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Challenging Sustainable Drainage Systems (SuDS): design and implementation.

		Funder
1	Tropical climates	Newton Fund
2	Informal settlements	National Research Foundation
3	Refugee camps	HUMANITARIAN elcha
4	Favelas	CONFAP Credeto Nacional das Fundadors Estaduais de Ampero à Pregulais

"Precarious settlements", slums: common/ different challenges

After Woods Ballard et al., 2015

The roles of Sustainable Drainage Systems (SuDs)

- Replicates natural drainage before development: Greenfield runoff
- Encourages infiltration, detention and slow conveyance
- Manages the environmental risks that result from urban runoff
- Enhances the environment
- Multiple benefit
- Flexible
- Greywater and stormwater management



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Sustainable Drainage in context

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SuDS devices grouped by their primary role	Example SuDS devices
Detention and/ or retention	Detention basin; retention basin; pond; wetland; engineered detention
Infiltration	Soakaway; infiltration basin; infiltration trench
Source control	Green roof; trees; rainwater harvesting; pervious paving system (PPS); sub-surface storage; rain garden
Filtration	Sand filter; filter strip; filter trench; bioretention
Conveyance	Swale; rill



Proportion of individual country's urban population living in slums (UN-Habitat definition)



Brazil: Law 1, 445/2007 the National Basic Sanitation Law includes urban storm water management

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SDG 6 the "water" SDG





Resolution 64/292, 2010 (United Nations General Assembly): Access to clean, safe drinking water and sanitation is a human right. What about drainage? Is that a human right?

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"However, despite a long history and growing experience in the application of NBSs, there are still many cases where water resources policy and management ignore NBS options – even where they are obvious and proven and effective. Water management remains heavily dominated by traditional, human-built (grey) infrastructure, and the potential for NBSs remains underutilized. Evidence suggests that this is still well below 5% of the total investment in water resources management infrastructure, despite rapidly growing investments in NBSs".

Sustainable Development Goal 6 Synthesis Report on Water and Sanitation

2018



Water and the SDGs – the crucial common denominator

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Using nature-based solutions helps humans and the environment

"One way to protect life and water supply is to harness nature itself – restoring forests, grasslands and natural wetlands, reconnecting rivers to floodplains, creating buffers of vegetation along water courses.

These nature-based solutions are not a panacea but, alongside human-made water and sanitation infrastructure, can help us live in harmony with the ecosystems that literally keep us alive."



Gilbert F. Houngbo, Chair of UN-Water, President of the International Fund for Agricultural Development 13 July 2018

BIOECODS (Bio Ecological Drainage Systems)

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Malaysian design to handle

- High peak rainfall intensities
- Tropical insect pests
- Get the water under the ground



Surface (left) and sub-surface water (right) after treatment



Use of native vegetation: Cow grass (*Axonopus compressus*) as used in the bioecological swale component of BIOECOD



Ghani et al. 2008; Sidek et al. 2002; Zakaria et al 2007

Determining the performance of large biofiltration cells in treating contaminated runoff from a slum settlement in South Africa



1. Surface water issues: General management,

flooding and pollution

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Tree microcatchments



Porous paving

and tree microcatchments



IIISII AVV





2. Greywater: sullage from food preparation, personal washing, clothes washing. Contains soaps, detergents, faecal bacteria, organic matter, skin cells etc. Combines with rainwater and some blackwater.



Communal disposal points for greywater



Lack of community engagement



02

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and ResilienceCGreywater management using biofiltration
Food/ water nexusC





Preliminary results



Origin	Lab.	E. coli	Date	Date	Temperature
	Nr.	cfu/100ml	Tested	Sampled	at reception (°C)
Influent	16805	77010	20/10/2017	20/10/2017	18.6
LSV	16806	2	20/10/2017	20/10/2017	18.6
LS	16807	1	20/10/2017	20/10/2017	18.9
PP	16808	124	20/10/2017	20/10/2017	18.8
PPV	16809	>2420	20/10/2017	20/10/2017	17.8
SSV	16810	1	20/10/2017	20/10/2017	18.8
SS	16811	<1	20/10/2017	20/10/2017	18.2

99% removal of *E.coli* bacteria; 75% reduction in orthophosphate (PO_4^{3-}); and 90% conversion of ammonia (NH_3) to nitrates and nitrites

Analysis of 2 harvests of leafy and bulbous plants conformed to South African standards for edible crops. Soils showed no signs of accumulation of heavy metals or excessive nutrient accumulation.

Meanwhile, in the UK....









5 x coarse (30mm) and 5 x fine (2-5mm) aggregate 1 pair unvegetated 1 pair with Aloe 1 with mesembryanthemum 1 with lavender and 1 with a mixture of plants

Mesembryanthemum

Control

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Synthetic greywater recipe: Washing powder Shampoo Cooking oil No wastewater – organic site!

Watered 2x per week, 1 bucket

Plans for the short-term future: Increase the nutrients in the GW.

Add fertiliser?

Ideas please!!!



C=Coarse F=Fine 1=Mixed plants 2=Aloe 3=Lavender 4=Mesembryanthemum 5=Control





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Nitrates Directive (91/676/EEC): <50 mg/l

Date	stillage	Boron mg/l
15/05/2019	C1	0.056
	C2	0.023
	C3	0.007
20/05/2019	C1	0.046
	C2	0.023
	C3	0.009

Plans for the future:

- Installation below the ground?
- Infiltrate into the ground? Depends on water quality
- Apply elsewhere?
- Trip to Water Hub....

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Refugee camps: Kurdistan Region of Iraq Study site: Gawilan



Challenges: Densely populated Waste is an issue WASH installed (a human right) No greywater disposal Little drainage: flooding Research Centre Agroecology, Water and Resilience



Why? Human and environmental health



Gawilan refugee camp, Kurdistan Region of Iraq



- 1. Background water sampling at 3 sites
- 2. Household survey: water use, personal bathing, greywater management etc
- 3. Community design of management train







Opened in 2013 Population ~8,000



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Issue: combined surface and grey water: Direct it "to another environment"

Information needed



Greywater and stormwater mixture accumulating below the camp

Solid waste in contaminated pools

Shelters



Stream of greywater from the camp carried in V-shaped concrete channels Greywater flows: site walkover



Flow into low-lying wet areas



Community engagement and SuDS workshops



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Male representatives of sector C (1512 residents) closest to the SuDs site, about their role as "producers" and potential "service users".

Site walk through with UNHCR WASH Associate, camp management and women from the SuDs community committee

Results of the SuDS workshop: participatory design Agroecology, Water and Resilience



The final design!

Coventry University







Olive trees planted in trickle trenches

And then....

November 22/23 2018: State of Emergency 3 December: 28 people killed 250,000 homeless











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Gawilan during the flooding



The future?

Damage assessed/ repaired Monitor interventions: SuDS square NFRM at the catchment scale SuDS retrofit at the camp scale





Landscaping complete, materials on site, 2000 trees



Okra growing along trickle trench

Journal of Refugee Studies Vol.0, No. 0 \oplus The Author(s) 2019. Published by Oxford University Press. This is an Open Access article distributed under the terms of the Creative Commons Attribution-NonCommercial-NoDerivs licence (http://creativecommon.com/glicences/by-no-cod4/00), which permits non-commercial reproduction and distribution of the work, in any medium, provided the original work is not altered or transformed in any way, and that the work is properly cited. For commercial resue, pleuse contactjournals.permissions@oup.com doi:10.1093/infer082

The Design, Construction and Maintenance of a SuDS management Train to Address Surface water Flows by Engaging the Community: Gawilan Refugee Camp, Ninewah Governate, Kurdistan Region of Iraq

SUSANNEM. CHARLESWORTH

Centre for Agroecology, Water and Resilience, Coventry University, Coventry, UK s.charlesworth@coventry.ac.uk

MITCHELL MCTOUGH

Centre for Agroecology, Water and Resilience, Coventry University, Coventry, UK and United Nations Development Programme, Iraq

ANDREW ADAM-BRADFORD

Centre for Agroecology, Water and Resilience, Coventry University, Coventry, UK and Greening Innovation Studio

MS received May 2019

Refugee camps are set up under crisis conditions in the Kurdistan Region of Iraq by the United Nations High Commissioner for Refugees (UNHCR) with Water, Sanitation and Hygiene (WASH) installed as a matter of course. However, in general, little account is taken of surface-water drainage or greywater management until the camp floods or greywater streams become an environmental or health issue. This article reports on the construction of a sustainable drainage systems (SuDS) management train in a refugee camp with the community and local non-governmental organizations to address excess surface water and lack of greywater management in this most challenging of environments. There is thus potential to influence policy, at the first stages of planning, to encourage the installation of drainage as well as WASH. SuDS mimic nature by percolating water into the ground, storing it and allowing slow

ace Water gement in nanitarian Contexts



ARUP

on surface water management & drainage for field practitioners

rs/fez082/5581824/ by guest

06 Oct

Version released 22nd January 2019

urvey/403939/question/Surface_

Reducing the opportunities for the Zika virus carrying mosquito to breed in poor areas of Brazil: using SuDS to address standing surface water

Microcephaly in infants 2015-2016.



Neglected and unprotected: The impact of the Zika outbreak on women and girls in northeastern Brazil. Human Rights Watch (2017)



Challenges: Densely populated Waste is an issue Little greywater disposal Little drainage

WASH

Lack of reliable potable supplies: storage of drinking water in open containers



Current practice to reduce Zika infections

Government-led initiatives:

- Fogging/spraying of insecticide
- Larvicide application
- Risk communication door-to-door via health workers





Household activities

- Clearing gutters/drains
- Covering water storage containers

Scientific trials and research:

- Wolbachia bacterium
- Genetic modification of mosquitoes



Testing for zika, dengue, chikungunya

Challenges

- Poor infrastructure
- Location
- Vulnerability to hazards:
 - Natural and climatological
 - Health
- Lack of integration with government initiatives/ planning/ social security support
- Socio-economic issues
 - Fluctuating population growth
 - House the most vulnerable communities
- Crime

Maracanau

Data collection via observation, datasets, interviews, questionnaires: Rebecca Lewis MRes Research Centre Agroecology, Water and Resilience





Observation







Open surface water drain blocked with solid waste

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Rosalina

Research Centre Agroecology, Water and Resilience



Rosalina







Questionnaires / interviews: preliminary results

- 1. Drainage vital, but must be integrated into a holistic environmental health management approach overall strategy solid waste, water/sanitation, health and hygiene
- Those working in favelas: first priority is education on 'environmental/ public health' before infrastructure improvement - communities don't connect microcephaly/zika with WASH/ socioeconomic issues
- 3. Needed to be introduced across the whole urban area, not just informal neighbourhoods.
- 4. Lack of understanding of lifecycle of *Aedes aegypti*, particularly in favela communities, but also "experts".
- 5. It was felt there wasn't a strong conclusive correlation with zika and favelas: zika/ microcephaly in wealthy areas.







Favelas/ informal settlements/ slumsRefugee campsTemporary: self-buildTemporary: set up formally by NGOCan become permanent Located in developing countriesNo WASH infrastructure unless installed by the communityWASH installedWaste disposal an issue Little-no surface water/ greywater managementFlooding and fire problems not addressedFlooding addressed with ditches and pipes: Not fit for purposeNo overall governance/ managementGovernance/ management by Governate in which the camp is locatedLimited understanding of SuDS, but reactive structures at the individual shack or community scaleLimited of understanding of SuDS.No guidelinesGuidelines for camp planning, very little addresses drainagePopulation stabilised/decreasing IndustriesPopulation increasingHouse the poorest, engage in service and tourism industriesHouse the displaced under crisis conditionsNo planningDrainage needs to be included at the earliest stage of planning			
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Technically it is feasible, it needs to be socially inclusive or it will fail accountability "WASH to WASH'D" Socially Kevin Winter UCT responsive transparency participation drainage Is drainage a human right? inclusion

Recommendations

Particularly in countries unfamiliar with SuDS, the design should:

- Engage with the community
- Be simple enough to enable residents, developers and engineers to understand
- Be easy to construct, using existing materials, skills and technology
- Be robust, to allow simple maintenance, repairs or replacement to be carried out
- Have funding in place for construction and maintenance
- SDG6?

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