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Urban Drainage in Ireland Enhancing Sustainable Systems

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Abstract

The current approach to stormwater management in Ireland new developments are restricted to a low level of overland runoff. This typically involves the use of holding tanks constructed at a reduced rate of development to attenuate runoff. However, this approach is not sustainable in the long term. Sustainable drainage systems (SuDS) are a more sustainable approach to stormwater management. This study presents an evaluation of the effectiveness of SuDS in Ireland. The study is based on a survey of SuDS practitioners and a review of the literature. The study indicates that SuDS are not as well understood as they should be. It also indicates that SuDS are not as widely used as they should be. The study concludes that SuDS are a sustainable approach to stormwater management and that they should be used more widely.

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

Introduction

The issue of sustainable drainage is a global agenda but issues with implementation remain. While considerable advances in the guidance and performance of drainage systems have been made in recent years, their role in the planning sphere has only recently been established. Prior to this, traditional systems that focused on conveyance of runoff, combined with stormwater treatment, were the norm. SuDS utilise natural processes to replicate natural drainage processes at any site, thereby improving the environment. Both hard and soft measures can be used to mimic the natural drainage process. Soft measures include ground water recharge, permeable paving, and infiltration systems. Hard measures include ponds, wetlands, and artificial wetlands. SuDS can provide a range of benefits, including improved water quality, reduced flood risk, and improved biodiversity. SuDS are a sustainable approach to stormwater management and should be used more widely.

Since the publication of the *Guidelines for Sustainable Drainage Systems* (2005), the SuDS have become mandatory in all new developments in Ireland. At this time, the Irish Office of Public Works initiated the FSU programme. The FSU included as one of its components a study on flooding issues with a view to providing guidance on the future of stormwater management in Ireland.

The first part of the study assesses the current practice and identifies the key issues associated with stormwater management in urban areas.

catchments (O'Sullivan 2010). Objective selected part of the study presented in paper identifies issues with current Ireland. The main aims were to:

- Assess the use of SuDS for water control in Ireland
- Determine the factors affecting the SuDS outcomes;
- Identify the barriers to the implementation of SuDS
- Identify perceived technical and regulatory constraints to SuDS design and implementation

Background

In the context of stormwater management, urbanisation alters areas of impervious surfaces coupled with land use change, resulting in loss of permeable surfaces (Kimpe 2000). This alters the natural hydrology of catchments resulting in greater high flows and lower low flows. Higher flows and floods result from a greater proportion of incident rainfall in catchments appearing as direct runoff to the sewer, compared with the culverting of natural streams that accompany development. conveyance of stormwater through the sewer network increases runoff volume being conveyed in artificial drainage network through the soil column and contributes to baseflow recharge to provide baseflows (Gardiner 2004). Stormwater management is often based on collection and conveyance of runoff to an outfall as, quickly, as possible, to the receiving watercourses in terms of increased discharge (Kemp 2010). This changed when the threats to the degradation of watercourses were realised and according to Niemczyszyn (1999) used a shift in storage approach to the treatment and detention of water. This approach, as implemented in urban areas, around the perimeter of development, measures to attenuate runoff to levels below greenfield values that would have occurred prior to development (Kemp 2010). This approach led to focus primarily on attenuating runoff to levels identified as safe to be passed through the natural treatment processes that occur through the column and subsequent runoff reaching the receiving watercourse contaminated by pollutants such as oils, detergents, trace herbicides. Such approaches were recognised as being a significant part of stormwater management strategies by broadened to include natural water quality to protect the new protection of water cycles ecosystems of watercourses (Niemczyszyn 2007). This is now engrained in SuDS guidance documents that require consideration of requirements that include volume and frequency of runoff as an example (Ward 2010). Integrated approaches to water management are being advocated for the sustainable management of surface water (Rauch 2005). These approaches are based on the promotion of reuse of stormwater and while similar, are referred to as different. Integrated Urban Stormwater Management (IUSM) has

attracted attention in Australia, New Zealand and the UK where water systems are more (Brown 2005). Water Sensitive Urban Design is another stormwater management approach that has been implemented in Australia (Cloughes 1999). Approaches of this type that incorporate site contribution to the catchment as part of stormwater management can reduce flood risk and improve the ecological integrity of water courses through reduction of pollutant and sediment loads (Larson et al 1997, Butler and Parkin 1997).

Although a review of sustainable drainage systems (Pratt 2001) identified their benefits when implemented across a city, need to be addressed for widespread adoption in terms of integrated approaches to stormwater issues with institutional framework and a better understanding of potential (Brown 2005; Nienow 2004). Regulatory instruments in planning legislation can pose problems (White and Howe (2005) identify impediments to implementation of various stages of development control processes such as regular maintenance in performance of some SuDS installations (Jeffery 2005), question longevity together with uncertainty in taking responsibility for maintenance and maintenance can also be perceived as a barrier (Kissack 1999). Although considerable guidance is provided in maintenance requirements, SuDS are available, awareness of this information and failing to fully understand its importance. According to Niemczynowicz (1999) issues in urban water engineering and management should be addressed through strategic measures. More recently applied technology has increased the need to improve better communications and capacity building among the key actors in urban water management. Effectiveness can also be improved by the framework in SuDS implementation together with continuing to educate both practitioners and the general public of SuDS benefits.

In the context of making mandatory, this paper presents some of the findings that are at the forefront of sustainable development in Ireland.

Methodology

Quantitative and Qualitative research methods were used to obtain information for this evaluation. The primary data collection method was a self-completed postal questionnaire that addressed all aspects of urban catchment analysis in Ireland. Questionnaires were distributed to 260 county council and local authority covering a range of organisations, agencies and departments with planning and development responsibilities and drainage and flood management.

A total of 291 questionnaires were distributed and from this 83 completed were returned. Seven incomplete questionnaires were also returned from respondents who completed the questionnaire and returned it with a note indicating that they had not completed it.

the, ~~61~~ claimed ~~to have~~ worked in designing ~~and~~ ~~Dis~~plement in

The ~~qualitative~~ work in this study ~~sc~~group ~~purpose~~ in Dublin (two groups and Galway ~~and~~ ~~this~~ ~~geographical~~ ~~spread~~ that issues across Ireland represent ~~Focus~~ ~~group~~ participants were recruited from questionnaire. The optimum number of ~~participants~~ ~~was~~ ~~identified~~ from ~~best~~ ~~practices~~ ~~between~~ ~~5~~ ~~and~~ ~~6~~ ~~to~~ ~~encourage~~ ~~attendance~~, focus groups were during lunch in centrally located hotels and ~~however~~ ~~fresh~~ ~~meets~~ ~~were~~ ~~canceled~~ ~~in~~ ~~the~~ ~~need~~ ~~to~~ ~~reschedule~~ ~~the~~ ~~attendance~~ ~~for~~ ~~the~~ ~~focus~~ ~~groups~~ ~~resulted~~ ~~in~~ ~~numbers~~ ~~summarised~~ ~~in~~ ~~Table~~ ~~2~~ ~~group~~ ~~topic~~ ~~guide~~ ~~was~~ ~~developed~~ ~~through~~ ~~consultation~~ ~~with~~ ~~the~~ ~~Technical~~ ~~Steering~~ ~~group~~ ~~to~~ ~~ensure~~ ~~independent~~ ~~and~~ ~~unbiased~~ ~~external~~ ~~reporting~~, ~~and~~ ~~appointed~~ ~~to~~ ~~moderate~~ ~~the~~ ~~groups~~.

Results

Approaches to Stormwater Management

Respondents to the questionnaire were asked to identify ~~the~~ ~~most~~ ~~used~~ ~~by~~ ~~the~~ ~~method~~ ~~for~~ ~~attenuating~~ ~~stormwater~~ ~~and~~ ~~development~~ ~~of~~ ~~the~~ ~~values~~. This was done ~~in~~ ~~the~~ ~~questionnaire~~ ~~by~~ ~~the~~ ~~full~~ ~~sample~~ ~~of~~ ~~71~~ ~~valid~~ ~~responses~~ ~~showing~~ ~~in~~ ~~the~~

Figure

As indicated by 72% of respondents structural attenuation/ storage managing has been common most cases, tanks are used in combination with flow restriction devices such as hydrocontrol Resipond plates. Also mentioned using proprietary systems measures such as attenuation swales, detention and retention ponds and treatment processes at a site were less commonly used. In the absence of policies that demand sustainable approaches to stormwater management the proportion of runoff volume would be likely to increase. Following the publication of the GSA SUDS new developments is mandatory except in situations where it is impractical due to circumstances. It should be noted however, that where SUDS are impractical and at more limited sites, the design constraints most appropriate recognition is that a encapsulated in a regional issued by Local Authorities is reflected in the following comment was made at a focus group

&..even the wind policy documents changed. It has gone from must consider SUDS an option to SUDS as an option, and if you don't, you must explain why not

This part of the questionnaire also required respondents to directly involved with a development that required SUDS. Although not directly related here results indicate that attenuation has been extensively used to control runoff, to the experience of SUDS installations and this subset represents a number of other main questions.

Sustainable stormwater management utilises natural processes at any site and minimises anthropogenic impacts. Optimising techniques and measures in the context of specific site characteristics are also the responsibility of the individual measures identified in Figure 1 do not in themselves constitute a series of techniques incorporated into regional controls in the management train. Some techniques such as water butts or roof collector examples of infiltration or infiltration runoff close to the point of origin downstream. Some techniques such as treatment systems for individual developments or groups of developments and such as a detention basin, swales and filter strips management train incorporating a number of measures will have the capacity to provide water quality improvements in addition to regional control measures. It is also noted that control runoff at catchment scale (not less than 2 hectares) and in some instances provide biological treatment to reduce pollutants from the contamination management approach involves assessing the characteristic of the catchment and dividing it into elements within a catchment to be optimised drainage can be developed for the individual catchment. The approach offers the potential for treatment to be utilised at catchment level so that the

pollutant load of runoff can be suitably passively reduced through a management train. Correctly designed with the therefore a number of methods implemented it can ensure the stormwater runoff improves water quality. Understanding the overall techniques of source, site therefore integrated management approaches is a drain that was assessed in this survey. Figure 2.

Figure 2

Figure 2 indicates that understanding of the concepts of source, control was widespread among respondents with 47.5% and 40.4% of respondents understanding source and site respectively. Regional control was less well understood with only 12.1% of respondents being aware of the concept. The data suggests that respondents experience less signs and symptoms of individual SuDS measures for a single or a group of adjacent considered in the context of the management train.

The individual measures for improved SuDS are summarized in Figure 3.

Figure 3

Detention (short storage) and retention (longer storage) represent 41% of the methods used, with the use of detention tanks and detention tanks accounting for almost 21% and 20% respectively. Infiltration stormwater through trenches, drains and soakaways is also used, with 18% of respondents reporting its use. The lower use of swales and wetlands is likely due to the perception that these measures are associated with excessive costs, which is a common misconception, however, and if integrated sympathetically and appropriately in landscape design, they do not need to be. Furthermore, intelligent design of these components in the overall development, where for example storm events can be stored temporarily on the surface of open spaces, can ensure that the need for swales and wetlands to be overly large.

Other methods mentioned by respondents include underground storage tanks, oversized pipes and roofwater harvesting measures that utilise soils to filter and remove pollutants from water runoff did not feature in any of the responses, suggesting that respondents are either not familiar with these methods of stormwater management or have reasons why these measures should not be implemented. This may also indicate the perceived divide that exists regarding the role of different aspects of stormwater control.

Factors Affecting the Selection of Stormwater Management Measures

Respondents were asked to give the importance of factors affecting selection and suitability of the site on a scale of 1 to 5 (1 is not at all important and 5 is very important). Results are summarised in Table 3.

Table 3 indicates that over 50% of respondents considered the factors listed in the questionnaire to be important with maintenance costs and safety concerns accorded the highest priority. It was also noted that respondents considered recreational amenities and life quality to be important by respondents. The ecological and environmental benefits given high priority in the decision making processes that develop.

Deterrents to the implementation of

From a given list of possible deterrents, respondents identified that the perceived limitations are summarised in Figure 4.

Figure 4

The findings are broadly in line with those reported elsewhere (McKissock 2003; K2004). Results indicate that the relationship between ongoing performance together with a commitment of responsibility for long-term maintenance and management of the implementation. Although such issues can be addressed by overcoming legislative and institutional integration of regulatory framework urban development involves all the relevant

stakeholders strategic concerns permeated the focus group discussions

Realisation that the longevity of SuDS is dependent on correct design and construction and ongoing maintenance represented in the following comment:

Local authorities don't want to be landed with more maintenance. SuDS may have to be undone if unsatisfactory. The Local Authority has to be compensated if they take charge of SuDS.

Comments of this type however, suggest that traditional drainage require maintenance. Thusly not the case for SuDS. This is a contributory factor in many pluvial floods. Furthermore, if constructed incorrectly will not function as designed and in SuDS installation not, the Local Authority will have any associated liabilities.

Perceived costs as a deterrent with considered to be 24% of respondents identified land costs as being a significant factor. This was reinforced when it was noted that it is more economically advantageous to install a concrete box under the development than use extensive SuDS.

The frequent reference to cost of SuDS implementation from many survey respondents is a lack of awareness regarding the issue. Inclusion in Figure 4 is some evidence that this is the case. The Cambridge City Sustainable Design and Adoption (WG) Ltd (2009) indicates that if incorporated into a general maintenance and associated SuDS street of excessive and if not significant for a general landscape.

Perceived excessive land takes for SuDS highly in Figure 4. Traditional drainage systems are typically buried underground with minimal land take. While it is accepted that SuDS take a more significant land take, this is not always the case and the actual land required for SuDS is often less than for traditional drainage. SuDS also offer more attenuation and water quality improvements than traditional drainage. SuDS options have smaller footprints but don't provide the same water quality and biodiversity benefits. It should also be noted that SuDS impose considerable constraints on development and SuDS are integrated into a development (Dickie).

A lack of experience or familiarity with SuDS is particularly amongst developers as reported by over 9% of respondents as being a

reflect the following focus: group comment

To most developers, this was a design of recent phenomenon & many are not familiar with it. A lot of time over phone explaining the basic design with them

Furthermore, many developers are unwilling to spend money on integration development schemes. However, it was also noted that knowledge engineering consultancies and appropriate local practices can

Lack of familiarity with the concept are common. Those who are familiar with it

While the quantitative and qualitative elements of this research reasons why installations were not popular amongst developers some features in countries were recognised when it was not

They certainly (developed) in the US and Scandinavia where there is an area of water to look out on

A small number of respondents identified the lack of a clear understanding of the range of SUD amongst the respondents that SUDs viewed in a narrow context limited. While infiltration is accepted that the presence of a building may limit the SUD require infiltration, other measures such as swales and Contractual obligation of fully installing SUDs were also identified as a potential deterrent.

Guidance materials for SUD design

The absence of guidance was cited by over 5% of respondents as an impediment to SUD. Further questionnaires were asked to rate the quality and availability of guidance on SUD design for more guidance would assist in SUD design. Results shown in Figure 5.

Figure 5

Of the 61 respondents, 60% were satisfied with guidance and reasons for dissatisfaction were generally associated with determining flow and calculations from developed catchments rather than installation issues. These issues are presented in the following group comments:

Some guidance on field runoff is also necessary. What is likely to be there is development?

I'd like more guidance on the urban fraction and the be particular catchment

The problem is the size of the catchments as some of the small. There is no guidance on the size of catchments

Respondents identified a list of guidance that they have access to. The question included a list of guidance established material and included a provision where respondents specific details of guidance documents that are used mentioned in Figure 6.

available. Responses to this question are summarised in

Figure

Discussion

Recent changes in water management policies in urban and rural Ireland have the use of SuDS as a means of countering adverse effects of growth. This study however, identified a more widespread and effective adoption of SuDS. At a basic level, 61 respondents (returned questionnaires) to the survey claimed to have experience with SuDS and Figure 3 shows measures commonly used in SuDS. However, these results appear inconsistent with Figure 2 where the control measures were understood by less than half the sample. The significant discrepancy may be due to the fact that respondents may have experience with individual components that control runoff but not a full understanding of the concept of a SuDS. This is a common problem for local authorities to larger downstream bodies and regional water companies. Given that this management train is, at the moment, highly deficient among practitioners.

The research focussed heavily on identifying deterrents to the adoption of SuDS. The most commonly cited impediments were a lack of knowledge and responsibility of the systems with which they are involved in the studies.

(McKissock et al 2003; Kirby et al 2004), largely from misconceptions and a lack of understanding of SuDS. Figure 4 shows that a major concern amongst respondents was that the responsibility for the system rests with the local authority, which is not in line with the existing drainage law. The use of SuDS while the ownership and maintenance of conventional drainage systems remains with the local authority. Understanding the responsibility for provision, operation and maintenance of SuDS will require changes to existing procedures in Ireland. This will require the Local Authorities to overcome the conservative attitudes of some Local Authorities and to become familiar with their installation (Dolan and O'Donnell, 2005).

The inclusion of land take and maintenance of SuDS in the management of SuDS is a misconception. Figure 4 shows that a major concern amongst respondents was that the responsibility for the system rests with the local authority, which is not in line with the existing drainage law. The use of SuDS while the ownership and maintenance of conventional drainage systems remains with the local authority. Understanding the responsibility for provision, operation and maintenance of SuDS will require changes to existing procedures in Ireland. This will require the Local Authorities to overcome the conservative attitudes of some Local Authorities and to become familiar with their installation (Dolan and O'Donnell, 2005).

This lack of understanding of SuDS is more surprising given the quality and availability of guidance on the design and implementation of SuDS (Figure 5). The knowledge is being gained from a very diverse set of sources (Figure 6) and therefore the awareness and improving understanding of SuDS amongst the public is making available a national guidance document. The engineering community also has a professional responsibility to maintain the SuDS implementation and Continuing Professional Development vehicle through which the knowledge base can be expanded.

Given Figure 3 indicates that measures in the past focussed on runoff volume rather than the catchment, the research suggests that the mandatory in development plans is a positive step towards a more holistic and integrated approach to drainage. This context is more holistic and integrated and that involves, planners, engineers and water resource management. In Ireland, the responsibility for planning is a key role of the Local Authorities. Administrative borders are not observed by water of the physical effects of different stormwater management assessed at river basin or catchment scale. Flood prevention will assist in this regard.

This study indicates that incorporating sustainability principles in stormwater management will require efforts at a number of levels. Not only will it require the application of technologies and and to increase education provision of integrated water management overall objectives are the main principles in current principles.

that will direct future key actions improving sustainability criteria

Conclusions

The main findings arising from the questionnaire responses on the basis of this study were as follows:

- (1) Until recently, stormwater management in Ireland was for with less consideration being given to quality aspects discharge to nearby drainage networks. Changes in stormwater management policies and standards have made water quality now at the forefront of management strategies.
- (2) A perceived barrier to the use of SUDs is ownership. SUDs systems require maintenance in order to operate going to own and maintain the system is a major implementation issue. These issues were identified as important by participants in the study of procedures used by Authorities for installing SUDs.

It should be noted however, that while costs featured prominently as a deterrent to the implementation of SUDs, these costs were more than costs associated with maintaining traditional drainage systems.

- (3) Guidance for design and implementation is currently drawn from a range of diverse sources. A holistic and integrated management would therefore benefit from national guidance supported by standards for SUDs.
- (4) Given that the engineering profession has a responsibility to maintain and develop its knowledge, Continuing Professional Development (CPD) may represent a potential vehicle through which knowledge in SUD design, implementation and ongoing performance can be expanded.

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Word Count (inclusive of abstract and references)

Table Breakdown of responses to questionnaires

Target S	Question es circu	Question es retu	Incomp e retu	Tota respo s	Respo e rat (%)
Contract Builder Develop	31	7	4	11	35.5
Consult	104	36	5	41	39.4
Public (Councils Academ State..	135	36	5	41	30.4
Insuran	14	1	2	3	21.4
Architec /Planners n design	7	3	1	4	57.1
Total	291	83	17	100	34.4

Table 2 Participant numbers at focus groups

Focus gro	Locatio	No. of Parti
1	Dublin N	12
2	Dublin S	5
3	Galway	4
4	Cork	4

Table 8. Factors which influence respondents' selection of SUDS

SUDS selection criteria	Importance of criteria (as noted by % of) respondents				
	Not at all important	Not very important	Neither important nor unimportant	Quite important	Very important
Provision of 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 attenuation
restricting runoff development runoff values

Figure 2 Respondents' understanding of techniques in the management
approach to stormwater management

Figure 3 Percentage of respondents having direct experience in
SuDS

Figure 4 Perceived deterrents to the implementation of
SuDS

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

Figure 6 Guidance material commonly used by respondents in
SuDS design

Figure 7 How respondents use guidance material