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Adaptive water quality management for communities most vulnerable to floods in secondary riverine cities in West Africa

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Abstract

Background: The frequency of extreme weather events associated with climate change, particularly floods, has increased in West Africa. Floods can negatively affect water quality by causing faecal pathogens contamination in riverine cities in West Africa. However, there is a paucity of data showing key vulnerabilities to and resilience strategies for major flooding in riverine cities of West Africa.

Aim: To assess risk factors, vulnerabilities and resilience strategies in the face of flooding events at household and community levels.

Methods: Geographical and transversal household surveys have been undertaken in Korhogo, Côte d'Ivoire (212,000 inhabitants, near a dam) and Kaédi, Mauritania (71,000 inhabitants, near a river). The household surveys undertaken in rainy season and covering the entire city followed a three category stratified sampling scheme: most vulnerable to floods, most protected, and intermediary (200 households in each).

Results: For Korhogo and Kaédi, respectively, we found 347 and 117 wells in close proximity to streets; 60% and 12% of households have their own wells in the yard; 90% and 69% of households have latrines in the yard; and 63% and 33% of households use water from wells for drinking purposes.

Conclusion: In the two West African cities studied here, flooding threatens on water quality and health, thus, adaptive management strategy for water is needed.

1 Introduction

Climate variability and climate change in Africa will cause floods to occur more frequently and with higher intensity in many regions of the continent (Hulme et al. 2001, Mbaye 2004; Sylla et al. 2010). In 2007, for example, 13 West African countries, including Côte d'Ivoire, Mauritania, Senegal and Togo, experienced floods, affecting more than 600,000 people (UN 2007). In the same year, over 200 major floods worldwide affected 180 million people (Pitt Review 2008). Damages, particularly the effects and impacts on water and health, were less efficiently managed in developing countries, due to a lack of early warning systems and because of inherent institutional weaknesses at both nationally and local levels. The challenges posed by Africa's low institutional and financial capacities for adaptation to climate change have been well documented (Cissé et al. 2010).

The short-term and long-term effects of floods on health have been documented for developed countries (Selena Gray 2008), but there is a paucity of studies on the health effects and impacts of flooding in the developing world. The grey literature from various non-governmental organizations (NGOs) regularly report on the short-term effects of floods on water and water-related diseases in flood-prone countries. According to these reports, the effects generally include the affected populations being moved from their residential area, loss of assets, personal anguish, and/or mental disorders. Some outbreaks of diarrhoeal diseases, including cholera, have also been associated with floods.

Currently, some 50% of urban dwellers live in cities or towns with fewer than 500,000 inhabitants (UNHabitat 2008a, b) and, in the near future, half of the increase in urban populations is expected to occur in urban settings of this size (Costello et al. 2009; Potts 2009). This influx of people will have a major impact on urban dynamics in Africa; not only in the capital cities, but also in secondary cities, particularly those in close proximity to water networks, such as rivers, man-made lakes and irrigation systems. These areas are prone to flooding, yet there is a lack of appropriate water management plans to enhance resilience of the individuals and the communities living there or prepare people and institutions for the challenges of adapting to climate change. Disaster prevention literature emphasizes the importance of adopting an adaptive management approach to water, protecting of water quality and the reducing water-related diseases in the short-, mid- and long-term (WHO 2009a, b). An adaptive management approach to water consists of an integrated surface water management, ground water management, solid waste management, adapted sanitation facilities, protection of aquatic ecosystems, and ecosystem services.

The present study is undertaken as part of a 3-year project entitled "An ecohealth approach to water and health management in relation to climate change: adaptive strategies to cope with drought and floods in four West African countries (Côte d'Ivoire, Mauritania, Senegal, Togo)", funded by the International Development Research Centre (IDRC) in Canada. The project targets four secondary cities, all of which are located in close proximity to major freshwater bodies: Korhogo, (near a dam); Kaédi, (near a river); Ziguinchor, (near a river); and Kara, (near a river), as seen in Figure 1.1 (Cissé et al 2010).

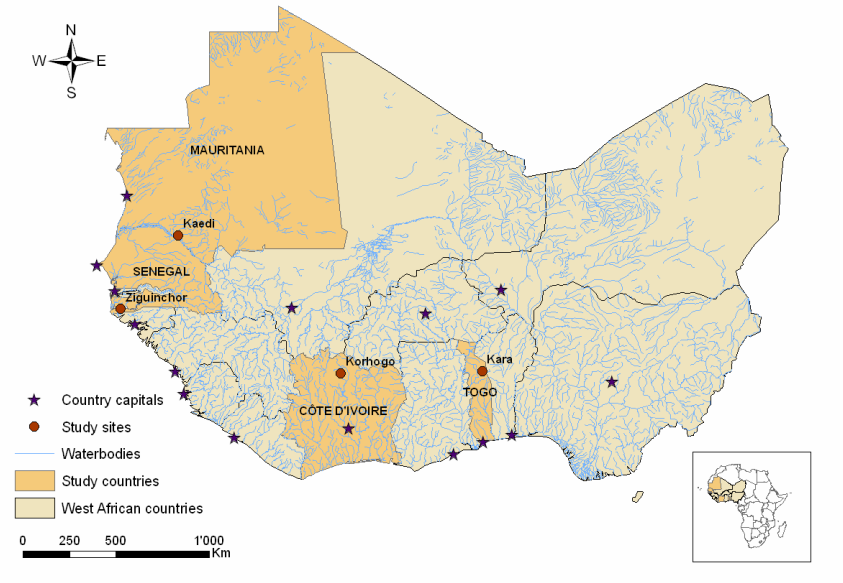

Figure 1.1: Location of the IDRC-funded ecohealth and climate change project, 4 riverside cities in West Africa

This paper uses a case-study approach to deepen our understanding of water quality issues in the context of local adaptation to climate change.

2. Methodology

2.1. Study sites

The present study focuses on the relationship between water, sanitation and floods in two West African secondary cities: Korhogo in Côte d'Ivoire and Kaédi in Mauritania. Korhogo is located 650 km north of Abidjan, Côte d'Ivoire's economic capital, and has an estimated population of 212,000 inhabitants. Kaédi is situated at 430 km from Nouakchott, the capital city of Mauritania, and has 71,000 inhabitants.

2.2. Research questions

The following research questions were pursued:

(i) Where are the areas and communities most physically vulnerable to floods in the respective cities?;

(ii) What are the main water supply systems and sanitation facilities in the city different zones?;

(iii) To what extent do floods impact the water and sanitation systems in the most vulnerable areas?;

(iv) What are the lessons learned from these case studies and what is the way forward for improving adaptive water management for floods and other effects of climate change?

2.3. General approach

The study follows the general approach of the umbrella regional project considering integrated risk assessment (IDRC/CCAA 2008), ecohealth (Lebel 2003, Cissé et al. 2008), and systems thinking (de Savigny and Adam 2009). We also considered the lessons learned and recommendations from recent publications dealing with adaptation to climate change in the water sector (Elliott et al. 2011, WHO and DFID 2010), flood management (Smith 2009) and the transition to adaptive water management (Pahl-Wostl 2005).

2.4. Methods

Data collection

A literature review was conducted, including grey literature (Ministry of Health (MoH) nad NGO reports, reports from in-country offices of international organizations) and key stakeholder interviews. During the project launch, workshops were held in each city. Individual talks and group discussions were held to obtain historical information and identify key stakeholders. Additional interviews were conducted with women and men to highlight gender dimensions.

At community level, an exhaustive geographical survey was conducted in each city. Survey teams recorded the main physical features of the local environment using hand-held geographical positioning system (GPS) devices and one specific recording form for each environmental factor (wells, open wastewater and stagnant freshwater bodies in the streets, small cleaner surface waters, solid waste dumps, health centres, major holes, animals fences, and green areas like urban agricultural fields).

A household survey was conducted based on a questionnaire. The questionnaire collected information on six relevant areas: (i) socio-demographic data; (ii) socio-economic data; (iii) hygiene and sanitation behaviour; (iv) knowledge, attitudes, perceptions and practice; (v) natural environment and ecosystems; and (vi) health. The cities were divided into three zones, depending on the level of physical vulnerability to flooding: (i) most vulnerable areas, (ii) most protected areas, and (iii) intermediary vulnerability. In each zone, a sample of 200 households was randomly selected and interviews were conducted with household heads. The surveys took place in Korhogo (February 2010 and September 2010) and in Kaédi (in October 2010 and April 2011). For each city, analyses for this paper were carried out for (i) the rainy season data from household surveys and (ii) both rainy and dry season data from geographical surveys.

Data analysis

Basic local climatic records were recorded and analysed with Excel. The geographic and cartographic data tables were recorded in Excel format and linked to a geographical information system (GIS) for mapping analysis using ArcGIS 9.3. The household survey data have been analysed using EpiInfo.

3. Findings: showing links between poverty, cities, drinking water, sanitation and floods

3.1. General features of the cities

In the two countries, the proportion of people living below the income poverty line (i.e. US$ 2 per capita per day) in the years 2000-2007 is important: 46.8% in Côte d'Ivoire and 44.1% in Mauritania (UNDP 2009, 2010; WHO 2010). Korhogo and Kaédi are both regional capitals, respectively the *Région des Savanes* and the *Wilaya du Gorgol*. Some of the poorest segments of the urban population live in underprivileged settlements in the two cities, and are located in areas particularly vulnerable to floods (close proximity to the river or the dam). The two cities were among those specially affected by the floods in 2007. The initial climate time-series data obtained for the two cities cover different periods: Korhogo (1972-2000),) and Kaédi (1968-2008). Korhogo is situated further south and in a wetter area than Kaédi. A feature of the two cities' climate data is given in Figure 3.1.

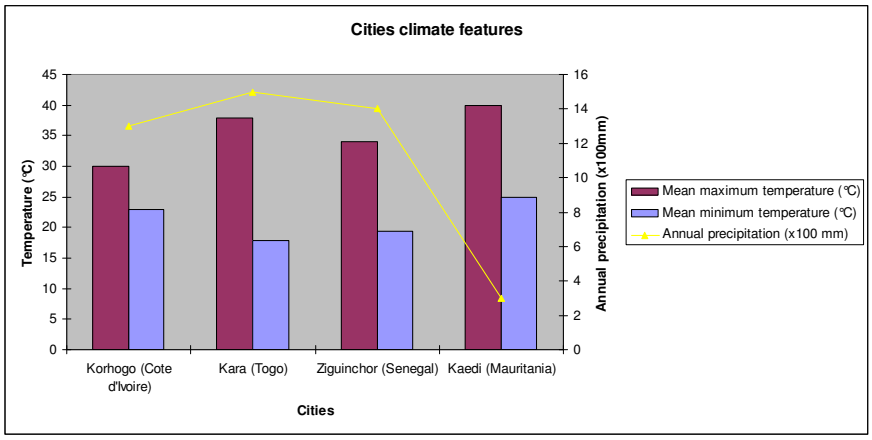

Figure 3.1: Climate features of 4 cities in West Africa

3.2. Drinking water from wells still important

Despite the fact that the cities are both regional capitals, the household surveys found that well water constitutes a major source of families' drinking water: 67% of households in Korhogo and 33% in Kaedi (Table 3.2a). In the zones more vulnerable to floods (Zone1) the figures are even higher (88% and 46%).

Table 3.2a: Wells water as source of households' drinking water in Korhogo (Cote d'Ivoire) and in Kaédi (Mauritania); household surveys September – October 2010 (rainy season)

		Korhogo (Cote d'Ivoire)		Kaédi (Mauritania)	
	Households Drinking Water from Wells	*n*	%	*n*	%
Zone 1	Yes	*173*	**88%**	*92*	**46%**
Most vulnerable	No	*24*	12%	*110*	54%
	total	*197*	100%	*202*	100%
Zone 2	Yes	*98*	**50%**	*61*	**35%**
Less vulnerable	No	*99*	50%	*114*	65%
	total	*197*	100%	*175*	100%
Zone 3	Yes	*124*	**63%**	*65*	**24%**
Intermediary	No	*73*	37%	*211*	76%
	total	*197*	100%	*276*	100%
City	Yes	*395*	**67%**	*218*	**33%**
	No	*196*	33%	*435*	67%
	Total	*591*	100%	*653*	100%

3.3. Households having latrines in the yard

Latrines in household yards are predominant in the city (80% in Korhogo and 69% in Kaédi), and the figures are similar in the more vulnerable zones of cities, respectively 82% and 80% (Table 3.3).

Table 3.3: Households having latrines in the yard in Korhogo (Cote d'Ivoire) and in Kaédi (Mauritania); household surveys in rainy season (September 2010 and October 2010)

		Korhogo (Cote d'Ivoire)		Kaédi (Mauritania)	
	Latrines in the Yard	*n*	%	*n*	%
Zone 1	Yes	*160*	**82%**	*160*	**80%**
	No	*35*	18%	*41*	20%
	total	*195*	100%	*201*	100%
Zone 2	Yes	*186*	**93%**	*95*	**54%**
	No	*13*	7%	*81*	46%
	total	*199*	100%	*176*	100%
Zone 3	Yes	*192*	**96%**	*194*	**70%**
	No	*9*	4%	*82*	30%
	total	*201*	100%	*276*	100%
City	Yes	*538*	**90%**	*449*	**69%**
	No	*57*	10%	*204*	31%
	Total	*595*	100%	*653*	100%

3.4. Mapping of city areas' vulnerability to flooding

The geographical surveys identified the number of wells in the streets during the rainy and dry seasons in both cities: more than 300 in Korhogo and more than 100 in Kaédi (Table 3.4). The differences in numbers between the two cities are linked to the fact that Korhogo has more inhabitants and covers a larger area than Kaédi.

Table 3.4: Number of wells in streets in Korhogo (Cote d'Ivoire) and in Kaédi (Mauritania); geographical surveys in dry season (February 2010 and April 2011) and rainy season (September 2010 and October 2010)

	Number of wells in the streets			
	Korhogo (Cote d'Ivoire)		Kaédi (Mauritania)	
	Dry season	Rainy season	*Dry season*	Rainy season
Zone 1	*318*	180	*32*	44
Zone 2	*80*	80	*72*	55
Zone 3	*83*	83	*24*	18
City	***481***	**343**	***128***	**117**

Mapping of the location of wells in the three zones during rainy season shows (even in a rather limited way) the threat to well water quality from floods. Figures 3.4a and 3.4b present the maps of wells in Korhogo and Kaédi during rainy season. They show that the number of wells threatened by floods is highest in the vulnerable zone and that the entire city well system needs an adaptive water management strategy to cope with extreme events caused by climate change.

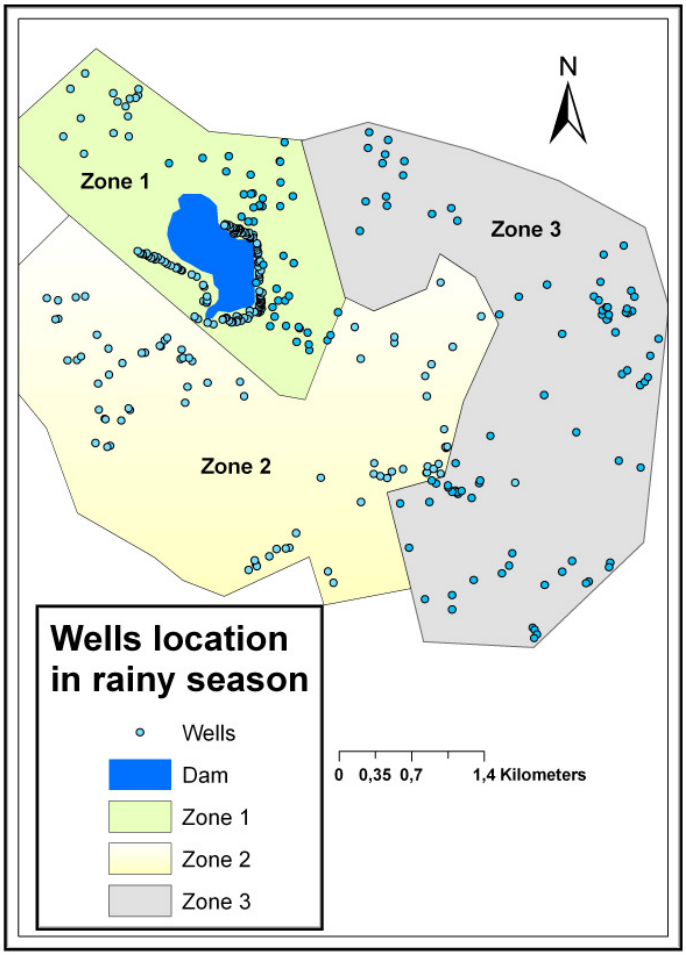

Figure 3.4a: Thematic map of wells locations during rainy season in the 3 delimited zones in Korhogo, Cote d'Ivoire (geographical surveys September 2010)

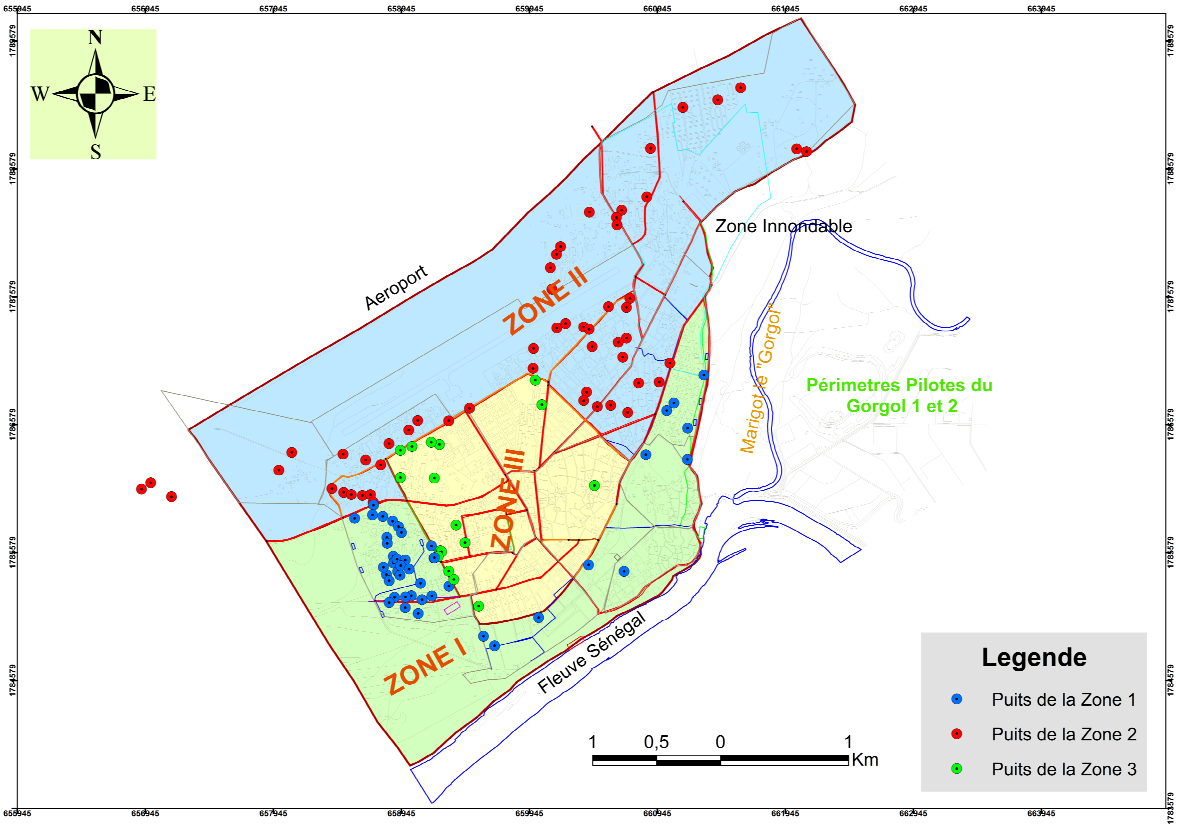

Figure 3.4b: Thematic map of wells locations during rainy season in the 3 delimited zones in Kaédi, Mauritania (geographical surveys October 2010)

4. Discussion and conclusions

In Korhogo and Kaédi (i) there is still a large number of wells in the streets, (ii) many households are relying on wells for their drinking water, (iv) sometimes households have wells and latrines not far from each other in the yard. Therefore, flood waters can pose health risks by contaminating drinking water and the food chain. Many experts warn that flooding will continue to cause more deaths and damage than any other hydro-meteorological phenomena (Mark Llewellyn 2006).

While case studies in developed countries report more about flood-related coughs, colds, bronchitis, heart attacks and troubles in personal relationships (Selena Gray 2008), in developing countries, there are additional and major concerns about water contamination and the increased risk of water-related diseases specific to the environmental background of the affected area .The higher spatial concentration of people in poor areas of cities, compared to more rural or remote villages, explains why even small scale flooding may have huge consequences on human wellbeing through its effects on habitat, water and sanitation.

Climate scientists have shown convincing evidence that climate change is occurring. Yet, many water and health sector professionals still have not woken up to the challenges that climate change presents (Bergkamp et al. 2003). The classical and conventional approach to water management commonly used today is not flexible enough to respond to the long-term uncertainties of climate change. There is a need of increasing the resilience of water and sanitation in the face of climate change (WHO 2010).

One of the first steps towards climate change in the water sector is to make communities and local governance actors aware of the areas physically vulnerable to floods and of the importance of protecting water quality. This is especially true in areas characterized by traditional water and sanitation facilities.

In secondary cities like Kaédi and Korhogo, the thematic maps highlighting the threat of floods to well water quality will can serve as communication tool between scientists and policy makers in the development of water safety plans and local climate change adaptation plans.

While a detailed study and discussion of the gender dimension of climate change threats is beyond the scope of this paper, the project has a component analyzing gender-specific elements of climate change adaptation challenges. The activities of women and men are affected differently by extreme climate change events like floods, in both rural and urban contexts (Hainard et al 2001). The experiences and results of the gender study will be presented in future publications.

We know also that improving flood management depends on several technical factors, such as precipitation intensity, volume, timing and phase that require proper measurement or estimation and good scientific and technical design know-how, which are missing in many developing countries.

The WHO emergency guidelines (Reed 2005) recommend, even when flooding does occur, to have: (i) at least one functioning water point per 250 people and (ii) the maximum distance from any shelter to water point is less than 500 meters. And after many years of plead for it (Scanlon et al. 2004), access to clean drinking water is now an official basic human right - just like the right to food and the right to live without torture and racial discrimination – since the Resolution of the UN General Assembly adopted in 2010 (UN News Centre 2010).

The ways the traditional wells are constructed make them vulnerable during flooding (Elliot et al. 2011) for many reasons: (i) infiltration of contaminated waters in wells, (ii) collapse of wells, and (iii) wells no more accessible. The usual constructing of wells near traditional sanitation facilities increases the risks of contamination in case of flooding. To protect wells many technical solutions and recommendations exist: (i) promoting construction of a sanitary seal that extends at least 1 to 3 meters below ground to prevent infiltration of contaminants; (ii) respecting the minimum recommended distance of 30 meters between a well and any single latrine.

It is important to regularly undertake surveys locating all the drinking water wells. This is what our project realised in Kaédi and Korhogo, and the experience may be repeated in all similar cities in the region.

The challenges of adaptive water management in low income countries under threat from climate change require a transdisciplinary approach, linking scientific communities, residential populations, and local and national authorities.

Fortunately, in recent years, the international community has made available many resources (WHO 2010, Elliot et al 2011) giving guidance, sharing lessons learned, and showing capacity building opportunities, from which the low income countries can benefit.

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