

THE CHALLENGES OF URBAN DRAINAGE

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URBAN DRAINAGE SYSTEMS

Interaction between human activity
and the natural water cycle

Abstraction of water from natural cycle
to provide water supply for human life

Covering land with impermeable
surfaces that divert rainwater
away from local natural system of
drainage

Wastewater = water supplied to
support life, maintain a standard of
living and **industry**. Drainage after
use to avoid pollution and health risk.

Stormwater: rainfall/snow on
built areas. If not drained properly
→ inconvenience, damage,
flooding, health risks, pollution



STORMWATER MANAGEMENT IN URBAN AREAS

Developed Countries

INCREASING URBAN DEVELOPMENT - CLIMATE CHANGE

FLOODING



SURFACE WATER POLLUTION

✓ DIFFUSE SOURCES

e.g. carpark, roads, (solids, metals, pesticides, hydrocarbons, solvents...)



✓ POINT SOURCES

Combined Sewer Overflows (CSO)



EVOLUTION OF URBAN DRAINAGE



Traditional approach (conveyance)

Prevention of flooding locally → Quick conveyance

Historically: combined sewer system → CSO

Over last 50 years: separate systems → surface water pollution due to diffuse sources

Quantity

> 1980

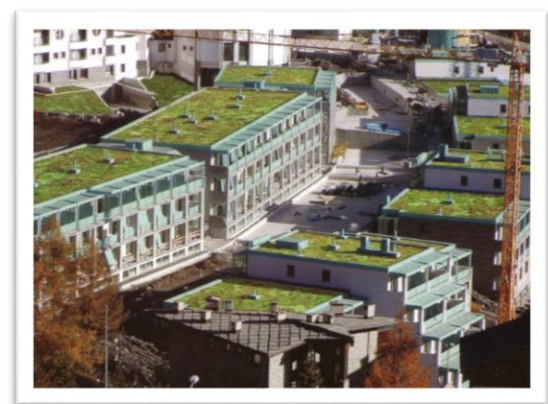
Conservative approach (storage)

Conveyance and temporary retention
e.g. Stormwater tanks



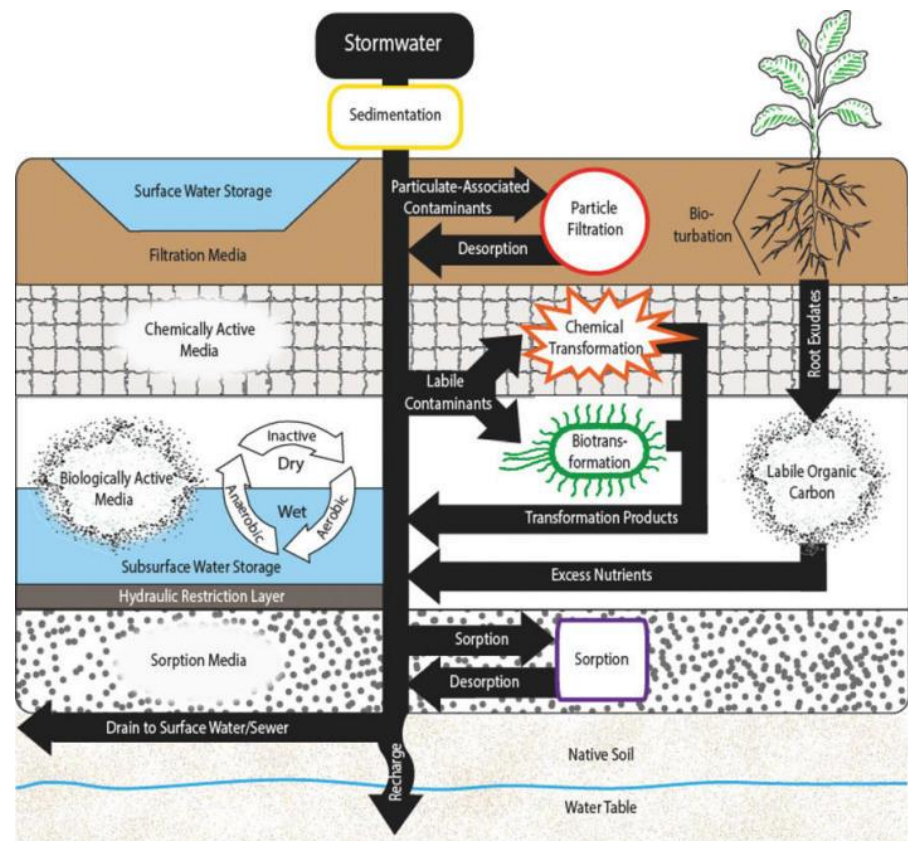
Quality

> 1990



Sustainable approach (management at source)

Stormwater is a resource - protection of water resources -
enhancing flood resilience - promote ecosystem services



DRAINAGE IN LOW-INCOME COMMUNITIES

Provision of drainage and solid waste management often lags behind water supply and sanitation.

Poorly managed runoff can lead to: frequent flooding → water supply and sanitation difficult to install/ineffective in operation; wastewater conveyed by storm drains; pollution from overflowing latrines; cross contamination of water supplies; ponding water as habitat for vectors → **severe health impact**

- Poorer households much more likely to inhabit areas at risk of flooding
- Slum dwellers: Least recourses to assist in the recovery from flood impact

→ Social/Institutional/technical issues - Need for integrated approach to stormwater, sanitation and solid waste management

Reduced capacity



Lack of drainage system



Workshop: CLIMATE RISKS TO KENYAN INFRASTRUCTURE

8th December 2017, Nairobi

Royal Academy of Engineering funded project “**Resilience of Linear Infrastructure in East Africa**” (PI: Fleur Loveridge, Civil Engineering, Univ. of Leeds)

Nairobi Metropolitan Area Transport Authority (NaMATA), Kenya Railways, ARUP, Overseas Development Institute (ODI), Stockholm Environment Institute (SEI), Kounkuey Design Initiative (KDI) Universities of Leeds, Bristol & Nairobi.

Engineering challenges – Community Engagement – Urban Planning – Political Economy

OUTCOMES:

- ✓ Lack of **drainage asset data** (drainage system plan and conditions=capacity)
- ✓ Uncritical transfer of developed countries **standards** led to costly inoperative infrastructures (e.g. silt traps design based on British climatic conditions)
- ✓ **Climate data** is out of date → undersized drainage results from standard designs, often adjusted by engineers on the basis of experience
- ✓ **Rapid urban development** challenges stormwater planning. In formal areas, better economy and multi-storey building → higher water consumption and pressure on existing drainage infrastructures

Workshop: CLIMATE RISKS TO KENYAN INFRASTRUCTURE

8th December 2017, Nairobi

- ✓ **Maintenance** (most of the drainage systems are open drains) → reduced capacity due to **siltation/erosion & solid waste** accumulation
- ✓ Improving drainage system at a relatively local level can create problems downstream/upstream → A holistic **approach to sustainable urban drainage system at the city scale** is required
- ✓ Need for **Engagement with landlords of properties built in floodplains** – Difficulties in obtaining information on land ownership
- ✓ Importance of **mapping flooded areas** to support stakeholders and governments in decision making
- ✓ Promote **community engagement** and a sense of ownership on drainage related projects from planning, design to construction and maintenance
- ✓ Potential of **SuDS/Green Infrastructures** in context of investments in urban upgrading projects that focus on slums. Need for demonstration projects.
- ✓ Lack of climate data prevent to **include climate change in Urban Planning**

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On June 3 2015, over 150 people who were seeking shelter at the Circle GOIL Filling Station died in an explosion after floods

Objectives

- To analyse the flood risk and assess the causes of urban flooding in a pilot area
- To develop a methodology for urban flood risk assessment

Methodology

Drainage + Solid Waste Management

- Stakeholder consultation
- Technical and social data gathered through smart surveys during fieldwork (smartphone app Akvo Flow to collect data)
- QGIS + Openstreet map
- 1D-2D Hydrodynamic model
- Georeferenced data from citizen through WhatsApp and Facebook





PROJECT FLOOD RISK ACCRA

FINDINGS

Flooding in the Alajo and New Town pilot areas are caused by a **combination of factors**:

- a) Drainage network not properly design and maintained
- b) High Heterogeneity of the drainage network (individuals and communities building their own drains due to failing or non existing infrastructures provided by government) → poor connection & erosion path
- c) Waste and Silt accumulation → reduced capacity especially in low-lying areas – awareness to be raised upstream areas
- d) Lack of spatial planning and weak cooperation between responsible institutions for drainage management
- e) Due to misrepresentation of storage/drainage capacity no clear conclusion of the model – for the areas studied flooding could be caused by downstream water levels

PhD Project: CITY SCALE MODELLING OF FACTORS AFFECTING URBAN PLUVIAL FLOOD RISKS IN RAPIDLY DEVELOPING CITIES

PhD Student: Victor Olajubu

Supervisors: Christian Berretta, Mark Trigg, Andrew Sleigh

Aim: to investigate the impact of climate change, rapid urbanization, reduced capacity of drainage due to solid waste and solids, drainage system design on urban flood risk at the city scale



Ojiro Rd, Nairobi – April 2016



Westlands, Nairobi – March 2018 – Kenya News

PhD Project: CITY SCALE MODELLING OF FACTORS AFFECTING URBAN PLUVIAL FLOOD RISKS IN RAPIDLY DEVELOPING CITIES

METHODOLOGY:

- ✓ Develop of model of coupled surface overland flows and urban drainage systems flow of greater Nairobi catchment using LISFLOOD FP linked to EPA Storm Water Management Model (SWMM).
- ✓ Acquisition Topographical data: MERIT (Multi-Error-Removed Improved-Terrain) DEM – an open global spaceborne topographical dataset
- ✓ Develop urban land expansion map for Greater Nairobi and analyse the impacts of overland flow from impermeable area (future developments) on resilience of urban drainage system.
- ✓ Use of CP4A precipitation datasets – resulting from HyCRISTAL ongoing NERC & DFID funded project using a new model (geospacial) for current and future climate (precipitation) scenarios in East Africa.



Thank you for your attention!

PROJECT: ASSESSMENT OF COMMUNITY BASED MAINTENANCE OF DRAINAGE SYSTEMS IN ACCRA, GHANA

DESK STUDY:

- Digitise drains that may not have been considered during previous survey → DEM
 - QGIS with Google Earth Satellite maps – Street view of Google Earth Pro

Multiple criteria to identify critical points:

- Points of low elevation
- Points or junctions of multiple drains
- Change in drainage characteristics: open system to a closed system (culvert)
- Broken/ damaged drains
- Proximity of drainage to heavy volumes of human activity (e.g Commercial activities/markets)

FIELDWORK:

- Field verification (Ground-truthing) of drains and critical points
- On-site observation of National Sanitation Day
- Informal interviews: Department of Urban Roads (DUR), Ministry of Local Government and Rural Development (MLGRD), and the Accra Metropolitan Assembly (AMA); Solid waste management company (Zoomlion)

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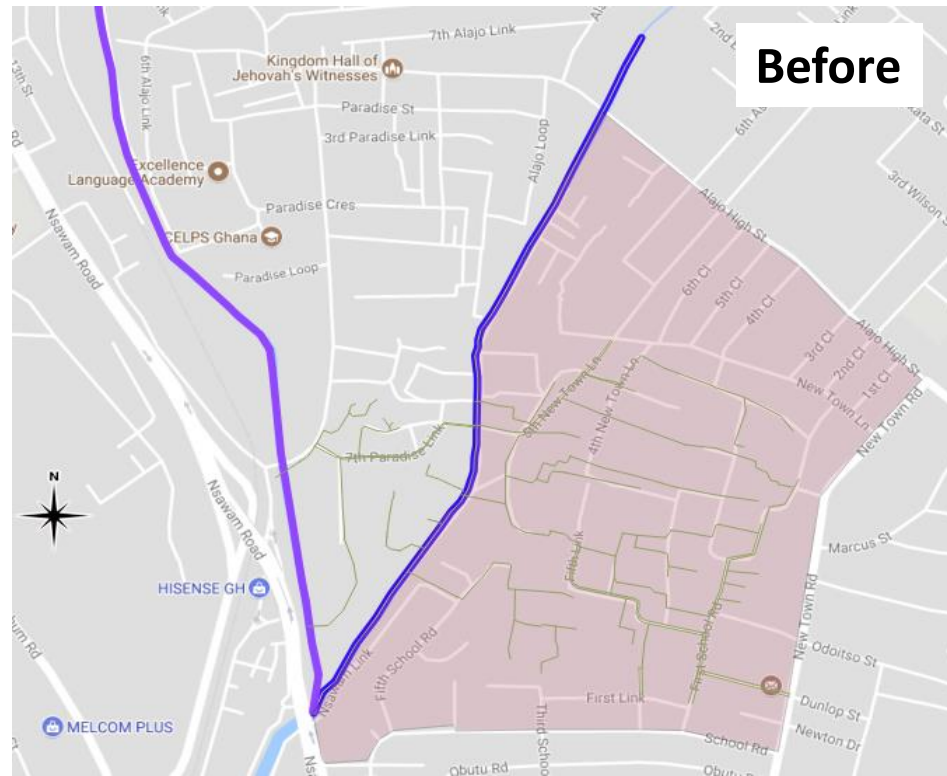
Reduced capacity



Natural drainage



Before



After

