



# The challenges of sustainable urban drainage in developing countries

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## Abstract

The majority of the world's population lives in so-called "developing" countries – many of them living in dire conditions in the slums to be found in most major towns and cities. A particular problem associated with these slums is poor drainage resulting in ongoing contact with contaminated water and flooding. It has been estimated that the total world population without improved sanitation in 2015 will be a massive 2.4 billion. Whilst not all sanitation need be water-borne, the need to cater for greywater (domestic wastewater) in addition to stormwater in high density urban areas makes it important that more serious consideration be given to providing adequate drainage. Unfortunately, drainage is not even one of the Millennium Development Goals (MDGs).

There are a number of texts on the subject of urban drainage in developed countries. A weakness with most of them though, is the general failure to look at the problem of urban water management in a holistic manner. For example, the failure to comprehend that every drop of water brought into an informal settlement has to be safely removed otherwise it becomes a health threat. Also, insufficient attention has been paid by engineers to the debilitating impact of weak social and institutional structures.

This paper summarises observations made by the author who has been trying to understand and deal with the challenge of providing sustainable urban drainage in the informal settlements of South Africa over a period of more than ten years. Whilst South Africa is not a typical developing country, its informal settlements have many features in common with those elsewhere in the developing world. The author sees the lack of sustainable urban drainage in informal settlements as a consequence of the failure of local government to provide appropriately serviced sites for the multitudes streaming into the towns and cities;

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however, he ascribes this failure mainly to the lack of adequate numbers of skilled personnel who are able to plan and implement urban drainage in a timeous and holistic manner – coupled with the lack of funding needed to pay for the work. Some suggestions are made as to how developed countries can assist; principally through professional support and the encouragement of NGOs.

**Keywords:** sustainable urban drainage, developing countries, local government, NGOs

## 1. Introduction

The majority of the world's population lives in the so-called “developing” countries – many of them living in dire conditions in the slums to be found in most towns and cities. A particular problem associated with these slums is poor drainage. Many slums are informal settlements that have come about through land invasion and lack proper planning. Slums arise through a combination of: rapid population growth (both through high birth rates as well as large immigration), weak local government (resulting in inadequate planning and management), insufficient investment (perhaps a consequence of a small tax base or/or high levels of corruption) and a lack of skilled personnel (both professional as well as maintenance). It is of concern that whilst the world is on track to meet the Millennium Development Goal (MDG) target on drinking water, it does not look set to meet the target on sanitation (to halve the number of people without access). Based on current trends, the total world population without improved sanitation in 2015 will still be a massive 2.4 billion (WHO, 2008). Whilst not all sanitation need be water-borne, the need to cater for greywater (domestic wastewater) in addition to stormwater in high density urban areas makes it important that more serious consideration be given to providing adequate drainage. No MDG target has yet been set for drainage; it is apparently not acknowledged to be a problem.

There are a number of texts on the subject of urban drainage in developing countries. Some of the more useful include: Pickford (1995), Mara (1996), Kolsky (1998), Parkinson & Mark (2005) and Parkinson *et al.* (2007). A general weakness, though, is the failure to see the problem of urban water management in a holistic manner. For example, in the texts just listed, Pickford (1995) and Mara (1996) focus almost exclusively on sanitation and sewerage, whilst Kolsky (1998), Parkinson & Mark (2005) and Parkinson *et al.* (2007) focus almost exclusively on stormwater drainage – although, to be fair, Parkinson & Mark (2005) do at least acknowledge the importance of “Stakeholder participation and partnerships” and devote a chapter to “Policies and institutional frameworks”.

In an similar vein, whilst much has been published in connection with the water supply and sanitation (WATSAN) and even water supply, sanitation and hygiene (WASH) – a common theme of the WEDC Conferences for example – this is mostly focused on the provision of small quantities of potable water and so-called “dry” sanitation (doesn't use water in its operation), whilst virtually nothing is ever said about drainage. This might be understandable in the context of small rural communities, however many high-density unplanned slums are to be found situated on marginal land vulnerable to flooding. The failure, for example, to comprehend that every drop of water brought into an informal settlement has to be safely removed otherwise it becomes a drainage problem and thus a possible health threat borders on criminal.

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Insufficient attention has been paid by almost all engineers to the debilitating impact of weak social and institutional structures.

This paper focuses on observations made by the author who has been trying to understand and deal with the challenge of providing sustainable urban drainage in the informal settlements of South Africa over a period of more than ten years. Whilst South Africa is not a typical developing country, its informal settlements have many features in common with those elsewhere in the developing world.

## 2. Definitions

It is useful at the outset to define what is understood in this paper concerning the terms: “sustainable”, “urban drainage” and “developing countries”.

### What is meant by “sustainable”?

“Sustainable” has become a buzzword in recent times. There are many definitions; the most common being probably that put forth by the Bruntland Commission: “...*development that meets the needs of the present without compromising the ability of future generations to meet their own needs*” (WCED, 1987). Another way of looking at sustainability is to ask the question: “can this activity / behaviour continue indefinitely?” If so, then it could be considered sustainable.

### What is meant by “urban drainage”?

Urban drainage includes the removal of all unwanted water from urban areas. It includes wastewater – including sewerage and greywater - and stormwater. Greywater, sometimes called sullage, is domestic wastewater predominately from baths, basins and washing machines. The unwanted water may, or may not, be used for other purposes with, or without, treatment. Indeed, it is part of the philosophy of sustainability that there is, ultimately, no waste; all “waste” from one process should be in input for another (see, for example, McDonough & Braungart, 2002).

### What is meant by “developing countries”?

According to Wikipedia (2010a), there is no generally accepted definition of a “developing country”. In general, “Developing countries are (those)... which have not achieved a significant degree of industrialization relative to their populations, and which have, in most cases a medium to low standard of living. There is a strong correlation between low income and high population growth.” Whilst designation as a “developing country” may convey some benefits, “The term **implies** inferiority of a ‘developing country’ compared to a ‘developed country’ which many countries dislike.” Whatever the definition, there does appear to be general consensus that the developed countries include most European countries, Canada, the United States, Australia, New Zealand, Japan, Singapore, South Korea and Taiwan, as well as Hong Kong region. All other countries could thus be considered “developing”. South Africa falls into a select group of developing countries that are sometimes called “Newly industrialized countries (NICs)” According to Wikipedia (2010a), these “are nations with economies more advanced and developed than those in the developing world, but not yet

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with the full signs of a developed country. NIC is a category between developed and developing countries. It includes Brazil, China, India, Malaysia, Mexico, Philippines, South Africa, Thailand and Turkey.”

It is to be expected that the many developing countries evidence large differences in the complexity of their infrastructure, not only between each other, but also within each country. In southern Africa, for example, the city centres were usually designed in the colonial or immediate post-colonial era to much the same standards as their European counterparts. In South Africa, the city centres of Cape Town, Durban, Johannesburg and Pretoria have urban drainage infrastructure that is quite similar to that to be found in, for example, Adelaide, Brisbane, Perth and Sydney. The differences are mostly to be found on the peripheries. The enormous flow of poor, largely unskilled people from the rural areas and neighbouring countries after 1990 has largely overwhelmed the resources of local government with its relatively small tax base and limited numbers of skilled personnel. Local government has struggled to provide housing – or even serviced land suitable for housing – at a rate approaching the requirement resulting in the mushrooming of informal – usually illegal – settlements surrounding the formal areas. To compound the problem, the pressure on the limited local government resources to provide services for recent migrants has often resulted in a decline in maintenance of existing services in the more established areas resulting in an increasing number of failures there. These are features in common with many developing countries. This suggests that many of the lessons drawn from studying the informal settlements of South Africa could be considered typical of this type of situation.

### **3. The informal settlements of South Africa**

#### **3.1 The extent of the problem**

In 1985, the cities of South Africa housed an estimated 16.3 million people (49.4% of the national population). This has almost doubled to some 31.2 million people (61.7% of the national population) in the 25 years to 2010 (UN-DESA, 2009). According to StatsSA (2009), 13.4% of household lived in informal dwellings (shacks) in 2008. In the City of Cape Town (CCT) alone, a city of some 3.3 million people, there are currently some 140,000 shacks in an estimated 230 informal settlements (CCT, 2009). Residents live in conditions of considerable deprivation in flimsy shelters with floor areas generally less than 20 m<sup>2</sup> which are largely constructed from scavenged materials such as corrugated galvanised iron, plastic, cardboard or timber sheeting. In some areas, shack densities exceed 200 dwellings per hectare (Armitage et al. 2010). The lack of adequate urban drainage frequently results in them being extremely polluted environments with a toxic cocktail of stormwater mixed with greywater, urban refuse and even faecal matter sometimes surrounding, and at times inundating, the crudely constructed shacks. This, coupled with poor nutrition, provide ideal grounds for the spread of disease that can prove fatal for the inhabitants whose immune systems may already be compromised by HIV/AIDS (Ashipala & Armitage, 2010).

#### **3.2 Issues confounding the provision of urban drainage**

There is clearly a wide variety of issues confounding the provision of urban drainage; however some of the more common are listed here:

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- Informal settlements generally come about when poor migrants to the city seek space where they can construct a shack for free. A premium is placed on proximity to job opportunities. Often the only open land close to job opportunities is land which has been alienated from formal development because of its unsuitability. Examples include: floodplains and low-lying ground (high water table, flooding problems), former waste-disposal sites (toxic gases, unpredictable settlement), land close to airports (noise problems) and steep slopes (difficult to build on). In other words, informal settlements are usually to be found in troublesome places. The alternative is for migrants to settle on the open land – often farm land – to be found on the periphery of the city and accept that a large portion of any earnings – not to mention time – will be spent on travel to work. This does not make economic sense and the migrants are quick to appreciate this.
  - As the land is almost invariably settled without permission, i.e. illegal, there is no town planning and obviously no existing services. This means that there are no demarcated plots to be allocated to the settlers, no roads to provide access, no electricity, no solid waste collection, no water supply, no sanitation and no formalised drainage system. The residents have had, at the beginning at least, to make their own provision for their basic services – and the results can be quite haphazard to say the least. The problem is quickly exacerbated by the fact that residents are often unable to prevent newcomers from taking any available scrap of land until eventually the shacks are so densely packed together that it is hard for services to be put in at all (Figure 1). Needless to say, fire becomes a serious hazard given the close proximity of highly flammable structures and the preponderance of the use of naked flames for cooking, heating and lighting.



Figure 1: Informal settlements are often very dense with little space for services

- Since the homes (shacks) are generally constructed cheaply out of any available material, it is quite common to find the buildings set into the ground so that the soil can provide some lateral support for the walls. In any case, bringing in material to raise the floor would entail considerable extra work – and potential cost if the material has to be brought in by vehicle. Lowered floor levels are inevitably a problem because as soon as it starts raining water quickly finds its way indoors. The problem is exacerbated if the surplus material from the construction of the houses is spoilt on the access paths outside

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the structures and/or later road “improvements” results in additional material being laid on them – thereby raising their levels relative to the floors of the shacks.

- In the absence of proper services, the (informal) drainage system quickly becomes the recipient of waste of all kinds including water, faeces and solid waste (Figure 2).



Figure 2: Solid waste (top left), greywater (top right), tap water (bottom left) and faeces (bottom right) being disposed into the drainage system

- Even when the local authority accepts the existence of an informal settlement, the fact that it is usually illegal – at least to start off with – means that they are reluctant to provide much apart from some “basic” services. These basic services typically comprise communal (shared) tapstands scattered through the settlement for potable water and communal toilets which may be scattered through the settlement, or, if access is a problem (remember no formal roads!), placed around the periphery. Some form of community-based “black bag” system (black polyethylene bags are commonly used for refuse disposal in South Africa) may be introduced to cater for solid waste removal. If it becomes clear that a particular informal settlement is likely to remain for a long period of time (many are now older than 20 years) or if the settlement is legalised, area lighting (lights placed on tall masts scattered around the settlement) and electrical connections (with “pre-pay” electricity meters) to each house may also be introduced. There is a general reluctance to provide any form of sewerage as this requires a large investment for

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what are supposed to be temporary settlements. This means that the sanitation option is generally a form of “dry” sanitation, typically: “container” (a receptacle with an opening on the top that has to be regularly emptied), “chemical” (such as is often used for sporting events in the developed world), VIP latrine (Ventilated Improved Pit latrine) or, more recently, some type of composting toilet. There is seldom any allowance for the disposal of greywater or any attempt to improve the surface drainage. As an aside, in South Africa there is usually no charge for any of the above-mentioned services. This is different to most other parts of the world where even the poorest of the poor are usually expected to make some contribution – at least to the purchase of potable water. This might result in different behaviour patterns in South African informal settlements relative to elsewhere.

- Even when settlements are regularly flooded (Figure 3) – even if residents regularly have to move to temporary shelters until the flooding subsides – there is a general reluctance to relocate to better drained areas. This is because it would invariably mean moving further away from job opportunities and from existing social support (which could comprise neighbours, local churches, welfare agencies, NGOs and even employers). In an environment where it is common to find more than half of adults functionally unemployed, drainage – even of sewage – has a much lower priority than finding the next meal. Social security, for example as enjoyed in Europe, is virtually unknown – and unaffordable – in the developing world.

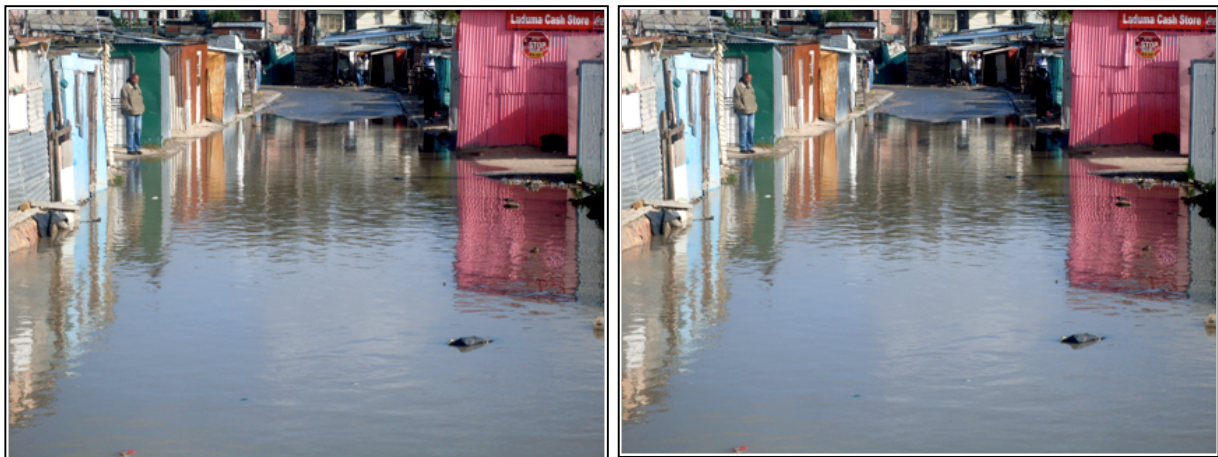


Figure 3: Informal settlements are regularly flooded during the rainy season

- With minor exceptions, residents appear to be unable to undertake the necessary planning and execution required to solve drainage problems themselves. Partly this is because their priorities lie elsewhere (the next meal for example), but it is also because effective political structures are lacking in most settlements. Collective action requires considerable co-operation between the residents themselves – particularly since it might involve the giving up of space and/or the movement of homes. Informal settlements are seldom occupied by one “community” – in the sociological understanding as “*a group that is organised around common values*” (Wikipedia, 2010c) – it is more likely that residents will come from different parts of South Africa – or even Africa – speaking different languages and supporting different political parties. What has been observed, however, is the development of “strongmen” who take control of the limited resources e.g. a toilet or a tapstand, and then either reserve it for their own use or charge their neighbours for

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access to these now forcibly “privatised” assets! From time to time when there has been an attempt by someone or some group to promote “self-help” schemes within a settlement, this has all too often been frustrated by others who are concerned that the government will not assist the residents of settlements that are able to help themselves. In South Africa, this attitude has been encouraged by repeated political promises to provide free housing (with the related services) to all poor people. Xenophobia – hostility to foreigners – has also become an ongoing problem in the informal settlements of South Africa as citizens have come to resent competition from the many economic and political refugees from neighbouring countries. In general, residents in informal settlements have shown a greater ability to organise resistance – sometimes violent – against poor service delivery or competition from foreigners, than to provide for their own services.

- On the few occasions where there have been attempts by local government to organise the residents of informal settlements into “condominiums” in an attempt to harness their co-operation in the construction and maintenance of services in the South American style, this has almost always failed. This could be as a consequence of an attitude of “entitlement” that has been encouraged by repeated political promises made by the South African government.

#### **4. The failure of local government**

Any engineer or planner looking at the litany of problems listed in the previous section would likely come to the conclusion that the problems associated with informal settlements – including drainage – are easily solved by a combination of money, planning and proper engineering. The agency that is responsible for arranging these is local government. Ultimately it is not the residents’ fault that they are living in an unsustainable manner so much as local government to whom is entrusted the task of service delivery.

The failure of local government in South Africa to provide sustainable services, including urban drainage, to its citizens – rich and poor alike – is a consequence of the following:

- Like any developing country, South Africa has a relatively small tax base. There are currently just under 7 million tax-payers out of a population of around 50 million (South Africa, 2010). On the other hand, local government is regularly unable to spend the money earmarked for service delivery – indicating that more could be done if employed the right personnel.
- South Africa has a severe skills shortage that has been getting worse in recent years. Currently there are only around 1400 civil engineering staff for 284 municipalities serving a population of around 50 million i.e. less than three per 100,000 compared with around 22 per 100,000 for English-speaking and Scandinavian countries. Research carried out in 2004 and 2005 indicated that there were 83 municipalities with no civil engineering professionals at all (Lawless, 2007). Whilst South Africa is in the fortunate position of having some world-class universities capable of producing fine engineers, many graduates are seduced by better salaries and seeming more secure environments in the developed world. Those that stay in the country are more likely to work for private companies than for local government which has a reputation for “red tape” and political insecurity. Whilst the country still has an excellent reputation for the provision of potable water (the tap water is safe to drink in most parts of the country), recent research has

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shown that only 7% of 449 wastewater treatment plants assessed in 2009 were certified as achieving “Green Drop” certification for excellent management (DWEA, 2010). The situation is likely to be much worse in a many other developing countries.

- What is true for civil engineers is true for all the other professions as well. It takes teamwork to provide sustainable solutions to service delivery. In particular, any attempt to upgrade informal settlements requires the mediation of trained community workers who can facilitate the complex negotiations between the local government and residents – and sometimes between the residents themselves. Unfortunately very few competent people are available.
- Even in the better resourced municipalities, the provision of services to informal settlements is often frustrated by the fragmentation of those responsible for service delivery into a number of departments that do not always work together – or even communicate – well. It is common to find “water and sanitation” in a different branch to “roads and stormwater”. The “cleansing” (solid waste), electricity and social services departments are almost inevitably separate. Meanwhile, responsibility for the informal settlements is often given over to the housing department. Funding comes from a number of different sources, but the emphasis is usually on capital projects rather than maintenance leading to distorted decision-making. In any case, much of a town’s income comes from rates which are not generally paid by the residents of informal settlements. Rate-payers – usually middle class residents – understandably want to see their money spent in their parts of the town. Very few municipalities employ enough project managers sufficiently skilled to successfully co-ordinate the different disciplines that are required to tackle the problems encountered in informal settlements.
- There is a general mistrust of local government by residents in informal settlements – for good reason; there have been innumerable examples of promises not kept. This means that residents are reluctant to co-operate with local government officials unless they are convinced that there is a likelihood of success.
- Government – and by extension, Local Government – has been too focused on the delivery of houses rather than basic engineering services such as water, sewerage, stormwater drainage, roads, electricity, solid waste removal, etc. Whilst a laudable aim – and politically understandable in the light of South Africa’s history as a racially divided country – attempting to provide houses for all has proven to be a “bridge too far” in the light of resource constraints. Furthermore, councillors elected to local government are frequently guilty of making decisions on the grounds of political expediency rather than in the best interests of the people they have been elected to serve. There is a tendency to focus on “form” rather than “substance” i.e. on things that “look good” such as the building of the new stadia for the football World Cup, rather than on the delivery of – often invisible – engineering services. There is also a tendency to focus on short term projects (to secure re-election) rather than on longer term projects that are more sustainable. Some politicians have even been accused of effectively sabotaging promising initiatives by opposition political parties in a bid to gain power.

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## 5. Towards the provision of sustainable urban drainage

It is clear from the foregoing that the main reasons for the failure of a large part of the developing world to provide sustainable urban drainage to its citizens – here exemplified by the situation in the informal settlements of South Africa – is largely one of resource constraints at the local government level. These constraints are unlikely to be removed in the short to medium term. Can anything be done in the interim? Some suggestions follow:

- Targeted financial aid from developed countries to developing countries might improve living conditions in the latter – and might actually benefit developed countries by reducing the “push” on poor people to migrate to them. Aid has, however, acquired a bad reputation in recent years as it is often seen as a way powerful countries can manipulate the governments of weaker countries. Aid has also often been subject to abuse; encouraging corruption and discouraging self-reliance. Moyo (2009), for example, provides a damning criticism of what aid has done to Africa.
- “Trade not Aid” is the current mantra of many governments; rightly moving the focus to the construction of more sustainable economies with a greater degree of participation by the citizens of developing countries. In this context, it is worth noting that many countries, notably those of the EU, use unfair tariff barriers to protect their economies and maintain their position of dominance. Trade is, however, only likely to be a long-term solution.
- Surprisingly enough, many developing countries weathered the recent economic downturn better than some developed countries. These countries may thus be in a position to borrow in a bid to address service delivery. On the other hand, money, by itself, will not solve the problem if there are insufficient numbers of skilled personnel who are able to usefully spend the additional money.
- Private consultants and contractors – including international water utilities – have made, and continue to make, a considerable contribution to the delivery of services to informal settlements. There are, however, severe limitations to the use of private companies including: the lack of “institutional memory” – knowledge of the history of service development in a region – and the need to work for a profit in an environment where funding is almost exclusively externally sourced. Private enterprise works best in an environment of well-written contracts and good supervision – which requires the requisite authorities to have access to high quality professional support.
- High quality professional support is the ultimately the type of assistance that is most urgently required in developing countries. The most useful aid from developed countries is the deployment of skilled professionals. To be sustainable, part of the brief must be to transfer skills to local people who would take over after a period of time. Care must, however, be taken to ensure a proper understanding of the local context by the foreign professionals to ensure appropriate solutions, and the adequate transfer of expertise to ensure the continuing success of initiatives once the overseas experts have moved away.
- NGOs have, over the years, often made an impact out of all proportion to their size. They are able to gain the trust of the residents in slums much easier than local government

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officials, and can thus facilitate self-help schemes as well as provide an intermediary between local government and the residents.

- Ultimately, informal settlements need to be abolished. Unfortunately this is unlikely to happen for many countries in the short to medium term. There are simply no alternatives for many of the urban poor. There thus needs to be a more pragmatic view to the existence of informal settlements that tolerates their existence in the short term whilst planning for their ultimate replacement by something more appropriate. The upgrading of informal settlements *in-situ* is not the focus of this paper, but it should be noted that it takes considerable skill to provide engineering services after a site has been settled. In the context of urban drainage, it usually requires the shifting of shacks to open up drainage routes. This in turn requires considerable negotiating skills – particularly if the settlement is densely settled. In very dense settlements it might be effectively impossible to provide adequate drainage and some compromise must be reached that accepts limited flooding and/or limited waterborne sewerage. Communal toilet blocks are often the inevitable consequence of the informality of the settlements. To be successful, they need to be maintained – preferably by janitors. If these janitors can be chosen from among the residents, and the residents can be induced to contribute towards their salaries then the risk of abuse is greatly reduced.

## 6. Conclusions

It is not about the sewer! The main challenges to sustainable urban drainage in developing countries has to do with the inability of local government to provide appropriately serviced sites for the multitudes steaming into the towns and cities. Subsequent “crisis management” fails to address the needs of the new residents who are then all too often forced through circumstances to fend for themselves. Whilst technical solutions are available, in the absence of adequate social and institutional planning and support, success is rare. Services are often implemented without due regard to consequences. Ultimately, the real obstacles to sustainability are the lack of adequate numbers of skilled personnel who are able to plan and implement urban drainage in a timeous and holistic manner – coupled with the lack of funding needed to pay for the work. Given historical problems with aid to developing countries, probably the best way developed countries can help with achieving sustainable urban drainage is by providing professional support to local authorities. NGOs have also shown themselves to be a considerable asset in mediating drainage solutions.

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