Climate, environment and Health :

What are the relationships between Climate and Meningitis? How could we use climate data to predict meningitis epidemics ?

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Possible Links between Climate and Health

- Nutritional statement (agricultural productivity, food security)
- Persons and goods security (hurricanes, food)
- Water Ressources (drought, landslide)
- leisures (Sunstroke, practising sport)
- Individual well-being and Comfort (psychological state, mood, way of live...)
- Economic development (seasonal, interannual and climatic variability)
- Temporal and spatial distributions of the infectious diseases (malaria, meningitis..)



Global Distribution of meningitis epidemic : around the world



Indirect contact (air, dust, eating food in meningitis cases isolated area)

Direct contact with a ill or a death person of meningitis

Predominant serogroups

- In Africa : group A
- In Europe: group B and group C
- In USA : group C \checkmark

Epidemic meningitis over Africa (West Africa)



Risk factors

Social factors (Hogson, 2005 ; Broutin et al., 2007)

Nber of people / house Exposure to smoke Education level Immunity Population dynamics

. . .

Climate and environment factors

Climate (Greenwood, 1984 ; deChabalier, 2000 ; Sultan et al., 2005 ; Yaka et al., 2008) Environment (Molesworth et al., 2003 ; Thomson et al., 2006)

Consequences

Irritated nasopharyngeal mucosal membrane
 Facilitate the penetration of the bacteria in the blood stream

Relationships Between Meningococal Meningitis (MCM) with Climatic factors

- 1. Geographical and climatic localization
- Global disease burden is in western Africa (MCM belt)
 - Sahelian or dry tropical climate
 - Between rainfall isohyets 300mm to 1000mm
 - Sahelian area characterize by lack / low of vegetation many month by year

2. Environment

- Variation of soil greenery influence on MCM risk transmission
 - Deforestation, clearing of woods favorable to soils erosion.
 - Erosion favorable to the ventilation of aerosols and divers micro - particles (dust) that increasing MCM risk transmission and infection



3. Climate :

• Factors influencing the bacteria (Neisseria meningitidis)

Weakened by **outside condition** (in extreme weather conditions)

Weakened by strong dryness

Weakened by ultra-violets radiations

Dead when temperatures higher than 37 °C

Factors influencing on the transmission and the outbreak of MCM

Temperature

Higher portage / carrying rate during dry and cool season

Epidemics occurring only in hot season

Air humidity

Drying, irritation and cracking of nasopharyngeal mucosal membrane

Picks occuring only in dry season

Wind (harmattan)

Picks occuring only when harmattan is blowing, characterized by dry and hot wind .

Lithometeores (earth aerosol, dust, various atmospheric particles)

Cause multiform aggressions of nasopharyngeal mucosal membrane Picks occurring only in dusty period

Rain (disease seasonality)

Cases start increasing at beginning of the dry season (January)

Sharp decrease with the beginning of rains, May-June

Disappearance of epidemics during rainy season

end /shift of epidemics when came unexpected extra season rains «God rains vaccination»

How to fight against MCM epidemics: Health Ministries and WHO strategies



- ✓ Multiple endemic and epidemic diseases
- ✓Limited resources
- ✓Lack of laboratory capacities
- ✓ Most of people don't go to public health services because of poverty
- ✓No existence of public health service in many areas
- ✓Lack of right demography statistical data to calculate alert and epidemics threshold rate in health districts.
- ✓ People prefer traditional patricians who are more cheaper, and come in public health district when it is very late
- ✓ Lag time for organism to react after vaccination (about 10 days)

The reactive vaccination: a frustrating strategy !!!





Ziniare 2006

MCM cases distribution and their propagation in Africa

Correspondence Factorial Analysis of MCM cases in Africa from 1966 to 1999



Selected countries : BURKINA FASO , NIGER



The third cause of death in Burkina Faso, Niger and many Sahelian Countries
 Burkina has the great cases in the world, following by Niger during last decade

MCM yearly dynamics in Burkina, Mali and Niger from 1940 to 2000



MONTHLY DISTRIBUTION

Monthly morbidity and mortality distribution of Meningitis in Burkina Faso from 1961 to 1984



OBJECTIVES

- 1. Determine if NCEP/NCAR Re-analyses parameters are associated with interannual variation of MCM cases.
- 2. Develop spatio-temporal models of MCM prediction using NCEP re-analyses
- 3. Test and validate these models for CSM survey and its early warning in African Sahelian Countries

APPROACH METHODOLOGY

 ✓ Elaboration of correlations maps between MCM IR anomalies in Sahel and NCEP Re-analysis

✓ Analysis of correlations maps and extraction of climate indexes in target zones

✓ Computation of statistical Multi-varied Analysis (Generalized Linear Model)

✓ Elaboration of the final model to predict the MCM annual IR trend

MODELISATION MCM - REANALYSES NCEP/NCAR IN AFRICAN SAHELIAN CONTRIES

Definition: Results of assimilation (from multiple sources) of observed data which are unequally distributed in space and short-term forecasts models (6hr) for a wide and three-dimensional cover of Ground - Ocean - Atmosphere assimilation.

DATA SELECTED : MCM epidemiological data from Burkina and Niger

Data in mesh of 2,5 degrees including:

- Pressure (slp)
- Specific moisture (shum)
- Relative humidity (rum)
- The temperature of the air (air)
- The temperature on ground and sea (skt)
- The module of wind (MOD)
- The zonal component of the wind (uwnd)
- The meridian component of the wind (vwnd)

Correlation between NCEP reanalysis climatic parameters and Meningitis data in Niger

Monthly Mean NCEP reanalysis et annually log incidence data of Meningitis



 \checkmark Significant and high correlation in November and December.

✓ Negatives Correlations with Meridional Wind Component (VWND)

Correlation between NCEP reanalysis climatic parameters and MCM data in Burkina

Monthly Mean reanalysis NCEP and annually log incidence data of Meningitis



✓ Significant and high correlation in October.

✓ Negatives Correlations with Meridional Wind Component (VWND)

Difference of monthly mean of wind surface during very high years of MCM comparing to very low years of MCS in Niger (up side) and Burkina Faso (down side) between 1966 to 2005.



An interesting prediction of meningitis occurrence in Niger (R=0.62; Rc (Skill) = 0.50)



Histogramme : Ln of MCM observed MCM (incidences from 1968 to 2005). Red Ligne : Predictions of Ln of MCM incidences occurrences from 1968 to 2005 after cross validation.

Prediction of MCM epidemics occurrences in BURKINA (1969 to 2005)

An significative prediction of MCM occurrence in Burkina (R = 0.42; Rc = 0.33)

Histogramme : Ln of MCM observed (MCM incidences from 1968 to 2005). Red Ligne : Predictions of Ln of MCM incidences occurrences from 1968 to 2005 after cross validation.

Prediction on Meningitis epidemic trends in Burkina Faso in 2012

For meningitis the coming season in Burkina Faso the morbidity trend will be : • around the normal (mean between yearly high and low case)

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Amplitude will be high than last year observed cases

Incidences de méningite cérébro-spinale prédites et observées (enregistrées) au Burkina Faso de 1969 à 2012. (En abscisses, les années ; en ordonnées, les logarithmes népérien des incidences annuelles de MCS).

Red Ligne : Ln of meningitis observed from 1968 to 2010. **Blue Histogram** : Prediction of Ln of meningitis from 1968 to 2012

LA SITUATION EPIDEMIOLOGIQUE 2012

(SEMAINES NOTIFIEES 01 – 15) (source: OMS-Afro)

Prediction on Meningitis epidemic trends in Niger in 2012

For meningitis the coming season in Niger the morbidity trend will be :

- around the normal (mean between yearly high and low case)
- 7 Observations_Niger 6 Predictions Niger 5 4 3 2 1 0 22012 22012 22012 22012 22012 22002 2002 22002 2002 22002 2000 20000 20000 20000 20000 20000 20000 20000 20000 20000 20000 20000
- Amplitude will be high than last year observed cases

Incidences de méningite cérébro-spinale prédites et observées (enregistrées) au Burkina Faso de 1969 à 2012. (En abscisses, les années ; en ordonnées, les logarithmes népérien des incidences annuelles de MCS).

Red Ligne : Ln of meningitis observed from 1968 to 2010. **Blue Histogram** : Prediction of Ln of meningitis from 1968 to 2012

Analysis of spatio-temporal and prediction of meningits in Burkina Faso by using climate factors

Source : Direction des études et de la Planification Ministère de la Santé

Analyse spatio-temporelle et prévision des épidémies de MCS au Burkina Faso suivant les facteurs climatiques

Distributions mensuelles des cas de MCS au Burkina (sur l'ensemble des districts étudiés)

Distribution temporelle d'anomalies des cas de méningite cérébro-spinale et d'humidité maximale au Burkina Faso de janvier 1997 à décembre 2004

Distribution temporelle d'anomalies des cas de méningite cérébro-spinale et de hauteur d'évaporation au Burkina Faso de janvier 1997 à décembre 2004

Spatio-temporal Analysis and Meningitis epidemics forecast by using climate factors in Burkina Faso

Linear regression models of meningitis seasonal cases (FMA) in Burkina health districts by using seasonal (SON, OND, NDJ) climate variability.

Regression Equation	Number of time serie	multiple R	R ²	F - ratio	Ρ
MCS_Dori = 0,87*Op_Dori_OND	8	0.87	0.76	21.9	0.003
MCS_Fada= -0,76* Vt_Fada_OND	8	0.76	0.58	9.62	0.017
MCS_Po=-0,644* Tv_Po_SON	8	0.65	0.42	4.95	0.06
MCS_Ouaga=0.698*Op_Ouaga_OND	8	0.7	0.49	6.642	0.03

S2E-ARGOS Project : Integrating Health people to Meteorological data collection and analyzing

Training of health people to collect / manage Met Data and health information for epidemics control (10 village in Burkina; 04 in Niger)

Project S2E-ARGOS Epidemic Spatial Survey in Burkina Faso with European Spatial Agency ✓ Daily minimum temperature

- ✓ Daily maximum temperature
- ✓ Daily rainfall
- ✓ Daily visibility (dust occurrence)

Totaux mensuels de pluie à DIABO (mm) en 2004 (données manquantes pour certaines semaines)

Minimal and maximal temperature, rainfall, visibility

data were collected and analysed by health people (nurses) living in village with farmers far away from town.

AT REGIONAL LEVEL - HEALTHMET Project Capacity building for the establishment of links between weather, climate and health services.

Banjul Action Plan:

- Action 2.3 HEALTHMET: "Support to the development of the activities of the National Health-Climate Working Groups (NHCWG) in participant countries (*Burkina Faso, Mali, Mauritania, Niger, Nigeria*) in accordance with the main outputs of the Niamey Workshop (October 2009) on reinforcement of links between Weather, Climate and Health"
 - "Information gathering: Information gathering: on the current status of collaboration between health and met in each country"
 - "National Seminars: Enhance and initiate NHCWG activities as applicable to each country and develop a short term national action plan to implement activities"
 - "Training: Capacity building at regional and national level"
 - "Fund raising activities: Respond to Banjul Action Plan"

HEALTMET Project National Health and Climate Working Groups

- Mission: promotion and implementation of joint activities of their institutions, directed to the acquisition and use of data and weather, climate and health information for the management, prevention and fight against climate sensitive diseases.
 - > To propose projects.
 - > To monitor them.
 - > To help in seeking funding.

This group is not dedicated to research but to operational activities.

- **Diseases targeted:** according to the Banjul Action Plan, NHCWG will initially target mainly two diseases:
 - > Meningitis
 - > Malaria
- Organization:
 - Activities and coordination conducted by the two focal points (Health and Met), with the supervision of their Directors.
 - The membership must be adjudicated before the first meeting. The composition must be open.

Terms of Reference of NCHWG / HEALTMET Projet Challenges

- Identify the needs of Health Services in terms of data, information and services on weather and climate.
- Identify inconsistencies and problems that handicap the use of routine information on weather and climate in the Health sector.
- Formulate a protocol for exchanging data between both sectors.
- Identify needs for research in Climate and Health issue.
- Identify needs in education and training.
- Facilitate access to tools on weather and climate in the Health sector.
- Increase use of early warning systems for climate-dependent disease prevention.
- Increase and strenth the capacity of national, local and community organizations in this area.
- Establish an Internet access secure database on Climat and Health.
- Organize, and present policy makers with, the scientific evidence on the impacts of climate change and climate variability on health.
- Organize an annual workshop on Climate and Health issue.
- Collaborate with similar entities throughout the region to share experiences and ideas.
- Mobilize resources to ensure sustainability of this Project.

GAP related to climate information

- To make accessible climate data and information to health people
- ➤To translate in simple and fluently words climate and meteorological information to health people
- >To enhance Met station for getting better Met data according to space distribution(health district area)
- ➤To better updating Met data base by strengh Met data transmission system
- >To think how to collect real and efficient Met data corresponding
- to humain affecting by Met Factors.
- >Inadaptated meteorological data format to some specific needs

or use

GAP related to Health (VBD) information

- ✓ Limited and difficulties to access to data base (sensitive data)
 ✓ Lack of laboratory capacities (Biological analysis should be done for better quality data)
- ✓ Most of people don't go to public health services because of poverty
- ✓No existence of public health service in many areas
- ✓ Demographical surveillance systems to understand people livelihood and growing
- Lack of right demography statistical data to calculate alert and epidemics threshold rate in health districts.
- ✓ People prefer traditional patricians who are more cheaper, and come in public health district when it is very late
- ✓ no enough sampling collection for efficient epidemiological studies
- ✓ absence of space time chronological series for climate sensitive diseases studies
- ✓ no enough data on longitudinal surveillance of vectors
- ✓ no enough data on soil surface survey data

Distribution of NAPAs projects by sector (from 44 least developed countries on 49 that have submitted their NAPAs program to the UNFCCC). Source: Mutunga and Hardee 2009

All 44 countries identify health, or the health sector, among the most vulnerable sectors to climate change and one in need of adaptation

The health sector accounts for only about 7 % of the 448 total projects and not ranked among the first five priorities in any of the countries

At National level What has been done in Burkina Faso?

- Creation of « Environment and Bioclimatology » Desk in Burkina Meteorological Office
- Research on relationship between climate- environment/ecosystem and diseases distribution.
- Improve knowledge on mechanisms of diseases emergence / spatiotemporal distribution related to climate/environment variability/change.
- > Collect and integrate vectors / diseases environmental / climatic data.
- Analyze relationship between vectors / diseases data and their potential controls related to environment / climate variability
- Use observations and forecasts of the environment and climate to predict future diseases risks.
- Prospect climate sensitive diseases outbreak forecasting by using climatic and environmental factors
- Contribute to build epidemic Health integrated early warning system and promote good health policy.
- Promotion of climate sensitive diseases studies by creating partnerships and exchange with national, regional and international research centers.

What has been done in Burkina Faso

- Interaction between National Meteo and Public Health Services
- Promotion of climate and health studies in Burkina
 - Since 1997, using study on "influence of climate factors on Malaria and Meningitis" (Yaka, 1997), some activities have been done to inform, sensitize health, climate and environment specialist, decision makers and public on climate and health studies opportunities and pertinence
 - In 12 February 2002, CMRB (Bioclimatoly Multidisciplinary Recherch Cell) was created : But not formalized institutionally and not functional because of lake of support and sponsor
 - Ph. D (Yaka, 2008) on "Prediction Meningitis epidemics based on climate information" in 2008
 - Institutional formal collaboration between health and Meteo Services since 2009 (Health and Met focal points has been designed)
- Integrating Met forecasting and information to health decision support tools
 - > Bulletin on yearly meningitis morbidity trend forecasting
 - Evaluation of Yearly meningitis morbidity trend forecasting
 - Working together on climate and health data

What has been done in Burkina Faso

- Interaction with Natioanl, Regional and International Climate Predictions Centers : WMO, AEMET, IRI, LOCEAN, NCEP-African Desk, IRD...
- Holding lauching of NCHWG workshop in last December with the help of AEMET and WMO
 - Identification of Objectives, duties, outcomes of NCHWG;
 - Elaboration of 1 year activities agenda and the way to mobilize fund;
 - Institutional Formalization of creation of NCHWG
- On Going Work on climate and health project with African Desk / NCEP (after 4 months visiting position)
 - > Perform previous MCM prediction models by using NCEP CFS model outputs
 - Use GIS applications to prepare operational space-time MCM disease outbreak maps for the public health sector for MCM epidemics early warning
- Submission of projects on Climate and Health studies for funding
- Publication on climate and health studies particularly meningitis, malaria ...
- Training of students on climate sensitive disease studies (Master and Medical Doctors degree) particularly on Measles, cholera

Thanks for your attention.

Questions and comments?