Annals of DAAAM for 2010 & Proceedings of the 21st International DAAAM Symposium, Volume 21, No. 1, ISSN 1726-9679
ISBN 978-3-901509-73-5, Editor B. Katalinic, Published by DAAAM International, Vienna, Austria, EU, 2010
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Annals of DAAAM International

APPROACH ON ENVIRONMENTAL HEALTH INDICATORS FOR MONITORING THE HEALTH IMPACT OF CLIMATE CHANGE

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Abstract: *The purpose of this study was to research and develop environmental health indicators that could serve as important tools for environmental health practitioners and policy makers responsible to anticipate, assess and reduce the adverse health impacts of climate change. We conducted a comprehensive review of the scientific literature, with particular attention to the identification of outcomes and actions related to climate change that could inform about the development of a "suite" of climate change environmental health indicators. Based on reviewed data, we categorized four indicators that include not only climate-sensitive health outcomes but also environmental, population vulnerability, and mitigation and adaptation indicators of climate change.*
Key words: *pollution, environment, health, indicators, climat changes*

1. INTRODUCTION

During the last years, the concern for climate change and the associated risks has grown continuously. In Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPPC), Working Group II states clearly that climate change is contributing to the global burden of disease and premature deaths (IPCC, 2007). The World Health Organization (WHO) estimates that the global burden of disease from climate change had exceeded 150000 excess deaths per year (WHO, 2003). To develop public health adaptation strategies and to project the impacts of climate change on human health, indicators of vulnerability and preparedness along with accurate surveillance data on climate-sensitive health outcomes are needed.

For this reason, we aimed in present study to identify environmental health indicators that could serve as important tools for environmental health practitioners and policy makers responsible to anticipate, assess and reduce the adverse health impacts of climate change. The analysis is primarily based on a limited literature review of climate change and health, with particular attention to the identification of outcomes and actions related to climate change that could inform about the development of a "suite" of climate change environmental health indicators. The indicators discussed in this paper include not only climate-sensitive health outcomes but also environmental, population vulnerability, and mitigation and adaptation indicators.

2. ENVIRONMENTAL HEALTH INDICATORS

2.1 Environmental indicators

Air quality

The main greenhouse gases (GEGs) released by human activities are carbon dioxide, methane, nitrous oxide, chlorofluorocarbons (CFCs), and halons. How much emissions of greenhouse gases add to the potential for global warming depends on how long they remain in the atmosphere before being removed or breaking down into other compounds and on how well they absorb the heat radiated by the earth. These two factors are combined in the Global Warming Potential (GWP) for each gas, which is used as a weighting factor for emissions of that gas. The weighted summation of the annual discharge of CO_2, CH_4, N_2O, and the use of CFCs and halons, expressed in *CO2 equivalents*, forms the indicator for climate change. CO_2 equivalents are obtainable from Environmental Protection Agency, whereas starting with 2007 Romanian government has issued a series of national laws to begin GEGs monitoring.

A warmer climate and thermal extremes temperatures associated with air mass stagnation events may increase exposure to urban air pollution and will affect regional and local air pollution concentrations. This has the potential to aggravate pre-existing respiratory and cardiovascular conditions, but it is difficult to determine which proportion of increase of air pollutants is attributable to elevated warming from climate change and which is due to anthropogenic sources.

Meteorological data

Both high temperatures and humidity increase an individual's risk of heat illness. Increasing temperatures directly raise body temperature, and increased humidity slows cooling of the body by decreasing sweat evaporation. For this reason we consider the following indicators are important to be track: *the temperature - maximum temperature, minimum temperatures, and apparent temperature* (or heat index, which combines humidity and temperature, and is important in looking at mortality effects) and the *wind speed* (because the air mass stagnation events are favorable for acute air pollution in urban). Daily information on temperature, relative humidity, and wind speed are easily obtainable from the National Institute of Meteorology, but there are few difficulties in linking weather and health outcome data on the same spatial and temporal scales. Health effects are more evident when extreme weather events occur. Meteorological events are classified as "extreme" on the basis of three criteria: rarity (i.e., that occur with relatively low frequency/rate); intensity (i.e., characterized by relatively small or large values compared to the norm); and severity (i.e., that result in large socio-economic losses). Indicators of direct climate effects include regional annual heatwaves and precipitation levels. *Heatwave is* defined as a period of at least five days, each of which has a maximum temperature of at least 25°C, including at least three days with a maximum temperature of at least 30°C (Huynen, 2001). *Precipitation extremes* can be described in different ways: precipitation deficits are often expressed as the number and duration of dry periods (that can lead to droughts); high precipitation events expressed as the number of wet days, consecutive wet days, and the frequency and intensity of heavy precipitation events (that can result in fast flash floods, or devastating floods, affecting large catchments and having longer duration).

2.2 Health indicators

The potential health effects of climate change have been extensively reviewed. Because of the multifactorial nature of

diseases, a carefully selection of those indicators that are highly sensitive to climate changes but relatively insensitive to other influences is important.

The study of the consequences of "extreme events" on health is of relevance because they are likely to increase in frequency under conditions of climate warming. Because deaths or illness are rarelly recorded as heat-related during a heat wave, we recommend focus primarily on excess mortality and morbidity. Morbidity and mortality data are available from National or Regional Centers for Health Statistics. Excess mortality can be calculated by comparing the number of deaths during an extreme event with those during a reference period that has been matched by day of the week and other potentially confounding factors, or by using a time-series approach. Also, we propose the rate of hospitalizations as well as rate of emergency department visits as useful indicators of heat related health outcomes. Other indicators can be used to project future health impacts based on changes in exposure, assuming exposure-response relationships remain constant over temporal and spatial scales. Thus, it is likely that the first detectable changes will be changes in the geographic range (latitude and altitude) of certain vector-borne infectious diseases and/or in the seasonality of the diseases (Curseu et al., 2010). Gaps in surveillance data for human cases of environmental infectious diseases and vectors and reservoirs are related primarily to the lack of surveillance infrastructure and lapses in communication.

2.3 Population vulnerability indicators

Eriksen and Kelly (2007) assessed the credible vulnerability indicators for climate adaptation policy and concluded that the vulnerability of a population depends on factors such as population density, age structure of the population, pre-existing health status and the quality and availability of public health care, as well as level of economic development, food availability, income level and distribution. Data on the first four of these usually are available at aggregate level from routine sources of demographic and health statistics. Socio-economic data often are available in fairly crude form, but it is easier to obtain markers that have direct bearing on the health impact of interest. Recommended indicators include the percentage of elderly, those in poverty, infants, and populations affected by chronic diseases (especially cardiovascular and respiratory disease) or receiving drug treatment, the obese and disabled, as well as pregnant and nursing women.

2.4 Mitigation and adaptation indicators

Use of renewable energy sources can be an alternative to this problem (Popa et al., 2008). Evans et al. (2009) have given some sustainability indicators for some renewable technologies. The ranking according to the corresponding indicator suggests electricity production from wind is the most sustainable followed by hydropower and then solar and geothermal were found to rank the lowest from the four non-combustion renewable energy technologies (Evans et al., 2009). Proposed mitigation indicators are use of *renewable energies*, and *vehicle miles traveled*. Adaptation is just as important as mitigation to reduce short-term and longer term health risks. Adaptation indicators are needed to measure the status of public health efforts to avoid, prepare for, and effectively respond to the risks of climate change. Proposed adaptation indicators include community access to *cooling centers* during heat waves, *early warning systems*, *surveillance systems* that collect data on the human health effects of climate change, and a *public health workforce trained* in climate change research, surveillance, or adaptation.

3. CONCLUSION

There is evidence that climate change has already affected human health through direct and indirect pathways. In order to evaluate these impacts, we presented surveillance indicators that include not only climate-sensitive health outcomes but also environmental, population vulnerability, and mitigation and adaptation indicators of climate change.

The health indicators must allow the enhanced surveillance of climate sensitive diseases in order to detect and respond to health impact of climat change. Developing these indicators is vital for evaluation program, health service planning, and communication. For example, tracking the number of visits at emergency department as well as the rate of hospitalization during heatwave may assist public health professionals to design targeted adaptation and response options for their specific regional requirements.

From the perspective of users of surveillance databases, it is essential that relevant existing databases be easily identified, that appropriate indicators be provided, and that processing of the data be done at a level suitable for investigators in multidisciplinary projects. Data gaps are especially critical for some environmental and population vulnerability indicators. Also, no domestic surveillance database exists for deaths and injuries for extreme weather events.

Understanding the capacity of a population to adapt to new climate conditions is also essential in order to achieve a more realistic assessment of the potential health impacts of climate change.

In conclusion, the indicators proposed in this paper are not an end in themselves. We hope that, if they are used with wisdom and restraint, they will serve as tools that can build support for needed actions.

4. ACKNOWLEDGEMENTS

The paper was realized in frame of the National Research Grant IGLOB 42-117 PN- II 2008.

5. REFERENCES

Curseu, D.; Popa, M.; Sirbu, D. & Stoian, I. (2010). Potential impact of climat change on pandemic influenza risk. In: *Global Warming: Engineering Solution*. Dincer, I., Midilli, A., Hepbasli, A. & Karakoc, T.H. (Eds.), pp. 643-657, Springer, ISBN 978-1-4419-1016-5, Milton Keynes UK

Evans, A.; Strezov, V. & Evans, *T. (*2009*).* Assessment of sustainability indicators for renewable energy technologies. *Renewable and Sustainable Energy Reviews* Vol.13, No.5, (June 2009) pp. 1082-1088, ISSN: 1364-0321

Eriksen, S.H. & Kelly, P.M. (2007). Developing Credible Vulnerability Indicators for Climate Adaptation Policy Assessment. *Mitigation and Adaptation Strategies for Global Change*, Vol. 12, No. 4 (May 2007) Springer Netherlands, pp. 495-524, ISSN 1381-2386

Huynen, M.M.T.E. et al. (2001).The impact of cold spells and heatwaves on mortality rates in the Dutch population. *Environmental Health Perspectives* Vol.109 No.5 (May 2001) pp. 463–70 ISSN: 0091-6765

Popa, M.S.; Contiu, G.; Precup, M. (2008). Unconventional Technologies and Competitive Engineering in the 21th Century, In *Proceedings of Tools and Methods of Competitive Engineering (TMCE) Symposium*, Horvath & Rusak (Eds.), Vol. II, pp.1075-1086, ISBN 978-90-5155-044-3, April 2008, Izmir, Turkey, published by Delft Univ. of Technology, Netherlands

*** IPCC. (2007). Climate change 2007. Impacts, adaptation, and vulnerability, Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, Parry, M.L., Canziani, O.F., Palutikof, J.P., van der Linden, P.J.(Eds.) ISBN 978 0521 70597-4 New York:Cambridge University Press

***WHO (2003). Climate change and human health: risks and responses. McMichael ,A. J. et al. eds. Geneva 2003 ISBN 92 4 156248 X