

MAXIMIZING THE BENEFITS FROM WATER AND ENVIRONMENTAL SANITATION

Maximising the benefits of urban drainage

Brian Reed and Charles Niwagaba

Urban drainage has important health, economic, environmental and personal impacts. However current design techniques focus on water quantity issues. A multidisciplinary approach brings more factors into the design process, increasing the benefits of a drainage system, but this changes the design information required and the range of solutions available. The increase in factors to be considered also requires the institutional arrangements to be reviewed, to reflect the wider range of issues involved.

Introduction

Whilst “appropriate technologies” for water and sanitation have been investigated and implemented for many years, very little work has been carried out into low-cost methods of managing urban drainage. The use of channels instead of underground pipes addresses some of the problems, but still aims to drain water as quickly as possible, with resulting impacts downstream. This paper is based on a year long scoping study, looking at the wide aspects of drainage and some possible appropriate technology solutions. However the results did not just reveal technological options, but the need for multidisciplinary management and co-ordinated, planned action (including consistent funding streams).



Photograph 1. Surface runoff needs managing

The impacts of urban runoff

Experience in the UK and other industrialized countries show that, when the management of the quantity and quality of drinking water has been addressed, the management of the quantity and quality of the wastewater produced by towns is then improved. Following this, attention turns to managing the runoff that results from rainstorms. However there are

important reasons for addressing the issue of stormwater management at an earlier stage, as it does impact on water supply and wastewater management.

Direct impacts from runoff

Impacts from runoff include flooding (damaging houses, disrupting travel and endangering lives), soil erosion, siltation and altering natural habitats (which may encourage vectors or discourage beneficial plants and animals). As the runoff becomes dirty with natural and man-made pollutants, it can degrade water sources.

Impacts on water supply

Water from rainfall can be directly used for water supply, either at local scale (rainwater harvesting) or at a larger level, capturing it in cisterns and tanks. Indirectly it recharges aquifers, rivers and lakes. Even if this is a partial solution, it reduces the reliance on other water sources and can provide low-cost, domestic level supplies. Rainwater can also have a negative impact, washing away pipelines or leaking into pipes, contaminating treated supplies.

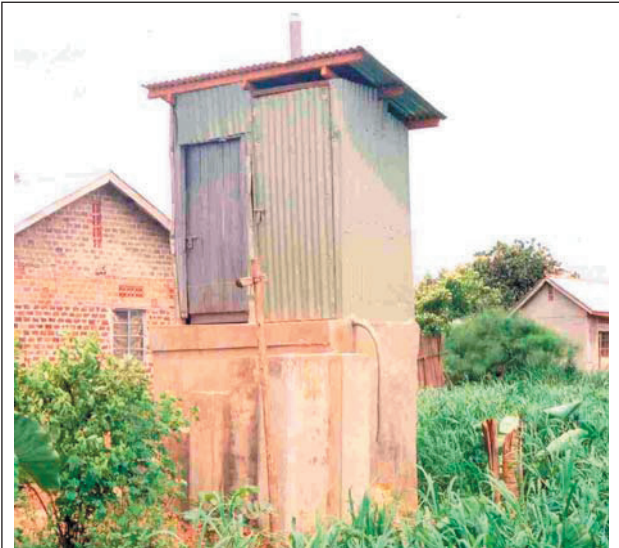


Photograph 2. Water pipes crossing drains are vulnerable

Impacts on wastewater and sanitation

Rainwater entering sewers can lead to them becoming full and overflowing. This also disrupts treatment works. Where

on plot sanitation is used, flooding can inundate pit latrines and septic tanks, causing them to overflow and pollute the surrounding ground water as well as soil. Solid waste can also be washed into drains, leading to further flooding.



Photograph 3. Latrines are raised to avoid flooding

Problems with managing runoff

The conventional method of managing runoff in industrialized countries is to convey it in underground pipes downstream of the urban area. These pipes have limited capacity and so once the design flow has been exceeded, another flow route is required. Some times these pipes contain both foul and stormwater, but even if they only contain storm water, the erosion of silt from roads causes the water to become contaminated and solid waste washed into the drains block the pipes.

The conventional solution to the problems of blocking sewers in low-income countries where solid waste management is lacking is to use open channels. This does not stop



Photograph 4. A blocked drain

the pollution problems or size limitations but does make cleaning them easier and is cheaper than using pipes as local labour and materials can be used. However they still block with silt and solid waste, so need to be designed with this in mind. This problem is more amplified in low-income countries, as often a number of roads are unpaved, thereby increasing on the amount of silt carried in the storm water. The former, together with solid waste deposition in open channels are the major causes of blockage of storm drains in developing cities.

A multidisciplinary perspective

The research project identified that urban runoff however is not just a wastewater issue. The number of stakeholders is large, with people using surface water for recreation, fishing, agriculture, regarding it as an asset rather than waste. However to be a worthwhile asset it needs to be protected, and not polluted. Addressing these aspects of urban surface water requires a different engineering response than the rapid drainage of water, valuing it rather than treating it as waste. This also values the controlling of the problem at source – minimising the production of runoff and silt in the first place.



Photograph 5. Urban agriculture is a drainage issue

Methodology

The research project worked in three countries (Uganda, Vietnam and Brazil), holding investigative workshops in each country and carrying out interviews and field visits to assess the situation, especially in low-income areas. A photographic record of significant issues was used to illustrate the findings.

Alternative engineering options

As conventional pipes and channels are not able to control water quality impacts from urban runoff, new techniques have been developed to manage runoff in a more sustainable manner. These have been termed Sustainable Urban Drainage Systems (SUDS) in the UK or Stormwater Best Management Practices (BMPs) in the USA. However, they are already being used in low-income countries, albeit on an informal basis. These alternative approaches are of interest in rapidly growing towns and cities.

Pervious pavements

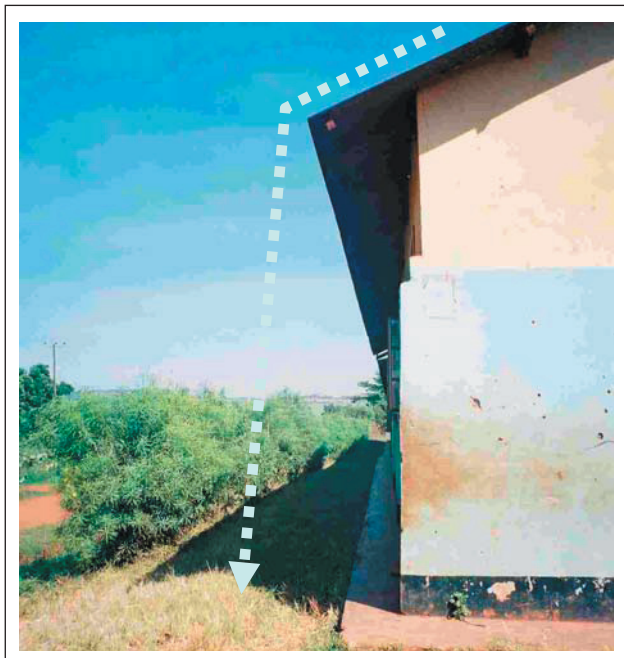
Runoff is caused when water cannot naturally infiltrate into the soil. By using a surfacing material that allows water to move through it, infiltration can continue.



Photograph 6. A pervious pavement

Infiltration

Formal infiltration features include soakaways and infiltration basins, but informally water can infiltrate to the ground when it falls onto permeable areas. Concentrating the flows in one area makes it more difficult to dispose of, so infiltrating it as early as possible avoids this.



Photograph 7. Rain falling from the roof infiltrates to the ground

Basins and ponds

Rather than trying to get rid of water as quickly as possible, holding it back can improve its quality through self-purification processes. Additionally, the flooding downstream is avoided. This also allows the water to be used for other purposes, or just to add an attractive feature to the environment. The design has to take into account the need to control vectors, which requires specific design details to limit breeding.



Photograph 8. An urban lake

Swales

Storm water will need to be conveyed away from where it falls if it is not to flood the area, but it can be drained slowly, avoiding erosion and promoting settlement of solids and pollutants. Vegetation protects the sides of the channel and helps treat the water.



Photograph 9. A swale

Coping strategies

The drainage features mentioned above are used in both industrialised and low-income countries. However, the research also identified coping strategies that poor people used to live with flooding, such as building bunds to divert water away from their house, raising the level of the house (and latrine).



Photograph 10. Using sand bags to divert surface flows

Maximising the benefits

Having new design options is not the only part of the process leading to getting more from urban drainage management. Several factors still need to be addressed.



Photograph 11. Raising the ground level to avoid flooding

Institutions

A multidisciplinary approach requires multidisciplinary management. Drainage however is often associated with highways departments; their priority is to keep the roads clear of standing water and protect the road construction from erosion. Consideration of water quality or the needs of fishermen downstream are not part of their remit. This stems from the financial benefits of runoff management; trying to link those who benefit (often downstream) and those who have to deal with the runoff before it gets too much of a problem to control.

Capacity development

Urban drainage has not had a high profile and design has been largely limited to pipes and channels. New techniques require new skills, not just technical but environmental, economic and management issues.

Data requirements

Urban drainage design requires local data, on rainfall and topography, as well as information on flooding and water quality. Using these alternative techniques extends that information to include community perceptions, views and priorities.

Finance

Whatever drainage system is used, it needs to be financed. Funding is often available as short-term, emergency resources, rather than responding to long term needs and planning, making more efficient use of the money.

A way forward?

Whilst advocating new techniques, it would not be practical to expect change in the short-term. The lack of data, capacity, funds and political will make the whole master planning approach unrealistic. Conventional pipe and channel techniques require the whole system to be in place – or start from the outfall and work upstream, otherwise the end of small portions of a larger system will cause flooding if

they discharge prematurely.

An alternative is to accept the piecemeal approach and use source control to reduce the runoff problem in small stages, each one decreasing the adverse impacts of the quality or quantity of runoff and turning it to a beneficial use. This would also reflect the disjointed funding profile often encountered.

Learning points

- Poor drainage management impacts on other water sectors
- Silt management is a major design issue
- Urban water features have a wide group of stakeholders
- Alternative techniques to pipes and channels are available
- Non-technical barriers may prevent a planned approach to managing urban stormwater
- A step-by-step approach to implementing management techniques may be more successful in the long run

Note/s

1. This document is an output from Knowledge and Research project R8168 funded by the UK Department for International Development (DFID) for the benefit of low-income countries. The views expressed are not necessarily those of DFID.
2. Other partners in the research were:
 - GHK International, UK
 - Center for Environmental Engineering of Towns and Industrial Areas (CEETIA), Hanoi University of Civil Engineering, Vietnam
 - School of Civil Engineering – Federal University of Goiás, Brazil
 - The Department of Civil Engineering, Makerere University, Kampala, Uganda.

Contact addresses

Brian Reed
 Assistant Programme Manager
 Water, Engineering and Development Centre,
 Loughborough University
 Leicestershire
 LE11 3TU, UK

Charles Niwagaba
 Assistant Lecturer
 Department of Civil Engineering
 Faculty of Technology
 Makerere University
 Kampala, Uganda