IW2017 | WORKSHOP REPORT

H1: Climate change and vector-borne diseases

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Summary of themes covered in workshop

1) Climate change (CC) impact on vector-borne diseases (VBD): an update from the trenches
Cyril Caminade (University of Liverpool, UK)

Overview of CC impact on VBD & spread of VBD into new regions
Components of the VBD system: pathogens, hosts, vectors
Climate has largest impact on Vectors (V) and Pathogens (P), but it also impacts the host (H)
What can we expect from CC effects?

- Temperature affect development of V and incubation rates of P
- The warm and wet Tropics have been the regions plagued the most by VBDs.
- VBDs are now emerging/re-emerging in temperate regions (e.g. Russia, China, middle altitude regions in the Tropics…). These are cooler regions that are now warming up. Thus what will happen under higher Tº conditions in both cold & warm regions? V and P will move in and out of the vectorial capacity~T curve space.

Drivers associated with human pathogens: Land Use Change (LUC), agriculture, demography, quality of public health services, movements of goods and people… there are several drivers of VBD emergence, and CC is just one of them (ranked 10 out of 10 in a study), but this is still relevant in the CC context.
Overview of ISIMIP project on CC & malaria: modelling future scenarios of tropical malaria using an ensemble of climate and malaria models.
Risk increase in high altitude regions, it might decreases in other lowland regions (Sahel) -> positive impact of CC, but potential negative impact on agriculture and water resources.
This modelling result is confirmed by recent observations e.g. Tropical malaria (Plasmodium falciparum) burden is increasing in North Kivu (DRC), Columbia, highlands of Kenya, and various vectors were reported at higher altitudes in Nepal. Infection risk tend to increase at mid altitudes in the Tropics.

Example of the Asian tiger mosquito in Europe: one of the most invasive species worldwide, which was introduced into Europe and the USA by the shipment of goods (lucky bamboo plants and recycled tires mainly) e.g. globalization. The species is spreading northward -> it has been anticipated by climate envelope models (by several studies published during the early 2010s) and its appearance in southern England in Kent, occurred earlier (2016-2017) than simulated (2030s).
Zika virus transmission risk was largest in 2015 over South America when the outbreak occurred. Optimal temperature conditions were related to a large El Niño event superimposed onto a warmer background.
Lyme disease, which is transmitted by ticks, is emerging in colder climates (examples shown for Canada and Russia) -> pathogens are also “climbing up” in latitude.
Were risk-models useful in anticipating issues? It depends on the selected disease but the answer is mainly yes. We also need to consider other drivers/factors (vulnerability indicators, economic scenarios), use ensemble simulations, within the framework of multidisciplinary projects, and we also need to work further on operational (seasonal and shorter term) risk models (early warning systems).

2) Invasion Scenarios of The Arbovirus Vector Aedes aegypti Into Europe
Joacim Rocklöv (Umeå University, Sweden)

Zika plan project, ISIMIP (malaria)

- Setting up process-based dynamic model simulating the life cycle of the mosquito. Others have used more statistical/empirical model. Need to reassess pros and cons of the different ecological niche modelling approaches.
- There are evidences that vector life-cycle is affected by climate (Temp & Rainfall) and socio-economic conditions.
- The model estimates the abundance of the mosquito vector. It uses: Growth rate of vectors; Parameters response curves DTR (Diurnal Temperature Range)~T -> Relative vectorial capacity
- The model can provide seasonal predictions of vector abundance
- Applied model to study potential invasion in EU
    - Time dependent parameters: if continuous seeding of vectors, then they should establish themselves in future scenarios. In Europe, climatic conditions are mostly unfavorable, but there is risk of establishment of Aedes aegypti in some southern European cities.
    - The model correctly simulated the observed establishment of Ae. aegypti in Madeira (Portugal).

- Model limitations and improvement:
    - Vectorial capacity, once the vector is established, is it able to transmit the dengue pathogen?
    - In warmer regions, disease risk might decrease, but mosquitoes can also adapt to new environmental conditions.

3) Mapping vulnerability to dengue in Mekong Delta region, Vietnam from 2002 to 2014 using geospatial data by water-associated disease index approach
Nguyen Cong Tien (Vietnam National Space Center (VNSC), Vietnam)

Dengue is a big issue in Asia and south-America
APN project description
Develop geospatial solution, control dengue in vulnerable regions
Statistical methods
Related web site: http://apn-climateandhealth.com

INTRODUCTION

- WADI index approach was used because: 1) WADI is a simpler model than a more complex statistical model, it also describes geography (GIS based system), and it is very flexible across different zones 2) it was validated for Malaysia, country with similar climatic conditions than Vietnam
- Study area: Mekong delta in the South of Vietnam. River divides into two branches. Number of observed dengue cases peaked in 2007, then decreased. Cases tend to occur during the July-Sep rainy season.

MATERIALS & METHODS

- Vulnerability index exposure indicator (population density) + susceptibility indicator (age, poverty, health care access - socio economic indicators) are employed. Risk scales between 0-1 – which is a linear combination of the different scores.
- Input data: MODIS land cover satellite data; Population density; Temperature and rainfall; Thresholds of the indicators are estimated from the literature

RESULTS

- Investigation of correlation between dengue~Temperature and Rainfall under 6 scenarios
- Validation: short term based on monthly data; long term validation (entire study period) show lower correlation

CONCLUSION

- Risk model helps to support public health authorities
- Provinces along the river are more vulnerable under CC effects
- Early warning possible 1 month in advance

WEB SITE:

- Accessible data and visualization tools. HV2CC - APN funded project. http://apn-climateandhealth.com

4) Effects of Climate Change on Ciguatera Fish Poisoning, and Social-Ecological Resilience: Case Study of French Polynesia

Lingfeng Zheng (Graduate School of Frontier Sciences, University of Tokyo, Japan)

- Ciguatera poisoning is one of the most severe sea food borne diseases.
- Observations show that Ciguatera is now moving into non-endemic areas where water is generally cooler.

- Transmission mechanism: Ciguatera is related to an algae that produces a toxin. This algae grows on coral reefs substrate, and then it bio accumulates through the trophic chain, from small to large fishes, finally arriving in human plates.
- Symptoms: diarrhea, muscle pain, mental health, symptoms can last for 6-24 months
- How CC affect ciguatera distribution and severity?
  - Algae colonizes bleached coral reefs which is further increased by CC effects
  - Water environmental condition can accelerate algae spread (e.g. temperature and light have a positive effect on ciguatera burden)
- Geographic distribution: Ciguatera is mainly distributed in the tropics and subtropics, but its area of colonization is now expanding.
- Case study in French Polynesia
  - Endemic region and humans are affected. There is disparity in the incidence rate among different islands, which makes it a good case study.
  - Social-ecological resilience and health surveillance issue: people are not necessarily reporting their symptoms to health authorities, this can cause a biased low incidence
  - Climatic (cyclones, heavy swells, tsunami…) and social stressors (seaside hotels, fisheries) have been destroying the coral reefs, further increasing the algal colonization process

Research questions:

- Is CC having an impact on Ciguatera in French Polynesia and which factors have an effect?
- What is the time lag of the bioaccumulation?
- What is the impact of Sea Surface Temperature warming on ciguatera burden?

MATERIALS & METHODS: statistical methods: correlation, regression, Poisson regression models and data issues:

- Doctors are required to report food poisoning cases
- Climate data used
- Consumption habit (fish data from FAO)
- Focus on Economic exclusive zones EEZ (200 nautical miles from the coasts where fishing activities are concentrated)

RESULTS:

- 35 months lag is an important indicator
- 11 months lag for precipitation
- ENSO: immediate effect
- Projected CC: SPC scenarios, country specific in South Pacific. SST and precipitation anomaly

CONCLUSION and POLICY RECOMMENDATIONS

- Time lag correlation 1-3 years. This delay can help in intervening
- Surveillance network to improve
- Improvement of data collection
- Better traceability of fish products
- Interdisciplinary research needed
- Build Partnership with international organizations

Questions:

- How to explain the statistical time lag correlation in a biophysical sense? Literature requires laboratory tests, different species can differ in the time lag response, and their abundance might also impact this time lag.
- Will this time lag remain the same in a warmer climate?
- How is the infection confirmed (surveillance issue)? It requires further field verification with reporting, laboratory tests … In most cases there is documentation of symptoms only, and not necessarily the causes (other food poisoning pathogens can cause similar symptoms). In this specific case it is not a big problem, because symptoms are very often associated with this disease in the most endemic regions in French Polynesia
- There is a positive correlation between temperature and ciguatera burden. What about the impact of salinity?

Most controversial question that came up in this workshop?

2nd presentation: Interannual climate variability: is this accounted for in disease models? Yes, because process-based model can run at daily time steps. But there are other natural climatic cycles and long term trends that might not be captured. Virus fitness is not necessarily accounted for. Adaptation/evolution of the vectors/disease is difficult to incorporate as well, and we also need to consider the mobility of vectors/hosts (through direct/indirect transportation).

Results of the discussion

- Accessibility to climate data by the health community has not been perceived as a big problem within this session. This might be due to the audience e.g. mainly data-science specialists attended this workshop. However accessibility to data is generally an issue which is commonly discussed in other health/climate research areas.
- Evidences are clear: models and observations agree on the fact that diseases are spreading into higher altitudes and latitudes. On the other hand, lowlands in the warmest regions might benefit from an additional warming (example of malaria decreasing during the 1980s Sahelian drought). Ciguatera related food poisoning, severe sea food borne disease, is recently moving into cooler water/non endemic areas.
- We are, to some extent, witnessing what models predicted about 10-15 years ago; some disease and vectors are emerging into new regions earlier than expected (example of the Asian tiger mosquito observed in Kent, UK in 2016).
- There is a lack of long-term monitoring projects and networks which would be insightful for both model improvement and model validation (creation of health-VBD observatory system).
- Model improvement would require the implementation of dynamical estimates of additional non-climatic factors. Socio-economic factors are of equal importance for VBD burden, but there is a current lack of space/time scenarios that can be used for such risk assessment.

Research gaps identified

- VBD establishment can be modeled with a large ensemble of methods, while the dynamical modelling of vectorial capacity (ability to transmit) and basic reproduction number (R_0) is in an early stage.
- Health data can be scarce especially when there is no reporting of disease burden by the local health authorities, or when only clinical symptoms are reported, without additional analysis on the causes of death or sickness (surveillance, laboratory clinical diagnostic, PCRs…)
- In disease models air temperature is usually taken into account, while e.g. pond water-temperature would be a better explanatory variable (need for further calibration – pond / surface water temperature models).

Next steps

Need to consider other drivers of diseases, need to use ensemble of simulations (e.g. using a large ensemble of emission scenarios, climate models and disease models – in other words using the ISI-MIP approach for health), multidisciplinary projects are key, development of operational risk models (short term e.g. using numerical weather prediction models or seasonal or using ensemble seasonal forecasts) is also needed. More studies needed to assess the relative importance of climate versus socio-economic factors on VBD burden. Pros and cons of mechanistic vs. correlative modelling approaches need to be investigated further.

Other

NA

3-5 keywords that characterize the session

VBD distribution, establishment, transmission; mosquito vectors; climate change impacts; statistical and process-based models.