Urban Drainage in Ireland – Embracing Sustainable Systems

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Abstract

The current approach to stormwater management in Ireland requires that outflows from new developments are restricted to greenfield values that would have occurred prior to development. This typically involved the use of holding tanks constructed within developments to attenuate stormwater from where it was released at a reduced rate via a control structure to a nearby drainage network or watercourse. Improved drainage policies now require that sustainable drainage systems (SuDS) are used to meet this objective. This study presents an evaluation of perceived issues that may impede the adoption of new policies. The findings are based on surveys and focus groups of practitioners involved with the planning and design of drainage systems. Although the study indicates that benefits of SuDS are reasonably well understood, their use, for many reasons, has remained less popular. Concerns with ongoing maintenance and long-term responsibility of SuDS remain impediments to the embracing of these systems in drainage strategies.

Keywords: SuDS, drainage, environment, urban development, sustainability, flood defence/ management, storm, river basin management.

Introduction

The issue of sustainable drainage is high on the global agenda but issues with implementation remain. While considerable advances in the technologies, awareness, guidance and performance of sustainable drainage systems (SuDS) have been made in recent years, their role within the Irish planning sphere has only recently become established. Prior to this, traditional systems that focused on the rapid collection and conveyance of runoff, combined in some cases with short-term storage were the norm. SuDS utilise natural resources in a way that replicates natural rainfall-runoff processes at any site, thereby minimising anthropogenic environmental impacts. Both hard and soft measures can be used to mimic these natural processes. Hard SuDS measures are ‘below ground’ and resemble more closely traditional drainage techniques but incorporate SuDS principles (examples include permeable pavements or proprietary SuDS features such as filtration systems). Soft SuDS measures such as swales, ponds and wetlands are ‘above ground’ and typically offer greater benefits in terms of water quality and biodiversity than hard options.

Since the publication of the Greater Dublin Strategic Drainage Study (Dublin Drainage Consultancy 2005), the use of SuDS has become mandatory in all new developments in Ireland. At this time, the Irish Office of Public Works initiated the Flood Studies Update (FSU) programme. The FSU included as one of its components a review of urban flooding issues with a view to providing direction on the future needs of the engineering community for improving methodologies for urban catchment flood analysis and stormwater management in Ireland.

The first part of the study assessed the practitioner’s perceptions of methods and associated guidance material used in Ireland for flood estimation in urbanising catchments (O'Sullivan *et al* 2010). The objective of the second part of the study, presented in this paper, identifies perceived issues with runoff control in Ireland. The main aims were to:

- Assess the use of SuDS for stormwater control in Ireland;
- Determine the factors affecting the selection of SuDS measures;
- Identify the deterrents to the implementation of SuDS;
- Identify the perceived technical adequacy of guidance material commonly used for SuDS design and implementation.

Background

In the context of stormwater management, urbanisation alters the land surface. Increased areas of impervious surfaces coupled with more compacted soils result in a significant loss of permeability (De Kimpe and Morel 2000). This alters the natural hydrology of catchments and results in river regimes with greater high flows and lower low flows. Higher flows and flood risk result from a greater proportion of incident rainfall on urban catchments appearing as direct runoff and this, combined with the sewers, gulleys and culverting of natural streams that accompany development, causes a more rapid conveyance of stormwater through the drainage network (Sheeder *et al* 2002). Increases in runoff volumes being conveyed in artificial drainage networks reduce infiltration through the soil column and diminish the capacity of recharge aquifers to provide baseflows (Gardiner 1994). Stormwater management traditionally focused on collection and conveyance of runoff to an outfall as quickly as possible, posing significant threats to receiving watercourses in terms of increased pollution and siltation loads (Kirby 2005). This changed when the threats to the degradation of watercourses from impervious areas were realised and according to Niemczynowicz (1999), the 1970's witnessed a shift to storage approaches where detention and retention were utilised. This approach, as implemented in heavily urbanised areas around Ireland, typically involved detention measures to attenuate runoff and restrict outflows to the greenfield values that would have occurred prior to development (Doyle *et al* 2003). These practices tended to focus primarily on attenuating runoff to greenfield values. Collected stormwater therefore by-passed the natural treatment processes that occur from percolation through the soil column and consequently, runoff reaching the receiving watercourses was often contaminated by pollutants such as oils, detergents, trace metals, pecticides and herbicides. Such approaches were recognised as being unsustainable and the main goals of stormwater management were progressively broadened from the 1980s to include natural water quality treatments together with the protection of water cycles and ecosystems of watercourses (Niemczynowicz 1999). These principles are now engrained in SuDS guidance documents that require consideration of a wider range of design requirements that include volume and frequency of runoff and pollution treatment (for example Woods-Ballard *et al*, 2007). Integrated approaches to stormwater management are also being advocated for the sustainable management of urban water environments (Rauch *et al* 2005). These approaches are based on the promotion of reuse and recycling of stormwater and while similar, are referred to differently in various countries. Integrated Urban Stormwater Management (IUSM) for example, is a concept that has attracted attention in Australia, New Zealand and the US where separate storm and waste water systems are the norm (Brown 2005). Water Sensitive Urban Design (WSUD) is another stormwater management approach that has been implemented in some locations in Australia (Coombes *et al* 1999). Approaches of this type that incorporate source (or site) controls in the context of a holistic approach to stormwater management can reduce flood risks and improve the ecological integrity of watercourses through improved levels of pollutant and silt removal (Krebs and Larsen 1997; Niemczynowicz 1999; Butler and Parkinson 1997).

Although a review of sustainable drainage measures undertaken by Pratt (2001) identifies their benefits when implemented correctly, various issues need to be addressed for their widespread adoption. In terms of integrated approaches to stormwater management, issues with institutional frameworks and intergovernmental relations are identified as potential barriers (Brown 2005; Niemczyonicz 1999). Regulatory instruments in terms of planning legislation can also pose problems (Lloyd *et al* 2001). White and Howe (2005) identify impediments to SuDS implementation at various stages of the development control process. Although regular maintenance is key to the long-term performance of some SuDS installations (Schlüter and Jefferies 2005), questions of their longevity together with uncertainties in who takes responsibility for their management and maintenance are also perceived obstacles (Kirby 2005; McKissock *et al* 1999). Although considerable guidance on technical aspects, implementation and maintenance requirements of SuDS is readily available, a lack of awareness of this information and a failing to fully understand its content are also impediments. According to Niemczynowicz (1999), challenges in urban water management are significant and should be addressed through long-term strategies. Not only are improvements in applied technologies required but the need to implement these through better communications and capacity building between the key actors in governmental organisations is also important. Effectiveness can also be improved by strengthening of the legislative framework in which SuDS are implemented together with continuing to educate both practitioners and society at large of SuDS benefits.

In the context of SuDS being mandatory, this paper presents some of the perceived issues that are at the forefront of ongoing debate on sustainable development in Ireland.

Methodology

Quantitative and Qualitative research methods were used to provide the necessary information for this evaluation. The quantitative element comprised the circulation of a self-completion postal questionnaire that addressed all aspects of urban catchment flood analysis in Ireland. Questionnaires were circulated to target sectors in all 26 counties of the Irish Republic covering a range of organisations, agencies and institutions involved with planning and design issues relating to urban drainage and urban flooding (Table 1).

A total of 291 questionnaires were circulated and from this 83 completed questionnaires were returned. Seventeen incomplete questionnaires were also returned. Of the 83 respondents who completed questionnaires, 75 had experience in drainage design and of these, 61 claimed to have worked in designing and implementing SuDS.

The qualitative work in this study comprised focus groups in Dublin (two groups), Cork and Galway and this geographic spread ensured that issues across Ireland were represented. Focus group participants were recruited from questionnaire respondents. The optimum number of participants at each focus group was identified from best practice as being between 6 and 8. To encourage attendance, focus groups were arranged during lunch in centrally located hotels and refreshments were provided. However, late cancellations and the need to reschedule the attendance of some participants to other focus groups, resulted in the numbers summarised in Table 2. A focus group topic guide was developed through consultation with the Technical Steering Group of the FSU and to ensure independent and unbiased reporting, external consultants were appointed to moderate the groups.

Results

Approaches to Stormwater Management

Respondents to the questionnaire were asked to identify their most commonly used method for attenuating stormwater and restricting outflows to pre-development runoff values. This was an open ended question to which the replies from the full sample of 75 valid responses are shown in Figure 1.

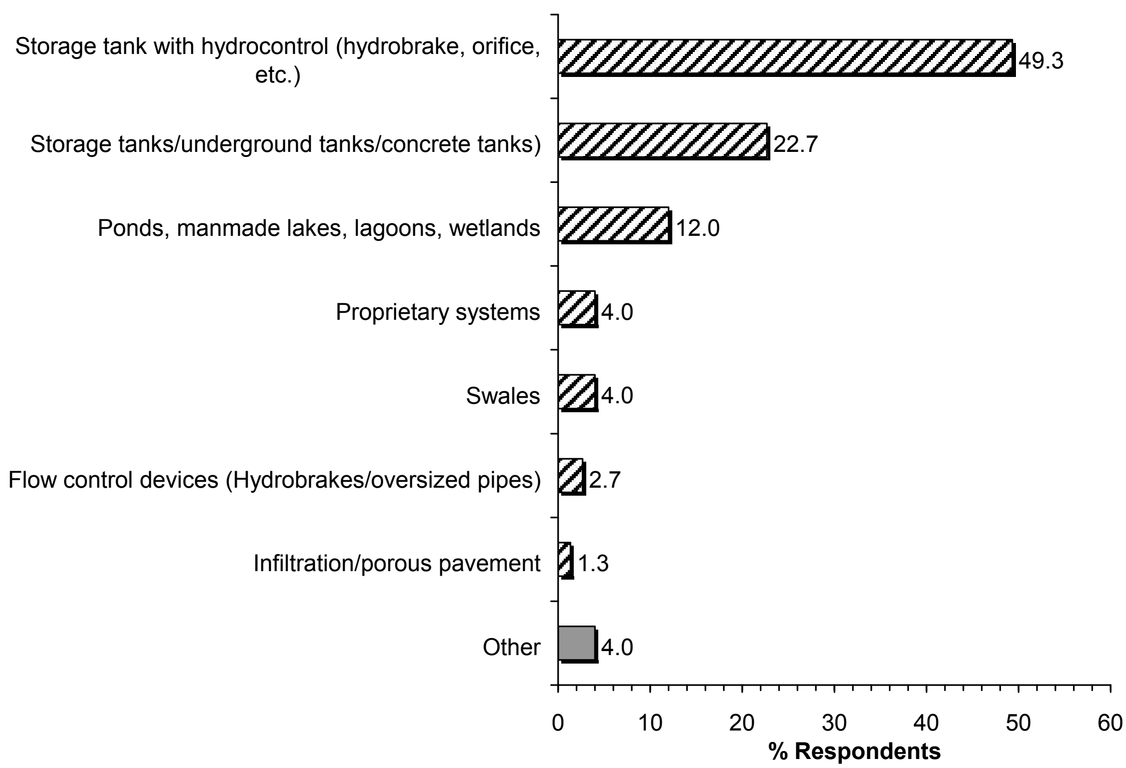

Figure 1

As indicated by 72% of respondents, the use of structural attenuation/ storage tanks for managing runoff has been common. In most cases, tanks are used in combination with flow restriction devices such as hydro-brakes or flow control orifice plates. Respondents also mentioned using proprietary systems for runoff attenuation. Measures such as swales, detention and retention ponds and wetlands that utilise the natural treatment processes of a site were less commonly used. Results suggest that in the absence of policies that demand sustainable drainage practices, approaches to stormwater management that focus primarily on runoff volume would be likely to continue. Following the publication of the GSDSD in 2005, the use of SuDS in new developments is mandatory, except in situations where their inclusion is impractical due to site circumstances. It should be noted however, that there are very few sites where SuDS are impractical and at more limited sites, the design constraints will dictate the system that is most appropriate. The recognition that this is now encapsulated in regional policies issued by Local Authorities throughout Ireland is reflected in the following comment that was made at a focus group:

> *"..... even the wording* (in policy documents) *has changed. It has gone from 'you must consider SuDS as an option' to 'you must have SuDS as an option,' and if you don't, you must explain why not"*

This part of the questionnaire also required respondents to state whether they had been directly involved with a development that required the implementation of SuDS. Although not reflected in Figure 1 where results indicate that attenuation structures have been extensively used to control runoff, 61 respondents claimed to have experience of SuDS installations and this subset represented the sample analysed for remaining questions.

Sustainable stormwater management utilises natural resources in a way that replicates natural rainfall-runoff processes at any site and minimises anthropogenic environmental impacts. Optimising techniques for collection and treatment of stormwater in the context of specific site characteristics are at the core of the concept. However, the individual measures identified in Figure 1 do not in themselves constitute SuDS. SuDS require a series of techniques incorporating source, site and regional controls in the context of a management train of methods. Source control devices (water butts or roof collectors for example) detain or infiltrate runoff close to the point of origin to reduce stress on downstream facilities. Site control comprises runoff and treatment systems for individual developments or groups of developments and may include elements such as detention basins, swales and filter strips. A management train incorporating a number of methods will have the capacity to provide water quality improvements in addition to runoff control. Regional control measures are often end-of-pipe facilities that control runoff at catchment scale (not less than 2 hectares) and in some instances have the potential to provide biological treatment to reduce pollutants from contaminated runoff. The management train approach involves assessing the characteristics and land uses of sub-divided drainage elements within a development such that an optimised drainage strategy can be developed for each of the individual sub-catchments. The approach offers the potential for treatment processes to be utilised at a sub-catchment level so that the pollutant load of runoff can be successively reduced as it passes through the management train. Correctly designed systems will therefore include a number of methods implemented in series that controls the stormwater volume and also improves water quality. Understanding the overall techniques of source, site and regional control is therefore integral to the management train approach of sustainable drainage and this was assessed in the survey. Results are shown in Figure 2.

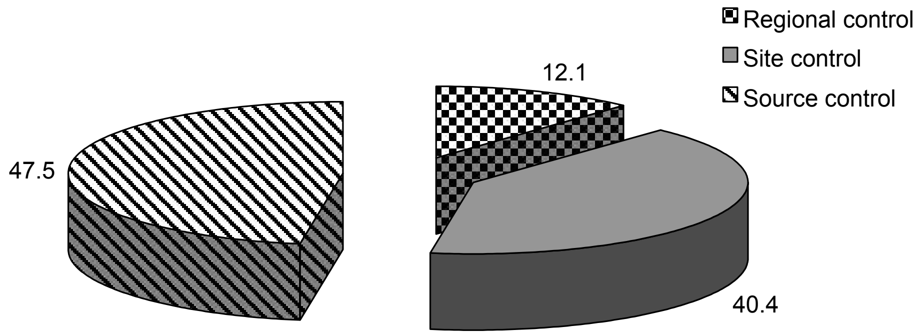

Figure 2

Figure 2 indicates that an understanding of the concepts of source, site and regional control was not widespread among respondents with only 47.5% and 40.4% of respondents understanding source and site control respectively. Regional control was less well understood with only 12.1% of respondents being aware of the concept. The data suggests that respondents' experience is associated with the design and installation of individual SuDS measures for a single or group of adjacent developments rather than considering drainage strategies in the context of the management train approach.

The individual measures for implementing SuDS most commonly used by respondents are summarised in Figure 3.

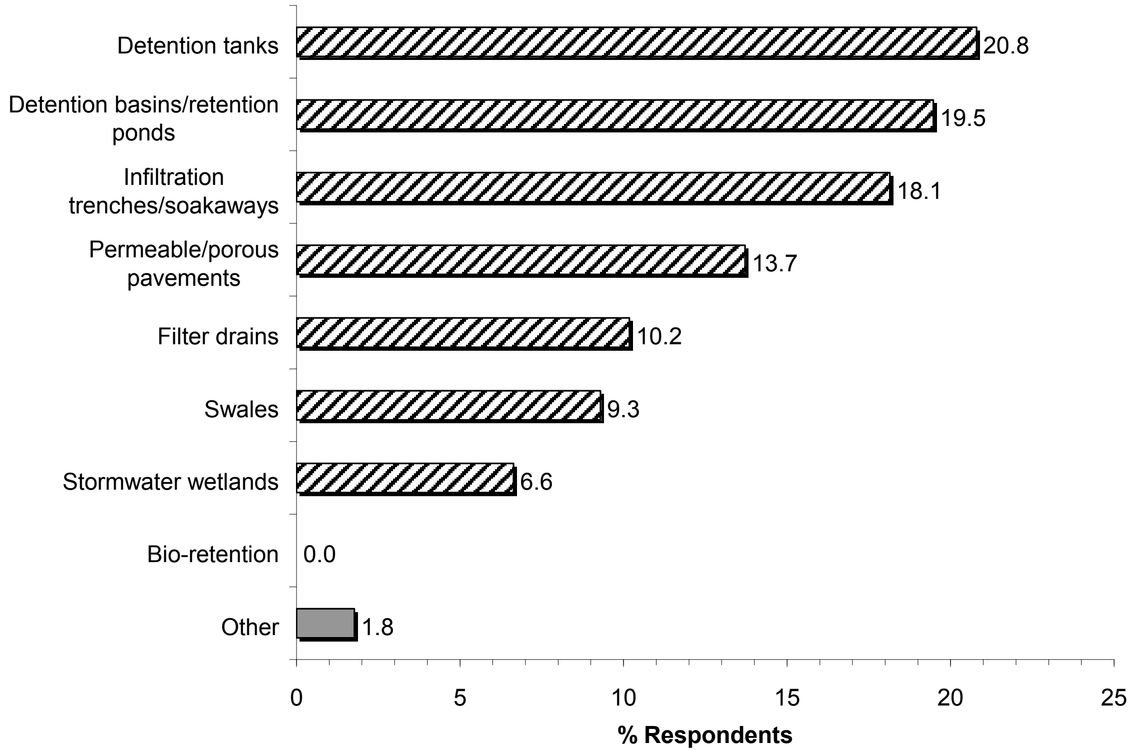

Figure 3

Detention (short-term storage) and retention (indefinite storage) of stormwater is well represented in Figure 3 with the use of detention tanks and detention basins/retention tanks accounting for almost 21% and 20% of citations respectively. Infiltration of excess stormwater through trenches, drains and soakaways is also well represented. The lower usage of swales and wetlands is most likely reflected in the perception that these measures are associated with excessive land-takes. This is a common misconception however, and if integrated sympathetically and appropriately into a given landscape, land-takes do not need to be high (Dickie *et al*, 2010). Furthermore, intelligent design of these components in the context of the overall development, where for example, extreme storm events can be stored temporarily on the surface of open spaces, reduces the need for swales and wetlands to be overly large.

Other methods mentioned by respondents include underground proprietary systems, oversized pipes and roof gardens. Bio-retention measures that utilise soils and plants to remove pollutants from water runoff did not feature in any of the questionnaire responses, suggesting that respondents are either not familiar with this method of stormwater management or have reasons why bio-retention measures should not be implemented. It may also indicate the perceived divide that exists regarding the quantity and quality aspects of stormwater control.

Factors Affecting the Selection of SuDS Measures

Respondents were asked to rank, from a given list, the importance of factors affecting the selection and design of SuDS on a scale of 1 to 5 (*where 1 is not at all important and 5 is very important*). Results are summarised in Table 3.

Table 3 indicates that in excess of 50% of respondents consider all the factors listed in the questionnaire to be important with maintenance costs and safety considerations being accorded the highest priority. However, the use of SuDS in providing areas of recreational amenity creating wildlife habitats were considered to be less important by respondents, suggesting that the ecological and environmental benefits of SuDS are not given high priority in the decision making processes that develop drainage strategies.

Deterrents to the implementation of SuDS

From a given list of possible deterrents, respondents identified the factors that they perceived limit the use of SuDS. These are summarised in Figure 4.

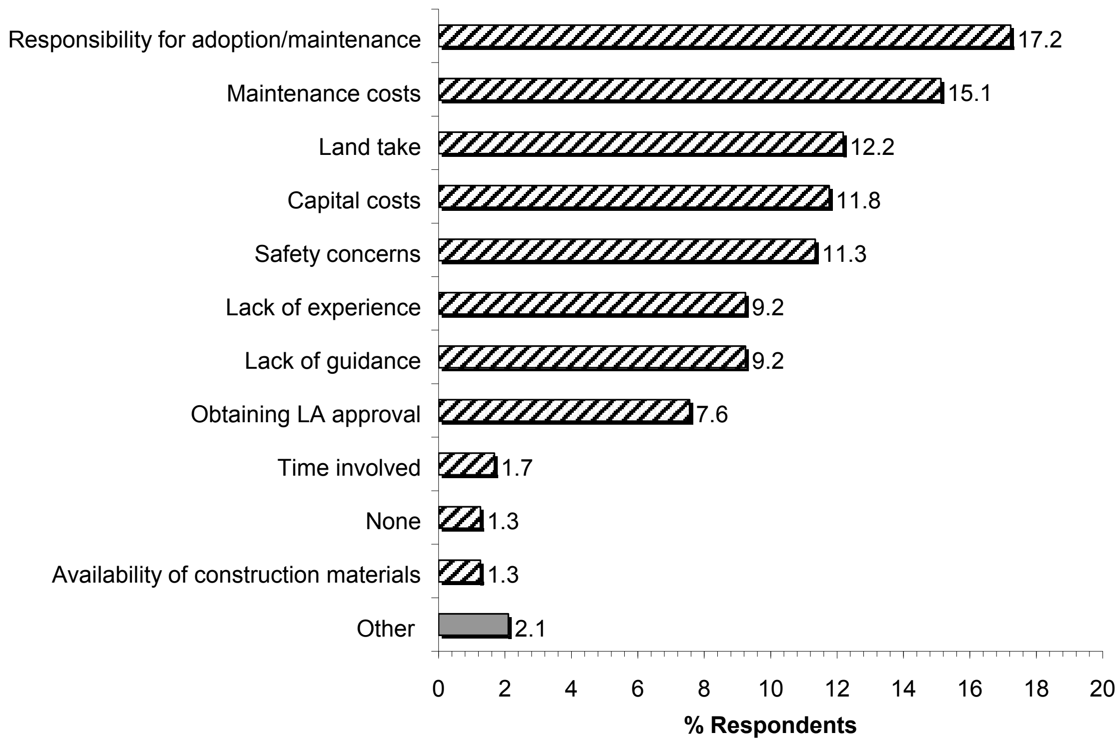

Figure 4

The findings in Figure 4 are broadly in line with SuDS deterrents reported elsewhere (e.g. McKissock *et al* 2003; Kirby 2004). Results indicate that perceived issues relate to ongoing performance together with concerns of who ultimately takes responsibility for long-term maintenance and management of the system after implementation. Although such issues can be addressed by overcoming legislative and institutional barriers in an integrated regulatory framework for urban drainage that involves all the relevant stakeholders in a long-term strategic approach (CIRIA, 2003), the concerns permeated the focus group discussions.

Realisation that the longevity and performance of SuDS is heavily dependent on their correct design and construction and that this is integral in minimising maintenance was represented in the following focus group comment:

> *"Local authorities don't want to be landed with more responsibility for maintenance. Some SuDS schemes may have to be undone if unsatisfactorily installed. The* (Local) *Authority has to be compensated if they take over* (take charge of) *SuDS"*

Comments of this type however, suggest that traditional drainage infrastructure does not require maintenance. This is obviously not the case and poor upkeep of normal systems is a contributory factor in many pluvial floods. Furthermore, any drainage system if constructed incorrectly will not function as designed and in these cases, whether it's a SuDS installation or not, the Local Authority will be saddled with any associated liabilities.

Perceived costs associated with SuDS were also considered to be deterrents. About 24% of respondents identified land costs and capital costs of the SuDS as being significant. This was reinforced at a focus group where it was noted that *"It becomes more economically advantageous to fill* (with stormwater) *a concrete box under the development* (than use extra land for SuDS)*"*.

The frequent reference to maintenance costs as a deterrent to SuDS implementation from many survey respondents highlights a lack of awareness regarding this issue and their inclusion in Figure 4 is somewhat unwarranted. A cost analysis of SuDS included in the Cambridge City Council, Sustainable Drainage Design and Adoption Guide (Wilson *et al*, 2009) indicates that if incorporated into a general maintenance strategy, the additional maintenance and associated costs of SuDS are not excessive and need not differ significantly from those for a general landscape.

Perceived issues with excessive land takes for SuDS also feature highly in Figure 4. Traditional drainage systems are typically buried underground and require only a minimal land take. While it is accepted that SuDS can necessitate a more significant land take, this is not always the case and the actual land required depends on the choice of method in the management train. Soft SuDS measures have larger land takes but offer more attenuation benefits and water quality improvements. Conversely, hard SuDS options have smaller footprints but don't provide the same water quality enhancement or biodiversity benefits as soft solutions. It should also be noted that while land issues impose considerable constraints on SuDS retrofitting, land take is a much lesser issue if SuDS are integrated into a development (Dickie *et al*, 2010)

A lack of experience or familiarity with the concept and benefits of SuDS, particularly amongst developers, was cited by over 9% of respondents as being a deterrent. This is reflected in the following focus group comment:

> *"To most developers, this whole notion of SuDS is a very recent phenomenon…many are not familiar with it. I have to spend a lot of time over the phone explaining the basic concepts of a SuDS design with them"*

Furthermore, many developers *are unwilling to spend money on integrating them* (into development schemes). However, it was also noted that knowledge of SuDS in engineering consultancies and architectural practices can also be poor:

> *"Lack of familiarity is a problem. Neither architects not engineers are familiar with it"*

While the quantitative and qualitative elements of this research focused mainly on the reasons why SuDS installations were not popular amongst developers, the benefits of some SuDS features in other countries were recognised when it was noted that:

> *"They can certainly sell* (development) *space in the US and Scandinavia where there's an area of water to look out on"*

A small number of respondents also identified the presence of impermeable boulder clay as an impediment to implementing SuDS in the Greater Dublin area. This reflects a poor understanding of the range of SuDS techniques amongst these respondents and suggests that SuDS are viewed in a narrow context limited only to infiltration measures. While it is accepted that the presence of boulder clay is a constraint that will preclude SuDS that require infiltration, other measures such as swales and rills may be appropriate. Contractual obligations for signing-off fully functional SuDS installations were also identified as a potential deterrent.

Guidance materials for SuDS design

The absence of formal guidance was cited by over 9% of respondents in Figure 4 as being an impediment to implementing SuDS. In a further question, respondents were asked to rate the quality and availability of guidance documentation for SuDS design and whether more guidance would assist in choosing SuDS for stormwater management. Results are shown in Figure 5.

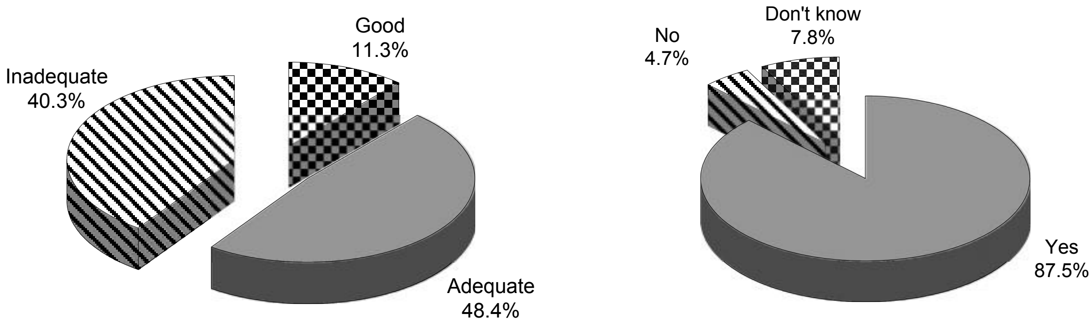

Figure 5

Of the 61 respondents, approximately 60% were satisfied with SuDS guidance and reasons for dissatisfaction were generally associated with perceived error sources in determining flow and volume calculations from developed catchments rather than design issues with SuDS installations. These issues were represented in the following focus group comments:

> *"Some guidance on the greenfield runoff is also necessary. What is the increase likely to be if there is development?"*
>
> *"I'd like more guidance on the urban fraction and the best size to use for a particular catchment"*
>
> *"The problem is the size of the catchments as some of these catchments are very small. There is no guidance in Ireland on how to treat different size catchments"*

Respondents also identified sources of guidance that they have accessed in designing SuDS installations. The question included a list of well established SuDS guidance material and included a provision where respondents could include more specific details of guidance documentation used. The sources mentioned are summarised in Figure 6.

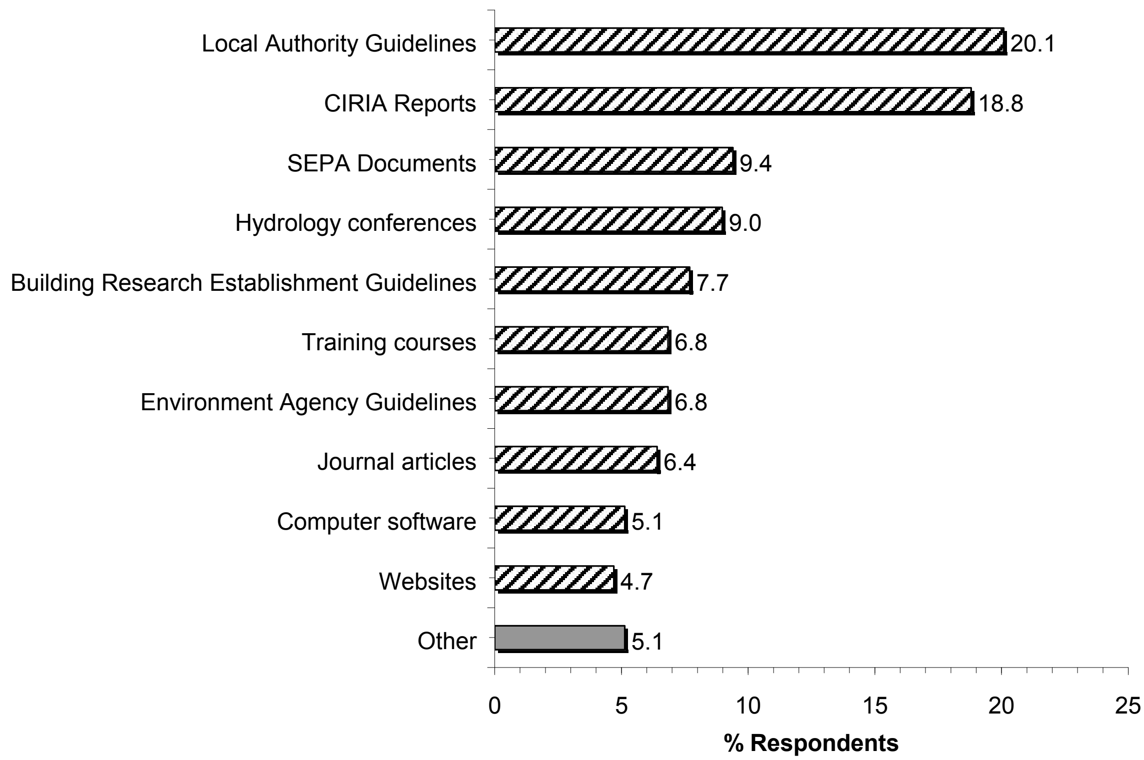

Figure 6

Figure 6 indicates that Local Authority guidelines and CIRIA (Construction Industry Research and Information Association) reports are the most commonly sourced documents for SuDS guidance in Ireland with approximately 20% and 19% of respondents having accessed these in the past. Local Authority guidelines generally referred to Volumes 2 and 3 of the GDSDS and the Dublin City Council – Stormwater Management Policy for Developers (Dublin City Council 1998). The CIRIA reports cited were R123, R142, C521, C523, C582, C609, R180, R156 and R142. SuDS Guidance in Scotland, published by the Scottish Environmental Protection Agency (SEPA), was used by in excess of 9% of respondents. The Building Research Establishment (BRE) Digest 365 was recognised as a useful source by almost 8% of respondents. Training courses offered by Engineers Ireland, the Institution of Civil Engineers (ICE) and the Institute of Hydrology (IoH), national conferences/ seminars, academic journals together with commercially available computer software packages and websites/ documentation from providers of proprietary systems also feature in Figure 6. Other citations made reference to reports produced by HR Wallingford Ltd, Pollution Prevention Guidelines (PPGs) produced by the UK Environment Agency, SEPA and the Environment and Heritage Service in Northern Ireland, the Highways Agency (HA) Report 103/01 (now superseded by (103/06) that provides guidance for the design of vegetative treatment systems for highway runoff and United States EPA fact sheets online.

Respondents were also requested to state how they became aware of the SuDS guidance available. Responses to this question are summarised in Figure 7.

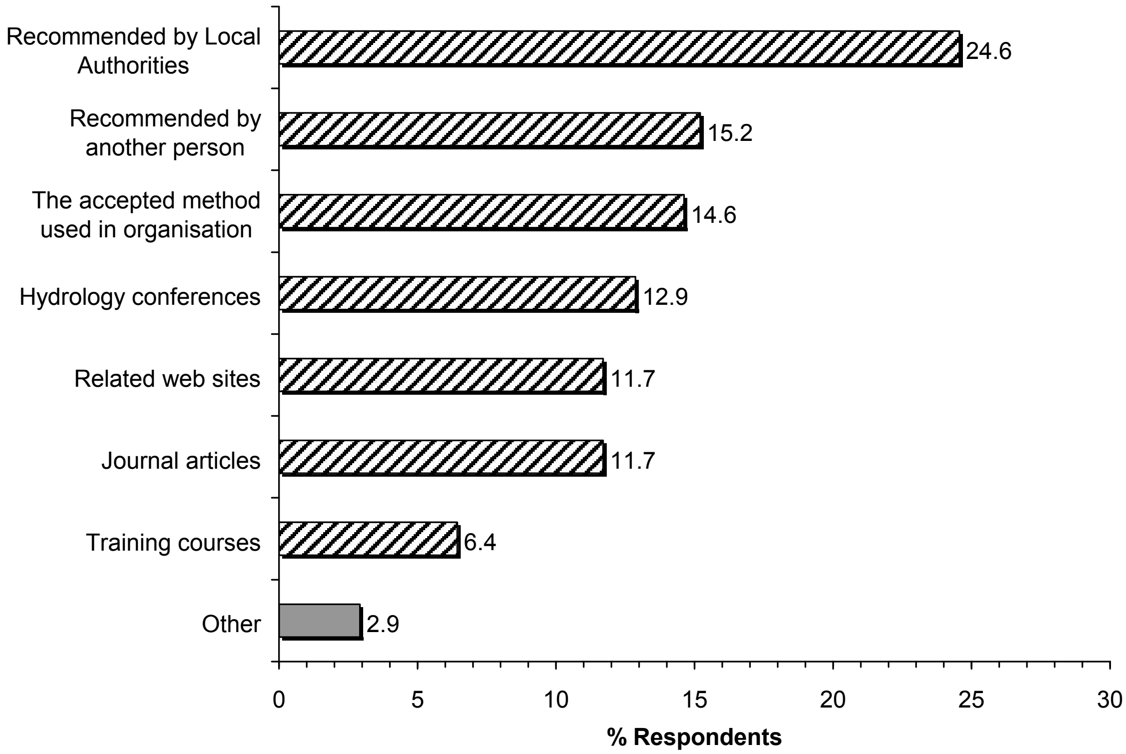

Figure 7

Discussion

Recent changes to stormwater management policies in urban and urbanising areas in Ireland have made the use of SuDS mandatory for countering adverse effects of urban growth. This study however, identifies potential impediments to a more widespread and effective adoption of SuDS. At a basic level, 61 respondents (almost ¾ of those who returned questionnaires) to the survey claimed to have experience implementing SuDS and Figure 3 shows the measures commonly used. In the context of SuDS however, these results appear inconsistent with Figure 2 where the concept of source and site control measures were understood by less than half the sample and regional control measures were understood by significantly less. The data suggests that while respondents may have experience with individual components that contribute to SuDS, evidence of understanding the concept of an integrated system that encompasses a progression from local source controls to larger downstream site and regional controls is less clear. Given that this management train is at the core of SuDS, the results highlight a knowledge deficit amongst some practitioners.

The research focussed heavily on identifying deterrents to the implementation of SuDS. The most commonly stated impediments relate to maintenance, land take and long-term responsibility of the systems, and while consistent with those identified in similar studies

(McKissock *et al* 2003; Kirby 2004), result largely from misconceptions and poor understanding of SuDS. Figure 4 shows that a major concern amongst survey respondents relates to where the long-term responsibility for the system rests. This is not surprising given that Irish drainage law was drawn up before the existence and use of SuDS. While the ownership and maintenance of conventional drainage systems is clearly understood, the responsibility for provision, operation and maintenance of SuDS is less well established. Taking in charge procedures in Ireland will require an ongoing process to overcome the conservative attitudes of some Local Authorities regarding SuDS combined with unfamiliarity with their installation and performance (Dublin Drainage Consultancy, 2005).

The inclusion of land take and maintenance issues in Figure 4 is symptomatic of common misconceptions regarding SuDS and is at odds with scientific literature that indicates that land take and maintenance costs need not be significantly greater than that for conventional drainage systems (Interpave, 2006;Wilson *et al*, 2009; Dickie *et al*, 2010). Furthermore, while maintenance costs were identified as deterrents to the implementation of SuDS, the role of source controls in reducing maintenance costs of other measures later in the management train was not identified by any survey respondent or focus group participant.

This lack of understanding of SuDS is more surprising given the satisfaction levels amongst participants with the quality and availability of guidance material for the design and implementation of SuDS (Figure 5). Results indicate that knowledge is being drawn from a very diverse set of sources (Figure 6) and therefore, scope exists for raising awareness and improving understanding of SuDS amongst the engineering profession by making available a national guidance document for Irish conditions. The engineering community also has a professional responsibility to maintain and develop knowledge on SuDS implementation and Continuing Professional Development (CPD) provides a vehicle through which the knowledge base can be expanded.

Given that Figure 3 indicates that drainage measures in the past focussed primarily on runoff volume rather than quality, the changes in drainage policy that have made SuDS mandatory in development plans are welcome supports for embracing sustainability principles in drainage practices. In this context, a more holistic and integrated approach that involves, planners, engineers and water resource managers should be promoted. In Ireland, the responsibility for many planning issues lies with geographically organised Local Authorities. Administrative borders are not observed by water and full evaluation of the physical effects of different stormwater management options should ideally be assessed at river basin or catchment scales. Implementation of the EU Floods Directive will assist in this regard.

This study indicates that incorporating sustainability principles in stormwater management will require efforts at a number of levels. None of the challenges are insurmountable but will require support to implement applied technologies and policies and to increase education provision of integrated water management strategies. The overall objectives are not just short-term and embedding in current practice the principles that will direct future actions is a key element in improving sustainability criteria.

Conclusions

The main findings arising from the questionnaire responses and focus groups that formed the basis of this study were as follows:

(1) Until recently, stormwater management in Ireland was focused on volume control with less consideration being given to quality aspects of water prior to its discharge to nearby drainage networks or receiving watercourses. Changes to stormwater management policies have made the use of SuDS mandatory and water quality is now at the forefront of management strategies.

(2) A perceived barrier to the use of SuDS is their maintenance and ownership. All SuDS systems require maintenance in order to operate effectively and who is going to own and maintain the system is a major challenge with the implementation of any SuDS scheme. These issues were identified as being important by participants top the study in the context of procedures used by Local Authorities for taking-in-charge of SuDS.

It should be noted however, that while maintenance costs featured prominently as a deterrent to the implementation of SuDs, these costs need not be significantly more than costs associated with maintaining traditional drainage systems.

(3) Guidance for design and implementation of SuDS in Ireland is currently drawn from a range of diverse sources. A holistic and integrated approach to stormwater management would therefore benefit from national guidance (preferably supported by software) for SuDS design.

(4) Given that the engineering community has a professional responsibility to maintain and develop its knowledge, the use of Continuing Professional Development (CPD) programmes is a potential vehicle through which the knowledge base of SuDS design, implementation and ongoing performance could be expanded.

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Table 1 Breakdown of responses to questionnaires

Target Sector	Questionnaires circulated	Questionnaires returned	Incomplete returns	Total responses	Response rate (%)
Contractor / Builder / Developers	31	7	4	11	35.5
Consultant	104	36	5	41	39.4
Public (Councils, LA, Academic, State...)	135	36	5	41	30.4
Insurance	14	1	2	3	21.4
Architects /Planners/Urban designers	7	3	1	4	57.1
Total	291	83	17	100	34.4

Table 2 Participant numbers at focus groups

Focus group no.	Location	No. of Participants
1	Dublin North	12
2	Dublin South	5
3	Galway	4
4	Cork	4

Table 3 Factors which influence respondent's selection of SuDS

SUDS selection criteria	Importance of criteria (as noted by % of respondents)				
	Not at all importan t	Not very importan t	Neither important nor unimportant	Quite importan t	Very importan t
Provision of an amenity	0	21.3	24.6	49.2	4.9
Creation of wildlife habitat	1.6	19.7	24.6	47.5	6.5
Cost of construction	0	3.3	14.8	44.3	37.7
Cost of maintenance	0	0	3.3	36.1	60.7
Safety considerations	0	0	4.9	27.9	67.2
Soil conditions	0	3.3	16.4	39.3	41.0
Availability of land	0	0	9.8	31.1	63.9
Limiting volume of runoff	0	1.6	11.5	52.4	34.4
Water quality management	0	1.6	11.5	52.5	34.4

Figure 1 Commonly adopted structural methods for attenuating stormwater and restricting outflows to pre-development runoff values

Figure 2 Respondent’s understanding of different techniques in the management train approach to stormwater management

Figure 3 Percentage of respondents having direct experience in implementing specific SuDS

Figure 4 Perceived deterrents to the implementation of SuDS

Figure 5 Rating of the technical guidance for SuDS (left) and whether additional guidance would assist respondents in choosing SuDS

Figure 6 Guidance material commonly used by respondents in SuDS design

Figure 7 How respondents became aware of guidance material