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Introduction: Infectious diseases

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In any discussion of the great challenges facing humanity in addressing global environmental problems, a small number of topics automatically rise to the top: climate change, the loss of biodiversity, and the sustainability of the services ecosystems provide us. But no threats to human welfare are more urgent than those posed by infectious diseases; we suffer already the devastating consequences of the emergence of new diseases such as HIV, the reemergence of old ones such as tuberculosis, and simply the increasing toll of endemic diseases such as malaria. Non-human animals play fundamental roles in the spread of many of these diseases – as reservoirs, as vectors, and as cauldrons for the creation of new types. Land-use practices and environmental management both affect the persistence and spread of endemic diseases, such as malaria. Furthermore, as animal populations increase their ranges, due to climate change and human-facilitated alien introductions, the potential for disease spread also increases. These factors, together with the increasing mobility of the human population, conspire to make these environmental problems of great and immediate concern.

Management of zoonoses and other infectious diseases poses problems that are both ecological and economic in nature. Land use involves tradeoffs between costs and benefits, including the potential for the spread or reduction of diseases. Of course, the costs to society are not limited to diseases of humans, or even of other animals: plant pathogens endanger forests, agriculture and other ecosystems, threatening ecosystem services on which we depend. Management of diseases involves the expenditure of limited resources, and this must be carried out in the most effective manner. It is in this context that we initiated this Special issue, with contributions that address selected core problems in the economics of disease management.

The papers in this Special issue explore environmental, developmental, and economic aspects of the management of disease, from the role of environmental change and economic development, to the implementation of optimization methods for control and eradication. In the opening article, Barrett and Hoel consider the problem of the eradication of a disease, a goal that historically has been successfully achieved only for smallpox. Eradication is a costly undertaking. Were resources unlimited, it would seem a no-brainer to opt for eradication. But, of course, resources are not unlimited, and so cost–benefit analysis is essential. Barrett and Hoel

develop such an analysis, and apply it to the current initiative to eliminate polio. The results are somewhat surprising: high vaccination rates are never optimal. More generally, the approach yields the conditions under which eradication is the optimal strategy. This theme is continued in the paper by Bolzoni and DeLeo, who carry out a cost–benefit calculation for the eradication, by means of culling, of classical swine fever in wildlife. Their results complement those of the first paper, by showing that a high culling rate in the early stages of the initial epidemic is similarly not likely to be an element of a good strategy.

Gaff, Joshi, and Lenhart turn attention to plant pathogens, similarly exploring the role of culling in controlling the economic damage. Although the focus of this paper is on plants, we have already seen from the Bolzoni and DeLeo paper that the importance of understanding the efficacy of culling is of much wider importance; a classic applied example is the outbreak of foot-and-mouth disease among European livestock six years ago.

Tol, Ebi, and Yohe explore broadly the role of climate change and economic development in disease spread, and find that these two factors may work in opposite directions in affecting spread. Climate change certainly has the potential to increase the range of vectored diseases, but at least some kinds of development may reduce ranges. Indeed, the authors recommend economic development, in particular in poor countries, as a mechanism to reduce the consequences of climate change.

Finally, Gilligan, Klein, Laxminarayan, and Smith provide a valuable general overview of the linkages between economic incentives and disease dynamics. There is a rich mathematical literature regarding disease models, both for animals and plants, but until recently there has been very little effort to incorporate explicitly the behaviors of individuals in response to the economic incentives that face them. The potential importance of linking the dynamics of diseases with the behaviors of individuals cannot be overestimated. How do individual behaviors and decisions lead to outbreaks? How do individuals change their behaviors during epidemics? How does one incorporate externalities in models, since infectious diseases automatically imply societal costs not adequately considered in the decisions facing individuals? This will surely be an important and exciting area of research in the coming decades, and the Gilligan *et al.* paper provides a wonderful introduction.

These papers are only a sampling, and in no way are meant to represent the full range of challenges in exploring the linkages among environment, development, and disease. Hopefully, however, they will be enough to demonstrate the wide range of issues that must be addressed in this area, the need for careful analyses, and the need for environmental and developmental economists to direct more attention to the relevant challenges.