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Are WASH services climate ready?

Vulnerability assessment and adaptation options

World Water Week, 27.08.2019

Session programme

14:00-14:05	**Welcome message** Barbara Evans, University of Leeds
14:05-14:25	**Introduction : links between WASH, climate and health & climate vulnerability assessments** Colette Génevaux, pS-Eau & Guy Howard, University of Bristol
14:25-15:20	**World café** [two rounds] 1. Climate risk and vulnerability assessment: the case of Livingstone Town Water Supply and Sanitation Service, Zambia 2. Building Resilience from the Bottom Up: Participatory WASH Vulnerability Analysis in Bangladesh 3. Building adaptation to climate change in health in least developed countries through resilient WASH (Ethiopia) 4. HyCRISTAL: Integrating Hydro-Climate Science into Policy Decisions for Climate-Resilient Infrastructure and Livelihoods in East Africa
15:20-15:30	**Wrap-up and conclusion** Leonard Tedd, DFID

Links between climate change, health and WASH services

Colette Génevaux

World Water Week, 27 August 2019

The main climate hazards directly impacts water resources, as well as WASH services

- Rising sea levels
- Variability of seasonal rainfall patterns
- A rise in average temperatures + heatwaves
- Increase of the periods of droughts
- Greater frequency and intensity of extreme events

Impacts on water services

Impacts on water availability and demand

- Increase in water needs for all uses
- But also potential decrease in saline areas

Impacts on infrastructure and facilities

- Over-use to meet high demand, risks of dry-pumping
- Floods can damage facilities (electrical equipment in particular) and impact access to water points

Impacts on service quality

- Interruption of service due to lack of resources or damaged infrastructures
- Drop in the water quality

Impacts on sanitation services

Impacts on service access and operation

- Degraded facilities due to floods: latrine collapse when poorly built, breakdown of pumps
- Disruption of emptying services, as some areas become inaccessible
- Failure of treatment processes: high temperatures can impacts biological processes, or due to hydraulic overload

Impacts on the environment

- Drop in water resource quality due to lower dilutions of pollutants
- Increased risks of untreated wastewater discharged in the environment: from the flooding of toilet pits or overflow of fstp or wwtp

Associated health effects

Increased risks of water and vector-borne diseases

- The lack of water in quantity and quality results in poor sanitary conditions
- Limited access to toilets result in more open defecation
- Dysfunctional faecal sludge or wastewater treatments pollute the environment and increase exposure to faecal contamination

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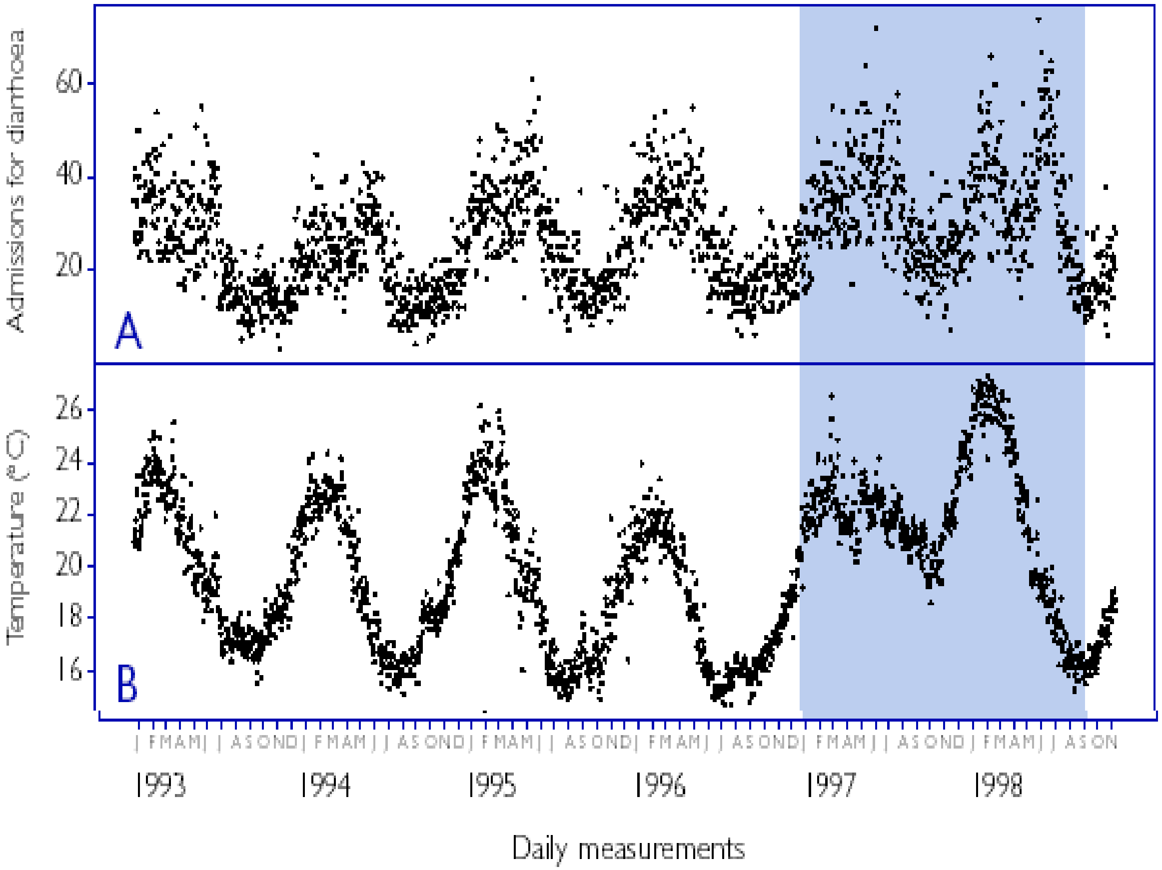
Increases in diseases of poverty may be even more important



Diarrhoea is related to temperature and precipitation. In Lima, Peru, diarrhoea increased 8% for every 1^0C temperature increase.

(Checkley et al, Lancet, 2000)

World Health Organization

Associated health effects

Increased risks of water and vector-borne diseases

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Greater migrations and/or risks of water use conflict in water scarce areas

More difficulty involved in the water chores, affecting primarily women and girls

Key considerations for taking action

- Assess the vulnerabilities at the different levels of intervention - local, national scales / watersheds, including the transboundary scale
- Identify areas of improvements and implement solutions
- Monitor & learn from experience

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Climate vulnerability assessments

Guy Howard

University of BRISTOL

What is a CVA?

- Systematic assessment of the impact that climate change will have on water and sanitation - safety, accessibility and sustainability
  - Can be quantitative, semi-quantitative or qualitative

- Important to be clear about purpose and scope from the outset
  - Macro-level CVA may be useful in terms of identifying priority areas for investment but detail in CVA will be limited for operational actions
  - Micro-level (e.g. particular groups of communities) – detailed CVA to define operational actions and priorities

CVA: issues of scale to consider

- Water security (or water resources) CVAs – typically large-scale (basin, national) – linking to macro-level decisions (IWRM)
  - May be transboundary (intranational or international)
  - Covers all uses of water and trade-offs between uses
  - Large-scale changes in demand and efficiency
  - Water supply and sanitation small overall component & may lack profile
- Water supply and sanitation CVAs – typically smaller-scale (to reflect nature of catchments etc)
  - Need detail of catchments and processes to understand hazards and risks
  - Local quality and quantity changes may be significantly larger than macro-level averages

What are the climate-related events of relevance to WASH?

Extreme events

- Flash flooding
- Drought – both seasonal and intra-seasonal
- Storm surges
- Contamination spikes – first flush/contamination fronts

Non-extreme changes

- River and groundwater flooding
- Reduced carrying capacity (intake and outflow waters)
- Temperature influenced quality changes (e.g. cyanobacteria)
- Temperature influenced excess demand
- Saline intrusion from sea-level rise

National (more qualitative) CVA of WASH

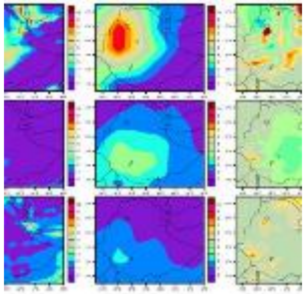
- Purpose: to inform national decisions on policy, investments and forward planning
  - **Examples**

  identify regions particularly vulnerable to climate events in the future and use this to make new investment case

  make policy/regulatory decisions regarding the choice of technologies (e.g. phasing out dug wells)

  identify areas where humanitarian responses are likely to be required to put in place preparedness plans and supplies

Types of information required: climate



- Current climate variability by sub-national unit
- Frequency of current extreme events by type
- Projections on temperature and precipitation from down-scaled models – look for sub-national projections; look for decadal projections if available(but be clear on uncertainty)
- Assessments already carried out on future risks of floods and droughts in different regions

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National CVA: WASH information needed

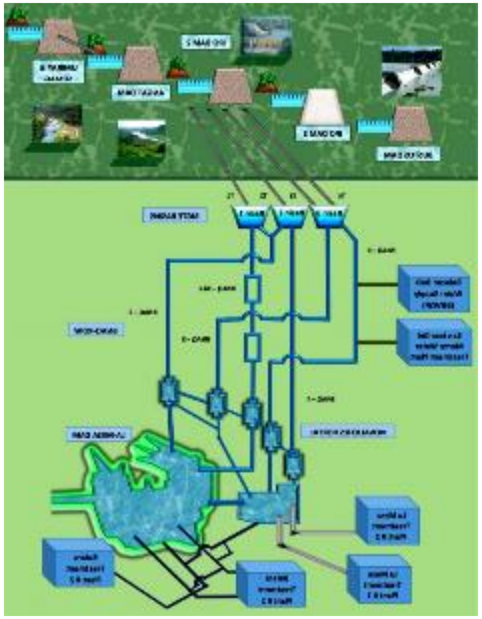
- Coverage dissaggregated by sub-national administrative unit and by:
  - technology type
  - service level
  - management system
- And note:
  - known major interruptions to water and sanitation services
  - known water quality problems (e.g. salinity, arsenic)
  - known diarrhoeal disease hotspots
- Evidence of susceptibility of technologies and management to extreme events
- Patterns of poverty and inequality
- Wider assessments of resilience and ability to adapt to climate change in different population groups

CVA at local level

- CVAs need to be done at local levels in order to understand vulnerability, resilience and options for improvement - feed into WSPs/SSPs
- Two approaches:
  - For utility supplies - system-specific
  - For small community supplies – carried out at community or multi-community level
  - Different levels of resources required for each, but in each need to integrate climate information & WASH expertise

Utility supplies: water

- Need to comprehensive picture of system:
  - sources and catchments, including polluting activities
  - hydrology, hydrogeology, limnology, cryosphere influencing sources
  - location of intakes and protection measures
  - treatment processes used
  - map of distribution systems overlain with topography, flood risk and socio-economic status
  - water quality and operational data, including failure data
- Need picture of likely climate changes
  - DO NOT try to down-scale, but use sub-national projections or any projections for the basin



Examples

US EPA

- Set of case studies at the Creating resilient water utilities website

https://www.epa.gov/crwu

Seattle eg from CRWU

Type	Resilience strategies
Tier One measures	Increase usable storage capacity by eliminating conservative operating assumptions from water system supply calculations; covers potential supply shortfalls in 2025
	Increase Chester Morse Lake refill; increase Cedar River watershed storage; increase South Fork Tolt Reservoir drawdown to increase total watershed storage
Tier two measures	Modify and optimise conjunctive use operations
	Increase use of Lake Youngs storage
	Implement additional conservation programs after 2030; covers potential shortfalls in 2050 and 2075.

Tier 1: low or no cost options for short-term
Tier 2: medium to high cost options for long-term

Analysis of potential impacts of climate change and development of adaptation options being updated for inclusion in 2019 WSP

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Small community CVAs: some challenges

Management, supply chains and support vary significantly, but maybe the weakest element rather than technology

Lots of different water supply technologies – maybe multiple sources or just one in a community. Very localised catchments

Different sanitation technologies may be found in one community, each with different vulnerability

Small community water supply CVA

Type of information	Data collection measures
Numbers and types of water sources (including multiple source use) and sanitation used	Inventories with as much detail as possible (e.g. well depth, age, lining material etc) water use and sanitation use studies
If treatment used, water processes used	Treatment plant design, field assessment
Source and catchment protection measures in place	Protected areas, land-use, trends in land use change, other users of water or discharges
Impact of current weather events	Water quality and sanitary inspection data (records and/or studies), weather data, regression analyses
Community ability/readiness to adapt	Review other climate resilience assessments, socio-economic status, focus groups with communities
Downstream users of water	How many, for what etc

Adaptation options for water services - examples

- Better demand management and resource knowledge
- Reduce vulnerability of the water service
- Diversify water sources when possible
- Optimise water service delivery systems
- Prepare for extreme events: develop information systems, contingency planning
- Resource protection and management

Adaptation options for sanitation services - examples

Increase safely-managed sanitation coverage

Reduce vulnerability of the service operation

- Adapt system designs to resist floods: adapted and standardized latrine conception; increased treatment capacity of fstp or wwtp
- Better monitoring of the quality of fecal sludge or wastewater treatments

Develop and strengthen stormwater & solid waste management

Mitigation options

Research is still needed to better know the potential of mitigation for water and sanitation services. However, some key points can already be considered:

Energy sources for water services

- Solar-pumping can be very appropriate for small water systems.
- Improve energy efficiency: optimised pumping times, increasing the capacity of reservoirs, streamline maintenance and potentially replace equipment or vehicles by low-emission ones

Mitigation for sanitation services

- Optimise or reduce distance to be travelled (in particular for the collection of excreta), reduce the volumes to be transported and treated
- Choice of wwt technology: low-emission treatment processes, gravitational treatment systems using renewable-energy sources, etc.
- Consider energy potential of sanitation in a circular economy approach: energy production - including within-system energy generation, reuse, etc.

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Conclusion

- WASH services are directly impacted by climate hazards

- A comprehensive understanding of climate risks on WASH systems is required
  - Data collection systems should be strenghtened
  - Climate vulnerability assessments are useful tools to give a comprehensive picture of the systems

- Adaptation of WASH services should consider the different scales of action
  - Adapted to the local context
  - In line with national approach, policies and strategies
  - Integrate cross-sectoral issues

- Mitigation potential for sanitation systems should be considered when appropriate

World café

1. **Building Resilience from the Bottom Up: Participatory WASH Vulnerability Analysis in Bangladesh**
   Virginia Newton-Lewis, WaterAid
2. **Building adaptation to climate change in health in least developed countries through resilient WASH**
   Waltaji Terfa Kutane, WHO Ethiopia
3. **HyCRISTAL: Integrating Hydro-Climate Science into Policy Decisions for Climate-Resilient Infrastructure and Livelihoods in East Africa**
   Barbara Evans, University of Leeds

From the bottom-up: community assessment of WASH vulnerabilities

Examples from Bangladesh and West Africa

Dr Virginia Newton-Lewis

Senior Policy Analyst – Water Security

27/08/2019

WaterAid

SW Bangladesh PVA

WaterAid

HyCRISTAL Urban

FUTURE CLIMATE FOR AFRICA

Mitigation – estimating direct emissions from real pit latrines

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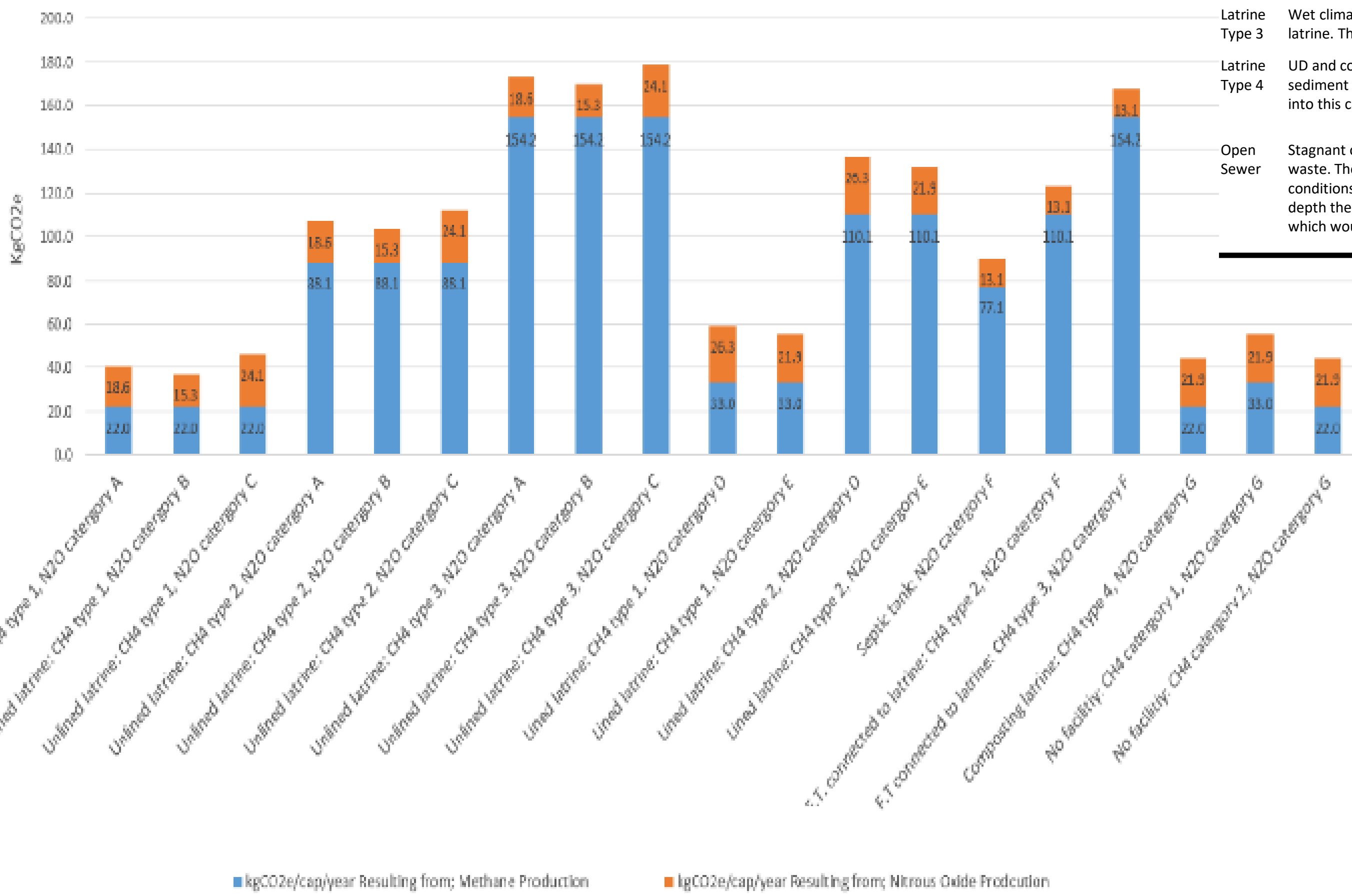
Predicted Emissions of Each Individual Storage Technology per User ($kgCO_2e$/cap/year)



OSS Technologies (correspond to CH_4 type)	
Septic Tank	Anaerobic environment. Half of BOD settles in tank.
Latrine Type 1	Household latrines in dry climate, with ground water table well below bottom of pit
Latrine Type 2	Communal latrines in dry climate, ground water table well below bottom of pit, Many users, higher volume of FS leading to a more anaerobic environment. These latrines are often poorly maintained.
Latrine Type 3	Wet climate/flush water use, ground water table higher than latrine. These types of latrine have more anaerobic conditions.
Latrine Type 4	UD and composting toilets, aerobic environments. Regular sediment removal for fertiliser. Bucket latrines may also fall into this category providing waste is correctly disposed of.
Open Sewer	Stagnant open sewers are often the site for illegal emptying of waste. They are heated by the sun which can lead to ideal conditions for methanogenesis however depending on the depth the sludge the top layers may be in aerobic conditions which would inhibit methane production.

N_2O Category	
A	nitrification in the upper layers of the pits, not much denitrification is predicted to occur at the bottom
B	simple latrines, where the conditions are predicted to be slightly less aerobic in the upper layers of the sludge
C	account for both denitrification and some nitrification
D	increased nitrification in VIPs and more denitrification occurring deeper within the pits
E	simple latrines with less nitrification occurring at the surface
F	septic tanks in warmer climated countries
G	composting latrines designed for arobic decompositions and open defecation practices

Mitigation – estimating direct emissions from real pit latrines

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Mitigation: GHG emissions from sanitation estimated breakdown by source - Kampala

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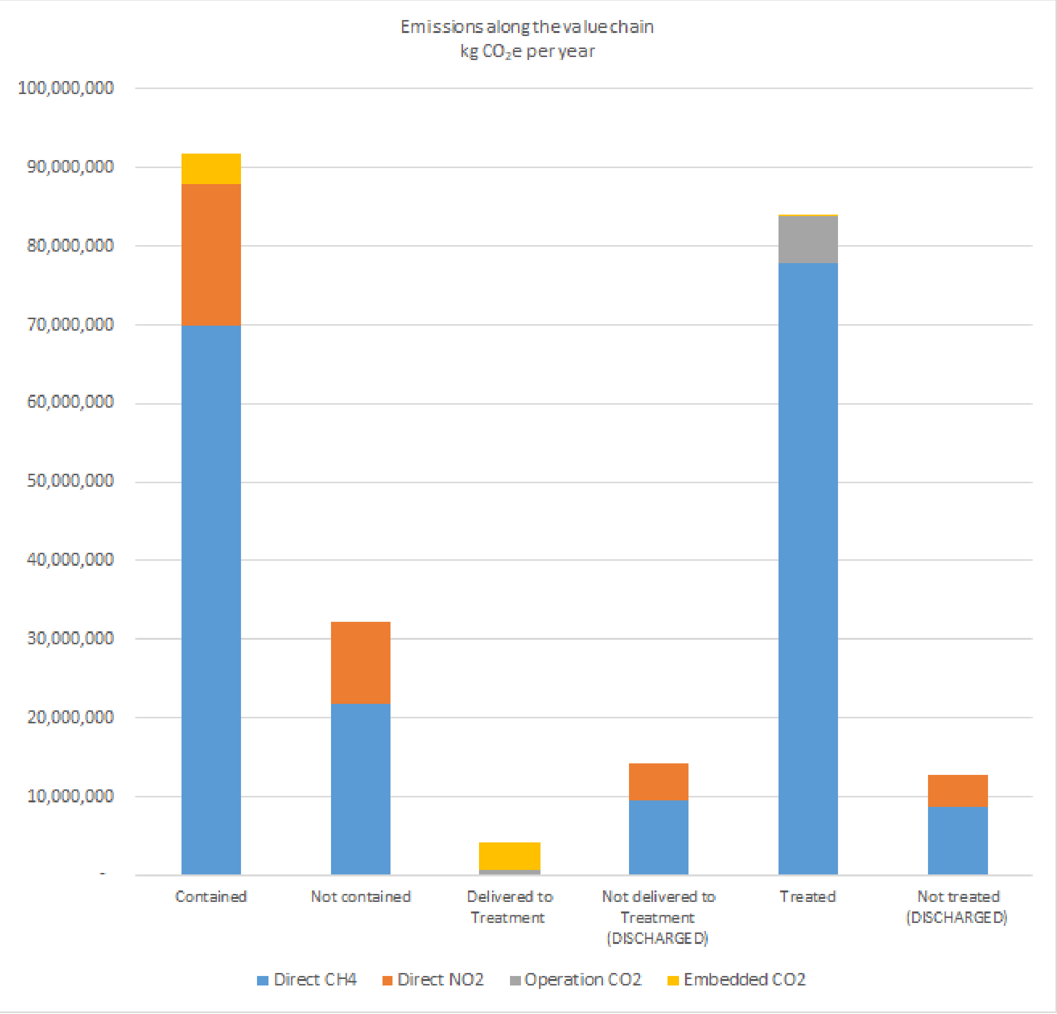

Mitigation: GHG emissions from sanitation (Lwisa 2013 adjusted and HyCRISTAL)

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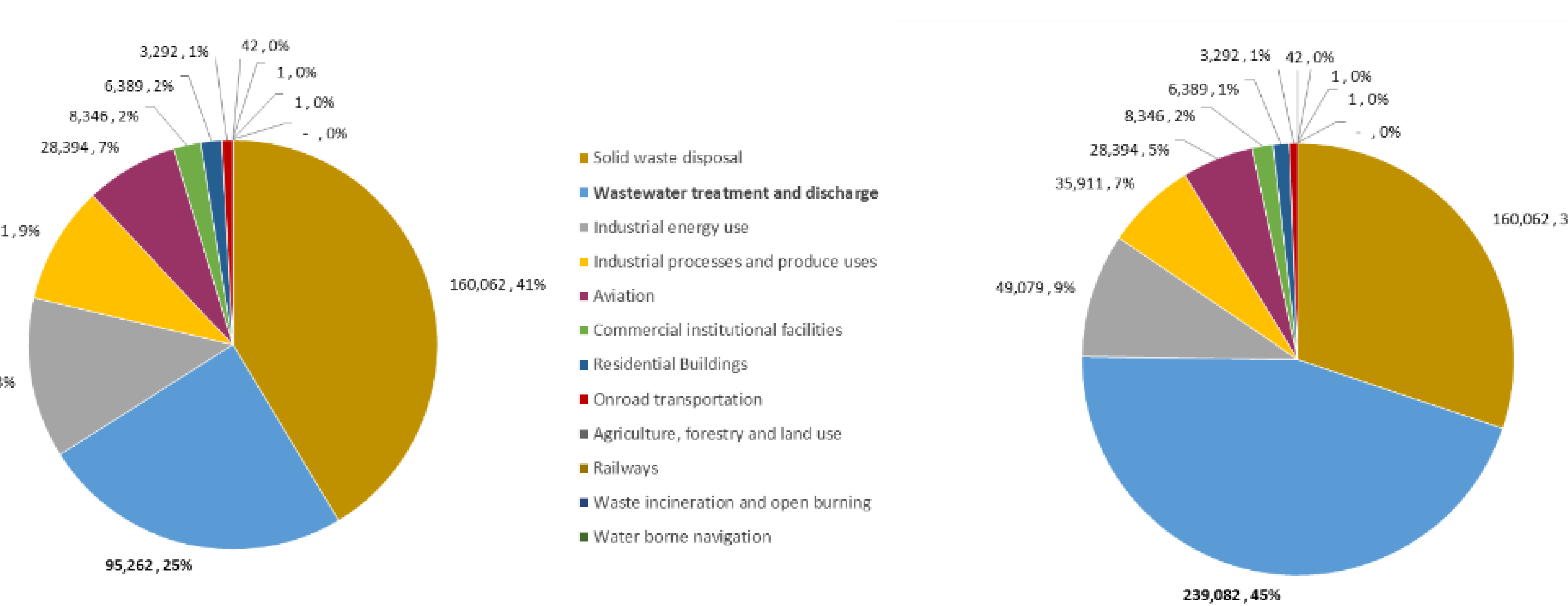
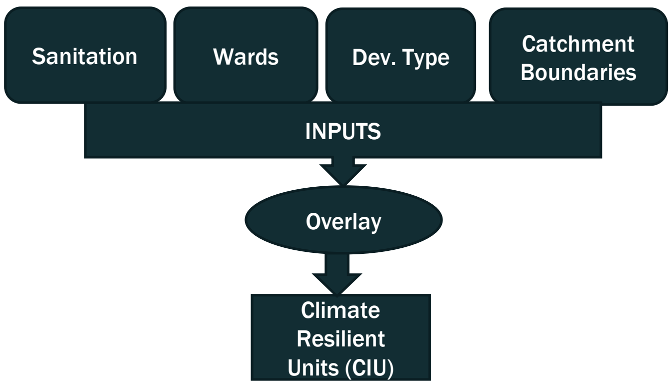
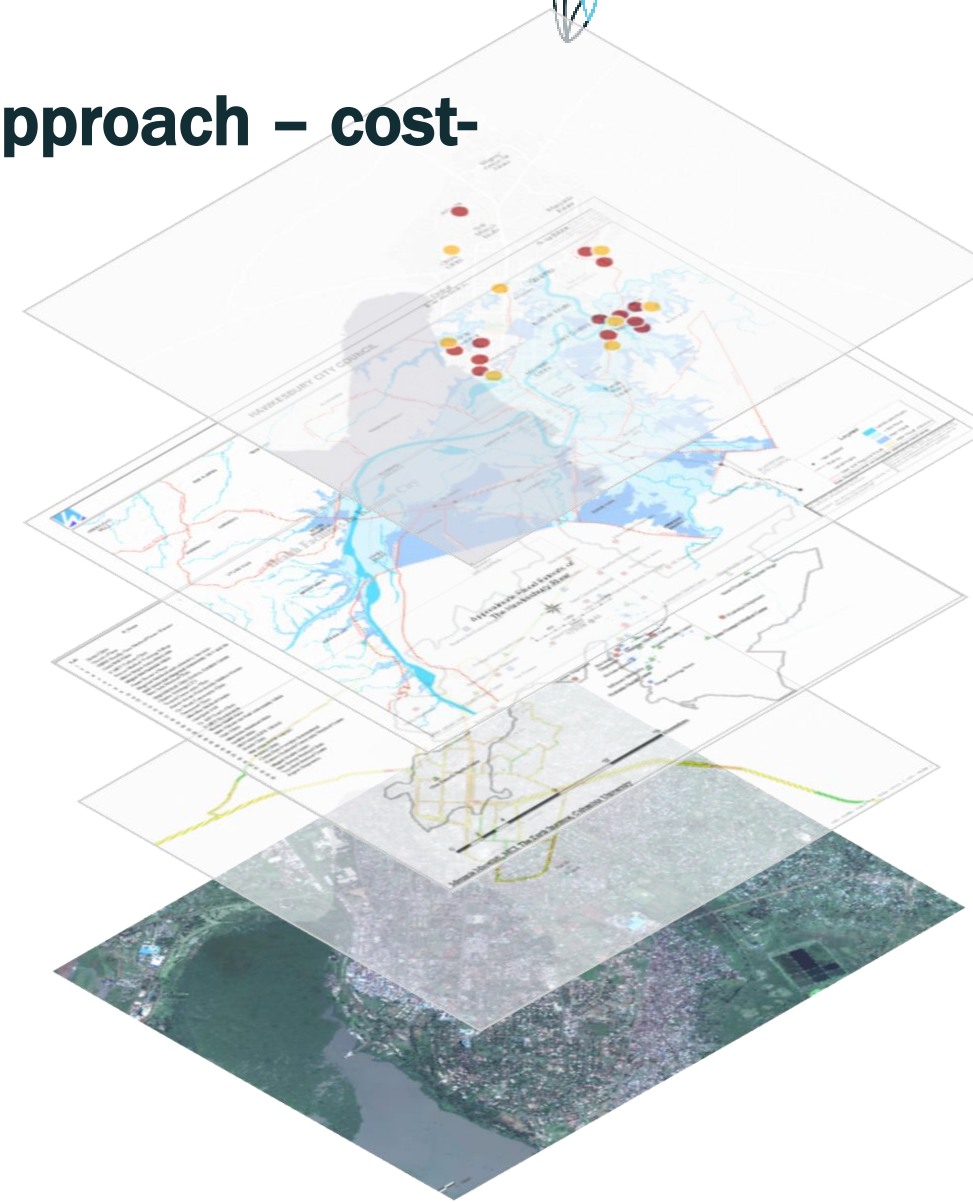
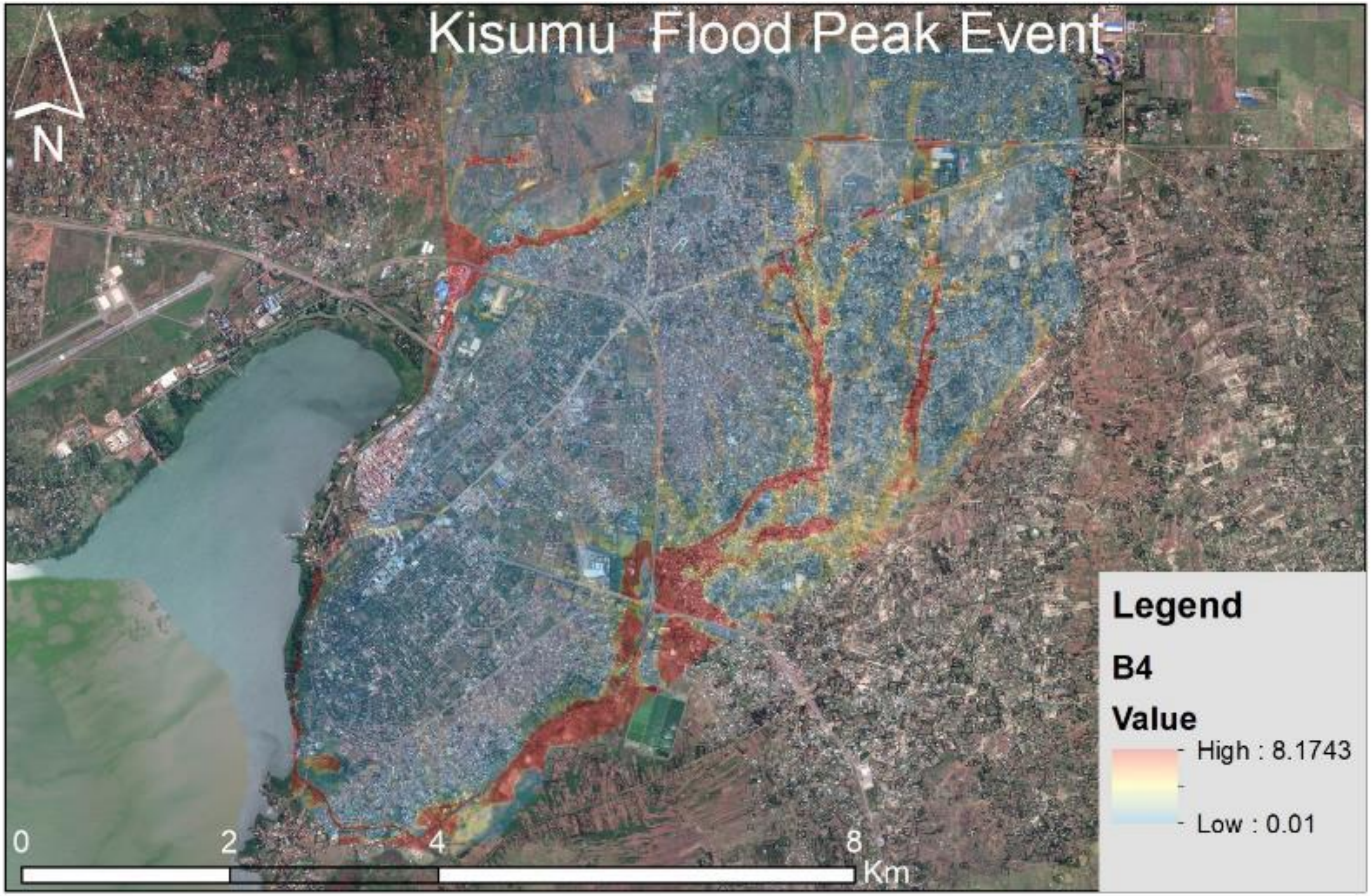


Adaptation: Risk based approach – cost-benefit calculations






Kisumu Flood Peak Event
N
Legend
B4
Value
High : 8.1743
Low : 0.01
0
2
4
8
Km

HyCRISTAL

We can then test the “value” of adaptation in terms of reduced health burden or infrastructure damage

CRU1

	Attributes
n	Number of households
nt	Number of toilets
P	population
tt	Type of toilet
ts	Toilet status (% full)
Vt	potential volume of faecal matter in toilet (full)
Vf	Volume of flood (at peak)
A	% area flooded
R	% flood water passing on to next CRU(s)
Cf	concentration of pathogens in floodwater
Ct	concentration of pathogens in toilets

CRU2

	Attributes
n	Number of households
nt	Number of toilets
P	population
tt	Type of toilet
ts	Toilet status (% full)
Vt	potential volume of faecal matter in toilet (full)
Vf	Volume of flood (at peak)
A	% area flooded
F	% flood water passing on to next CRU(s)
Cf	concentration of pathogens in floodwater
Ct	concentration of pathogens in toilets

CRU3

	Attributes
n	Number of households
nt	Number of toilets
P	population
tt	Type of toilet
ts	Toilet status (% full)
Vt	potential volume of faecal matter in toilet (full)
Cf	concentration of pathogens in floodwater
Ct	concentration of pathogens in toilets

CRU3 calculations:

Number of people affected by flood:
$N_3 = P_3 \times A_3$

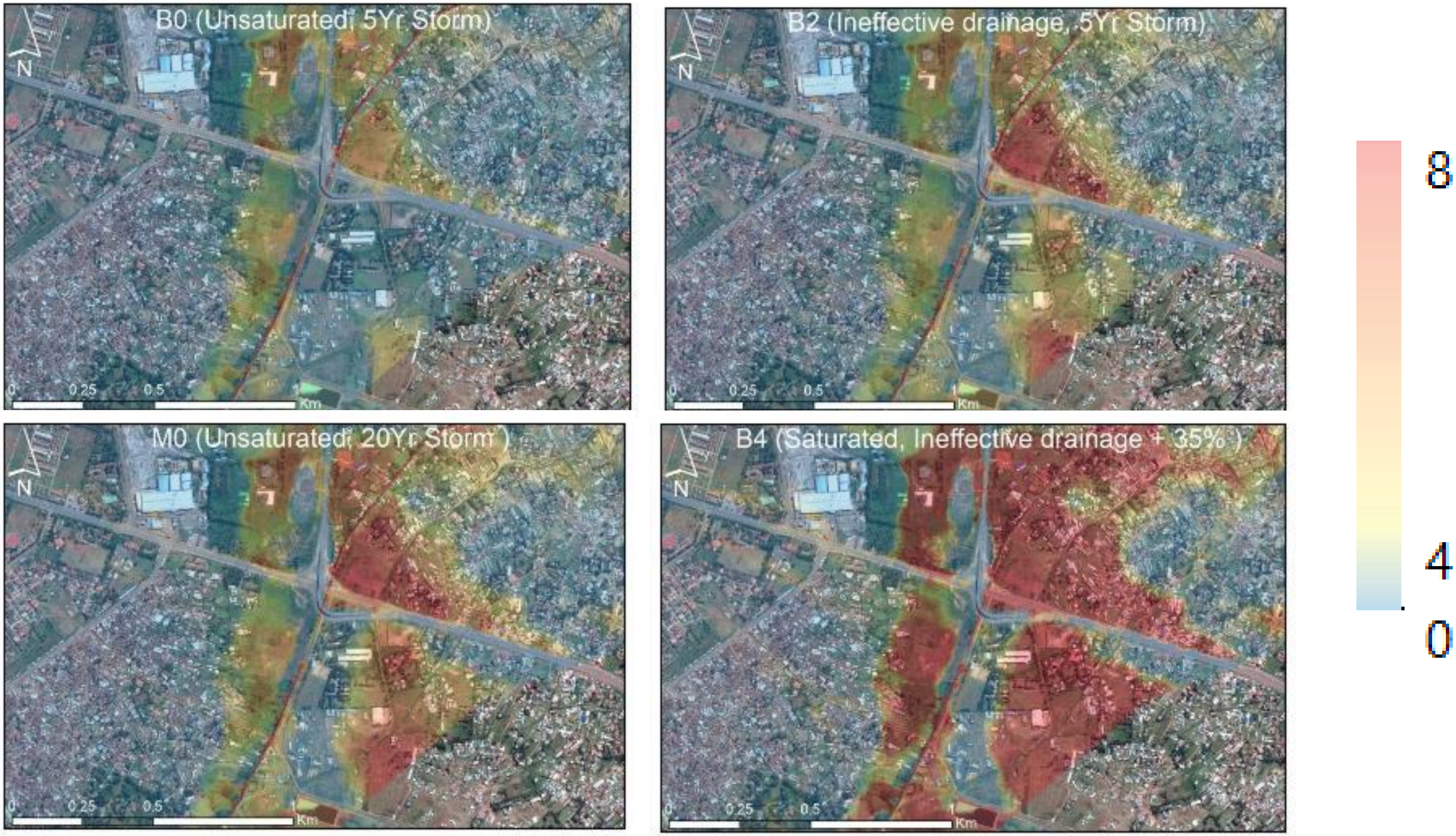
Background pathogenic hazard from toilets within area:
$\frac{(nt_3*s_3*A_3)*(Ct_3*Vt_3)}{Vf_3 + (nt_3*Vt_3*s_3)} = PHE_3$

Additional pathogenic hazard from incoming floodwater:
$(Vf_1*F_1*Cf_1) + (Vf_2*F_2*Cf_2) = PHI_3$

Concentration of pathogenic hazard exiting CRU3:
$PHE_3 + PHI_3 = PHO_3$

Risk of disease/ disease incidence: $R_3 = f[N_3 \times PHO_3]$

Total disease incidence: $R_T = R_1 + R_2 + R_3$


B0 (Unsaturated; 5Yr Storm)
B2 (Ineffective drainage, 5Yr Storm)
M0 (Unsaturated; 20Yr Storm)
B4 (Saturated, Ineffective drainage + 35%)
N
0
0.25
0.5
1
Km
8
4
0

World café

3. Building adaptation to climate change in health in least developed countries through resilient WASH

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