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Climate change and resilience of the Senegalese health system in the face of the floods in Keur Massar

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Abstract

This article is based on the observation that the affected populations perceive existing community-based adaptation strategies to the health effects of floods differently. We explore the resilience of the local health system to climate change (CC) in Keur Massar (Senegal) using a monographic approach based on a qualitative survey of flooded households, health professionals, hygiene agents, community health actors, administrative and local authorities, agents from the Ministries of Health and Environment, and experts from the ecological and meteorological monitoring centre (n = 72). The effects of CC on health are modulated by financial, organisational, social and cultural factors. The effects of CC on health are modulated by traditionally praised by self-centred health governance, which is often based on standardisation of problems and thus not sufficiently attuned to local contexts, especially the climate vulnerability index (CVI) of households and health structures. Despite the existence of programs to combat the consequences of CC, the notorious lack of exhaustive mapping of areas with a high CVI hinders the effective management of the health of the affected populations. A typology of forms of mobility in the context of flooding-

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ground floor to the upper floor, borrowing a room, renting a flat, seasonal residence—reveals inequalities in access to care as well as specific health needs management of vectorborne diseases, discontinuity of maternal, newborn and child health care, and psychosocial assistance. The article outlines how a health territorialisation based on surveillance and response mechanisms can be co-constructed and made sustainable in areas with a high CVI. Integrating this approach into national health policies allows for equity in health systems efficiently and sustainably.

KEYWORDS

climate change, climate vulnerability index, floods, health territorialisation, resilience, Senegal

Highlights

- Using a retrospective qualitative study, we describe the resilience of health system to climate-induced floods (CC) in the Keur Massar health district (Senegal).
- The weak coordination of local public actions underpins the standardisation of interventions geared towards preserving livelihoods to the detriment of endogenous capacities.
- The adaptation of the supply of care materialises through the extension of consultation hours, the setting up of local medical stands, the strengthening of the role of community health workers, and the facilitation of access to letters of guarantee for mutualist households.
- The populations are rehabilitating intra- and inter-households to preserve their health, especially that of vulnerable people (children, elderly, and disabled).
- The resilience of the local health system is disjointed, spontaneous, and rational, requiring territorial health policies in areas with high climate vulnerability indexes.

1 | INTRODUCTION

Climate change is a global issue that affects people's quality of life, including Senegal. Often analysed from the point of view of the socio-economic regression of the inhabitants most exposed by studies in environmental sciences¹ the consequences of climate change (CC) affect the health field as well. This article attempts to fill this gap by continuing studies on the resilience of health systems, which has become an international issue. According to the Lancet Countdown report, the health status of the next generation of humans depends on the drastic reduction in greenhouse gas emissions and the level of resilience of health systems.² Resilience refers to the ability of components of a health system facing destabilising experiences, events, or shocks (quotas or expected, sudden or

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insidious, internal or external), to adapt and transform to maintain and improve access (for all) to comprehensive, relevant, and quality health care and services without pushing patients into poverty.³

In recent years, especially since the 2013-14 Ebola outbreak in West Africa, the idea that health systems must be resilient when faced with sudden shocks has attracted considerable attention.⁴ Applying the concept of resilience to health systems is still often geared towards internal shocks to health systems.^{5,6} However, the multifaceted health impacts of CC⁷ require a more comprehensive diagnosis integrating externalities to the health system, particularly those induced by CC.^{8,9} Studies are beginning to focus on this perspective, including assessing the effects of high temperatures on nutrition, maternal and infant mortality,^{10,11} the emergence or re-emergence of endemic diseases,¹² or analysing local risk management behaviours related to environmental and health impact.¹³ However, very little research is devoted to evaluating national response mechanisms,^{14,15} especially the nature and extent of the resilience of the components of the health system affected by CC.

In Senegal, this research on the health consequences of floods induced by CC is all the more necessary as the country is engaged in universal health coverage policies,¹⁶ in particular through the consolidation of the role of community health workers in improving the provision of care in remote areas, including vulnerable ones.¹⁷ It is recognised that the floods further weaken the health systems of the countries of the South. In Togo, Benin, South Sudan, and Pakistan, access to hospitals, which was already difficult, became more difficult after the floods.^{18,19} The total destruction of some health facilities leads to the isolation of those communities. It follows the decline of health indicators in vaccination coverage, childbirth assisted by qualified personnel, and detection of cases of malnutrition.²⁰

In response to this situation, actions have been taken to assist populations, among which is the strengthening of epidemiological surveillance by setting up a geographic information system (GIS) to prevent the health consequences of floods and to consider response mechanisms.²¹ The health system's response is also reflected in the distribution of hygiene kits, the awareness of populations impacted on good hygiene practices (washing of hands and water purification), and prevention against the spread of waterborne diseases.²² In addition, health facilities often have vital products (food and first aid kits) distributed by the State and international organisations to provide primary care through mobile teams.¹⁹

However, the role of impacted populations in the response remains little known, hence the importance of understanding resilience jointly between supply and demand actors to gain a better understanding of endogenous capacities.^{15,22-24}. The objective is to study the resilience of the local health system in Keur Massar–located in the suburbs of the capital–an area with a high climate vulnerability index (CVI).

2 | MATERIAL AND METHODS

2.1 | Conceptual framework and design of the study

Many authors combine the concept of resilience with other concepts—performance, responsiveness, strengthening, and sustainability—to study health systems.^{25,26} They propose their vision and interpretation of this concept by adapting and improving it when identifying gaps.⁴ In this article we take Ridde and al.³ approach to the resilience of health systems.

Resilience is thus understood as the capacity of the health system, faced with flood shocks, to absorb, adapt and/or transform to maintain and/or improve the access of its members to comprehensive, relevant and quality health and hygiene services.^{3,27} We sought to report empirically: (i) the responses of decision-makers to the effects of floods on health; (ii) The articulation with local adaptation strategies deployed by both supply and demand actors; (iii) the ongoing transformations in social and professional relationships around addressing the health consequences of floods induced by CC; (iv) the failures of these strategies to prevent optimal management of future health consequences. This is what we have named configurations, resulting from a bottom-up approach at the initiative of members of a *natural group*²⁸ affected by any phenomenon. It is based on local political, financial and

organisational capacities, individual knowledge, and collective beliefs. This approach recognises that different points of view structure the relationships between populations and natural shocks, through specific ways of overcoming corollary health events.

We conducted a retrospective qualitative study, that is, a survey of the environment after the floods, when populations began to organise themselves to deal with the health consequences and the difficulties in accessing cares. It is based on a monograph of an exemplary case,²⁹ in a flooded environment in the health district of Keur Massar. The survey approach concerned the literature review and the collection of empirical data. We used CC policy documents, in particular those produced by the National Committee on Climate Change (COMNAC) and the national agency for civil aviation and meteorology (ANACIM). And we collected empirical data. A total of 72 people participated in the research. The data, derived from observations in the study environment as well as from the discourses reported by the communities, were combined and analyses in relation to the inconveniences caused by floods induced by CC.^{30,31}

2.2 | Sampling

The research lasted 5 months (from December 2022 to May 2023). We chose the survey targets at different levels (decision-makers, health workers, and populations), depending on their role in the health pyramid system (see details in Table 1).

⇒ Interviews were conducted with key informants directly involved in the fight against CC. These key informants include, on the one hand, the elected local administrative authorities, officials from the Ministry of Health, the ministry of environment and sustainable development (MEDD), and the Ecological Monitoring Centre. The issues focus on policy measures to address the effects of the CC in general, particularly floods: perceptions on the

Statistical analysisDHIS2- Senegalese health system data platformEvolution of diseases during the winter season in the health district of Keur MassarComparison of the curves over the last 10 yearsKeys informing interviewsSemi-structured interviews with stakeholders ranging from national level decision makers and donors down to facility managersSemi-structured interviews with professionals in health centres and health post19 key informants from two ministers (2 environment, 11 health), administrative authority (2) and local authority (4).Life storySemi-structured interview with heads of flood-affected householdsExposure to disease risk, health maintenance strategy, health needsQualitative research conducted in 6 districts. Included: 4 life story by district with women and men (total of 24 participants)Focus group discussionStructured discussions at community level, in local languagesCommunity participation and impact of actions to safeguard livelihoods; continuity of careQualitative research conducted in 6 districts. Included: 6 focus group discussions with members of the neighbourhood councils. 3 focus group discussions with community health workers (total of 29 participants)	Research component	Description of tool	Variables examined	Sample size
Keys informing interviewsSemi-structured interviews with stakeholders ranging from 	Statistical analysis	DHIS2- Senegalese health system data platform	Evolution of diseases during the winter season in the health district of Keur Massar	Comparison of the curves over the last 10 years
Life storySemi-structured interview with heads of flood-affected householdsExposure to disease risk, health maintenance strategy, health needsQualitative research conducted in 6 districts. Included: 4 life story by district with women and men (total of 24 participants)Focus group discussionStructured discussions at 	Keys informing interviews	Semi-structured interviews with stakeholders ranging from national level decision makers and donors down to facility managers	Semi-structured interviews with stakeholders ranging from ministry officials, experts at national level, administrative and municipal authorities to health professionals in health centres and health post	19 key informants from two ministers (2 environment, 11 health), administrative authority (2) and local authority (4).
Focus group discussionStructured discussions at community level, in local languagesCommunity participation and impact of actions to safeguard livelihoods; continuity of careQualitative research conducted in 6 districts. Included: 6 focus group discussions with members of the neighbourhood councils. 3 focus group discussions with community health workers (total of 29 participants)	Life story	Semi-structured interview with heads of flood-affected households	Exposure to disease risk, health maintenance strategy, health needs	Qualitative research conducted in 6 districts. Included: 4 life story by district with women and men (total of 24 participants)
	Focus group discussion	Structured discussions at community level, in local languages	Community participation and impact of actions to safeguard livelihoods; continuity of care	Qualitative research conducted in 6 districts. Included: 6 focus group discussions with members of the neighbourhood councils. 3 focus group discussions with community health workers (total of 29 participants)

 TABLE 1
 Summary of research tools, Senegal health system resilience during floods.

efficiency of interventions as well as prospects for health care in areas with high climate vulnerability indexes. On the other hand, the same technique has been used by health professionals, communities, and hygiene workers. The criterion of choice is based on their confrontation with the rising demand for health in their area of responsibility. According to the conceptual framework, discussions focused on (dis)-continuity of care during flooding: the displaced or fixed strategies put in place, the means mobilised and still mobilised, the actors involved, and the lessons learnt. The investigations took place in the health centre (district hospital), six primary health posts, and one health box, polarising areas affected by the floods.

- ⇒ Life stories were used in interviews with affected households in the seven neighbourhoods most affected by the floods: Darou Rahman 2, Jaxaay, Parcelles assainies unité 3, Mame Dior, Cité Wardini, Darou Salam and Cité Sotrac. Two criteria guided the choice of households to investigate. First, from a gender perspective, households in which a man is the head of the household and, on the other hand, households in which it is women who hold this position. Second, the types of houses (floor, no floor) and the characteristics of the families (owners, tenants, permanent or intermittent residents) were also retained. According to the conceptual framework, discussions focused on exposure to disease risk and identifying strategies in place to protect against the waterborne diseases.
- ⇒ Focus groups were conducted with members of the neighbourhood councils. Investigations in these affected neighbourhoods took place in the form of visits commented on by a leader in the neighbourhood. According to the conceptual framework, the discussions focused on people's perceptions of the effects of flooding on their way of life, inequalities in access to care, emerging health needs, and collective strategies to deal with adjusting health needs.

2.3 Analytical approach

Our analytical approach favours the logic of generative causality of social reactions. It describes a constellation of entities and activities organised in such a way that they cause a particular type of result.³² The generative causality used here is distinguished from successional causality (A produces B which produces C, the context variables being controlled) because it sees reactions as an irreducibly causal notion that allows an explanation of the detail of the process and not of the immediate and direct effects of the cause.^{32,33} The social and professional mechanisms deployed during the floods highlight configurations of resilience around health specifically in the health district of Keur Massar and not throughout the Senegalese health system. Our study is more in line with the desire to report 'focused configurations' on the basis of an empirical case study rather than 'abstract configurations' based on a more general theory.³⁴ We do not seek to discover an immutable law that would work in all contexts and for all health systems, but rather regularities of configurations specific to a health district whose occurrence of resilience around health would be frequent, but not necessarily permanent.^{3,27} Our analytical approach is therefore more in line with the continuity of case study approaches.²⁹

The qualitative data produced by the individual interviews and focus groups are transcribed and entered in Word. Unrecorded interviews were also reported in Word. Observation data and photos taken are also transcribed and commented (observation notes) and are an integral part of the body of analysis. Following transcription, the data are exported to qualitative data processing software (Nvivo) for coding and categorisation³⁵.

3 | RESULTS

Unlike studies on the resilience of the health system highlighting the specific capacities of the hospital organisation, there is a range of initiatives taken outside the hospital by health system stakeholders in Keur Massar, even if they are not coordinated to harmonise the response. While the consequences of the floods have prompted national (wadial *nawett* [*preparing for wintering*] and ORCEC) and local (departmental or communal flood development committees)

policy measures, they are more geared towards improving the physical environment. At the same time, health challenges are often left to the discretion of affected communities. While the mechanisms produced are diversified according to the actors' financial, professional, and cultural capacities, the empirical results show that the actions carried out are complementary and give rise to specific configurations in the Keur Massar District (see Figure 1).

Figure 1 provides a comprehensive view of the empirical elements that make up the configuration of the resilience of stakeholders in the Keur Massar Health District to the health consequences of floods.

3.1 Context of flood contingency policies in Senegal

3.1.1 | Sociohistorical of floods in Senegal

In Senegal, a combination of population displacement policies from downtown Dakar to the periphery has created an inextricable situation for poor communities, which suffer flooding year after year.³⁶ Indeed, a succession of events has led to the deterioration of the quality of health in the suburbs of Dakar. Chronologically, the events begin from the construction of the city of Dakar, limited to the Plateau in 1850, to the flooding in Keur Massar in 2022, through the expansion of the suburbs, the rural exodus following the severe drought of the 1970 s, the uncontrolled settlement of populations in *non-aedificandi* areas, and the return of rains from the 2000 s onwards. The return of wetter conditions in this region is not a return to previous conditions, but the entry into a new climate regime more marked by extreme rains.³⁷ The Figure 2 below illustrates the impact of urbanisation on flooding in Senegal, particularly in Dakar and its suburbs.

As a result, populations often live with rainwater, or even wastewater, and are at risk of disease.

3.1.2 | Policy responses to floods

The scientific literature considers that the recurrence of flooding is linked to CC.^{22,24,38} In response to this situation, Senegal has taken policy measures, including the formulation of the national adaptation action plan (NAAP),



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FIGURE 2 Urbanisation and flooding in Dakar neighbourhoods.

funded by the global environment facility since 2006. The objective is to mobilise state resources for national crisis management through various programs led by climate and hydrology monitoring centres (ANACIM, DGPRE) and research centres (Universities and Research Institutes, CSE, ISRA, etc.).

In order to strengthen NAAP's actions, the COMNACC was established in 2011. It has become a central platform for inter-ministerial cooperation on CC. Together with the Ecological Monitoring Centre, its technical arm, it also plays a key role in disseminating climate information and supporting the integration of adaptation strategies into sectoral policy letters in the Agriculture, Sanitation, and Health sectors. But its mission, geared towards sanitation and the preservation of livelihoods, that is, water resources, agriculture, and coastal areas, shows that the environment is still predominant in terms of health.

3.2 | Effects of flooding in Keur Massar

3.2.1 | Reduction of the capacity to provide care

Keur Massar is located in the suburbs of Dakar, erected as a department in 2021. It has six municipalities: Keur Massar South, Keur Massar North, Jaxaay, Malika, Yeumbeul North and Yeumbeul South. Keur Massar is the county capital. This town covers an area of 25 km², with a total population of 793,000 inhabitants divided between 140 neighbourhoods. In addition to being suffocated by the Mbeubeuss landfill, this area where approximately 100,000 people/day pass (Ndl, City Hall, 2023) has a health centre, six public health posts, two private health posts, and four health boxes. The evolution of its administrative status has not yet resulted in an improvement in the supply of healthcare practitioner and resources. At the same time, floods invade more than half of health facilities (Ndl, Conseil départemental, 2023), drastically reducing care provision capacity during wintering periods.

3.2.2 | Health degradation after floods

Flooding has a degrading effect on people's health. On the one hand, the stagnation of water promotes the emergence or re-emergence of waterborne diseases such as malaria, coughing, diarrhoea in children, dermatosis and acute respiratory infections. And, on the other hand, they interrupt road traffic and drastically limit access to some flooded health stations, thus increasing the demand for management of water diseases. Despite a slight decrease in 2020 (due certainly to COVID-19), consultations related to water diseases (cough, diarrhoea, malaria,

and others) in children under 5 years of age and adults remain significant during the last 5 years (DHIS2, Keur Massar district).

3.2.3 | Psychological trauma following flooding

As shown above, the narrowing of the land base and the inflation of per square metre costs in the capital over the past 15 years closes this window of opportunity and no longer allows modest families to acquire a new, serviced, and secure plot. Forced to live in the periphery in a *non-aedificandi* zone, these families suffer the health consequences of insecurity in their locality. Indeed, the area of Keur Massar, adorned by ruined houses abandoned by the owners following the floods, filled with homeless people at the Mbeubeuss landfill... is considered by the authorities to be a criminogenic locality: 'The crime rate in Keur Massar is the highest in the Dakar region!' (Male, 53, director of the centre for promotion and social reintegration). The violence between affected neighbours indicates a collective psychosis exacerbated by the flooding situation.

Here, um, during the floods, no one goes out at night. We go to bed at 8 p.m. Even if you have a sick person, you must wait in the morning to bring him to the hospital. Deserted or uninhabited homes are squatted by Indian hemp dealer gangs and road cutters. There is not a day without a case of theft, or physical or sexual assault being reported! This is the reason why, we live with fear in the belly all the time, but especially at the approach of wintering.

(Woman, 47, married.)

Insecurity underlies the self-containment of households, which has an impact on the physical and mental health of the population.³⁶ Indeed, conflicts arise within families or between neighbours in a situation of disaster, which can lead to violence of which 'women and children are often the main victims!' (Man, 51 years old, sub-prefect). However, health system actors do not remain inert at the adverse health effects of floods. They develop strategies to adapt or at least mitigate the impact on the population.

3.3 | Stakeholder strategies to mitigate the consequences of floods

3.3.1 | Implementation of interdepartmental synergy

The survey reveals that the technical services of the State and local authorities follow the protocol enshrined in the sectoral policy of the NAAP to develop strategies to combat the security, social, economic, and health consequences of floods. Under the leadership of the MEDD, sanitation works are installed in the flooded areas of Rufisque and Keur Massar, and firefighters are propositioned with pumping equipment in areas deemed endemic. As the authority in managing environmental crises, the MEDD unilaterally appreciates the need to activate the 'ORCEC Plan' which consists of deploying the civil protection and the national fire brigade at the scene of the tragedy. It is within such a framework that there is a broken coordination between the actors. Despite a high demand for health in flooded areas, officials of the Ministry of Health and Social Action play only an indirect supporting role, on the solicitation of local elected officials. MSAS does not have a specific division responsible for the effects of CC on population health within the MEDD. The creation of the Ecological Monitoring Centre aimed to bridge this gap by acting as a cross-matter and coordinating role between the different ministries. However, its main research mission does not significantly influence the development of cross-cutting public policies, and its absence at the local level leaves a gap in the harmonisation and variation of actions to be carried out.

3.3.2 | Preservation of livelihoods

The reaction of the territorial authorities is a receptacle and an application of the measures taken by the MEDD. In the affected areas, the first reflex of the administrative authorities (prefect and sub-prefect), hygiene officers, elected municipal representatives (departmental and communal council) and local authorities in flood management is geared towards securing the physical and material integrity of the populations. In this sense, immediate measures have been taken to evacuate the water into the houses and alleys of the neighbourhoods to avoid loss of life. The free supply of electricity by the town hall to power the electric pumps (or the purchase of fuel), the purchase of sandbags, and the deployment of firefighters to help households and health facilities fight against water is part of this. The other initiative refers to distributing necessities (food) to affected families. During this period, the health inputs of health facilities do not enjoy the same importance as those of affected families. Although health facilities receive drug endowments from local authorities, stock shortages (drugs, gloves, disinfectants, etc.) and a shortage of health workers pose major challenges for health workers during the floods. In the opinion of local authorities, the choice of methods of intervention is intrinsically linked to the availability of funds.

I would point out that neither the departmental council nor the town halls have a budget for flooding. Flood management is not a transferred competence. We draw on funds for miscellaneous expenses to make a move. (He shrugs his shoulders!)

(Man, 39 years old, departmental advisor)

The budgets allocated to health by local and regional authorities do not change while needs fluctuate according to the times of the year, the impact of heavy rains and the demand for health. Through adaptation measures, health professionals and communities have tried to address these health concerns.

3.3.3 | Increased capacity of health facilities

In the health centre, the adaptability of the routine of care services in the face of the high demand for health in times of flood is materialised by the increase in the supply of consultation and the decrease in the quality of the reception. Indeed, the *turn-over* during the relay between morning team and guard team hinted at a moment of disruption in care between 2 and 5 P.M. To fill this floating of three overtimes, the management of the health centre recruited 3 midwives and 3 gynaecologists to meet the high demand in the neonatology department. According to the District Chief Medical Officer, since the arrival of new recruits, benefits have increased fivefold. They increased from an average of 100 deliveries in the month to 600 deliveries, and from 15 caesarean sections to 100 cesarean sections. Although they are not exclusive to the flooding situation, these pragmatic measures also help to ensure access to care for patients arriving, despite rising transport prices in times of flooding. They make it possible to avoid referral of patients to other hospitals that may result in additional deterrent expenses for adherence to prescribed medical treatments. However, the willingness of health officials to systematically and comprehensively take care of all patients affected by floods, especially pregnant women, is hampered by low reception capacity.

In times of flooding, parturients cannot be sent to their homes because access is difficult. We are obliged to put them in observation, by several in the same bed. [...] It's positive, but it turns off on the quality of care because we don't have the necessary reception capacity! To tell you, today the demand is higher than the supply. Developing supply in times of floods has led to problems.

(Man, 46 years old, doctor)

For the requirements of post-partum observation, parturients are put to three on the same hospital bed. As a result, they risk getting nosocomial diseases that reduce the quality of care. To avoid these situations at the margins

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of hygiene standards and quality care standards, medical stands are installed in some neighbourhoods for early care that can mitigate hospitalisation cases.

In the opinion of the post nurses and midwives, about 3/4 of the cases of sick people escape the care of public health facilities during wintering periods. They even face logistical difficulties in reducing the remaining 1/4 because health posts are often flooded and unable to provide quality care.

3.3.4 Developing local care outside health establishments

In such a framework, displaced strategies are developed by paramedical personnel to ensure continuity of care within communities, deprived of consulting patients for financial reasons or the impracticability of roads hampered by water (see above). The providers form mobile teams, consisting of nurses, midwives, and caregivers, working in paramedic stands set up in flooded neighbourhoods where they welcome patients to provide primary care: dressing, vaccination, pre- and post-natal consultation...

Traditional health workers are also mobilised in neighbourhoods. For example, *bàjjenu gox* (neighbourhood godmothers) are paid by local organisations to raise awareness among women of reproductive age about compliance with child consultation and vaccination appointments. At the same time, home care providers (DSDom) are responsible for community monitoring of communicable diseases including malaria, tuberculosis, and diarrhoea. Following the same approach, neighbourhood councils help improve neighbourhood health and hygiene. A neighbourhood council is a consultation framework composed of neighbourhood leaders, delegates, community health workers, and simple members living in the neighbourhood. It is the first link in the local administration. It is composed of commissions according to the imperatives of development of a neighbourhood. In the specific case of Keur Massar, district council members are assigned different roles. Through *WhatsApp* groups, they answer questions about health, inform residents about issues of collective interest and organise inter-unneighbourly aid, enforce preventive measures (handwashing devices in mosques and churches, ban wild draining of septic tanks on the street), and mobilise households in health preservation activities (set setal, clearing of canals). In addition, they provide psychological assistance to households on security issues (fear of going out at night, risk of burglary of deserted homes) and trauma (fears of recurrence of floods, tension between neighbours and within couples, violence against children).

3.3.5 | Easing of procedures for obtaining letters of guarantee from health mutual

The participation of mutual (community-based health insurance) managers in this collective effort concerns improving access to care, by facilitating the procedures for obtaining letters of guarantees to mutualist households. This is because

in times of flooding, mobility is really reduced. Our beneficiaries often complain on the phone about additional costs to recover the letters of guarantee without which their services will not be refunded. We wanted to ease the procedure. In consultation with health personnel, we have chosen to leave copies of letters already signed in health centres and stations. In this way, mutualists are no longer obliged to go back and forth between the mutual and the hospital in order to be reimbursed. (Man, 56, Manager of Community Health Mutual.)

The impracticability of water-submerged roads creates inflation in transport prices causing many treatment disruptions, including in mutualist households with longer therapeutic routes. To treat themselves at a lower cost, beneficiaries of health mutuals are obliged first to go to a health facility, then to return to the mutual fund to take a 'guarantee letter' to be reimbursed for the services provided (consultation ticket, purchase of medicine and medical examination fees). These multiple journeys require more transport spending for poor households. To compensate

for this and encourage mutualist households to go to the hospital, the managers of community health mutuals have simplified the procedure for reimbursement of benefits by making available guaranteed letters resigned at all service delivery points in the district of the health district.

3.3.6 | Strengthening community ties around collective action

The floods' health consequences have helped strengthen the links between the inhabitants. They can pool their strength to set up initiatives to address health challenges in their living environment. Among these community initiatives, there are *set-setal sessions* (mobilisation for cleaning and weeding of neighbourhoods) to combat insalubrity exacerbated by houses abandoned by poor households. In addition, the heads of households interviewed reported the prohibition of children's games in wastewater as a popularised collective practice. Due to the risk of disease, the child becomes a vulnerable target that 'everyone seeks to protect' in order to preserve other children from contagious diseases and, consequently, the health of the community. It is in this sense that parents contribute financially to allowing schools in the neighbourhood to benefit from a sprinkling (anti-vector sprinklers), carried out by hygiene workers. Other examples of mutual assistance among inhabitants include the provision of cars or carts to transport the sick of the neighbourhood to the hospital. Impacted families also develop mobility within inside home to preserve their health (see Box 1).

BOX 1: (Im)mobility to preserve health

Faced with the risk of diseases in their homes despite the reactions of the authorities and the measures of health professionals, populations are developing forms of mobility within households to preserve their health.

- (i) Affluent families and owners of buildings migrate from the ground floor submerged by rainwater to higher floors. They overlay bricks to form landings that act as stairs to access those floors. People from these families are moderately extirpated from the risk of disease.
- (ii) Families owning houses without floors, but active in formal or informal work, mobilise funds to temporarily rent a room or apartment for 3–4 months, the time of a return to a normal situation. This strategy provides greater health security.
- (iii) There are also homeowners, but seasonal families, who consider their flooding homes in Keur Massar as a second home. These families, mostly nuclear and restricted, have more ease to move than the others mentioned above. They also stand out by their ability to carry out rehabilitation work each year before returning to their secondary home.
- (iv) Community solidarity allows children, seniors, sick people, and people living with disabilities to be entrusted to host families in neighbouring neighbourhoods less affected by floods. This strategy is more used by poor homeowners, made up of retirees and informal sector workers. The latter benefit from their local roots in the social fabric of community solidarity to overcome the trials of the waters, by borrowing rooms or rehousing in schools by the City Hall. Thus, in the absence of preserving the whole family from the risk of disease, a sorting is carried out in favour of vulnerable people.
- (v) Finally, in the absence of family and community assistance, tenant households less entrenched in the fabric of community solidarity remain inactive and prefer to live in wastewater and rainwater, using disinfectant products (bleach water, mosquito pumps, mosquito nets) as the main means of preventing diseases. Among these families, there are many cases of acute respiratory infections, diarrhoea, and dermatosis.
- Source: Diallo and Ridde, field data, 2023.

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3.3.7 | Self-medication as therapeutic alternatives

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Residents use self-medication or heteromedication. In the first case, families use medicines already used in previous episodes of disease.

I stayed in the house for almost two months without going out! I had coughs and buttons on my feet, but I couldn't move. Since I had a lot of medicines in my bag, I used antibiotics to relieve myself! (Man, 69, retired, civil aviation.)

And in the second case, they relay drug information to treat dermatoses and IRAs.

During the floods, I stopped postnatal consultations. [...] I had malaria, but I was unable to pay a round trip 4,000 FCFA taxi to consult the doctor. We had other priorities like food and rental! [...] To treat myself, I listened to the advice of my neighbours, and I also used traditional plants.

(Woman, 34, single mother, saleswoman.)

Given access constraints, each household preserves its health by caring for its patients based on their social status and financial capacity. All these reactions contribute to structurally transforming health relationships.

3.4 | Impacts of floods on the organisation of the health system

3.4.1 | Political awareness from above

The situation of floods is transforming health reports. As we have shown, policymakers are becoming increasingly sensitive to the health challenges caused by the effects of CC, including floods. The actions undertaken are still a response to the negative impacts of environmental degradation on livelihoods. But a dynamic of joint resolution of environmental and health problems is at work. Under the guidance of the MEDD, study reports are produced to better prepare the process of integrating the National Adaptation Plan into sectoral policy letters.

Administrative, municipal, and health officials, at the heart of the local response system, also attach great importance to the health problems caused by floods. Despite limited means, sparing solutions are being found. The issue of flooding is on the agenda of departmental development councils, and smaller, less formal meetings occasionally bring stakeholders together to discuss decisions to strengthen the health system (prefect/district chief doctor/district heads/mayor's health commission). These positive transformations in the political and professional imagination of health officials contrast with people's interpretations of the health causes of floods and the means to mobilise to deal with them.

3.4.2 | Collective but restrictive community awareness

The impacts of CC on their quality of life are not immediately noticeable to the populations surveyed. The relationship between CC and floods is not apparent to them, as it seems technical, abstract, and disconnected from their daily life. Instead, they conceive of the health challenges of floods as the result of the philanthropic actions of the populations. The heads of neo-arrival households denounce abandoned houses. For them, these uninhabited houses constitute the nest of flies and mosquitoes. Members of development associations and educated young

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people stress the rise of the water table due to the construction of habitats in *non-aedificandi* areas as a major health challenge on the use of tap water.

During the rainy season, as people try to find ways to drain rainwater with sandbags, motor pumps, gravas dams, the water comes out of the earth. So, the real problem is the rise of the water table. Here you dig 1 m you find water. Besides, it's completely polluted, and that's what we drink! Imagine the consequences on health!

(Woman, 24 years old, married, elected local)

Seniors, first arrivals in flooded neighbourhoods, rather evoke religious predictions as an explanatory factor for heavy rains and epidemics:

Serigne Saliou Mbacké had asked the regime in place for hundreds of hectares in Khelkom for agriculture. At the time Djibo Ka, Minister of Agriculture, replied that he could not do anything because of the drought in the country. But he said there would be more drought, the rain will be abundant in the years to come. That's what we are experiencing right now. But whenever there is a lot of water, it is accompanied by disease.

(Man, 72-year-old, married, head of the household, retired customs.)

These discourses nourished by experience and social, cultural, and religious knowledge weaken the link between the floods and CC. The collective imagination of populations dissociates CC, floods, and health. Hence the need to draw up a communication plan in order to raise awareness and prepare people to fight in the medium and long term. It is in this sense that the prevention role of home care providers (DSDom) and neighbourhood councils is a relevant innovation in the Keur Massar area.

3.4.3 | A broadening of the map of community health workers in the aftermath of the floods

As a result of the flooding, the range of community health workers has expanded beyond traditional community health workers (relays, *bàjjenu gox*, caregivers and matrons). Indeed, the low prevalence rate of malaria in Dakar (population <5% according to the EIPS 2020–2021) means that several prevention interventions, such as intradomestic sprinklers, chemoprevention of seasonal malaria, and the mass distribution campaign of impregnated mosquito nets, are not carried out in this region. However, this disease is the first cause of consultation and, therefore, deserves additional preventive and curative interventions compared to other health districts in the Dakar region. According to the coordinator of the national disease control programme, "In most structures in Dakar, the beds are often occupied by malaria cases. In the green zone [Dakar in particular] the decline in the immunity of the population rapidly favours the onset of serious cases and thus causes deaths" (https://www.seneplus.com/sante/91-537-cas-de-plus-recenses-en-2021).

To ensure better community management of simple malaria cases, the health authorities of Keur Massar rely on DSDoms. The latter, whose presence is more dedicated to rural areas, are engaged in the fight against malaria by administering rapid diagnostic tests and granting antimalarial medicine throughout the year. In addition, reminders and communications via social networks (WhatsApp in particular) made by members of neighbourhood councils in collaboration with the *bàjjenu gox* encourage pregnant women to continue medical treatment. The presence of DSDoms and members of neighbourhood councils in the community health system marks a widening of the circle of community health workers, allowing better epidemiological surveillance at the bottom of the scale of the health pyramid in times of flooding.

4 DISCUSSION

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4.1 | Weak alignment of response strategies

This corroborates a similar assessment in Nigeria, where it was found that, despite government disaster management policies, there are not organised and coordinated institutional structures to plan and respond to floodrelated emergencies.²² Another assessment of the impacts of the floods on the health of the inhabitants of the savannah in Togo and Benin also highlighted the inconsistencies of the State's ad hoc interventions alongside the victims,³⁹ pushing them to adopt adaptation measures that are proving insufficient.⁴⁰ It is therefore not surprising that the forms of resilience noted are spontaneous, disjointed, and rational.

The case study of the health district of Keur Massar in Senegal reveals the interesting dimension of the climate of innovation³⁸ and adaptation in the health system^{3,27,41}: (i) Institutional officials are constantly looking for solutions to converse the achievements in the fight against the disease. In this sense, administrative procedures are simplified to allow operational actors to act on time; (ii) to keep your position in town and show that good results are being achieved, health professionals are demonstrating adaptability by finding solutions, not only innovative, but especially adapted to the local context; (iii) in order not to get rid of (as was the case with the former flooded neighbourhoods) residents of flooded areas of Keur Massar, propose emergency care measures and, through a community solidarity mechanism, try to mitigate the economic, health and psychological consequences of flooding on affected households.

All these resilient practices based on demonstrating of local roots raise the question of how to connect response interventions sustainably when there is no territorial programme for areas with high climate vulnerability. Substantially, there is the paradox of Dakar (capital of Senegal) which is believed to be more endowed in health facilities at such a sign that certain health interventions are suppressed in this region.¹² However, suppose one accepts that the climate/health couple plays with scales.⁴⁰ In that case, the territorialisation of health becomes a *sinae qua none* for reconsidering the nature of ecological inequalities between the downtown (Dakar) and its suburb, which faces the indirect consequences of CC, in particular the resurgence of malaria.

4.2 | A necessary territorialisation of health

The territorialisation discussed here will go through three main components. First, it will map areas with a high climate vulnerability index using a GIS²¹ that integrates mixed (qualitative and quantitative) data on the community (see Figure 3) to identify, systematise, and characterise the health districts concerned.

All localities with a 'red' score at the end of the evaluation will then have to be enroled in an emergency response programme. In addition to medical, paramedical and community staff, it will be composed of crisis communication specialists, psychologists, and civil protection officers (physical and material safety of impactors, first responders). Its role will be to ensure community care, nourished by a constant dialogue with households, members of neighbourhood councils, local elected representatives, and administrative authorities. The populations affected by the floods in Keur Massar are particularly vulnerable. The cost of repairing homes is exorbitant, while most families living in this situation are destitute, mostly made up of precarious women and retired people.

Finally, in order to implement this policy, it would be necessary to strengthen the SS budget within these identified areas. Funding from the 'Green Health Fund' will cover the purchase of medical devices, the continuous supply of inputs (bednets, sprinklers), the strengthening of human resources (such as psychologists and community staff), and the acquisition of compliant logistics (all-terrain ambulance vehicles).



FIGURE 3 Proposed population vulnerability assessment model.

Territorial approaches to health policies are well known internationally. In general, the local construction of health is based either on the geographical boundaries of a territorial authority or on the socio-cultural boundaries of a given community.⁴¹ In order to succeed, the territorialisation of health mentioned here should not be based on either one or the other, but on both. Indeed, areas with a high climate vulnerability index are a geographical reality that does not always confuse the boundaries of territorial districts or specific communities. As a result, the allocation of funds for the financing of interventions would benefit from the distribution of subsidies in an equitable manner to the relevant health districts of the events related to CC.^{42,43} This recommendation has been endorsed by many key informants. They believe that the sustainability of actions depends heavily on the financial capacity of local authorities, health service providers, and community health workers. This would allow for the development and implementation of interventions other than those in national programs that are efficient and capable of meeting the health needs of affected populations. Attention should therefore be paid to multisectoral action and community engagement.^{44,45}

4.3 Some public health implications

In the fight against the health consequences of CC on populations, emphasis must be placed on the resilience and equity of communities. The three lessons learnt below point to opportunities for action to strengthen public health in areas with high climate vulnerability, particularly in Keur Massar (see Box 2).

BOX 2: Implication of public health outcomes

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Involvement 1—a low financial contribution to the organisation of the response The reactions of national decision makers and local leaders suffer from a lack of local coordination, resulting in overlapping interventions. The lack of a budget dedicated to addressing the health consequences of floods limits the scope of the strategies, resources (human and material), and actions undertaken. They leave aside some health and hygiene concerns. However, the financial and organisational contributions of institutional, administrative and municipal leaders are crucial to increase the capacity of stakeholders in the health care system to act.

Involvement 2-Adaptability Built on the Heap

Faced with the health consequences of floods, supply and demand actors are building effective adaptation measures. However, the response activities put in place are the result of organisational, community, and family DIY. Clearly formulated health needs (social assistance) are not considered by health professionals. It is within such a framework that we see the emergence of a new type of actor —neighbourhood council members—who are positioned on the psychological care of households and on the fight against insecurity in order to preserve mental health and social cohesion. An inclusive action plan would allow not only for capitalisation on this unprecedented experience, but also harmonisation and sustainable achievements.

Involvement 3–Consolidating Ephemeral Transformations

The actors are not at the same level of sensitivity on the health consequences of floods. However, each group—decision makers, professional, or community—tries to play a strong role in fostering continuity of care. As a result, it seems important to align response activities based on generative logic. This will involve linking budget allocations, technical skills, and indigenous knowledge in order to strengthen capacity for action, response, and anticipation; consolidating achievements; and perpetuating interventions.

Source: Diallo and Ridde, field data, 2023.

The practical implications raised in this study corroborate the suggestions already made in 2023 by the Lancet Countdown expert team that all health system actors have a central role in health system adaptation and mitigation, understanding and maximising the health benefits of any intervention, and communicating needs for accelerated responses.

4.4 | Retrospective qualitative survey: Reflexive feedback on scientific validity criteria

Most of the conclusions in this article are based on qualitative data derived from the perceptions of the stakeholders we met. This data, derived from observations in the study environment and from the discourses reported by the communities and stakeholders, were combined and analysed about the inconveniences caused by floods induced by CC. This approach meets the criteria of scientific validity of data from qualitative research, particularly through the triangulation of informants, the intersubjectivity of preliminary results and discourse analysis.³⁰ We have jointly analysed the processes studied from our analyses and interpretations without retroactively modifying their initial judgement.³¹

The results of Senegal's retrospective qualitative study suggest that the strong awareness of the causality between the health consequences of floods and CC underpins many adaptation initiatives by health system

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stakeholders. On the other hand, reactions are not always aligned, as is often when it comes to collective risk and crisis management.⁴⁶ Decision makers and health professionals are convinced of the direct causal link between CC and floods and the need to mitigate health consequences to preserve the quality of life of populations. On the other hand, the people attribute the cause of the deterioration of their quality of life to human acts and the lack of political will of the State. This fracture, underpinned by different perceptions of risk, cultural determinism, professional standards, and the living conditions of individuals, prevents the sustainability of actions which, to be effective, will need to be integrated into sustainability by combining scientific and indigenous knowledge.^{23,47}

5 | CONCLUSION

From the example of Keur Massar, we see a mixed resilience of the Senegalese local health system based on intertwined configurations with each other. Despite the high sensitivity of providers to the deleterious effects of CC, organisational constraints (lack of human and material resources, poor coordination at the local level) underlie less systematic reaction strategies. Forced to adapt to their climate vulnerability, populations are putting in place more sustainable mechanisms based on a community fabric of solidarity and mutual aid that the healthcare system continues to marginalise. The major challenge remains the governance of uncertainties relating to international (allocations of resources from the Green Climate Fund) and national financing methods (budget allocation of local and regional authorities), and local response mechanisms. Health needs are increasing despite the status quo on human and material resources available to health systems. In this respect, the territorialisation of health remains a sustainable perspective and an important lever that can guarantee equity in access to care between populations. The aim will be to develop a local policy anchored with endogenous capacities (professional and traditional) to integrate adaptation strategies into managing emerging health needs.

According to the WHO, climate crises seriously threaten the achievement of universal health coverage, increasing the burden of disease and exacerbating barriers to access to health services. If one admits that 'many of the steps taken to prepare for unexpected shocks such as a pandemic are similar to those required to adapt to the extremes of weather and new threats expected from CC',² should we then rethink universal health coverage to better address the specific needs of areas with a high climate vulnerability index in the same way as the COVID-19 pandemic? This seems all the more necessary to get out of a rhetorical public health denounced for 20 years, but which continues on its way and often makes the concept of universal health coverage illusory in Africa.

AUTHOR CONTRIBUTION

Valery Ridde: Research protocol, Critical revision of the article, Final approval of the version to be submitted. **Abdoulaye Moussa Diallo**: Research protocol, Data collection, Data analysis and interpretation, Drafting the article.

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CONFLICT OF INTEREST STATEMENT

The authors declared that they have no conflict of interest.

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DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

ETHICS STATEMENT

This study obtained the approval of the National Health Research Ethical Committee of Senegal (CNERS), which made it possible to collect health data from health centres and households. Ethical approval is required for this study but does not set a deadline for the start of the fieldwork.

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