**Literature review Climate Change Risk 2011**

“Risk indicates the degree of potential losses that could result from an interaction between hazards and community; thought of as a product of the probability of hazards occurrence and the degree of vulnerability(i.e. Hazard x Vulnerability) (Rashed, 2006)

Risk in environmental health is characterized as much as possible quantitatively. Epidemiologists quantitatively calculate risk using either relative risk (also know as risk ratio) (RR) or odds ratio (OR). “In the most basic sense, RR is the ratio of the absolute risk of a given outcome in the exposed group to the absolute risk of the same outcome in the unexposed group. Absolute risk is the probability that the outcome (e.g. disease, mortality) will occur in a given time period.” (Oleckno, 2002)

Health Risk Assessment and Risk Management Framework (Yassi, Kjellstrom, de Kok, & Guidotti, 2001)

Step 1A: identify hazards based on results from relevant toxicological & epidemiological studies

(Diffenbaugh, 2007) (Hare, 2005) (Cromley, 2002) (The International Bank for Reconstruction & Development/The World Bank, 2008)

Step 1B: Hazard identification is a “qualitative” description of potential health effects

Step 2: Dose-Response Assessment—describes and quantifies the relationship between exposure/absorbed dose and related health risks

Step 3: Exposure Assessment—measures the exposure itself; identifying the sources of exposure, estimating intake into the body by various routes and obtaining demographic information to define the exposed population.; provided by monitoring and surveillance systems when possible; or by calculated or estimated from mathematical models showing how emissions are carried by air, water or in the ground.

Risk Assessment: integration of steps 1 to 3…ideally should produce a quantitative estimate of the risk in the population or estimates of the potential risk under different plausible exposure scenarios. If different health effects are likely to occur, risks must be calculated for each one. Must take into consideration sources of uncertainty like: potential confounding factors, differences in biokinetics and or poor specification of exposure.

In many situations only a qualitative risk assessment may be appropriate….then reasoned judgment is used. (Yassi, Kjellstrom, de Kok, & Guidotti, 2001)

Epidemiology

Risk can also be determined by epidemiological studies. (Risk Ratios---Relative Risks); Standardized Mortality Ratio (Observed/Expected Deaths)

Epidemiology studies must distinguish between association (risk occurs more often) and causation (risk factor played a role in events leading to the disease).

For the health risks associated with climate change, it is better to use risks defined through “ecological studies.” A major challenge for environmental health risk assessments for climate change in ecological models is going to be whether a comparison population will be found that is not “undergoing climate change/green house gasses exposure.”

For an “Ecological Study” the unit of analysis is the population group or region (as well as country, countries, province or census tract or even continents) rather than the individual. Problems generally arise in these types of studies because you don’t know if the individuals who have developed disease or health problems are the same ones who have been exposed. Exposure status [in epidemiological terms] is a term for classifying groups in this type of study according to their level of exposure (i.e. temperature gradients, greenhouse gases, etc.)

Ecological models are usually incomplete as evidence for causal association. We cannot assume that all individuals in a greenhouse gas scenario will be exposed to the same risks—doing so would lend itself to “ecological fallacy.” (Oleckno, 2002)

There are five types of ecological studies (Yassi, Kjellstrom, de Kok, & Guidotti, 2001)

1. Exploratory: “studies that look at variations in outcomes across ecological units such as countries.” (Oleckno, 2002)
2. Space-time cluster studie
3. Multiple group comparison studies: “studies that look for test associations between average exposure levels and overall outcome rates…with data usually coming from secondary sources. (Oleckno, 2002)
4. Time trend (time-series) studies: their purpose being “to detect changes in the average exposure level and outcome rates for a single population over time.” (Oleckno, 2002) Think of looking at heat and GHG monitoring for a single country with collected data specific to that population.
5. Mixed studies

Climate Change & Greenhouse Effect (Yassi, Kjellstrom, de Kok, & Guidotti, 2001)

Epidemiologists have started investigating how to determine the environmental health impact from climate change and greenhouse gases.

Climate Change will impact heat balance retained by the planet

1. Increase in heat leads to global warming and chaotic weather conditions (with much variation)
2. Decrease in heat leads to cooling, longer winters and increase in water trapped in polar caps

They concur with the body of existing literature on climate change that the Impact human health will arise because of:

1. Heat stress
2. Natural weather disasters
3. Changes in the patterns of disease vectors for humans and animals
4. New infectious disease patterns
5. Unreliable crop production
6. Local food shortages
7. Flooding

They also agree that many health problems will be indirect and resulting from socio-economic conditions.

Vulnerable Regions & Populations(Patz)

Patz, a leading environmental health scholar has summarized succinctly the current views of anticipated (and not from previous ecological risk models) environmental health risks tied to climate change. Most of the studies on environmental health risks including Patz’s do not provide explicit models that generate quantitative methods but are conjectural and based on the information in the Appendix.:

* Thermal Stress: relationship between temperature and morbidity and mortality is J-shaped (asymmetric) with a steeper slope at higher temperatures. In US heat waves are more deadly than hurricanes but varies according to geography
  + Average of 175 Americans succumb to heat extremes each summer: ~20,00 people were killed in the US from 1936 through 1975 by effects of heat and solar radiation
  + 2003 European heat wave is estimated to have killed over 22,000.
  + Most of excess mortality is concentrated in elderly and people with pre-existing conditions.
  + Threshold temperature above which mortality sharply increases is location specific.
  + \*\* The risk of death increases substantially during heat waves when thermal stress persists for several consecutive days coupled with high overnight temperatures.\*\*
  + Urban Heat Islands --- areas that generates and retains heat as a result of buildings, human and industrial activities …
    - Black asphalt and dark surfaces (roads, parking lots and rooftops) reduce albedo (reflectivity) and are dense heat retaining activities.

The only study for this paper that provided explicit modeling for environmental health risk using an ecological epidemiologic framework was produced by the World Bank in the 2008 monograph, *Environmental Health and Child Survival: Epidemiology, Economics Experiences.* (The International Bank for Reconstruction and Development, 2008)Appendix D of this report gives explicit risk model calculations and sources used for epidemiology calculations for relative risk (RR) in environmental health risk modeling.

The World Bank monograph’s provides appendices that show equations used in the calculations for relative risks and absolute (they referred to as conterfactual) risk. The appendices for the report will be sent as an attachment to this document.

The mathematical equations for environmental risk are cumulative and combine risks from multiple factors for a disease outcome like diarrhea (which is expected to increase in countries with increasing climate changes.) The risk factor calculations also take into account both indirect and direct factors (see figure D.1 Summary of the Methodology).

Two important points are made in this study that are key to future environmental health risk determinations from climate change and green house gases.

The first point made is that there are:

“Multiple environmental risk factors may contribute to a particular disease and mortality from this disease, and an environmental risk factor is often associated with several levels. It is therefore desirable to create exposure categories allowing for as many combinations of risk factors and levels of risk as is practically feasible and to compute the population shares that fall in each category.” (The International Bank for Reconstruction and Development, 2008)

The second key point is that:

“Current research literature does not contain estimates of the combined relative risk of multiple environmental risk factors and that they overcome this problem by assuming a Cox proportional hazard model in their calculation of relative environmental health risks.” (The International Bank for Reconstruction and Development, 2008)

The World Health Report is also important because it defines how to calculate the environmental health burdens attributable to multiple disease factors in Appendix E

Appendix (see 2nd attachment). It shows how one can calculate environmental attributable fractions based on relative risk using the example of mortality from acute respiratory illnesses from different environmental sources like indoor air pollution and external pollution sources.

Conclusion

The concerns about environmental health risks from green house gases are valid. However too many documents, reports and articles only offer general and anecdotal claims about these risks. It is not sufficient to state the obvious about increased mortality and morbidity from this effect.

What is needed is rigorous environmental ecological epidemiologic studies like the one contained in the World Health Report above that shows how the risks can be calculated with existing secondary source data.

A retrospective study is feasible but none of the material submitted to me provide this level of detail.

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SUMMARY APPENDIX

In general the Greenhouse Effect on Human Health is described using the following information and assumptions.

1. Greenhouse Gases (CO2, Methane, Water Vapor, NOx) act like “transparent” glass in a greenhouse allowing infrared radiation to pass through and warm the planet but also as an insulator trapping absorbed heat.
2. They have maintained a life giving stability of world temperatures.
3. Accumulation of gases have raised temperatures (global warming) by 1 degree Celsius and it is expected to increase by 3 to 4 degrees by in the next 50 years
4. CO2 accounts for 50% of the effect of these gases and is the most difficult to control
   1. Is generated by any form of combustion
   2. Inevitable in the burning of fossil fuels
   3. Is highest in the 160,000 years
   4. Removed by plant absorption through natural growth an agriculture
   5. Deforestation reduces capacity of biosphere to remove carbon dioxide and to act as a stabilizing mechanism for climate change
5. Global Warming Health Effects
   * 1. See above under climate change
6. Unlike previous periods of climate change “humankind is now dependent on intricate systems of agriculture, trade and communications ---that will be disrupted.(Yassi, Kjellstrom, de Kok, & Guidotti, 2001)
   1. Violent behavior from food shortages or heat stress (shown through previous studies)
   2. Will increase frequency of severe precipitation in especially in the tropics
   3. Will increase frequency and severity of violent weather disturbances like hurricanes, tornadoes, typhoons, floods and blizzards.

Overview of Climatic Effects(Lippman, 2003)

“The effects are hard to predict since possible synergism and numerous feedback mechanisms in the real climatic system are largely unknown or hard to model. Some of the possible mitigating feedback mechanisms are:

* Increase in earth surface temperature due to CO2 will lead to increased cloudiness that may act to decrease incoming solar radiation and counteract any warming trend…however
* Increased CO2 (less soluble in water at higher temperatures) results in a decrease ocean uptake enhancing warming trend.
* Ice/snow melts decreases surface albedo and increases absorption of solar radiation… increasing warming effect.
* Differential heating causing heat gradients and wind effects…adding to climate effects.

Temperature Related Ozone Changes from Climate Change

One study estimated a nonlinear temperature change showed an increase in ozone levels and increased particulate matter of 2.5 micrometers or less by 16% & 25% respectively with other variables were held constant.

Avg. # of days exceeding the health based 8 hour ozone standard was found to increase by 60% (12 to 20) for 15 cities in one model.

Predictions of increased pollen since CO2 promotes growth and reproduction by plants.