The Virtues of Mundane Science

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I had when a Youth read and smiled at Pliny's Account of a Practice…to still the waves by pouring oil into the sea… The learned, too, are apt to slight too much the Knowledge of the Vulgar.

\- Benjamin Franklin[1]

Sustainable resource management has become the most hotly debated and challenging concept in environmental research and development policy. Based largely on a notion defined by the Brundtland Commission[2] a decade ago, calls for attention to sustainability have become de rigueur in the academic, conservation, and international development communities. Discussion of the issues involved have led to general agreement on four key points: policy action is often required in the face of uncertainty and prior to attaining a full scientific consensus; environmental policy must confront and address the political economy of resource exploitation; current economic theory provides an inadequate foundation for the validation and management of many ecosystems and natural resources; and interdisciplinary research is fundamental to understanding sustainability.[3] As it happens, one of the most important contributions made by the work to date has been to encourage coordination and collaboration across disciplines.[4] Nonetheless, one key element seems to be missing from the discussions about sustainable resource management: the scope those discussions ought to have. Unless that scope is broadened to include pressing but often overlooked problems – what one may call "the mundane" – research on sustainability and the policies conducive to it will continue to have only limited impact.

Academic definitions of "cutting edge" research topics exclude many of the issues that affect the largest number of people and have the greatest impact on the environment; everyday life is rarely the subject of research. For example, while new and emerging "high profile" diseases pose important challenges to medical science and public health, very different illnesses take the greatest overall toll on poor communities in developing nations. In central Kenya, for example, the overwhelming majority of medical cases reported – respiratory infections; skin, eye, and ear ailments; diarrhea; and urinary tract infections – stem largely from such commonplace factors as indoor air pollution from cooking fires and a lack of potable water and adequate food (see Table 1 on page 3).[5] Globally, acute respiratory infections, malnutrition, diarrhea, malaria, and measles account for a dramatic (if unexciting from a research standpoint) 71 percent of the 12.2 million deaths of children less than 5 years old. Finding solutions to these problems does not require less sophisticated research or environmental management, yet support for work on these mundane topics is weak relative to their importance to humans and the environment.[6]

Bias Against the Mundane

In Kenya and in other developing countries, the vast majority of health problems stem from "mndane" factors such as poor sanitation and indoor air pollution.

The prejudice against research on mundane topics has created a conceptual *cordon sanitaire* within many disciplines. In energy and development research, it appears as a disproportionate focus on advanced combustion systems, commercial fuels, and large centralized power facilities, even though more than 3 billion people rely on wood, charcoal, and other biomass fuels for the bulk of their energy needs.[7] In the agricultural sciences, it appears as an emphasis on genetic manipulation of crop varieties and idealized test-plot trials, in contrast to the relatively few on-farm studies of simpler technologies that reflect the actual constraints on subsistence and small-scale farmers.[8] In development and resource economics, it manifests itself in the focus on products traded in formal markets as opposed to those produced and consumed locally.[9] In development policy, it is seen in the emphasis on multibillion dollar institutional loans as opposed to support for small-scale, local-level credit ventures like Bangladesh's Grameen Bank, whose approach has proved very successful but which initially met with stiff resistance from the World Bank. In the humanities and social sciences, the *cordon sanitaire* shows up in the focus on "primitive," exotic, and distant societies as opposed to more proximate communities that combine often disparate populations in less tidy social, economic, and political networks.[10] Even in ecology, which has made important strides in practical conservation-oriented research, the prejudice is reflected in the preponderance of studies of "virgin" or climax forests as opposed to the complex successional mosaics associated with human influences.[11] These everyday topics are not wholly neglected, of course, but the attention they receive is small in relation to the critical role they play in determining whether particular resource-management practices are sustainable or not[12].

This article argues that the major obstacles to developing sound environmental practices are not principally technological (although expanding our research efforts in that area is critically important). Instead, the primary stumbling block is the lack of integrative approaches to complex systems and problems. A mundane example—efforts to improve wood- and charcoal-burning cookstoves—illustrates the important advances that are possible from integrating scientific, engineering, and social science research with very practical implementation programs. The article then discusses five broad misconceptions and prejudices that have impeded research on sustainable development. It concludes with a set of policy recommendations intended to generate debate and move mundane science from a peripheral to a central position in approaches to environmental and social sustainability.

Cookstoves for the Poor

The history of efforts to improve cookstoves provides an excellent case study of the role mundane science could play in promoting sustainable development. Though often lost to view, the use of biomass fuels is one of the most important issues on this area. Such fuels comprise 40 to 60 percent of total energy consumption, both industrial and domestic, in many developing nations. Household cooking alone accounts for more than 60 percent of total energy use in sub-Saharan Africa (exceeding 80 percent in several countries). Further, some poor families spend 20 percent or more of their disposable income on wood and charcoal or devote upwards of 25 percent of their household labor to collecting wood.[13] Inefficient combustion of these traditional fuels results in high concentrations of pollutants that cause acute respiratory infections. These infections, in turn, are the most pervasive cause of chronic illness in developing nations and the culprit in an estimated 4.3 million deaths per year.[14]

Table 1. Most Common Diseases, Laikipia District, Kenya, 1993

Disease	Cases Repor	Percentage	Proximate cause(s)
Respiratory infections	80,562	33.8	Cooking fires, smoking
Malaria	35,986	15.1	Living in marginal environments
Skin Diseases	19,959	8.4	Cooking fires, poor sanitation
Accidents	9,450	4.0	
Diarrheal Diseases	9,035	3.8	Poor sanitation
Urinary Tract Infections	8,655	3.6	Lack of basic medicine
Intestinal worms	8,204	3.4	Poor sanitation, poor food storage
Rheumatism	7,776	3.3	
Eye infections	6,831	2.9	Cooking fires
Ear infections	6,433	2.7	Cooking fires, lack of basic medicine
Other diseases	45,390	19.0	
Total	**238,281**	**100.0**	

SOURCE: Unpublished data compiled by the Laikipia regional office of the Kenyan Ministry of Health

Efforts to improve cookstove efficiency and reduce pollution (along with making the stoves inexpensive and easy to use) have a long and at times tortured history.[15] Many of the classic problems with development efforts—the overemphasis on technology in isolation, the inapplicability of laboratory trials conducted under ideal conditions, and insensitivity to gender and household dynamics—were encountered in cookstove design and dissemination programs. Progress has been made, however, by integrating the efforts of engineers, ecologists, sociologists, economists, government agencies, members of professional development organizations, and non-governmental and community groups. (*For details, see the box on page 4)* Stove programs have led to the dissemination of more than 120 million stoves in China (reaching a remarkable 60 to 70 percent of all households), several million stoves each in India, Sri Lanka, and Bangladesh, and hundreds of thousands in a number of African nations, including almost 1 million in Kenya, where more than 50 percent of urban households and 10 percent of all households, use improved stoves.[16] But steady and sufficient funding for such projects has been difficult to obtain: Fewer than 200 projects have been undertaken during the last decade, most with budgets of only thousands or tens of thousands of dollars.[17]

Funding constraints not withstanding, cookstove programs have been the focus of or impetus behind a remarkable array of scientific, economic, environmental, and methodological advances. Beyond the direct impacts on fuel use, indoor air pollution, and household economics, the detailed household analysis necessary to evaluate impacts and design optimal adoption strategies have contributed to innovations in participatory rural appraisal techniques and gender-sensitive and open-ended interviewing, as well as to new theories of networking, communication, and the diffusion of innovations.[18] Designing and disseminating better cookstoves has stimulated new work on low

IMPROVING COOKSTOVES

Worldwide, nearly 3 billion people cook their meals over open fires or on simple metal canisters that utilize biomass fuels such as wood, charcoal, dung, and crop residues.[1] In terms of energy use, these cooking systems are very inefficient, often delivering as little as 10 to 20 percent of the potential heat to the cooking pots. As a result, people in rural areas spend an inordinate amount of time gathering fuel, and forests and soils are suffering from excessive removal of combustible materials. Traditional cooking practices are also highly polluting, creating serious health problems in developing countries.

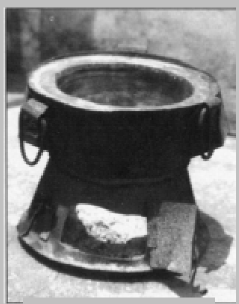
Since the 1970's, international aid organizations have been promoting the development of cleaner, more efficient cookstoves for the developing world, and a few hundred individual projects are now under way in more than 50 countries.[2] Although recent efforts have been reasonably successful, the process was by no means as simple and straightforward as originally anticipated. Professionals from a number of fields have had to overcome significant technical and social problems to design, produce, and disseminate cookstoves suitable for a variety of local conditions.

From an engineering standpoint, the new stoves had to meet four requirements: to maximize fuel combustion by maintaining a high temperature and an adequate supply of oxygen; to maximize radiative heat transfer to the pots by keeping them close to the flames; to maximize convection by circulating as much of the hot gases over the pots as possible; and to maximize conduction by adding insulation. In addition, to be readily accepted by the public, the stoves had to be inexpensive, easy to use, and adapted to local fuels, foods, and cooking methods.[3]

The development of the *jiko* stove in Kenya illustrates the difficulties inherent in meeting such diverse requirements. The *jiko* is a charcoal burning metal stove shaped like an hourglass, the upper portion of which has a ceramic insulating liner. It costs roughly $2 (U.S.), uses 1,300 pounds less fuel per year, and saves urban households as much as $65 per year (one-fifth the average annual income in Kenyan cities). The initial designs had serious flaws, however: The stoves were unstable, burned too hot, and their openings did not match the size of most cooking pots. In addition, they were too expensive for the rural households to whom they were primarily being marketed.

These problems were ultimately solved through a combination of additional technical research, consultations with local craftspeople and potential users, and the development of less expensive, wood-burning versions for rural households. Some of the earliest designs were done not by engineers but by aid workers with little technical background and the mistaken belief that appropriate technology was simple technology.[4] As it turned out, an extensive research program was necessary to determine the physics underlying such "simple" stoves, and even then the final design required much trial and error. Suggestions from users have been critical to developing a more efficient, commercially viable model capable of performing well in the home as well as in the laboratory.

Today, hundreds of local craftspeople manufacture some 20,000 stoves per month, and more than 1 million are in use throughout Kenya. Variants of the *jiko* are also finding their way into other African countries, and a diverse array of stove development efforts is under way in Asia and Latin America as well.



A jiko cookstove

1. For a more extensive account of cooking practices and stove development, see D. M. Kammen, "Cookstoves for the Developing World," *Scientific American*, July 1995, 64; and D. F. Barnes, K. Openshaw, and R. van der Plas, *What Makes People Cook with Improved Biomass Stoves?*, Technical Paper No. 242, Energy Series (Washington D.C.: World Bank, 1994).
2. Barnes et al., note 1 above, pages 39-44.
3. S. R. Connors, "Wood-Conserving Cookstoves," unpublished paper.
4. H. Krugman, *Review of Issues and Research Relating to Improved Cookstoves*, IDRC-MR152e (Ottowa, Canada: International Development Research Centre, 1987).

temperature combustion and materials science and provided pointers for technology dissemination efforts in a variety of fields.[19] Stove programs also contributed to the surprising discovery that indoor environments are the most important source of human exposure to pollutants in the rural area of many developing nations.[20] (These programs were part of a concerted effort to explore previously neglected small-scale or diffuse sources of trace-gas emissions, including rice paddies and the production of charcoal by pyrolysis—all of which turned out to be globally insignificant.[21]) This is a remarkably large amount of research to stem from a mundane topic and a modest investment.

Mundane science programs such as those involved in cookstove research, development, dissemination, and analysis are rare but not unique. The development of oral rehydration therapy (ORT) for cholera and other diarrheal diseases involved a similar mix of laboratory work on the linkages between glucose and electrolyte transport in the small intestine and field studies on the misconceptions in treatment strategies.[22] Like cookstove research, "the history of ORT reveals an extraordinarily long path to discovery followed by an ongoing struggle for legitimacy and implementation… and [illuminates] the conflicts between 'high' and 'low' technology."[23]Another example, that of "mundane economics," is described at the end of the article in the box on Grameen banking.

Five Fallacies

As the quotation from Benjamin Franklin at the beginning of this article attests, lack of attention to mundane science is a long-standing problem. It shows up in contemporary research generally, and in environmental science and resource sustainability work in particular, in the form of five key fallacies: Mundane science is antiscientific in spirit; the greatest overall returns come from basic rather than applied research; at best, mundane science is simply an application distinct from (and potentially in conflict with) basic research; mundane science is subjective, while basic science is objective; and mundane science has more to do with society than science.

The first fallacy is that an emphasis on mundane science amounts to a rejection of scientific and technological progress. In reality, the dichotomy between science and mundane problems has more often been due to mainstream scientists' lack of interest in such problems than to attacks from the "fringe". A good example of this is the "appropriate technology" (AT) movement spearheaded by E.F. Schumacher, which focuses on the design and practical implementation of inexpensive windmills, latrines, bicycles, and other tools of everyday life, particularly to help the poor.[24] Academics and development planners pursued AT in the years following the OPEC oil embargoes, but it later dropped out of the international development mainstream despite its great relevance and cost-effectiveness. Instead of emerging as a research and policy ally of development planners, AT necessarily evolved into an opposition movement.[25]

The perception that efforts to broaden the mainstream view amount to a rejection of science is belied by such examples as the "peasant science" movement in the Philippines called MASIPAG. This alliance of farmers has rejected the packages of rice varieties, fertilizers, pesticides, and directed development offered by the International Rice Research Institute (IRRI) because these packages give them too little control over the management, quality, and timing of their yields. Instead, MASIPAG farmers, in collaboration with researchers from the University of the Philippines in Los Baños, have adapted modern methods of crop hybridization to develop rice varieties that meet their own criteria for cost, yield, disease resistance, soil impact, and taste.[26] In other words, MASIPAG farmers have employed IRRI's own technology to meet local needs and development concerns not satisfactorily addressed by IRRI. This example shows that rejecting particular scientific programs, which are embedded in particular economic and political contexts, is not a rejection of science per se.

Researchers often fail to understand the sophistication of traditional practices such as this Pakistani villager's use of different biomass fuels for different purposes.

The second fallacy assumes that science is a zero-sum game where investment in anything but traditional basic research reduces the chance of breakthrough discoveries. This view is based more on a culture of entitlement than on scientific reality, however. Greater applicability of scientific research has historically not only generated new hypotheses and research directions but has also increased financial and political support for research in general. The popularity of (and financial support for) most scientific fields is tied to their periods of practical importance. Examples include petrology and geology (following the demonstration of accurate methods for locating subterranean natural resource deposits), nuclear physics (following the Manhattan Project), and molecular biology and computer science (following the commercialization of applications in both of these fields).[27]

Worldwide, more than 3 billion people cook over open fires or highly inefficient and polluting stoves.

The third fallacy–the perceived tension between basic and applied research–is partly a product of post-World War II research and development policy formulated by Vannevar Bush, director of the U.S. government's wartime Office of Scientific Research and Development.[28] Bush constructed his famous blueprint for postwar science policy around the ideas that "basic research…is the pacemaker of technological progress" and "applied research invariably drives out pure."[29] In part because of this formulation, basic research has flourished over the past

50 years while applied research has lagged behind: The (basic-to-applied) funding ratio in the federal budget has increased from 1:3 50 years ago to 1:1 today.[30] This reallocation of funds has contributed to the pervasive distinction between esoteric science and mundane implementation. Development work generally, and that on sustainable development in particular, is now done primarily by professional practitioners and consultants with the support of a relatively small and fragmented research corps.[31]

The fourth fallacy is that development outcomes (both successes and failures) are essentially technological rather than sociological in nature. For example, even though development efforts in the Third World have generally failed to assist the poor and protect the environment, development analysts persist in seeing these outcomes as accidental or the result of noncompliant subjects. Critics argue that development fails to attain its explicit ends because it usually benefits a favored few (by opening new avenues for state control of natural resources and extending the reach of government bureaucrats and multinational corporations) rather than the majority.[32] Another problem is that rural development and modernization commonly undermine local resource management institutions before new ones are ready to replace them. This creates a window of *mis*opportunity during which time enormous resource degradation can occur.[33] Examples include the gold rush in the Amazon that led to forest destruction, massive mercury poisoning of rivers, and epidemics of new diseases among indigenous residents.[34] Because such consequences are unintended, however, they are generally perceived as accidental rather than systemic; as a result, they receive little attention.

There is a related tendency among mainstream analysts to treat the development process as apolitical. Although the international development community presents “development” as a universal good, there are winners and losers in virtually every intervention.[35] The normative nature of the development enterprise inhibits the feedback that would reveal this. Much of the research and writing done by the development community, for example, appears only as a “gray” literature of internal project reports, which are not subjected to scrutiny and debate in peer-reviewed journals. This practice contributes to the view that topics pertaining to sustainable development lie beyond (or beneath) the proper scope of science.

As part of the “peasant science” movement, rice farmers in the Philippines have adapted modern hybridization methods to develop their own varieties.

One such topic is the ad hoc adaptations of local communities to their changing physical and social environments. Javanese rice farmers, for instance, routinely mix different pesticides together to lower costs and raise potency–a practice that is not only not part of the prescribed technological regimen but actually violates government regulations.[36] Because the farmers are not supposed to be doing this, however, development researchers have not devoted much time to studying this practice.

The fifth fallacy is that the mundane aspects of development have more to do with society than with science. For example, the vast majority of the research related to the Green Revolution has focused on food production rather than storage and postharvest distribution because the former is considered part of science while the latter is not–even though as much as 40 percent of some harvests is lost to spoilage, corruption, and inadequate infrastructure.[37] This preference for research on plant hybridization and molecular biology instead of the mundane issues of food storage, equity, and security epitomizes the technical-fix approach to science and development. Even more important, it suggests why the line between science and nonscience has been drawn where it has: Mundane questions often threaten the status quo, while esoteric issues do not. The most threatening questions of all, of course, are why this is the case and what can be done about it.

Lifting the Veil

The case of cookstoves is representative of a number of initiatives in mundane science, including the design of delivery systems for oral rehydration therapy, participatory methods of rural resource accounting and management, and microloans for the poor.[38] The challenge is to legitimize and expand this philosophy and the type of work to which it leads.

There are a number of ways to give such initiatives a larger role in research and policy decisions.[39] These include giving much more support to academic-industry and academic-practitioner partnerships; extending academic boundaries to encompass the entire range of human-environment interactions; breaking down the often antagonistic division between development professionals and academia; instituting a more open review process for development publications, projects, and institutions; removing the barrier between development planners and the intended beneficiaries or local populations;[40] and addressing the frequently counterproductive tension between pure and applied research. The primary obstacles to implementing these proposals are cultural and institutional, not scientific. Expanding our commitment to mundane science requires that we overcome a Catch-22, however: Mundane issues generate little interest until a crisis emerges, at which point a solution is expected at once because the problem appears to be so simple. Unless we overcome the bias against mundane science, we will be wedded to shortsighted, partial solutions to emerging issues in development and the environment. Serious research requires a commitment to sustained periods of training, preparation, and support, which mundane science rarely receives. A valuable principle to use in the design and evaluation of sustainable development initiatives is that of use-inspired basic research, which–however basic the science involved–has a clear focus on applications.[41] The robust output of Benjamin Franklin himself–spanning the fields of architecture, fluid dynamics, physics, shipbuilding, navigation, and weather forecasting–is testament to the benefits of combining mundane and theoretical research.

MUNDANE ECONOMICS: GRAMEEN BANKING

An illuminating example of the application of mundane science to sustainable development is provided by the Grameen Bank of Bangladesh, which pioneered the extension of small amounts of credit to the poor.[1] The bank was the brain child of Muhammad Yunus, a professor of economics in Bangladesh. Yunus began by reversing the traditional relationship between the poor and large lending institutions: Instead of asking how to make the poor more creditworthy, he asked how banks could be more responsive to their needs. Whereas the assumption in so-called poverty alleviation programs was (and often still is) that the poor cannot be trusted with money, Yunus assumed that they could and that society was at fault for not making this possible. At the heart of the Grameen Bank's solution to the problem is the "lending circle," typically a group of five women who jointly manage and guarantee their loans. Through these circles, the bank first educates borrowers about money management and small-scale economic development and then makes small loans to them, usually no more than $20 (U.S.) per household the first time. When the borrowers have repaid these loans, they become eligible for larger and larger ones, culminating in housing loans of several hundred dollars. In all cases, however, borrowers proceed at a pace determined by their own capacity, not the needs of the lender. The combination of the Grameen Bank's trust in people, its education program, and its reliance on lending circles has resulted in a phenomenally high 98 percent loan repayment rate, which exceeds the rate received by commercial banks even in developed countries (to say nothing of that of multilateral development banks). Indeed, the Grameen Bank's approach to alleviating poverty has been one of the most successful in contemporary development history. Whereas the bank began with loans of no more than $50 each to some 20 families, it now operates in one-half of Bangladesh's 30,000 villages, making loans of more than $400 million annually. Furthermore, the bank's approach has been emulated in many other developing (as well as some developed) countries.

Grameen's basic strategy is now being extended beyond banking, providing a new model for development. Yunus and his colleagues are planning to adapt the concept of collective resource management to meet a variety of needs, including giving the poor access to modern telecommunications technology (e.g., cellular phones and the Internet) and providing solar and wind energy infrastructure to isolated or neglected communities.[2] Such projects, of course, are met with skepticism–just as the Grameen Bank's lending policies initially were. Indeed, the traditional banks in Bangladesh have never stopped doubting Grameen's viability. Over time, however, their doubts have become increasingly irrelevant.

Grameen's expansion of the market for sophisticated technology among the poor will make it even easier for them to obtain such technology. Historically, every time sales of photocells, cellular phones, windmills, laptops, and so forth have doubled, unit process have fallen roughly 20 percent.[3] Grameen has opened the door to these and other technologies and services among the poor, which, combined with improved access to credit, will spur locally controlled (as opposed to aid-driven) development and (ideally) local commercial activities.

The Grameen approach, of course, is not without its problems. Ironically, some of them stem from its very success and the tremendous interest it has generated. In recent years, there has been a flurry of popular articles, academic studies, and development reports on the Grameen approach, culminating in a Microcredit Summit in Washington D.C., in February 1997, which set a goal of "expanding microcredit to 100 million of the world's poorest families."[4] This ambitious goal will require a huge expansion in human capital. As the Summit Declaration noted,

[f]ield experience has shown that one field worker can serve 200 borrowers. Assuming this staff-client ratio, 500,000 field workers will be needed in order to serve 100 million clients. If one assumes a dropout rate during training of 15 percent, the total number of intakes of trainee field workers should be 575,000.[5]

While the Grameen Bank's achievements show that village-level organizing on this scale is possible,[6] they also suggest that not just any organization can accomplish it. The Grameen Bank grew slowly over a period of 20 years, and a number of the original borrowers are now top managers. Now, however, the bank is attracting attention–and funding–from the world bank, large commercial banks, and U.S., Japanese, and European aid agencies. Their desire to inject hundreds of millions of dollars into small-scale lending may come without the patient, two decade build-up of human capacity, educational programs, and local accountability that have characterized Grameen's lending. Too often, conventional loans come with demands for instant returns and sound-bite successes, a constraint that precludes the careful learning so essential to Grameen's success. In fact, the potential for trouble is not confined to the big lenders, as the declaration of the Microcredit Summit makes clear:

It is important to recognize that many NGO's will need to dramatically change their approaches, capabilities, and systems if they are to be successful in microcredit. Microcredit needs to be approached as a socially responsible business, not as charity or social welfare. It is difficult to incorporate a successful microcredit program into an institution that has a relief, social service, or paternalistic approach or helping the poor.[7]

If properly implemented, however, the Grameen concept could serve as a basis for community development in which many of the recent advances in technology and participatory planning come together. This simple–and classically mundane–concept, adapted and developed through a humble and applied process, offers fresh insight into–as well as a theoretical challenge to–much of traditional development economics.

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1. Current information on microcredit activities and the Grameen Bank may be found at http://webwrite.com/partners-bsbdc/micrnews.htm.
2. Ibid.
3. L. Argote and D. Epple, "Learning Curves in Manufacturing," *Science* 247 (23 February 1990): 920.
4. See the Microcredit Summit Declaration and Action Plan at http://www.igc.apc.org/results/Declaration.htm, preamble, paragraph 1.
5. Ibid.
6. Ibid.
7. Ibid.