Michelle Sullivan Govani's Commentary on "Biodiversity and Human Health"

Commentary On
Case: Biodiversity and Human Health

In this case, Kiera confronts a variety of roadblocks and ethical dilemmas. First she must contemplate different ways the community could value the forest and its biodiversity (“Ecosystem Services”). Then, she must explore the literature related to “Biodiversity and Disease” to ensure a complete understanding of the points of consensus and of disagreement in the research community. Of course, this is an issue for more than just scientists. Kiera should be fully aware of social and political implications of the research as well (“Environmental Justice and Disease Management”). Finally, Kiera will need to consider how to best communicate the research, including uncertainties, to the public, and this requires a decision regarding what the role of science should be in making a public policy decision about the forest (“Communicating Science and the Role of Science in Public Policy”).

Ecosystem Services

One major issue that Kiera will contend with is to decide how the forest is valuable and which of those values she will utilize in an argument to protect the forest. There are many ways to value a forest; these values may be tangible or intangible, economic or spiritual, human-centered (anthropocentric) or nature-centered (ecocentric). And one could argue that these values are or are not mutually exclusive.

In 2001, called into action by the United Nations (UN) Secretary General, the Millennium Ecosystem Assessment (MEA) initiated a major evaluation of human impacts on the environment. The MEA panel released their synthesis report, “Ecosystems and Human Well-Being,” in 2005, and in it they popularized the term “ecosystem services” to name the benefits human gain from healthy ecosystems (Millennium Ecosystem Assessment 2005). In 2015, the UN released the Sustainable Development Goals, a set of targets and topics they hope to address by 2030.

Reiterated in the goals are commitments to reduce poverty and protect life both on land and in water (United Nations 2016).

The appeal by the UN and others, including the Nature Conservancy, to value biodiversity in economic or instrumental (how biodiversity can be useful to humans) terms, has encountered pushback from some in the science and environmental communities. In a heavily circulated essay published in *Nature* in 2006, Stanford biologist Douglas McCauley argued that instrumental valuation of nature is flawed because it cannot guarantee protection of biodiversity in perpetuity. Markets fluctuate, and so too will the market value for a given ecosystem service. Additionally, technological advancements by humans may eventually replace services provided by an ecosystem, and thus make protection of that ecosystem unnecessary in instrumental terms. Finally, some ecosystems simply do not provide any obvious or market-valued services to humans (McCauley 2006).

When dealing with governments and businesses, however, it may be more effective to negotiate in economic terms. For example, when the earliest U.S. National Parks were proposed to Congress, it was the appeal to tourism dollars and the railroad industry that convinced doubtful Congress members to back the parks (Runte 2010). Still today, the National Park Service releases extensive reports detailing the financial benefits that park units bring to local communities and the national economy.

Perhaps, as Belinda Reyers (scientist for the South African Council for Scientific and Industrial Research) and her colleagues argue, the best path forward is to use a combination of instrumental and intrinsic value arguments to support biodiversity conservation: “If this debate leads to polarization of the conservation community, it may prevent the emergence of common understanding of how best to push forward with conservation, which in our experience, is what all sides of the current debate desire” (Reyers et al. 2012, 506).

Assuming that Kiera does decide to bring attention to the ecosystem services that the biodiversity in the Indonesian forest provides, human health could be a significant focal point for her argument. According to the World Health Organization (WHO), human health “ultimately depends upon ecosystem products and services (such as availability of fresh water, food and fuel sources)...” Directly related to *biodiversity*, healthy ecosystems can also harbor a variety of species that may have pharmacological value- an ecosystem service that could directly benefit progress in medical science. (WHO 2016).

Biodiversity and Disease

In the last decade, much research has been conducted to better understand another potential ecosystem service provided by biodiversity: disease control. Reductions and alterations in biodiversity have cascading effects on biogeochemical interactions throughout an ecosystem to which infectious diseases are sensitive. Specifically, researchers have found that intact biodiversity acts to regulate and control *vector-borne and parasitic diseases*. However, the research community is not in unanimous agreement; some researchers claim that there is no connection between biodiversity and disease control. Kiera will need to wade carefully through the competing claims and carefully present uncertainty in the research to the public and to government officials.

In 2006, Bard College biologist Felicia Keesing and colleagues first reported an “inverse relationship between [bio]diversity and disease risk,” which they termed the “dilution effect” (Keesing et al. 2006). The dilution effect describes the process by which greater levels of biodiversity will decrease (dilute) the chances that a pathogen will meet its host. When a system contains more species, there are more opportunities to interrupt the life cycle of a disease, and there exists a smaller concentration of vectors for the disease (Bonds in Barclay 2012). Declines in biodiversity tend to eliminate species that prey on vectors for disease. And often, the animals that survive biodiversity declines are the “weedy species,” those that are likely to be good disease hosts (Keesing et al. 2010; Barclay 2010).

In a 2012 study, Harvard professor Matthew Bonds and colleagues found that countries with high levels of biodiversity (such as biodiversity hotspot, Indonesia), will see a 30% increase in disease burden should 15% of biodiversity be lost. This finding could be alarming, considering that increasing human development has led to unprecedented biodiversity loss, with current extinction rates at least 100 to 1000 times background rates and future rates (in the next 50 years) predicted to be 10 to 100 times present rates of extinction (Mace et al. 2005).

Claims concerning the inverse relationship between biodiversity and disease outbreaks are disputed. A meta-analysis found weak support for the dilution effect (Salkeld et al. 2013), and another concluded that the relationship is far too complex to come to any conclusion (Wood et al. 2014). Most recently, a review published by

NOAA Senior Science Advisor, Paul A. Sandifer, and colleagues (2015) argues that although there is “strong evidence linking biodiversity with production of ecosystem services and between nature exposure and human health,” most “studies were *limited in rigor* and often *only correlative*” (emphasis added). But their conclusion is caveated: “we believe the best current answer to the question of whether increased biodiversity reduces risk from infectious diseases is ‘probably not, but it depends.’ This question requires further research about the mechanisms and effects of biodiversity on disease transmission…” (Sandifer et al. 2015). Even studies that assert to have evidence for the inverse relationship between biodiversity and disease outbreaks admit that more research is needed to determine a mechanism of causation and to formulate a general theory on the effect of biodiversity on disease control (Bonds et al. 2012; Morand et al 2014; Citivello et al. 2015).

In general, however, the Keesing et al. (2006) team’s initial findings have been supported in the literature with studies showing patterns resembling the dilution effect for malaria in particular, (Allan et al. 2009; Ezenwa et al. 2006; Swaddle and Calos 2008), in addition to meta-analyses detecting similar patterns across vector-borne and parasitic diseases more generally (Bonds et al. 2012; Morand et al. 2014; Civitello et al. 2015; Keesing and Ostfield 2015).

Environmental Justice and Disease Management

The Bonds et al. (2012) study also demonstrates the negative economic impacts of disease burdens. This is a not a new idea; previous studies have linked disease outbreaks to poverty (Garchitorena et al. 2015; Bonds et al. 2010; Bloom and Canning 2000). Bonds et al. claim that such economic effects could explain the differences in income among tropical and temperate regions. And indeed, poverty and disease have similar, distinctive geographic distributions. The tropics hold 93% of the global burden of vector-borne and parasitic diseases and are home to 41 of the 48 “least developed countries” and only two of 34 “advanced economies” (Lopez et al. 2006; UNCTAD 2008; IMF 2009).

Though more research is needed to see if there is causation underlying this correlation, Bonds et al. (2012) argue that the manner in which income increases with latitude “is highly suggestive of underlying biophysical drivers” particularly because vector-borne and parasitic diseases spend much of their life cycle outside the human host, and are thus dependent on environmental conditions (including levels of biodiversity).

The links among biodiversity, vector-borne and parasitic diseases, and poverty have environmental justice implications. According to the US Environmental Protection Agency, "Environmental justice is achieved when everyone, regardless of race, culture, or *income*, enjoys the same degree of *protection from environmental and health hazards* and *equal access to the decision-making process* to have a healthy environment in which to live, learn, and work" (EPA 2016; emphasis added). If lesser income communities and countries are more often subject to human activities that destroy biodiversity and instigate disease outbreaks, then environmental justice is not fulfilled. Perhaps one policy outcome of this body of research is that local communities should be informed of the possible disease risk that accompanies biodiversity destruction and be consulted before nearby human development that threatens endemic species and ecosystems occurs.

Understanding the relationship between biodiversity and disease could also change policies for management of tropical diseases. Tropical diseases are typically managed as medical and public health issues, but perhaps public health officials and tropical disease specialists should also note the role of biodiversity in disease outbreaks, especially for diseases that spend parts of their life-cycle outside of humans (Barclay 2012). The potential role of biodiversity conservation in tropical disease management has not escaped the attention of the WHO: "'If we see biodiversity loss increasing infectious disease transmission as a general rule, that's an argument for conservation […],' says Diarmid Campbell-Lendrum, a senior expert on health and environment at WHO" (Quoted in Barclay 2010).

Communicating Science and the Role of Science in Public Policy

Kiera now has the tricky task of communicating the science, as well as the social and political implications, to the community of stakeholders. She will encounter the difficulty of conveying scientific uncertainty to a public audience, and she and the community will need to decide how scientific findings should be used in the policy sphere.

If disease control and protection of human health truly are quantifiable ecosystem services, they should be considered among the list of other ecosystem services provided when weighing decisions regarding human development and biodiversity conservation (Bonds et al. 2012; Keesing and Ostfield 2015). The trouble is that whether or not policy makers believe and act on this claim depends on which experts and literature are consulted and how that information is interpreted. In the

US, disagreement among experts would likely lead to political gridlock with both sides of an argument finding evidence to substantiate their positions. In other countries and cultures, you may find a different outcome. For example, many countries in the European Union interpret contested scientific findings in light of the precautionary principle, under which the existence of substantial literature showing a connection between biodiversity loss and health risk would be enough to drive policy decisions to avoid potential risk.

Whether Indonesia operates more like the US or the EU, Kiera has an obligation to present both sides of the debate to the public, to the plantation employees, and to the government. There are a few ways she can describe the uncertainty found in the scientific literature. First of all, natural systems such as the Indonesian forest are inherently variable. This variability encompasses the effect that biodiversity has on disease outbreaks. It is possible that a scientific consensus regarding the effects of biodiversity declines on disease may never be reached because of the considerable randomness that exists in the natural world. In addition to the endemic uncertainty of the study subject, the perspectives of the scientists themselves are varied and affect both the questions and hypotheses they pose, as well as the methods they use to address them (Pielke 2007).

If disagreement over this relationship was a purely scientific issue, why hasn't over a decade of continued, intensive scientific research settled the debate? In their classic essay, *Risk and Culture*, Dame Mary Douglas and Aaron Wildavsky, an anthropologist and a political scientist respectively, argue that the reasoning behind a continued debate like this is due to the fact that risks (including the risk of disease outbreaks) have both objective and subjective facets (1982). Though science can advance our knowledge, including awareness of what we don't know, it cannot reduce uncertainty, particularly the political strain. Douglas and Wildavsky quote Philip Handler, President of the National Academy of Science from 1969-1981, "The *estimation* of risk is a scientific question… The *acceptability* of a given level of risk, however, is a political question, to be determined in the political arena" (Douglas and Wildavsky 1982, 65).

Although Handler's point is not entirely sound (estimation of risk is also subject to politicization, particularly in terms of the assumptions that different risk estimation tools make), the general premise stands. The role of science is to understand how different choices can lead to different outcomes. The role of politics then, is to choose which outcomes and thus which choices are acceptable (in Kiera's case, by way of public forum and vote) (Pielke 2007).