

1. Overview and Summary

This book recognizes that sustainable development is a primary challenge of the 21st century (with poverty alleviation as the main goal), and sets out a framework called “Sustainomics” developed over the past 15 years to meet that challenge. Sustainable development is broadly defined here as “a process for improving the range of opportunities that will enable individual human beings and communities to achieve their aspirations and full potential over a sustained period of time, while maintaining the resilience of economic, social and environmental systems”.

The main message of this volume is optimistic – although the problems are serious, an effective response can be mounted, provided we begin immediately. Sustainomics seeks to show us the first practical steps in making the transition from the risky business-as-usual scenario to a safer and more sustainable future.

Sustainomics is “a transdisciplinary, integrative, comprehensive, balanced, heuristic and practical framework for making development more sustainable.” Unlike other traditional disciplines, it focuses exclusively on sustainable development. Thus, the main principle of the framework seeks to make ongoing and future development efforts more sustainable, as a first step towards the ultimate goal of sustainable development. Other key principles stress: (a) balanced consideration of the three dimensions of the sustainable development triangle (social, economic and environmental); (b) better integration by transcending conventional boundaries imposed by discipline, space, time, stakeholder viewpoints, and operational needs; and (c) practical application of innovative methods and tools throughout the full cycle from data gathering to policy implementation and feedback.

This volume also seeks to clearly illustrate the methodology with empirical case studies that are practical and policy-relevant over a wide range of geographic and time scales, countries, sectors, ecosystems and circumstances. Every application does not necessarily give equal weight to all elements of the triangle (i.e., social, environmental and economic). Many cover all three aspects, while others primarily address two aspects (e.g., economic and environmental), or a single aspect (e.g., economic cost-benefit analysis, social multistakeholder consultative process, etc.), with the other aspects covered less prominently. In general, the book shows how a broad array of sustainomics-compatible methods and tools could be applied simply and practically to a variety of problems, to make development more sustainable.

I have tried to make the book both accurate and readable. However, because of its wide coverage and length, some parts may seem complex and others too simple, depending on the academic training and disciplinary background of the reader. A fair balance is maintained between theory and applications, recalling the famous rebuke by Nobel-Laureate Wassily Leontief (1982): “Page after page of professional economic journals are filled with mathematical formulas leading the reader from sets of more or less plausible but entirely arbitrary assumptions to precisely stated

but irrelevant theoretical conclusions”. Generally, the analytical sections are rigorous but relatively free of technical jargon, while mathematical and other details are provided in annexes. The case studies have been simplified to show as clearly as possible, the practicality and policy-relevance of the underlying principles involved. They are presented in decreasing order of geographic scale -- from global to local applications. The extensive bibliography should be useful to those who wish to research specific topics further. I hope that the book will appeal to a wide audience, including students, researchers, teachers, policy analysts, development practitioners, public and private sector decision makers, concerned citizens and all stakeholders.

To conclude, sustainomics is put forward as an innovative transdisciplinary framework (or transdiscipline), based on a holistic set of key principles, theories and methods. It draws on many other approaches and techniques, because no single traditional discipline can cover the vast scope and complexity of sustainable development issues. The advantages and shortcomings of sustainomics are frankly laid out, with the expectation that future contributions by other potential “sustainomists” will rapidly build on the strengths, remedy gaps and inconsistencies, and further flesh out the initial framework and applications.

1.1 OUTLINE OF THE BOOK

Part I of the book contains four chapters covering the introduction and fundamentals. Chapter 1 provides a broad overview of the entire volume. The first section outlines the various chapters and provides a road map for the reader. Next, we set out the rationale and motivations for the book, including key sustainable development challenges (especially poverty), major global agreements on sustainable development, lessons of history and future scenarios, and vision for a practical way forward. A brief history and introduction to the fundamental elements of sustainomics are provided, followed by a review of key ideas. The chapter ends with selected information on the status of modern development.

Chapter 2 lays out the basic principles, concepts and methods of sustainomics in greater detail. A practical approach based on *making development more sustainable*, or MDMS, is described, as an alternative to pursuing abstract definitions of sustainable development. The sustainable development triangle, comprising the social, economic, and environmental domains is introduced, and the driving forces and concepts of sustainability underlying each viewpoint are explained. The integration and synthesis of these three viewpoints is facilitated by two complementary approaches, based on the concepts of optimality and durability. The poverty–equity–population nexus and linkages between economic efficiency and social equity are discussed. A variety of practical analytical tools are outlined, to implement the sustainomics framework – including the Action Impact Matrix (AIM), sustainable development assessment (SDA), cost-benefit analysis (CBA), multi-criteria analysis (MCA), etc. It is important to select relevant, time and location specific indicators of sustainable development. The need to harmonize

development with nature, and restructure the pattern of growth is explained, especially in developing countries, where poverty alleviation will require continued increases in income and consumption.

In Chapter 3, we explore the economy–environment interface (and related social linkages). Economic CBA is a key element of SDA and the project cycle. Basic concepts of CBA are set out, including decision criteria, efficiency and social shadow pricing, and measurement of costs and benefits. Practical techniques for economic valuation of environmental assets and services play a key role in incorporating externalities into traditional CBA. When such economic valuation is difficult, MCA helps to make trade-offs among disparate objectives. Key issues like discounting, risk and uncertainty are discussed. The two-way links between economywide (macroeconomic and sectoral) policies and environment (and social) issues are outlined. The incorporation of environmental considerations into the conventional system of national accounts is explained.

Chapter 4 expands on the social and ecological inter-linkages, which play a key role in determining the use of natural resources. The Millenium Ecosystem Assessment (MA) conceptual framework and cyclic interaction between the ecological and socio-economic domains is summarized, including the main ecosystem services which sustain key components of human well being. Ecological cycles involving birth-growth-decay-death-regeneration help us understand ecosystem dynamics. Property rights regimes determine how socioeconomic forces interact with environmental resource, especially in the case of traditional societies and native peoples who are heavily dependent on ecological resources, as well as the landless poor who subsist in degraded areas. Finally, environmental and social assessments are described, as important tools that complement economic assessment (CBA) – all three are key elements of SDA.

Next, we turn to applications of sustainomics at various scales: global and transnational, national and macroeconomic, sub-national sectoral and system, and project and local. Part II of the book contains two chapters (5 and 6) with case studies covering the global and transnational levels.

In Chapter 5 the sustainomics framework is applied to study the circular linkage between two global level issues -- climate change and sustainable development. The role of adaptation and mitigation are analysed, and several applications are provided. First, alternative climate change mitigation response strategies are assessed in terms of optimality and durability. Next, we examine the interplay of equity and efficiency in joint implementation (JI) and emissions trading, between Annex 1 and non-Annex 1 countries. The final case study describes how climate change might interact with sustainable development at the national level – by analysing greenhouse gas (GHG) mitigation prospects in Sri Lanka.

Chapter 6 examines a unique trans-disciplinary, international scientific dialogue within the Intergovernmental Panel on Climate Change (IPCC), describing how researchers are analysing climate change and sustainable development links. Then, the AIM tool is used to explore two way linkages between two international

activities -- the millennium development goals (MDGs) and the findings of the MA. Finally, we examine the practical functioning of a transnational, multi-stakeholder, multi-level consultative process, involving the UNEP Dams and Development Programme (DDP).

Part III of the book comprises three chapters (7, 8 and 9), covering case studies of sustainomics at the countrywide and macro levels, which deal with a wide range of countries, policy issues and models.

Chapter 7 reviews past research on the sustainability of long term economic growth, including economy–environment linkages. Some stylized facts about environmental and social impacts of growth-oriented macroeconomic policies are summarized. Unforeseen economic imperfections can interact with growth to cause environmental and social harm. An environmental-macroeconomic analysis confirms that second-best remedial measures could help to limit the damage. Environmental concerns may be introduced into the standard static IS-LM macroeconomic model. The role of green accounting and concepts such as genuine savings are discussed. The AIM approach plays a key role in environmental-macroeconomic analysis. A “policy-tunneling” model shows how elimination of economic imperfections permits continued growth while limiting environmental and social harm. Finally, some of these ideas are illustrated through a case study of Brazil. A combination of sectoral and macroeconomic models are used to examine the effects of growth oriented strategy pursued by the Brazilian government during the past decades, on a range of sustainable development issues like poverty, employment, urban pollution and deforestation in the Amazon region. Ideas for future research are discussed.

Chapter 8 explores two different theoretical approaches to making development more sustainable at the national macroeconomic level. The literature on the relationship between optimization and sustainability in growth models is reviewed. First, a sustainomics-compatible mathematical model examines the conditions under which development paths focusing on optimal economic growth, might also be made more sustainable. The model is numerically solved using stylized data. Second, a theoretical model looks at the circumstances that may justify the use of second best adjustments to macroeconomic policies, to compensate for pre-existing economic distortions that give rise to environmental harm. Three developing world examples (Botswana, Ghana and Morocco) show how macroeconomic policies might combine with local imperfections to harm the environment, and appropriate remedial measures are discussed.

Chapter 9 focuses on computable general equilibrium (CGE) models. First, we apply the ECOGEM model, to assess economic, environmental and social policy linkages in Chile. The model systematically and holistically analyses different economy-wide policies and their impact on the Chilean economy. It combines different environmental and social policies so as to enhance positive cross effects or to mitigate the negative side effects of any single policy. Complex interrelations between the diverse sectors and agents of the economy are captured. Winners and

losers are identified, but the results obtained are not always obvious, i.e., indirect effects are also relevant. In the second example, a static CGE model is applied to study the effects of macroeconomic policies on deforestation in Costa Rica. The results support the more conventional partial equilibrium approach that establishing property rights tends to decrease deforestation, because such rights allow forest users to capture the future benefits of reduced logging damage today. Findings about effects of discount rate changes also parallel results of partial equilibrium models -- higher interest rates promote deforestation, and vice versa. The CGE approach also identifies the indirect effects of intersectoral links, and shows the importance of pursuing sectoral reforms in the context of growth. A dynamic CGE model of Costa Rica, where the value of forest conservation, capital accumulation, and interest rate are endogenized, gives the same results as the static CGE model.

Part IV of the book contains five chapters (10 to 14) describing case studies and applications of sustainomics at the sub-national and meso levels within several countries -- involving energy, transport, water, ecological and agricultural systems, and resource pricing policies.

In Chapter 10, we begin with a general review of links between energy and sustainable development, including a worldwide assessment of energy sector status and issues. Next, the sustainomics approach is used to develop a comprehensive and integrated conceptual framework for energy-related decision making framework called sustainable energy development (SED), which identifies practical sustainable energy options by taking into account multiple actors, multiple criteria, multi-level decision making, and policy constraints. The methodology is applied to demonstrate how social and environmental externalities could be incorporated into traditional least-cost power system planning in Sri Lanka, using both CBA and MCA. The study is relatively unique in its focus on assessing environmental and social concerns at the system level planning (including technology choices among hydro, oil, coal and renewable energy based generation), as opposed to the more usual practice of carrying out such analyses only at the project level. Sustainable energy policies for Sri Lanka are identified. Another case study applies SED to the South African energy sector, using multi-criteria analysis to assess the social, economic and environmental trade offs arising from policy options relating to electricity supply and household energy use. Finally, long term UK electricity expansion options are examined, to show that decentralized energy may be more sustainable than centralized generation.

Chapter 11 starts by reviewing generic sustainable transport priorities. Then, we examine how transport policy could be made more sustainable in Sri Lanka, including the analysis of fuel pricing policy, alternative fuel choices, and a range of transport projects. Two classic externalities are discussed. First, the detrimental impact on health from local air emissions are estimated using the benefit transfer method, and the specific health benefits of introducing unleaded petrol are assessed. Second, the effects of traffic congestion in the city of Colombo are studied, including estimation of the cost of time wasted. Several specific infrastructure

projects and other measures for reducing congestion are analysed, and an overview is provided of sustainable transport policy options for Sri Lanka.

Chapter 12 explores how to make water resource management more sustainable. The first section describes the natural hydrological cycle and how interventions have affected it. Next, water and development linkages are examined, including a review of the global status of water resources, water shortages and rising costs, poverty issues, and sustainable livelihoods. A comprehensive framework for sustainable water resources management and policy (SWAMP) is outlined, which parallels the sustainable energy development (SED) approach of Chapter 10. The SWAMP methodology is practically applied to a typical water resources project involving groundwater for urban use in Manila, Philippines. The case study analyses the effects of environmentally harmful externalities like aquifer depletion, saltwater intrusion along the coast, and land subsidence, and then identifies remedial policy measures. Finally, another case study demonstrates a simple, low-cost, socially acceptable, and environmentally desirable approach to purifying drinking water and reducing waterborne diseases that has yielded significant economic, social and environmental gains to poor villagers in Bangladesh.

Chapter 13 sets out case studies dealing with both natural and managed ecological systems – i.e., forests and agriculture, respectively. First, we analyse the management of megadiversity natural ecosystems in rainforests to identify generic policies that make forest management more sustainable. Next, a case study of Madagascar is presented to achieve a better understanding of the specific environmental and socioeconomic impact of national parks management policies on tropical forests. Relevant policy implications are drawn. Various techniques are used to economically value damage to forests and watersheds, timber and non-timber forest products, impacts on local inhabitants and biodiversity, and ecotourism benefits. In a second case study, we examine the potential impacts of climate change on managed ecosystems (agriculture) in Sri Lanka. A Ricardian model is used to estimate the past effects of natural variations in both temperature and precipitation. Then, several scenarios of future climate change are imposed to assess future agricultural production. The harmful impacts of rising temperatures generally dominate the beneficial effects of increased precipitation. Policy conclusions are drawn for sustainable agricultural policy in Sri Lanka.

Chapter 14 examines natural resource pricing policy issues within a national economy -- the economics of both renewable and non-renewable resources are discussed. The principles of sustainable pricing policy (SPP) are explained and applied to energy, based on the sustainable energy development framework (Chapter 10). First, economic principles are used to determine efficient energy prices which lead to economically optimal production and consumption of energy. Next, environmental aspects may be incorporated by economically valuing relevant impacts (Chapter 3). Finally, efficient prices may be made more sustainable by adjusting for economic second best distortions, social consideration like affordable (subsidized) prices to meet basic needs of the poor, and other general policy

objectives such as regional or political consideration. The closing section describes how the SPP framework might be used for pricing of other natural resources like water, and examines water-specific issues.

Part V of the book contains two chapters (15 to 16) dealing with case studies and applications of sustainomics at the project and local levels, that cover topics like hydropower, solar energy, water supply, sustainable hazard reduction and disaster management, and urban growth.

Chapter 15 commences with the sustainable development assessment of small hydro projects in Sri Lanka, by applying multi-criteria analysis to economic, social and environmental indicators. The second case study analyses new and renewable energy projects and national energy policy in a typical developing country. It highlights the use of different policy tools (including the interlinked shadow and market prices) to influence human behaviour and ensure more sustainable energy use – based on solar photovoltaic (pv) energy for agricultural pumping. Then, rural electrification projects in Sri Lanka are analysed with a focus on new and renewable energy technologies, and rural energy priorities are set out.

Chapter 16 explains how the natural hazards become major disasters, because of heightened vulnerability, often due to prior damage inflicted by unsustainable human activities. A practical framework is presented for mainstreaming sustainable hazard reduction and management (SHARM) into national development – involving the stages of relief, rehabilitation and reduction (planning, preparedness and prevention). The two-way linkages between hazards and sustainable development are analysed. These ideas are illustrated by a case study that assesses the impacts of the 2004 Asian tsunami in India, Indonesia, Maldives, Sri Lanka and Thailand. A comparison of the Tsunami impacts on Sri Lanka, and Hurricane Katrina on New Orleans, raises important questions about the role of social capital in coping with disasters. Issues concerning the sustainability of long term growth in Asian cities are described, including policy options to address these problems -- especially in the rapidly expanding mega-cities. The vulnerability of cities to natural hazards and environmental degradation are analysed and illustrated through a case study of floods in Rio de Janeiro. Finally, we examine two examples of how urban development is becoming more sustainable in developed nations – in Canada and the European Union.

1.2 RATIONALE AND MOTIVATIONS

This section summarizes several important motivations underlying this volume.

1.2.1 Addressing key sustainable development challenges today

The first and main rationale is the urgent need to address key sustainable development challenges of the 21st century, described below:

Poverty, inequity and human well-being

Key sustainable challenges that exist today are as follows (see also Box 1.1).

- alleviating *poverty* for the 1.3 billion people who live on less than \$1 per day and the 3 billion people who live on less than \$2 per day.
- providing adequate *food*, especially for the 800 million people who are malnourished today -- this will require food production to double in the next 35 years without further land and water degradation.
- supplying *clean water* to the 1.3 billion people who live without clean water, and provide *sanitation* for the 2 billion people who live without sanitation.
- supplying adequate *energy* for basic needs, and providing access to the 2 billion people who live without electricity.
- providing a *healthy environment* for the 1.4 billion people who are exposed to dangerous levels of outdoor pollution and the even larger number (especially women and children) exposed to dangerous levels of indoor air pollution and vector-borne diseases.
- providing *safe shelter* for those who are vulnerable to natural disasters and those that live in areas susceptible to civil strife.

Future climate change will exacerbate all the above problems impacting most severely on the vulnerable poor, who are least responsible for the problem. Further, poverty is worsened by high levels of global inequality. At the turn of the century, the richest 20% of the world population (1.2 billion people) consumed almost 85% of global output or about 60-fold more than the poorest 20%. Highly inequitable income distributions also persist within many countries (World Bank 2000). In Brazil and South Africa, the ratios of national income received by the richest and poorest 10% of the population were 53% and 42% respectively. Corresponding figures for India and USA were 10% and 14%.

Recent research opens up promising new prospects to make both consumption and production more sustainable (Munasinghe et al, 2009). Anthropogenic carbon emissions typify modern resource over-exploitation, while exactly the same arguments could be made for other resources like energy and water. The consumption of 1.4 billion richer humans today accounts for some 75% of total emissions. Instead of viewing these consumers as part of the problem, they should be persuaded to contribute to the solution (Munasinghe 2010).

Making consumption patterns more sustainable through simple actions will reduce carbon emissions significantly – e.g., using energy saving light bulbs, washing laundry at lower temperatures, eating less meat, planting trees or using more fuel efficient cars. Such actions will not only save money, but are also faster and more achievable than many so-called big technology solutions. Furthermore, families that purchase low-carbon products and services can stimulate innovation in businesses, while encouraging politicians to take radical steps towards a lower carbon world. Many existing “best” practice examples can be replicated widely,

while innovative businesses are already developing the future “next” practice products and services.

Box 1.1 Summary of millennium development goals (MDG)

The UN Millennium Development Goals ([MDG 2009](#)) provide a basis for measuring global progress towards sustainable development. In 2000, all countries agreed on 8 development goals that would serve as targets for 2015.

Goal 1: Eradicate extreme poverty and hunger, by halving the population (1) whose income is less than a \$1/day; and (2) who suffer from hunger; between 1990 and 2015.

Goal 2: Achieve universal primary education, by ensuring that all children will complete full primary schooling by 2015.

Goal 3: Promote gender equality and empower women, by eliminating gender disparity in primary and secondary education preferably by 2005 and in all levels of education no later than 2015.

Goal 4: Reduce child mortality, by lowering the under-five mortality rate by two-thirds between 1990 and 2015.

Goal 5: Improve maternal health, by reducing maternal mortality rates by 75% between 1990 and 2015.

Goal 6: Combat HIV/AIDS, malaria and other diseases, by reversing the spread of HIV/AIDS, and the incidence of malaria and other major diseases by 2015.

Goal 7: Ensure environmental sustainability, by (1) integrating sustainable development into country policies and program and reversing the loss of environmental resources; (2) halving the population without sustainable access to safe drinking water and basic sanitation by 2015; and (3) achieve a significant improvement in the lives of at least 100 million slum dweller by 2020.

Goal 8: Develop a global partnership for development, by (1) improving trading and financial systems; (2) addressing the special needs of least developed countries; (3) addressing the special needs of landlocked countries and small island developing states; (4) dealing comprehensively with the debt problems of developing countries; (5) developing and implementing strategies for decent and productive work for youth; (6) providing access to affordable, essential drugs in developing countries; and (7) making new technologies available in cooperation with the private sector, especially information and communications.

Energy services (not explicitly identified), are essential to achieve the MDGs (UNDP 2005c).

A “virtuous cycle” of mutually supportive sustainable consumption and production can cut across national boundaries and interests. It will complement the traditional top down emphasis on action by governments, who lack political will to take bold steps. Finally, the rich must not only help the many billions of poor to emerge from poverty, but also set a better example that will encourage the latter to seek more sustainable consumption paths.

Globalization

Globalization is a major sustainable development challenge. There are many benefits, but the focus here is on identifying potential risks, in order to address the underlying problems. This phenomenon has been driven by two fundamental forces - underlying technological change, which has accelerated the integration of markets, and the freer movement of raw materials, goods, services, labour, capital, information and ideas. For example, during 1950-98 world exports of goods increased 17-fold (from \$311 billion to \$5.4 trillion), the global economy expanded six-fold; and international tourist arrivals increased 25-fold (from 25 million to 635 million); during 1970-98 the number of transnational corporations grew eight-fold (from 7,000 to 54,000); and during 1960-98 the number of non-cellular telephones lines linked directly to the global phone network grew eight-fold (from 89 million to 838 million) (French, 2000).

Globalisation also implies a gradual weakening of the influence of individual national governments. While this process may improve opportunities for economic growth, recent research has pointed out that it fails to provide equal opportunities either across or within nations (Ehrenfeld 2003). In addition, globalization is associated with significant social and environmental costs that are rarely assigned monetary values and often fall on the poor and disadvantaged, while the benefits accrue mainly to the wealthy.

The environmental costs of globalization (due to pollution of air, land and water, and depletion of natural resources) are mostly associated with increased free trade across borders and industrial activities. Pollution may shift to (mainly developing) countries where environmental protection laws and property rights are not adequately enforced or do not exist. Meanwhile, the burden of global environmental issues like climate change will fall disproportionately on poorer countries that have contributed least to the problem. Furthermore, these countries are less well equipped to deal with such impacts due to lack of financial and technical resources (IMF 2002). Biodiversity loss has worsened due to the wave of globalization and stimulation of unsustainable development activities, reduction of forests, over-fishing, land degradation etc. (MA 2005a). Loss of biodiversity in turn impacts on sustainable development, as it undermines ecosystem health and reduces resilience (Munasinghe 1992a). For example, globalization has promoted monoculture agricultural practices that favour commercially successful crops, and reduce the diversity of less successful crop varieties.

The social costs of globalization often remain hidden and indirect before surfacing suddenly (Ahmad 2005). Among many such social issues are growing inequity, social unrest, unemployment, dissolution of families and communities, and instability of socio-economic systems (Stiglitz 2002). The widening of the gap between rich and poor is a frequent issue that is raised by many critics of globalization. Open borders for flow of capital and finished products combined with technological advancement has increased the power of multinational corporations and given them enormous economic profits. However, these profits may not be

fairly distributed between multinational corporations and workers (especially in developing countries). Inequity is worsened when seemingly borderless multinationals externalize costs of production in order to increase profits, while jeopardizing social and environmental resilience within borders.

One of the main challenges that globalization poses concerns the inadequacy of current systems of governance to manage this new integrated world. Globalization permits positive as well as negative economic, environmental or social activity in one country to be transmitted to another -- for example, an economic downturn or an upturn in USA is easily felt in Latin America, or the economic "footprint" of Japan may have a heavy influence on deforestation in South East Asia. At the same time, advances in information sharing and international communications may help to make development more sustainable. For example, the Global System for Sustainable Development based at MIT seeks to map information on sustainable development and make it widely accessible, as a dynamic, distributed global knowledge network operating on the Internet (Choucri 2003, URL: <http://gssd.mit.edu/>). Another example is the open source philosophy of Linux, which provides free operating system software (URL: <http://www.linux.org/>).

On the positive side, the rise of the General Agreement on Tariffs and Trade and the World Trade Organisation has led to a dramatic increase in world trade, and a corresponding jump in standards of living. Elimination of trade barriers would generate global gains in economic growth in excess of \$750 billion US per year (Common Wealth of Australia, 1999). The beneficial effects of competition stemming from globalization improve the position of all parties, with the potential for increased output as a result of the rationalization of production on a global scale, the spread of technology and competitive pressures for continual innovation on a worldwide basis (Micklethwait & Wooldridge, 2000), and economies of scale that can potentially lead to reductions in costs and prices. The result is a potential for greater human well being throughout the world. Countries that have grown prosperous through extensive trade interactions are less likely to use armed conflict to resolve their differences. Trade and investment, and the economic growth they encourage, are very positive forces in reducing international tensions. For less developed countries, globalization offers access to foreign capital, global export markets, and advanced technology while breaking the monopoly of inefficient and protected domestic producers. Faster growth, in turn, promotes poverty reduction, democratization, and higher labor and environmental standards (Lukas, 2000)

In brief, globalization is not an inanimate process -- it is controlled by people. Reform of the global institutional framework is needed, especially the World Bank, International Monetary Fund, and World Trade Organisation. Changes include better voting structure and representation (Stiglitz 2006). Reforms should also increase transparency, limit conflicts of interest, improve accountability, enforce the international rule of law, and enhance the ability of developing countries to participate meaningfully in decision making. The sustainomics approach suggests that it will be possible to shape the forces of globalisation for the greater good, based

on rational analysis, good governance and ethics.

Private-public balance

Between 1985 and 1994, \$468 billion worth of state enterprises were sold off to private investors, globally. However, with a few notable and highly controversial exceptions, governments have not been as eager to sell off their vast natural resource holdings, including forest lands, parks, and waterways (Cole 1999). Some economists argue that natural resources would be better managed economically and environmentally by the private owners than by governments. However, since non-use values of the resource have no monetary value, this may discourage owners from conserving the resource, leading to unsustainable overexploitation of the resource without considering the long term benefits of conservation.

Privatization of state property may provide a unique opportunity to address not only existing financial issues, but also environmental ones which are neglected due to a lack of investments or poor knowledge of new technology. However, unless a clear legislative framework is set up to deal with the problems under the new system, the profit maximizing private sector may not invest the required amount of capital to minimize environmental impacts and acquire environmental friendly technology. Inadequate regulation may also cause social problems by permitting privatized providers of basic needs like energy and water services to raise prices to levels that are not affordable by the poor (See Chapter 14).

Multinational organizations usually transfer modern, environmentally friendly technology and install advanced pollution control equipment in their plants. However, this may not be the latest technology although it is in compliance with the (lower) environmental standards in developing countries. These lower standards are due to two reasons. One is to attract more foreign capital from the international investment market and the other is due to the delay in identifying and introducing new standards.

Another problem may arise if the government agency usually involved in privatization of State Owned Enterprises (SOEs) is mainly interested in generating a higher income from the transaction, rather than in solving any environmental problems. Lack of transparency in the privatization process will exacerbate such problems.

Environmental damage

Global environmental trends have reached a dangerous crossroads as the new century begins, (Ayensu et al., 2000; IPCC, 2001d, 2007d; Baille *et al.*, 2004; MA, 2005a; UNEP, 2006; Worldwatch, 2001; WRI, UNDP, UNEP and World Bank, 2000). Signs of accelerated ecological decline have coincided with a loss of political momentum on environmental issues. This failure calls into question whether the world will be able to reverse these trends before the economy suffers irreversible damage.

New scientific evidence indicates that many global ecosystems are reaching critical thresholds. The Arctic ice has already thinned by 42%, and 27% of the world's coral reefs have been lost in the last century, suggesting that some of the planet's key ecological systems are in decline. Environmental degradation is also leading to more severe natural disasters, which have cost the world about \$700 billion during the last decade - as much as in the previous four decades combined. One sign of ecological decline is the risk of extinction that hangs over dozens of species of frogs and other amphibians around the globe, due to pressures that range from deforestation to ozone depletion. With many life support systems at risk of long-term damage, decisions need to be made whether to move forward rapidly to build a sustainable economy or to risk allowing the expansion in consumption, the increase in greenhouse gas emissions, and the loss of natural systems that undermine future development.

Even after a decade of declining poverty in many nations, 1.2 billion people lack access to clean water and hundreds of millions breathe unhealthy air. While the consumption of the rich is the main burden on natural resources, poor people in developing countries are also pushed to destroy forests and coral reefs in a desperate effort to raise living standards. Environmental degradation is increasing vulnerability to natural disasters – mainly among the poor. Lack of land has led people to settle in flood-prone valleys, unstable hillsides, and exposed coastal zones where environmental damage to protective natural systems has increased their vulnerability to disasters such as Hurricane Mitch (1998) - which inflicted economic losses of \$8.5 billion in Central America, and the Asian Tsunami (2004) – which killed over 250,000 people in South and East Asia (see Section 16.2). Unless fossil fuel use slows dramatically, the Earth's temperature could rise as high as 4-5 degrees C above the 1990 level by 2100, according to the latest climate models (See Chapter 5). Such an increase could lead to more extreme events, acute water shortages, declining food production, and the proliferation of deadly diseases such as malaria and dengue fever, which will especially harm the poor.

Conflict and competition for resources

Violent conflict blights the lives of hundreds of millions of people. It is a source of systematic violations of human rights and a barrier to progress towards the MDGs. Poverty and the lack of progress towards the MDGs may themselves exacerbate conflicts.

For many people in rich countries the concept of global insecurity is linked to threats posed by terrorism and organized crime. Meanwhile, the interaction between poverty and violent conflict in many developing countries is destroying lives on an enormous scale. Failure to build human security by ending this vicious cycle will have global consequences. In an interdependent world the threats posed by violent conflict do not stop at national borders. Development in poor countries is a key element in achieving global peace and collective security. Current approach may be overemphasizing military strategy and not paying adequate attention to addressing

poverty and human security concerns.

The nature of conflict has changed, and new threats to collective security have emerged. The twentieth century was defined first by wars between countries and then by cold war fears of violent confrontation between two superpowers. Now these fears have given way to fears of local and regional wars fought predominantly in poor countries within weak or failed states, and with small arms as the weapon of choice. Most of the victims in today's wars are civilians. There are fewer conflicts in the world today than in 1990, but the share of those conflicts occurring in poor countries has increased – often arising from the struggle for valuable resources (like water, oil, gold, diamonds, etc.), and exacerbated by foreign interests. In an increasingly interconnected world, local conflicts could spread quickly. More effective international cooperation could help to remove the barrier to MDG progress created by conflict, creating the conditions for sustainable development and real human security.

The human development costs of violent conflict are not sufficiently appreciated. In the Congo deaths attributable directly or indirectly to conflict exceed the losses sustained by Britain in the First and Second World Wars combined. In the Darfur region of Sudan nearly 2 million people have been displaced because of conflict. Conflict undermines nutrition and public health, destroys education systems, devastates livelihoods and retards prospects for economic growth. Of the 32 countries in the low human development category as measured by the UNDP Human Development Index (HDI), 22 have had some conflict since 1990. Countries that have experienced violent conflict are far more likely to be performing well below the MDG projections for 2015 (see Section 1.4). Of the 52 countries that are failing to reduce child mortality, 30 have experienced conflict since 1990. Such costs underline the need for conflict prevention and resolution, and post-conflict reconstruction, as three basic requirements for building human security, accelerating progress towards the MDGs, and making development more sustainable.

As indicated earlier, globalization and privatization could intensify competition for resources and lead to conflicts. Both international and national mechanisms need to be strengthened to prevent and manage conflicts. Due to the rising demand for goods and services along with the economic development, the level of extraction or utilisation of natural resources increases. Higher demand and competition for oil, coal, water, land, forest products, recreational areas, and other natural resources lead to long run depletion of, and competition for those resources -- especially when there are no appropriate policies for sustainable utilization.

Competition for scarce natural resources will intensify in the future due to the unsustainable present usage of natural resources. This issue is linked to the environmental harm problem discussed above. It will be necessary to invest more on research and development to identify more efficient method of resource use to fulfill human requirements, and find effective conservation measures. Furthermore, greater efforts need to be devoted to enhancing both international and national institutional mechanisms and management capacities to respond to the competition for natural

resources and harm to fragile ecosystems. Promoting pluralistic, multi-stakeholder, multi-level consultation is important for resolving differences and avoiding conflicts (see Section 1.2.4, and Chapter 6).

Poor governance

Poor governance has caused the massive waste of resources, which has hampered efforts to address sustainable development problems like poverty, hunger and environmental degradation (see Section 4.2). Corruption, inefficiency, greed, rape of natural resources, and other manifestations of bad governance abound. Overcoming them is a major challenge for those who govern and are governed. Good governance needs to be participatory, consensus oriented, accountable, transparent, responsive, effective and efficient, equitable, inclusive, and follow the rule of law (ADB 2006). Among the key outcomes are that corruption is minimized, the views of minorities are taken into account, the most vulnerable in society participate in decision-making, and policy becomes responsive to the present and future needs of society.

Where there is poor governance, there is more scope for corruption. An overview of corruption around the world demonstrates that its most common causes are economic in nature. Corruption thrives in the presence of excessive government regulation and intervention in the economy; substantial exchange and trade restrictions; and complex tax laws. Corruption is further favored by lax spending controls, and when the government provides goods, services and resources at below-market prices (for example foreign exchange, credit, public utilities and housing, access to education and health facilities, and access to public land). There is potential for corruption when officials take decisions that are potentially costly to private individuals or companies – e.g., tax incentives, zoning laws, timber rights and rights to extract mineral resources, investment permits, privatizations, and monopoly rights over exports and imports or domestic activities (Tanzi 1998; Abed and Davoodi 2000). Factors that contribute indirectly to corruption include, the quality and remuneration of the civil service, the effectiveness of deterrents, the example set by the country's leadership, the nature of meritocratic recruitment and promotion in civil service, the quality and effectiveness of legal enforcement, and the degree of transparency in government operations (Haque and Sahay 1996, Van Rijckeghem and Weder 1997).

Poor governance can have a major negative impact on economic performance by reducing investment and economic growth. It diverts public resources to private gains, and away from needed public spending, reduces public revenues, misallocates talent to rent-seeking activities, and distorts the composition of government expenditures and of tax revenues (Mauro 1995). Empirical evidence suggests that corruption reduces spending on publicly provided social services (Tanzi and Davoodi 1997), and results in lower spending on health care and education services, such as medicine and textbooks (Gupta et al. 2000a). Higher levels of corruption also tend to be associated with rising military spending (Gupta et al. 2000b). Corruption can worsen poverty and equity (see Section 2.3.5), because it exacerbates

an unequal distribution of wealth, and unequal access to education and other means to increase human capital (Gupta et al, 1998; Hindriks et al., 1999).

Given the high costs of corruption, why do governments not eliminate it? Because, when corruption is endemic, the likelihood of detection and punishment decreases and incentives are created for corruption to increase further. Individuals at the highest levels of government may have no incentives to control corruption or to refrain from taking part in rent-seeking activities. At the same time, eradication of corruption may be costlier in countries where the level of institutional development and the general economic environment is weak (Dabla-Norris and Freeman, 1999). Empirical evidence suggests that the rule of law (including effective anticorruption legislation), the availability of natural resources, the economy's degree of competition and trade openness and the country's industrial policy affect the breadth and scope of corruption (Leite and Weidmann 1999).

1.2.2 Fulfilling major global agreements on sustainable development

A second powerful motivation for developing the sustainomics framework is provided by the need to meet the many major global targets relating to sustainable development, widely agreed by world leaders in recent years (see Section 1.3.1).

The Stockholm Conference on the Human Environment in 1972 was a watershed gathering that brought international community together to focus on development and environment issues. It focused on benefits of science and technology on economic growth. After fifteen years, the report of the World Commission on Environment and Development (WCED 1987) served as another important milestone, which brought the concept of sustainable development into the mainstream. They succinctly paraphrased sustainable development, as "meeting the needs of the present generation without jeopardizing the ability of future generations to meet their needs". However, due to lack of an operational definition and experience, little success was realized in practice.

The next step was the Agenda 21 document agreed at the UN Earth Summit (UNCED) in Rio de Janeiro in 1992 (UN 1992), which was intended as a blueprint for putting sustainable development into practice. Although the conference was able to generate worldwide enthusiasm, funding for the ambitious Agenda 21 targets never materialised. The UN Commission for Sustainable Development (CSD) was established to monitor progress on Agenda 21, but many indicators of SD declined, particularly the environment indicators. Greater progress was made on other important agreements produced in Rio – e.g., the framework convention on climate change (UNFCCC), convention on biodiversity (CBD). Modest progress was also achieved after Rio with several new international agreements, including the Montreal Protocol (ozone), Kyoto Protocol (climate), and UN convention on desertification.

In 2000, the UN Millennium Summit produced the Millennium Development Goals (MDG), universally accepted by world leaders as a practical benchmark for

measuring progress towards sustainable development (see Box 1.1 and Section 1.4). Supplementary targets were also agreed at the World Summit on Sustainable Development (WSSD) in Johannesburg in 2002. The WSSD focused on the shortcomings of the post-Rio development process, and sought to reinvigorate sustainable development activities worldwide. It yielded the goal-oriented and comprehensive Johannesburg Plan of Implementation, including targets relating to poverty and WEHAB (water, energy, health, agriculture and biodiversity). Most recently, the UN Millennium Development Project was endorsed in 2005, to press forward with the MDG.

In summary, there have been several international agreements on sustainable development during the past decades, but with progressively declining targets. At the same time, implementation of these goals has generally fallen short of their aims (see Section 1.4). The many international conferences and reports have helped to bring about a paradigm shift in development thinking. However, the linkages among scientific evidence, policy making and practical application need to be strengthened (see Section 1.3). In addition, scientific understanding is still inadequate on new global trends such as globalization and privatisation, which implies that the achievement of MDG and other targets will require dynamic implementation processes that adapt to new knowledge. Therefore, ongoing discussions and consensus-building among scientific experts, decision makers and other stakeholders need to be intensified.

1.2.3 Avoiding worst case future scenarios and learning from past experience

The third major motivation arises from the need to avoid disastrous future outcomes by learning from the past experience of human development.

Lessons of history

Several ancient civilizations have shown remarkable durability by lasting 4000 years or more, including those located in the Yellow river basin in China, the Nile river basin in Egypt, and the Saraswati river basin in India. Other regions like the Sahel and the dust bowl in the USA have demonstrated the fragility and collapse of carrying capacity in marginal lands exposed to the pressure of unsustainable human activity over time.

Building on this historical experience and using modern analytical tools, a number of scenarios of future world development have emerged – see Table 1.1. While a range of optimistic and pessimistic futures are considered, we are especially concerned about avoiding the more disastrous scenarios. Among the undesirable and alarming outcomes are the “barbarization” scenario of the Global Scenarios Group, the IPCC A2 scenario projecting dangerously high growth of GHG emissions, and the Millennium Ecosystem Assessment “order from strength” scenario. These scenarios provide ample motivation for renewed efforts to address the major global problems and prevent the potential deterioration of society into chaos and anarchy.

Table 1.1 Summary of some recent global scenario exercises

Name	Description
Global Scenario Group (GSG)	Global scenarios based on 3 classes – conventional worlds, barbarization (bad), great transitions (good). (Gallopín 1997; Raskin et al. 1998 & 2002)
Global Environment Outlook 3 (GEO-3)	Similar to GSG with emphasis on regional texture (UNEP 2002)
World Energy Council (WEC)	Multiple global energy scenarios to year 2100 (1998)
IPCC Emission Scenarios (SRES)	GHG emission scenarios to year 2100; axes of change are sustainable vs. unsustainable & globally integrated vs. fragmented (IPCC-SRES 2000)
Millennium Ecosystem Assessment (MA)	4 scenarios based on future status of ecosystems (2003); axes of change are globally integrated vs. regional & environmentally proactive vs. reactive.

One particular extrapolation of past experience serves as a powerful rationale for this book. Two catastrophic famines or holocausts during the late nineteenth century, killed tens of millions in the developing world (Davis 2001). They were the outcome of negative synergies between adverse global environmental factors (i.e., the El-Niño droughts of 1876-78 and 1898-1901), and the inadequate response of socio-economic systems (i.e., vulnerability of tropical farming forcibly integrated into world commodity markets). In the eighteenth century, the quality of life in countries like Brazil, China, and India was comparable with European standards. However, colonial dictates and rapid expansion of world trade, re-oriented production in developing countries (from food to cash crops) -- to service distant European markets. By the time the El-Niño droughts struck in the nineteenth century, the domination of commodity and financial markets by Britain forced developing country small holders to export cash crops at ever deteriorating terms of trade. This process undermined local food security, impoverished large populations, and culminated in holocausts on an unprecedented scale -- which have been identified as one major cause of the present state of underdevelopment in the third world. From a sustainomics perspective, the corollary is clear, based on the precautionary principle (see Chapter 5). The future vulnerability of developing country food production systems to a combination of climate change impacts and accelerated globalization of commodity and financial markets, poses significant risks to the survival of billions, especially the poorest (Munasinghe 2001a).

Recent economic, social and environmental bubbles – triple threat

Human responses to recent problems have been inadequate. The world is facing

multiple economic, social, and environmental threats, best characterized by a “bubble” metaphor based on false expectations, where a few enjoy immediate gains while a vast unsuspecting majority will pay huge “hidden” costs in the future. These threats can interact catastrophically, unless they are addressed urgently and in an integrated fashion, by making development more sustainable. Piecemeal responses have proved ineffective, since the problems are interlinked and feed on one another.

The most urgent and visible problem is the economic collapse. In the past decade, a greed-driven asset bubble rapidly inflated the value of financial instruments well beyond the true value of the underlying economic resource base. The collapse of this bubble in 2008 caused the global recession. It is estimated to contain about \$100 trillion of “toxic” assets (twice the annual global GDP).

Meanwhile, a social bubble based on poverty and inequity is hidden by the illusion of economic growth in recent decades, excluding billions of poor from access to productive resources and basic necessities (see Section 1.2.1). Poverty is now exacerbated by the economic recession, which is worsening unemployment and access to survival needs. This bubble cannot be ignored indefinitely, without grave consequences for humanity.

Finally, mankind faces the bubble of environmental externalities, whereby myopic economic activities continue to severely damage the natural resource base on which human well being ultimately depends (see Section 1.2.1). Beyond degradation of local air, land and water resources, climate change is the ultimate global manifestation of this threat.

And what are our current priorities as we face these challenges? Governments have very quickly found over four trillion dollars for stimulus packages to bail out rich bankers and revive shaky economies by encouraging consumption. However, only about 100 billion dollars per year is devoted to help billions of poor people, and far less to combat climate change and ecosystem damage.

Thus, a unique opportunity was lost to move in new directions, by using the stimulus funds to finance green investments and social safety nets, while reforming global markets and price policies. Even worse, the recession has further dampened enthusiasm to address more serious long term poverty and climate issues. The lack of political will shown by world leaders who failed to agree on an effective action plan at COP15 (the 2009 climate change summit in Copenhagen) is solid evidence of this trend.

1.2.4 Vision for a practical way forward

The fourth and final motivation is to set down some ideas which might serve as the first steps along a practical path towards the ultimate goal of sustainable development. This transition is depicted in Figure 1.1.

- (1) The top row recognizes that our current focus is on surface level issues like poverty, inequity, exclusion, resource scarcities and conflict, mis-governance and environmental harm. These problems are driven by powerful forces including globalization and unconstrained market forces, based on the

“Washington Consensus”. Present trends could lead to a breakdown in global society, due to the ineffectiveness of governments seeking to cope with multiple, interlinked crises, using myopic, reactive and uncoordinated responses. A recent example is the futile attempt to alleviate oil scarcities by promoting corn-ethanol, which meanwhile worsened food security arising from a drought-driven worldwide grain shortage.

Main issues	Poverty, inequity, exclusion, conflict, environmental harm, climate etc.	←	<u>Present human responses</u> Business-as-usual with high risks from Unrestrained, myopic market forces (Washington consensus, globalisation, etc.) Reactive: piecemeal, mainly government
Immediate drivers	Consumption, population, technology, governance	←	<u>Practical transition step (Sustainomics)</u> Making development more sustainable (MDMS), using systematic policy reform based on existing knowledge to manage market forces Proactive: integrated govt., business, civil society
Underlying pressures	Basic needs, social power structure, values, choices, knowledge base	←	<u>Long term goal (new SD paradigm)</u> Fundamental global sustainable development transition through multi-level, multi-stakeholder, citizens networks, advanced policy tools, responsive governance, and better technologies. Proactive: integrated civil society, business, govt.

Sources: Adapted from IPCC (2001a), Munasinghe (2001a), Raskin et al. (2002)

Figure 1.1 Practical role of sustainomics in the transition to global sustainable development

Although policy reforms are proposed to correct for market deficiencies, most current measures tend to be reactive and defensive. Conditions could worsen sharply under such a business-as-usual approach, and lead to a breakdown of global society. One highly undesirable outcome is the “barbarization” scenario (Table 1.1), where the rich live in protected enclaves and the poor barely survive outside in chaotic conditions.

- (2) The middle row depicts the practical contribution of the sustainomics approach. It offers an intermediate but practical step which takes us forward via proactive measures that make current development more sustainable. Society moves gradually towards the ultimate goal of sustainable development by influencing key immediate drivers of change, including consumption patterns, population, technology and governance -- and thereby shaping global trends and managing market forces. The sustainomics framework also facilitates direct manipulation of underlying pressures. More broadly, using existing experience and tools that make development more sustainable today, business and civil society could help governments move proactively towards the ultimate goal of sustainable

development. There is emphasis on early action, to overcome the huge inertia of “supertanker earth”, and begin steering it away from its risky current path towards safer waters using existing experience and tools. Co-evolving socio-economic and ecological systems need to be guided by rational human foresight, at a moment in history where a major global transition might lead to disastrous results (see Section 4.1.3)

- (3) The third row follows on from the successful implementation of the second (transition) row. Here, our children and grandchildren might pursue their long term goal of a truly global sustainable development paradigm. They would need to work on deep underlying pressures linked to basic needs, social power structure, values, choices, and knowledge base. Fundamental changes are necessary, driven by social justice and equity concerns, through inspired leadership, a networked, multi-stakeholder, multi-level global citizens’ movement, responsive governance structure, improved policy tools, advanced technologies and better communications (including the internet). The World Social Forum (Leite 2005) and Global Transition Initiative (Raskin 2006) are two such efforts to build pluralistic global citizens networks. Chapter 6 describes some multi-level, multi-stakeholder, trans-disciplinary dialogues, where networks of experts and practitioners play a key role.

1.3 BRIEF HISTORY AND SUMMARY OF SUSTAINOMICS

1.3.1 Evolution of the sustainomics approach

This section provides a brief overview of how sustainomics evolved, from an institutional perspective. The Prologue of this book provides a more personal viewpoint. The sustainomics framework draws together two broad streams of thought -- i.e., development (focused on human well-being) and sustainability (systems science oriented), as described below.

Development stream (human well-being focused)

Current approaches to sustainable development draw on the experience of several decades of development efforts. Historically, the development of the industrialized world focused on material production as the basis of human well-being. Not surprisingly, most industrialized and developing nations have pursued the economic goal of increasing output and growth during the twentieth century. While the traditional approach to development was strongly associated with economic growth, it had important social dimensions as well.

By the early 1960s the large and growing numbers of poor in the developing world, and the lack of ‘trickle-down’ benefits to them, resulted in greater efforts to improve income distribution directly. The development paradigm shifted towards equitable growth, where social (distributional) objectives, especially poverty alleviation, were recognized as being distinct from and as important as economic

efficiency in contributing to well-being.

Protection of the environment has now become the third major objective of sustainable development. By the early 1980s, a large body of evidence had accumulated that environmental degradation was a major barrier to human development and well-being, and new proactive safeguards were introduced (such as the environmental assessments).

Some key milestones relating to the evolution of recent thinking on sustainable development include: the 1972 United Nations Environmental Summit in Stockholm, 1987 Bruntland Commission report, 1992 United Nations Conference on Environment and Development (UNCED) in Rio de Janeiro, 1995 World Summit on Social Development in Copenhagen, UN Millennium Summit and Millennium Development Goals (MDG) in 2000, [Earth Charter \(2000\)](#), 2002 World Summit on Sustainable Development (WSSD) in Johannesburg, UN Millennium Development Project approved as a follow-up to MDG in 2005, and UN Decade on Education on Sustainable Development (1995-2014) – see Section 1.2.2.

Sustainability stream (systems science oriented)

Meanwhile, the scientific community became more interested in exploring the concept of sustainability. During the 1980s a number of relevant international scientific research initiatives dealing with nature emerged, including the World Climate Research Programme (WCRP) in 1980, International Geosphere and Biosphere Programme (IGBP) in 1986, and DIVERSITAS (on biodiversity and ecology) in 1990. The United Nations Intergovernmental Panel on Climate Change (IPCC) was also established in 1988 (by WMO and UNEP), with global scientific expertise to periodically assess information on climate change. However, global sustainability issues like climate change were mainly framed by natural scientists as problems involving biogeophysical systems, largely divorced from their social context. Although the social aspects have received increasing attention in the scientific debate, it was considered an “add-on” rather than a fundamental element.

In the 1990s, it was recognized that human activity was a major factor influencing global changes -- e.g., in the work of existing scientific bodies like the IPCC (IPCC 1996a, 2001a), and creation of new bodies like International Human Dimensions to Global Environmental Change (IHDP) in 1996. In 1995, the IGBP GAIM (Global Analysis, Integration and Modelling) Task Force was established to integrate the knowledge generated in the various IGBP core projects. Since then, a series of international conferences and initiatives have called for (i) a more integrated approach between the natural and the social sciences and (ii) a better link between scientific activities and sustainable development problems – especially the human dimension. Among the significant outcomes of this trend was the Millennium Ecosystem Assessment (MA) launched by UN Secretary General Kofi Annan in 2001, which linked ecosystems, human communities and development.

Emergence of sustainomics

Amongst these multiple initiatives, the first ideas about sustainomics were outlined from 1990 onwards in several conference presentations by Mohan Munasinghe, culminating in a formal paper presented at the Rio Earth Summit in 1992, which set out key elements of the framework (Munasinghe 1992a). Subsequently these ideas were further elaborated for practical application (Munasinghe 1994a). The aim was a more holistic and practical synthesis that would help to make development more sustainable, by integrating the concerns of the development community (who focused on pressing development issues like poverty, equity, hunger, employment, etc.), and the interests of the scientific community (who emphasized research on sustainability science, environment, etc.). The neologism “sustainomics” was coined to project a more neutral image by focusing attention on sustainable development, and avoiding any disciplinary bias or hegemony. Sustainomics also seeks to balance people-oriented Southern Hemisphere priorities including promotion of development, consumption and growth, poverty alleviation, and equity, with environment-oriented Northern Hemisphere concerns about issues like natural resource depletion, pollution, the unsustainability of growth, and population increase.

Sustainable development is broadly described as “a process for improving the range of opportunities that will enable individual human beings and communities to achieve their aspirations and full potential over a sustained period of time, while maintaining the resilience of economic, social and environmental systems” (Munasinghe 1992a). Adapting this general concept, a more focused and practical approach towards making development more sustainable sought “continuing improvements in the present quality of life at a lower intensity of resource use, thereby leaving behind for future generations an undiminished stock of productive assets (i.e., manufactured, natural and social capital) that will enhance opportunities for improving their quality of life”.

The sustainomics framework is described in greater detail in Chapter 2. In particular, it encourages decision making based on the balanced and consistent treatment of the economic, social and environmental dimensions of sustainable development, and draws on a sound but evolving body of scientific knowledge, including the natural and social sciences, engineering and humanities. A decade or more of experience in further developing and practically applying the sustainomics framework in the field, was described at the 2002 World Summit on Sustainable Development (Munasinghe 2002a, GOSL 2002). Meanwhile, the approach has been cited and used in the work of many world bodies (e.g., ADB, CSD, EC, OECD, UNDP, UNEP, World Bank, etc.), governments (e.g., Canada, Netherlands, Philippines, Sri Lanka, UK, etc.), and individual researchers – specific references are given throughout the text. This book seeks to provide a comprehensive assessment of sustainomics today.

1.3.2 Summary of basic principles and methods

The sustainomics framework draws on the following basic principles and methods (Munasinghe 1992a, 1994a, 2002a) -- details in Chapter 2.

(a) Making development more sustainable (MDMS)

The step-by-step approach of “making development more sustainable” (MDMS) becomes the prime objective, while sustainable development is defined as a process (rather than an end point). Since the precise definition of sustainable development remains an elusive and perhaps unreachable goal, a less ambitious strategy that merely seeks to make development more sustainable does offer greater promise. Such a gradient-based method empowers us to address urgent priorities without delay, and it is more practical because many unsustainable activities are easier to recognize and eliminate. Although MDMS focuses on implementing short and medium term measures, we also follow a parallel track by continuing efforts to better define and achieve the long term goal of sustainable development. MDMS does not imply any limitation in scope (e.g., restricted time horizon or geographic area – see item (c) below). The approach also seeks to keep future options open and identify robust strategies which meet multiple contingencies and increase resilience.

(b) Sustainable development triangle and balanced viewpoint

Sustainable development requires balanced and integrated analysis from three main perspectives: social, economic and environmental. Each view corresponds to a domain (and system) that has its own distinct driving forces and objectives. The economy is geared towards improving human welfare, primarily through increases in the consumption of goods and services. The environmental domain focuses on protection of the integrity and resilience of ecological systems. The social domain emphasizes the enrichment of human relationships and achievement of individual and group aspirations. Interactions among domains are also important.

(c) Transcending conventional boundaries for better integration

The analysis transcends conventional boundaries imposed by discipline, values, space, time, stakeholder viewpoints, and operability. The scope is broadened and extended in all domains, to ensure a comprehensive view. Trans-disciplinary analysis must cover economics, social science and ecology, as well as many other disciplines. Unsustainable values like greed need to be replaced by more moral and ethical approaches. Spatial analysis must range from the global to the very local, while the time horizon may extend to decades or centuries. Participation of all stakeholders (including government, private sector and civil society) through inclusion, empowerment and consultation, is important. The analysis needs to encompass the full operational cycle from data gathering to practical policy implementation and monitoring of outcomes.

(d) Full cycle application of practical and innovative analytical tools

A variety of practical and novel tools and methods facilitate governance over the full cycle from initial data gathering to ultimate policy implementation and feedback, and also emphasize full life cycle analysis of products and processes.

Two complementary approaches based on “optimality” and “durability” may be used to integrate and synthesize across economic, social and environmental domains, within an integrated assessment modeling framework. An issues-implementation transformation map (IITM) helps to translate issues in the environmental and social domains, into the conventional national economic planning and implementing mechanisms within line ministries and departments.

Restructuring the pattern of development to make economic growth more sustainable is explained through a “policy tunneling” model, especially useful in poor countries, where poverty alleviation will require continued increases in income and consumption. Other practical tools include the Action Impact Matrix (AIM), integrated national economic-environmental accounting (SEEA), sustainable development assessment (SDA), environmental valuation, extended cost-benefit analysis (CBA), multi-criteria analysis (MCA), integrated assessment models (IAMs), and so on. A range of sustainable development indicators help to measure progress and make choices at various levels of aggregation.

The Action Impact Matrix (AIM) process is the key link from initial data gathering to practical policy application and feedback. Critical sustainable development concerns are included in conventional national development strategy and goals in two main ways: an upward link where sustainable development issues are embedded in the macro-strategy of a country via the medium- to long-term development path; and a downward link where such issues are integrated into the national development strategy in the short- to medium-term, by carrying out sustainable development assessments (SDA) of micro-level projects and policies.

Brief review of key ideas

The principle conclusion of this book is that we have made significant progress towards understanding and implementing the concept of sustainable development since the 1990s. The way forward is by taking practical steps toward MDMS, as set out in the sustainomics framework. Many unsustainable practices are obvious and may be addressed incrementally today, as we progress towards the long term (and less clear) goal of sustainable development. Sufficient examples exist of good (and bad) practices, and the lessons learned permit us to address immediate problems like poverty, hunger, and environmental degradation in a more sustainable manner, while concurrently seeking to better define and attain the ultimate goal of sustainable development.

The core principles underlying the sustainomics framework provide a good starting point for systematic analysis of sustainable development problems: (a) making development more sustainable, (b) sustainable development triangle

(economic, social and environmental dimensions) and balanced viewpoint; (c) transcending conventional boundaries (discipline, space, time, stakeholder viewpoint, and operability) for better integration; and (d) full cycle application of practical and innovative analytical tools (including the AIM).

Furthermore, the case studies in this book (and elsewhere) demonstrate that the approach of making development more sustainable has already yielded encouraging practical results and shows increasing promise for the future. Specific examples described here begin with global problems like climate change and analysis of international and national level policy responses. Next, we learn from the experience of transnational institutions like the World Commission on Dams (WCD), the Intergovernmental Panel on Climate Change (IPCC), the Millennium Ecosystems Assessment (MA), and the Millennium Development Goals (MDGs), which work through multi-stakeholder, multi-level, multi-disciplinary processes involving governments, business, civil society, and scientists. At the national macroeconomic level, a wide range of country applications involving a variety of models are presented, which provide useful insights for practical economy-wide policies.

Within countries, case studies cover sustainable development of key sectors like energy, transport and water, as well as important ecological systems involving forests and agriculture. Resource pricing policy could be used as a practical and flexible tool for making development more sustainable. Finally, the book shows how the sustainomics framework may be applied at the project and local levels, in areas like hydropower, solar energy, water supply, sustainable hazard reduction and disaster management, and urban growth.

We accept that sustainomics is incomplete -- there are both gaps in knowledge and problems of implementation. Nevertheless, our hope and expectation is that the important contributions of other potential "sustainomists" will rapidly help to further flesh out the initial framework and applications set out in this volume.

1.4 MILLENNIUM DEVELOPMENT PROSPECTS AND WORLDWIDE STATUS

This section reviews recent trends and prospects in relation to the MDG, as an appropriate backdrop for the subsequent chapters.

One yardstick for measuring the progress of civilization is the ability of humans to manipulate energy, matter and information. We may distinguish four eras (Munasinghe 1987, 1989; De Vries and Goudsblom 2002). The first was the nomadic hunter-gatherer phase starting several million years ago, including the domestication of fire and use of stone tools. Around 8000 BC a second transition to the agricultural period began, associated with farming settlements and agricultural implements. The advent of the industrial age in the 18th century was even more rapid, and characterized by increasingly crowded and polluted urban centres, and machines. The 20th century marks the fourth transition to a planetary civilization, increasingly linked together by fast communications, rapid transportation,

information technology and computers. During this process, both *extensive* and *intensive* development took place. With each transition, extensive development and growth in the scale of activities, expanded the footprint of humanity (see Figure 2.8). At the same time, intensive development increased the internal complexity, inter-linkages and ability to process information within society. Nevertheless, human beings are still utterly dependent on the biogeosphere for their existence and thus, extensive growth makes us more vulnerable to environmental degradation. Meanwhile, intensive development improves resilience due to greater complexity, interconnections and redundancy, but also increases vulnerability to harmful disturbances that are quickly transmitted to all parts of the globe (e.g., financial and market instabilities, or new diseases).

Many recent books have set out key sustainable development problems and potential remedies – taking optimistic, pessimistic or intermediate viewpoints (Easterbrook 1995, Environment and Development Economics 1998, IPCC 2001a, Jodha 2001, Lomborg 2001, MA 2005, Maddison 2001, McNeill 2000, MDG 2005, Munasinghe and Swart 2005, Myers and Simon 1994, Speth 2004, UNDP 2003, WB 2006, Worldwatch 2003). While it is difficult to generalize, environmentalists and natural scientists have tended to see the glass half empty, while economists and technological optimists have perceived the glass half full – reflecting a range of opinions. This book takes the middle path, arguing that the problems are serious enough to warrant urgent attention, while existing and emerging remedies could provide adequate solutions if early action is taken.

Below, we summarize the disappointing progress on the MDGs -- the most widely accepted set of global sustainable development targets today.

Poverty and hunger

More than 1 billion people survive on less than \$1 a day. More than 800 million people have too little to eat to meet their daily energy needs. Over 25% of children under the age of 5 in developing countries are malnourished, retarding their physical and mental development and threatening their survival. In Asia, the number of people living on less than \$1 a day dropped by nearly a quarter of a billion from 1990 to 2001. In over 30 countries, hunger was reduced by at least 25% during the last decade. Sub-Saharan Africa is the hardest hit by hunger and malnutrition.

The proportion of people lacking the food needed to meet their daily needs is on the decline – see Section 13.3. The percentage of people with insufficient food was lower in 2000–2002 than in 1990–1992 in all regions except Western Asia. However, progress has slowed over the past several years, and the number of hungry people increased between 1997 and 2002, probably due to growing populations and poor agricultural productivity. Hunger tends to be concentrated among the landless or among farmers whose plots are too small to provide for their needs.

Efforts to eradicate poverty and hunger are frequently set back by conflict and natural disasters. The average income of the extremely poor in sub-Saharan Africa declined. Reversing this negative trend requires faster economic growth that reaches

the poor — a challenging task in the face of disease and armed conflicts. Hunger and poverty, in turn, can provide fertile ground for conflict (especially when combined with factors such as inequality), and make it more difficult to cope with disasters. Strategies to combat child malnutrition include breastfeeding for the first six months, increasing the use of micronutrient supplements, reducing infectious diseases, and improving access to clean water and sanitation.

Primary education

More than 115 million children of primary school age do not go through proper schooling. These are mostly children from poor households, whose mothers often have no formal education either. Education, especially for girls, has social and economic benefits for society as a whole. Achieving this goal will require dramatically scaled-up efforts in sub-Saharan Africa, Southern Asia and Oceania. In these regions and elsewhere, increased enrolment must be accompanied by efforts to ensure that all children remain in school and receive a high-quality education.

In five regions, 90% of children or more are enrolled in primary school. Sub-Saharan Africa has made progress, but still has over a third of its children out of school. In Southern Asia, Oceania and Western Asia, enrolment is also lagging, with about 20% of children out of school.

Gender equality

Achieving parity in education is critical if women are to engage fully in society and the global economy. Although women have increased their share in paid non-agricultural employment, they remain a small minority in salaried jobs and are overrepresented in the informal economy. Having an equal voice in decisions is a key element of women's empowerment.

Countries with the widest gender gap in primary education have made progress in increasing the proportion of girls enrolled in school. This gap still remains a serious concern in Southern Asia, sub-Saharan Africa and Western Asia. In countries where resources and school facilities are lacking, only boys are sent to school. However, in countries where overall enrolments are high, girls are well represented in both primary and secondary education (e.g., in Latin America).

Women's access to paid employment is lower than men's in most of the developing world. Women in Southern Asia, Western Asia and Northern Africa still hold only about 20% of paying jobs in sectors outside of agriculture. In Latin America and the Caribbean women now hold over 40% of paying jobs. Over 60% of people working in family enterprises without pay are women

Child mortality

Every year, almost 11 million children below the age of 5 die (about 30,000 children a day). Most live in developing countries and die from a disease or a combination of diseases that can be prevented or treated by existing inexpensive means.

Malnutrition contributes to over half these deaths. Improvements in public-health services are key, including safe water and better sanitation. Education, especially for girls and mothers, saves children's lives. Raising incomes can help, but little will be achieved unless services reach those who need them most.

In 1960, more than 1 child in 5 died before age 5 in the developing regions. By 1990, the rate decreased to 1 in 10. Only in Northern Africa, Latin America and the Caribbean and South-Eastern Asia has maintained this pace. In these regions, economic growth, better nutrition and access to health care have spurred improvements in child survival. Almost half of all deaths among children under age 5 occur in sub-Saharan Africa, where progress has slowed owing to weak health systems, conflicts and AIDS. More than one third of all deaths occur in Southern Asia, despite the reduction in poverty. Countries that have experienced conflict, including Cambodia and Iraq, have seen sharp increases or no improvement in child mortality since 1990. Countries reeling from AIDS, especially in Southern Africa, have also seen rises in child mortality.

Most of these lives could be saved by expanding low-cost prevention and treatment measures. These include exclusive breastfeeding of infants, antibiotics for acute respiratory infections, oral re-hydration for diarrhea, immunization, and the use of insecticide-treated mosquito nets and appropriate drugs for malaria. Proper nutrition is part of prevention, because malnutrition increases the risk of dying from these diseases. Better care for mothers and babies before and after birth would reduce the one third of these deaths that occur in the first days of life.

Maternal health

Currently, 200 million women have an unmet need for safe and effective contraceptive services. Twenty times as many women suffer serious injuries or disabilities. Countries with already low levels of maternal mortality have made progress. Reductions in the worst-affected countries will require additional resources to ensure that the majority of births are attended by doctors, nurses or midwives who are able to prevent, detect and manage obstetric complications. When problems do arise, women must be able to reach a fully equipped medical facility in time. Universal access to reproductive health care, including family planning, is the starting point for maternal health.

In 2000, the average risk of dying during pregnancy or childbirth in the developing world was 450 per 100,000 live births. The chances of dying during pregnancy or childbirth over a lifetime are as high as 1 in 16 in sub-Saharan Africa, compared with 1 in 3,800 in the developed world. This risk could be substantially reduced if women had adequate family planning services, good medical care and access to emergency obstetric-care facilities in case of unexpected complications.

Advances were made in most developing regions between 1990 and 2003 in providing medically skilled attendants at birth. Major improvements were achieved in South-Eastern Asia, Northern Africa and Eastern Asia, but there was no change in sub-Saharan Africa, where maternal mortality is highest.

HIV/AIDS, malaria and other diseases

More than 20 million people have died around the world since the epidemic began (in the 1980s), it being the leading cause of premature death in sub-Saharan Africa and the fourth largest killer worldwide. And by the end of 2004, an estimated 39 million people were living with HIV. Thailand and Uganda have shown that infection rates can be reversed with vision and leadership. Historically, malaria has been a far greater scourge. It currently claims the lives of a million people a year and is estimated to have slowed economic growth in African countries by 1.3% a year. Tuberculosis, once thought defeated, is making a comeback, helped by the emergence of drug-resistant strains and the vulnerabilities created by HIV and AIDS. Not surprisingly, all three of these diseases are concentrated in the poorest countries. They can be largely controlled through education, prevention and, treatment and care.

Globally, 4.9 million people were newly infected with HIV in 2004 and 3.1 million died. HIV is spreading fastest in the European countries of CIS and in parts of Asia. In countries where the epidemic is still at an early stage, programmes targeted at the most vulnerable are effective.

Because there is no cure for AIDS, prevention is essential. But millions of young people know too little about HIV to protect themselves. Surveys in sub-Saharan Africa and South-Eastern Asia show low knowledge about the basics about how to avoid infection. During the second half of 2004, the number of people receiving antiretroviral therapy in developing regions increased from 440,000 to 700,000, but that figure is only about 12% of those who would benefit from these medications. Treatment and care need to be expanded to reach millions more.

Malaria is endemic in many of the world's poorest countries, affecting 350–500 million people a year; 90% of the one million malaria deaths each year occur in sub-Saharan Africa, where more than 2,000 children die each day from malaria. Tuberculosis kills 1.7 million people a year, most of them in their prime productive years. The number of new tuberculosis cases has been growing by about 1% a year, with the fastest increases in sub-Saharan Africa and CIS. In 2003, there were nearly 9 million new cases, including 674,000 among people living with HIV.

Environmental sustainability

Land is becoming degraded at an alarming rate. Plant and animal species are being lost in record numbers. The climate is changing, bringing with it threats of rising sea levels and worsening droughts and floods. Fisheries and other marine resources are being overexploited. The rural poor are most immediately affected because their day-to-day subsistence and livelihoods more often depend on the natural resources around them. Though the exodus to urban areas has reduced pressure on rural lands, it has increased the number of people living in unsafe and overcrowded urban slums. In both urban and rural areas, billions of people lack safe drinking water and basic sanitation. Overcoming these and other environmental problems will require greater

attention to the plight of the poor and an unprecedented level of global cooperation.

Forests cover one third of the earth's surface and constitute one of the richest ecosystems. In the last decade alone, 940,000 square kilometres of forest were converted into farmland, logged or lost to other uses. Some 19 million square kilometres (over 13% of the earth's land surface), have been designated as protected areas. This represents an increase of 15% since 1994. Loss of habitats and biological diversity continues, with more than 10,000 species considered to be under threat.

The transfer of new energy efficient technologies to developing countries is not happening fast enough. In poor nations, the lack of clean fuels has a direct impact on rural households which depend on wood, dung, crop residues and charcoal for cooking and heating. Indoor air pollution caused by these fuels is estimated to cause more than 1.6 million deaths per year, mostly among women and children.

The fraction of population using safe sources of drinking water in the developing world increased from 71% in 1990 to 79% in 2002. However, over a billion people have yet to benefit, with lowest coverage in rural areas and urban slums. In sub-Saharan Africa, 42% of the population is still unserved. The obstacles to progress (which include conflict, political instability and low priority for investments in water and sanitation) are especially daunting, because of high population growth rates.

Much slower progress has been made globally in improving sanitation. About 2.6 billion people (representing half the developing world) lack toilets and other forms of improved sanitation. Sanitation coverage in the developing world rose from 34% in 1990 to 49% in 2002. If present trends continue, close to 2.4 billion people worldwide will still be without improved sanitation in 2015. A dramatic increase in investment is needed to meet the sanitation target.

The urban population of developing countries is growing at over 3% per year, or three times faster than in rural areas. Thus, including migration to the cities and additional births, about 100 million people are added to urban communities of the developing world each year. By about 2008, the urban population exceeded the rural population in developing regions. Nearly one in three city dwellers (almost 1 billion people) live in slums, in conditions characterized by overcrowding, few jobs or security of tenure, poor water, sanitation and health services, and widespread insecurity, including violence against women. Not surprisingly, disease, mortality and malnutrition are much higher in slums than in planned urban areas. Surveys suggest that in some African cities, the death rate of children under age 5 who live in slums is about twice as high as that of children in other urban communities.