A Toolkit for Eco-epidemiological Enquiry Under Global Ecological Change

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Can epidemiology remain relevant in the face of global ecological change?

"We seem to have been living for a long time on the assumption that we can safely deal with the parts, leaving the whole to take care of itself. But now the news from everywhere is that we have to begin gathering up the scattered pieces, figuring out where they belong, and putting them back together. For the parts can be reconciled to each other only within the pattern of the whole to which they belong."

- Wendell Berry (b. 1934)

Contemporary global-scale issues with major human health implications → complexity

- Global geoclimatic system changes (e.g., global warming, sea level rise, ocean acidification)
- Mass forced and voluntary migrations
- Urbanization and the development of mega-cities
- Expansion of consumption-intensive lifestyles (e.g., into China and India, each with 1B + populations)
- Increasing global and within-country disparities
- Global trade (e.g., fuels, food, manufactured goods, hazardous waste)
- Resurgence of old diseases and emergence of new (e.g., malaria and tuberculosis, HIV/AIDS, SARS and bird flu)

Problem definition

- Epidemiology is not well-equipped to address human health problems associated with global consumption and production practices driving ecosystem degradation in local or in distant locales
- Development of new methods and concepts is needed for epidemiology to contribute usefully to this realm of major emerging health concerns

Epidemiology, Environmental Epidemiology, and Eco-epidemiology

- A term applied to ecological influences on human health
- A conceptual approach that unifies molecular, social, and population-based epidemiology, in a multi-level application of methods aimed at identifying causes, categorizing risks, and controlling public health problems
- Either over-arching of environmental epidemiology, or *vice versa*

Adapted from Last, JM. A Dictionary of Epidemiology, 4th Edition, 2001

Newtonian vs. Complexity Paradigms

- Reductionism vs. Holism
- Predictability vs. unpredictability
- Linear vs. non-linear
- Uncertainties acknowledged
- Deterministic vs. non-deterministic
- System equilibrium vs. instability

Toolkit – a glimpse at 8 tools

- Integrated Assessment
- Integrated Scenario Analysis
- Participatory methods
- Ecological Footprint Analysis (EFA) and Disaggregated EFA
- The DPSEEA model
- Product Life-Cycle Analysis (PLCA)
- I=PAT
- Kuznets curves

Integrated Assessment (since 1996)

- A structured process of dealing with complex issues, using knowledge from various scientific disciplines and/or stakeholders, such that integrated insights are made available to decision-makers”
  - Rotmans, 1998

Integrated Assessment - Applied

- A systems-based perspective
- Holistic and integrated (disciplinary) approach, providing perspectives for addressing global health issues
- Greater emphasis on understanding processes (pathways) than on prediction (cause and effect)
- Interdisciplinary approach is required
- Makes explicit multiple interactions that exist between natural, economic and social systems

Integrated Scenario Analysis

- Scenario analysis provides a means for structured thinking about the future
- Scenarios are descriptions of journeys to possible futures that reflect different assumptions about how current trends will unfold, how critical uncertainties will play out, and what new factors will come into play
  - Rotmans, 2006

Integrated Scenario Analysis - Applied

- Issue focus rather than discipline-specific
- A response to uncertainty about what the future will bring
- A time horizon of decades is used
- “What-if” questions are asked
- Local, regional, continental and global scales are addressed
- Incorporates human values, motivations, and behaviours

Participatory Methods

- Policy exercises and focus groups
- Linked to ‘post-normal science’ (Functowicz and Ravetz, 1994)
- Involvement of relevant stakeholders

Participatory Methods - Applied

- Focus groups elicit preferences, opinions, and viewpoints
- Participatory modeling allows stakeholders to explore the implications of their ideas
- In scientist-stakeholder workshops, a research agenda can be formulated
- By stakeholders identifying key issues, a range of possible futures can be explored
- In policy exercises, participants assume different roles to simulate a decision-making process

Ecological Footprint (EF)

- The total area of productive land and water ecosystems required by a concentration of people (e.g., a city) to sustain its current level of activity. Resources provided by ecosystems supply material and energy needs as well as waste assimilation services. Modern cities in wealthy countries tend to have very large ecological footprints.
- To sustain itself, the city imports resources (air, water, food, building materials, etc) and exports its wastes

Disaggregated EF Analysis

- Disaggregation of the EFA means tracing material and energy demands to the actual source ecosystems, and determining health-related impacts at that level

Disaggregating an EFA - Applied

- Tracing banana markets (consumption) to production sites, and investigating human health implications of ecological impacts (e.g., water contamination) of pesticide use on banana plantations
- Linking farmed Atlantic salmon production to the ecological impacts of the "reduction" fisheries that supply important biological inputs; assessing human health impacts associated with transfers of high-quality protein from poorer to richer countries, with no universally accessible compensatory imports

DPSEEA

Driving Force(s) – Pressure(s) – State(s) – Exposure(s) – Effect(s) – Action(s)

D **Driving Forces**: Overarching policies, values, social norms, and economic priorities

P **Pressures**: Usually physical phenomena, often described by "more of this" or "less of that"

S **States**: Situations created by Pressures that lead to contexts for human exposures

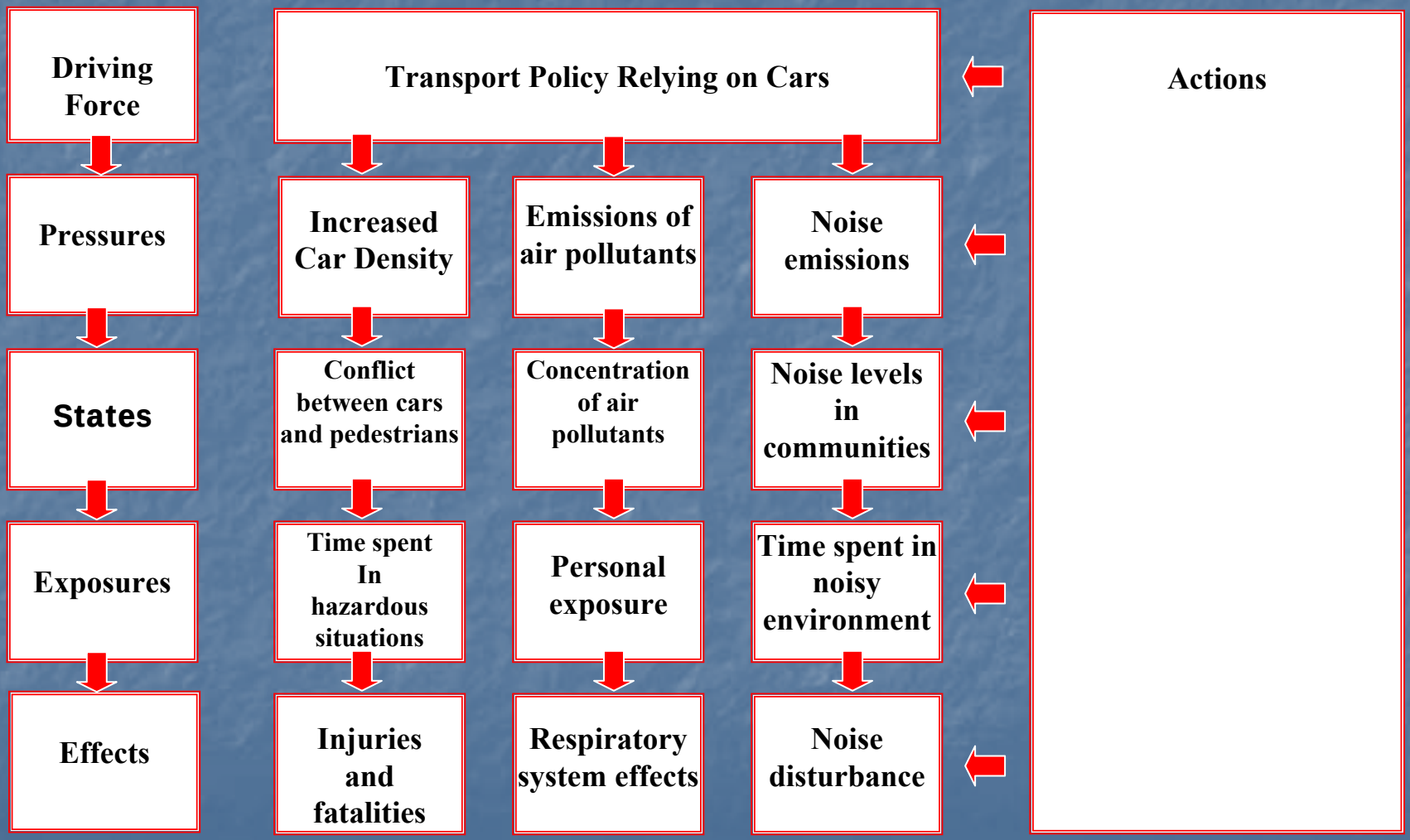
E **Exposures**: Human interaction with situations or agents believed to present some level of health risk

E **Effects**: Human health consequences

A **Actions**: Interventions (e.g., policies and programs) intended to effect change somewhere in the system

DPSEEA - Applied

(On TRANSPORT – from Racioppi, 2001)



Product Life-Cycle Analysis

- Origins in the energy audits of the 1960s and 1970s; a collection of techniques for analyzing the material and energy throughput associated with the products of industry
- Procedures may help in identifying the full complement of ecological impacts associated with specific products of industry

Product Life-Cycle Analysis - Applied

- Requires that typically-externalized considerations are made explicit
- Waste disposal through legal or illegal trade, or pollution associated with any consumer product, have health and well-being consequences

I=PAT

Integrity = Population * Affluence * Technology

Stresses the interdependence of forces which often are treated independently as needs for “population control,” “reduced consumption,” or “green technologies”. Helps in making our values and assumptions transparent

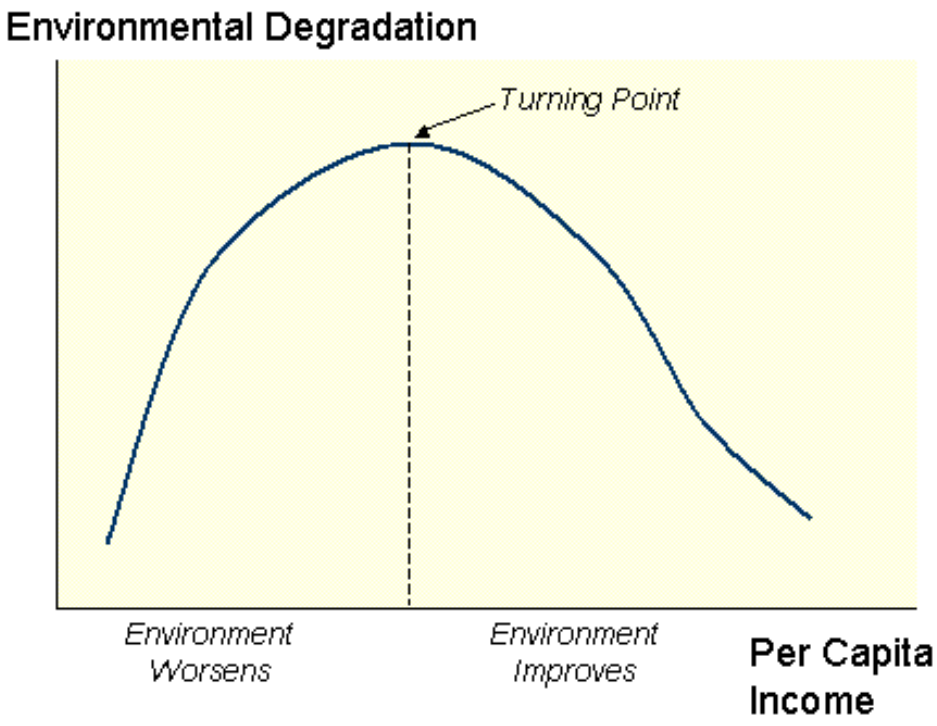
I=PAT globally - Applied

- In addressing threats to global life-supporting ecosystems, determinants at play are stressors relating to each of the need for controlling population growth, over-consumption, and inappropriate uses and abuses of technology
- The interplay of all determinants is critical for their recognition, investigation, and in formulating policy

"Kuznets" Curves

Attributed to economist Simon Kuznets for his exploration of the relationship between national income and income equity (distribution), but adapted to conceptualize relationships between national economic growth and pollution; may be useful for conceptualizing other ecology-health relationships

The environmental Kuznets curve



David Abler, Penn State University, 2007

Kuznets Curves - Applied

The relationship between the proportion of domestic food production exported and the loss of domestic biodiversity has implications for sustainability locally and globally, with health and well-being consequences

Summary (1 of 3)

- **Integrated Assessment**: Interdisciplinary approach provides understanding of cross-linkages and pathways under complexity
- **Integrated Scenario Analysis**: Permits understanding of where current trends will lead
- **Participatory Methods**: Provides a mechanism for broadening understanding of complex issues

Summary (2 of 3)

- **Ecological Footprint**: provides comparative measure of gross demand on the biosphere
- **Disaggregated EFA**: connects our consumption patterns with ecological impacts relevant to population health
- **DPSEEA**: Helps free us from being "prisoners of the proximate" to look at powerful distal determinants of health

Summary (3 of 3)

- **Product Life-Cycle Analysis**: assists in identification of source ecosystems affected by consumption/production practices
- **I=PAT**: Reminds us to treat population growth, consumption, and technological issues interdependently
- **"Kuznets" curves**: help in hypothesis generation

Recommendations

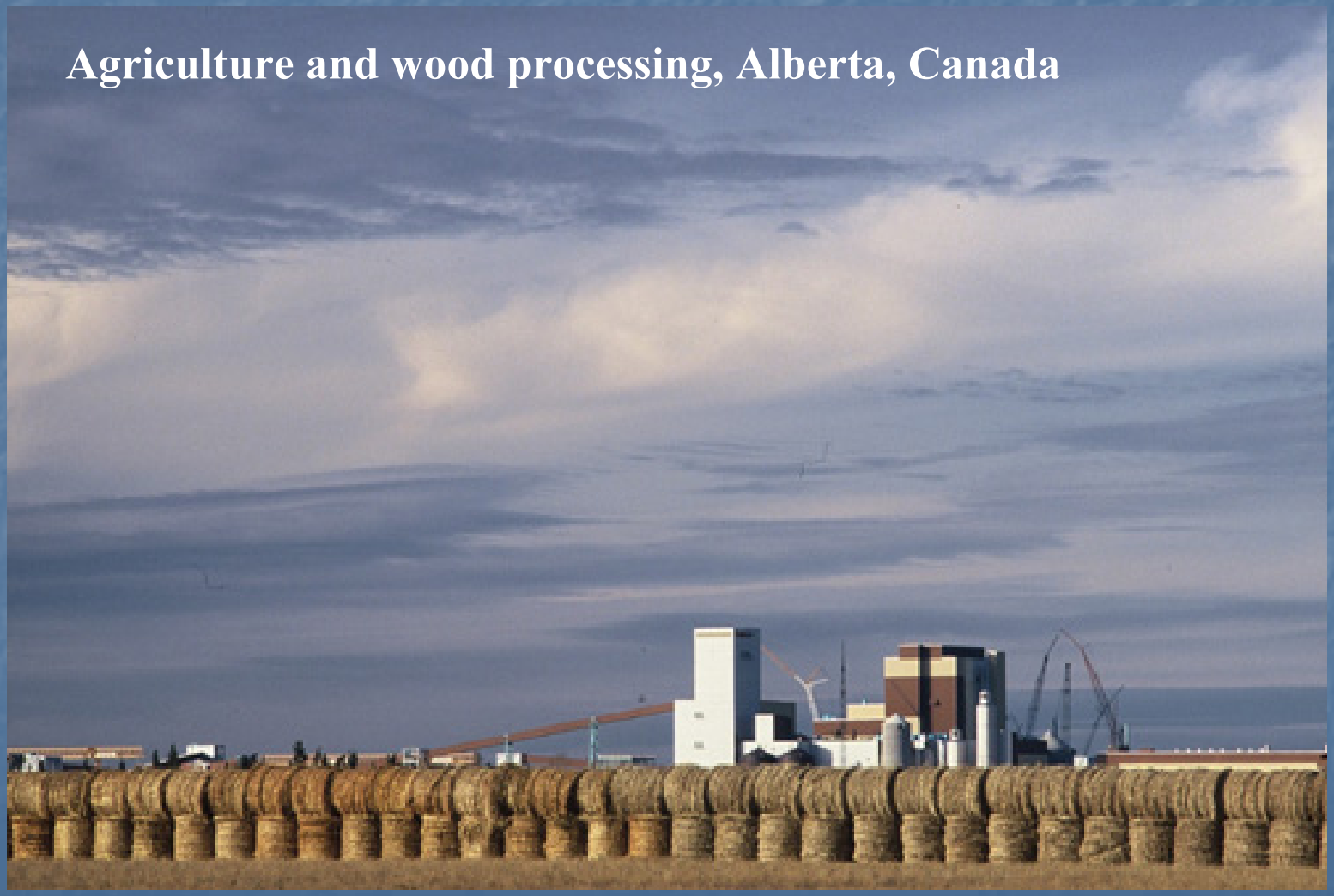
1. Improve basic ecological, economic, sociological, geopolitical, and systems thinking education among epidemiology students
2. Encourage and support transdisciplinary eco-epidemiological investigations of real-world industrial practices
3. Develop and employ methods for eco-epidemiological (population health) surveys of globally traded goods, including assessment of the distributive justice of ecologically-related health risks and benefits
4. Develop and teach public health ethics in relation to health risks and benefits related to global ecological change induced by human population, consumption (affluence), and technological factors

Appearing next week …

Ladd BD and Soskolne CL. A Toolkit for Ecoepidemiological Enquiry under Global Ecological Change.

Ch. 25. In: Soskolne CL, Westra L, Kotzé LJ, Mackey B, Rees WE, Westra R. (Editors) **"Sustaining Life on Earth: Environmental and Human Health through Global Governance".** Lexington Books, a Division of Rowman & Littlefield Publishers, Inc., Lanham, Maryland, USA. 482 pages

Thank you



IA - Message for eco-epidemiology

- IA models combine knowledge elements from various disciplines in an analytical framework to assess the socio-economic and environmental consequences of human activities
- Cross-linkages and pathways are explicated
- IA models provide a structured representation of a complex system

ISA - Message for eco-epidemiology

- Only when we see likely futures can we act to prevent harms by steering away from them
- By being structured, we know which component to target for intervention
- Research based not on body counts or “smoking guns”, but rather on avoiding such outcomes

PM - Message for Eco-epidemiology

- An extended peer community provides a superior form of quality control under complexity
- Only by exploring futures with explicit assumptions can we then identify those areas that interventions could impact to arrive at more favourable futures

EFA - Message for eco-epidemiology

- The production, use, and final disposition of the "stuff" of our daily lives are serious ecological and **population health** (**epidemiological**) concerns
- Epidemiologists have focused heavily on proximate exposures and effects, and have developed sophisticated methods of statistical analysis for handling data in this range; however, emerging ecosystem-related risks are unmanageable by historical modes of investigation
- Global features of the production, use, and disposal of the goods and services that we use daily are ecological and ***population health*** concerns; traditionally, these features have been neglected by epidemiologists

DPSEEA - Message for eco-epidemiology

- Investigation of proximal exposures and outcomes are important, but can detract from upstream system drivers that create the entire multiple exposure/multiple effect (MEME) context

PLCA - Message for eco-epidemiology

Details of the impact of products throughout their "life-cycle" (from resource extraction, to processing, to use, to recycling or disposal) are important for identifying associated ecological impacts—the starting point for eco-epidemiological investigations of associated health consequences

I=PAT - Message for eco-epidemiology

- Global trade complicates the I=PAT model

For example: a health-relevant Impact (such as the loss of arable land for local food production) in one country may be driven by consumer demand (Affluence) in another country.

TRANSDISCIPLINARITY

Transdisciplinary approaches to human health are approaches that integrate the natural, social, and health sciences in a humanities context, and in so doing transcend each of their traditional boundaries. Emergent concepts and methods are the hallmark of the transdisciplinary effort.

(Adapted from David Rapport by Colin Soskolne, 1999)

Rosenfield, Patricia L. The potential of transdisciplinary research for sustaining and extending linkages between the health and social sciences. Social Science and Medicine, 1992;35(11):1343-1357.