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Evaluation of the Health Impacts of Lead Pollution from the Surface Waters of the Djiri River by Crossing Hazard and Vulnerability Issues (Republic of Congo)

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Abstract: ***The objective of this study is to assess the health impacts of air pollution of the Djiri River on the populations of the area covered by the Djiri health district. The Djiri area north of Brazzaville is growing in population and the presence of industrial facilities that can produce toxic emissions can compromise the health of residents. This study follows a previous study that diagnosed the presence of lead in the waters of the Djiri River at levels (average annual pollution) above the WHO guide value (Norme 2006). Health data collected based on cardiovascular and respiratory diseases was carried out at five health centres in the Djiri Health District and assessed both the damage caused to the population by leaded Djiri water, to apply two scenarios of health risk coverage conceptualized for determining health gains. No mortality was observed in health centres, but the following cases of morbidity are observed: -20050 cases of morbidity in high blood pressure in 2016 including 8659 cases in women versus 11391 cases in men; -20537 cases of morbidity in high blood pressure in 2017 including 9534 cases in women versus 11,003 cases in men; -17730 cases of morbidity in acute respiratory infection in 2016 including 8243 cases in women compared to 9487 cases in men; -19867 cases of morbidity in acute respiratory infection in 2017 including 8350 cases in women compared to 11517 cases in men; Overall, there were 40587 cases of morbidity in high blood pressure compared to 37597 cases of morbidity in acute respiratory infection over the period 2016-2017. Meeting WHO's recommendations for short-term lead would lead to a health gain for the Djiri Health District each year of: - 1673 cases of morbidity in high blood pressure; - 1550 cases of morbidity in acute respiratory infection. In the long term, for a decrease in the average annual degree of lead pollution of 0.01 mg/l, the potential health gain is estimated at 18 cases of morbidity in high blood pressure avoided per year and 17 cases of morbidity in acute respiratory infection avoided per year. Of the total cases of mordibility observed (78184 cases), 28853 in the Djiri River and Kintelé Central areas are considered as cases attributable to water pollution as the use of the Djiri River waters by populations in these areas and 49331 cases other areas of the Djiri Health District are considered to be cases likely due to pollution of the djiri River waters since these areas are a little further from the Djiri River.***

Keywords: Metal Pollution, MERISE and Information System, WHO Water Quality Standards, Health Events, Health Impacts, Health Indicators.

1. Introduction

Samples taken over a 12-month period between May 2016 and December 2017 on the Djiri River have been used to diagnose lead water pollution.

Faced with this diagnosis and given the potential damage caused by lead to human health, it is necessary to embark on the search for solutions to cover health risks.

This study is part of the protection of water ecosystems (rivers, rivers, rivers, seas, etc.) against pollution in general and in particular in our study area, the Institute for Research in Exact and Natural Sciences (IRSEN) and the Faculty of Science and Technology (FST) are in collaboration in the implementation of this.

This work aims to assess the health impacts of lead pollution of the waters of the Djiri River by crossing the hazard (health event) and the vulnerability of the issues (damage to the population) and the proposal of the health risks.

In achieving the following objectives, we have adopted the following methodological approach:

- Completion of health data collected on lead-related diseases (Cardiovascular and Respiratory) in some health centres in the Djiri Health District;
- Identifying the vagaries and related issues;

Building the database;

- Construction of the health impact indicator (annual average vulnerability level) by crossing each hazard and issue;
- Construction of the health impact indicator (average vulnerability level) by crossing the period and the area of origin of populations;
- Mapping the vulnerability of populations in the Djiri Health District;
- Construction of health risk coverage scenarios;
- Application of scripts.

This approach is similar to that recommended in the pollution health impact assessment guide published by the Institute for Health Watch (InVS) in 1999 and updated in March 2003 by the InVS, considering the evolution of knowledge on the impact long-term pollution on mortality.

2. Introducing the Study Area

2.1. Study period

The study period chosen covers 2 years, from 2016 to 2017. It was selected based on the period of assessment of surface water pollution in the Djiri River.

2.2. Area of study

The field of study consists of inhabited areas covered by the Djiri Health District.

During this study, we consider that all populations of the Djiri River and Kintelé center areas and Marien Ngouabi Military Academy run the same risk of exposure to lead poisoning given their proximity to the Djiri River and the site other areas are likely to be at the same risk.

Table 1: GPS coordinates of areas selected for the survey

IDENTIFIANT_ZONE	ZONES	LONGITUDE_EN_DEGRE_DECIMAL	LATITUDE_EN_DEGRE_DECIMAL
1	Académie militaire Marien N.	15,30219444	-4,133786111
2	Cimétière d'itatolo Koko NDEBA	15,27358333	-4,1475
3	Djiri rivière	15,31138889	-4,130111111
4	Don Bosco	15,26306944	-4,15195
5	Kintélé Centre	15,34720278	-4,132622222
6	Marché Soprogi	15,26078333	-4,159705556

Source: Field data

Comment:
Table 1 shows the selected areas in the Djiri Health District, their GPS coordinates and for each area a health centre has been encased for data collection.

3. Materials and Methods

3.1. Materials

The set of hardware and software useful to run this study are summarized in the following table :

Table 2: Materials and Software

N°	BESOIN	TYPE DE BESOIN	USAGE	QUANTITE OU FREQUENCE
1	POWER VIEW	OUTIL LOGICIEL	CARTOGRAPHIE ET SIG	1
2	GOOGLE MAPS	OUTIL LOGICIEL	GEOLOCALISATION DES ZONES	1
3	MS EXCEL 2016	OUTIL LOGICIEL	PRODUCTION DES DONNEES STATISTIQUES	1
4	XLSTATS	OUTIL LOGICIEL	ANALYSE DES DONNEES (A.C.P)	1
5	ORDINATEUR PORTABLE	MATERIEL INFORMATIQUE	OUTIL DE TRAVAIL	1
6	COLLECTES DES DONNEES SANITAIRES	FRAIS DE TERRAIN : MISSIONS ET PRIMES DES TACHERONS	DEPLACEMENT ENTRE LES ZONES POUR LA COLLECTE DES DONNEES	3 PASSAGES/CENTRE

Comment: Hardware and software summary
Table 2 summarizes the various hardware and software used for this work.

3.1.2. Methods

3.1.2.1. Data collection

Health data collected was conducted between October 2018 and December 2018 to collect health data on 2016 and 2017; We visited six centres in the Djiri Health District :

- DJIRI PONT HEALTH CENTRE ;
- CABINET MEDICAL SAINTE LIGHT ;
- KINTELE INTEGRE HEALTH CENTRE ;
- -DAVINA SOINS CENTRE ;
- -MILITARY INFIRMARY ;
- LE GLOBAL MEDICAL PRACTICE.

The health data collected are mainly related to cardiovascular and respiratory pathologies, it was to identify in an aggregated way with each of the health centres mentioned above, the observed cases of mortality and morbidity (hospitalization, consultation) on cardiovascular and respiratory diseases.

3.1.2.2. Completion of the Health Impact Assessment

The collection of health data is the first step in the process of assessing health impacts. It covers the period 2016-2017 and has been carried out in five health centres in the Djiri Health District. The collected data makes it possible to achieve :

- Identifying the vagaries and related issues:
- Identify health events that arise as a result of lead poisoning and observed targets ;
- The construction of the relational database ;
- Build a conceptual model of the data, the relational pattern of the database and the physical model of health data ;

- The construction of health impact indicators (annual average vulnerability level) by crossing each hazard and issue ;
- Implement and inform the database under MS ACCESS 2016, link the database to the MS Excel 2016 application program and build impact indicators by dynamic crossover according to hazard and stake ;
- The construction of the health impact indicator (average vulnerability level) by crossing the period and the area of origin of populations ;
- Build impact indicators by dynamic cross-table by period and area of origin ;
- The coupling of the MS Excel 2016 and Power view application programs for the completion of a geographical distribution of lead poisoning observations across the selected areas of the Djiri Health District.

3.1.2.3. Construction of health cover scenarios

Table 3: Scenario of health risk coverage

	Polluant	Scénario	Expression des resultats
A Court Terme	PLOMB	Scénario 1 : Diminution de la moyenne annuelle à la valeur guide de l'OMS soit 0,01 mg/l	Décès évités/an Hospitalisations respiratoires et cardiaques évitées/an
A Long Terme		Scénario 2 : Diminution de 0,01 mg/l de la moyenne annuelle	Hospitalisations cardiaques évitées/an Gain d'espérance de vie à 30 ans

- Scenario 1 : quantifies the Number of deaths and hospitalizations prevented if WHO's water quality targets are met.
- Scenario 2 : aims to estimate the health benefits of a 0.01 mg/l drop in the average annual value.

They are studied for the only pollutant selected.

Application of scenarios:

<u>**Scénario 1 :**</u>
- N_{Ob} defines the average Number of cases observed per health event per year ;
- V_G WHO guide value of selected pollutant ;
- $DP_{Moyen_{annuel}}$ the average annual level of pollution ;
- N_{Ev} Determines the Number of cases averted per year using the following formula :

$$N_{Ev} = N_{Ob}\left(1 - \frac{V_G}{DP_{Moyen_{annuel}}}\right)$$

<u>**Scénario 2**</u>**:** aims to estimate the health benefits of a 0.01 mg/l drop in the average annual value.
- N_{Ob} Defines the average Number of cases observed per health event per year ;
- V_G WHO guide value of selected pollutant ;
- $DP_{Moyen_{annuel}}$ The average annual level of pollution ;
- N_{Ev} Determines the Number of cases averted per year using the following formula:

$$N_{Ev} = \frac{N_{Ob} * V_G}{DP_{Moyen_{annuel}}}$$

3.1.2.4. Contribution of Computer Analysis to the quality of National Pathological Statistics

Health data collections immediately lead to the need for a structured information system (data base) to ensure both the storage and quality of data in the short and medium term to achieve a long-term national health statistics portal for health districts.

To make the expected contribution, we used the systemic approach to the design of information systems known as MERISE (Jean Patrick MATHERON, Hubert TARDIEU, 2000) to enable us to model the data and this modeling build the related database.

The entity-association formalism of the MERISE computer analysis method will be used to describe and model the process of producing statistical data from health districts in the Republic of Congo in order to create a database reliable, confidential and secure national health care facilities.

The methodology to be applied in the short and medium term is as follows :
- Developing the dictionary of data based on the data materials obtained during the collection of health data : Reference of the headings or information to be provided in the database ;
- Building the conceptual model of data : description of all the information on the process of managing health statistics ;
- Building the logical model of data : describing the data without addressing the constraints of implementing the data, this model reflects the organizational choice of data (relational table, file etc.)
- Building the physical model of the data : the presentation of the data as it will be implemented ;
- Implementation of the database : realizing the actual data structure.

In the long term, we will carry out a web portal allowing each health centre to house its health statistics on the web and public health actors to have immediate data on analyses on different pathologies, carry out the monitoring of pathologies.

4. Results and Discussion

4.1. Results

Pollution Indicator: LEAD

Table 4: Average Annual Exhibition 2016-2017

MESURE EXPERIMENTALE								
	TEMPS	MESURE AVAL	MESURE AMONT	EXCEDENT DE MESURE	VALEUR GUIDE OMS (2006)	INDICE DE POLLUTION	DEGRE DE POLLUTION	TEST DE POLLUTION
PLOMB	1	2,8	1,42	1,38	0,01	138	2,79	Pollution Observée
	2	0,77	0,36	0,41	0,01	41	0,76	Pollution Observée
	3	1,07	0,8	0,27	0,01	27	1,06	Pollution Observée
	4	1,13	0,83	0,3	0,01	30	1,12	Pollution Observée
	5	0,62	0,44	0,18	0,01	18	0,61	Pollution Observée
	6	0,9	0,5	0,4	0,01	40	0,89	Pollution Observée
	7	0,27	0,17	0,1	0,01	10	0,26	Pollution Observée
	8	0,5	0,3	0,2	0,01	20	0,49	Pollution Observée
	9	0,8	0,7	0,1	0,01	10	0,79	Pollution Observée
	10	0,73	0,6	0,13	0,01	13	0,72	Pollution Observée
	11	0,9	0,5	0,4	0,01	40	0,89	Pollution Observée
	12	0,83	0,7	0,13	0,01	13	0,82	Pollution Observée
						DEGRE MOYEN DE POLLUTION	0,933333333	

Source: Physico-chemical analysis data (IRSEN)

Comment:
Table 4 shows clues and indicators of lead metal pollution in the surface waters of the Djiri River and observes a source of lead pollution between the downstream and upstream points of this river.

Table 5: Mortality and Morbidity Indicators (annual average), 2016-2017

Moyenne des Cas Observés	ANNEE		
INDICATEURS	2016	2017	MOYENNE INTER-ANNEE
Morbidité -Hypertension Arterielle	1671	1711	1691
Morbidité -Infection Respiratoire Aigue	1478	1656	1567
Mortalité -Hypertension Arterielle	0	0	0
Mortalité -Infection Respiratoire Aigue	0	0	0

Source: Health Centre Data

Comment:
Table 5 shows the average annual values of observations by health event and year:

- on average 1671 cases of morbidity on high blood pressure compared to 1,711 cases observed in morbidity on high blood pressure in 2016, for an inter-year average of 1691 cases of morbidity on high blood pressure ;
- on average 1,478 cases observed in morbidity on acute respiratory infection compared to 1956 cases observed in morbidity on acute respiratory infection in 2017, or an inter-year average of 1567 cases of morbidity on acute respiratory infection ;
- No cases of mortality were observed.

Table 6: Breakdown of overall morbidity by patient area of origin and type of pathology in 2016

ANNEE : 2016							
NBREDE CAS OBSERVES	ZONES						
Type de Pathologie	Académie militaire Marien N.	Cimétière d'itatolo Koko NDEBA	Djiri rivière	Don Bosco	Kintélé Centre	Marché Soprogi	Total général
Cardio-vasculaire	3804	1460	4212	3586	4150	2838	20050
Respiratoire	2754	2190	3111	2575	4550	2550	17730
Total général	6558	3650	7323	6161	8700	5388	37780

Source: Health Centre Data

Table 7: Breakdown of overall morbidity by patient area of origin and type of pathology in 2017

ANNEE : 2017							
NBREDE CAS OBSERVES	ZONES						
Type de Pathologie	Académie militaire Marien N.	Cimétière d'itatolo Koko NDEBA	Djiri rivière	Don Bosco	Kintélé Centre	Marché Soprogi	Total général
Cardio-vasculaire	2291	4380	3108	2528	3895	4335	20537
Respiratoire	2410	5110	2721	2279	3106	4241	19867
Total général	4701	9490	5829	4807	7001	8576	40404

Source: Health Centre Data

Comment:
Tables 6 and 7 show the distribution of overall morbidity by area of origin of patients and type of pathology (Annual total on cardiovascular and respiratory cases in morbidity);

This table highlights the following observations:

- 20537 cases of morbidity on cardiovascular diseases (hypertension) versus 19867 cases of morbidity on respiratory diseases (acute respiratory infection) in 2017 ;
- 20050 cases of morbidity on cardiovascular diseases (hypertension) compared to 17730 cases of morbidity on respiratory diseases (acute respiratory infection) in 2016 ;

- Over the two years, the dominance of high blood pressure over acute respiratory infections is observed ;

However, no cases of mortality of any type of pathology combined were observed.

Table 8: Determining morbidity rates by health event and 2016 issue

ANNEE	NOMBRE DE CAS OBSERVES Zones/EVENEMENT SANITAIRE	ENJEUX Femme	Homme	Total général	TAUX DE MORBIDITE Femme	Homme
	Académie militaire Marien N.	3178	3380	6558	0,484598963	0,515401037
2016	Morbidité -Hypertension Arterielle	1789	2015	3804		
	Morbidité -Infection Respiratoire Aigue	1389	1365	2754		
	Mortalité -Hypertension Arterielle	0	0	0		
	Mortalité -Infection Respiratoire Aigue	0	0	0		
	Cimétière d'itatolo Koko NDEBA	2555	1095	3650	0,70	0,3
	Morbidité -Hypertension Arterielle	1095	365	1460		
	Morbidité -Infection Respiratoire Aigue	1460	730	2190		
	Mortalité -Hypertension Arterielle	0	0	0		
	Mortalité -Infection Respiratoire Aigue	0	0	0		
	Djiri rivière	2833	4490	7323	0,386863307	0,613136693
	Morbidité -Hypertension Arterielle	1577	2635	4212		
	Morbidité -Infection Respiratoire Aigue	1256	1855	3111		
	Mortalité -Hypertension Arterielle	0	0	0		
	Mortalité -Infection Respiratoire Aigue	0	0	0		
	Don Bosco	2589	3572	6161	0,42022399	0,57977601
	Morbidité -Hypertension Arterielle	1466	2120	3586		
	Morbidité -Infection Respiratoire Aigue	1123	1452	2575		
	Mortalité -Hypertension Arterielle	0	0	0		
	Mortalité -Infection Respiratoire Aigue	0	0	0		
	Kintélé Centre	3550	5150	8700	0,408045977	0,591954023
	Morbidité -Hypertension Arterielle	1587	2563	4150		
	Morbidité -Infection Respiratoire Aigue	1963	2587	4550		
	Mortalité -Hypertension Arterielle	0	0	0		
	Mortalité -Infection Respiratoire Aigue	0	0	0		
	Marché Soprogi	2197	3191	5388	0,407757981	0,592242019
	Morbidité -Hypertension Arterielle	1145	1693	2838		
	Morbidité -Infection Respiratoire Aigue	1052	1498	2550		
	Mortalité -Hypertension Arterielle	0	0	0		
	Mortalité -Infection Respiratoire Aigue	0	0	0		
	Total général	16902	20878	37780	0,447379566	0,552620434

Source : Health Centre Data

Table 9: Determining morbidity by health event and issue (Targets in 2017)

ANNEE	NOMBRE DE CAS OBSERVES Zones/EVENEMENT SANITAIRE	ENJEUX Femme	Homme	Total général	TAUX DE MORBIDITE Femme	Homme
	Académie militaire Marien N.	2210	2491	4701	0,470112742	0,529887258
2017	Morbidité -Hypertension Arterielle	1035	1256	2291		
	Morbidité -Infection Respiratoire Aigue	1175	1235	2410		
	Mortalité -Hypertension Arterielle	0	0	0		
	Mortalité -Infection Respiratoire Aigue	0	0	0		
	Cimétière d'itatolo Koko NDEBA	4745	4745	9490	0,50	0,5
	Morbidité -Hypertension Arterielle	2555	1825	4380		
	Morbidité -Infection Respiratoire Aigue	2190	2920	5110		
	Mortalité -Hypertension Arterielle	0	0	0		
	Mortalité -Infection Respiratoire Aigue	0	0	0		
	Djiri rivière	2510	3319	5829	0,430605593	0,569394407
	Morbidité -Hypertension Arterielle	1352	1756	3108		
	Morbidité -Infection Respiratoire Aigue	1158	1563	2721		
	Mortalité -Hypertension Arterielle	0	0	0		
	Mortalité -Infection Respiratoire Aigue	0	0	0		
	Don Bosco	1977	2830	4807	0,411275224	0,588724776
	Morbidité -Hypertension Arterielle	952	1576	2528		
	Morbidité -Infection Respiratoire Aigue	1025	1254	2279		
	Mortalité -Hypertension Arterielle	0	0	0		
	Mortalité -Infection Respiratoire Aigue	0	0	0		
	Kintélé Centre	3004	3997	7001	0,42908156	0,57091844
	Morbidité -Hypertension Arterielle	1750	2145	3895		
	Morbidité -Infection Respiratoire Aigue	1254	1852	3106		
	Mortalité -Hypertension Arterielle	0	0	0		
	Mortalité -Infection Respiratoire Aigue	0	0	0		
	Marché Soprogi	3438	5138	8576	0,400886194	0,599113806
	Morbidité -Hypertension Arterielle	1890	2445	4335		
	Morbidité -Infection Respiratoire Aigue	1548	2693	4241		
	Mortalité -Hypertension Arterielle	0	0	0		
	Mortalité -Infection Respiratoire Aigue	0	0	0		
	Total général	17884	22520	40404	0,442629443	0,557370557

Source: Health Centre Data

Comment

Tables 8 and 9 show annual morbidity rates based on the issue (gender) and area of origin of the patients;

These two tables show that in the majority of areas men are more affected by morbidity than women 55% of men compared to 45% of women in 2016 and 56% of men compared to 44% of women in 2017.

Of the total observations, 44% were women compared to 56% of men affected by morbidity in high blood pressure and morbidity in acute respiratory infection.

Table 10: Average Morbidity by Patient Origin Area and Pathology Type

Moyenne DE CAS OBSERVES	ANNEE				Moyenne inter-année
	2016		2017		
ZONES	Cardio-vasculaire	Respiratoire	Cardio-vasculaire	Respiratoire	
Académie militaire Marien N.	951	689	573	603	704
Cimétière d'itatolo Koko NDEBA	365	548	1095	1278	821
Djiri rivière	1053	778	777	680	822
Don Bosco	897	644	632	570	686
Kintélé Centre	1038	1138	974	777	981
Marché Soprogi	710	638	1084	1060	873
Moyenne inter-année	**835**	**739**	**856**	**828**	**814**

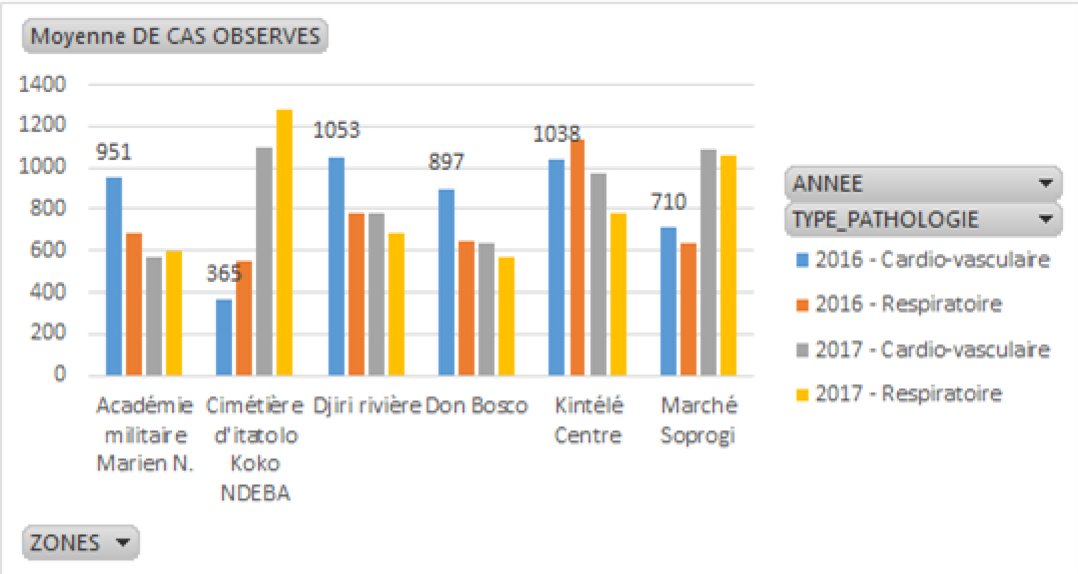


Figure 5: Medium Mordibity by Patient Origin Area and Pathology Type

Comment:

Table 10 and Figure 5 show the distribution of average annual morbidity by patient area of origin and type of pathology.

The highest interannual average on overall morbidity is observed in the Kintelé central area (an average of 981 cases of overall morbidity) ;

Table 11: Observations by Health Centre and Type of Pathology

Somme DE CAS OBSERVES	Type de Pathologie						TOTAL	TAUX DE FREQUENTATION	
	Cardio-vasculaire		Total Cardio-vasculaire	Respiratoire		Total Respiratoire			
ZONES	Femme	Homme		Femme	Homme			Cardio-vasculaire	Respiratoire
CM DJIRI PONT	2929	4391	7320	2414	3418	5832	13152	0,556569343	0,443430657
CM LE GLOBAL	3035	4138	7173	2600	4191	6791	13964	0,545392336	0,486321971
CM ONG APB	2824	3271	6095	2564	2600	5164	11259	0,463427616	0,458655298
CS DAVINA	2418	3696	6114	2148	2706	4854	10968	0,464872263	0,442560175
CS SAINTE LUMIERE	3650	2190	5840	3650	3650	7300	13140	0,444038929	0,555555556
CSI KINTELE	3337	4708	8045	3217	4439	7656	15701	0,611694039	0,487612254
TOTAL	**18193**	**22394**	**40587**	**16593**	**21004**	**37597**	**78184**	**0,519**	**0,481**

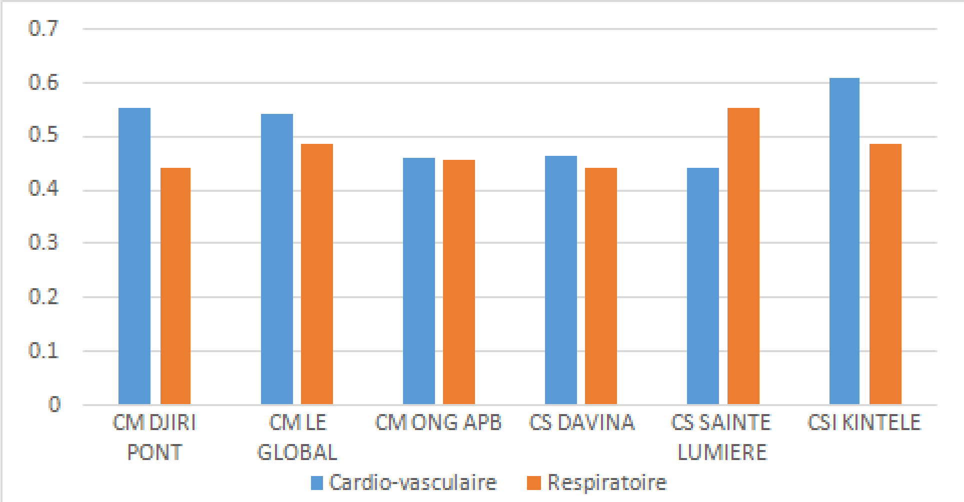


Figure 6: Observations by Health Centre and Type of Pathology

Comment

Table 11 and Figure 6 summarize observations of all Health Centres and are tracked down by type of pathology. These presentations show that the Integrated Health Centre in Kintelé was in the period 2016-2017 the most frequented by cases of morbidity on cardiovascular diseases (HTA) followed by the medical practice DJIRI PONT; On respiratory diseases (IRA) the health centre SAINTE LUMIERE was in the period 2016-2017 followed by the medical practice LE GLOBAL. There are no general health impacts in terms of mortality.

- **Monitoring of pathologies according to geographical zones**

Table 12: Follow-up of periodic health events by zone

ANNEE : 2016							
NOMBRE DE CAS OBSERVES	ZONES						
EVENEMENT SANITAIRE	Académie militaire Marien N.	Cimétière d'itatolo Koko NDEBA	Djiri rivière	Don Bosco	Kintélé Centre	Marché Soprogi	TOTAL
Morbidité -Hypertension Arterielle	3804	1460	4212	3586	4150	2838	20050
Morbidité -Infection Respiratoire Aigue	2754	2190	3111	2575	4550	2550	17730
Mortalité -Hypertension Arterielle	0	0	0	0	0	0	0
Mortalité -Infection Respiratoire Aigue	0	0	0	0	0	0	0
TOTAL	6558	3650	7323	6161	8700	5388	37780
ANNEE : 2017							
NOMBRE DE CAS OBSERVES	ZONES						
EVENEMENT SANITAIRE	Académie militaire Marien N.	Cimétière d'itatolo Koko NDEBA	Djiri rivière	Don Bosco	Kintélé Centre	Marché Soprogi	TOTAL
Morbidité -Hypertension Arterielle	2291	4380	3108	2528	3895	4335	20537
Morbidité -Infection Respiratoire Aigue	2410	5110	2721	2279	3106	4241	19867
Mortalité -Hypertension Arterielle	0	0	0	0	0	0	0
Mortalité -Infection Respiratoire Aigue	0	0	0	0	0	0	0
TOTAL	4701	9490	5829	4807	7001	8576	40404

Source: Data collected in health centers

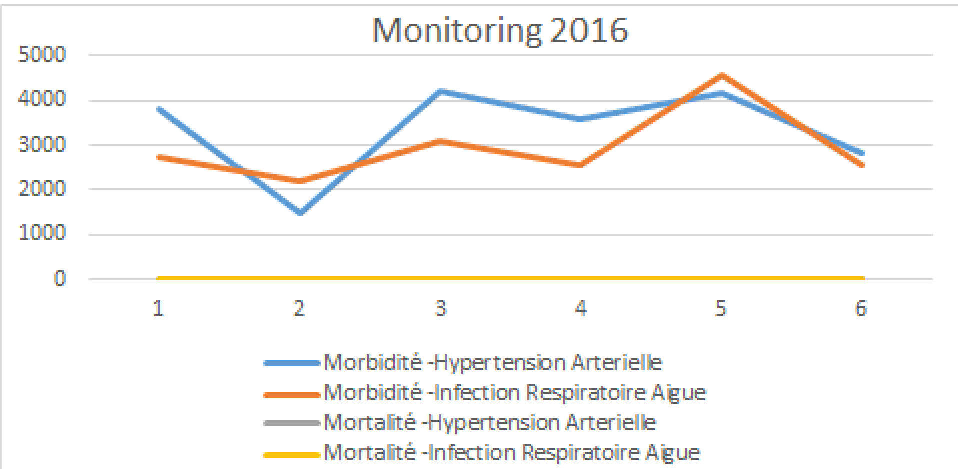


Figure 7: Trend in observations by area and health events (2016)

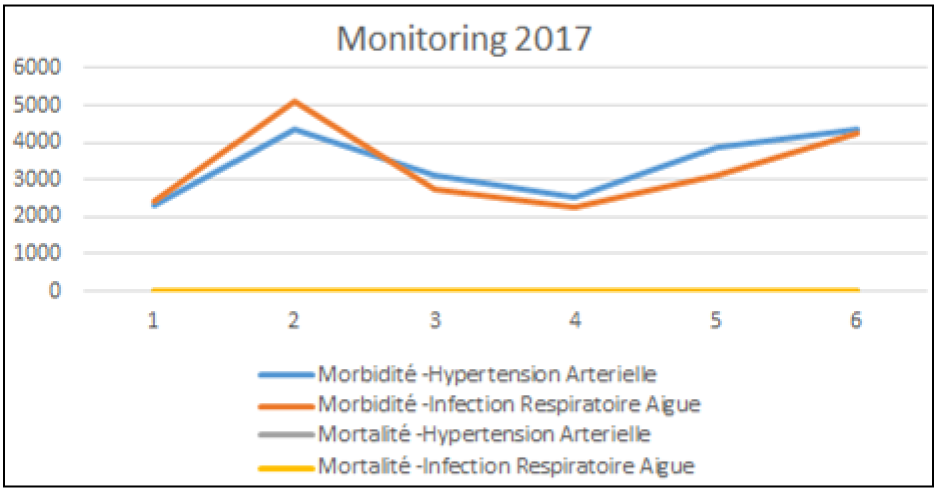


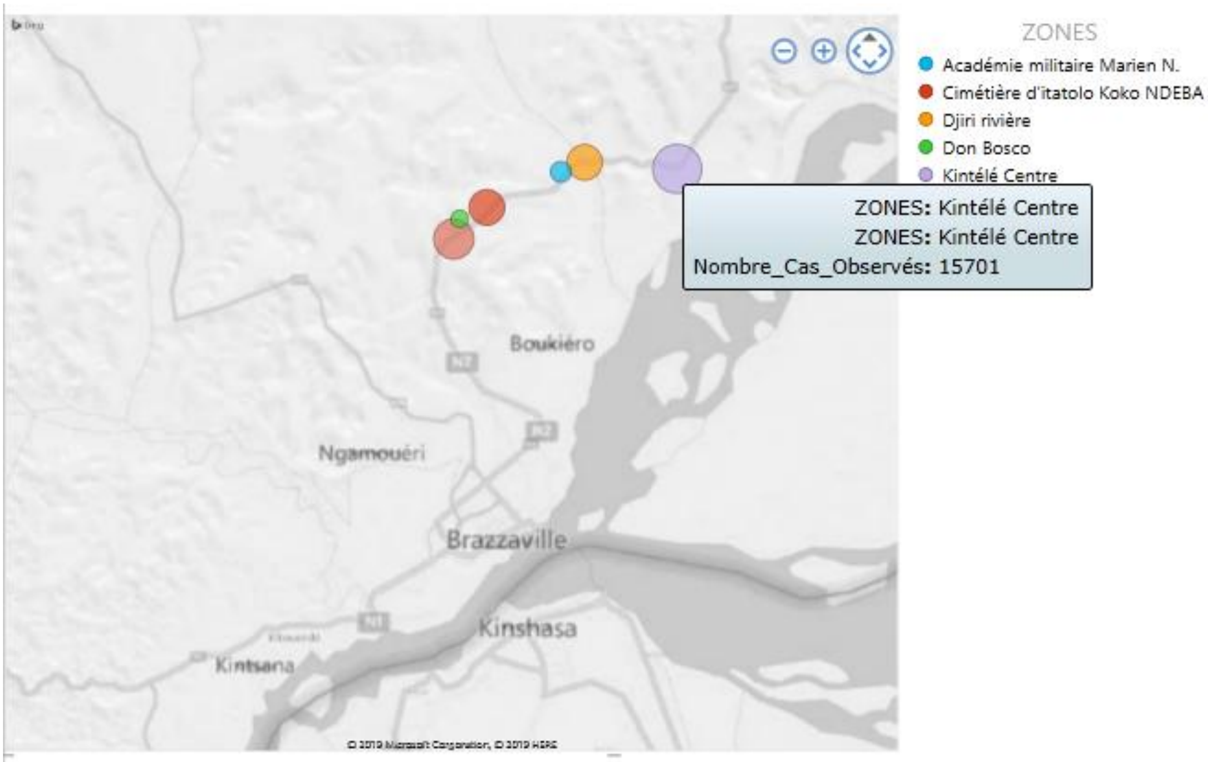
Figure 8: Trend in observations by area and health events (2017)

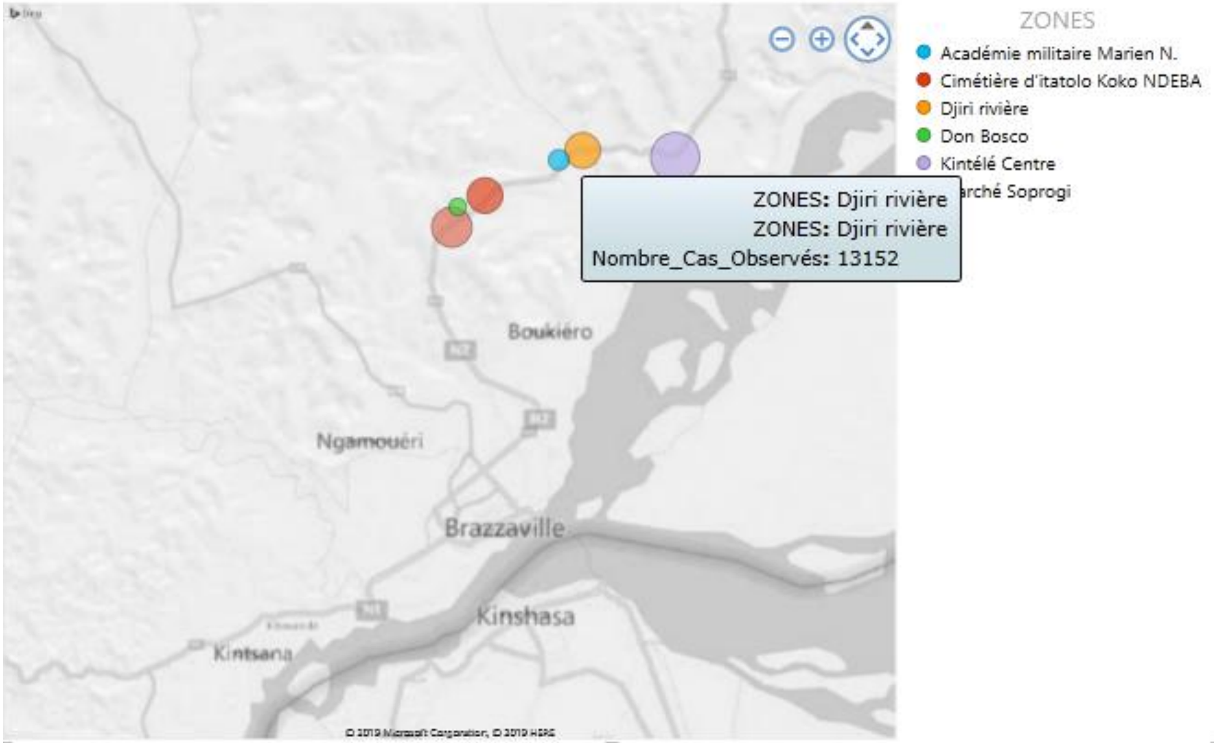
Comment:

Table 12 and figure allow to follow the trends of the pathologies through the observations collected in the different health centers of the health district of Djiri.

Between the two pathologies observed in Figure 7, there are maximum trends in the Kintelé Center area in 2016 (4450 cases of acute respiratory infection morbidity) and in the Djiri River area in 2017 (4311 cases of morbidity in high blood pressure), minimal trends are observed in the Itatolo Koko NDEBA cemetery area in 2016 (1460 cases of high blood pressure morbidity, 2190 cases of acute respiratory infection morbidity).

We have produced cartographic illustrations by coupling of the MS Excel 2016 application program and the Power view tool which allows to produce quality interactive reports or maps based on structured data in Excel:

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Cimétière d'itatolo Koko NDEBA
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Don Bosco
Kintélé Centre
rché Soprogi
ZONES: Djiri rivière
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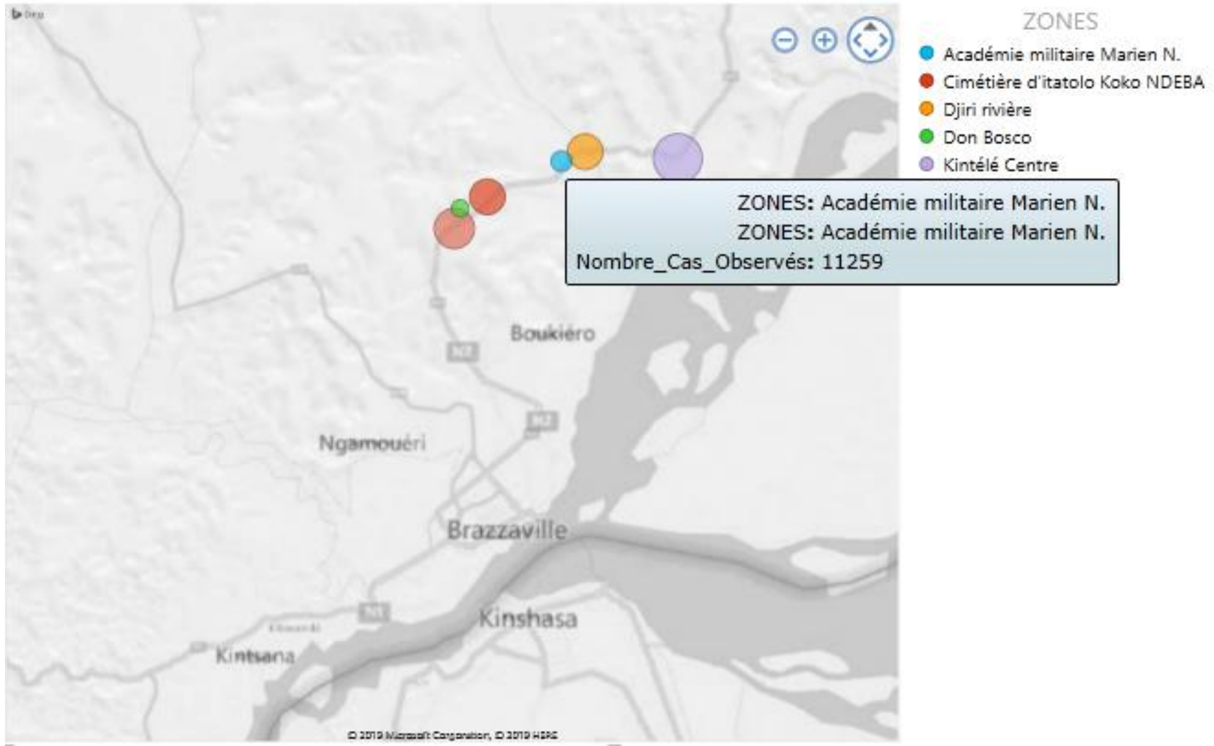
Ngamouéri
Brazzaville
Kinshasa
Kintsana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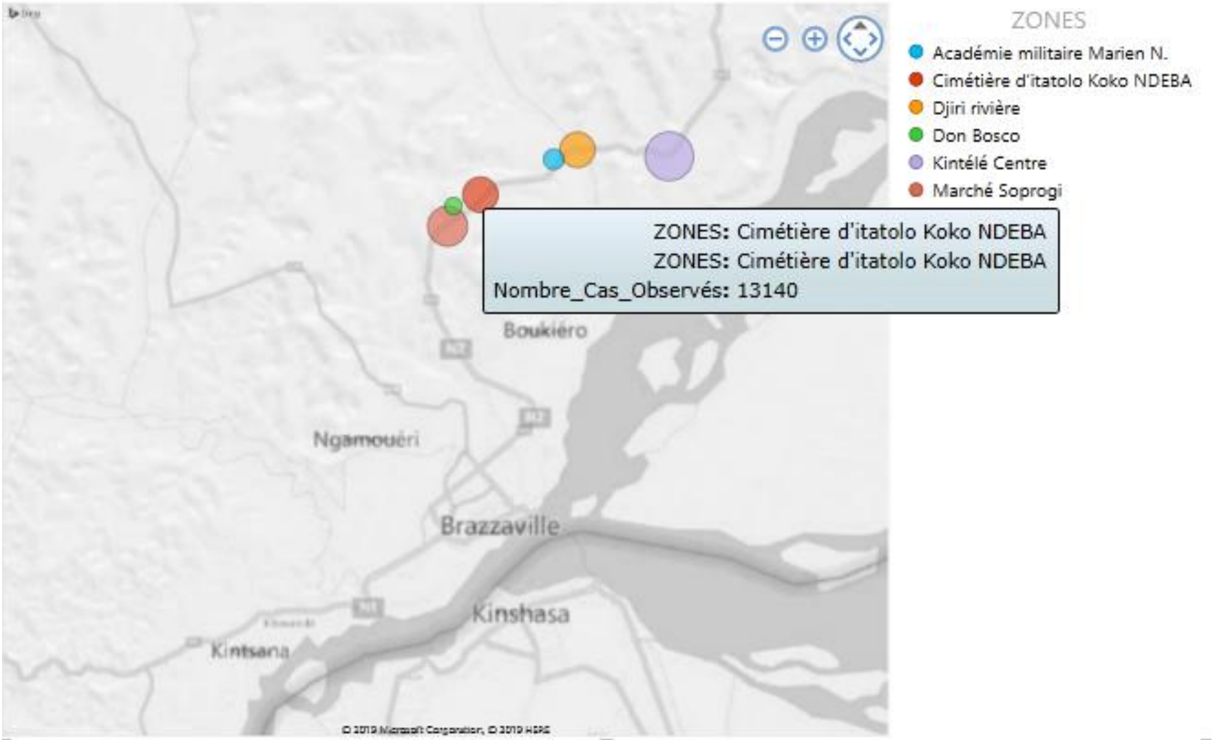
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Don Bosco
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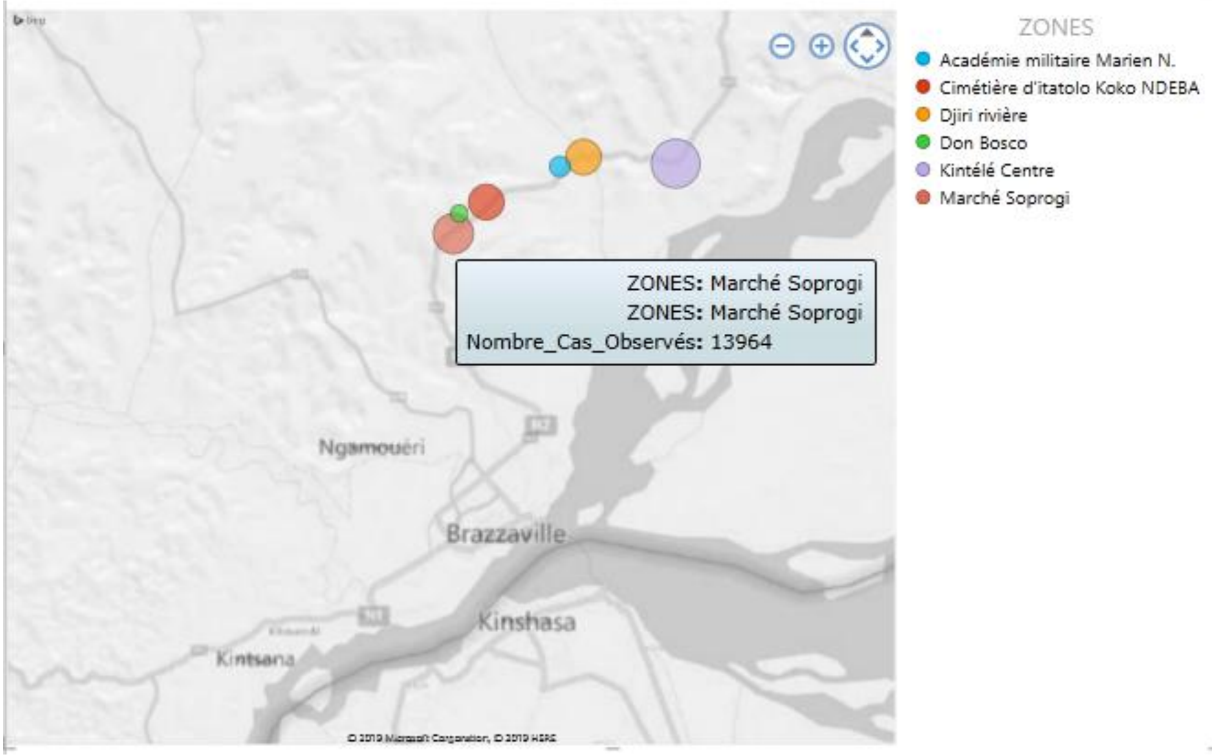
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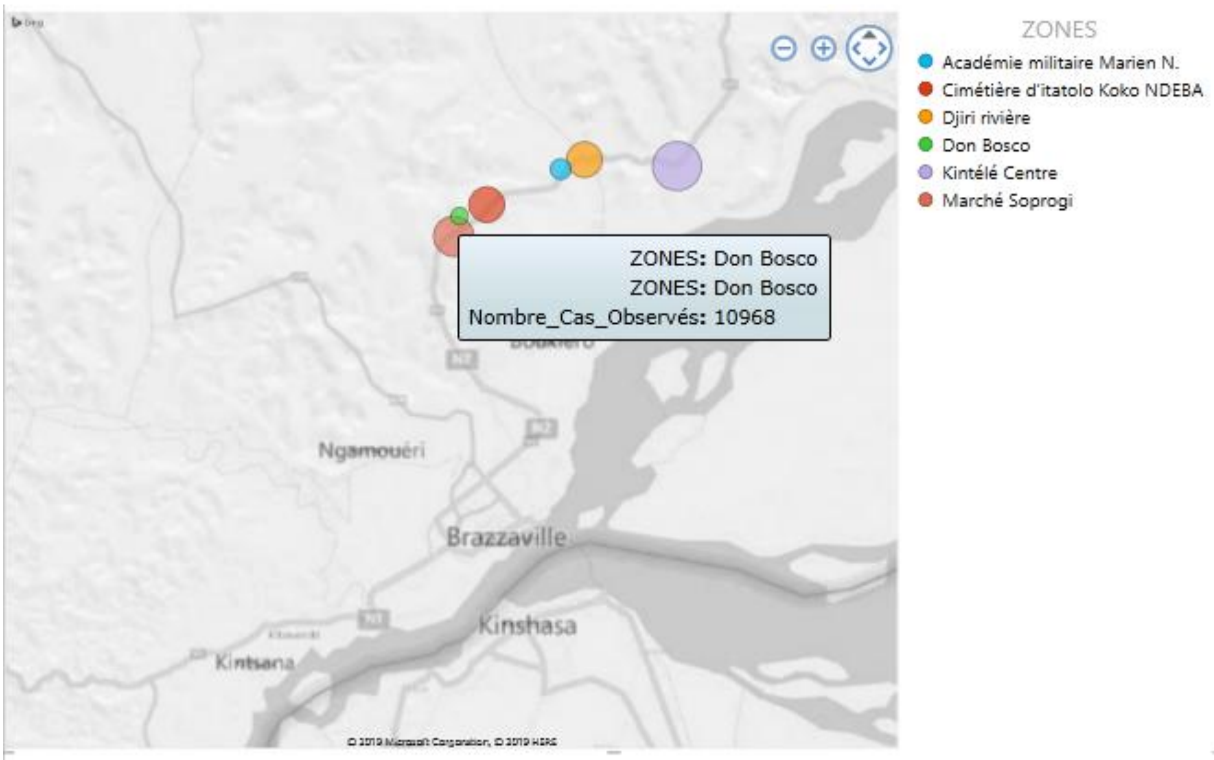
Kintsana



Comment:

The various maps shown above show a decreasing overall morbidity such as: Kintelé area, Soprogi market area, Djiri river area, Itatolo Koko NDEBA cemetery area, Marien Ngouabi military academy and Don area. Bosco.

Health risks coverage

Table 12: Inter-annual average of observations (2016-2017)

EVENEMENT SANITAIRE	Moyenne des Observations inter-annuelle
Morbidité -Hypertension Arterielle	1 691
Morbidité -Infection Respiratoire Aigue	1 567
Mortalité -Hypertension Arterielle	-
Mortalité -Infection Respiratoire Aigue	-

Source: Data collected in health centers (2016-2017).

Comment: Table 12 presents the inter-annual average of observations.

Table 13: Scenario Assessment

POLLUANT	VALEUR GUIDE OMS (Norme 2006) EN MG/L	DEGRE MOYEN ANNUEL DE POLLUTION HYDRIQUE	Moyenne Annuelle des observations HTA	Moyenne Annuelle des observations IRA	Moyenne Annuelle des observations Globales
PLOMB	0,01	0,93	1 691	1 567	1 629
Scénario : 1	Ramener le Degré Moyen annuel de Pollution Hydrique à la Valeur Guide OMS	Nombre Cas Evités		Pourcentage de cas Evités	
		MORBIDITE HTA/AN	MORBIDITE IRA/AN	% MORBIDITE HTA/AN	% MORBIDITE IRA/AN
		1 673	1 550	51,3449111	47,5798201
Scénario : 2	Application de la diffrence entre le degré moyen annuel de Pollution Hydrique et la valeur guide comme scénario de couverture de risque.	Nombre Cas Evités		Pourcentage de cas Evités	
		MORBIDITE HTA/AN	MORBIDITE IRA/AN	% MORBIDITE HTA/AN	% MORBIDITE IRA/AN
		18	17	1,075268817	1,075268817

Comment:

In the short term, the reduction of the annual average degree of pollution to the WHO guideline would make it morbid:

- To avoid 1673 cases of morbidity-related hypertension per year over an annual average of 1691 cases of arterial hypertension reported between 2016 and 2017;
- To avoid 1550 acute respiratory infections per year over an annual average of 1567 cases of acute respiratory infection reported between 2016 and 2017;

Scenario 2 would prevent 18 cases of morbidity-related hypertension per year from a reported annual average of 1673 cases, 68 cases of acute respiratory morbidity infection per year from a reported annual average of 1567 between 2016 and 2017.

Information system of national statistics of health districts

The collection of health data allowed us to highlight the semantics and dynamics of the health statistics information system. This leads to the identification of the conceptual model of data facilitating the short-term implementation of the national database on pathological statistics of the health districts of the Republic of Congo (Figure 1).

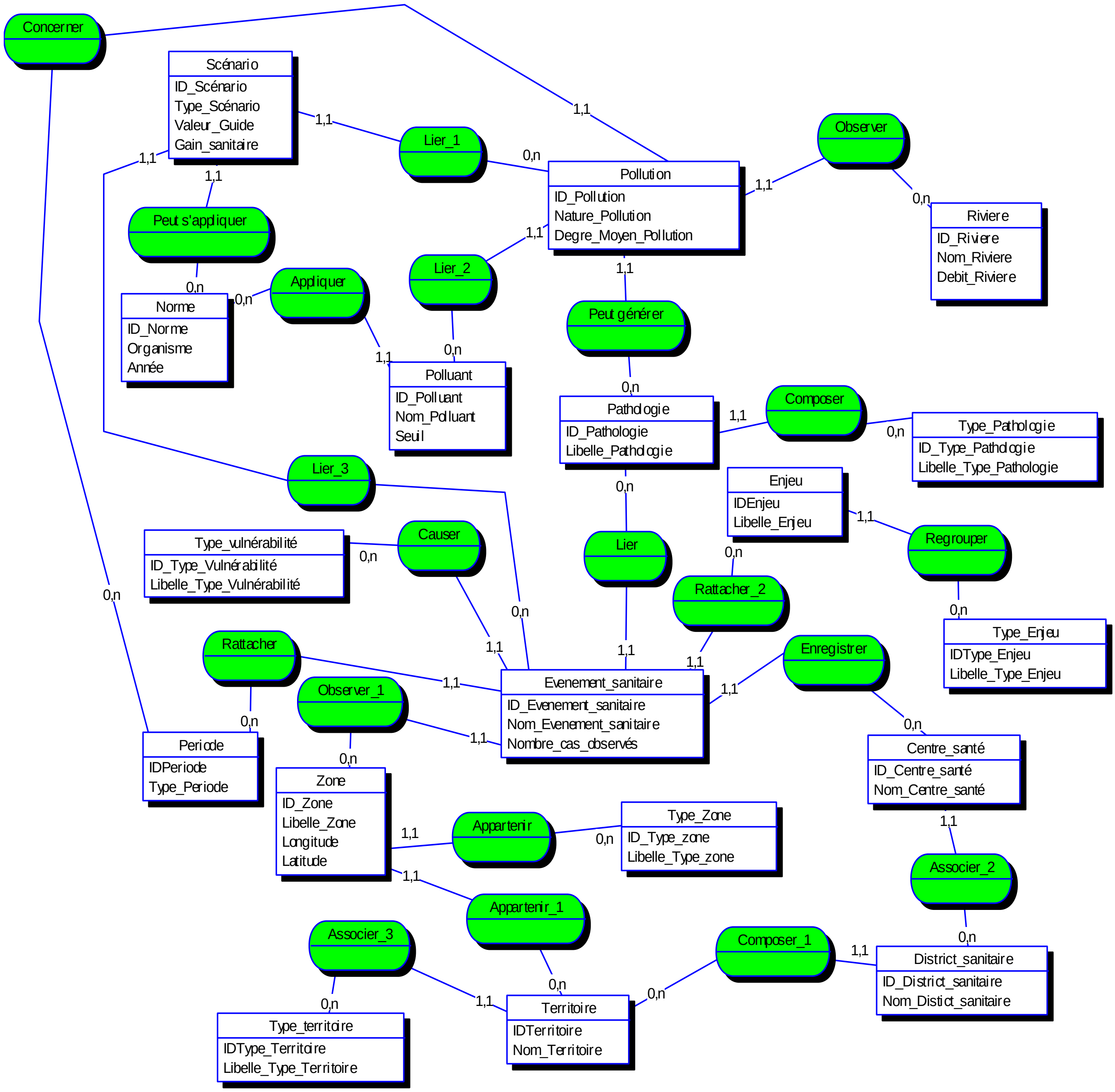
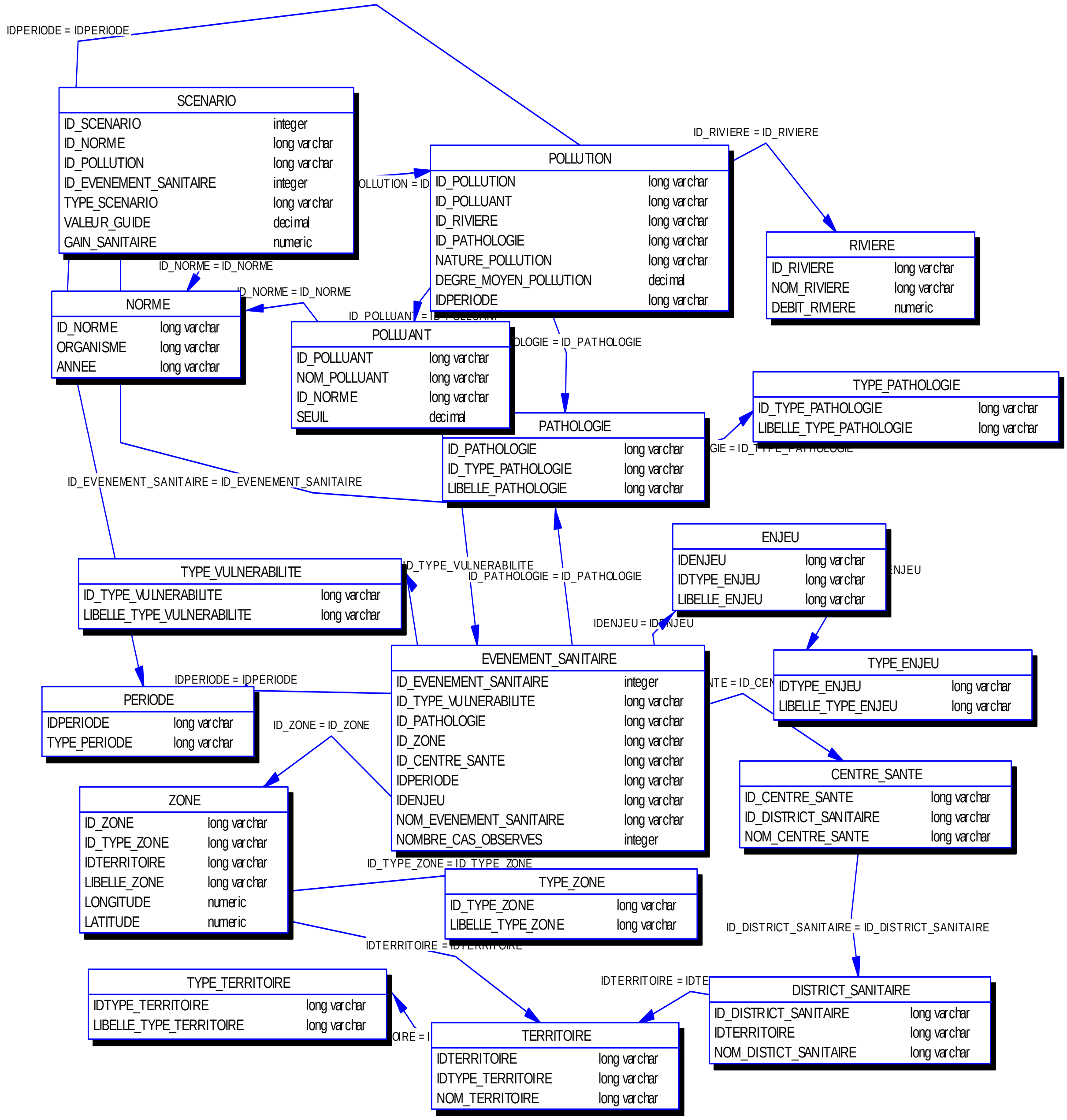


Figure 1: Conceptual Model of Entity-Association Data

The following diagram is the physical representation of the database:



This implementation is extended to pathological risk analysis data on river water pollution. This database implemented on the database management system SQL Server 2012 will be interfaced in the short term by an IT application allowing health centers in all health districts of Congo Brazzaville to house their data and to easily carry out the reporting and the monitoring of pathologies.

4.2. Discussion

Many studies relating to the health impacts of ecosystem pollution (atmospheres, water, etc.) often take as a starting point the pathological investigations to be carried out at the level of the health centers covering the study area and they lead to the evaluation of damage caused to the targets by these pollutions, as case examples:

- Evaluation of the health impact of urban air pollution in the agglomeration of Saint-Étienne, Institute of Public Health Surveillance, 2009-2011;
- Monitoring the health effects of air pollution in urban areas, Institute for Public Health Surveillance, March 1999;
- Our study actually began with the collection of health data in six health centers in the health district of Djiri and resulted in the results presented in 4.1;

The data collected revealed 15701 cases of morbidity in the central Kintelé zone, 13152 cases of morbidity in the Djiri river zone attributable to the pollution of the waters of the Djiri river leaded by the proximity of these two rivers. areas of the Djiri River and pollution emitting industrial site explains; The morbidity observed in other areas of the Djiri health district, which are somewhat distant from the Djiri River and the industrial site, is considered to be morbidity, probably due to water pollution or emissions from the industrial site.

The data collected made it possible to evaluate, by crossing the health event (hazard) of the population type or stake (male and female) morbidity as damage or impact for the period of these health events: this damage is described by the average number of cases of pathological morbidity observed over a specified period.

Thus, 1516 cases in women against 1866 in men on the morbidity in arterial hypertension and 1383 cases in women against 1750 in men on the morbidity in acute respiratory infection. Overall morbidity 1449 cases observed on average in women against 1808 cases observed in men.

These results are morbidity-oriented because the collection centers are not equipped to receive extremely serious cases that can be attributed to deaths.

This approach for constructing a health impact indicator is addressed in the air pollution risk assessment studies (Institute for Public Health Surveillance, 2009-2011, Institute for Public Health Surveillance, March 1999) but in the context of our study. the health impact indicator constructed requires monitoring over at least four years in order to clearly identify the regular average trend of each health event in terms of morbidity or mortality;

Evaluation of scenarios of coverage of health risks and health gain

The vulnerability observed in the population in terms of morbidity (high blood pressure, acute respiratory infection) requires the construction of health risk coverage scenarios; our study allowed us to design and simulate two scenarios as a proposal for the prevention of health risks of the impacts of water pollution on populations.

The scenarios of risk coverage enable us to prevent cases of morbidity in high blood pressure (51.9030% of cases averted per year for all cases observed), cases of morbidity in acute respiratory infection (48.0970% of cases avoided per year). on all cases observed), an overall health gain of 98.92% of morbidity cases avoided per year.

This approach of simulation evaluation of sanitary risk coverage scenarios is borrowed from urban air pollution assessment studies adapted to our context of water pollution (Jean-Marc Yvon, Caroline Huchet-Kervella Institute for Public Health Surveillance (InVS)), Cire Rhône-Alpes, 2009-2011, etc.).

Design and implementation of the national information system on the pathological statistics of health districts.

Several studies on the health impacts of water pollution do not generally lead to the creation of an information system that makes the process of management and valuation of health data operational and automated.

At the local level, no national decision-making tool is put in place to carry out this process. Our study is a national contribution to the improvement and enhancement of health data; the conceptual modeling of the data illustrated in 3.1.2.3 describes this system and allows both to generate the national database and to program the national web portal on the monitoring of health conditions.

This information system responds to all user requests sent from various workstations. The benefits of this software engineering contribution are:

- The statistical reports of the health districts are made with great ease;
- The easy monitoring of health pathologies;
- The monitoring of risk hedging actions on recurrent pathologies;
- Decision support tool for public health managers;

The health database implemented as a result of these health data collections and will strongly contribute to the quality of data on national pathological statistics in the short and medium term and in perspective to the implementation of the National Portal of Pathological Statistics, such tool does not exist to date in the Congo Republic.

5. Conclusion

Significant potential health benefits

Lead pollution levels in the Djiri River study area are above WHO guideline values during the sampling period that assessed the pollution.

The benefits of a reduction in lead levels to the WHO guideline value in this study area would mean that on average there would be an average shortfall of about 1629 morbidity cases each year, or an average of 1691 cases of hypertension morbidity. arterial, that is on average 1567 cases of morbidity in acute respiratory infection and contributes effectively to the improvement of the public health system in Congo Brazzaville per year.

However, the results of this study underestimate these benefits by not taking into account the pathological cases living in the Djiri areas that have not passed through the health centers of the health district of Djiri because these too can be linked water pollution and affect a larger share of the population.

This study also illustrates that the health gain associated with a decrease in chronic exposure is less than the health gain associated with a decrease in short-term exposure. Thus, it is more important to act daily on the pollution of the lead study area when the WHO guideline is exceeded by daily variations in concentrations.

These results confirm the interest of the implementation of actions to reduce the exposure of the population to water pollution.

At the local level, an EPP (Water Protection Plan) for the study area will have to be put in place and approved immediately. It aims to reduce, by the end of 2020, variations in lead concentrations in the waters of the Djiri River: a 99% reduction in the average degree of current lead pollution in the waters of the Djiri River would reduce the lead levels in these waters. waters to values acceptable by the WHO standard.

The planned actions relate to the different sources of pollution (industry, residential and transport). These efforts should make it possible to reduce the overall level of pollution and consequently reduce the health impact of water pollution.

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