Cross-disciplinary Communication Needed to Promote the Effective Use of Indicators in Making Decisions

Joan L. Aron, PhD
Robert H. Zimmerman, PhD

ABSTRACT

This paper examines problems of assessment and decision-making that result from poor or inadequate communication of indicators among the disciplines of public health, the physical sciences, and economics. The specific examples used are drawn from climate impacts in the Americas although the issues are more general to environmental health. In terms of physical processes, problems arise in confusion about indicators at different steps along the DPSEEA framework of environmental health indicators and general scientific uncertainty about the underlying physical processes. Communication between public health and economics is hindered by a lack of understanding of economic costs used in making decisions and the presence of implicit value judgments in economic analysis. Organizational structures may further inhibit the effective use of indicators. Finally, the paper discusses the Pan American Health Organization proposal to enhance the communication of indicators by using information technology networking to support communication among program managers and decision-makers at the national and local levels. The aim of this initiative is to establish a better environment for making decisions. The problem of cholera in Peru is shown as an example of the need for better communication.

RÉSUMÉ

L'article porte sur les difficultés de l'évaluation et de la prise de décisions liées à de mauvaises ou trop peu nombreuses communications au sujet des indicateurs entre les disciplines de la santé publique, des sciences physiques et des sciences économiques. Même si les enjeux sont d'ordre plus général sur le plan de l'hygiène de l'environnement, les exemples sont tirés des répercussions sur le climat des Amériques. Du point de vue des processus physiques sous-jacents, il y a confusion quant aux indicateurs de l'hygiène de l'environnement pour les diverses étapes du cadre DPSEEA, et il règne une incertitude générale chez les scientifiques. Le manque de compréhension des coûts économiques utilisés pour la prise de décisions et les jugements de valeur qu'on porte implicitement dans l'analyse économique font obstacle à la communication entre les intervenants du secteur de la santé publique et ceux du secteur économique. De plus, les structures organisationnelles peuvent nuire à l'utilisation efficace des indicateurs. Les auteurs analysent aussi la proposition de l'Organisation panaméricaine de la santé visant l'amélioration des communications sur les indicateurs au moyen du réseautage des technologies de l'information pour faciliter les échanges entre les gestionnaires de programmes et les décideurs à l'échelle nationale et régionale. L'objectif du projet est d'améliorer les conditions pour la prise de décisions. Le problème de choléra au Pérou est utilisé comme un exemple à illustrer le besoin de la meilleure communication.

Correspondence: Dr. Joan Aron, Science Communication Studies, 5457 Marsh Hawk Way, Columbia, Maryland, 21045, U.S.A., Tel: 410-740-0849, Fax: 410-964-3598, E-mail: joanaron@mmscnet.org
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This paper examines problems of assessment and decision-making that result from poor communication of indicators among the disciplines of public health, the physical sciences, and economics. The mere production of a particular set of indicators is not sufficient. It is necessary to understand and enhance the process for their utilization in decision-making.

Climate and health indicators

The World Health Organization (WHO) has developed a DPSEEA conceptual framework for environmental health indicators: driving force (D), pressure (P), state (S), exposure (E), effect (E), and action (A).[1] However, decision-makers face confusion about the indicators at different steps in the DPSEEA framework and the expression of scientific uncertainty about the underlying physical processes. Communication across multiple disciplinary perspectives is necessary to ensure that decision-makers can understand indicators and develop appropriate responses. Examples drawn from climate impacts related to hurricanes, El Niño events and glacial retreat in the Americas are presented.

Hurricanes

The impacts of hurricanes depend on the characteristics of atmospheric events as well as the vulnerability of affected populations and infrastructure, factors often poorly understood. For example, great hurricane-related economic losses in the U.S. during the early 1990s were attributed in a U.S. Senate report to more frequent and severe storms. Hurricane Andrew in 1992 notwithstanding, the period of 1991-1994 was in fact relatively quiet.[2] What had changed is that development in hurricane-affected areas had placed more population and infrastructure at risk, a fact not emphasized in that report.

The impacts of Hurricanes Georges and Mitch can be partially attributed to increased societal vulnerability as well. The Director of the Pan American Health Organization (PAHO) stated that "those persons who lost the most had the least to lose"[3] in reference to these events. Many participants of the fourth Conference of the Parties to the United Nations Framework Convention on Climate

TABLE I
Standard Methods for Assessing Economic Value in Health Programs and Challenges in their Interpretation

Technique	Purpose	Challenges / Benefits
Cost-Benefit Analysis Uses either: Human Capital Theory (return on investment = individual's production) Welfare Economics (what consumers are willing to sacrifice to have a program)	Determine if investment in a program is worthwhile	• Many benefits in health are not in market system • Assignment of $ is controversial • Need to aggregate measures of costs and benefits across time periods for long-term processes
Cost-Effectiveness	Determine least expensive way to achieve goal	• Aggregate effects of mortality and morbidity into a single measure of quality of life (QoL) • Valuation problem for quality-adjusted life year • No consensus for QoL exists as indicator of cost-effectiveness • Need to aggregate measures of costs and benefits across time periods for long-term processes
Multiple Criteria	Seeks to make tradeoff between factors more explicit	• May produce too many options • Cost of assembling and educating stakeholders may be high • Tradeoffs might be represented inconsistently in different groups
Standardization	Often the goal for analyses	• Disguises ethical conflicts

Change in Buenos Aires declared that the effects of Hurricane Mitch were a harbinger of the dangers of global warming. Yet the reality is that action needs to be taken against poverty, poor land-use practices and inadequate preparedness regardless of global warming.[4]

El Niño Events

Climate-sensitive sectors are strongly affected by El Niño events in the Americas. The process is very complex and extends over many months.

Despite some typical patterns, each El Niño event develops differently. Indicators of stages of these events have great potential value for monitoring and understanding their variability. However, the use of indicators for many different aspects of these events is a tremendous source of confusion. For example, during the major El Niño event of 1997-1998, reports of successful forecasting coexisted with reports of major errors. Even if a forecast is successful in climatological terms, it may not be useful in making decisions to mitigate impacts because it is difficult to predict the impact of El Niño on weather at very local scales.

The communication to decision-makers must explicitly address indicators for four linked domains. They are: Pacific sea surface temperatures, reflecting physical processes at the core of El Niño events, although some regions may also be affected by changes in the Atlantic and Indian Oceans; seasonal climate, usually expressed over a broad region; specific outcomes in the health sector; and actions that can be taken to mitigate impacts. A challenge throughout is the uncertainty inherent in each of these domains.

Glacial Retreat

A large part of the population in Latin America depends on the hydrological cycle in mountains. Mountains provide the sources of major rivers, such as the tributaries of the Amazon. However, valley glaciers are receding in Latin America and the rest of the world. Deglaciation can augment streamflow in the short run (as the glacier melts) and reduce streamflow in the long run, disrupting ecosystems and social organization. Current projections of the impact of global climate change anticipate both an increase in average global surface temperature (melting glaciers) as well as an increase in precipitation (possibly adding to glaciers). The balance between these two processes is the subject of ongoing research. In this case, decision-makers and scientists should establish a dialogue and review the potential indicators of change. Scientists can provide more climatological and hydrological information as research progresses. Decision-makers can provide needed input on potential social impacts and develop indicators over time. Limitations in scientific prediction do not necessarily prevent useful societal responses.

Economic indicators

Decisions depend not only on assessments of risks to public health but also on estimates of costs of interventions and impacts. The fundamental problem is that resources are scarce. The goal of economic analysis is to provide insight about allocating scarce resources efficiently. However, methods for economic valuation make assumptions and value judgments that are not always explicit. An indicator that may look straightforward may contain objectionable assumptions. Table I summarizes standard methods used in assessing economic value and some of the associated challenges inherent in their interpretation.

Organizational processes

Organizational processes may inhibit the effective use of indicators. This section provides a summary of perspectives on problems in organizational linkages between scientists and decision-makers.

Surprises

Some surprises may be due to uncertainties inherent in the complexity of social and environmental phenomena. Other surprises are due to the ways scientific data are presented to and used by decision-makers. Even gradual phenomena may generate surprises[5, pp 44-45] due to habituation to warnings and the short time scale for political decisions.

Embedded Assumptions

How scientific bureaucracies control information and embed hidden assumptions in data analysis has been explored in applications of geographic information systems (GIS). The most obvious way in which an analysis of environmental equity can be biased is in the selection of data, since most studies rely on secondary data sources collected by government agencies that are laden with social norms.[6] Databases may also have errors such as census undercounts. General-purpose interfaces introduce bias if they are not well suited to a particular need.[7]

Expertise and the Policy Cycle

Political scientists typically divide the policy process into four stages: agenda setting, policy formulation, policy implementation and policy evaluation. Scientific expertise does not usually drive an agenda, but works to provide legitimacy for it and is generally recognized as contributing tools to the analysis of decisions during the formulation of policy. The use of expertise is limited by the political constraints surrounding a decision. Decision-makers are subject to requests from special interests, bureaucratic demands, and short-term political pressures. Science and expertise can be used to bolster a decision made for other reasons. Moreover, when there are underlying value differences between conflicting parties, more data may actually generate more conflict as information is used selectively to support favoured positions.[8] In translating policy into practice, "experts play a key role in providing specificity to vaguely worded legislative mandates."[9] A policy that calls for "an adequate margin of safety" cannot implement itself. However, if political obstacles can be overcome, scientific difficulties remain in sorting out causal effects among multiple influential factors.

Future work by the Pan American Health Organization

The effective use of indicators in environmental health decision-making depends on establishing a good environment for making decisions. Individuals from multiple disciplines need to communicate and develop a shared understanding of the issues. The Division of Health and Environment at PAHO has developed information technology to access information. Future efforts will focus on enhancing networks of people who can utilize the new technology. The case of cholera in Peru illustrates the need for enhanced communication in using indicators for environmental health decision-making.

In January 1991, a major cholera epidemic started in the coastal area of Peru and eventually spread throughout Latin America.[10] The epidemic was preceded by scattered cases of cholera in several coastal cities, including Trujillo, with the earliest case detected on October 23, 1990.[11] Why did cholera return after a century? According to Bell and Wilson,[12] government officials in Peru decided to stop chlorinating drinking water after they received warnings in the early 1990s about the cancer risk posed by trihalomethanes (THMs) as byproducts of chlorination of drinking water. They claim that Peru had a poor institutional infrastructure that could not effectively utilize a risk assessment generated by the U.S. Environmental Protection Agency (EPA).[12] We claim that the essential issue is one of poor characterization of the decision-making environment in combination with poor communication about environmental health decisions in both developed and developing countries.

The implication of the U.S. EPA risk assessment as the cause of the cholera epidemic in Peru first appeared in the international scientific press late in 1991.[13] In Anderson's scenario, the decision to stop chlorinating many wells occurred in Lima, Peru in the 1980s after the U.S. EPA promulgated in 1979 the total THM standard of less than 0.10 milligrams per liter for U.S. community water systems that serve at least 10,000 people.[14] Anderson's article has been used to argue that the decision not to chlorinate was the cause of the cholera epidemic in Peru.[15, p.81] However, Anderson[13] presented opposing points of view about the influence of the THM assessment. Frederic Reiff, PAHO's regional director for water quality, stated that the decisions "may have been based more on the practical and economic difficulties of chlorination than on analysis of the risks". Robert Clark, director of the EPA Drinking Water Research Division, added that he thought Peruvian officials "were simply using the EPA's position, so they could turn around and point the finger at us and say, 'Well, they told us not to.'" Such statements strongly suggest the need for a better characterization of how water treatment decisions in Peru are made. Discussion of an assessment does not mean that it determines an outcome.

Salazar-Lindo and colleagues[16] provide more detailed information on the role of chlorination in Peru as a barrier to this spread of cholera. Their study investigated the water supply systems of Trujillo and Iquitos, both of which were affected by the 1991 epidemic. Trujillo lies along the arid coast of Peru and relies on groundwater obtained from 43 drilled wells. Iquitos is situated in the jungle and relies on water pumped up from a river below the city. Before the cholera epidemic, engineers in charge of the Trujillo system believed the groundwater was pure and did not require chlorination and they were also concerned about the carcinogenic risk of chlorination. The system in Iquitos suffered from poor design and management and chlorination was applied irregularly at the treatment plant. Local differences in sources of water – groundwater versus surface water – are important. The lack of chlorination was an explicit decision only where groundwater appeared to be pure. This suggests that the decision about chlorination in Trujillo did not depend on carcinogenic risks, but rather that knowledge of carcinogenic risks buttressed a decision made for other reasons. It also appears more generally that operational and fiscal difficulties played an important role in the lack of chlorination in Peru.

It is critical to examine the risk assessment employed by the engineers in Trujillo and ask who else agreed with them – were there other indicators of risk that were ignored? In studies of unexpected events, Glantz et al.[5, p.12] stress the importance of asking who is surprised. It is likely that opinions about the need for chlorination of the public water supply in Trujillo before 1991 varied. If disagreement can be confirmed, then one should ask how one view prevailed and how better communication can improve the quality of decisions. Comparisons among the Peruvian coastal cities first to experience the return of cholera would be especially informative.[11]

Cholera transmission in Peru has also been linked to an aquatic reservoir of the cholera vibrio and the warming of ocean waters during El Niño events.[10] Current understanding of the joint impact of climatic influences and chlorination policies is limited. Studies of cholera in Peru that focus on the aquatic reservoir and El Niño do not mention the debate about chlorination in Peru.[10,11] The decision not to chlorinate has been used to dismiss the influence of climate.[15] Some reports (e.g., World Resources Institute[17,pp 22-23]) are atypical in addressing both the decisions about chlorination in Peru and aquatic reservoirs of the cholera vibrios and El Niño.

A comparison of the first and second years of cholera transmission in Trujillo demonstrates the complexity. In 1991, 75% of the cases occurred within the first eight weeks of the epidemic, the pattern typical of coastal cities.[16] Transmission appeared to be largely controlled by intensive efforts to chlorinate the sources of water and to persuade the population to disinfect water before drinking; a pattern suggestive of a common-source outbreak. In 1992, however, the number of cases was smaller and the appearance of cases was more spread out in time, raising questions about exposures and the effectiveness of previous control efforts. Work in Nukus, Uzbekistan demonstrates the importance of water pressure, a secure system, and the presence of a filtration system to remove particulate matter, in preventing diarrheal diseases related to water supplies.[18,19] The water system managers in Trujillo did not maintain water pressure in the system or monitor water quality on a regular basis.

The reemergence of cholera in Peru coincided with an extended El Niño pattern, conventionally designated as the period 1991-1995.[17, p. 23] However, the classification of that time period is contentious.[20, pp.84-85] In the western tropical Pacific (Niño 4 indicator), warmer ocean temperatures persisted from 1990 through 1995, consistent with one long El Niño event. In the eastern tropical Pacific near Peru, Ecuador and the Galapagos Islands (Niño 1 and Niño 2 indicators), the ocean temperatures peaked three times during that period, suggesting three distinct El Niño events; the first and largest peak in ocean temperature occurred in late 1991 and early 1992. Local El Niño indicators need to be linked to local weather conditions, which in turn need to be linked to specific modes of disease transmission and specific actions for intervention.

The potential use of forecasts of El Niño in cholera prevention depends on identifying activities that should be responses to specific forecasts. One major difficulty is that El Niño has broad regional impacts but inconsistent local impacts. In preparation for the 1997-1998 El Niño event, President Fujimori of Peru made great investments in physical mitigation based on the assumption that the event would unfold as in 1982-1983; however, the 1997-1998 event turned out to be most similar to the event of 1925-1926.[21, p.14] Because the details are so hard to predict, Peru should always be readying itself on a national basis.[21] Preparations for floods related to El Niño must also be integrated into overall plans to mitigate the impact of natural disasters on drinking water and sewerage systems.[22] Communication is needed to coordinate disaster relief, infectious disease control and water system management.

The example of cholera in Peru has demonstrated the complexity of the decision-making environment and the factors affecting the control of disease. In the story of chlorination in Peru, it is striking that multiple influences are often presented but clearly ignored in favour of a particular factor. Understanding why multiple influences are ignored deserves further inquiry. The challenge is to communicate indicators that can characterize these interactions. The importance of these issues extends far beyond Peru; cholera is one of the few bacterial diseases that can still cause pandemics[10] and the U.S. EPA's assessment of the carcinogenic risk due to chlorination is thought to "have induced many authorities in developing countries to reduce or even abandon the use of chlorine."[23,p.29]

CONCLUSION

Improved cross-disciplinary communication is needed to promote the effective use of indicators in making decisions. Cross-disciplinary communication has to address the joint influences of multiple indicators, different types of analysis for economic factors, and organizational barriers to informed decision-making.

As PAHO develops its plans for using information technology to support networks of decision-makers at the local level, it will be faced with many questions about the scope of information and uncertainty. The lesson learned from the U.S. acid rain assessment is that "there must be widespread agreement on what questions are being asked, why they are important, what counts as answers to them and what the social use of these answers might be."[24] PAHO should work closely with local decision-makers to ensure that they can make effective use of new networks.

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