	Oversee the Planning System; responsible for policy, research, approval of plans and major planning decisions. • Planning Policy Guidance, • Minerals Planning Guidance • Regional Planning Guidance. Appoints inspectors for Examinations in Public, Local Plan Inquiries and Planning Inquiries.
Planning Inspectorate *Hold Local Plan Inquiries; Sit on panels for Examination in Public; Public Examinations (regional plans.*	Provides independent and impartial advice on the resolution of planning issues and determines appeals/applications on behalf of the Government on the use of land, natural resources and the environment. Hold local plan inquiries. Historically appointed by DTLR (Department of Transport, Local Government and the Regions – functions now split into Department for Transport and ODPM).
Regional Assembly *Consulted on strategic planning applications*	Prepare draft regional strategies for approval by ODPM. Undertake regional strategy studies and produce guidance.

Organisation	Function
Environment Agency (EA) *Statutory Consultee on structure plans and defined planning applications. Consultee on development plans. Advises Regional Planning Bodies. Prepares a range of non-statutory plans.* *Not responsible for managing coastal erosion and only empowered to offer a warning service for groundwater flooding.*	Protect and enhance the environment and to make a positive contribution towards sustainable development. Water management functions of the Agency include: • water resources regulation and planning • water quality regulation and planning • flood risk management of main rivers, estuaries and the sea, including strategic planning, flood defence asset management and operations, regulation of developments affecting or affected by flooding, and flood forecasting and warning • conservation and recreation.
Internal Drainage Boards *Development Planning Consultee*	Drainage and flood defence for low-lying land in parts of Districts. Regulation of watercourses apart from designated main rivers.
Water Service Providers *Development Planning Consultee. Companies may interact with the planning system individually or via Water UK (the water industry association).* OFWAT	Provision of public services for potable water supply and sewage disposal and treatment. Responsible for public sewers required to effectually drain foul sewage and SW run-off from developed areas. Primary water resource coordinators. Financial regulator for the water service providers in England & Wales; setting prices by interpreting Government policy, and balancing the needs of the water companies, the customers and other stakeholders to ensure cost effective services, whilst maintaining the long term future for service provision
Water Voice Local Councils *County, District and Unitary Authorities are responsible for implementation of planning policy, determining planning applications. Parish and Town Councils are consultees.*	The independent watchdog of the water industry To promote the economic, environmental and social well being of their area. Develop structure plans, local plans, unitary plans (Level 1 & 2) and now local development frameworks. Determine planning applications. Drainage, flood alleviation and regulation of watercourses apart from designated main river and critical ordinary watercourses. Provision of emergency services and planning for civil contingencies. Management and maintenance of certain highways and public open space.

Organisation	Function
Riparian land/house owners	Accept flows from upstream, responsible for own on-site water systems.
Developers	Deliver new housing, commercial developments etc guided by the local plan. Fund essential infrastructure under Planning Act agreements. Contribute to water supply and drainage infrastructure costs through commercial negotiations with the service providers.
Land managers (other than the above) *Advisory or informal consultee other than English nature who are statutory consultees on structure plans and for designated sites*	These include e.g. English Nature, local wildlife trusts, and Countryside Agency etc. These may manage nature and wildlife reserves, designate sites of special scientific Interest etc.
Financial service providers *Providing finance for purchase and insurance of properties and businesses*	These include banks, insurance companies, mortgage lenders and their trade associations who set levels of service based on commercial factors and determine if the flood risk of current or new properties is acceptable

A more detailed assessment of the responsibilities of the different stakeholders is made by Ashley et al (2005), but it can be clearly seen from the table that there is a high level of differentiation of responsibilities and that their integration is not easy. Notwithstanding the potential interpersonal barriers, gaps, overlaps, competing organisational objectives and lack of empowerment; all create barriers to successful integration. This is not a problem specific to England and Wales. Although other countries such as Germany and the Netherlands have different organisational models, there are still difficulties in integrating activities and also competing demands for financing.

In order to help with the understanding of the problem and to simplify the process of resolution, it may help to consider the different community constellations to which the stakeholders belong. This is illustrated in Figure 3, in which three community constellations are shown representing those interested in:

- Flood and coastal defence (the major system)
- Urban drainage and sewerage (the minor system)
- Spatial planning and development (driving urbanisation, but cross cutting)

It should be noted that some of the stakeholder communities may fall into more than one constellation.

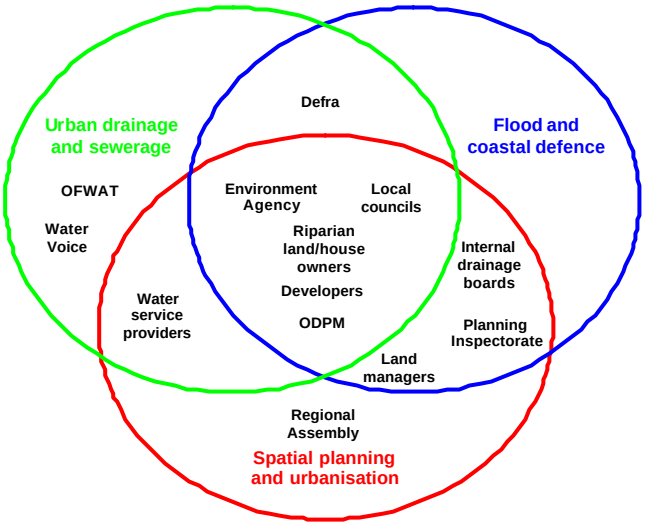

Figure 3: Stakeholder community constellations

The urban drainage and sewerage constellation may be viewed as the service providers of integrated urban drainage. The flood and coastal defence constellation has a similar role for the rivers and coastal waters and an integrating role for river basin and coastal zone management. The spatial planning and urbanisation constellation is the driving force that creates the need for water management.

In any relationship, tensions can develop. In the case of urban drainage, these are often caused by misunderstandings of the responsibilities, rights and roles of the different organisations which result from the lack of an appropriate integrating framework. Without such a framework, the prejudices of individuals based on personal experience, including lack of empowerment, may have undue influence on proceedings. For example, depending on personal experience, individual members of the urban drainage and sewerage constellation may perceive developers customers, for whom services are willingly provided, or as unprincipled, profiteers who should be treated with a high degree of suspicion.

As well as the potential tensions and the opportunities for collaboration between the constellations, there are also tensions and opportunities within each constellation, and for each constellation to move forward in its relationship with the others, it must address its own problems first. In order to do this it will have to manage its own inter-organisational boundaries, and understand and respect the position and needs of the other organisations within the constellation. It will also have to wish to work collaboratively with the other organisations within the constellation to provide agreed levels of performance to the other constellations and the wider world.

Comment: This sentence is too long

3. The urban drainage and sewerage constellation

Figure 4 shows the relationships between local authorities and sewerage undertakers, (the main service providers within the constellation, the Environment Agency, which integrates river basin and coastal zone management and provides environmental regulation, Government, which develops policy and strategy, OFWAT which provides financial regulation and the different communities, the customers for whom services are provided

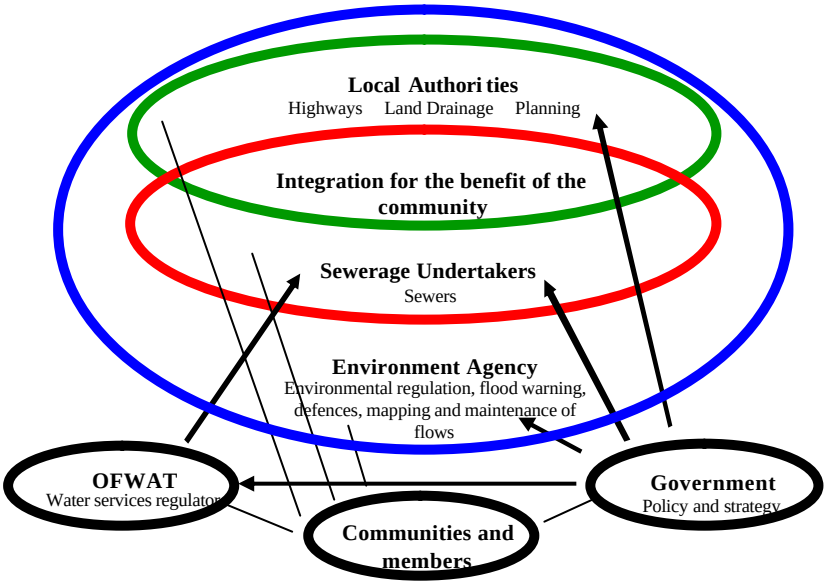

Figure 4. Relationships between stakeholders (Blanksby et al 2005)

The figure shows the absolute need for integration of the activities of local authorities and water service providers. The reason for this is simple. The sewrage undertakers manage, maintain and operate the vast majority of the minor drainage system, and with the exception of main rivers and COWS, the local authorities have responsibility for the major drainage system in urban areas and for the planning decisions which affect both. The potential impact of planning decisions on urban drainage systems is shown by the graphs of increasing impermeability in the Keighley area of Bradford between 1971 and 2001 shown in Figure 5. This study of groups of low, medium and high density private sector and social housing by Duckworth (2005) shows the increased impermeability within property curtilages as a result of permitted and controlled development and identifies that there is a potential for further significant increases in impermeability. The analysis to date suggests that such uncontrolled development is a major contributing factor to some of the flooding within the area, and that the most cost effective ways of dealing with this and the potential impacts of climate change will be disconnection and source control.

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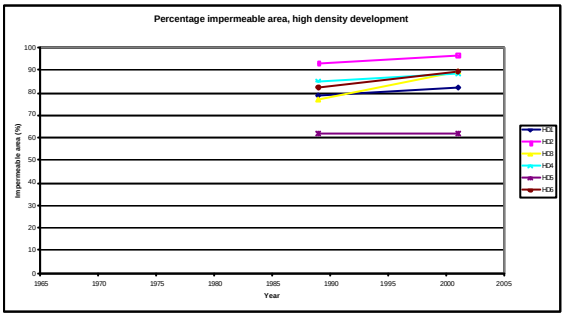
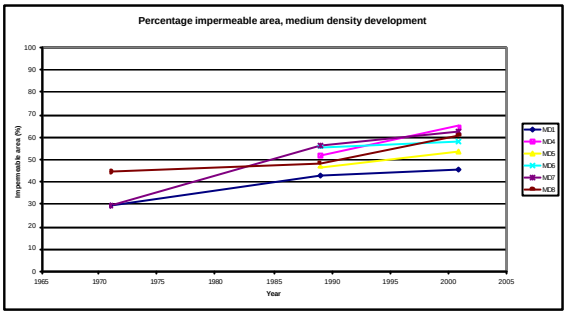
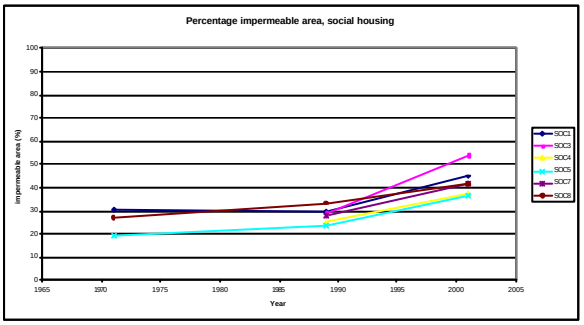


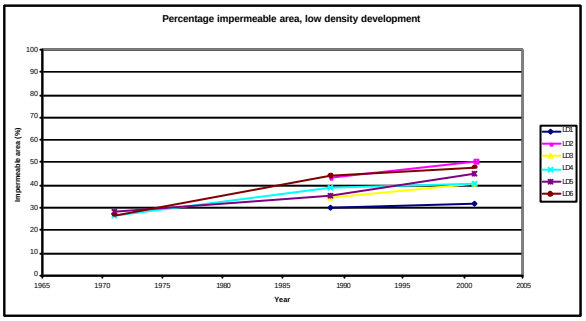
High density



Medium density



Social housing



Low density

Figure 5: Increase in impermeability within curtilages of properties 1971 – 2001 (Duckworth 20

Comment: These are far too small and impossible to read

4. Integration of key aspects of urban drainage

Three activities that form a framework to facilitate the better integration of urban drainage management have been developed. These are:

1. Delineate ownership and performance of the component parts of the urban drainage system
2. The analysis of the performance of the urban drainage system and the causes of non compliance with expected performance
3. The demonstration of the needs for and benefits of different adaptive strategies

This framework is illustrated in Figure 6, and Figures 7, 8 and 9 portray each of the activities in turn

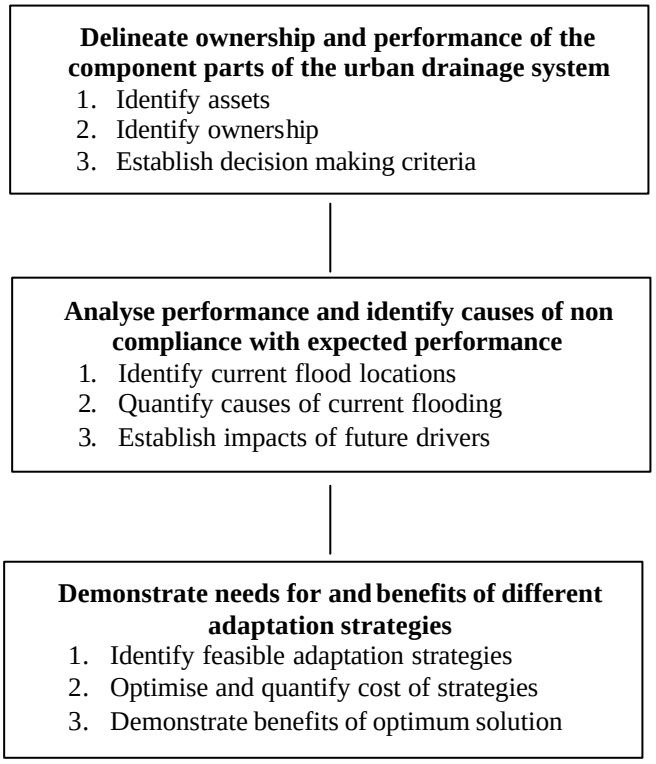


Figure 6: A framework for integrated urban drainage management

4.1. Delineate ownership and performance of the component parts of the urban drainage system

In Figure 7, the polygon bounded in red represents the Minor drainage system, comprising a combination of private and public combined and surface water sewers and new and retrofitted SuDS. The owners of these different drainage components are responsible for their performance up to a prescribed level. Currently, only the public sewerage undertakers have prescribed triggers for action; other owners will take action in an ad hoc way depending on their perception of the problem, their resources and their priorities. Aspirational performance targets for the conveyance of minor drainage systems have been defined for private sewers and drains, public sewers and for SuDS, nd are summarised in Table 2. The conveyance capacity of the drainage system is the point at which the system is full and water floods out onto the ground.

Comment: I am sure you could not mean what was there to start with

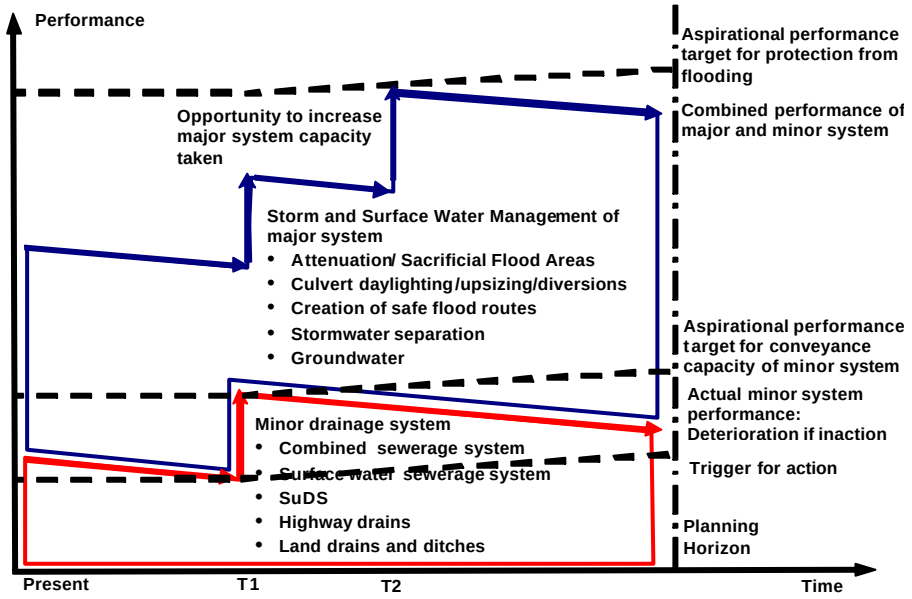


Figure 7. Performance of major and minor drainage systems, a framework for identifying ownership and responsibility: Adapted from Akornor and Page (2004)

The blue polygon in Figure 7 represents the major system. Where minor drainage systems exist, the major system is expected to provide flood protection over and above the aspirational level of performance of the minor system. The major system comprises the earth's surface and in the urban area, which includes watercourses, highways, parking areas, paths, gardens and green space. Aspirational performance targets for protection from flooding, i.e. the degree of protection for the protection of properties from flooding have also been defined and these are also summarised in Table 2.

Table 2: Aspirational levels of service for major and minor drainage systems

Flood return period (years)	Flood probability	Performance measure	Source
10	0.1	Conveyance capacity of minor drainage system in rural areas.	BS EN 752
20	0.05	Conveyance capacity of minor drainage system in residential areas (presumably at periphery of drainage system).	BS EN 752
30	0.033	Conveyance capacity of new minor drainage systems in residential areas	Sewers for Adoption 5th Edition and SuDS Framework
		Conveyance capacity of minor drainage systems in city centre/commercial areas (and presumably residential areas at core of system).	BS EN 752
50	0.02	Conveyance capacity of minor drainage system where railways and underpasses may otherwise be flooded	BS EN 752
75	0.013	General level of protection of buildings from flooding for insurance purposes	ABI statement of principles on the provision of flood insurance
100	0.01	Minimum level of protection of buildings from flooding in new developments	Interim Code of Practice for SUDS
200	0.005	Maximum level of protection of buildings from flooding in new developments	Interim Code of Practice for SUDS
		Minimum level of protection for residential properties for flooding giving "normal terms of cover"	ABI statement of intent

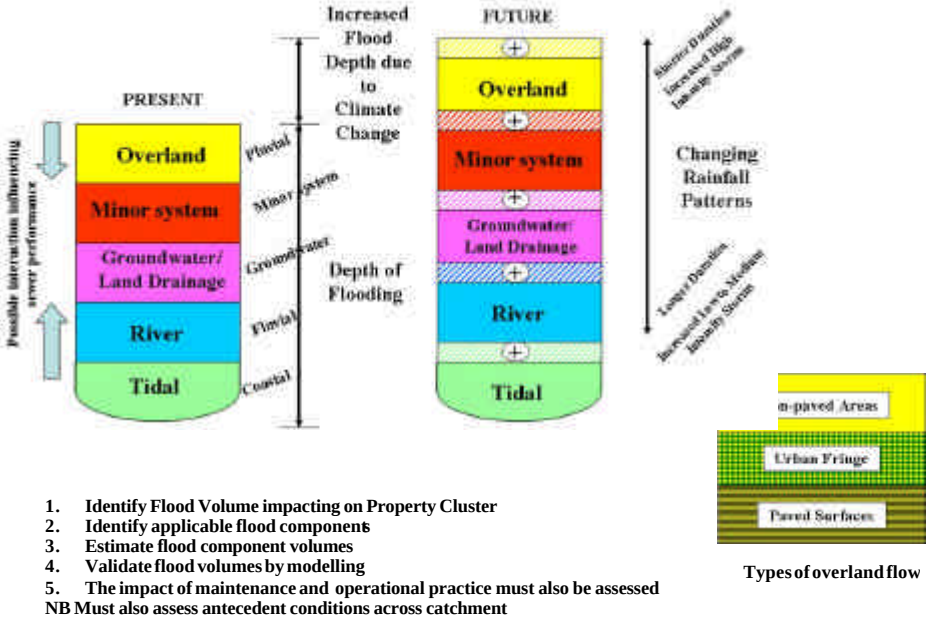
The levels of protection of buildings set by the ABI may be viewed as an economic, (business driven) standard, whereas those set in the Interim Code of Practice for SUDS will be influenced by perceptions relating to the welfare of residents. This concept reflects the people oriented nature of urban drainage culture and the relationship between water service providers, local authorities and the communities that they serve. It should be noted that Sewers for Adoption requires all flood waters in excess of the conveyance capacity of the minor drainage system to be contained within surface pathways.

The Interim code of Practice for SUDS goes beyond the protection of properties within developments. It requires the maintenance of green field runoff rates for 2 year return period (0.5 probability) events and the maintenance of green field runoff rates and volumes for 100 year return period (0.01 probability) events so as to provide off site protection for rivers. This standard points the way forward for source control for all new and redevelopments.

Figure 7 shows that the performance of the major and minor systems will be required to increase with time. This is because the aspirational levels of service take account of the pressures from climate change and urbanisation and therefore capacity will have to expand if the levels of service are to continue to be met. Climate change is accounted for in the requirements of the ABI, the Interim Code of Practice for SUDS and guidance such as PPG 25. Sewerage undertakers have researched the impact of climate change (UKWIR, 2003) and typically they assess the impact of urban development plan proposals on sewerage systems as part of their drainage area stud y processes. However, because of the high levels of uncertainty in current methodologies, these remain areas that require further development.

Comment: Need to neb emore explicit about what you mean by this

4.2. The analysis of the performance of the urban drainage system and the causes of non compliance with expected performance



1. **Identify Flood Volume impacting on Property Cluster**
2. **Identify applicable flood components**
3. **Estimate flood component volumes**
4. **Validate flood volumes by modelling**
5. **The impact of maintenance and operational practice must also be assessed**

NB Must also assess antecedent conditions across catchment

Types of overland flow

Figure 8: Flood component analysis – framework for identifying causes and attributing responsibility for problems (David Wilson)

Figure 8 depicts the different sources of urban flooding. Each of the sources may be vertically differentiated to represent asset ownership. The minor system in urban areas would currently be predominantly drains and sewers. The other components form part of the major system. The processes by which responsibilities are attributed are site specific, involving combinations of site surveys and modelling. Hence agreement on the modelling methodology to be adopted will be required for each study undertaken. The processes will change with the advent of new modelling tools, and the level of detail will depend on the balance of ownership and the scale of the problem. It is easier to quantify current problems than potential future ones as climate change, future urbanisation, demographic factors, the modelling of future flows and the routing of future floods all contribute to uncertainty. The uncertainties are easier to manage when dealing with local problems than when carrying out large scale strategic assessments. Therefore, different approaches are required for strategic studies which are used to develop general policies and guidance, than for local studies which address specific problems.

4.3. The demonstration of the needs for and benefits of different adaptive strategies

Figure 9 represents growing uncertainty associated with the drivers affecting future flood risk and the adaptive responses. The three main drivers relate to urbanisation and climate change. Urbanisation may be structured or unstructured. Structured development is that which is related to spatial development plans and includes new development and major redevelopments. Unstructured development, also termed as urban creep may be viewed as an almost random phenomenon. Property and land owners decide whether or not to develop in accordance with their aspirations and resources. Depending on circumstances, some development may be permitted under the Town & Country Planning General (Permitted Development) Order 1995, and in others it may be controlled. Notwithstanding this, the building regulations will still apply.

The adaptive responses include the management of the major and minor drainage systems, and actions that society itself may take. All three types of response may require individuals and communities to change their expectations and behaviour.

Figure 8 shows that the changes because of the drivers and responses lie within envelopes. These envelopes are site specific. For instance, development in a central urban area which is currently 100% impervious will not result in additional runoff, and so flood risk is not affected. However, changes in flood pathways and the creation receptors vulnerable to flooding will increase the risk. Alternatively, changes in pathways and receptors may reduce risk. A second example is the gradient of the line for climate change, which is dependent on the emissions scenario.

The horizontal red line in Figure 8 represents the threshold of acceptability of flood risk. The current performance of the drainage systems is represented by the horizontal axis of symmetry. In this example, the current state of urbanisation and capacity in the major and minor drainage systems are such that an increased flood risk is acceptable, but the opposite is equally possible.

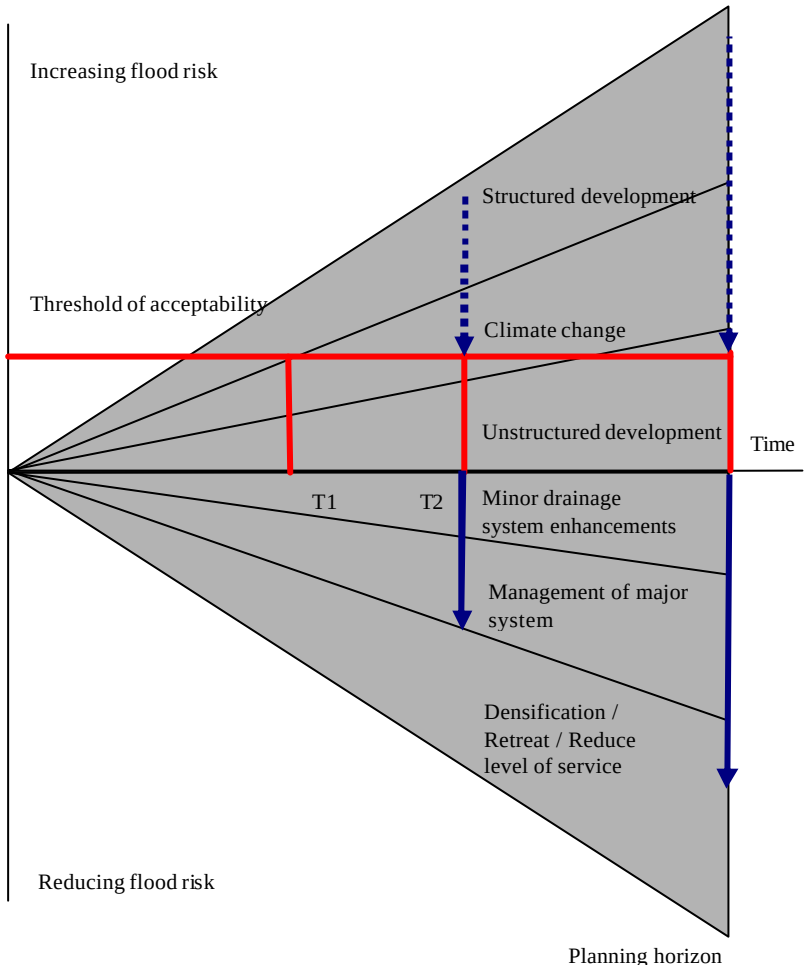


Figure 9: Strategic management of uncertainty - framework for demonstrating the need for adaptive responses (Blanksby et al, 2005)

At time T1 unstructured development, using the current drainage system and climate change, result in the flood risk rising to the threshold of acceptability. The threshold would be exceeded, if the structured development had been connected to the current drainage system. However, the use of the Interim Code of Practice for SUDS for the drainage associated with this development has held down the risk.

At time T2, the pressures of climate change and development are such that the threshold of acceptability is exceeded. This is represented by the dotted blue arrow. This can be managed by the provision of additional capacity within the minor drainage system, the management of the major system without the need for major changes in expectations of

the community, (the solid blue arrow). However, by the time that the planning horizon is reached, acceptable performance cannot be met without changes in expectations.

If the threshold of acceptability matches current performance, then any future pressure will require a response. If it is less than current performance, then it is likely that enhancements of the major and minor drainage systems are already being planned or implemented.

The need for changes in expectations of individuals and communities may be highlighted by simulating the different climate change and urbanisation scenarios and by demonstrating the limitations and determining the cost-benefits of enhancements to the minor and major drainage systems.

4.4. Discussion of framework components

The problems of finding better ways to adapt to increasing loads on urban drainage systems are not confined to the UK. In many European countries the conflicting demands of the Water Framework Directive, which appears to set major challenges for water quality, and the increasing risk of hydraulic overloading have prompted a change in design standards and approaches to sewer design, to one in which risk-cost-benefit is at the core (Hauger et al, 2005). The delivery of these approaches rests mainly with public bodies in most of Europe, uniquely in England is the provider in the private sector and hence there are divisions between who is responsible for the various components of the urban drainage system.

Figure 7 encapsulates the need for management of the boundaries between the different organisations involved in integrated urban drainage management in England. The communities who pay for and who are served by the different organisations are not concerned about the boundaries, or that one part of the system is over or under performing at any one time. It is the total package of sensible routing of foul drainage and surface water with minimum inconvenience that matters. Consequently, local authorities, sewerage undertakers and the Environment Agency should be able to take appropriate measures to provide the most cost effective service meeting the agreed needs of the communities they serve.

Comment: Drainage surely?

Comment: This ignores the role of others such as highway authorities

It is not necessarily the case that the organisations whose assets are deficient are in a position to provide the most cost effective solution to the problem. The studies currently being carried out in Bradford and Greater Glasgow, and in the European partner communities of the Interreg IIIb projects TRUST, Urban water, Urban Water Cycle and NORIS are demonstrating that disconnection and source control are often the most effective way of solving urban flooding, irrespective of the causes, and that they will potentially be the best way of managing future flood risk pressures. There is an added bonus that this may also fulfill water quality needs (WFD) as well as flooding and emphasises the need for an integrated approach to be taken. Unfortunately current institutional segregation militates against this.

Having established that it is the best solution that is required, it is still necessary to identify the organisation that is responsible for funding the solution. Figure 8 provides the mechanism for this. However, the figure does not deal with issues such as the ongoing operation and maintenance of disconnection and source control measures such as SUDS or the routing of emissions from these measures in urban areas where local watercourses are unavailable.

If the barriers to the integration of the activities of local authorities and sewerage undertakers are overcome, there is still a requirement to demonstrate the need for more local solutions to flooding problems to the wider audience, and this is where the activities illustrated in Figure 9 come in to play. Irrespective of the motives behind the actions of individuals and organisations, the best way to identify and gain support for a particular course of action is to demonstrate its overwhelming benefits over others. This is especially the case where strategic options affect the expectations and future behaviour of stakeholders, and was done as part of the Foresight Future Flooding project (OST 2004), The analysis carried out in Foresight Future Flooding is now required to be translated in more detail to the local level. Quantitative analysis of the potential adaptation strategies at Bradford and Glasgow are considering the benefits of conveyance, storage, control, source control and disconnection options. Where source control and disconnection are demonstrably the most cost effective options, then it makes sense to encourage local stakeholders to adopt them. This means that barriers must be removed and incentives provided, especially where stakeholders do not suffer from flooding themselves. The benefits and problems associated with each of potential adaptation strategies identified are discussed briefly below:

Comment: EA??

Comment: In all of thjs you have largely overlooked the role of the riparian landowner and the fact that we have a huge number of home owners who are completely unwilling to take responsibility for their own properties.

Conveyance

If in-sewer conveyance solutions are used to relieve these pressures, then additional flows will be delivered to CSOs and there will be a resulting increase of emissions. If emissions are to be maintained at current levels then additional storage will have to be built into the system.

Storage

If storage solutions are to be used to relieve increasing flood risk pressures, then additional flows will be passed downstream to treatment when the storage is emptied. The storage may be designed to operate during many events and in this case there will be an environmental benefit of reduced CSO emissions, but this will increase the volume treated. Alternatively, the storage may be designed to operate only during extreme events, in which case, although there will be minimal impact on treatment there will be little environmental benefit at CSOs and there will still be a need to manage the emptying of the tanks after extreme events and the impact of this on the treatment process (Ashley et al, 2001).

Sewer system control (Including real time control)

Comment: Do you mean RTC? If so, say so

During extreme rainfall the system will generally be operating at capacity, unless the system is sufficiently large to have significant spatial variation in rainfall. Unless the latter is a frequent occurrence, sewer system control has little benefit in flood

management, but may be used during lesser, more frequent events to maximize storage and reduce CSO emissions. This will increase the volume to be treated, but, has a potential for reducing the impacts of urbanization and climate change on the quality of receiving waters.

Disconnection

Source control involving disconnection will reduce flood and CSO emissions without adverse impact on the sewage treatment process, but currently risks subsequent reconnection under the 'right to connect'.

Source control

Source control without disconnection will reduce flood and CSO emissions, but the draining of the storage will increase volumes treated

5. Conclusion

The work reported here has highlighted the need for an integrated and cross-institutional approach to the more effective management of urban drainage, if this is to keep pace with future changes in climate change and expectations. There is a further need to focus and carry out work that is appropriate at a local level and does not follow a 'one-size-fits-all' perspective. A framework in which appropriate analytical tools can be used has been developed and applied in Keighley and Glasgow. The project teams working on AUDACIOUS, FRMRC, and the Bradford and Greater Glasgow Interreg projects have new approaches that will inform the development of the Making space for water pilot projects. These include the loose framework identified in this paper and an appropriate range of tools being developed for use in specific projects. Barriers to the successful implementation of integrated urban drainage management have been identified and it is apparent that action by government will be required to overcome some of these. With the advent of the integrated urban drainage management scoping review, it is now time for the wider urban drainage and spatial planning communities to start to consider and debate the issues and to think about how they need to be organised better to address the challenges ahead.

Comment: Where is your storm and surface water management plan stuff?

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