Climate Research for Development (CR4D)

End of Grant Workshop

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The African Academy of Sciences

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Implementing an early warning system for building communities' resilience to health impacts of change in the North of Senegal (IW4HI)

Ibrahima SY, Ph.D, Centre de Suivi Ecologique (CSE), Dakar

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CONTENT

- Context and objectives
- Research activities implementation
- Results and main findings
- Conclusions, lessons and impact

Context and objectives

Context

- Results of the ACASIS (Heat Waves in the Sahel and Impacts on Health) project in northern Senegal clearly attributing excess mortality and morbidity to heat wave episodes from 2012 to 2014 ;

- Heat waves as major public health problem in the northern regions of Senegal according to climate projections of rising temperatures ;

Context

- Relevance for monitoring health risks associated with heat waves, but health actors do not have sufficient quality information and scientific capacity to manage this phenomenon ;

- Need for an early warning system to manage heat waves through a health warning system by projecting epidemiological impacts calculated according to heat indices from RCP scenarios.

Aim and objectives

Aim of the research:

- The aim of the research project is to strengthen the resilience of the health system and communities to better address the health effects of rising temperatures through the implementation of an early warning system capable of detecting heat waves in northern Senegal.

Specific objectives:

- Improve near-real time and medium-term heat wave detection and forecasting using synoptic forecasts (ECMWF) and S2S products;
- Assess the vulnerability of the health system and communities to health risks associated with heat waves;
- Establish a heat early warning system to strengthen heat wave surveillance and prevention;
- Strengthen the capacity of health system actors and communities to manage health risks related to heat wave impacts.

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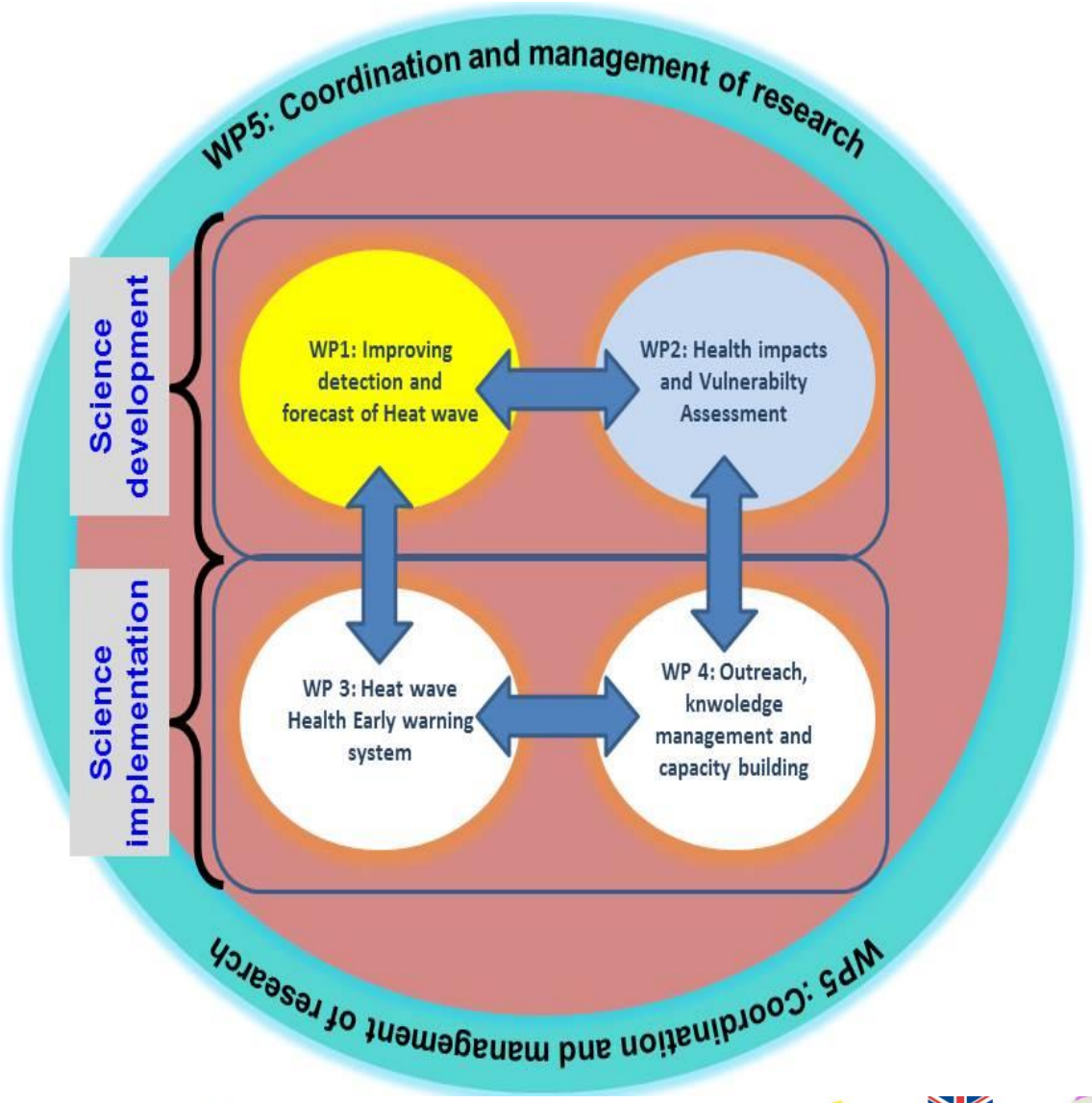
Research activities implementation

Research activities implementation

➢ Research approach implementation:

- Focus on areas and communities vulnerable to heat waves;
- Transdisciplinary and multisectoral cooperation with 4 work-packages;
- Approach combining science development and science implementation.



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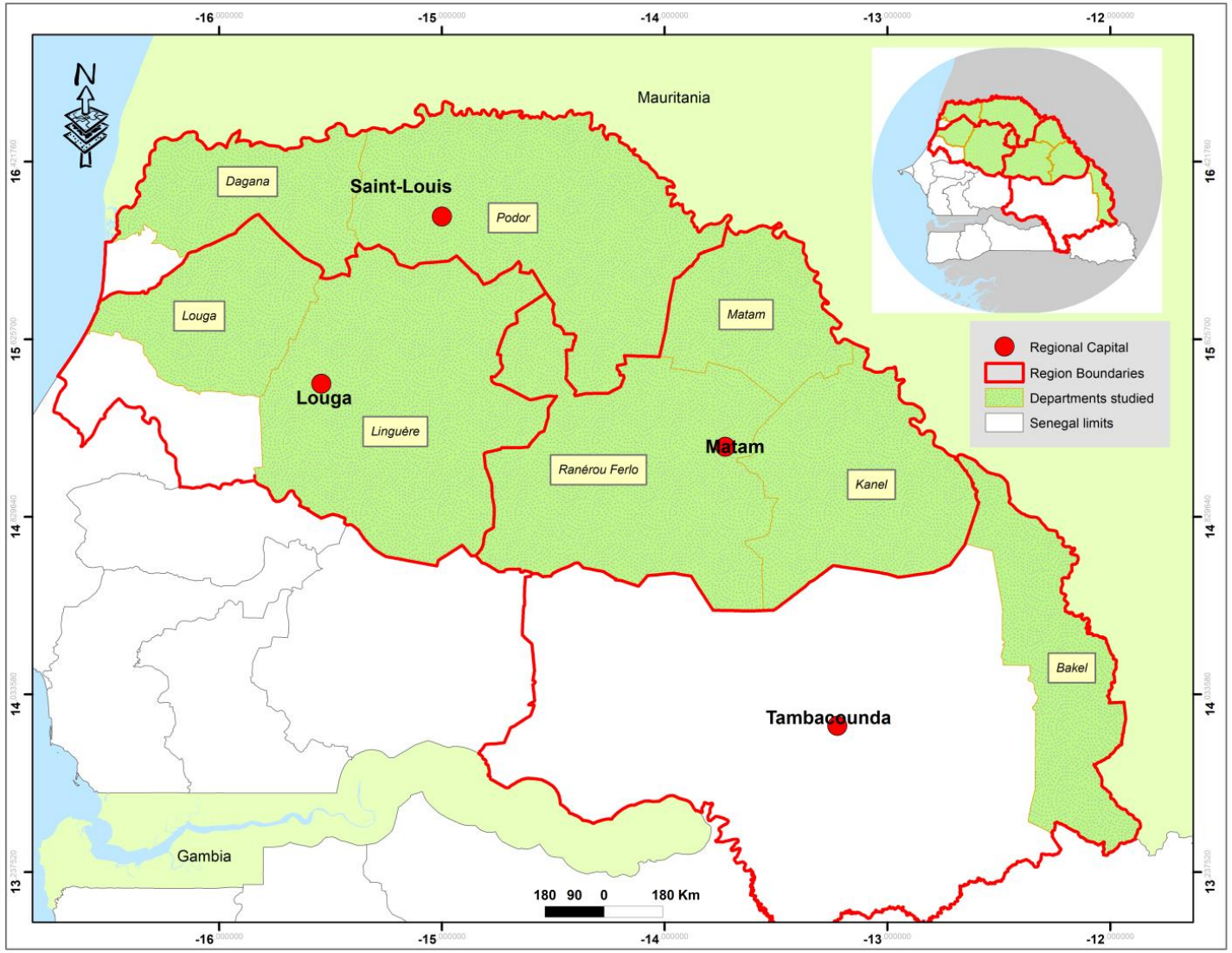
Research activities implementation

Location of the study area:

- ✓ North and North-East Departments;
- ✓ Population 1,928,962;
- ✓ Sahelian continental climate;
- ✓ Minimum temperature of 30°C and maximum of 45°C.



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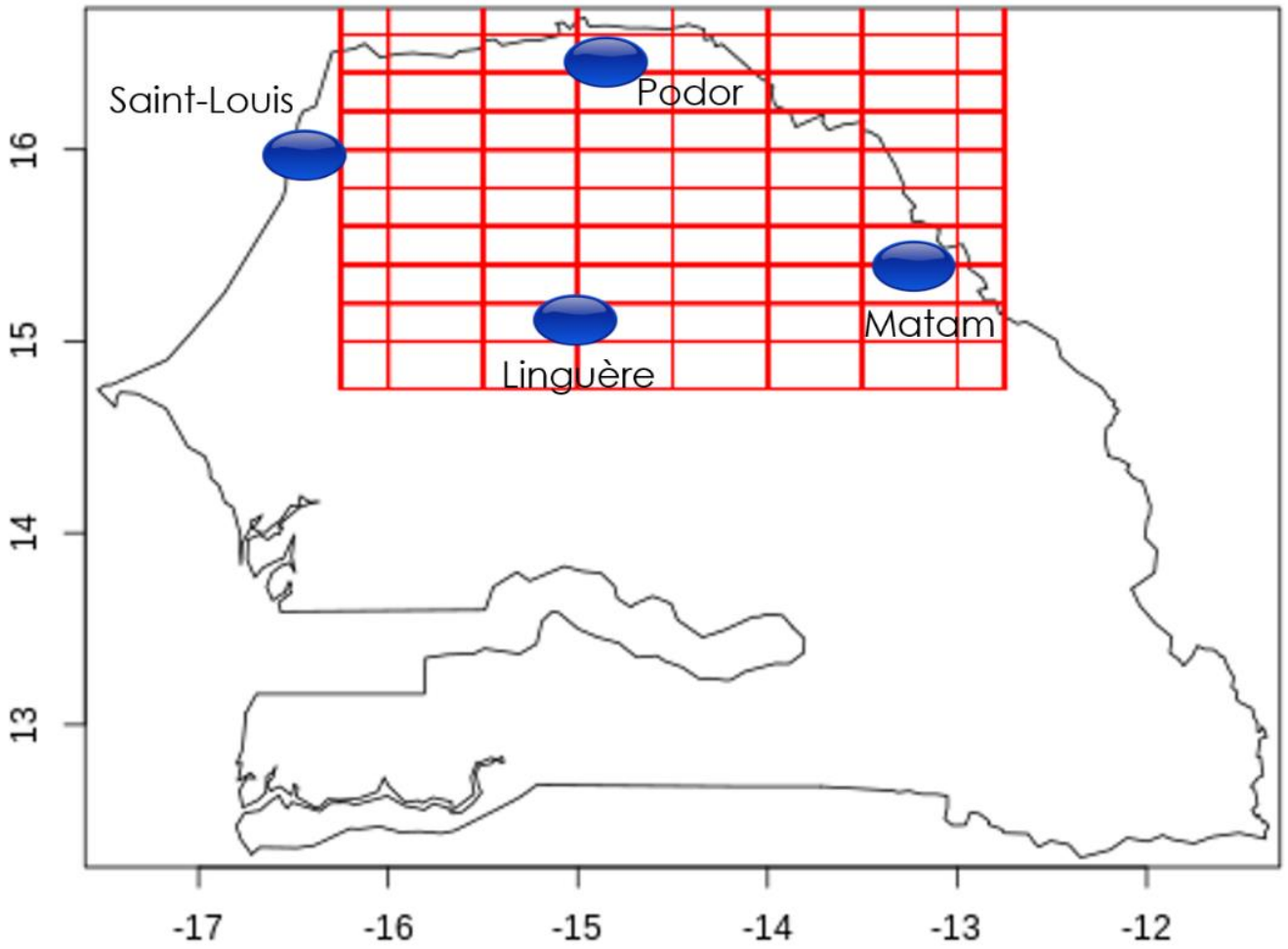
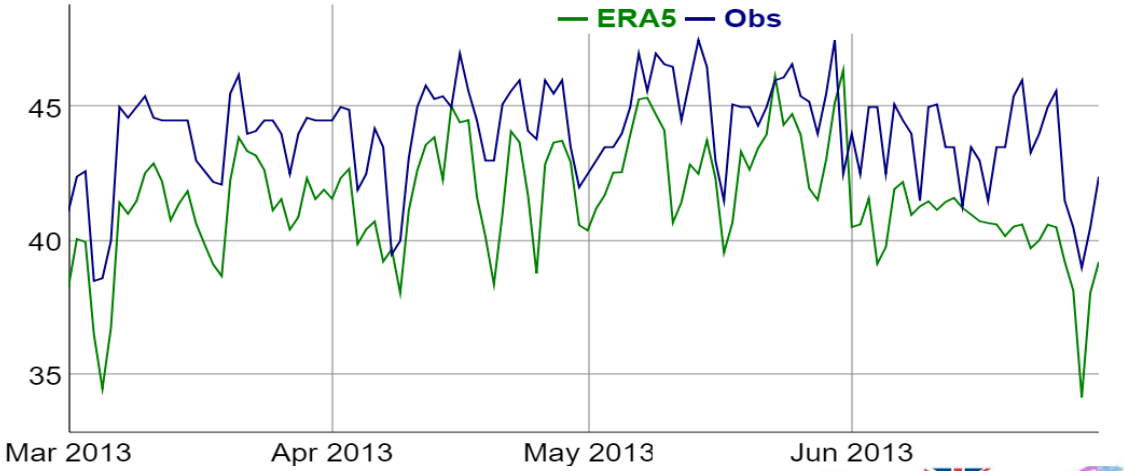
Research activities implementation

- **Climate data:** **historical and projection models data**



- **04 synoptic weather observation stations (ANACIM)**
- **Data from ERA-5 reanalysis fields**

Correlation between data used



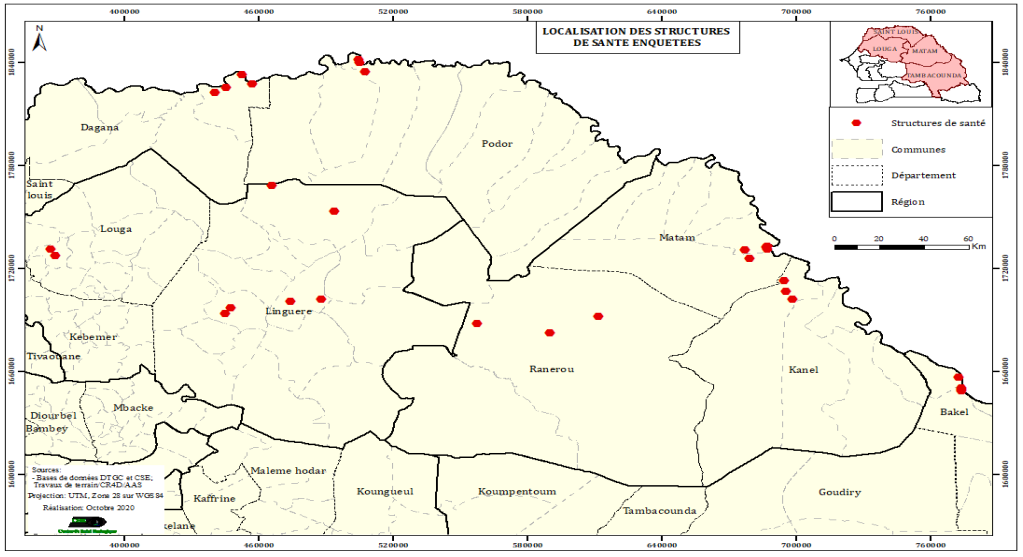
Research activities implementation

Routine health data: daily and monthly (April, May and June) of health facilities records from 2009 to 2019

General daily consultation from 2009 to 2019

N	District (Centre de santé)	Régistres	Date Jour/Mois/Année	Age	Sexe	Adresse	Symptômes	Diagnostic
1	Centre de santé de Dagana	Consultation générale	03-avr-17	7	M	Diameguene	Diarrhée	Diarrhée
2	Centre de santé de Dagana	Consultation générale	03-avr-17	21	M	Kao Dagana	Céphlée	Céphalée
3	Centre de santé de Dagana	Consultation générale	05-avr-17	24	F	Diameguene	Céphlée + vertiges	Hypotension
4	Centre de santé de Dagana	Consultation générale	05-avr-17	10	F	Diameguene	Antécédent de fièvre + vertiges	Syndrôme grippal
5	Centre de santé de Dagana	Consultation générale	06-avr-17	12	M	Diameguene	Dermatose	Dermatose
6	Centre de santé de Dagana	Consultation générale	06-avr-17	40	F	Thiangaye	Céphlée	Céphalée
7	Centre de santé de Dagana	Consultation générale	06-avr-17	6	M	Diameguene	Céphlée	Céphalée
8	Centre de santé de Dagana	Consultation générale	11-avr-17	5	F	Diameguene	Dermatose	Dermatose
9	Centre de santé de Dagana	Consultation générale	07-avr-17	11	F	Diameguene	Dermatose	Dermatose
10	Centre de santé de Dagana	Consultation générale	11-avr-17	10	M	Diameguene	Céphlée	Céphalée
11	Centre de santé de Dagana	Consultation générale	12-avr-17	70	M	Diameguene	Céphlée	Céphalée
12	Centre de santé de Dagana	Consultation générale	12-avr-17	55	F	Diakhasselene	Vertige+fièvre	HTA connue
13	Centre de santé de Dagana	Consultation générale	13-avr-17	15	F	Diameguene	Céphlée	Céphalée
14	Centre de santé de Dagana	Consultation générale	14-avr-17	40	M	Diameguene	Céphlée	Céphalée
15	Centre de santé de Dagana	Consultation générale	14-avr-17	18	F	Diameguene	Céphlée	Céphalée
16	Centre de santé de Dagana	Consultation générale	18-avr-17	5	M	Almadie	Dermatose	Dermatose
17	Centre de santé de Dagana	Consultation générale	18-avr-17	75	F	Koylel	TA 10/6	Hypotension
18	Centre de santé de Dagana	Consultation générale	18-avr-17	16	F	Diamaguene	Céphlée	Céphalée
19	Centre de santé de Dagana	Consultation générale	19-avr-17	32	M	Mbilor	Diarrhée	Diarrhée
20	Centre de santé de Dagana	Consultation générale	19-avr-17	24	F	Kao Dagana	TA 10/6	Hypotension
21	Centre de santé de Dagana	Consultation générale	20-avr-17	64	M	Diamaguene	TA 16/10	HTA connue
22	Centre de santé de Dagana	Consultation générale	20-avr-17	6	M	Diamaguene	Diarrhée liquidienne	Diarrhée
23	Centre de santé de Dagana	Consultation générale	20-avr-17	19	F	Diameguene	Céphlée	Céphalée
24	Centre de santé de Dagana	Consultation générale	20-avr-17	19	M	Diameguene	Céphlée	Céphalée
25	Centre de santé de Dagana	Consultation générale	20-avr-17	32	F	HLM	Toux de 2 j + céphalée	Grippe
26	Centre de santé de Dagana	Consultation générale	21-avr-17	20	F	Diameguene	Céphlée	Céphalée
27	Centre de santé de Dagana	Consultation générale	21-avr-17	30	F	Diameguene	Dermatose	Dermatose
28	Centre de santé de Dagana	Consultation générale	24-avr-17	7	M	Sinthiane	Fièvre de plus de 5 j	Grippe
29	Centre de santé de Dagana	Consultation générale	24-avr-17	33	F	Diameguene	TA 13/9	HTA connue

MORBIDITE JOURNALIERE | MORTALITE JOURNALIERE | Nombre de décès



Personal health interview

Département	Commune	Code Commune	Quartier	Code quartier	5. Nom du District Sanitaire :	6. Nom et prénom du MCD	7. Nom et prénom enqu	Latitutde
Bakel	Bakel	1	Montagne centrale	3	Posté de santé urbain de bakel	Fatoumata Diawara	Mody Cissoko	14.8987133333
Bakel	Bakel	1	HLM	1	District sanitaire de Bakel	Dr. Aliou Ba	Mody Cissoko	14.9155683333
Bakel	Bakel	1	HLM	1	Infirmerie gendarmerie nationale de Bakel	Major (préfére rester anonyme)	Mody Cissoko	14.9071450000
Podor	Podor	C01	Sinthiane	Q05	Amadou Malick Gaye de Podor	Malick Anne	Harouna Ndiath	16.6426950000
Podor	Podor	C01	Bir Podor	Q03	Poste urbain de Podor	Fatou Ndiaye	Papa Malick Ndiaye	16.6552616667
Bakel					Poste de santé tuyabou	Harouna ba	Mody Cissoko	14.9727150000
Kanel	Kanel	1	Kanel 2	5	Kanel	Mariette Ndiaye fall	Kedia	15.4853100000
Kanel	Ndendory	2	Seno palel	2	Seno palel	Dieynaba ndour	Kedia	15.3875716667
Podor	Guèdé village	C01	Guia	Q01	Poste de santé guia	ICP Soma Niane	Harouna Ndiath	16.5947366667
Kanel	Ouro sidy	3	Ouro sidy	3	Ouro sidy	Maïmouna faye	Kedia	15.4293416667
Matam	Ourossogui	2	Ainoumady	1	Infirmierie du camp militaire de Ourossogui	Major kori ngom	Mody Cissoko	15.6038983333
Matam	Matam	1	Soubalo	3	Soubalo Matam	Mamadou thiaw	Kedia	15.6660233333
Matam	Nabadji civol	C03	Boynadji	1	Poste de santé de Boynadji	Hawa Guissé	OHS	15.6494416667
Matam	Matam	C01	Gourel Serigne	Q01	District de Matam	Paule Fondjo	Oumar Harouna Sy	15.6537233333
Matam	Ourossogui	C01	Moderne	C03	Poste de santé moderne 3	Boya Diaw	OHS	
Dagana	Dagana	C01	Diamegeune	Q01	Centre de santé de Dagana	Hamidou Diallo	Papa Malick Ndiaye	16.5105983333
Dagana	Bokhol	C02	Mbilor	V02	Poste de santé de Mbilor	Mame Anna Fall	Papa Malick Ndiaye	16.4845650000
Ranerou	Ranerou	1	Fourdou	1	District Santé de fourdou	ICP Madeleine Ndiong	Amadou Sy	15.2167616667
Ranerou	Ranerou	1	Younouférou	2	Poste de santé de Younouférou	ICP Ousmane Diaw	Amadou Sy	15.2657033333
Louga	Louga	1	Diélerou	2	Louga		Demba ba	15.6550150000
Matam	Matam	1	Diamel	5	District Matam	Amadou djiby ba	Butane Cissé	14.6917450000
Ranerou	Ranerou	3	Ranerou	1	Ranerou	Aliou Ndour	Birane Cissé	15.3038833333
Linguere	Linguère	2	Linguère coumba1	1	Linguère	Pape saliou ndoye	Birane Cissé	15.3969150000
Dagana	Gaé	2	Tivaoune	1	Dagana	ICP Mme Faye yacine Diouf	Birmanie Cissé	16.5768583333
Dagana	Bokhol	3	Diamono	1	Dagana	Youssou seye	Butane Cissé	16.5280883333
Louga	Louga	3	Thiokhna	3	Louga			15.6224066667
Linguere	Linguère	6	Ouarkhok(village)	2	Poste de santé de Ouarkhok	Aissatou Fall(Sage femme)	Amadou Barry	15.3839700000
Linguere	Dara djoloff	8	Thiamene(village)	2	Poste de santé de Thiamene	Papa Maguette Seck	Amadou Barry	15.3217533333
Linguere	Téssékéré	9	Téssékéré(Commune rurale)	1	Poste de santé de Téssékéré	Pape Sow ICP	Amadou Barry	15.8584483333
Linguere	Téssékéré	9	Widou Thiengoly	2	Poste de santé de Widou Thiengoly	Ibnou Diakhaté	Amadou Barry	15.9942750000
Linguere	Dara Djolof	8	Montagne		District sanitaire de Dara Djolof	Dr Ndiaye	Amadou Barry	15.3500066667

Enquete personnel sante VF

- Diabetes
- High blood pressure
- Asthma
- Respiratory diseases
- Diarrhoea
- Cough/Cold

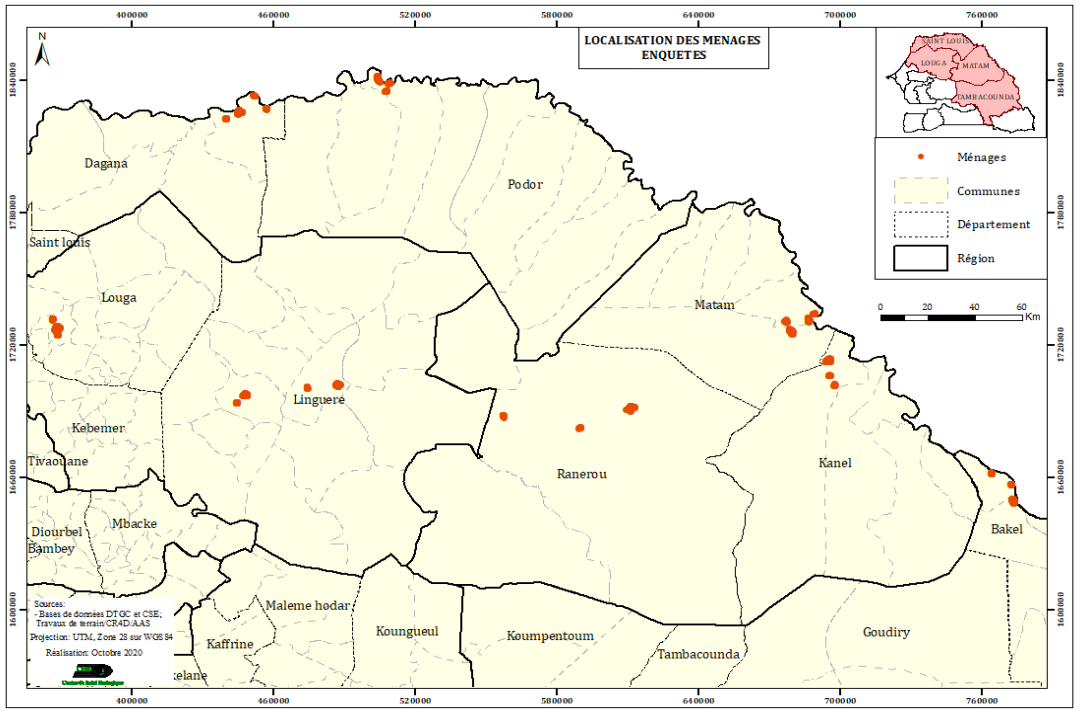
Research activities implementation

- **Socio-economic, environmental and epidemiological data:** household and health worker surveys in August 2020

Household surveys

District	Zone	Sample
Linguere	DJOLOF	235
Louga		259
Podor	FLEUVE	224
Dagana		246
Ranérou	FOUTA	170
Kanel		215
Matam		236
Bakel		232
TOTAL		**1817**

Health worker surveys location



Research activities implementation

- **Socio-economic, environmental and epidemiological data: household and health worker surveys in August 2020**

District sanitaire	Quartiers	Villages	Ménages	Personnel de santé (MCD/ICP)
Bakel	Montagne centrale, HLM, Ndiayega	Tuabou, Diawara	232	3
Kanel	Yirla, Kanel 2, Thilol, belaal, Lao, Hoha	Wouro Sidy, Séno palel	215	3
Matam (Ourossogui)	Soubalo, Gourel serigne, Tantadji, Halwar, Hainoumady, Mango, Windé, Moderne	Diamel, Boynadji	236	5
Ranerou	Ranerou 1, Gourel saré, nelby, Bélel	Younouféré, Fourdou	170	4
Linguere (Dahra djolof)	Escale, Linguere coumba, linguere Diambon, Thiely, Bétoir, Dialou rail, Montagne, Thieunge, Angle islam, Loumbol, medina ndiaye, nguénene	Thiaméne, warkhokh	235	5
Louga	Santhiaba, Keur Serigne Louga, Montagne, thiokhna, artillerie	Nguidile, dielerlou	259	3
Podor	Law Demba, Sinthiane, Thioffy, Mbodiène, Bir Podor et Khar Yalla,	Gui, Diatar	232	3
Dagana	Diamegueune, Magg Dann, Gadd ga, Sinthiane, Darou Salam, Santhiaba, Arafat, Almadies	Mbilor, Gaya, Bokhol	250	4
	TOTAL		**1829**	**30**

53 neighbourhoods and 17 villages (1829 households)

08 MCD and 22 ICP (30 health workers)

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Data analysis

Climate data:

- Temperature thresholds exceeded on three days of the 90th percentiles;
- Daily maximum average;
- Trends in temperature anomalies.

Routine health facilities data:

- Descriptive statistics (pivot tables);
- Cross-tabulated analyses in the form of correlative trend curves.

Heatwaves linked diseases and risk factors analysis:

Descriptive statistics (pivot tables);

Factorial and correlative statistical analyses;

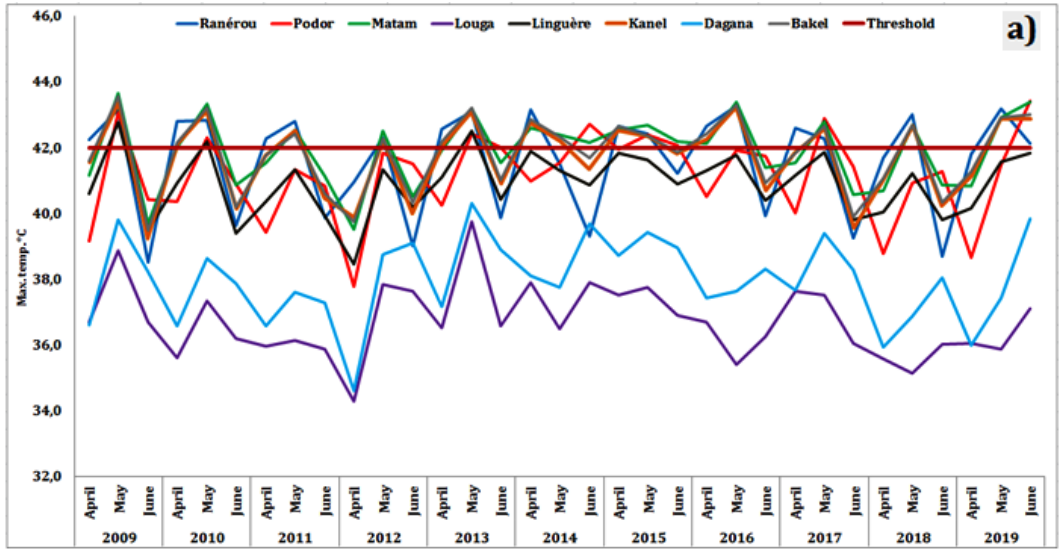
Chi-2 tests (Fischer/Pearson), logistic regression with Odds Ratios (OR).

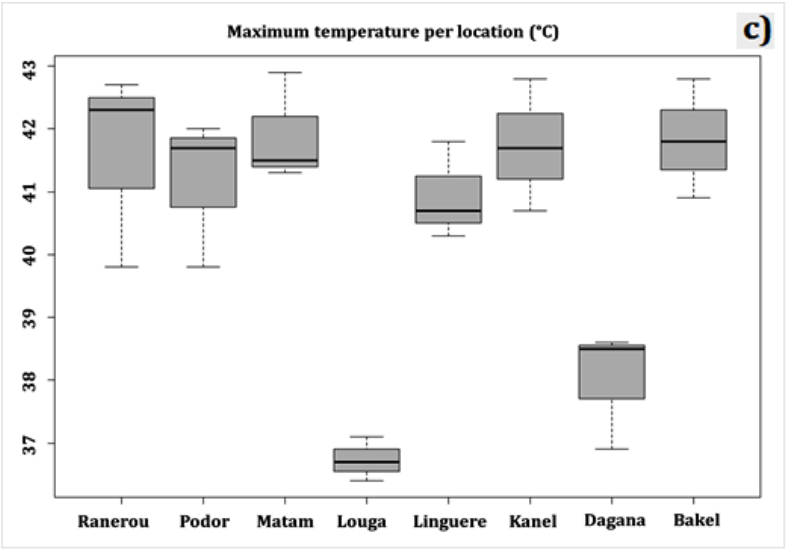
Results and main findings

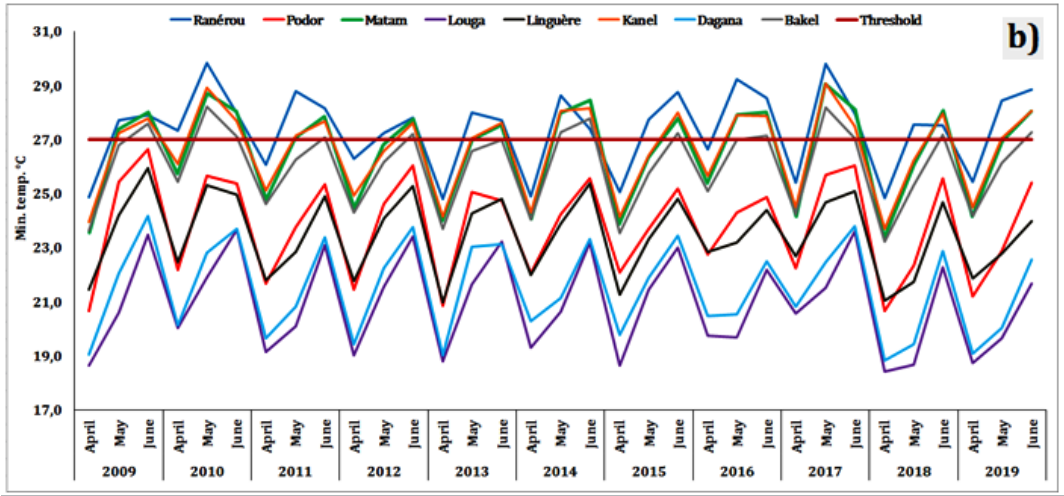
Main results and findings

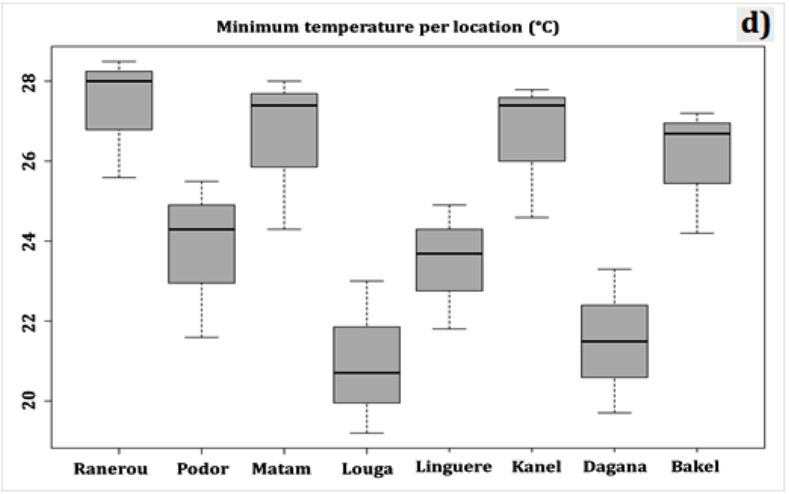
- **Temperature trends and heat waves in the northern part of Senegal**

- Detection of heatwave events in the period 2009 to 2019 and level of exposure of localities;
- Localities of Ranerou, Matam, Kanel, Bakel and Podor.







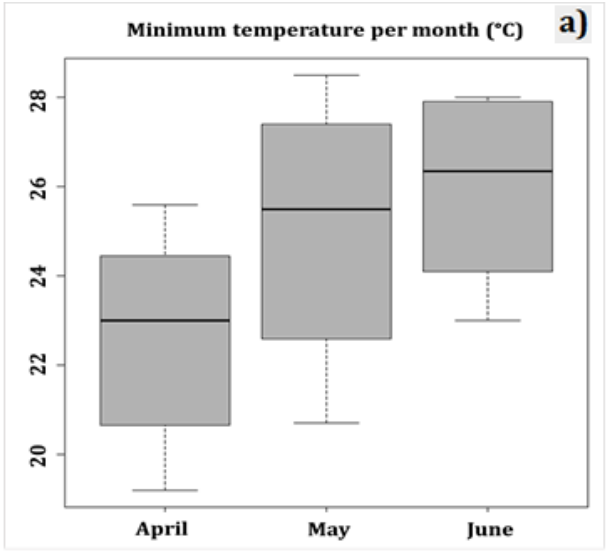


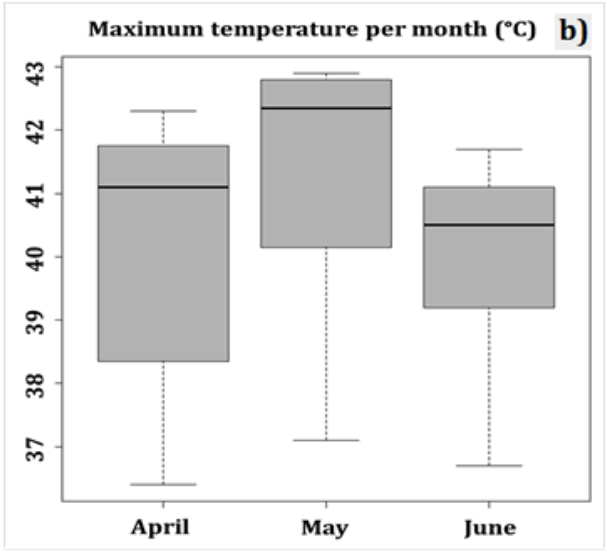
Main results and findings

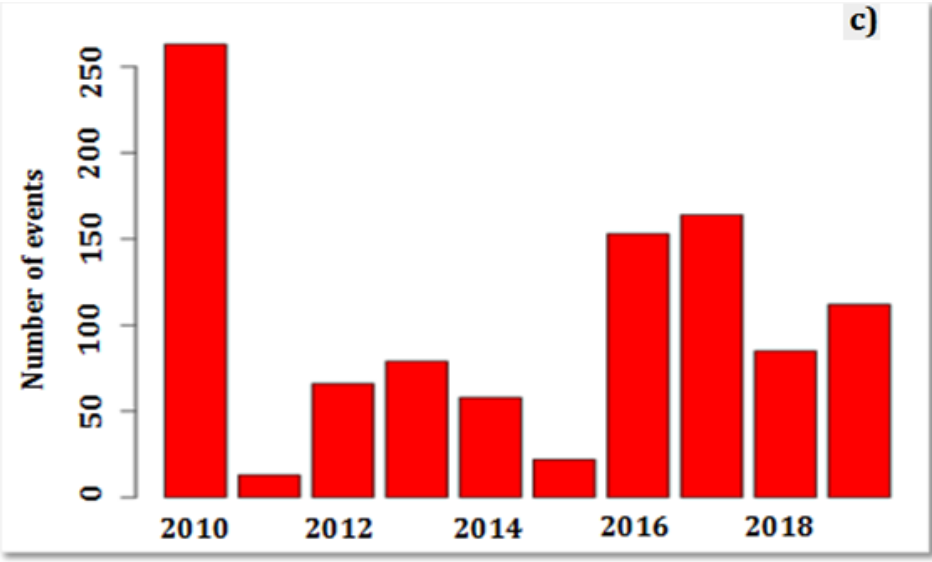
- **Temperature trends and heat waves in the northern part of Senegal**

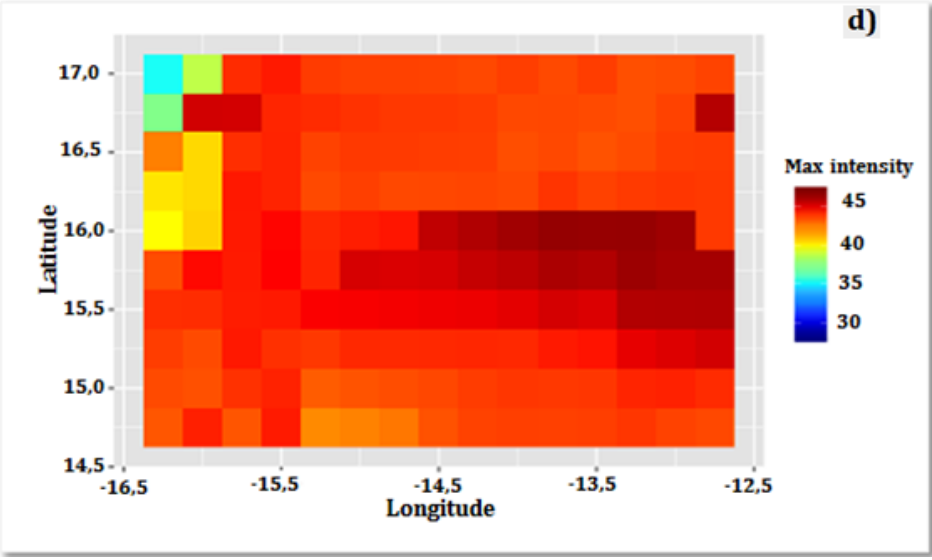
Heatwave events during the period 2009 to 2019:

- **Heatwave months (a and b):** occurrence most important in april, may and june
- **Number of events (c):** 2010, 2013, 2016, 2017, 2018 and 2019 with high frequency;
- **Location in terms of intensity (d):** areas located in northern south most exposed to heatwaves events with high intensity in 2013 and 2018.









Main results and findings

- **Distribution of morbidity and mortality of heat wave sensitive diseases**

➢ Cumulative cases from 2009 to 2019 and prevalence of six temperature-sensitive diseases:

Matam (44,514 cases)

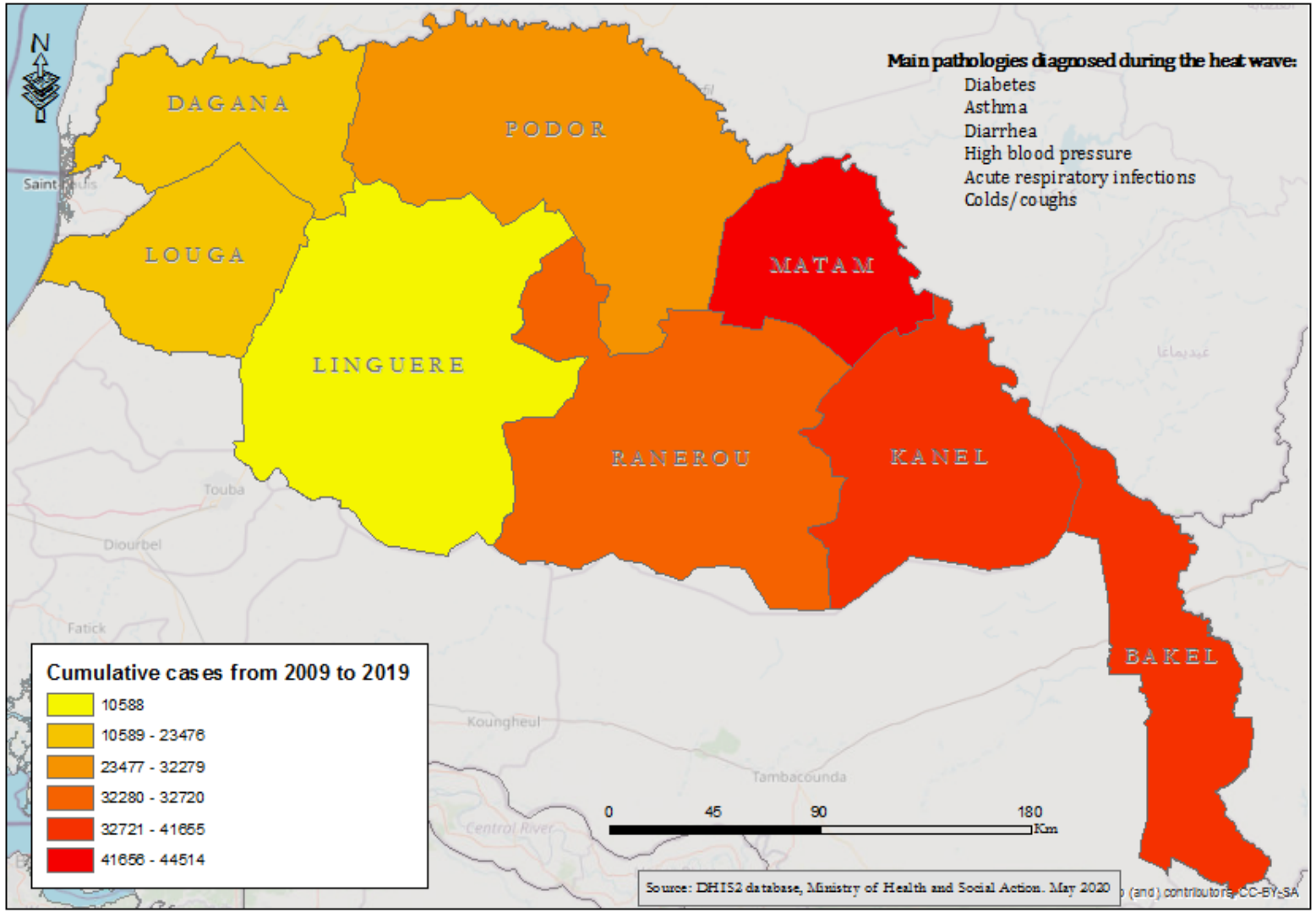
Kanel (41,655 cases)

Bakel (41,204 cases)

Dagana (23 476 cases)

Louga (21 527 cases)

Linguère (10 588 cases)



Main results and findings

- **Distribution of morbidity and mortality of heat wave sensitive diseases**

Spatial distribution of morbidity and diseases susceptible to heat waves:

Kanel (17,7%)

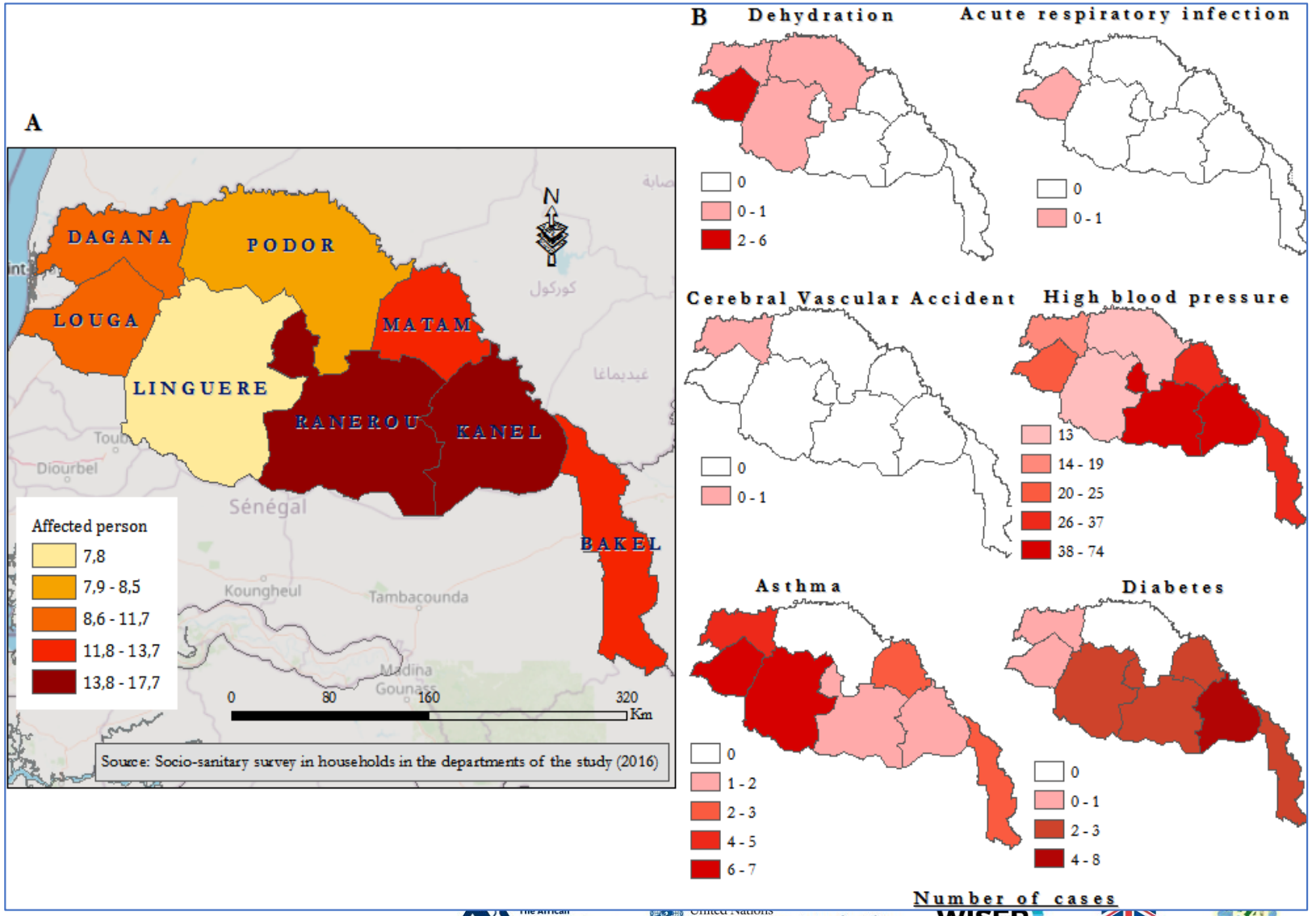
Ranérou (16,1%)

Matam (13,7%)

Bakel (13,7%)

Linguère (7,8%)

Podor (8,5%)



Main results and findings

- **Distribution of morbidity and mortality of heat wave sensitive diseases**

Reported mortality is unevenly distributed across departments

Matam (25,2%)

Bakel (23,5%)

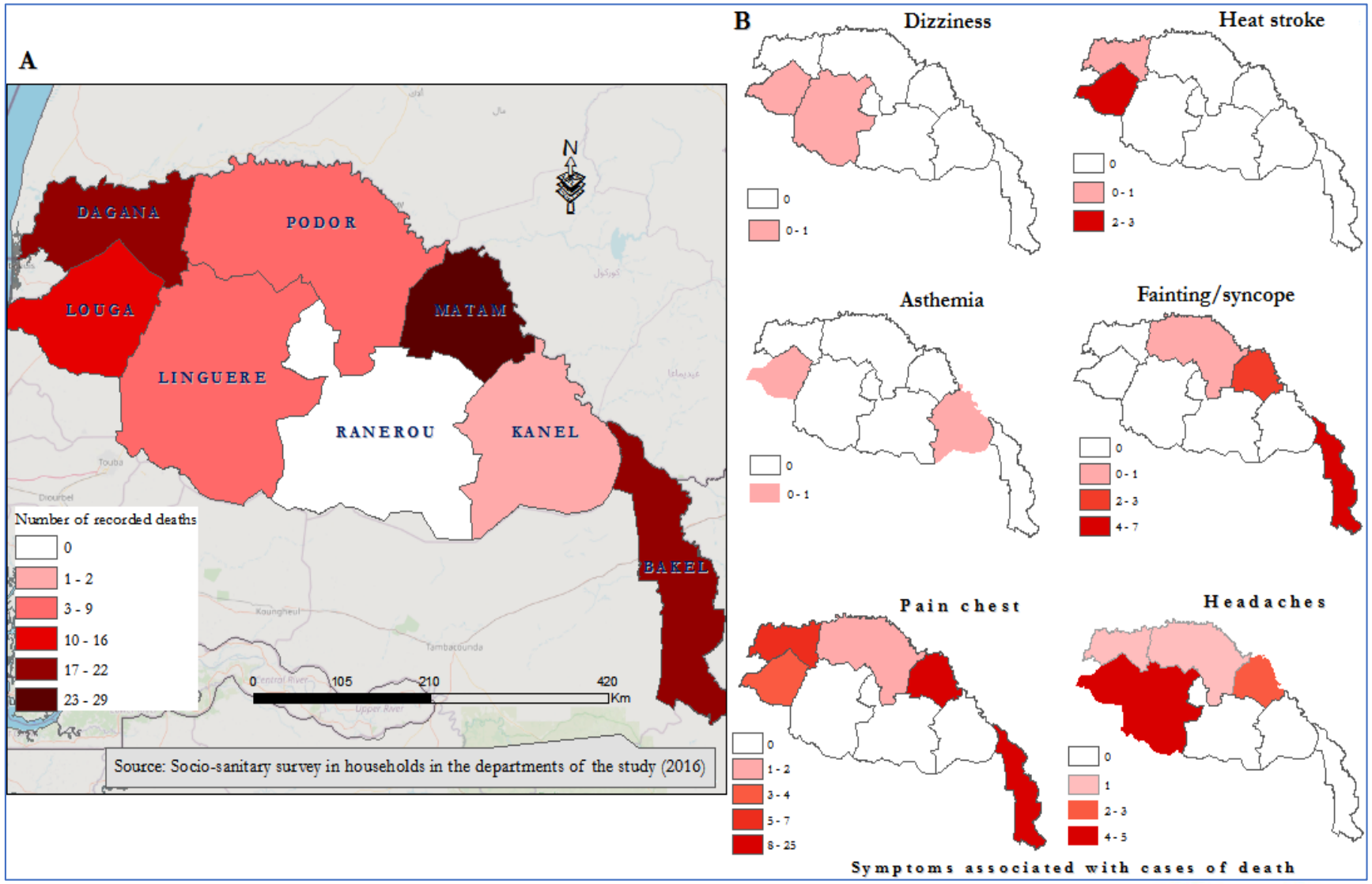
Dagana (22,7%)

Louga (10%)

Podor (8,4%)

Linguère (9,2%)

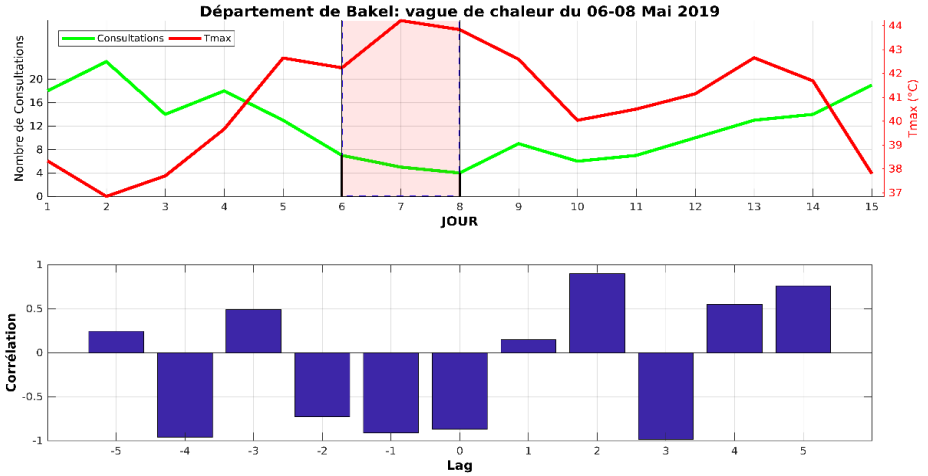
Kanel (0,8%)

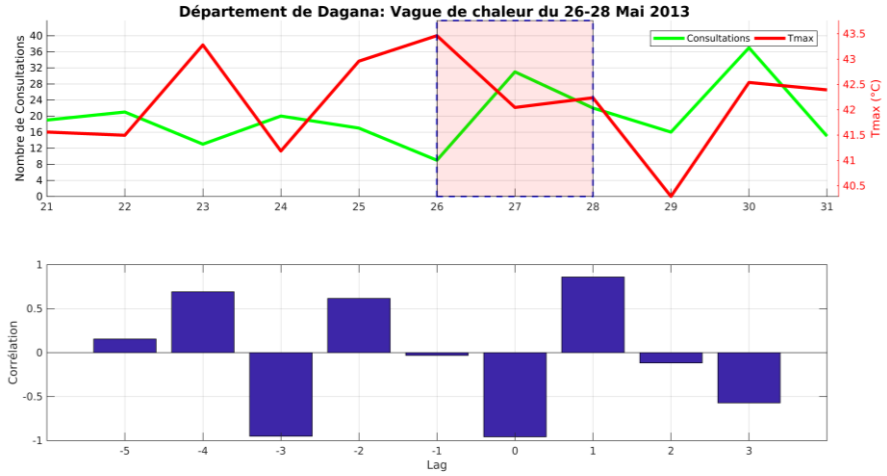


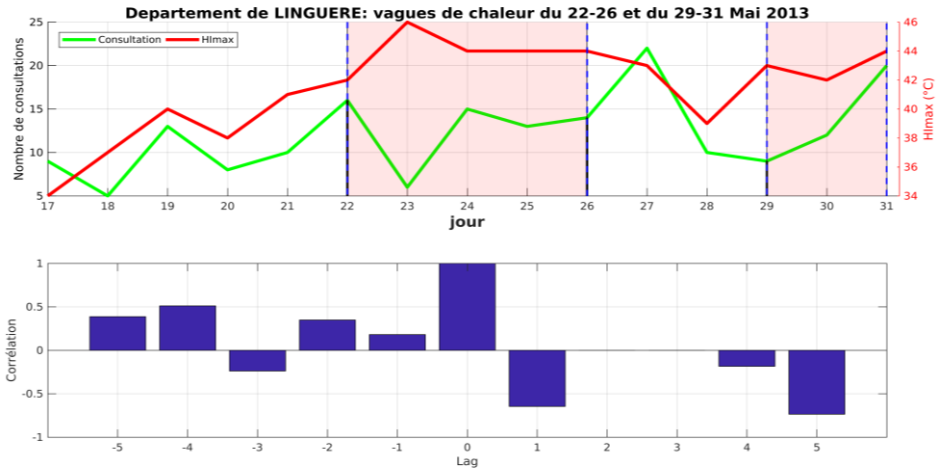
Main results and findings

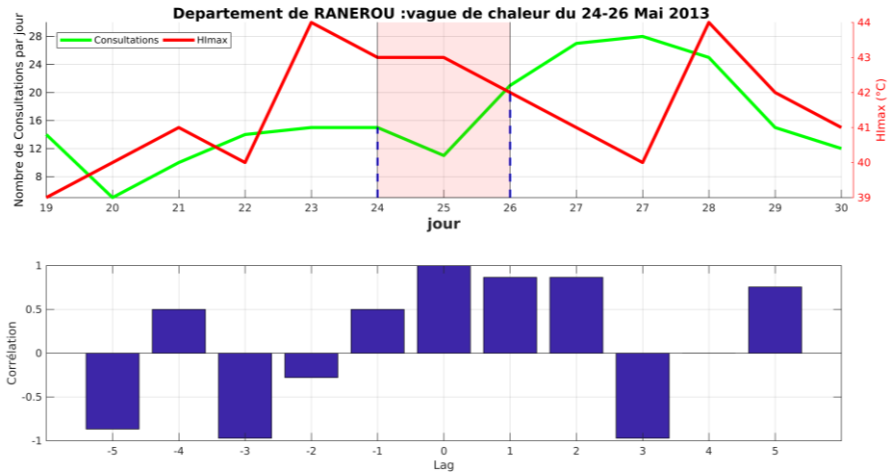
- **Correlation between heatwaves and daily consultations**

- Time lag between peak temperatures and number of consultations increasing three days after heatwave event occurrence.









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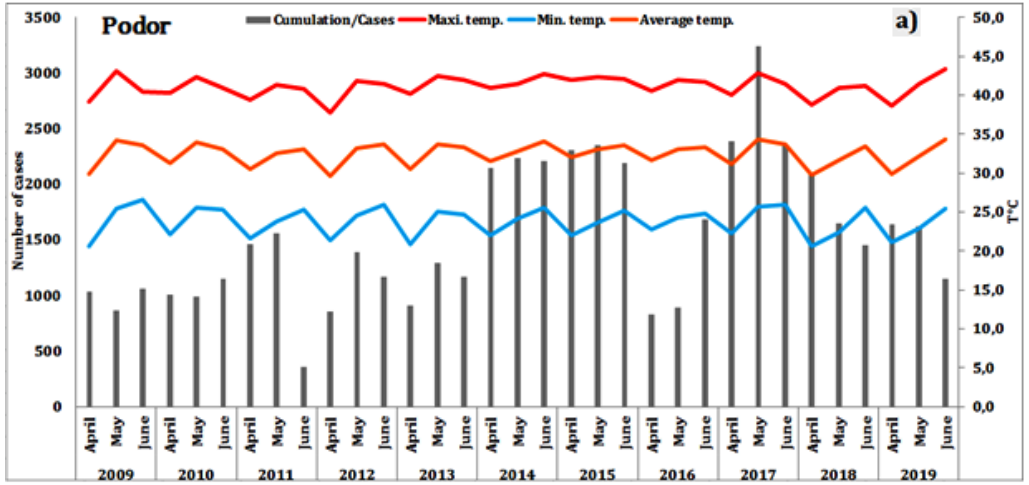
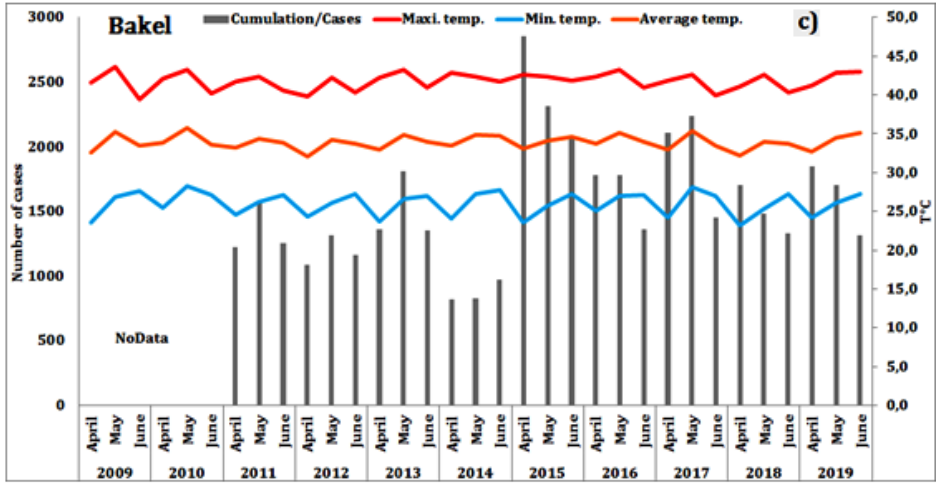
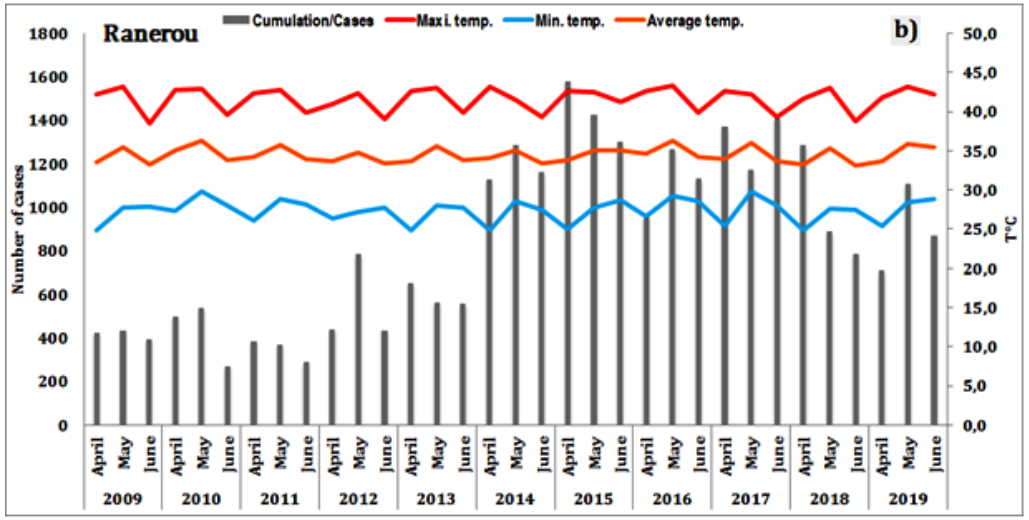
Main results and findings

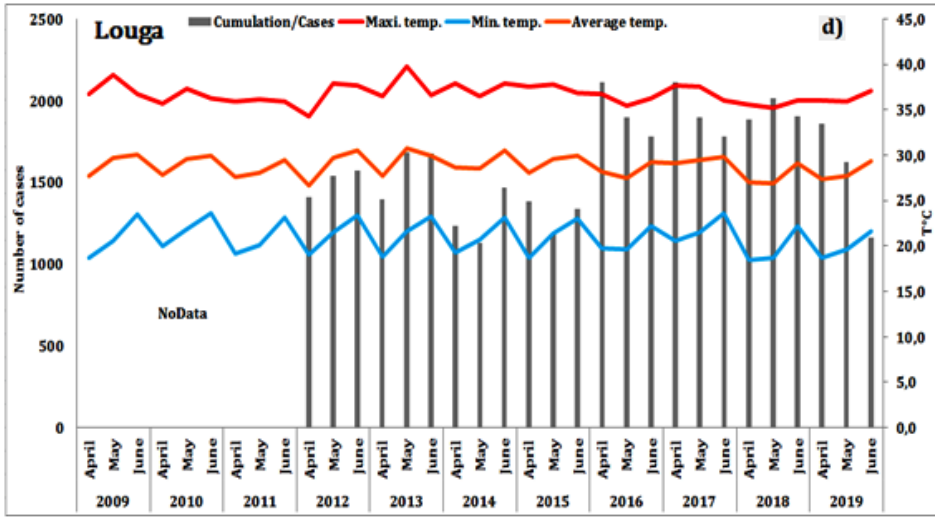
Relationship between cumulative pathology and temperature (°C): example of (a) Podor, (b) Ranerou, (c) Bakel and (d) Louga

- More consultation in April and May (2009-2019);
- Compared to other months of the year, consultation cases are more higher in April and May;
- More consultation cases in heat wave years (2014, 2013, 2015, 2016, 2017).









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Main results and findings

- **Exposure and vulnerability risk factors to the health impacts of heatwaves**

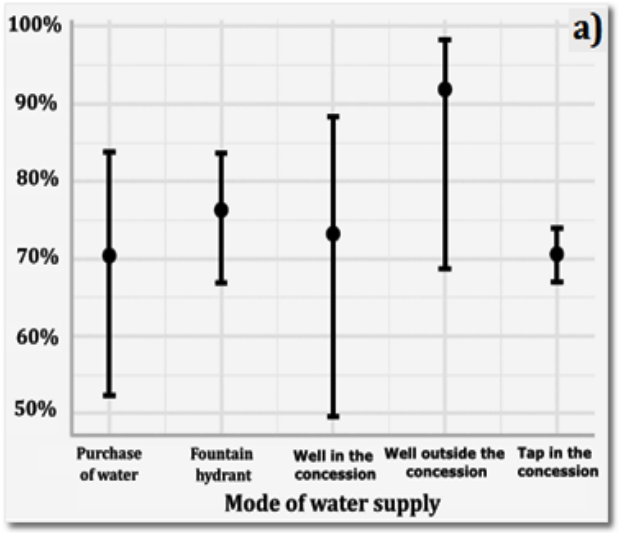
- Several risk factors increase the vulnerability of populations to heatwaves;
- Older people living in houses built with cement are more exposed to the effects of heatwaves;
- People with co-morbidities, particularly chronic diseases are highly exposed to the effects of heatwaves.

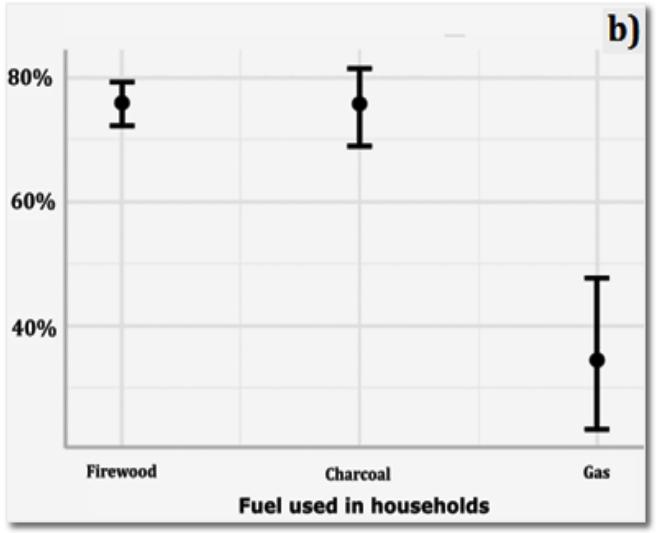
Risk factors	Coef.	Std. Err.	z	P>z	[95%	Conf.	Significance
Gender person	-.6504591	.1605448	-4.05	0.000	-.965121	-.3357972	***
Household population density	.1103047	.0490329	2.25	0.024	.014202	.2064075	*
Type of housing used	-.6888186	.1745533	-3.95	0.001	-1.030937	-.3467005	***
Housing material construction	.3784948	.1907388	1.98	0.003	.0046536	.752336	***
Type of energy used	.5459268	.2305418	2.37	0.018	.0940732	.9977804	*
Household water avalaibility	.046807	.2048986	0.23	0.010	-.3547868	.4484008	*
Fan or air conditioner avalaibility	-.3625368	.1803599	-2.01	0.000	-.7160357	-.0090378	***
Type of fuel used in household	.7673144	.1763332	4.35	0.000	.4217077	1.112921	***
Previous and chronic health problems	1.685009	.217815	7.74	0.006	1.2581	2.111919	**
People with a health history	-0.14319	0.04296	-2.95	0.000	-3.333	.2064075	***

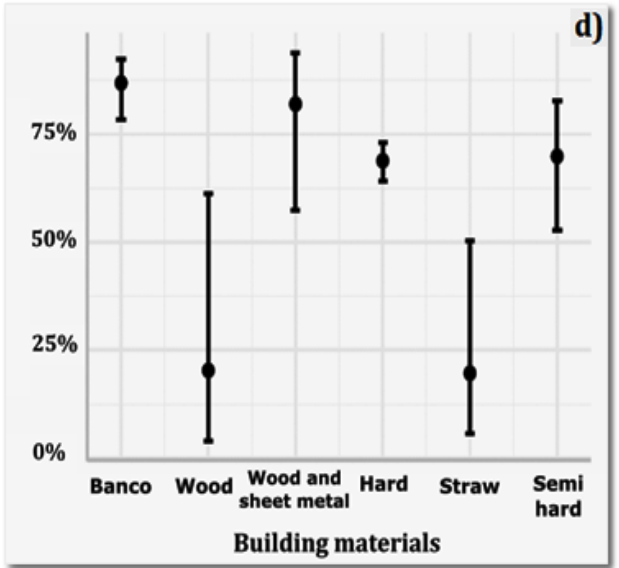
Main results and findings

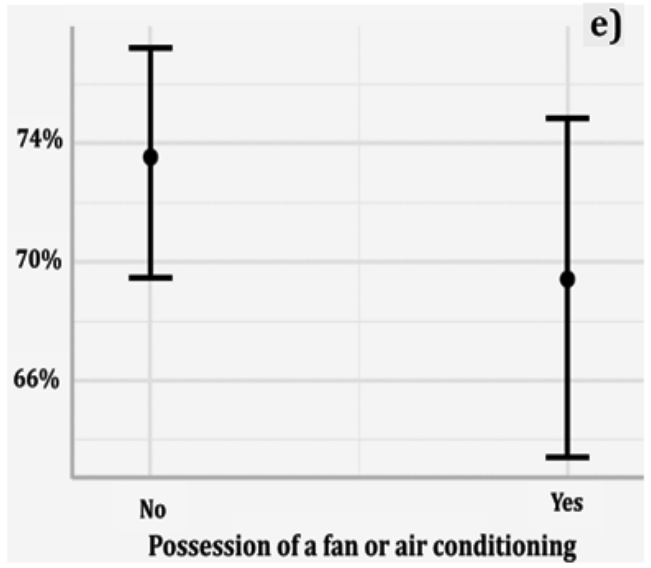
- **Exposure and vulnerability risk factors to health impacts of heat waves**

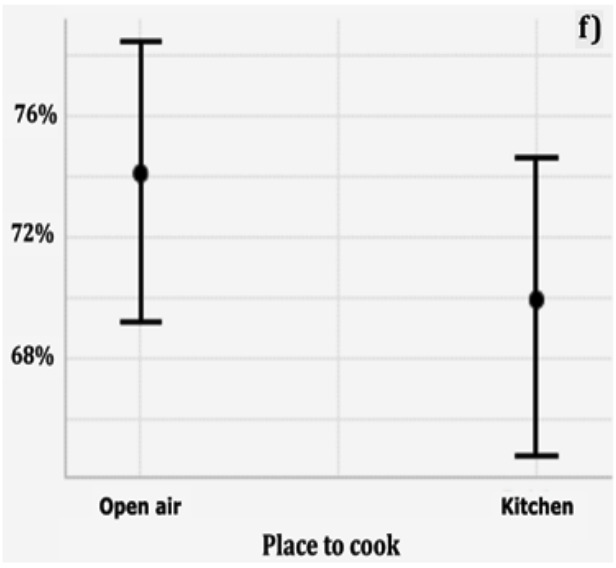
  - **Social and environmental determinants as main risk factors:**







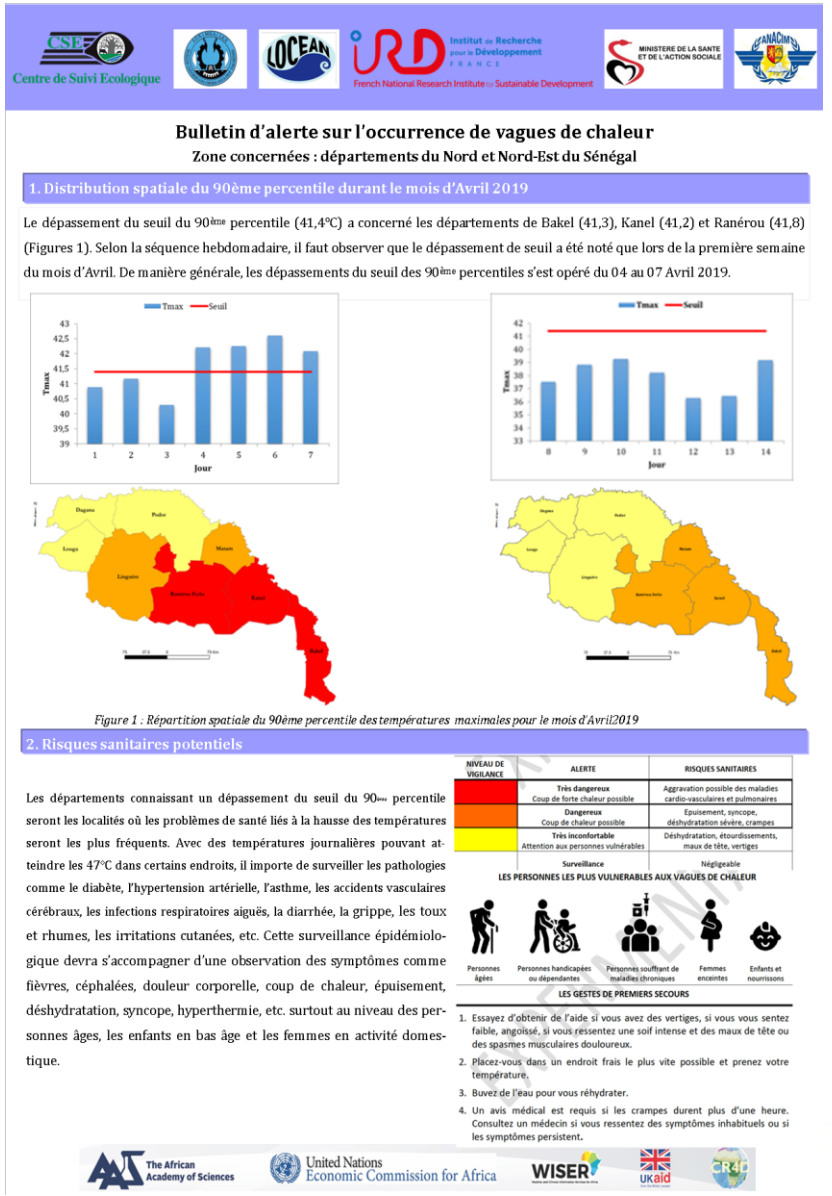




Main results and findings

- **Capacity building of health workers and local communities on the implementation of an early warning system**

- Sharing and validation of research results on heatwaves with health workers and community relays;
- Presentation of the early alert bulletin to deliver to health workers and local communities;
- Presentation of the early warning system using the community-based health surveillance system network of health districts.



Bulletin d'alerte sur l'occurrence de vagues de chaleur

Zone concernées : départements du Nord et Nord-Est du Sénégal

1. Distribution spatiale du 90ème percentile durant le mois d'Avril 2019

Le dépassement du seuil du 90ème percentile (41,4°C) a concerné les départements de Bakel (41,3), Kanel (41,2) et Ranérou (41,8) (Figures 1). Selon la séquence hebdomadaire, il faut observer que le dépassement de seuil a été noté que lors de la première semaine du mois d'Avril. De manière générale, les dépassements du seuil des 90ème percentiles s'est opéré du 04 au 07 Avril 2019.

Figure 1 : Répartition spatiale du 90ème percentile des températures maximales pour le mois d'Avril2019

2. Risques sanitaires potentiels

Les départements connaissant un dépassement du seuil du 90ème percentile seront les localités où les problèmes de santé liés à la hausse des températures seront les plus fréquents. Avec des températures journalières pouvant atteindre les 47°C dans certains endroits, il importe de surveiller les pathologies comme le diabète, l'hypertension artérielle, l'asthme, les accidents vasculaires cérébraux, les infections respiratoires aiguës, la diarrhée, la grippe, les toux et rhumes, les irritations cutanées, etc. Cette surveillance épidémiologique devra s'accompagner d'une observation des symptômes comme fièvres, céphalées, douleur corporelle, coup de chaleur, épuisement, déshydratation, syncope, hyperthermie, etc. surtout au niveau des personnes âges, les enfants en bas âge et les femmes en activité domestique.

NIVEAU DE VIGILANCE	ALERTE	RISQUES SANITAIRES
	Très dangereux Coup de forte chaleur possible	Aggravation possible des maladies cardio-vasculaires et pulmonaires
	Dangereux Coup de chaleur possible	Epuisement, syncope, déshydratation sévère, crampes
	Très inconfortable Attention aux personnes vulnérables	Déshydratation, étourdissements, maux de tête, vertiges
	Surveillance	Négligeable

LES PERSONNES LES PLUS VULNERABLES AUX VAGUES DE CHALEUR

Personnes âgées | Personnes handicapées ou dépendantes | Personnes souffrant de maladies chroniques | Femmes enceintes | Enfants et nourrissons

LES GESTES DE PREMIERS SECOURS

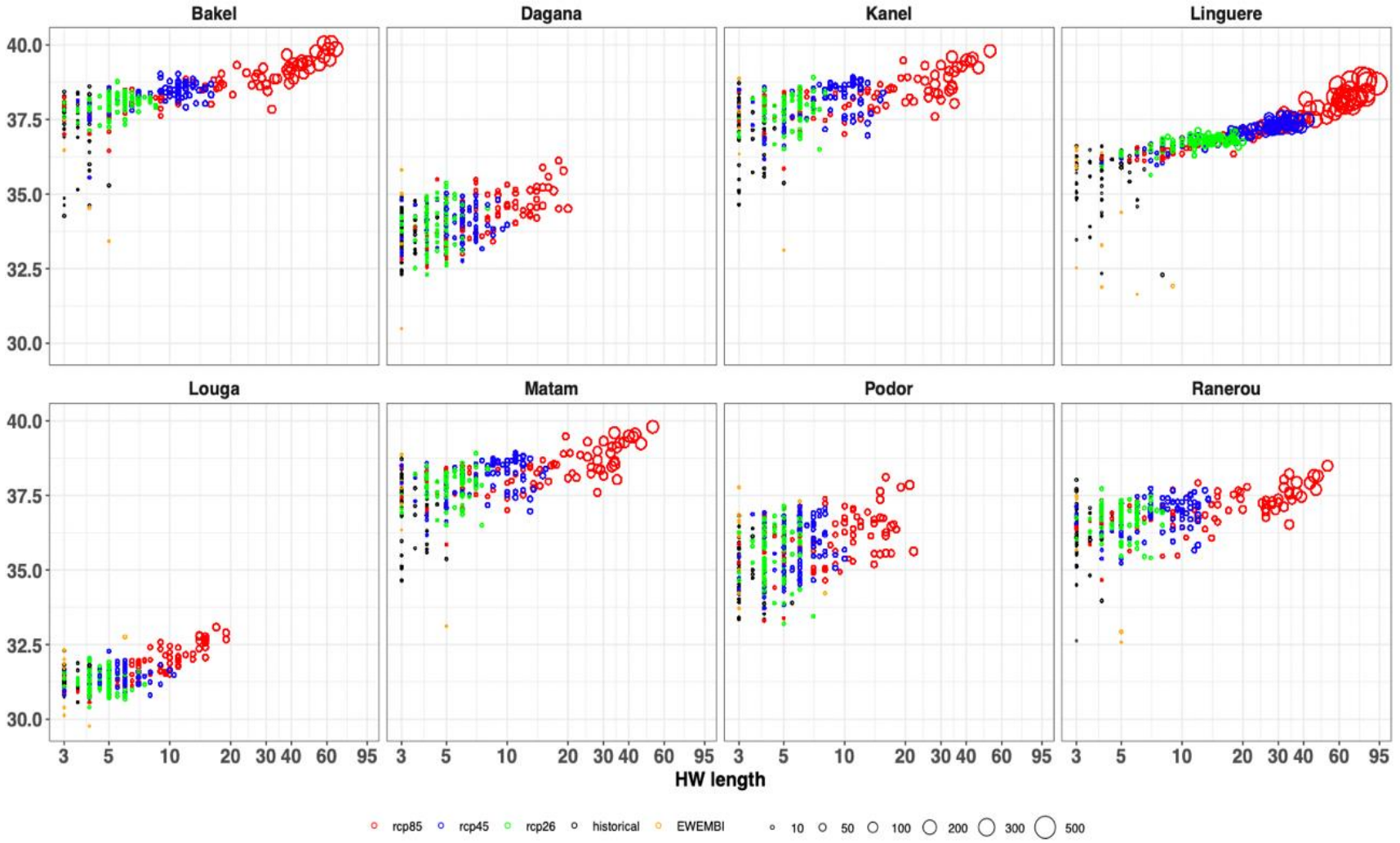
1. Essayez d'obtenir de l'aide si vous avez des vertiges, si vous vous sentez faible, angoissé, si vous ressentez une soif intense et des maux de tête ou des spasmes musculaires douloureux.
2. Placez-vous dans un endroit frais le plus vite possible et prenez votre température.
3. Buvez de l'eau pour vous réhydrater.
4. Un avis médical est requis si les crampes durent plus d'une heure. Consultez un médecin si vous ressentez des symptômes inhabituels ou si les symptômes persistent.

Main results and findings

- **General increase in present and future temperature with exceptional values in 2100**

✓ Increase of the frequency, duration and average of heatwaves occurrence between march and may from 1950 to 2099;

➢ Peak temperatures in northern Senegal could frequently exceed 45°C in spring by the end of the century with exceedances of the 95th percentile threshold.



Conclusions, Lessons & Impact

Conclusions

- Increasing trend in minimum and maximum temperatures in the northern part of Senegal: 2010, 2013, 2017 and 2018 considered very hot with a large number of heat wave days;
- Phenomenon of excess morbidity with an increase in the number of consultations for pathologies sensitive to the increase in temperature linked to the sensation of heat felt;
- Several risk factors: age, gender, living conditions, lifestyles, socio-economic comfort level and types of activity, health history, etc.;
- Need to combine heat wave indices with excess morbidity and mortality to develop a bio-meteorological risk indicator that can feed into a heat wave early warning system;
- Consider heat waves in the North zone as a major public health problem, improve heatwaves detection and develop early warning system;
- Intensify research on climate-sensitive diseases in order to better orient prevention measures and support the national adaptation plane of health sector.

Lessons / Impact

Lessons

Vulnerability to heatwaves is not only related to the occurrence of extreme temperatures but also to the lack of adaptation strategies or capacity of communities to respond to the health impact of heatwaves;

Heatwaves occurrence will increase highly the severity and gravity of chronic diseases in the investigated localities while projection models predict intensity of heatwaves in the future.

Managing health problems related to rising temperatures requires development of an early warning system to build resilience of populations and health system to heatwave impacts.

Impact

Better understanding of heatwave events, their impacts on health populations of north-eastern Senegal, vulnerability factors, both environmental and social for policy change and community resilience.

Establishment of a multisectoral framework for the production of quality scientific information which strengthens the capacity of actors (climate, health and communities) to prevent the heatwave health impacts.

THANK YOU