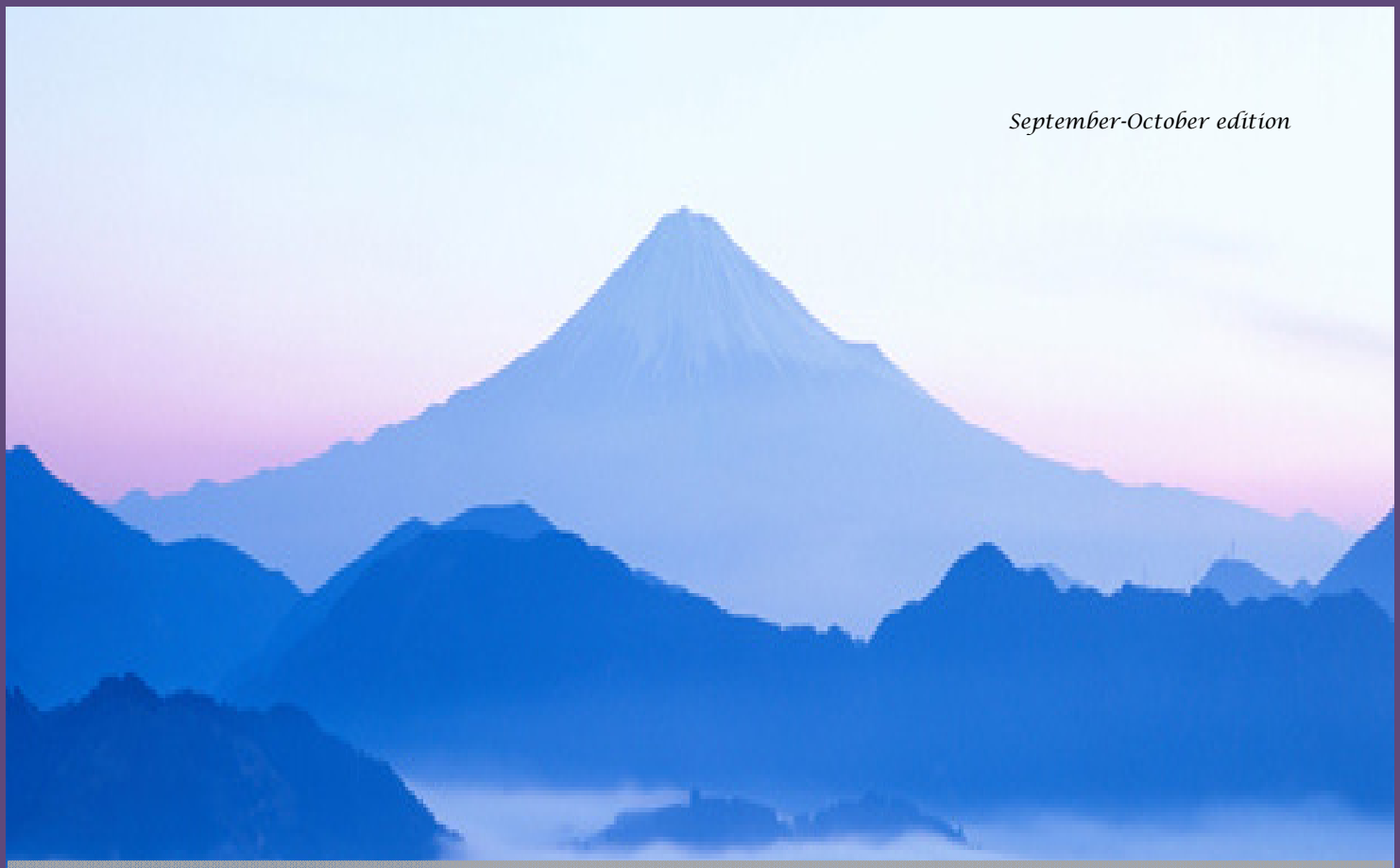

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EDITORIAL ARTICLE:

Sustainability in the 21st Century

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The rapid run-up of global food and fuel prices over the last year or so has reminded all of us of the interconnected nature of our world. Rising incomes in India and China led to both rising demand for food and to changes in dietary preferences, with meat, fish, and dairy products taking on a greater importance. Governments' concerns to increase their energy independence (i.e., to depend less on imported fuels) and to reduce the carbon emissions of the fuels they do use sparked an explosion of interest in alternatives to fossil fuels. Biofuels fit the bill on the energy side, but the diversion of food crops to fuel production has further raised global prices for grains and oilseeds and caused some to question the ethics of this approach. Some countries have seen new production and business opportunities arising from the rapidly-changing food and fuel environment while others have struggled to deal with their populations' basic needs.

Clearly, the world has some way to go before we figure out how to balance our consumption and production in more sustainable and equitable ways. It is evident that we will need to draw on the learning of many disciplines – engineering and materials science, biology and agriculture, political science and economics, geography, climate science, and anthropology – and to explore how we might better communicate with each other and work together to define feasible approaches to creating a more sustainable future.

The National Academy of Sciences, National Academy of Engineering and the Institute of Medicine ("the Academies") in the United States are supporting efforts to do just that. Through a Roundtable on Science and Technology for Sustainability, the Academies have brought together experienced professionals from a variety of disciplines and different sectors (academia,

business, government, and civil society) to identify and consider key topics in the area of sustainable development. An early priority was looking at the process of translating knowledge (especially interdisciplinary knowledge) to action. This was followed by a deeper consideration of the role that partnerships play in fostering sustainable outcomes. Other issues that are being debated include: the sustainability of urban environments, energy and biofuels development, the choice of appropriate metrics for assessing sustainability, and the use of third-party certification processes as a way to monitor and encourage sustainability.

The Roundtable's "partnerships for sustainability" project symposium held in June, 2008, engaged a wide group of people on this important topic. The project drew on the experiences of some partnerships that responded to the initiatives launched in September, 2002, at the World Summit on Sustainable Development (WSSD) in Johannesburg, South Africa. In addition to hundreds of partnerships formally registered with the U.N., countless other public-private partnerships for sustainable development have been established at various levels. Development agencies have worked through partnerships in local communities for years. Businesses both large and small are increasingly turning to partnerships (business-to-business and cross-sector) to meet the challenges of sustainability. Foundations are likewise forging new alliances in order to match their relative strengths and skills to better serve communities.

Yet with all of this activity in the area of partnerships for sustainable development, the Roundtable found that little information exists about what makes some partnerships successful and others less so. The Roundtable, therefore, commissioned case studies of 11 partnerships where sustainability was an explicitly anticipated outcome. Participants in the symposium reviewed and discussed the findings, adding depth and insight to the case study findings. A workshop summary will be published in late 2008. For more information, go to http://sustainability.nationalacademies.org/

Inter linkages between Environmental Change and Development

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Environmentally sustainable development is one of the most challenging problems facing the world today. Yet surprisingly, our understanding of the environment-development relationship is limited. For taking concrete steps towards sustainable development, the first step is to understand how development and environmental change affect each other, the second step is to assess the magnitude of these effects and the third step is to identify the institutions through which effective interventions can be implemented. In spite of voluminous literature on longstanding debates amongst academicians, substantial research is still needed to answer the question at the very first step itself.

The empirical literature in the social sciences like economics have mostly assessed the effect of the economic development on environmental quality by treating the relationship as a unidirectional relation, without considering any plausible effect of environmental change on development. Lack of accounting for the other direction of the relationship, i.e. the effect of environmental change on indicators of development, generates biased results that obscures our understanding of the environment-development relationship and can generate misplaced policy priorities.

For example, it is often conjectured that rural poor damage the environment due to lack of resources or technological knowledge for adopting sustainable technologies. At the same time, these poor people are expected to be adversely affected due to damage to the natural resource base as they rely upon these resources for their sustenance. Hence it is tempting to infer that interventions that can generate environmental improvement will help in poverty alleviations as well. However an improvement in the environmental quality may not benefit the poor if it occurs by excluding the poor from accessing the natural resource.

Hence an analysis that assesses the effect of poverty on environment without accounting for the other side of the relationship, will present us an incomplete picture of the relationship. The

economic development in the developed countries might generate the impression that the environment-development relationship is indeed a unidirectional relationship, where the development process affects the environment, but economic progress does not appear to get affected by the environmental change. Although the long run implications of environmental change for the developed countries are difficult to predict and widely debated, we can see contemporaneous impact of environmental change in developing countries.

In developing countries, especially in the rural areas, where people are predominantly dependent on natural resource extraction for their sustenance there are strong feedbacks of environmental degradation on the lives of the poor. For instance, environmental deterioration may increase the demand for children to fetch water and fuel wood or manage livestock, which plays a vital role in providing economic support to a rural household. If rural population growth caused the environmental depletion to start with, then there may arise a reinforcing downward spiral wherein population growth depletes the environment, spurring yet more population growth, and so on.

Similar argument goes with rural poverty as well. Since the rural poor in developing countries rely heavily on natural resources like forest, water, pasture for their sustenance, they are extremely vulnerable to degradation of these resources. Financial and technological constraints facing the poor combined with weak property rights can result in degradation of the natural resource base on which they rely so heavily and the resource degradation in turn can further impoverish them, which can again create a vicious negative circle. This negative spiraling relationship between rural poverty and resource degradation has been termed as the 'poverty-environment nexus'.

Intermediating forces may operate to break or lessen this cycle, including migration and/or government and community action to stem environmental decline. In the light of anecdotal evidence of such strong inter-linkages between environment and development in rural areas of several developing countries academicians from varied disciplines are increasingly emphasizing the need for analyzing the interactive bi-directional relationship between environment and development issues in a unified framework. The lack of such analysis may be attributed to the difficulty in obtaining adequate data especially data on environmental quality and estimation challenges involved in estimating relationships involving bi-directional links.

Technological advancements are aiding the limited availability of traditional survey data from developing countries. For instance, if we want to focus on vegetative resources we can use satellite image based vegetation indices, like Normalized Difference Vegetation Index (NDVI), as an indicator of environmental quality. The Normalized Difference Vegetation Index provides a pure biological measure of vegetation quality. Normalized Difference Vegetation Index, is gaining wider applications in social sciences as there are several advantages of using satellite imaging data as an indicator of environmental quality.

First, satellite images provide more accurate and reliable data as they are free from the measurement errors associated with the traditional survey indicators like area under forest. Second, more frequent measures are available from satellite images. Normalized Difference Vegetation Index is constructed from 10-days composite images. In contrast, forest area surveys can be available on an annual basis at best. Third and the most important advantage of Normalized Difference Vegetation Index, is its ability to capture the difference in vegetative quality across space as well as time, which the widely used indicator, area under forest, fails to capture.

For example, a measure of area under forest cannot help us in distinguishing between one square kilometer of evergreen tropical forest and vegetation on an equal area in a semi-arid region. However Normalized Difference Vegetation Index, would take a much higher value for the former than the later. Similarly, if a designated forest area is degraded over time or old growth forest is replaced by new plantation, Normalized Difference Vegetation Index would reflect the change in form of a decline in vegetative index over time, while the traditional measure will not reflect any change, as the designated area under forest remains unchanged.

Hence, Normalized Difference Vegetation Index is clearly a better indicator of variation of vegetation quality across space and time. Using Normalized Difference Vegetation Index, data as indicators of environmental health and socio-economic indicators from districts of South, West and Central India, we have conducted systematic econometric analysis of the environment-population growth and environment-poverty relationship where we account for the bi-directional links using an estimation method called the generalized method of moments (GMM). India presents a great case to study the rural environment-development relationship.

Despite the impressive growth in GDP in this decade, population growth and rural poverty remain two of the most contentious issues for India that needs to be addressed for improving overall human development and these development indicators are also intricately associated with rural natural resource extraction that shapes the trajectory of the environmental quality. Among key findings of the population-environment analysis are that environmental decline spurs increased rural natural growth and increased net rural in-migration, which in turn prompt further environmental decline; environmental improvement spurs increased urban natural growth and increased net urban in-migration; and environmental scarcity spurs environmental improvement. The results from the poverty-environment analysis depict that rural poverty fuels vegetation degradation and vegetation degradation has a reinforcing negative effect on severity of rural poverty.

Hence the analysis provides evidence in support of a downward spiraling 'poverty-environment nexus' in the study region. These analyses highlight the use of technological advancement for overcoming traditional data limitations as well as utilizing the efficient estimation procedures for analyzing bidirectional relationships, which provide us consistent estimate of how environment and development indicators affect each other. And most importantly, such analyses help us in reiterating the urgent need for policy formulations that take into account the environment-development inter-linkages in order to make progress towards sustainable development.

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