

### 2.0

Developing the Naturenomics  $^{\text{\tiny TM}}$  Model

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	Contents	Page no.
4.	Introduction  Moving towards a healthy planet  RANJIT BARTHAKUR, NatureFirst	1
2	Achieving Progress  Design for a Sustainable Economics  ROBERT GILMAN	4
3,	Where is the wealth of the Nation?  WORLD BANK PUBLICATION	15
4	•The Genuine progress indicator 2006: A tool for sustainable development  JOHN TALBERTH, CLIFFORD COBB, NOAH SLATTERY	21
	<u>Land</u> • World food securityRANJIT BARTHAKUR & DIPAK KRIPALANI	
6.	• Could food shortages bring down civilisation? LESTER R. BROWN	35
W.	Considerations of sustainable design and planning of Urban areas ALEX BURTON	42
8	Energy  Low-carbon energy - A roadmap, world watch institute report 178  CHRISTOPHER FLAVIN	55
9.	New energy economy emerging in the United States  LESTER R. BROWN	63
<b>4</b> @,	• Renewable energy options - A synopsis PROFESSOR JOHN TIDWELL	66
44.	<u>Water</u> Achieving Water Security through Innovative Solutions  SWATI ARUN PRASAD & SAURABH JOSHI	75
12,	• Water Eutrophication: Sources and drivers of nutrient pollution MINDY SELMEN & SUZIE GREENHALGH	84
<b>13</b> .	<u>Waste</u> Rethinking Waste Management in India, the Integrated Approach  RATI BHATTACHARYA	92
44	Secured Landfills: The bucket at the end of the solid waste management chain  VANDANA BHATNAGAR & SUNJAY GUPTA	108
45.	<u>Air</u> Urban air quality managemen: Co-ordinating transport, environment and energy developing countries.	
<b>46.</b>	MASAMI KOJIMA & MOGDA LOVEI  Indoor air pollution in India: A major environmental and health concern  AN ICMR BULLETIEN, VOL-31, NO.5	126
43	<u>Carbon</u> • Forest, Carbon and Climate Change - "Evaluating the true carbon value of ourforests"	134
14 <b>(2)</b>	RANJIT BARTHAKUR, SWATI ARUNPRASAD AND SAMIR MENON	4.60
	• Green job: towards sustainable work in a low carbon economy	
ij	• Towards Copenhagen and beyond A WORLD WILDLIFE FUND INITIATIVE, SUPPORTED BY NATUREFIRST-GEMS	158



#### Towards a Healthy Planet - The Naturenomics™ Way

Ranjit Barthakur, NatureFirst

The existence of a sustainability gap is now irrefutable. We have undisputable scientific evidence with studies by the IPCC and the Stern Review, and pragmatic confirmations from changing weather patterns, including an increasing number of natural calamities and rising global temperatures. All this has a devastating impact on the health of our planet and it is this fact that is, more and more, becoming a matter of huge global concern.

Our planet today is in an unhealthy state due to:

- <u>The unprecedented growth in the global economy</u> over the past five decades, driven by new levels of international trade and investment.
- <u>Significant global population growth</u> exerting ever increasing demands on the earth's limited resources.
- <u>Harmful human activity</u>, predicted to increase the global air temperature by 1.8 degrees C to 4 degrees C.
- Global environmental degradation, We are now caught in a vicious cycle, as we try to
  sustain our economies and support our growing populations. There is a <u>stressed</u>
  relationship between ecology and the environment, pushing the demand on local eco
  systems beyond their sustainable yield, resulting in diminishing natural capital that will in
  turn limit future economies.

On our current path of development and growth we are setting off a series of adverse impacts resulting in significant, and in places irreversible, ecological imbalance. Our consumption levels are depleting vital natural assets, degrading our planet, causing significant biodiversity loss and leaving us, the population of the planet, with an impounding energy and water crisis.

We are also starting to witness environmental devastation from global climate change and warming.

#### Closing the sustainability gap

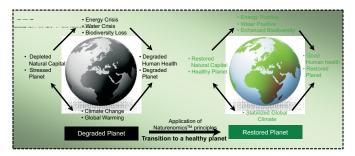
Before our current path of growth and consumption leads to further irreversible environmental change we need a fundamental shift in attitude and in the way we approach our economic activities. Towards building an <a href="mailto:eco-economy">eco-economy</a> that will nurse our planet back to health and this need must be addressed quickly.

The pioneering work of the Inter Governmental Panel on Climate Change and Al Gore on evaluating the risk of climate change caused by human activity has played a major role in bringing to international attention the issue of climate change. Gore's documentary 'An Inconvenient Truth' still stands to be one of the most popular presentations on the subject.

This International change in attitude has spurred businesses to start exploring both the risks and opportunities of climate change. The number of environmental non governmental

organisations in many countries, including India, has also increased substantially.

At the core of what needs to be addressed by countries and businesses at large is greater effort to embrace and practice "sustainability" - enabling a system to maintain its processes and functions into the future. We at NatureFirst have taken cognisance of this fact, creating an alternative paradigm to economic development, a concept we have come to call Naturenomics  $^{\text{TM}}$ , a differentiated approach to economics promoting the essential interdependence between nature and economics.



#### Introducing Naturenomics™

Our first publication Naturenomics™, produced in 2007, introduced this differentiated and alternative approach to economic development for countries and organisations, highlighting the stressed relationship between the economy and ecology.

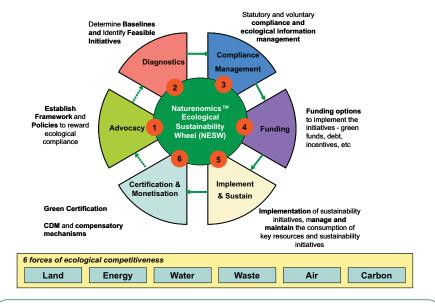
The book contained articles about a Naturenomics™ based business pattern reversal by pricing the non-marketed services of environmental assets and calculating its value as a generator of future incomes and liabilities. It identified the need to adopt strategies which have inherently integrated environmental policies and standards. This first Naturenomics™ publication was a threshold publication for us and has provided a platform for our ongoing work and advocacies.

#### Naturenomics™ 2.0

We are now excited to present to the world our second publication, "Naturenomics  $^{\text{TM}}$  2.0". This compilation takes a step further in addressing the need for a changed economics for the modern world, promoting the need for ecological competitiveness.

Naturenomics 2.0 reflects the progress we have made and the developments undertaken with the Naturenomics™ model, proposing a stronger link between ecological competitiveness and economic sustainability. In it we promote our inherent belief that to 'trust in ecology is to trust in the future'.

To this end we have created the <u>Naturenomics™ Ecological Sustainability Wheel (NESW)</u>, which illustrates our core value proposition, <u>delivering economic solutions that are ecologically driven</u>. It shows our 360 degree process, how we are able to identify and then deliver initiatives that promote ecological competitiveness, which in turn delivers economic sustainability. It is a robust process that can be applied to governments, philanthropic and commercial organisations alike.



Through the implementation of the NESW, we are able to analyse the key areas of resource efficiency, deliver the ecologically sustainable initiatives, facilitate the financing for the implementation of the initiatives and consequentially unlock financial and ecological benefits for our clients.

Supported by the 6 forces of ecological competitiveness, (or LEWWAC), by using NESW we can select appropriate sustainability initiatives, map them and then execute them to deliver both ecological and economic benefits to our clients.

Naturenomics™ 2.0 is about the development of our Naturenomics™ Model, a model with good examples of successful practical application, through which our model has been further enhanced and developed. Like our NESW model, Naturenomics™ 2.0, follows the theme of LEWWAC; Land, Energy, Waste, Water, Air and Carbon with articles across these elements.

Our publication includes pre-published articles by noted institutes and authors together with original articles authored by the NatureFirst team. We illustrate both the wider global picture and areas of environmental and economic concern, together with how theses global issues are impacting on India, looking at the resulting stresses on our environment, natural capital, health, urban areas, future economy and future of our industry.

All of our publications are supported by the Naturenomics™ Knowledge Foundation and cover topics ranging from strategic efforts towards combating climate change to specific concept notes on food, biodiversity security and the role of industries in combating global warming. The Naturenomics™ Knowledge Foundation is supported by a young team with their thoughts on today's environmental controversies and the economic roller coaster that confronts the world.

In the delivery of Naturenomics™ 2.0 we would like to extend our grateful thanks to all the renowned environmentalists, academicians and my colleagues at NatureFirst for their valuable contribution and continuous support in sharing our belief in Naturenomics™ and supporting us by lending their learning's for the world to consider and action.



#### **Design for a Sustainable Economics**

By Robert Gilman, (1992)

'Economic thinking is dangerously outmoded, but an emerging new framework could become the design guide for the 21st century'

Many of the articles have referred to the need to change the way we approach economics and economic issues. That's a nice general thought, but is it really possible to go from this recognition of the need to a practical program? The good news is that not only is it possible, but many of the models needed to demonstrate a more sustainable approach to economic life have existed for years. At a conceptual level as well, the pieces for a practical and positive alternative to conventional economics are falling into place. In this article I sketch out the key features of a sustainable economics. Accompanying the article are descriptions of two models that illustrate what some of the new institutions might be like.

#### **Economics in crisis**

There have always been critics of the conventional, marketplace approach to economics started by Adam Smith. Yet for more than 200 years it seems to have worked - with some modifications and additions - remarkably well. In the last two decades, however, it has become less and less effective - to the point where economists speak of their profession being in profound crisis.

I see a parallel to this with the crisis in physics that occurred at the beginning of the 20th century. Physics was then completely dominated by the tradition started by Sir Isaac Newton - a tradition that had been brilliantly successful in explaining most of the recognised physical phenomena of the time. However, as physicists began to probe into atoms, Newtonian physics just didn't work for the new experimental results. Out of that crisis came the recognition that the Newtonian view of the world was too simple, and the scope of physics needed to be expanded to include non-Newtonian theories of quantum mechanics and relativity. Within this expanded worldview, the rules of Newtonian physics now are seen as special cases that apply only under certain limited conditions.

I think that economics is now, relative to its own crisis, where physics was in the first decade of this century: The failure of the theory is growing more acute all the time, but the profession is still dominated by those who are steeped in the old approach. A new approach is gaining strength and supporters, but it is still a few years away from full recognition as the legitimate successor. What is this new approach that may be on its way to becoming the "new economics"? I will call my interpretation of it here "sustainable economics," although, as you might expect during a time of conceptual ferment, there are many variations on the new approach and many names used for them, such as green, holistic, ecological and real-life economics. To understand what sustainable economics is, and why it would be superior to conventional economics, we need to start with a brief recap of conventional economics. I'll need to go through a number of definitions and distinctions, but this is far more than an academic exercise.

The conventional economics concepts I'll be describing provide the basis on which those in power all over the world (which to some degree includes most of us in the rich industrialised countries) justify the destruction of the Earth. It would be hard to find a more pervasive, pernicious and powerful evil than the seemingly innocent concepts that currently rule our economics lives. Let me be more precise, for it is not so much the concepts on their own - they have served a historically useful role. The real evil is the continued dominant use of these concepts long after they have become seriously outdated and destructive. This is indeed the belly of the beast, and until we can replace these concepts with a more Earth-friendly approach, our prospects are grim.

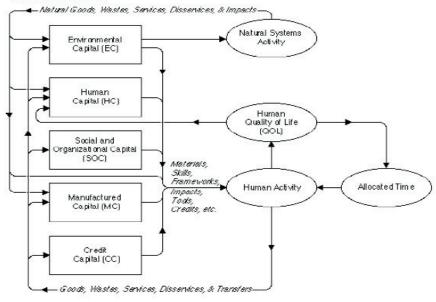
#### THE CONVENTIONAL PICTURE

So let's plunge in, with the aid of the following diagram:

#### Two Views Of Economic Reality

# Land Labor Labor Labor Manufactured Capital Consumption Investment

#### Sustainable ...



The top diagram gives the conventional picture (used across the board by capitalists, socialists and communists alike) of the major factors involved in economic activity. It begins with the three "factors of production": land, labour, and manufactured capital.

Land was initially included in recognition of the importance of agriculture, but as industrialisation progressed it has been broadened to represent all raw materials, like minerals and timber.

**Labour** covers all direct human inputs into economic activity, although in practice it has been treated largely as a simple head-count - e.g., how big is the "labour-force" or how many unemployed.

Manufactured Capital refers to buildings, tools, and equipment.

The oval labelled **Economic Activity** stands for the process by which Labour, with the aid of Manufactured Capital, converts Land (as raw materials) into **Goods & Services**.

Some of these Goods & Services need to be **Invested** back into the factors of production to either maintain or improve them. Whatever is left over can then be **Consumed** to produce Utility or **Welfare** for individuals and households.

At first glance, this picture seems fairly reasonable. After all, it would not have survived as the dominant view of economics if it was totally absurd. Yet it misses many important facets of real economic life, and distorts even those it does include. It will help, in understanding these deficiencies, to compare it to the lower diagram.

#### THE FIVE FORMS OF WEALTH

This lower diagram is intended as a more realistic model of economic activity. It begins by expanding the three factors of production into five reservoirs of wealth. The concept of the first four I have taken from Ekins. The fifth I've added for completeness in this diagram. In keeping with normal economic terminology, they are all called "capital" but that does not mean that they are thereby reduced to commodities to be bought and sold. But I'm getting ahead of my story; let's look more closely at each of these forms of capital:

**Environmental Capital (EC)** expands beyond the idea of Land to include all natural systems, such as the atmosphere, biological systems, and even the sun. In recognition that these natural systems are more than just inert "resources" the diagram includes Natural Systems Activity, who's functioning depends on the quality of Environmental Capital and whose results impact, for good or ill, Environmental, Human, and Manufactured Capital, as well as directly on Human Activity. For example, sulphur dioxide released into the atmosphere becomes part of EC. The Natural System Activity of precipitation converts this sulphur dioxide into acid rain, acid rain then adversely impacts lakes and forests (EC), respiratory health (HC), and buildings (MC), among other things. In a similar way, the natural activity of the sun produces both positive and negative impacts on EC, HC, and MC.

Another aspect of the dynamic character of natural systems is that EC can be self-maintaining and even self-building. Powered by the sun, EC can be a long-term, continual source of enormous human benefit. EC is not locked into a zero-sum game.

One of the gross simplifications of the conventional picture is the idea of free substitution between capitals, i.e., it really doesn't matter if one of the three factors of production is depleted as long as another, of equal or greater price, is built up in the process. The absurdity of this becomes clear when the notion of Land is expanded to Environmental Capital. Much of the real wealth in EC, such as the ozone layer or complex ecosystems like tropical rainforests, simply can't be replaced by other forms of capital. As we will see with the other four capitals as well,

there is some room for tradeoffs between them, but each is sufficiently unique and vital that there are strong limits to substitution between them.

**Human Capital (HC)** expands beyond Labour to include quality as well as quantity. According to Ekins "Human Capital has three components: health, knowledge and skills, and motivation." These three components behave differently than material forms of wealth. First, within an optimal range, all three of these are enhanced by use rather than worn down.

Second, they all obey an economy of multiplication rather than an economy of scarcity. That is, if I have a skill that I teach to you, I don't thereby lose that skill, and indeed my skill probably improves in the process. Similarly, if I am healthy, that benefits, rather than taking away from, your health, and if I am motivated, that will likely enhance the motivation of those around me. The limiting factors for HC are not interpersonal competition over the scarce resources of health, knowledge or motivation, but rather they are limits imposed by time and, in many parts of the world, competition over food, clean water, and other material supports for HC.

**Social and Organisational Capital (SOC)** recognises a major form of wealth that is ignored in the conventional diagram. It includes all of the interpersonal "software" that enables societies and organisations to function: habits, norms, roles, traditions, regulations, policies, etc. - in other words, the non-physical part of culture. SOC is different from HC in that HC is attached to a particular individual (you can walk out the door with it) while SOC is transpersonal, and can remain with an organisation even though the individuals who comprise that organisation keep coming and going. On a broader scale, it includes law, government, the feeling of community, the dynamics within families, as well as all art and knowledge that have become part of the culture.

Like the quality, or "software," aspects of HC, SOC is generally enhanced by use and is not generally diminished by sharing. There are certain forms of knowledge whose commercial value is enhanced by keeping it scarce or difficult to come by, but that is different from the question of its overall value within the system. There are also many forms of SOC, like language, that increase in value for each individual as they are shared with more individuals.

**Manufactured Capital (MC)** includes, as in the conventional picture, buildings, tools, and equipment. In this picture, however, the idea of MC is broadened in two ways. First, the conventional practice is usually to count as MC only equipment, etc., used by businesses. Thus a stove in a restaurant is a tax-deductible business asset, while a stove in a home is a "consumer durable," not counted as capital. In the new approach, the assets of households are treated on the same footing as the assets of businesses or other organisations. Second, MC in the lower diagram includes anything physical that has been manufactured and has not been returned to the environment, so it includes all kinds of supplies and material as well.

MC is the classic form of capital, and so it is the source of many of the conventional ideas about capital. Some of these are that each object of MC can be used in only one place at one time (it obeys a zero-sum economy of scarcity), and MC always deteriorates, generally faster with use. As a system, however, even MC has some of the self-reproducing qualities of EC and HC. After all, it takes factories to make factories, so in practice MC tends to grow exponentially, just like human population, if not limited by other factors.

The major limitations on MC are EC, at both ends of life. That is, at the start of the life cycle of a manufactured object, EC can provide only a limited supply of non-renewable raw materials, such as copper or oil, and can sustainably supply only a limited flow of renewable materials, such as wood. At the other end of the life cycle, as the object returns to the environment as waste, natural systems are limited in their ability to assimilate this output from MC, both in terms of the quantity and the quality of the waste.

It is crucial, in understanding the role of MC, to notice that the ultimate value in MC lies in its use, not its production or disposal, and yet frequently its use is the part of its lifecycle with the least adverse environmental impact. Thus everything that can be done to prolong the span of use between the initial extraction of raw materials from EC and the eventual disposal back to EC, such as long-life designs, easy repair, and good recycling, will enormously enhance the net value of MC within the context of all five forms of wealth.

Credit Capital (CC) is another reservoir of wealth not included on the conventional diagram, nor in Ekins' work. It is defined here as a reservoir of credits and promises, so it includes money and debt, but not stocks or deeds, which are ownership rights tied to other forms of capital. Of course conventional economics is well aware of CC, but CC was left off of the upper diagram because that diagram began its history describing only physical flows. Only later did "Goods" become "Goods & Services." The lower diagram includes both physical (e.g., MC) and non-physical (e.g., SOC) quantities, so there is no reason to exclude CC - and it certainly is an important aspect of real economic life! CC could be considered as a special case of SOC (just as MC could be considered as a special case of EC), but it is so important for economic understanding that it has been broken out as a separate capital.

Like each of the other capitals, CC has its own unique characteristics. It makes a vital contribution to economic functioning for two reasons: First, the lifecycle of humans (and many businesses too) is such that we need to invest when we are young (in such things as education and housing), we can produce more than we need to consume when we are middle-aged, and we often need to consume more than we can produce when we are old. Thus we need a mechanism to allow us to spread the concentrated productive capability of our middle years to enable investment and consumption throughout life. Second, many goods and services can deliver more value than they cost, both for households and for businesses. Borrowing allows tapping that value to repay the loan and still have a net surplus of value left over.

Of course, that is not how borrowing always works. If the money is spent on items that do not return a net surplus, then the future is burdened with repaying the extravagance of the present. Another difficulty with CC is that it usually functions as a means to transfer wealth to the wealthiest members of society from everyone else (see sidebar). Thus the real value of CC to the society as a whole depends on how it is used and whom it benefits, as well as how much there is.

#### **ACTIVITY**

As in the upper diagram, these five capitals are blended together, in various proportions, in support of some Human Activity. A new addition, however, is the explicit recognition of Time as a limited resource that must be allocated among various alternative activities.

Another change is that the notion of "economic activity" has been broadened here to any human activity. Does this mean that everything is being reduced to economics? Hardly. Rather, it is the recognition that every human activity has impacts on quality of life, on how we allocate our time, and on the five capitals. Thus every human activity has an economic dimension, and we can not expect to get a realistic picture of economic life if we begin by categorically excluding any aspect of life.

There are two flows that emerge out of Human Activity. One of these may seem superficially like the Goods & Services in the upper diagram, but the content of the flow and the structure of the diagrams are significantly different. First for content: the notion of Goods & Services (i.e. only intended results) is broadened in the lower diagram to recognise that wastes and disservices are also a part of economic reality, whether we like it or not. In addition, transfers are added to cover changes in CC and certain exchanges among the other capitals.

8

These Goods, Wastes, Services, Disservices, & Transfers all flow back to the five capitals. No longer is the stream broken into two parts labelled Investment and Consumption with only Investment flowing back. This is a major change in the structure of the diagram, and it is done for the following reasons.

The notions of Investment and Consumption as used in the upper diagram are much too simplistic. For example, the upper diagram has no way of acknowledging that consumption (as in the use of energy and materials) goes on as part of the manufacture of goods.

The lower diagram replaces these notions with the more complex, and more realistic, notions of inputs and outputs from the various capitals. In this picture, Investment and Consumption are not distinct categories, but can be different aspects of the same activity. Consider eating. Let's assume that the food is classified as EC (although some foods are more accurately MC). The most obvious aspect of eating is the consumption of this food (output from EC) as an investment in health and motivation (input to HC). In addition, if the eating is done in a building, at a table, using dishes and silverware, these forms of MC will support the activity (output from MC) and may undergo some wear and tear (output from MC, input to EC). The peace and quiet (or lack thereof) surrounding the meal will be greatly influenced by various social norms (output from SOC), and the interaction during the meal may affect the interpersonal relationships of those present (input to SOC). Air quality (output from EC) will also affect the quality of the experience. On top of all this, there may be some transfers of money (CC) involved. Now tell me, was that meal an investment or was it consumption?

Notice that not all outputs result in consumption (e.g., using social norms doesn't "consume" them; on the contrary, using them usually strengthens them). Nor can all inputs be classed as investment (e.g. toxic wastes input to EC are at best a negative investment).

#### **QUALITY OF LIFE**

At the heart of the lower diagram is an oval labelled Human Quality of Life (QOL). There is a superficial correspondence between Utility/Welfare in the upper diagram and QOL in the lower, but, as with Activity, the meaning of the concepts and the structure of the diagrams around these elements are significantly different. In both diagrams, these elements serve as the "goals" for activity. That is, the assumption in the upper diagram is that people want to maximise their Welfare. The parallel assumption in the lower diagram is that people want to maximise their Quality of Life.

As usual, the conventional concept is simple - too simple. Welfare is assumed to be achieved by the indiscriminate satisfying of any and all human wants, expressed in terms of the price paid for the goods or services, which, according to the diagram, are the only contributors to welfare. Thus \$1 million spent on a private yacht is assumed to generate as much welfare as the same amount spent on pre-natal care for thousands of children.

The new approach recognises that price is not the true measure of value in supporting QOL. There are many aspects of this distinction between price and value; let me describe two here. First, even if the marketplace functioned perfectly in conventional terms, "voting" in the marketplace (which sets prices) is on the basis of one-dollar, one-vote (biased toward the wealthy), whereas QOL, based on human experience, needs values allocated on a one-person, one-vote basis. Second, as the pre-natal care example illustrates, unborn children (as well as the natural environment) have no direct voice in setting today's prices, even when they bear the brunt of today's price-based decisions.

Developing a better measure of value require a deeper understanding of what contributes to quality of life. One particularly illuminating approach has been developed by Manfred Max-Neef, based on his experience with community development in Latin America (see sidebar on Ekins' books on page 55).

He begins by creating a matrix of universal human needs and modes of experience, and then looks at the many culturally dependent ways in which we humans attempt to satisfy these needs. (Being refers to attributes, such as health, self-esteem, passion, etc., most of which would be aspects of HC; Having covers physical objects plus institutions, i.e., MC plus some SOC and EC; Doing refers to actions, i.e. Human Activity; and Interacting refers to locations and milieus, i.e., the context aspects of MC, SOC, and EC). His matrix (without the "satisfiers" filled in) looks like this:

Universal Needs	Modes O	nce Interacting
Subsistence Protection Affection Understanding Participation Recreation Creation Identity Freedom		

The matrix can be used, for example by a community group, by filling it in with various ways that each need is being or could be met.

Of course, not all supposed satisfiers are equally effective or beneficial. Indeed, one of the great strengths of this tool is that it allows those who use it to compare alternative satisfiers to see which ones (1) are most

effective in what they intend, and (2) impact other needs, positively or negatively.

This matrix connects back to QOL in that each of these nine needs must be adequately met in order for a person to have an adequate quality of life. Another important aspect of many of these needs, like the needs for food and rest as part of Subsistence, is that, while they are on-going, they are not infinite. Other, more unbounded needs, like Understanding or Creation, are limited ultimately by available time. In either case, they are not best satisfied by attempting to consume ever increasing qualities of goods and services.

Contrast this rich description of the factors contributing to QOL with the upper diagram where Utility/Welfare is contributed to only by Consumption. In other words, the only way this picture allows humans to increase their welfare is through destroying the subsequent usefulness of various goods and services (i.e. consuming them), and what's more, the degree of welfare is in direct proportion to the rate of destruction. I know that sounds silly, but believe it or not, this diagram - complete with its assumptions about consumption and welfare - forms the conceptual basis on which essentially all major economic and economically-related political decisions are made (or at least justified) all over the world. It is on this basis that politicians proclaim their conviction that" economic growth" (i.e. increases in the production of goods and services) is the key to increasing human welfare.

The structure of the lower diagram is very different, as are its implications. In this diagram, every human activity has an experience associated with it that the experiences will assess as contributing to or detracting from their quality of life, whether that activity is primarily productive, consumptive, or neither. Even when the activity is in some sense consumptive (as with the case of eating), the positiveness of the experience is affected by many factors, not just quantity of consumption.

Furthermore, Utility/Welfare is a dangling dead end, while QOL is an integrated part of the system. The experienced level of QOL affects motivation (thus the link to HC) and it affects the amount of Allocated Time devoted to this activity.

The conventional economist may well object at this point that, "All this talk about QOL sounds nice, but unless there is an objective way to measure QOL, it is useless." There are two responses to this. At a fundamental level, we need to see these alternatives conceptual approaches in historical perspective.

Conventional economics was developed at a time when the model for conceptual systems was Newtonian physics - simple, linear chains of cause and effect that could be modelled with numerical precision. Today, we understand that most of life – from biological systems, to climate, to social systems -doesn't fit the Newtonian model. The leading edge of theory now has to do with complex, highly interactive, highly non-linear systems for which numerical precision is not possible. Nevertheless, simply determining a good set of components connected by the appropriate feedback loops to represent these complex systems can lead to great insight and useful results. The old rule used to be, "If you can't measure it, don't include it." Today's rule is, "Include elements on the basis of their likely significance, not their measurability."

Having said that, the second response is that in fact there is a great deal that can be objectively measured as to how well Max-Neef's set of needs are being met, and thus the adequacy of QOL. Not necessarily with Newtonian precision, but with enough statistical accuracy to be useful.

#### **PERSONAL APPLICATION**

To ground these concepts, let's look at how they can be used at a personal level. Think of the major activities of your day. They could likely be put into categories such as self-care (sleeping, eating, bathing, etc.), paid work (including commuting and other associated activities), household activities, recreation, shopping, and so on. Each one of these activities 1) takes time, 2) draws on the five capitals, 3) has impacts back on the five capitals, and 4) affects your experienced QOL.

Let's assume that your goal is to maximise your on-going QOL, while also minimising any adverse impacts on any of the five capitals. Achieving this goal (or even coming close!) requires a complicated balancing act.

The lower diagram can reflect this while the upper one can't. Consider, for example, the time you spend on paid work. According to the lower diagram, it would be "rational" for you to choose a job that

- Provided direct job satisfaction (input to QOL)
- Placed you in a healthy environment with clean air and water (output from EC, input to HC) didn't depend on non-renewable resources or unsustainable use of renewables (draining output from EC)
- Minimised pollution and other negative inputs to EC
- Gave you opportunities to learn (input to HC)
- Had a low level of stress and other hazards to your health (avoiding negative inputs to HC)
- Had a sufficiently orderly social structure so that you could efficiently focus on your own task (output from SOC)
- Enabled you to participate in shaping the organisational routines and culture (input to SOC)
- Provided you with good tools in a pleasing and efficient building (output from MC)
- Paid you enough to cover your expenses in the rest of your life (CC).

The lower diagram says that all these things (and more) need to be taken into consideration as you pursue your goal. The upper diagram takes a much simpler approach: the only purpose of having a job is to earn money so that you can consume goods and services when you are not on the job. From the conventional point of view it is not "rational" to consider anything other than the amount you are paid. From the new point of view it is not rational to consider only what you are paid. Which approach seems more realistic to you? Which approach is reflected in the great bulk of our laws, institutions and cultural assumptions?

We can take this comparison even further. In the model represented by the lower diagram, it would be perfectly rational for people to reduce their need for income by living as efficiently as possible within their household, and then to use this reduction to allow them to work under conditions that provided more direct QOL and/or required less time in paid work. Furthermore, it would be perfectly rational for a society as a whole to facilitate all of its members to do this, developing new social and economic institutions if necessary. The net result would be an increase in per capita QOL accompanied by a decrease in the production of goods and services (which is measured by the Gross National Product).

Such a decoupling of QOL and GNP is impossible in the conventional view. As you can see from the diagram, maximising Utility/Welfare implies maximising Consumption, which implies maximising the production of Goods & Services - there, is no other way.

#### THE ROAD AHEAD

This is just one example of the profoundly different conclusions that follow from these two views of economic reality. We need to do more, however, than just explore these concepts in principle. To put them into practice will require, as best as I can tell, more movement in three main areas:

**Indicators** - If we are to give full and equal importance to each of the five capitals, we need good measures, good indicators, for each. We need to be able to track the changes in both quantity and quality for each, and have ways to make comparisons between them. Much work has been and is being done around the world on developing such indicators, and this work needs now to accelerate. These indicators will give us a better way to keep score.

**Rights and Responsibilities** - A second part of giving proper importance to each of the five capitals is clarifying our legal relationships to them. The world has begun this process relative to its environmental commons, but from the perspective of sustainable economics, the whole range of "ownership rights" needs to be reassessed for each of the five capitals. This reassessment will give us a new framework within which to play the economic game.

**Institutions** - Finally, to actually play the economic game in a sustainable way, we need to create institutions consistent with this framework. I've offered the Mondragón Cooperative Group and the JAK banking system (see sidebars) as examples of the kinds of institutions we need to establish on a much broader scale. Fortunately, there are many other such examples. We have decades of good worked to build on.

Let's get on with it.

#### Real-Life Economics

I've drawn considerable inspiration for this article from two recent books authored and edited by Paul Ekins: Real-Life Economics: Understanding Wealth Creation (coedited with Manfred Max-Neef; NY: Routledge, July 1992) and The Gaia Atlas of Green Economics (with Mayer Hillman and Robert Hutchison, NY: Anchor Doubleday, February 1992). Both books cover the same general territory, but Real-Life Economics is addressed to a professional and academic audience while The Gaia Atlas of Green Economics is more popular in its presentation.

Paul Ekins, a Research Fellow at the Department of Economics, Birbeck College, University of London, is a co-founder of The Other Economic Summit (TOES). He is also Research Director for the Right Livelihood Award, and the founder of the Living Economy Network. His two books draw very effectively on this background to present the best overview of green economics that I have seen anywhere. I highly recommend them.

#### Interest-Free Banking

Could a banking system work without charging interest to borrow and paying interest to depositors? A non-profit association in Sweden, known as JAK, has been doing it successfully for more than 20 years. When I first found out about them, I was rather sceptical, expecting that they did it through some kind of hidden subsidy, but as I've studied their system I've been delighted to find that, rather than some trick, they do it through a genuine social invention.

The heart of their invention is this: Rather than operating as a bridge between two classes - borrowers and lenders - JAK expects the borrowers and lenders to be the same people, but at different times in their lives. Thus JAK requires every borrower to save, over and above repaying their loan, as much and for as long as their loan.

If I borrow \$10,000 for 10 years, JAK won't charge me any interest (although they will charge me a modest fee), but, in addition to gradually repaying the \$10,000, I must gradually save enough so that I have a positive balance of \$10,000 at the end of the 10 years. I won't get any interest on this savings, but I can withdraw it once I have fully paid off the loan.

My savings provides the funds which others can borrow, just as the interest-free savings of others permitted me to borrow. It is profitable for me to do this because the combined loan payments and required savings are still less than the normal loan payments plus interest of a regular bank, plus, I get all my savings back!

For more information, write to JAK, Ängsvägen 15, S-147 43 Tumba, SWEDEN.

#### Mondragón Cooperative Group

I had the good fortune to spend a week in Mondragón, Spain, this March, studying what many people feel is the world's most successful group of employee-owned, democratically-controlled businesses. I had read, and written, about them for years, so I knew they were remarkably successful in conventional business terms: This group of over 160 coops, with a total of over 23,000 worker-members and over \$3 billion in sales in 1991, has been consistently more productive, more profitable and faster growing than surrounding businesses since its start in 1956. During that time they have had essentially no layoffs (even when local unemployment was over 25%) and more than 95% of their business start-ups have succeeded.

What I hadn't fully appreciated before I went was that Mondragón is also a surprisingly pleasant place to live and work. In addition to their great business record, the coops have far better safety and environmental records than surrounding businesses. The community itself (of about 27,000) is designed so that everyone is within easy walking distance of green fields and woods.

Mondragón is a model of what is possible when businesses and communities choose to take a whole-system approach that balances the roles of all five capitals in the interest of a sustainable quality of life.

There are some clouds on Mondragón's horizon, mostly due to the competition they feel from huge multinational corporations, but I expect they will weather these challenges as well as they have the many in their past.

#### Natural Gist

- A conventional model of economics based upon showing utilisation of land, labour and manufactured capital, is oversimplified, outdated and destructive to our prospects and our planet.
- A sustainable model of economics expands upon the 3 factors of production identifying 5 reservoirs of wealth; environmental capital, human capital, social and organisational capital, manufactured capital and credit capital.
- Quality of life (QOL) is measured by a sustainable model of economics. Decoupling this from Gross National Product (GNP), as this assumes QOL is linked to consumption, but does not recognise the impact this consumption has upon our natural capital.
- Activity within our natural systems is illustrated by the sustainable model and how it gives rise to; natural goods, wastes, services, disservices and impacts, all of which flow back into the five capitals.
- Putting it into practise: To put the sustainable model into practice we require three things: Indicators that can identify changes in the quality and quantity of life, clear rights and responsibilities for each of the five capitals and the creation of institutions developing the principle of sustainable economics.

Design for a Sustainable Economics, by Robert Gilman, (1992).

Was originally published in "In Context", A Quarterly of Humane Sustainable Culture, 1996, the original can be found at: http://www.context.org/ICLIB/IC32/Gilman.htm Robert Gilman is President of Context Institute, Founding Editor of IN CONTEXT



#### Where is the Wealth of Nations? Measuring Capital for the 21st Century

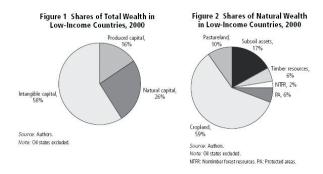
World Bank Publication, (2006). Abridged

#### Where is the wealth of nations?

The World Bank publishes what could be termed the 'millennium capital assessment'. Monetary estimates of the range of assets, produced, natural, and intangible, upon which development depends. While important gaps remain, this comprehensive snapshot of wealth for 120 countries at the turn of the millennium seeks to deepen our understanding of the linkages between development outcomes and the level and composition of wealth.

#### Natural resource wealth

Figures 1 and 2 provide important insights into the role of natural resources in low-income countries (excluding oil states where resource rents exceed 20 % of gross domestic product [GDP]). The first key message is that natural capital is an important share of total wealth, greater than the share of produced capital. This suggests that managing natural resources must be a key part of development strategies. The composition of natural wealth in poor countries emphasises the major role of agricultural land, but subsoil assets and timber and non timber forest resources make up another quarter of total natural wealth.



The large share of natural resources in total wealth and the composition of these resources make a strong argument for the role of environmental resources in reducing poverty, fighting hunger, and lowering child mortality. The analysis in this volume proceeds from an overview of the wealth of nations to analyse the key role of the management of wealth through saving and investments. It also analyses the importance of human capital and good governance and engages finance ministries in developing a comprehensive agenda that looks at natural resources as an integral part of their policy domain.

#### Wealth management

It also provides an overview of the wealth estimates with a focus on the implications for policy makers. It introduces the notion of development as a process of portfolio management—a powerful framework for action. Certain assets in the portfolio are exhaustible and can only be transformed into other assets through investment of the resource rents. Other assets are renewable and can yield sustainable income streams. Economic analysis can guide decisions concerning the optimal size of these assets in the portfolio.

The wealth estimates suggest that the preponderant form of wealth worldwide is intangible capital—human capital and the quality of formal and informal institutions. Moreover, the share of produced assets in total wealth is virtually constant across income groups, with a moderate increase in produced capital intensiveness in middle-income countries. The share of natural capital in total wealth tends to fall with income, while the share of intangible capital rises. The latter point makes perfect sense—rich countries are largely rich because of the skills of their populations and the quality of the institutions supporting economic activity.

The article takes the reader through the methodology used to estimate wealth, explaining the methods and assumptions used. The total wealth estimates reported in 'Where Is the Wealth of Nations?' are built upon a combination of top-down and bottom-up approaches. Total wealth, in line with economic theory, is estimated as the present value of future consumption. Produced capital stocks are derived from historical investment data using a perpetual inventory model (PIM). Natural resource stock values are based upon country-level data on physical stocks and estimates of natural resource rents based on world prices and local costs. Intangible capital, then, is measured as the difference between total wealth and the other produced and natural stocks. The estimates of natural wealth are limited by data—fish stocks and subsoil water are not measured in the estimates—while the environmental services that underpin human societies and economies are not measured explicitly.

The introduction of the wealth estimates methodology and results sets the stage for the three leading questions in the volume. The central tenet of 'Where Is the Wealth of Nations?' While wealth composition may, to some extent, determine the development options available to a particular country, the quality of development depends crucially on how wealth changes over time. Natural capital can be transformed into other forms of capital, provided resource rents are efficiently invested.

#### Do changes in wealth matter for the generation of well-being?

Natural resources are special economic goods because they are not produced. As a consequence, natural resources will yield economic profits—rents—if properly managed. These rents can be an important source of development finance, and countries like Botswana and Malaysia have successfully used natural resources in this way. There are no sustainable diamond mines, but there are sustainable diamond-mining countries. Behind this statement is an assumption that it is possible to transform one form of wealth—diamonds in the ground—into other forms of wealth such as buildings, machines, and human capital.

Saving is obviously a core aspect of development. Without the creation of a surplus for investment there is no way for countries to escape low-level subsistence equilibrium. Resource dependence complicates the measurement of saving effort because depletion of natural resources is not visible in standard national accounts. Adjusted net or genuine saving measures the true level of saving in a country after depreciation of produced capital; investments in human capital (as measured by education expenditures); depletion of minerals, energy, and forests; and damages from local and global air pollutants are taken into account.

The article describes the estimation of adjusted net saving. It then goes on to present and discuss the empirical calculations of genuine saving rates available for over 140 countries. Development has been referred to as a process of portfolio management.

The Hartwick rule for sustainability actually mandates that in order to achieve sustainable consumption, countries should invest their rents from natural resources.

Drawing on a 30-year time series of resource rent data underlying the adjusted net saving estimates, it constructs a Hartwick rule counterfactual: how rich would countries be in the year 2000 if they had followed the Hartwick rule since 1970? The empirical estimations in this article test two variants of the Hartwick rule—the standard rule, which amounts to keeping genuine saving precisely equal to zero at each point in time, and a version that assumes a constant level of positive genuine saving at each point in time. In many cases, the results are striking. The calculations show how even a moderate saving effort, equivalent to the average saving effort of the poorest countries in the world, could have substantially increased the wealth of resource-dependent economies. In 2000, Nigeria, a major oil exporter, could have had a stock of produced capital five times higher.

Moreover, if these investments had taken place, oil would play a much smaller role in the Nigerian economy today, with likely beneficial impacts on policies affecting other sectors of the economy. Republica Bolivariana de Venezuela could have four times as much produced capital. In per capita terms, the economies of the Republica Bolivariana de Venezuela, Trinidad and Tobago, and Gabon, all rich in petroleum, could today have a stock of produced capital of roughly US\$30,000 per person, comparable to the Republic of Korea.

Adjusted net saving is introduced as a more inclusive measure of net saving effort. Yet, if population is not static, then it is clearly per capita welfare that policy should aim to sustain. While adjusted net saving is answering an important question—did total wealth rise or fall over the accounting period?—it does not speak directly to the question of the sustainability of economies when there is a growing population. If genuine saving is negative, then it is clear in both total and per capita terms that wealth is declining. For a range of countries, however, it is possible that genuine saving in total could be positive while wealth per capita is declining.

Countries with high population growth rates are effectively on a treadmill and need to create new wealth just to maintain existing levels of wealth per capita. In general, the results suggest very large saving gaps in Sub-Saharan Africa when population growth is taken into account. Excluding the oil states, saving gaps (the increase in saving required to maintain current levels of wealth per capita) in many countries are on the order of 10 percent to 50 percent of the gross national income (GNI).

Against this must be set the realisation that reigning in government consumption by even a few percentage points of GNI is extremely painful and often politically perilous. Macroeconomic policies alone seem unlikely to close the gap.

Economic theory suggests that current net saving should equal the change in future well-being, specifically the present value of future changes in consumption. It tests this hypothesis. The saving tests using historical data reported in this volume suggest that a particular variant of genuine saving, one that excludes education expenditures, damage from carbon dioxide emissions, and the immiserating effects of population growth, is a good predictor of future changes in well-being.

Genuine saving is, therefore, a potentially important indicator to guide development policy. The analysis includes a further key result: when the sample of countries is limited to high-income countries, there is no apparent empirical relationship between current net saving and future well-being. This raises an important distinction between developed and developing countries. It says quite clearly that asset accumulation, the apparent driver of future welfare when all countries are tested, is not a significant factor in rich countries. This result makes eminent sense. In the richest countries it is clear that technological change, institutional innovation, learning by doing, and social capital, to name a few factors, are fundamental drivers of the economy.

While saving is at the basis of sustainable development, the composition of wealth determines the menu of options a given government has available. The second key question looks at specific types of wealth and their role.

#### What are the key assets in the generation of well-being?

As pointed out, most of a country's wealth is captured by what we term intangible capital, the article deals with the decomposition of intangible capital into subcomponents. By construction, the intangible capital variable captures all those assets that are unaccounted for in the estimates of produced and natural capital.

Intangible assets include the skills and know-how embodied in the labour force. The category also includes social capital, that is, the trust among people in a society and their ability to work together for a common purpose. The residual also accounts for all those governance elements that boost the productivity of labour. For example, if an economy has a very efficient judicial system, clear property rights, and an effective government, the effects will result in a higher total wealth and thus a higher intangible capital residual.

The regression analysis shows that human capital and rule of law account for the majority of the variation in the residual. Investments in education, the functioning of the justice system, and policies aimed at attracting remittances are the most important means of increasing the intangible components of total wealth. It is observed that as countries become richer, the relative importance of produced and intangible assets rises in ratio to natural assets. Thus, the development process primarily entails growth in the modern sectors of manufacturing and services, which depend heavily on more intangible forms of wealth. Yet, the value of natural resources per person does not decline as income rises, particularly for agricultural land.

The article tests the hypothesis that land and other natural resources are, in fact, key in sustaining income generation. Underlying any wealth accounts is an implicit production function, which is a blueprint of the combinations of different assets with which we can achieve a given level of output. These blueprints are usually written as a mathematical function, which describes the precise relationship between the availability of different amounts of inputs, such as physical and human capital services and the maximum output they could produce. The substitutability between inputs is then measured as an elasticity of substitution. The results provide some interesting findings. There is no sign that the elasticity of substitution between the natural resource (land) and other inputs is particularly low. Wherever land emerges as a significant input, it has an elasticity of substitution approximately equal to or greater than one.

This outcome, on one hand, confirms that countries' opportunities are not necessarily dictated by their endowments of natural resources. On the other hand, it validates the importance of a Hartwick rule of saving the rents from the exploitation of natural resources if we are to achieve a sustained level of income generation.

#### How can comprehensive wealth and its changes be measured in national accounts?

A central tenet of the volume is the need for a pragmatic vision of sustainable development as a process of administering a portfolio of assets.

Having committed themselves to achieving sustainable development, governments face a number of challenges beyond the traditional concerns of their natural resources and environmental agencies. Policy makers setting environmental standards need to be aware of the likely consequences for the economy, while economic policy makers must consider the sustainability of current and projected patterns of production and consumption. Such integration and adoption of the notion of sustainable development by governments have been the motivation for developing environmental accounting.

The article provides a context to explore the usefulness of the system of environmental and economic accounts (SEEA) as an operational framework for monitoring sustainability and its policy use. The article summarises the four general components of the environmental accounts. Furthermore, it reviews a few policy applications of environmental accounting in industrialised and developing countries, and also indicates potential applications, which may not be fully exploited at this time.

#### Putting it all together

It is in developing countries where accounting based on comprehensive wealth and its changes is most likely to be a useful indicator to guide policy. The evidence in this volume suggests that investments in produced capital, human capital, and governance, combined with saving efforts aimed at offsetting the depletion of natural resources, can lead to future welfare increases in developing countries. The step from saving to investment is crucially important. If investments are not profitable, the effect on wealth is equivalent to consumption, but without the boost to well-being presumed to accompany consumption.

Achieving the transition from natural-resource dependence to a sustained and balanced growth requires a set of institutions that are capable of managing the natural resource, collecting resource rents, and directing these rents into profitable investments. Resource policy, fiscal policy, and political economy all have a role to play in this transformation.

#### Natural Gist

- Vatural capital is an important share of total wealth, greater than produced capital
- In poor countries natural resources are a large share of total wealth and have a key role in reducing poverty, fighting hunger and lower child mortality.
- Natural capital will yield economic profits and also enable produced capital investments if <u>managed properly</u>. In fact it natural capital is key to sustaining income generation.
- Saving is a core aspect of sustainable development, by creating surplus for investment which enables countries to escape low levels of subsistence. Invested savings should be used to reduce dependency on depleting natural capital stock.
- Genuine savings or adjusted net saving measures the true savings effort after the depreciation of; natural capital, produced capital and human capital has been taken into account. It is an important indicator to guide development policy.
- The saving to investment step is critical. Good governance of natural capital must be a key part of any development strategy. Achieving the transition from natural-resource dependence to sustained and balanced growth requires institutions capable of managing the natural resources effectively.
- Countries with high population growth rates are on a treadmill needing new wealth just to maintain existing levels per capita. The composition of a countries wealth determines the options available to the government.

#### Where is the Wealth of Nations?

This article is an abridged version of the published book, Where is the Wealth of Nations?: Measuring capital for the 21st Century. Written by a team including; Hamilton K, Ruta G., Bolt K., Markandya A., Galinato S., Silva P., Ordoubadi M., Lange G & Tajibaeva L.A World Bank Publication, (2006).

The original article at 208 pages has been summarised by NatureFirst-GEMS.

To see the full article please go to:
http://books.google.co.uk/books?id=4bJQge7WFHAC&dq=Where+is+the+Wealth+of+Nations%3F+Measuring+Capital+for+the+21st+Century+World+Bank+Publication+2006&printsec=frontcover&source=bl&ots=VQNBq0QMEu&sig=OlcWAbbyTvuia3N5YQijhrZO23s&hl=en&ei=nNp\_SpnnNpiQ6AOa7J1P&sa=X&oi=book\_result&ct=result&resnum=6#v=onepage&q=&f=false



#### **The Genuine Progress Indicator 2006**

Dr. John Talberth, Clifford Cobb, and Noah Slattery. Abridged

#### The Genuine Progress Indicator 2006

In October of 1995, the Atlantic Monthly published "If the GDP is Up, Why is America Down?" a seminal piece exposing the paradox of economic growth in America. Despite the chorus of upbeat economic assessments made by economists at that time, most Americans were feeling left behind, worse off, and troubled by their future prospects. The piece introduced readers to the Genuine Progress Indicator (GPI), a more holistic measure of the nation's welfare that took into account the costs of environmental degradation, inequality, insecurity, and social breakdown. Measuring economic welfare using the GPI rather than GDP painted a far less rosy portrait of the American economy, but one that was much more reflective of the experiences of American citizens.

Redefining Progress has now released the first significant update to the GPI since that time. The full report, which incorporates data through 2004, can be viewed online at www.rprogress.org. As in 1995, we have been hearing a lot about how well our economy is doing. At the same time, we are all too aware of the increasing toll associated with global warming, poverty, urban sprawl, exported jobs, and war The GPI 2006 update addresses these and other aspects of our well being that fail to register in GDP figures and other common measures of economic progress. The results of this new study are alarming—while per capita GDP has risen dramatically—from \$11,672 in 1950 to well over \$36,595 today; per capita GPI has stagnated in the \$14,000-\$15,000 range since the late 1970s. Figure 1 illustrates these trends.

#### What is the Genuine Progress Indicator?

During World War II gross domestic product (GDP) accounts were introduced to measure wartime production capacity (Cobb et al., 1995). Since then, GDP has become the world's most ubiquitous indicator of economic progress. It is widely used by policymakers, economists, international agencies and the media as the primary score card of a nation's economic health and well being. Yet, as we know from its creator Simon Kuznets the GDP was never intended for this role (Kuznets, 1934). It is merely a gross tally of products and services bought and sold, with no distinctions between transactions that enhance well being and those that diminish it. Instead of distinguishing costs from benefits, productive activities from destructive ones, or sustainable ones from unsustainable ones the GDP simply assumes that every monetary transaction adds to social well being by definition. In this way, needless expenditures triggered by crime, accidents, toxic waste contamination, preventable natural disasters, prisons and corporate fraud count the same as socially productive investments in housing, education, healthcare, sanitation, or mass transportation. It is as if a business tried to assess its financial condition by simply adding up all "business activity," thereby lumping together income, expenses, assets and liabilities.

Beginning with the seminal work of Daly and Cobb (1989) there have been several attempts to develop alternative national income accounting systems that address these deficiencies. Collectively, these systems measure what is commonly referred to as "green" GDP? Major objectives of these green GDP accounting systems are to provide a more accurate measure of welfare and to gauge whether or not an economy is on a sustainable time path (Hanley, 2000). Two of the most popular green GDP systems are the Index of Sustainable Economic Welfare (ISEW) and the Genuine Progress Indicator (GPI).

FIGURE 1: Real GDP and GPI Per Capita 1950-2004 in \$2000



While methodologies differ somewhat, the ISEW, GPI, and other green GDP accounting systems all involve three basic steps (Stockhammer et al., 1997; Neumayer, 2000). Computation usually begins with estimates of personal consumption expenditures, which are weighted by an index of inequality in the distribution of income to reflect the social costs of inequality and diminishing returns to income received by the wealthy. Additions are made to account for the non-market benefits associated with volunteer time, housework, parenting, and other socially productive time uses as well as services from both household capital and public infrastructure. Deductions are then made to account for purely defensive expenditures such as pollution related costs or the costs of automobile accidents as well as costs that reflect the undesirable side effects of economic progress. Deductions for costs associated with degradation and depletion of natural capital incurred by existing and future generations are also made at this stage. Table 1 (page 3) provides a line by line summary of these adjustments in 2004, the latest year for which data are available.

By making these adjustments, the GPI corrects the deficiencies of GDP by incorporating aspects of the non-monetised or non-market economy, separating welfare enhancing benefits from welfare detracting costs, correcting for the unequal distribution of income, and distinguishing between sustainable and unsustainable forms of consumption.

#### What improvements were made in 2006?

The GPI 2006 update makes a number of improvements and additions to the basic GPI methodology first developed in the late 1990s. These improvements can be grouped under two broad headings: new data sources and new calculations. Examples of new data sources include the Bureau of Labour Statistics' American Time Use Surveys (ATUS) in 2003 and 2004. The new ATUS data was used to improve our calculations of the value of housework, parenting, and volunteering. As another example, we incorporated new research from the U.S. Forest Service on logging related erosion and deforestation. We also used new data as well as new valuation studies to assign costs to farmland, wetland, and forest losses.

The GPI 2006 update also includes calculations that did not appear in our previous GPI publications. One calculation is the non-market benefits associated with higher education, benefits that amount to \$16,000 per year per college educated worker. We expanded our deforestation estimates to include economic damages associated with loss of roadless areas, ancient forests in the Pacific Northwest and Alaska, and loss of loblolly pine forests in the Southeast. We also added carbon emissions damage to reflect the ever increasing costs of global warming. A complete explanation of these improvements appears in the full report.

#### Key results from the 2006 update

A detailed GPI accounts for the 1950-2004 period reveal alarming results. While per capita GDP has risen dramatically, from \$11,672 in 1950 to well over \$36,595 today, per capita GPI has stagnated in the \$14,000-\$15,000 range since the late 1970s. This implies that since the late 1970s, the benefits of economic growth have been entirely off set by rising inequality, deteriorating environmental conditions, and a decline in the quality of our lives. Key findings of our 2006 update include:

- Drought, floods, sea level rise, and severe storms exacerbated by global warming are taking
  their toll on the U.S. economy. Conservatively, we estimate the costs of our carbon emissions
  on existing and future generations to be just over \$1 trillion per year. The losses from
  hurricanes like Katrina represent the "cashing out" of environmental debt that is properly
  accrued in the GPI.
- Income inequality is at its greatest level since 1950. The income distribution index—which measures income inequality—increased by 20% since 1968, the year the nation's income was distributed most equitably. When growth is concentrated in the wealthiest income brackets it counts less towards improving overall economic welfare because the social benefits of increases in conspicuous consumption by the wealthy are less beneficial than increases in spending by those least well off. So a dollar of economic growth today counts far less than it did when our income distribution was more equitable.
- Urban sprawl gobbles up prime farmland; increases commute times, exacerbate urban air, water, and noise pollution, and increases accident rates. We estimate the costs of urban sprawl to be over \$1.1 trillion each year.
- Globalisation has exported America's vast manufacturing infrastructure overseas and with it a
  source of productive investments. As a result, an increasing share of foreign investment in the
  U.S. today is used to finance consumer debt and government spending for tax breaks and the
  wars in Iraq and Afghanistan. This puts us in the position of being a net borrower. Net
  borrowing today is a record \$254 billion, a cost overlooked by GDP.
- The GDP counts all \$600 billion plus spent on wars each year as a benefit —despite the fact that over half of all Americans disapprove of the war and decry its daily toll on American families, our long term security, the environment, Iraqi and Afghanistan societies, and our international reputation. The GPI recognises that this spending is defensive—at best it helps maintain the status quo, at worst, it is a liability on our future. In any case, it should not be counted towards progress.
- The increase in the number of college graduates in the population is increasingly paying off in
  the form of many non-market benefits such as increases in the stock of knowledge, worker
  productivity, civic participation, job market efficiency, savings, research and development
  activities, charitable giving, and health. These benefits amount to roughly \$828 billion each
  year.
- Volunteerism is on the rise, and represents some of the most valuable work performed in our country. The GPI estimates the value of volunteer work in America to be over \$130 billion. On a per capita basis, the value of work performed by churches and synagogues, civic associations, neighbourhood groups, and non-profits rose from \$202 in 1950 to \$447 today, implying that over the past few decades, Americans have become more generous with their time and that this time is of much greater worth.

#### **Policy implications**

Anielski (2001) asserts that GPI accounts "provide vital information for holistic and integrated policy decision making, covering virtually every area of government policy." In the GPI 2006 Update, we demonstrate the usefulness of GPI accounts to public policy by examining the

effects of globalisation, tax cuts, and urban sprawl on GPI growth. By using GPI in the framework of standard economic growth models, we demonstrate the fallacies of relying exclusively on GDP growth as a guide to public policy.

#### Globalisation (economic openness)

The vast majority of economic growth models used today demonstrate that greater economic openness (globalisation) has a strongly positive effect on economic growth. However, those models rely on GDP growth, not growth in true economic welfare. In the GPI 2006 update, we refine a model used first by Talberth and Bohara (2006) testing the relationship between globalisation and growth in GPI. Our modelling suggests a significant negative non-linear correlation between growth in the U.S. GPI and economic openness. In other words, while openness indeed enhances the GPI up to a certain point, once that threshold is surpassed, GPI growth begins to decline. The results provide some empirical support for the burgeoning literature associating greater openness with environmental degradation, income inequality, and an increase in economic activity that may be self cancelling from a welfare perspective. They also suggest a cautionary approach to trade liberalisation policy that is cognisant of the fact that liberalisation may be counterproductive past a particular threshold.

#### Tax cuts

Tax cuts have been one of the most visible economic policy debates since the Bush Administration took office in 2001. The issue has been a bone of

Table 1: GPI contributions and Deduc	ction	s (2004)
Contributions		Amount
		(billions)
Personal consumption expenditure		\$7,588.60
Weighted personal consumption	+	6.318.41
expenditure (adjusted for inequality)		
Value of housework & parenting	+	2,542.16
Value of higher education	+	827.98
Value of volunteer work	+	131.30
Service of consumer durable	+	743.72
Service of streets & highways	+	111.55
Net capital investment (positive in 2004,		388.80
so included in contributions)		
Total positive contributors to the GPI	<b>\$1</b>	1,063.92
Deductions		Amount
		(billions)
Cost of crime		\$34.22
Loss of leisure time		401.92
Costs of unemployment & under-		176.96
employment		
Cost of consumer durable purchase		1089.91
Cost of commuting		522.61
Cost of household pollution abatement		21.26
Cost of audio accidents		175.18
Cost of water pollution		 119.72
Cost of air pollution		40.05
Cost of noise pollution		 18.21
Loss of wetlands		53.26
Lost of farmland		263.86
Loss of primary forest cover		50.64
Depletion of non-renewable resources		1,761.27
Carbon dioxide emissions damage		1,182.82
Cost of Ozone depletion		478.92
Net foreign borrowing (positive in 2004,		254.02
so include in deductions)		
Total negative deductions to the GPI		6,644.83
Genuine Progress Indicator 2004		4,419.09 
	,	

contention in both policy and academic circles. In the context of standard growth theory, tax cuts can stimulate long term economic growth by encouraging productivity-enhancing investments, stimulating research and development, increasing consumer spending, and removing market distortions. On the other hand, tax cuts can harm economic growth if not matched by a commensurate decrease in government spending; otherwise, they will raise deficits and interest rates. If tax cuts disproportionately benefit the wealthy, the resulting "windfall gains" on asset holders may undermine incentives for new investments (Gale and Orszaq, 2005).

To shed light on this debate, we modelled the effects of per capita tax collections on GPI growth (lagged). We found a strong positive correlation between the change in per capita tax collections and growth of the GPI. This finding is consistent with the historical relationship between higher taxes and high economic growth (as measured by GDP) noted by Hashemzadeh and Wayne (2004). A full investigation of these findings to determine the exact channel by which changes in taxes influence GPI growth is beyond the scope of our GPI 2006 Update. Nonetheless, as with openness, we demonstrated the potential usefulness of GPI data to inform the debate over tax cuts and other adjustments to tax policy.

#### Sprawl

In the GPI 2006 Update, we examined how the degree of urbanisation affected the GDP – GPI gap. By looking at the gap, we can simultaneously consider changes in economic growth (GDP) and welfare (GPI). In years when the gap is widening, the costs of economic growth are more than off set by the deleterious social and environmental welfare costs of that growth. In years when the gap is closing, positive contributions to GPI overshadow these costs and economic growth is welfare enhancing. The urbanisation variable included in our model is a good proxy for urban sprawl since it measures the amount of urban land per person.

There is little dispute that public policy has a direct influence on the extent of urban sprawl. According to the Environmental Protection Agency (EPA), a number of federal urban growth and development programs "intentionally or unintentionally accelerated the spread of low density development and businesses at greater distances from towns and cities" (EPA, 2006). The question is whether or not urban sprawl enhances or detracts from welfare by causing the GDP – GPI gap to widen or close since more urban land area per capita has both beneficial (i.e. more public infrastructure services) and adverse (i.e. lost farmland) effects on the GPI. Our model found a strong positive relationship between growth in urban land area per capita and the gap. This suggests that on balance, the personal consumption, time savings, and public infrastructure benefits from sprawl are more than off set by the costs associated with traffic congestion, auto-accidents, carbon emissions, and lost farmland.

#### **Future GPI Updates**

This year, Redefining Progress is planning to launch an invigorated campaign to discredit GDP as a basis for economic performance monitoring and policy making and spotlight the importance of alternatives such as the GPI. To this end, we are planning to issue more regular updates to the GPI to coincide with quarterly and annual releases of GDP figures. At the same time, we will be recruiting a top notch team of economists to help bolster the GPI's accuracy by conducting original non-market valuation studies and otherwise improving the data on which the GPI is based. We will also be advocating for increased use of the GPI in policy settings at the federal, state, and local level. Finally, as we have done so successfully with the Ecological Footprint, we are planning to integrate the GPI into formal education at both the K-12 and college levels. We are looking for non-profit partners, donors, and experts to help with this effort. Please contact Redefining Progress to find out how you can help.

#### Natural Gist

- Gross domestic product (GDP) was introduced during World War II to measure wartime production capacity. Since then GDP has become the world's most universal indicator of economic progress.
- GDP is oblivious to gross inequalities. It plummets as communities become more self reliant and implies crime is good for economic growth.
- Green GDP systems that are popular are; index of Sustainable Economic Welfare (ISEW) and the Genuine Progress Indicator (GPI).
- The Genuine Progress Indicator (GPI) is one of the first alternatives to GDP vetted by the scientific community and used regularly by government and non-governmental organisations worldwide.
- GPI is a holistic measure of the nation's welfare as it takes into account the costs of environmental degradation, inequality, insecurity, and social breakdown.
- If GPI is falling it implies that the economic system is eroding the sustainability of those stocks and limiting the next generation's prospects. If GPI is stable or increasing in a given year the implication is that stocks of natural and social capital on which all goods and services flows depend will be at least as great for the next generation.
- GPI can be applied to standard economic growth models and past data to inform policy debates, tax cuts, and urban sprawl and promote economic openness.
- Future GPI iterations will make it more accurate, robust and more widely endorsed.

#### The Genuine Progress Indicator 2006, Dr. Talberth J., Cobb C., & Slattery N.

The original article is a joint effort by Dr. Talberth J., Cobb C., & Slattery N, published at Redefining Progress, the nature of economics website. Redefining Progress is a leading public policy think tank.

To accommodate this key piece, NatureFirst - Green Ecological Managed Services have taken core extracts from this article. To read the full article please go to: http://www.rprogress.org/publications/2007/GPI2006\_ExecSumm.pdf (executive summary)

http://www.rprogress.org/publications/2007/GPI%202006.pdf (full article)



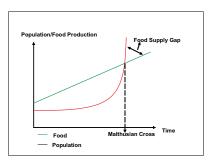
#### **World Food Security - A Global Warning**

Ranjit Barthakur & Dipak Kripalani, NatureFirst

#### **Background and Context**

Traditionally the concern over food security was looked upon as a simple relationship between quantities of food produced vis-à-vis the world population.

The Rev. Thomas Robert Malthus, way back in 1798, was one of the first people to study the relationship between world population and food. According to Malthus, human population, if left unchecked, grows in geometric progression (exponentially), while food supply grows only in arithmetic progression (linearly). Thus according to the Malthusian thinking, population growth will sooner or later outgrow the food supply.



However, over time the variables involved in food security have become more complex and it is no longer a simple relationship between population and food production. Our understanding of food security has also become more complete.

To predict future availability of food it is not just enough to project population to forecast demand. One also needs to know the rate of income growth and have good estimates of how food expenditure changes as incomes rise.

Supply predictions have graduated from trend projections of land area and yields to the need to project changes in production intensity, the relationship between yields and research investment, the degree to which stocks of resources—water, land, energy—potentially constrain output, and the impact of declines in fisheries on food security. Further questions of such environmental constraints continue to emerge.

From 1970s onwards food supply under went further dramatic changes. The Green Revolution brought about dramatic increases in production and productivity. In the late nineteenth and twentieth centuries improvements in biological understanding—genetics and agronomy—and the development of synthetic agricultural chemicals, substantially increased yields per unit of land and this became an alternative to simply expanding agricultural land area. Furthermore, genetically altered plants matured earlier and enabled more crops per year and irrigation development led to an increase in both yields and cropping intensity.

However, the "Green Revolution" also began to raise environmental and social issues about rapid increases in crop yields. Soon many of the issues that emerged post 1970s - new varieties, population, and resource limits – were added to the issues of global food security.

The very problem of food insecurity that was to be solved by the "Green Revolution", in the long run seemed to be exacerbated by it.

The modern concept of food security has developed in the last three decades. The modern definition of food security not only includes food availability, but also has additional elements such as economic access to food and the biological absorption of food in the body.

#### What is Food Security?

"....when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life..."

The current reasons for global food insecurity are many: conflict, poverty, population growth, environmental degradation, limited agricultural technology, ineffective policies, and disease. Large-scale scarcity, however, is no longer on the list since the growth rate in world food production has at last surpassed population. This, means enough food is available per person, but this food is distributed unevenly. Many low income countries have difficulty producing enough food and so food scarcity remains at a national level. Plus there is inequality of food consumption within countries - the result of uneven purchasing power. This problem exists even with in the high income, and food surplus countries such like the United States.

#### Challenges to Food Security

Global food security faces the following challenges, on both the demand and supply side:

## Demand Side Challenges Rampant population growth Food availability Access to food Changing consumption patterns Supply Side Challenges Land resources management Water resources management Agro chemicals Genetically modified food Loss of crop productivity

Such challenges are explained in more detail below.

#### **Demand Side Challenges**

#### Rampant Population Growth

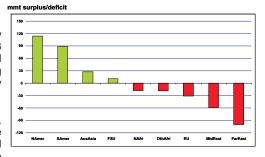
The United Nations (UN), 2001, report indicates that world population will grow from 7.2 billion (2015) to 9.3 billion (2050) and of them 800 million people (8.6%) are expected to be challenged in terms of food security.

This population explosion along with high levels of per capita consumption, arising out of greater levels of per capita income especially in the developed countries, have made the threat of global food insecurity very eminent. During the last decade alone the world food consumption has increased at an average rate of 19%. Seven countries have a population of over 100 million (China, Indonesia, Brazil, India, Pakistan, Nigeria and Bangladesh), and all but Bangladesh have high levels of per capita food consumption. In India, projections indicate that population will be 1.5 billion by 2050 which will increase demand for an already stressed food production. Rising population and increased per capita income will push up demand and this needs to be met through enhanced food productivity.

The explosion in population has also affected the per capita availability of agricultural area. In 2003, the global average agricultural area per capita was only 0.78 Ha.

The average figure for the developed nations was healthier at 1.33 Ha/person, while it was miserably low for the developing nations at 0.63 Ha/person. This reduction in land availability per person has far reaching implications on agricultural productivity and thus food security.

For many of the world's people, agriculture remains a subsistence activity. 90 percent of the food produced in the world is consumed within the



country producing it, and most of that usage lies outside of the commercial system.

#### Food Availability

Food availability is a very important component of food security. The composition of food consumption is estimated to remain unchanged and continue to depend on a relatively few number of traditional food commodities such as cereals and grains.

The average annual growth rate of per capita food production from 1996 - 2005 has been 1.1%, 0.2%, and 0% for the world, developed nations and developing nations respectively. Over the same period the world population has been growing at an average rate of approximately 1.5%. The imbalance is evidently clear.

The availability of food is also dependent to a large extent on the regional flows of food supply. The global distribution of population is not even — nearly 51% of the global population is concentrated in the developing & underdeveloped countries of the world. Unfortunately, the distributions of global food does not correspond to the global distribution of population. This results in an uneven distribution of food leading to a situation where countries with higher purchasing power are over supplied while the lesser developed and nations in transition are left with a short fall in supply. Consequently equitable regional distribution of food becomes an important aspect in achieving food security.

But food availability does not guarantee food security, which depends also on the ability to buy food and to utilise it effectively. Individual health and education levels, as well as local conditions such as safety of the water supply, affect the ability to utilise food effectively.

#### Access to Food

After food availability access to food is the next most important aspect of food security. Food accessibility is another term for the capacity of people to purchase the available food. It is directly dependent on the levels of income and prosperity of nations.

Despite the global increase in food supplies since the 1970s, there is still in excess of 850 million undernourished people in the world today. Most of these people are concentrated in some of the poorest nations of the world, such as the Sub Saharan nations, like Bangladesh, with the level of hunger and undernourishment highest in rural areas. This is ironic as these very same rural areas produce most of the world's food.

Greater food security, however, is not just about cost, choice and access to supplies; it also is about the ability to pay. Worldwide, some 1 billion people in 70 of the lower income countries are hungry, and the situation could grow worse in the poorest countries. Most of these people live in rural areas where food is produced. Reducing poverty is a major key to food security.

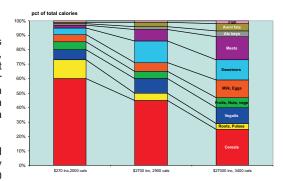
Today, about half the world's population -3 billion people - live in abject poverty. Roughly three-fourths of these poor people live in rural areas dependent upon agriculture. No country that has raised the majority of its people out of poverty has done so without attacking the causes of rural poverty.

Thus in ensuring food security it is imperative that accessibility to the food produced also be increased through sustainable development mechanisms.

#### **Changing Consumption Patterns**

Food consumption patterns constantly undergo changes, primarily driven by income levels. It is generally observed that as the per capita income increases in countries, the general consumption pattern of food also undergoes a change.

In low-income countries (around \$270 per capita income), the daily consumption of food is about 2000



calories on average, with around 70%-75% of food consumption being cereals and pulses. As the per capital income rises, higher protein items such as milk, eggs and meat increasingly enter the food consumption profile. At high income levels, only a small portion of the diet comprises of cereals and pulses, with the larger portion of the diet containing more high protein and high value foods. As countries develop, and per capital income increases, the consumption patterns shift significantly, and this shift also needs to be taken into account to ensure food security.

#### Supply Side Challenges

The major challenge to food security in the world is the underdeveloped agricultural sector that is characterised by several environmental problems including over exploitation of natural resources like soil, water, forest, atmosphere and the genetic base, which put together has led to a fragile ecosystem. Water and air pollution due to indiscriminate use of agrochemicals such as inorganic fertilisers and pesticides, soil degradation, depletion of soil fertility and extinction of plant species are among the glaring problems that raise questions about the feasibility of the technology being utilised to meet the challenges of current and future food demand.

The key challenges are:

#### **Land Resource Management**

Constant increase in demand, from a burgeoning population, for food, fodder, fuel and shelter puts a tremendous pressure on our land resources, This results in a continuous decline of the cultivable land area at a fast rate. Vegetation that is cleared for varied human activities results in accelerated run-off which in turn gives rise to soil erosion and landscape degradation. These are among the glaring environmental problems badly affecting soil productivity and continuously turning productive lands into wastelands.

Among the different processes responsible for land degradation, erosion of soil (through water and wind) is the most destructive. Efficient land resource management needs to be given adequate attention to increase the productive capacity of land and to prevent it from deterioration. Using soil surveys and watershed analysis due priority needs to be given to suitable location, specific soil conservation and land reclamation measures.

Shifting cultivation involves clearing a patch of forested land, cultivating it for two to three years and then abandoning it for 10-20 years. This allows the natural forest to grow back, repairing itself and the soil to regain its fertility. It is cultivation technique that also helps in retaining useful trees and plant varieties. The Jhum cycle, as it is called, practices conservation and the retention of the ecological balance.

However, with rising population pressure, communities want to grow more food and have cleared greater areas of forest land and returned to the fallow plots much sooner than 10-20 years. The length of the fallow phase between two successive cropping phases has come down to even two and three years in places. This has resulted in soil degradation; fall in yield, lower returns, and a reduction in green cover.

It is this change in traditional practice, arising out of changing demands, that has given jhum agriculture a bad name. Separately, forests are being exploited for timber and hills are being flattened for soil and stones. Often, this denuding of the forest too is blamed upon jhum cultivation.

#### Ethanol / Bio Diesel and World Agriculture

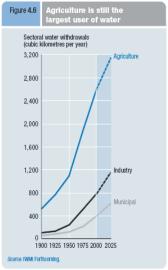
The world is currently facing severe food price inflation especially in terms of food grain and soya beans. However unlike previous occasions when the food price inflation has been the result of weather reduced harvest, this time the chief cause is demand rapidly outstripping supply. This has been further exacerbated by the rapid growth of the Ethanol industry in the US, which consumed 81 million tonnes of grains in 2007.

Food prices for grains will never be able to compete with fuel prices for grains. As the global demand of grains for fuel increases, more and more food grains will be diverted to fuel production, simply because of better returns from fuel production. This will lead to a worsening food price situation. The result may be 1.2 billion hungry people by 2025. Source: Lester R. Brown, Earth Policy Institute (EPI), 2008

#### Water Resource Management

Alone agriculture remains the dominant user of water resources and the gap between population growth and demand for water has also tremendously increased: as the world becomes richer and more industrialised, each person in it has been using more water. In developing countries agriculture still accounts for more than 80% of water consumption. The agricultural sector faces the real challenge. People have a minimum basic water requirement of 20-50 liters each day. Compare this with the 3,500 liters to produce enough food for a daily minimum of 3,000 calories. In other words, it takes roughly 70 times more water to produce food than people use for domestic purposes. Growing a single kilo of rice takes 2,000-5,000 liters of water. But some foods are thirstier than others. It takes eight times more water to grow a tonne of sugar than a tonne of wheat.

Agiculture is still the largest consumer of water



Source: Human development report 2006

It is estimated that 40% of all crops grown in the world today are grown using irrigation. The practice of irrigation can increase the productivity of crops on what would otherwise be rain-fed agriculture. It can also expand agriculture into areas where it would not otherwise be practiced due to aridity. Such uses lead to vast quantities of water exploitation and also cause extensive pollution, primarily by introducing non point source contaminants. Runoff from agricultural fields often contains fertilisers, animal manure, or pesticides that together form a major source of water pollution.

The National Policy on Water, 2002 (India) declares water as a scarce and precious natural resource to be planned, developed and conserved on an integrated and environmentally sound basis. Water resources in India will continue to decline due to increased urbanisation and industrialisation.

A World Bank Survey reveals that most of India's irrigation projects suffer from deficiencies of design, construction and maintenance. This is resulting in, amongst other things, poor drainage and water logging, large volumes of water loss, low water use efficiency and loss of a large quantity of fertilisers.

The measures that can be adopted for recommended production technology and crop planning include increased water use efficiency, crop diversification, use integrated watershed development to utilise rainwater, ground water, soil water and runoff water efficiently, artificially recharging the ground water through a series of check dams in natural streams, percolation tanks and recharge wells.

#### **Agro Chemicals**

Despite the fact that an extensive use of fertilisers and effective control of pests and insects through pesticides has largely been responsible for a quantum jump in agricultural production, their injudicious use has given rise to a number of environmental issues.

There has been a phenomenal increase in the use of pesticides in the world over the last three decades to combat pest attack. The multifarious harmful consequences of its indiscriminate use have posed a serious threat to the ecosystem and so has the per capita consumption of fertilisers, which has increased. Although pesticides have always played an important role to prevent crop losses caused by crop pests, their indiscriminate use has given rise to grave consequences such as residual toxicity in food, feed, fodder, environmental pollution, development of resistance in pests to pesticides, destruction of predators and parasites and pest resurgence.

Environmental pollution such as eutrophication and nitrate contamination of the surface and ground water resources are also caused by such agro-chemicals. Moreover, pesticides and fertilisers can be expected to be over -used due to risk aversion among farmers. This means farmers will prefer to over-use chemincals rather than under use them, as the latter option is associated with the risk of lower profit from crop yield. The fact that the increased use of pesticides has seriously endangered our environmental sustainability an integrated approach to pest management must be given adequate importance to make agriculture eco-friendly.

However with increasing awareness on the ill effects of pesticides, and the increasing popularity of Genetically Modified food, a decreasing trend in the extent of pesticide use has been gradually observed.

#### Genetically Modified (GM) Food

Genetically Modified (GM) foods promises, in a number of ways, to meet the growing need of the population, such as; improving food availability, nutritional quality and shelf life of harvested produce and in developing plants resistant to insect pests, disease pathogens and herbicides.

However, as is true with all innovations and changes involving complex systems, there will always be trade-offs. Making the best choices will always be a matter of weighing the risks against the benefits, so as to avoid or mitigate the unwanted consequences, and intelligently decide which to accept and which to reject. Genetically modified crops (GMCs) have attracted many critics because of their potential impacts on biodiversity, toxicity to non-target organisms, cross-resistance in pests, the higher prices of seeds and foods, monopoly of companies, patent and regulatory approval, and safety to consumers. Some consider that GMCs are unwanted, unsafe and unnecessary, and can lead to an increasing depletion of bio-diversity in agriculture while others favour their introduction and use. The debate about its advantages and disadvantages continues among a wide spectrum of people from different walks of life.

#### **Loss of Crop Diversity**

Existence of strains with vast genetic diversity within the same crop species provides a basis for crop improvement. Apart from physical & biological adaptation, a host of economic, cultural, religious, and survival factors have played a role in such diversification for instance several varieties of rice and other crops were grown in many parts of India just for their use during festivals, marriages, or other auspicious occasions; several others were grown for their taste, colour or smell; yet others for their pesticide or soil fertilisation characteristics.

Considering the case of India, like many large tropical countries, it is characterised by a complex mosaic of distinct agro- ecosystems differentiated by their climate, soil, geology, vegetation, crops grown (?) and other features. According to agricultural scientists at least 166 food crops have originated in India, including rice, pigeon pea, turmeric, ginger, pepper . However enormous exploitation of forest resources to accommodate human activity has resulted in a loss of valuable gene pools of different crop species including their wild relatives.

And with present intensive agriculture, continuous cultivation of a limited number of high yielding and economically profitable cultivars of choice, often the end result is the narrowing of genetic biodiversity. It in turn not only aggravates the infestation of insect pests and diseases, but also raises concerns about the stability of production. Depletion of genetic diversity, an unfettered outcome of the current trend of cultivation, seriously threatens the future progress of the genetic improvement of crop.

This erosion of agricultural bio- diversity threatens long term stability & sustainability of agriculture itself in several ways. Firstly, it erodes the genetic base on which scientists depend for continuous improvement of crops. Secondly, by opting for high yield varieties (HYV's), farmers becomes increasingly dependent on the industry dominated market and the Government.

#### Conclusion

For every human being, today is a reality and tomorrow is a possibility meaning the hungry need food today and not just promises for tomorrow. To overcome this problem we have to produce more crops but produce it differently, in a manner that high yields can be obtained in perpetuity without any associated ecological or social impact. A farming systems' intensification, diversification and value addition are extremely important to generate the needed on farm and non farm employment, but an awareness for food security has to be spread. There is also a need for greater research in the field of breeding crop varieties to ensure they have the quality and characteristics needed for food processing and exports.

There is no time to relax, both on the production and consumption fronts - concurrent attention to production and consumption is important. Enhancing production through an ever green revolution is a priority task. However, eliminating widespread endemic hunger is both a national responsibility and an ethical obligation.

The biggest questions that remains to be answered are; can we feed a growing population with biologically diverse agriculture and can farmers achieve livelihood security through diversity? It is evident that there is great potential to increase and sustain food production through a mix of strategies to revive diversity.

Hence it is not a question of "feeding the world" but "keeping the world fed" wherein lies true food security.

## Natural Gist

- Increased food demand, is largely due to population growth. A United Nations (UN), 2001, report indicates that world population will continue to grow from 7.2 billion (2015) to 9.3 billion (2050) and of them 800 million people or 8.6% are expected to be challenged in terms of food security.
- In the 1970's, severe food stress led to the <u>Green Revolution</u>, enabling a significant increase in food production and productivity. However it seems in the long term food insecurity has actually been exacerbated.
- Today the growth rate in world food production has surpassed population so there is <u>globally enough food per person</u>, but food is distributed unevenly.
- Current causes of food insecurity on both the supply and demand side are: conflict, poverty, population growth, environmental degradation, limited agricultural technology, ineffective policies and disease.
- Enhancing production through an <u>ever green revolution</u> is a priority task to eliminate endemic hunger.
- We need to investigate how we feed a growing population with biologically diverse agriculture. Aiming for farmers to achieve <u>livelihood security through diversity</u>.



#### **Could Food Shortages Bring Down Civilisation?**

By Lester R Brown, (May 2009)

The biggest threat to global stability is the potential for food crises in poor countries to cause government collapse.

One of the toughest things for people to do is to anticipate sudden change. Typically we project the future by extrapolating from trends in the past. Much of the time this approach works well. But sometimes it fails spectacularly, and people are simply blindsided by events such as today's economic crisis.

For most of us, the idea that civilisation itself could disintegrate probably seems preposterous. Who would not find it hard to think seriously about such a complete departure from what we expect of ordinary life? What evidence could make us heed a warning so dire—and how would we go about responding to it? We are so inured to a long list of highly unlikely catastrophes that we are virtually programmed to dismiss them all with a wave of the hand: Sure, our civilisation might devolve into chaos—and Earth might collide with an asteroid, too.

For many years I have studied global agricultural, population, environmental and economic trends and their interactions. The combined effects of those trends and the political tensions they generate point to the breakdown of governments and societies. Yet I, too, have resisted the idea that food shortages could bring down not only individual governments but also our global civilisation.

I can no longer ignore that risk. Our continuing failure to deal with the environmental declines that are undermining the world food economy—most important, falling water tables, eroding soils and rising temperatures—forces me to conclude that such a collapse is possible.

#### The problem of failed states

Even a cursory look at the vital signs of our current world order lends unwelcome support to my conclusion. And those of us in the environmental field are well into our third decade of charting trends of environmental decline without seeing any significant effort to reverse a single one.

In six of the past nine years world grain production has fallen short of consumption, forcing a steady drawdown in stocks. When the 2008 harvest began, world carry over stocks of grain (the amount in the bin when the new harvest begins) were at 62 days of consumption, a near record low. In response, world grain prices in the spring and summer of last year climbed to the highest level ever.

As demand for food rises faster than supplies are growing, the resulting food-price inflation puts severe stress on the governments of countries already teetering on the edge of chaos. Unable to buy grain or grow their own, hungry people take to the streets. Indeed, even before the steep climb in grain prices in 2008, the number of failing states was expanding [Purchase the digital edition to see related sidebar].

Many of their problems stem from a failure to slow the growth of their populations. But if the food situation continues to deteriorate, entire nations will break down at an ever increasing rate. We have entered a new era in geopolitics. In the 20th century the main threat to international security was superpower conflict; today it is failing states. It is not the concentration of power but its absence that puts us at risk.

States fail when national governments can no longer provide personal security, food security and basic social services such as education and health care. They often lose control of part or all of their territory. When governments lose their monopoly on power, law and order begin to disintegrate. After a point, countries can become so dangerous that food relief workers are no longer safe and their programs are halted; in Somalia and Afghanistan, deteriorating conditions have already put such programs in jeopardy.

Failing states are of international concern because they are a source of terrorists, drugs, weapons and refugees, threatening political stability everywhere. Somalia, number one on the 2008 list of failing states, has become a base for piracy. Iraq, number five, is a hotbed for terrorist training. Afghanistan, number seven, is the world's leading supplier of heroin. Following the massive genocide of 1994 in Rwanda, refugees from that troubled state, thousands of armed soldiers among them, helped to destabilise neighbouring Democratic Republic of the Congo (number six).

Our global civilisation depends on a functioning network of politically healthy nation-states to control the spread of infectious disease, to manage the international monetary system, to control international terrorism and to reach scores of other common goals. If the system for controlling infectious diseases—such as polio, SARS or avian flu—breaks down, humanity will be in trouble. Once states fail, no one assumes responsibility for their debt to outside lenders. If enough states disintegrate, their fall will threaten the stability of global civilisation itself.

# A new kind of food shortage

The surge in world grain prices in 2007 and 2008—and the threat they pose to food security—has a different, more troubling quality than the increases of the past. During the second half of the 20th century, grain prices rose dramatically several times. In 1972, for instance, the Soviets, recognising their poor harvest early, quietly cornered the world wheat market. As a result, wheat prices elsewhere more than doubled, pulling rice and corn prices up with them. But this and other price shocks were event-driven—drought in the Soviet Union, a monsoon failure in India, crop-shrinking heat in the U.S. Corn Belt. And the rises were short-lived: prices typically returned to normal with the next harvest.

In contrast, the recent surge in world grain prices is trend-driven, making it unlikely to reverse without a reversal in the trends themselves. On the demand side, those trends include the ongoing addition of more than 70 million people a year; a growing number of people wanting to move up the food chain to consume highly grain-intensive livestock products [see "The Greenhouse Hamburger," by Nathan Fiala; Scientific American, February 2009]; and the massive diversion of U.S. grain to ethanol-fuel distilleries.

The extra demand for grain associated with rising affluence varies widely among countries. People in low-income countries where grain supplies 60% of calories, such as India, directly consume a bit more than a pound of grain a day. In affluent countries such as the U.S. and Canada, grain consumption per person is nearly four times that much, though perhaps 90% of it is consumed indirectly as meat, milk and eggs from grain-fed animals.

The potential for further grain consumption as incomes rise among low-income consumers is huge. But that potential pales beside the insatiable demand for crop-based automotive fuels. A fourth of this year's U.S. grain harvest—enough to feed 125 million Americans or half a billion Indians at current consumption levels—will go to fuel cars.

Yet even if the entire U.S. grain harvest were diverted into making ethanol, it would meet at most 18% of U.S. automotive fuel needs. The grain required to fill a 25-gallon SUV tank with ethanol could feed one person for a year.

The recent merging of the food and energy economies implies that if the food value of grain is less than its fuel value, the market will move the grain into the energy economy. That double demand is leading to an epic competition between cars and people for the grain supply and to a political and moral issue of unprecedented dimensions. The U.S., in a misguided effort to reduce its dependence on foreign oil by substituting grain-based fuels, is generating global food insecurity on a scale not seen before.

#### Water shortages mean food shortages

What about supply? The three environmental trends I mentioned earlier—the shortage of freshwater, the loss of topsoil and the rising temperatures (and other effects) of global warming—are making it increasingly hard to expand the world's grain supply fast enough to keep up with demand. Of all those trends, however, the spread of water shortages poses the most immediate threat. The biggest challenge here is irrigation, which consumes 70% of the world's freshwater. Millions of irrigation wells in many countries are now pumping water out of underground sources faster than rainfall can recharge them. The result is falling water tables in countries populated by half the world's people, including the three big grain producers—China, India and the U.S.

Usually aquifers are replenishable, but some of the most important ones are not: the "fossil" aquifers, so called because they store ancient water and are not recharged by precipitation. For these—including the vast Ogallala Aquifer that underlies the U.S. Great Plains, the Saudi aquifer and the deep aquifer under the North China Plain—depletion would spell the end of pumping. In arid regions such a loss could also bring an end to agriculture altogether.

In China the water table under the North China Plain, an area that produces more than half of the country's wheat and a third of its corn, is falling fast. Over pumping has used up most of the water in a shallow aquifer there, forcing well drillers to turn to the region's deep aquifer, which is not replenishable. A report by the World Bank foresees "catastrophic consequences for future generations" unless water use and supply can quickly be brought back into balance.

As water tables have fallen and irrigation wells have gone dry, China's wheat crop, the world's largest, has declined by 8% since it peaked at 123 million tons in 1997. In that same period China's rice production dropped 4%. The world's most populous nation may soon be importing massive quantities of grain.

But water shortages are even more worrying in India. There the margin between food consumption and survival is more precarious. Millions of irrigation wells have dropped water tables in almost every state. As Fred Pearce reported in New Scientist:

Half of India's traditional hand-dug wells and millions of shallower tube wells have already dried up, bringing a spate of suicides among those who rely on them. Electricity blackouts are reaching epidemic proportions in states where half of the electricity is used to pump water from depths of up to a kilometre [3,300 feet].

A World Bank study reports that 15% of India's food supply is produced by mining groundwater. Stated otherwise, 175 million. Indians consume grain produced with water from irrigation wells that will soon be exhausted. The continued shrinking of water supplies could lead to unmanageable food shortages and social conflict.

## Less soil, more hunger

The scope of the second worrisome trend—the loss of topsoil—is also startling. Topsoil is eroding faster than new soil forms on perhaps a third of the world's cropland. This thin layer of essential plant nutrients, the very foundation of civilisation, took long stretches of geologic time to build up, yet it is typically only about six inches deep. Its loss from wind and water erosion doomed earlier civilisations.

In 2002 a U.N. team assessed the food situation in Lesotho, the small, landlocked home of two million people embedded within South Africa. The team's finding was straightforward: "Agriculture in Lesotho faces a catastrophic future; crop production is declining and could cease altogether over large tracts of the country if steps are not taken to reverse soil erosion, degradation and the decline in soil fertility."

In the Western Hemisphere, Haiti—one of the first states to be recognised as failing—was largely self-sufficient in grain 40 years ago. In the years since, though, it has lost nearly all its forests and much of its topsoil, forcing the country to import more than half of its grain.

The third and perhaps most pervasive environmental threat to food security—rising surface temperature—can affect crop yields everywhere. In many countries crops are grown at or near their thermal optimum, so even a minor temperature rise during the growing season can shrink the harvest. A study published by the U.S. National Academy of Sciences has confirmed a rule of thumb among crop ecologists: for every rise of one degree Celsius (1.8 degrees Fahrenheit) above the norm, wheat, rice and corn yields fall by 10%.

In the past, most famously when the innovations in the use of fertiliser, irrigation and high-yield varieties of wheat and rice created the "green revolution" of the 1960s and 1970s, the response to the growing demand for food was the successful application of scientific agriculture: the technological fix. This time, regrettably, many of the most productive advances in agricultural technology have already been put into practice, and so the long-term rise in land productivity is slowing down. Between 1950 and 1990 the world's farmers increased the grain yield per acre by more than 2% a year, exceeding the growth of population. But since then, the annual growth in yield has slowed to slightly more than 1%. In some countries the yields appear to be near their practical limits, including rice yields in Japan and China.

Some commentators point to genetically modified crop strains as a way out of our predicament. Unfortunately, however, no genetically modified crops have led to dramatically higher yields, comparable to the doubling or tripling of wheat and rice yields that took place during the green revolution. Nor do they seem likely to do so, simply because conventional plant-breeding techniques have already tapped most of the potential for raising crop yields.

# Jockeying for food

As the world's food security unravels, a dangerous politics of food scarcity is coming into play: individual countries acting in their narrowly defined self-interest are actually worsening the plight of the many. The trend began in 2007, when leading wheat-exporting countries such as Russia and Argentina limited or banned their exports, in hopes of increasing locally available food supplies and thereby bringing down food prices domestically. Vietnam, the world's second-biggest rice exporter after Thailand, banned its exports for several months for the same reason. Such moves may reassure those living in the exporting countries, but they are creating panic in importing countries that must rely on what is then left of the world's exportable grain.

In response to those restrictions, grain importers are trying to nail down long-term bilateral trade agreements that would lock up future grain supplies. The Philippines, no longer able to count on getting rice from the world market, recently negotiated a three-year deal with Vietnam for a guaranteed 1.5 million tons of rice each year.

Food-import anxiety is even spawning entirely new efforts by food-importing countries to buy or lease farmland in other countries [Purchase the digital edition to see related sidebar].

In spite of such stopgap measures, soaring food prices and spreading hunger in many other countries are beginning to break down the social order. In several provinces of Thailand the predations of "rice rustlers" have forced villagers to guard their rice fields at night with loaded shotguns. In Pakistan an armed soldier escorts each grain truck. During the first half of 2008, 83 trucks carrying grain in Sudan were hijacked before reaching the Darfur relief camps.

No country is immune to the effects of tightening food supplies, not even the U.S., the world's breadbasket. If China turns to the world market for massive quantities of grain, as it has recently done for soybeans, it will have to buy from the U.S. For U.S. consumers, that would mean competing for the U.S. grain harvest with 1.3 billion Chinese consumers with fast-rising incomes—a nightmare scenario. In such circumstances, it would be tempting for the U.S. to restrict exports, as it did, for instance, with grain and soybeans in the 1970s when domestic prices soared. But that is not an option with China. Chinese investors now hold well over a trillion U.S. dollars, and they have often been the leading international buyers of U.S. Treasury securities issued to finance the fiscal deficit. Like it or not, U.S. consumers will share their grain with Chinese consumers, no matter how high food prices rise.

# Plan B: Our only option

Since the current world food shortage is trend-driven, the environmental trends that cause it must be reversed. To do so requires extraordinarily demanding measures, a monumental shift away from business as usual—what we at the Earth Policy Institute call Plan A—to a civilisation-saving Plan B.

Similar in scale and urgency to the U.S. mobilisation for World War II, Plan B has four components: a massive effort to cut carbon emissions by 80% from their 2006 levels by 2020; the stabilisation of the world's population at eight billion by 2040; the eradication of poverty; and the restoration of forests, soils and aquifers.

Net carbon dioxide emissions can be cut by systematically raising energy efficiency and investing massively in the development of renewable sources of energy. We must also ban deforestation worldwide, as several countries already have done, and plant billions of trees to sequester carbon. The transition from fossil fuels to renewable forms of energy can be driven by imposing a tax on carbon, while offsetting it with a reduction in income taxes.

Stabilising population and eradicating poverty go hand in hand. In fact, the key to accelerating the shift to smaller families is eradicating poverty—and vice versa. One way is to ensure at least a primary school education for all children, girls as well as boys. Another is to provide rudimentary, village-level health care, so that people can be confident that their children will survive to adulthood. Women everywhere need access to reproductive health care and family-planning services.

The fourth component, restoring the earth's natural systems and resources, incorporates a worldwide initiative to arrest the fall in water tables by raising water productivity: the useful activity that can be wrung from each drop. That implies shifting to more efficient irrigation systems and to more water-efficient crops. In some countries, it implies growing (and eating) more wheat and less rice, a water-intensive crop. And for industries and cities, it implies doing what some are doing already, namely, continuously recycling water.

At the same time, we must launch a worldwide effort to conserve soil, similar to the U.S. response to the Dust Bowl of the 1930s. Terracing the ground, planting trees as shelterbelts against windblown soil erosion, and practicing minimum tillage—in which the soil is not ploughed and crop residues are left on the field—are among the most important soil-conservation measures.

There is nothing new about our four interrelated objectives. They have been discussed individually for years. Indeed, we have created entire institutions intended to tackle some of them, such as the World Bank to alleviate poverty. And we have made substantial progress in some parts of the world on at least one of them—the distribution of family-planning services and the associated shift to smaller families that brings population stability.

For many in the development community, the four objectives of Plan B were seen as positive, promoting development as long as they did not cost too much. Others saw them as humanitarian goals—politically correct and morally appropriate. Now a third and far more momentous rationale presents itself: meeting these goals may be necessary to prevent the collapse of our civilisation. Yet the cost we project for saving civilisation would amount to less than \$200 billion a year, a sixth of current global military spending. In effect, Plan B is the new security budget.

#### Time: Our scarcest resource

Our challenge is not only to implement Plan B but also to do it quickly. The world is in a race between political tipping points and natural ones. Can we close coal-fired power plants fast enough to prevent the Greenland ice sheet from slipping into the sea and inundating our coastlines? Can we cut carbon emissions fast enough to save the mountain glaciers of Asia? During the dry season their melt waters sustain the major rivers of India and China—and by extension, hundreds of millions of people. Can we stabilise population before countries such as India, Pakistan and Yemen are overwhelmed by shortages of the water they need to irrigate their crops?

It is hard to overstate the urgency of our predicament. [For the most thorough and authoritative scientific assessment of global climate change, see "Climate Change 2007. Fourth Assessment Report of the Intergovernmental Panel on Climate Change," available at www.ipcc.ch] Every day counts. Unfortunately, we do not know how long we can light our cities with coal, for instance, before Greenland's ice sheet can no longer be saved. Nature sets the deadlines; nature is the timekeeper. But we human beings cannot see the clock.

We desperately need a new way of thinking, a new mind-set. The thinking that got us into this bind will not get us out. When Elizabeth Kolbert, a writer for the New Yorker, asked energy guru Amory Lovins about thinking outside the box, Lovins responded: "There is no box."

There is no box. That is the mind-set we need if civilisation is to survive.

# **Natural Gist**

- Food security is a real threat to the political stability of poor countries as well as global stability.
- International security in the 20th Century is more threatened by failing states than superpower conflict. States fail when they can no longer provide personal security, food security and basic social services. Failing states, like Somalia, are the source of terrorists, drugs, weapons, refugees and infectious diseases, which threaten our global security.
- Three decades of environmental decline, together with population growth, has undermined our world's food economy. Food scarcity is increasing and if the food situation continues to deteriorate, entire nations will break down at an ever increasing rate.
- 3 environmental trends threatening food security are; increased water shortages, increased loss of topsoil and rising surface temperature.
- Food-import anxiety by countries has led to higher food prices and political jostling to secure long term supplies of food as demand for increases and countries become more reliant on food imports.
- Poor countries have more environmental degradation due to unsustainable agricultural practices, limiting their capacity to produce sufficient food. Poor countries suffer most from food shortages and cannot compete with affluent countries to pay higher food prices to secure imported food.
  - <u>Plan B, a civilization saving plan</u>, has 4 components; a massive reduction in carbon emission, the stabilisation of world population, the eradication of poverty and the restoration of our forests, soils and aquifers.
- We need a new way of thinking to implement the changes needed. The thinking that got us into our bind will not get us out.
- Time is our scarcest resource. It is hard to overstate the urgency of our predicament. Nature sets the deadlines and is the timekeeper. Plan B must be delivered quickly to reverse the downward trends and beat the natural and political tipping points.

# Could Food Shortages Bring Down Civilisation? By Lester R Brown, (May 2009)

The article was first published May 2009 in the Scientific American Magazine and can be found at: http://www.scientificamerican.com/article.cfm?id=civilization-food-shortages

Lester R Brown is founder of the Earth Policy Institute and the author of many books on the subject of sustainability, economics and the environment.



#### **Considerations of Sustainable Planning and Design of Urban Areas**

Alex Burton, NatureFirst

## The case for delivering a sustainable urban environment

Urban areas are the economic powerhouses of world. Following the process of industrialisation stretching back to the early 1800s, there has been a century's long migration from country to towns, with all of its attendant social and environmental consequences. Whatever the nature of the incentives, most people clearly prefer to live in cities. In 1800, 3% of the world's population lived in urban areas. According to the United Nations Population Fund, the number of urban dwellers will rise to 5 billion by 2030. By the end of this century, that number will be closer to 66% and super cities will be common place.

World cities take up just 2% of the Earth's surface, but they account for roughly 78 % of the carbon emissions, 76% of industrial wood use, and 60 % of the water tapped for use (UNEP 2002). To date there has never been a city of more than a million people that did not run on fossil fuels such as coal, gas or oil. London in 2000 had a population of 7.4 million and used the equivalent of two super tankers of oil a week, equivalent to around 20 million tonnes of oil per year. Such excessive consumption of finite resources is by its very nature unsustainable.

The concept of sustainability is 'the ability of something to maintain itself indefinitely'. A sustainable city must have adequate infrastructure and flexibility to support the needs of its population, as well as those of the ecosystem as a whole. Cities should align their consumption with realistic needs, produce more of their own food and energy, and put much more of their waste to use. However these issues are complicated by the vastly different lifestyles followed by people of different cultures across the world.

One critical issue for sustainability is whether, and how, this figure can be reduced. These figures suggest that the struggle to achieve an environmentally sustainable economy will be won or lost in the world's urban areas. Sustainable development was the central theme of the UN Earth Summit at Rio de Janeiro in 1992, which called on governments to produce their own strategies for sustainable development. The topic of urban sustainability is now of international interest and is a growing field of development, knowledge and discovery.

The current aspiration for many countries is to deliver a Carbon Neutral City (a city that runs without a carbon footprint). Several such developments are underway including; Masdar in Abu Dhabi (image right) and The Dongtan project on Chongming Island, China (image left). In a similar vein, the governments of Costa Rica, Norway, and even Libya have announced grand, state-sponsored development plans that promise some version of carbon neutrality—offsetting greenhouse gas emissions, often by producing clean, renewable energy. All these developments will be testing theories and approaches in achieving a living carbon neutral city model



This article introduces the key areas to be considered when undertaking a sustainable approach to the planning and design of urban areas. We have divided these into:

- Urban Planning (including transport infrastructures)
- Green Governance
- Sustainable Buildings Green Architecture
- City Greening Landscape Interventions
- Social Sustainability

Each of these topics is a significant area of study so in this article we have sought merely to introduce and frame the issues influencing each.

## Delivering a sustainable urban environment

**Urban Planning** (including transport infrastructures)

## Urban form:

Although urban sustainability is not dependent on form alone expectations about the influence of urban form on sustainability are high. There has been considerable research into the idea that certain urban forms are better placed to promote the ideal of sustainability than others. It has been estimated that as much as 70% of delivered energy is subject to the influence of land use planning (Barton, 1990). Attitudes vary about the potential reductions that can be achieved in transport emissions, but a conservative estimate is that they could be reduced by 16% through a combination of land-use planning policies and other supportive measures (ECOTEC, 1993).

The book 'Achieving Sustainable Form' by Williams, Burton and Jenks, explores which urban forms are more sustainable with regards to urban ecology, social equity, land conservation, greenhouse gas emissions, environmental quality, accessibility, economic performance, pollution and health. The urban models that have in the past been explored include; urban villages, the compact city, mixed-use and single-use neighbourhoods, and edge, corridor and fringe city models. However a highly favoured model has been the compact city model.

## The compact city:

The compact city model is based on traditional high-density European cities such as Paris and Barcelona. In simple terms the model seeks to control growth of the city in area and promote higher density living. The reasoning is that this form can reduce travel demand because people work near to their homes and make use of local services and facilities. It also provides population densities high enough to support viable public transport services and, through improved urban design, encourage cycling and walking. In the USA, sprawl is endemic and

has been recognised as costly in economic, environmental and social terms. The compact city model, for this reason has been widely adopted into policy in many developed countries; however it is not without its flaws. This model can, it seems negatively impact on other important sustainability aims such as facilitating the provision of outdoor open space, there is also doubt by some critics whether manipulation of urban form can contribute to sustainable mobility at all in the face of broader socio-economic and cultural trends.

# Sustainable transport:

Currently transport indicators worldwide are moving in an unsustainable direction. Since the 1980s, the majority of industrialised countries have experienced increases in the proportion of car journeys compared with public transport (ibid), and overall the car accounts for around 80 % of passenger kilometres travelled. In most countries, road and motorway network densities are increasing steadily (ibid). Perhaps unsurprisingly traffic numbers and private vehicle ownership are also rising.

In a sustainable city model public transport systems should be promoted over car use. In order for this to be effective the public transport system must be efficient, affordable, clean, desirable and convenient. The creation of desirable, walkable urban environments and the promotion of green modes of transport such as cycling, should also be actively pursued.

#### Current sustainable cities:

Many of the current carbon neutral cities being delivered, such as Masdar, have been started from scratch. This approach allows designers freedom to control the city layout to ensure for example; buildings benefit or mitigate against solar gain. For existing cities there are also questions about our ability to implement substantial physical changes. Existing urban form generally evolves slowly, however existing cities can be turned green, with one of the best global examples initiated in the 1970's. Canada's third-largest city, Vancouver, has earned accolades from urban planners around the world for a development strategy that minimises its impact on the environment. It has also been embraced by businesses and citizens, which in turn builds the economic success of the city.

- Since 1996, the Vancouver has promoted alternatives to driving. Resulting in a 44% increase in walking, a 180% increase in bike trips, a 20% increase in transit use, and a 10% reduction in vehicle trips.
- Methane gas captured from the Vancouver Landfill is used to generate heat and electricity. It is the biggest GHG reduction initiative in the entire region
- All new commercial and multifamily buildings are required to meet the strictest energy efficiency requirements in Canada.
- Targets have been established to reduce greenhouse gases (GHGs) throughout the city: 6% by 2012, 33% by 2020 (compared to 2007 baseline), 80% by 2050,
- All new construction in Vancouver be GHG neutral by 2030.

#### In Conclusion:

The emerging theory is that instead of searching for one definitive sustainable form, the emphasis should be on determining which urban form is suitable in any given locality, developing a solution appropriate for the scale and location of the development. By taking this inclusive approach, the danger of developing sustainable 'islands' within 'seas' of unsustainability can be avoided. In terms of planning practice, more inter-disciplinary working is required. To do this, professionals such as transport planners, highway engineers, urban designers and housing officers, as well as employers, facilities managers and end-users must work together.

#### **Green Governance**

Unless cities change their management practices, resources expended on protecting the environment and delivering sustainable cities will be wasted. The United Nations Environment Program (UNEP) has concluded that many environmental problems of the past arose because of inappropriate management and a lack of understanding about the impact of these management practices upon the environment. It is essential therefore when developing a sustainable city model that new management methods are researched and implemented.

The United Nations has stated that evidence from the 1980s and early 1990s shows 'good governance' can bring major economic and social gains, and less environmental degradation. Many problems such as poor housing, lack of piped water, provision for sanitation and drainage, lack of basic services such as health care, serious and often rising problem of urban violence, problems of traffic congestion, air and water pollution arise largely from a failure of government institutions to manage rapid change and to tap the knowledge, resources and capacities among the cities population.

The book 'Governing sustainable cities' (Evans, Joas & Sundback) concludes that good governance is a necessary precondition for the achievement of sustainable development and that the mobilisation of local communities is an essential part of this process. It is recognised that this requires huge shifts in behaviour and attitudes.

#### Green architecture

'Green architecture' is a sustainable method of building design; it is design and construction with the environment in mind. Sustainable architecture seeks to minimise the negative environmental impact of buildings by enhancing the efficient use of materials, energy, and development space. Many countries now provide clear guidance for the delivery of green buildings and developments. In the U.S. The Green Building Council, a non-profit community of leaders, is working to make green buildings available to everyone within a generation. Its L'EED' (Leadership in Energy and Environmental Design) certification scheme provides independent, third-party verification that a building project meets the highest 'green' building and performance measures.

# Energy efficiency:

Energy efficiency over the entire lifecycle of a building is the most important single goal of sustainable architecture. Architects use many different techniques to reduce the energy needs of buildings and increase their ability to capture or generate their own energy. The most important and cost effective element of an efficient heating, ventilating, and air conditioning (HVAC) system is a well insulated building. A more efficient building requires less heat generating or dissipating power, but may require more ventilation capacity to expel the polluted indoor air.

In colder climates, heating systems are a primary focus for sustainable architecture because they are typically one of the largest single energy drains in buildings. In warmer climates where cooling is a primary concern masonry building materials with high thermal mass are valuable for retaining the cool temperatures of night throughout the day. In addition builders often opt for sprawling single story structures in order to maximise surface area and heat loss.

Buildings are often designed to capture and channel existing winds, particularly cool winds coming from nearby bodies of water. Many of these valuable strategies are employed in some way in the traditional architecture of warm regions.

Energy for a sustainable building can come from also from 'energy recapture', the recycling of an energy source normally treated as a waste product, and/ or from alternative green energy production such as:

- Solar panels
- Wind Turbines
- Solar water heating

## Building materials:

The use and demolition of conventional building construction along with the manufacturing of building materials, has significant impact on the environment. In the United States, buildings account for 65% of electricity consumption, 30% of greenhouse gas emissions, 30% of raw materials use, 30% of landfill waste and 12% of potable water consumption.

Building materials typically considered to be 'green' includes; rapidly renewable plant materials like bamboo and straw, lumber from forests certified to be sustainably managed; recycled stone, recycled metal, and other products that are non-toxic, reusable, renewable, and/or recyclable. Building materials that are extracted and manufactured locally to the building site minimising energy consumption embedded in their transportation.

Utilising recycled or second hand materials, reduces the use of new materials creates a corresponding reduction in embodied energy (energy used in the production of materials) and during construction phase, reduces the amount of material going to landfills. Finally sustainable architecture can look to retro-fit old structures to serve new needs in order to avoid unnecessary development.

## Examples of sustainable building materials:

Recycled denim or blown-in fibre glass insulation, rapidly renewable and sustainably harvested wood, Trass, Linoleum, sheep wool, concrete (high and ultra high performance, roman self-healing concrete, panels made from paper flakes, baked earth, rammed earth, clay, vermiculite, flax linen, sisal, seagrass, cork, expanded clay grains, coconut, wood fibre plates, calcium sand stone, locally-obtained stone and rock, and bamboo, which is one of the strongest and fastest growing woody plants, and non-toxic low-VOC glues and paints. Architectural salvage and reclaimed materials can include any good wood, stone, doors, windows, mantels and hardware.

#### Infrastructure needs:

One central and often ignored aspect of sustainable architecture is siting. Although many may envisage the ideal ecological home or office structure as an isolated place in the middle of the woods, this kind of placement is often detrimental to the environment. First, such structures often serve as the unknowing frontlines of suburban sprawl. Second, they usually increase the energy consumption required for transportation and lead to unnecessary auto emissions. There is opportunity for cross learning between countries and different regions however different countries and regions must identify and develop solutions that are specific to their cultural, economic, social, ecological, climatic and physiological needs.



Several architectural practices are now able to deliver sustainable buildings whether they be residential, educational, commercial or industrial. Such knowledge and experience can be effectively driven by government initiatives. The UK Government has undertaken a Carbon Challenge Program in which a 6.1Ha carbon neutral community at Hanham Hall, Bristol, is planned for delivery by 2011. This was a competitive project that sought developers to deliver the highest level (Level 6) of the UK Government's new Code for Sustainable Homes to demonstrate that zero carbon homes, combined with cutting edge building design, are economically viable on a commercial scale. The UK Governments goal is for all new homes to be zero carbon from 2016. So such initiatives are key to promoting our understanding on how best to deliver a sustainable and carbon neutral city.

# Landscape architecture

Landscape professionals are perhaps better placed than others involved in environmental design and management to embrace and promote the principles of sustainable design. Landscape architecture is often characterised as being firmly rooted in the uniqueness of 'place' and opportunities to reinforce local and regional character and identity of a place should not be missed.

# Creation of urban open spaces:

The role of parks and green open spaces in urban areas is often underestimated, with the potential of these areas to improve both the quality of life for city dwellers and urban sustainability as a whole still not fully realised.

- Acting as green lungs to the congested cityscape. Providing recreation opportunities
  together with pollution control, flood water drainage, bio diverse habitats, seasonal variety
  and interest, benefiting the aesthetic quality of the place.
- Well-maintained parks enhance the quality of life, providing scenic views and convenient recreation opportunities and providing nearby properties with an increase in value and marketability.
- Well used urban open spaces stand the test of time. In the UK and commonwealth open spaces created in the Victorian era (and before) are still appreciated in many cities and countries, having withstood potential development in areas now highly sought after.

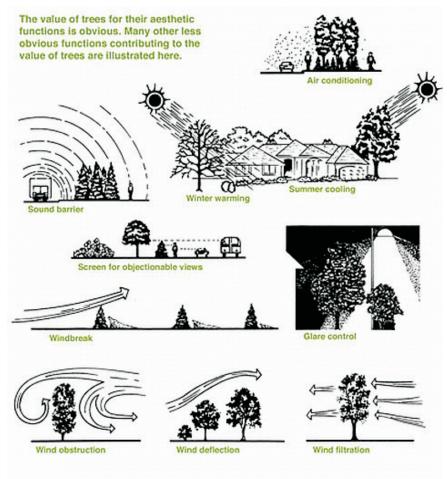
- Visually green cities offer a higher quality of life; this in turn consistently attracts and retains businesses. Companies that can locate anywhere go to places that attract good people.
- Popular parks and greenways foster entrepreneurial economic development, such as; food services, rentals, sales, and repair of recreation equipment helping to retain wealth within the local community.

#### Planting trees:

Trees have tremendous symbolic value, they humanise the city, acknowledge our affinity with the natural world and provide a focus for community participation in the urban environment. Trees also exert an influence on their environment physically contributing to cleaner air and a healthier environment, research suggests that trees can:

- Reduce pollution levels, removing pollutants including Nitrogen Oxides, Sulphur and Ammonia and capture air borne particulate matter on leaf surfaces.
- Influence the microclimate by cooling and humidifying the surrounding air, reducing energy required to run air/con systems, reducing wind speeds with a positive effect on heat loss from buildings, acting as a buffer against high noise levels.
- Offset carbon production and assist in the delivery of carbon neutral cities. Trees absorb carbon dioxide and produce oxygen, over a 100 year lifespan a tree 'breathes' in around 1 tonne of Co<sub>2</sub> emissions.
- Promote local biodiversity, especially when the tree planted is of local provenance. If sourced locally such plants also minimise transportation distances and protect the local economy, so that it financially benefits.
- Contribute to the economic success of a city, by creating more desirable streets and commanding higher values (up to 15%), acting as 'green magnets' attracting businesses and employees.

Based on this evidence the planting of trees should be maximised in a sustainable city model. However in the urban environment their benefit is often overlooked. Existing trees are frequently felled to accommodate new development and are not mitigated through new tree planting. Underground utilities and services often take precedent over the accommodation of street trees as each vies for urban space. Poorly detailed planting results create bad publicity for trees through root damage to footpaths and roadways, damaging expensive hard landscape materials and creating hostile walking environments.



# Habitat diversification:

Urban ecological restoration and stewardship is important for sustainability. For centuries, 'developed society' has tried to control and dominate nature, becoming increasingly disconnected from it. However the city can be more biologically diverse than some rural areas, with species threatened elsewhere finding refuge in cities. Cities can attract animals which are capable of using what humans, directly or indirectly, produce: nesting or resting on buildings, feeding on waste and lawns and so forth.

The presence of nature in cities is both necessary and desired. We are not speaking here of a nature made to be clean and artificial, as in the hygienist tradition, but of a "wild" nature, whereby biodiversity becomes an avowed goal of urban management. Unfortunately the proliferation of undesirable species can cause discontent, causing fear of nature. People will not tolerate what they consider to be a threatening or the offending presence of nature.

Brambles and nettles, crows and starlings, wasps or ants are generally not welcome in man's environment, and even less so in such an entirely manmade habitat as the city. Understanding and preserving biodiversity means taking into account the spatial organisation of different types of habitat within urban areas and the surrounding countryside in one entity. Most human beings live and will go on living in cities; for this reason, environmental planning and more specifically the question of urban fauna are strongly influenced by urban residents' perceptions of nature. Developing urban biological diversity could thus include programmes aimed at increasing contacts between man and "wild" species and raising public awareness.

#### Urbanagriculture:

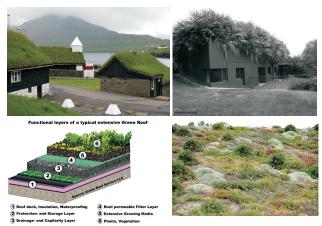
In addition to promoting nature, the landscape of a city can also be used to deliver food production in the city. City farming is prevalent and growing – as long ago as 1993 it was estimated that city farms were contributing 15% to world food production and it was expected to grow to 33% by 2005. According to the UNDP, some 800 million people worldwide were involved in urban agriculture in 1996, growing fruits, vegetables, and herbs, as well as raising livestock. City farming makes a hefty contribution to the fight against poverty and hunger and therefore also contributes towards the social sustainability of the city. Such economies can also empower women. For example women in a vegetable-growing cooperative in Bogota, Colombia, earn three times more than their husbands do.

City farmers also play a major role in waste recycling, creating a closed system in which organic wastes - from food, manufacturing and sewage - are reused instead of festering in dumps and polluting waterways. Human waste is turned into compost, domestic wastewater safely irrigates many crops, and aquaculture stabilises animal manure. In Mexico City many families keep pigs, urban pig farmers recycle up to 4,000 tons of the city's food wastes every day.

Urban agriculture can be a classless activity now promoted in cities all over the world. Through good city planning urban agriculture can be accommodated in the holistic design of the cityscape in a way that avoids detrimental impact on the aesthetics of the city.

## Green roofs:

Green rooftops have gained momentum in many countries over the past six years as building owners recognise their advantages over conventional roofing. Green Roofs are roofs partially or completely covered with vegetation growing in soil medium over a waterproof membrane. They can be 'Extensive'; little soil, low maintenance planting, with no physical human access or 'Intensive'; more soil depth, all types of planting (including lawns and trees), higher maintenance and often with a garden style of access. Green roofs are now generally seen as being more energy efficiency than traditional roof systems, provide reduced rainwater runoff, enhance city biodiversity, add green/ amenity space and are aesthetically enhancing to the cityscape.



Due to the benefits they deliver the use of green roofs have been present in some cultures for a long time such as the traditional buildings with green roofs on the Faroe Islands, Denmark, (top left image on the previous page). Now several countries are exploring incentives for moving the practice into the mainstream. Despite the theoretical advantages of implementing a green roof system, a look at cities that are leading the world in green roof coverage reveals the need for a growing range of policy tools to drive their delivery.



Images from left to right and top to bottom, from previous page as well: Faroe Islands, Denmark; Modern Green Roof; Section through modern green roof system; extensive green roof system; Hundertwasserhaus Green Roof Design, Vienna; Musee de Quai, Paris, Green Wall System.

#### SUDS:

SUDS or Sustainable Urban Drainage System is a concept that allows long-term environmental and social factors to influence decisions about drainage. Many existing urban drainage systems cause problems of flooding, pollution or damage to the environment and are not proving sustainable. A SUDS approach takes into account the quantity and quality of runoff, and the amenity value of surface water in the urban environment.

Built-up areas need to be drained to remove surface water. Traditionally the solution for this has been done using underground pipe systems designed for quantity, to prevent flooding locally by conveying the water away as quickly as possible. The alteration of natural flow patterns can lead to problems elsewhere in the catchment. Water quality issues have become increasingly important, due to pollutants from urban areas being washed into rivers or the groundwater. Once polluted, groundwater is extremely difficult to clean up. Conventional drainage systems cannot easily control poor runoff quality and may contribute to the problem. The amenity aspects, such as water resources, community facilities, landscaping potential and provision of varied wildlife habitats have largely been ignored. Conventional drainage systems are not designed with these wider considerations in mind. Continuing to drain built up areas with limited objectives and ignoring wider issues is not a sustainable long-term option causing an impact on the terrestrial and aquatic environments.

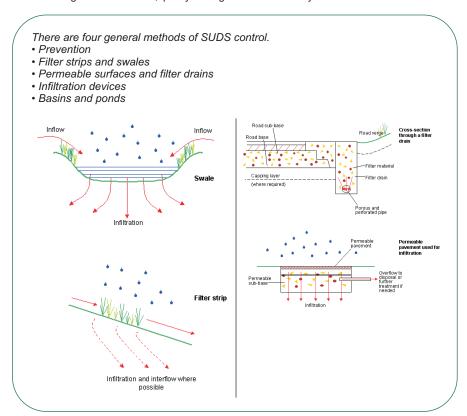
Sustainable Drainage Systems (SUDS) are more sustainable than conventional drainage methods because they:

- Manage runoff flow rates, reducing the impact of urbanisation on flooding
- Protect or enhance water quality
- Are sympathetic to the environmental setting and the needs of the local community
- Provide a habitat for wildlife in urban watercourses
- Encourage natural groundwater recharge (where appropriate).

# They do this by:

- Dealing with runoff close to where the rain falls
- Managing potential pollution at its source now and in the future
- Protecting water resources from point pollution (such as accidental spills) and diffuse sources.

They may also allow new development in areas where existing sewerage systems are close to full capacity, thereby enabling further development within existing urban areas. Urban drainage is moving away from the conventional thinking of designing for flooding to balancing the impact of urban drainage on flood control, quality management and amenity.



SUDS are made up of one or more structures built to manage surface water runoff. They are used in conjunction with good management of the site, to control flooding and pollution. These controls should be located as close as possible to where the rainwater falls, providing attenuation for the runoff. They also provide varying degrees of treatment for surface water, using the natural processes of sedimentation, filtration, adsorption and biological degradation.

SUDS can be designed to function in most urban settings, from hard-surfaced areas to soft landscaped features. The variety of design options available allows designers and planners to consider local land use, land take, future management and the needs of local people when undertaking the drainage design, going beyond simple drainage and flood control. The range of options means that active decisions have to be made that balance the wishes of different stakeholders and the risks associated with each option.

Through good landscape design SUDS can be delivered in conjunction with other sustainable aims such as creating high quality amenity space and habitat diversification so its benefits should not be seen in isolation.

#### Local materials and plants:

The upfront capital cost of materials should be considered in the delivery of sustainable environments. Materials selection and use can not only reduce the wider environmental harm, but also increase the environmental performance of a scheme. On a simplistic level materials should be selected that have required minimal levels of energy and resources to implement them and utilise minimal resource in maintaining them, although considerations of longevity and the need for materials to be fit for purpose are also important consideration.

Using materials of local provenance can assist in many ways:

- Minimises need for transportation of goods and materials.
- Promote local/ regional character and identity.
- For plant materials, it can be used to promote local biodiversity
- Invests in and promotes the local economy

An assessment of environmental performance will become increasingly importance as countries implement sustainable certification schemes for developments.

# Conclusion

Atopic area we have not discussed in isolation is that of social sustainability, this is a huge topic area in its own right and difficult to define. To a point social sustainability of an urban environment can be delivered through good governance of a city. However the physical design of the city appears to play a key role in creating usable spaces and promoting social sustainability. Through design decisions it is possible to influence patterns of activities, to create better or worse conditions for outdoor events, and to create lively or lifeless cities. In the book the 'Life between buildings' by Gehl it is stated that it is the specially attractive activities that disappear when external city conditions are poor and that such pursuits thrive where physical conditions are favourable. Outdoor activities that are particularly dependent on the quality of the outdoor spaces are the optional, recreational activities, and by implication, a considerable part of the social activities. Activities that keep a city vibrant, desirable and healthy.

It is clear delivering a sustainable city involves discussion and decisions made on many levels from large scale urban planning to the detail design considerations. Long term management and governance is fundamental to ensure proposed approaches are implemented and that local residents and businesses understand and engage with these processes. Seeing and understanding the short and long term benefits of a sustainable approach will help us deliver the changes needed. Our sustainable cities example, Vancouver in Canada, has this year been ranked first as the world's most liveable city (out of 140 global cities) by the Economist Intelligence Unit's 2009 Liveability survey. This demonstrates how the relationship between good sustainability and a healthy economy is so inextricably linked.

#### Natural Gist

- Excessive consumption of natural resources is unsustainable. Covering 2% of the Earth's surface, world cities account for roughly 78 % of the carbon emissions.
- Sustainable cities must have adequate infrastructure supporting the needs of its population as well as the ecosystem as a whole.
- Urban professionals must work together to deliver sustainable cities. This is a technical and professional challenge.
- 70% (estimate) of delivered energy is influenced by land use planning (Barton 1990). Emphasis should be on identifying the urban form suitable for the scale and location of the development.
- Good governance reduces environmental degradation and bring major economic and social gains. The United Nations Environment Program (UNEP) concludes many environmental problems of the past are arisen from inappropriate management.
- Green architecture can minimise the environmental impact of buildings, ensuring the efficient use of materials, energy, and development space.
- Landscape interventions benefit ecology, micro-climate, air quality, water management processes, recreation activities, social well being, economy, land and property values and provide an important carbon sink. Skilled delivery and long term management is key to its success.
- Urban agriculture is growing; in 2005 city farming was contributing 33% (estimate) to world food production. It has a major role in reducing urban waste, poverty and hunger.
- The economic benefits of a sustainable approach is proven by Vancouver, Canada, which has been placed as the world's most liveable city (1st out of 140 global cities) by the Economist Intelligence Unit's 2009 liveability survey.



#### Low-Carbon Energy: A Roadmap, Worldwatch Institute Report 178,

By Christopher Flavin, 2008, Abridged

# **Avoiding catastrophe**

Speaking in Washington on June 23, 2008 James Hansen, the leading climate scientists at the U.S. National scientist at the U.S. National Aeronautics and Space Administration, had a sharp warning for policymakers: "If we don't begin to reduce greenhouse gas emissions in the next several years, and get on a very different course, then we are in trouble....this is the last chance.

Annual fossil fuels have shot up 35% above their 1990 rates. The atmospheric concentration of carbon dioxide which plays a key role in regulating the climate has never seen risen above 300 parts per million (ppm).

However in the year 2007, the atmospheric concentration of co2 passed 384 parts per million and it is already equivalent to 430 parts per million if it was to include other greenhouse gas emissions (Figure 1).

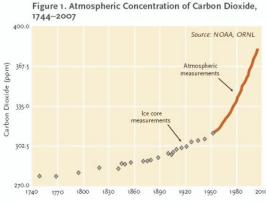


Figure 1. Source: NOA, ORNL

A study by Former World Bank Chief Economist Nicholas Stern concluded that climate change cut global economic output by between 5 and 20%. In his book, The Age of Turbulence, Alan Greenspan, the leading free market economist of the day, included climate change as one of five forces that could derail the U.S. economy by 21st century. The uneven and disruptive changes could set off additional crisis within and between societies and undermine their stability.

Today fossil fuels provide 4/5th of the energy that powers the global economy. Burning fossil fuel on such a large scale could prove disastrous for the earth's biosphere. The United Nations Framework Convention on Climate Change adopted in 1992 commits nations around the world globe to prevent dangerous climate change.

It demands for reducing the atmospheric concentration of Co2 from exceeding 450 parts per million to 350 ppm below the current level. The magnitude of the challenge is obvious when the emissions path needed to avoid catastrophic climate change is compared with the current trajectory (Table 1).

Indicator	2007	2050 business as usual	2050 stabilisation scenario
Co2 concentration (parts per million)	384	550	440
Population (billion)	6.7	9.2	9.2
Energy use (billion tons oil equivalent)	12.0	23	16
Energy related co2 emissions (billion tons)	29.9	62	15

The bottom line is: to keep the world's climate within the range it has occupied for at least a million years, recent emission trends will need to be quickly reversed. The goal of reduction of global emissions to zero has been adopted by the European Union and was endorsed by industrial country leaders at G8 Economic Summit in Japan, giving it political as well as economic significance.

The U.S. Department of Energy estimates that world energy use and carbon emissions will grow by nearly 50% by 2030—an average rate of 1.7% per year. This would take emissions to more than 40 billion tons in 2030 and, assuming continued growth at that rate, to 62 billion tons in 2050. The fact that the energy needs of developing countries such as India and China are accelerating with the increased thrust on building industries and infrastructure changes.

In 2006, industrial countries, with less than 20% of the world's population, contributed roughly 40% of global emissions, and they are responsible for more than 60% of the total CO2 emissions. With the current scenario of independence on fossil fuels, China has surpassed United States in emissions in 2007 and two together accounted for 40% of global emissions. (Table 2)

Country or region	Co2 emissions (Billion tons)		Co2 emissions per capita		Co2 emissions per \$ GDP	
	1990	2007	1990	2007	1990	2007
United States	4.8	6.1	18.7	19.2	823	437
China	2.3	5.9	2.0	4.4	2,523	844
European Union- 27	3.6	3.8	7.6	7.6	514	258
India	0.6	1.5	0.8	1.2	898	503
Japan	1.0	1.2	8.3	9.7	446	290
Africa	0.6	1.2	1.0	1.2	864	595
Others	9.0	10.2	-	-	-	-
World	22.0	29.9	4.2	4.3	863	460
* Does not include emissions resulting from gas flaring, cement making, or land use change.						

Providing energy services for a larger global economy of 2050 whilst reducing the  $co_2$  emissions to 15 billion tons will require an energy system that is different from today's. For the world as a whole to reduce its emissions by at least half by 2050, today's industrial countries will need to cut theirs by more than 80%. According to most official assessments, including that of the IPCC, getting there depends on some combination of a three-pronged strategy:

- 1. Reducing energy consumption through new technologies and lifestyles,
- 2. Shifting to carbon-free energy technologies, and capturing
- 3. Storing the Co<sub>2</sub> released when fossil fuels are combusted.

A variety of combinations of these three options can in theory turn the picture around.

It will require that emissions from oil should be limited to the extent that the output could be a third or more below the current level by 2050. This means that transportation fleets will have to shift from conventional energy options to cleaner ones such as electricity produced from renewable energy, advanced biofuels and compressed natural gas. Potentially policymakers and industrialists will have to focus on carbon capture and storage (CCS) technology so that it can be compatible with the low-carbon energy economy. It will take at least a decade to develop and deploy large scale CCS technology, a technology which can significantly contribute towards low carbon coal plants.

## A convenient truth

After the steep rise in the energy prices, energy experts are of the opinion that there has to be a reduction in the energy wasted and increasing the economic output that can be produced within the given amount of energy which can prove economically and environmentally beneficial.

How do we define energy productivity? Energy productivity measures an economy's ability to extract useful services from the energy that is harnessed. Energy productivity has increased steadily with countries like Germany and Japan showing a higher productivity. But it's observed that over half of the energy harnessed is converted to waste heat and that it is not being used to meet energy needs.

This calls for enormous potential to improve energy productivity in the decades to come.

#### No-carbon energy

A substantial reduction in the carbon emissions will require introduction of carbon free sources of energy. Nuclear power is gaining increased attention these days but it still faces considerable obstacles in expansion in the decades ahead.

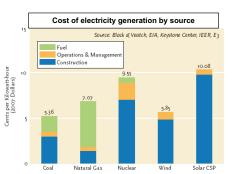
A more robust carbon free energy options calls for renewable energy including solar, wind, biomass and geothermal energy. There is a strong possibility that ocean energy from tides, waves, currents and thermal convection would be the next generation energy options.

Renewable energy technologies are advancing steadily with governmental support, growing concerns about climate change which has in turn spurred wide varieties of small and medium companies who are pouring billions of dollars into array of renewable technologies. Renewable energy supply already supplies nearly one-fifth of the world's electricity. While most of this comes from large hydropower, which is growing very slowly, wind capacity is expanding at 24% per year and solar at over 40%, rivalling the computer and mobile phone industries. (Figure 1)

# Wind power

Since 2000, wind power has gone from a tiny niche electricity supplier to become a significant force in the global power business. Deploying giant multi-megawatt wind turbines made by companies such as General Electric, Siemens, Vestas and Gamesa, the wind industry is now booming.

As the industry is growing, the investments in the sector are also increasing with more efficient wind technologies costing less.



e.g. in United States, wind power now costs fewer than six cents per kilowatt-hour on average less than natural gas and roughly even with coal. (Figure 2)

#### Solar power

The solar industry is starting from a smaller base but is growing even more rapidly than wind power. Annual production of solar cells (semiconductors that turn sunlight into electricity) rose 41% in 2006 and 51% in 2007. From Silicon Valley, California, to Munich, Germany, and Shenzen, China, scores of companies are pursuing an extraordinary array of approaches to improving solar cell design and lowering costs.

Solar power cells still calls for significant subsidies, but the Prometheus Institute projected in 2007 that as the industry progresses, the prices for large scale installed system will fall 50% by 2010 to \$4 per watt(without incentives)in the best locations.

Even as solar cells enter the mainstream, attention has focused on using solar thermal energy through large concentrating solar power (CSP) plants. Built mainly in deserts, these plants provide wholesale electricity that is transmitted to cities and industries via high voltage power grids, in the same way most power is today.

Modern CSP Plant - The world's first modern CSP plant was built in California's Mojave Desert in the late 1980s, but it was not until the past few years that the technology experienced a dramatic renaissance.

# **Geothermal energy**

Geothermal energy - heat from deep in the Earth's crust—is another large potential source of electricity. Major portion of the energy comes from countries such as United States, the Philippines and Mexico. A new generation of geothermal technology is being developed which will make it possible to tap much larger geothermal resource base. Advanced geological sensing and drilling techniques developed by the oil industry are being combined with new heat exchanger materials and systems. By piping water into porous geological structures 1 to 10 kilometres beneath the Earth's surface and then bringing the heated water back to a plant at the surface, electricity can be generated.

Several studies have assessed the scale of the major renewable resources and what their practical contribution to the energy economy might one day be. (Table 3)

Energy source	Potential contribution
Concentrating solar power (CSP)	Seven states in US Southwest could provide more than 7,000 GW of solar generating capacity- nearly seven times US electric capacity from all sources
Solar water heaters	Could easily provide half of world's hot water
Rooftop solar cells	Could provide 10% of grid electricity in the United states by 2030
Wind power	Could easily provide 20% of world's electricity; offshore wind farms could meet all of the European Union's electricity needs
Geothermal	Could provide 100 GW of electricity capacity in the USA alone
Wave and ocean thermal energy	Contribution could be on same order of magnitude as current world energy use

On average, wind and solar power require less land to provide a given amount of power than hydropower or coal do. And sometimes, renewable energy requires no land at all. Renewable energy also has a big advantage when it comes to a resource that is more limited than land is: most forms of renewable energy have minimal water requirements compared with fossil fuels and nuclear power, and as water scarcity grows, the significance of that advantage will increase.

In contrast with fossil fuels, almost every country has large-scale domestic sources of renewable energy—including many developing countries that have no oil resources. Africa, Australia, China, India, the Middle East, and the United States all have vast amounts of solar energy. Iceland, Indonesia, and the Philippines are rich in geothermal energy and scores of countries are rich in biomass waste materials that flow from their farm and forest industries.

## Designing a new energy system

Electricity is the single most important element of today's energy system, essential for lighting, cooling, electronics, and many industrial processes. Its role will only grow as air conditioning and electronics proliferate and as new technologies allow electricity to be used to power motor vehicles and to heat and cool homes efficiently using ground-source heat pumps. Electricity also happens to be the output of the largest and most easily replaced contributor to carbon dioxide emissions: coal-fired power plants. It is therefore fortuitous that solar, wind, geothermal, and biomass are all able to produce electricity.

Renewable energy sources also have their own limitations. The biggest one is variability. For example wind and solar sources, produce on average only 25–40% of their rated capacity, depending on the technology being used and the way it is sited.

To move towards a new model one can consider:

- Implementing local generating capacity using combined heat and power (CHP) systems, including advanced technologies such as micro turbines and fuel cells that can be turned on and off as needed.
- 2.Integrating variable renewable energy sources with a digitally smart grid, as this is more flexible and has the ability to balance demand and supply.
- 3.Developing the capacity to store energy economically so that it is available when needed with options such as pumped hydro, compressed air, and advanced chemical batteries and fuel cells.
- 4.Selectively add a new generation of efficient, low-cost gas turbines to provide spare backup power.

Currently Denmark generates about 20% of its electricity using the wind and occasionally wind energy meets more than 100% of peak demand on the country's west coast. To unleash the full potential of efficient and renewable energy sources will require upgrading the early 20th century electricity grids that provide no feedback between consumer and producer, which requires a physical visit just to read the metre.

#### Innovative solutions

#### Smart grids:

New digital grids include electronic controls that smoothly integrate electricity consumers with all types of power plants—large, small, and variable—and with electricity storage facilities. Digital grids allow the electricity system to operate much the way the Internet does—as an electronically controlled network that responds instantly to decisions made by users,

providing the same kind of efficiency, interconnectivity, and precision as the digital devices that it powers. The Pacific Gas and Electric utility in California is in the process of installing 9 million smart metres for its customers, while Europe is projected to have 80 million smart meters installed by 2013.

# Expanding the high voltage transmission system:

Tapping the full potential of renewable energy will also require expanding the high voltage transmission system in many parts of the world.

#### Electric and hybrid vehicles:

Low-carbon electricity is central to a low carbon energy economy, but by itself, it is not enough. Reducing motor vehicles' heavy dependence on oil is another key step, and the most promising near-term strategy is shifting to a new generation of electric and hybrid vehicles.

## Natural gas:

Natural gas will also play an important role in the transition to Figure 5. U.S. Electricity Generation by Source, 2007 and Two Scenarios for low-carbon energy. Natural gas produces half the carbon 2030 dioxide per unit of energy that coal does, and because it can be used far more efficiently, natural gas permits as much as a 75% reduction in CO2 emissions compared with coal. Natural gas should be viewed as a premium fuel with an economic value that matches or exceeds oil and with an environmental profile that gives it a solid advantage over other fossil fuels.

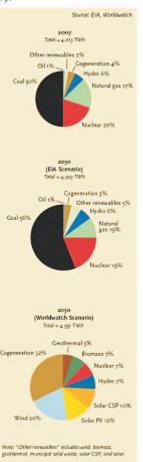
To illustrate what a low-carbon power system might look like, we have sketched out a scenario for the United States in 2030.

In the Worldwatch scenario, emissions from the U.S. power sector would be 90% lower than they are today. Notably, no single renewable resource would need to provide more than 20% of the country's electricity.

A stronger grid, extensive cogeneration, and modest storage would allow such a system to operate reliably with only a fraction of the inflexible base load plants that dominate today's power industry. And if this scenario is feasible for the United States — which has the world's largest electricity system—then something similar is possible in most countries, with some achieving a low-carbon power system somewhat earlier and others a bit later.

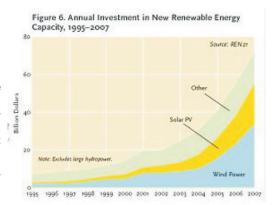
# Jumpstarting a revolution

A successful transition will nonetheless require a powerful combination of government policy changes, steady technological progress, and the rechanneling of private investment. According to conventional wisdom, the energy sector is far from such a transformation. New renewable energy sources, including solar, wind, geothermal, and biomass, represent less than 4% of the total energy supply, and in 2008 total U.S. government support of renewable energy research and development (R&D) came to little more than \$650 million—about the amount the government spent in Iraq in a single day.



An estimated \$71 billion was invested in new renewable electric and heating capacity in 2007, up from just \$20 billion in 2002.

Tiny firms may be the real game changers, following in the footsteps of companies like Microsoft and Google, which quickly came to dominate their more established competitors, bringing a level of innovation that larger firms are rarely capable of. In Silicon Valley, clean energy has become the hottest new sector for entrepreneurs and investors.



Venture capitalists typically make money by investing in technologies with small market shares but high growth potential. They like the energy sector because of its vast size—far larger than the I.T. sector

The best example is solar photovoltaic, where producers are pursuing a host of strategies for reducing materials requirements, raising efficiency, and lowering manufacturing costs of the crystalline cells that dominate the market. Beyond the advance in technology, the economics of renewable energy will further improve as the scale of production grows—the same phenomenon that has successively turned televisions, personal computers, and mobile phones from specialty products for high income technology pioneers into mass-market consumer devices.

Energy markets virtually everywhere are regulated, heavily subsidised, inefficient, and rarely predictable. What happens to the energy economy, and to the world's climate, in the years ahead will be heavily influenced by hundreds of policy decisions made at international, national, and local levels—and whether these new policies can be sustained.

Many energy economists argue that the reason fossil fuels dominate today is their inherently lower cost compared with the alternatives. This suggests that internalising environmental costs by putting a price on carbon—likely through a carbon dioxide tax or a regulatory cap on emissions such as the one in Europe—would solve the climate problem.

To be effective, climate policy will need to address not just the price of emissions but the failures of energy markets that limit the ability of prices to send a clear signal.

Growing political support for green energy provides further evidence that the world may be on the verge of a major transformation of energy markets.

Urgency and vision are the twin pillars on which humanity's hope now hangs.

#### Natural Gist

- Fossil fuel powers the global economy, providing 4/5ths of its energy. Industrial countries with less than 20% of the world's population has contributed roughly 40% of the global emissions and responsible for more than 60% of the total Co2 emissions.
- Recent emission trends will need to be quickly reversed to keep climate within the range it has occupied for the past million years.
- A new energy system is required if we are to service the larger global economy of 2050 while reducing current Co2 emissions. In fact today's Industrial countries will need to cut their current emissions by 80%.
- Carbon free energy sources are required to deliver a substantial reduction in carbon emissions. The most robust carbon free energy options are renewable energies such as solar, wind biomass and geothermal.
- Jumpstarting a revolution. New renewable energy sources represent less than 4% of total energy supply. To succeed we require a powerful combination of government policy change, steady technological progress and the rechanneling of private investment.
- Government support has enabled a steady advance of renewable energy technologies and encouraged extensive investment by small and medium companies.
- Tiny firms may be the real game changes, bringing a level of innovation larger firms are rarely capable of. In Silicon Valley clean energy is the hottest new sector for entrepreneurs and investors.
- Humanity's hope now hangs on the two pillars of urgency and vision.

# Low-Carbon Energy: A Roadmap, Worldwatch Institute Report 178. By Christopher Flavin, 2008.

This is an abridged version of the original 52 page article, a joint effort from the American Clean Skies Foundation, Casten Family Foundation, Richard and Rhoda Goldman Fund, Steven C. Leuthold Family Foundation, Shared Earth Foundation, Shenandoah Foundation, Flora L. Thornton Foundation, Wallace Genetic Foundation, Inc., Johanette Wallerstein Institute, and Winslow Foundation.

NatueFirst-Green Ecological Managed Services have taken key extracts from this article. For further reading the full article can be found at: http://www.worldwatch.org/press/prerelease/EWP178.pdf



## **New Energy Economy Emerging in the United States**

By Lester R. Brown, (October 2008)

As fossil fuel prices rise, as oil insecurity deepens, and as concerns about climate change cast a shadow over the future of coal, a new energy economy is emerging in the United States. The old energy economy, fuelled by oil, coal, and natural gas, is being replaced by one powered by wind, solar, and geothermal energy. The transition is moving at a pace and on a scale that we could not have imagined even a year ago.

Consider Texas. Long the leading oil-producing state, it is now also the leading generator of electricity from wind, having overtaken California two years ago. Texas now has nearly 6,000 megawatts of wind-generating capacity online and a staggering 39,000 megawatts in the construction and planning stages. When all this is completed, Texas will have 45,000 megawatts of wind-generating capacity (think 45 coal-fired power plants). This will more than satisfy the residential needs of the state's 24 million people, enabling Texas to feed electricity to nearby states such as Louisiana and Mississippi.

After Texas and California, the other leaders among the 30 states with commercial-scale wind farms are lowa, Minnesota, Washington, and Colorado. And other states are emerging as wind superpowers. Clipper Wind power and BP are teaming up to build the 5,050-megawatt Titan wind farm, the world's largest, in eastern South Dakota. Already under development, Titan will generate five times as much electricity as the state's 780,000 residents currently use. This project includes building a transmission line along an abandoned rail line across lowa, feeding electricity into Illinois and the country's industrial heartland.

Colorado billionaire Philip Anschutz is developing a 2,000-megawatt wind farm in south central Wyoming. He already has secured the rights to build a 900-mile high-voltage transmission line to California. With this investment, the door will be opened to developing scores of huge wind farms in Wyoming, a wind-rich state with few people. Another transmission line under development will run north-south, linking eastern Wyoming's wind resources with the fast-growing Colorado cities of Fort Collins, Denver, and Colorado Springs. Wind-rich Kansas and Oklahoma are looking to build a transmission line to the U.S. Southeast to export their wealth of cheap wind energy.

California is developing a 4,500-megawatt wind farm complex in the Tehachapi Mountains northwest of Los Angeles. In the east, Maine—a wind energy newcomer—is planning to develop 3,000 megawatts of wind-generating capacity, far more than the state's 1.3 million residents need. Further south, Delaware is planning an offshore wind farm of up to 600 megawatts, which could satisfy half of the state's residential electricity needs. New York State, which has 700 megawatts of wind-generating capacity, plans to add another 8,000 megawatts, with most of the power being generated by winds coming off Lake Erie and Lake Ontario. And soon Oregon will nearly double its wind generating capacity with a 900-megawatt wind farm in the wind-rich Columbia River Gorge.

Wind appears destined to become the centre piece of the new U.S. energy economy, eventually supplying several hundred thousand megawatts of electricity.

Solar power is also expanding at a breakneck pace. The nation's wealth of solar energy is being harnessed by using both photovoltaic cells and solar thermal power plants to convert sunlight into electricity. For solar cell installations, California, with its Million Solar Roofs plan, is far and away the leader. New Jersey is also moving fast, followed by Nevada.

The largest U.S. solar cell installation today is a 14-megawatt array at Nellis Air Force Base in Nevada, but photovoltaic electricity at the commercial level is about to go big time. PG&E has entered into two solar cell power contracts with a combined capacity of 800 megawatts. Together, these plants will cover 12 square miles of desert with solar cells and will have a peak output comparable to that of a large coal-fired power plant. Solar power plants are appealing in hot climates because their highest output coincides with the peak demand for air conditioning.

Solar thermal plants that use mirrors to concentrate sunlight on a vessel containing a fluid—heating it to 750 degrees Fahrenheit to generate steam and produce power—have suddenly become an enormously attractive technology. The United States has the world's only large solar thermal complex, a 350-megawatt project completed in 1991. But as of September 2008 there are 10 large solar thermal power plants under construction or in development in the United States, ranging in size from 180 megawatts to 550 megawatts. Eight of the plants will be built in California, one in Arizona, and one in Florida. Within the next three years, the United States will likely go from 420 megawatts of solar thermal generating capacity to close to 3,500 megawatts—an eightfold jump.

Along with wind and solar, geothermal energy is also developing at an explosive rate. As of 2008 the United States has nearly 3,000 megawatts of geothermal generating capacity, 2,500 of which are in California. Suddenly this too is changing. Some 96 geothermal power plants now under development in twelve western states are expected to double U.S. geothermal generating capacity. With California, Nevada, Oregon, Idaho, and Utah leading the way, the stage is set for the massive future development of geothermal energy.

The new energy economy will be powered largely by electricity from renewable sources. Electricity will light, heat, and cool buildings. As we shift to plug-in hybrid cars, light rail transit systems in cities, and high-speed electric intercity rail systems like those in Japan and Europe, our transport system will also be powered largely by electricity.

It is historically rare for so many interests to converge at one time and in one place as those now supporting the development of renewable energy resources in the United States. To begin with, shifting to renewables increases energy security simply because no one can cut off the supply of wind, solar, or geothermal energy. It also avoids the price volatility that has plagued oil and natural gas in recent decades. Once a wind farm or a solar thermal power plant is built, the price is stable since there is no fuel cost. Turning to renewables will also dramatically cut carbon emissions, moving us toward climate stability and thus avoiding the most dangerous effects of climate change.

The shift also will staunch the outflow of dollars for oil, keeping that capital at home to invest in the new energy economy, developing national renewable energy resources and creating jobs here. At a time of economic turmoil and rising joblessness, these new industries can generate thousands of new jobs each week. Not only are the wind, solar, and geothermal industries hiring new workers, they are also generating jobs in construction and in basic supply industries such as steel, aluminium, and silicon manufacturing. To build and operate the new energy economy will require huge numbers of electricians, plumbers, and roofers. It will also employ countless numbers of high-tech professionals such as wind meteorologists, geothermal geologists, and solar engineers.

To ensure that this shift to renewables continues at a rapid rate, national leadership is needed in one key area—building a strong national grid. Although private investors are investing in long-distance high-voltage transmission lines, these need to be incorporated into a carefully planned national grid, the electrical equivalent of President Eisenhower's interstate highway system, in order to unleash the full potential of renewable energy wealth.

And, finally, this energy transition is being driven by an intense excitement from the realisation that people are now tapping energy sources that can last as long as the earth itself. Oil wells go dry and coal seams run out, but for the first time since the industrial revolution we are investing in energy sources that can last forever. This new energy economy can be our legacy to the next generation.

## Natural Gist

- A new energy economy is emerging in the United States, as fossil fuel prices rise, oil insecurity deepens and concerns about climate change cast a shadow over the future of coal.
- Texas is the largest provider of wind generated electricity with 6,000 megawatts of wind-generating capacity and 39,000 megawatts in the construction/planning stages.
- Solar generated power is expanding in the US, using photovoltaic cells and thermal power plants. Converting sun's energy into electricity. Within 3 years, the solar thermal plants in the United States will jump from generating 420 megawatts to 3,500 megawatts.
- Geothermal can generate nearly 3,000 megawatts of energy as of 2008 in the United States.
- Powered by electricity, the new energy economy will come from renewable sources. This will reduce carbon emissions, move us towards climate stability and create new green jobs.
- Fundamentally the USA needs a strong national grid, this requires strong national leadership to build and private investment must be incorporated to release the wealth possible from renewable energy.

### New Energy Economy Emerging in the United States.

By Lester R. Brown, (October 2008).

This article was taken form the Earth Policy Institute Website and can be found at: http://www.earthpolicy.org/Updates/2008/Update77.htm

Lester R Brown is founder of the Earth Policy Institute and the author of many books on the subject of sustainability, economics and the environment.



## A Synopsis of Renewable Energy Technology

By Professor John Tidwell

# Renewable Energy

An ethical, scientific and technological debate, energy is at the heart of creation. Energy supply sustains all aspects of life within our ecological world. This brief considers why we need energy supply, the environmental dilemma, and the options. Questions are put for discussion, since the problems are complex and conclusions varied. One conclusion is that renewable energy must:

- 1. Urgently replace most fossil fuel use,
- 2. Be increasingly implemented for development, environment and sustainability.
- Have equal importance to current energy solutions in terms of technology, economics and politics of renewables

However perhaps the greatest challenge is for individuals and organisations to make choices within their own responsibilities.

## The importance of energy

Energy supply has immense benefit, but the sheer scale of present global demand does increasing harm, especially from pollutant emissions and other adverse environmental impact. Per capita commercial energy use in the USA is twice that in the UK, which is 50 times parts of central Africa. Resulting financial benefit and harmful emissions are in similar proportions. Is the disparity an economic imperative or inefficient greed? What is a fair allocation?

In fuel poverty people die from lack of warmth; women exhaust themselves obtaining firewood, then breathe the carcinogenic smoke. Transport is essential, but what of the air pollution? Wealth and health require energy supply. Tourism and leisure squanders energy with abandon. Should I limit my excess so others with none may have some? But how can I pass my excess to others? Are there clean forms of energy supply? It is often said that such environmental challenges are 'a moral equivalent of war'; only co-ordinated and unselfish commitment can obtain success.

Discussion: Of the energy we purchase, how much is wasted through inefficiency and lack of conservation?

Nothing lives, moves, communicates, cooks, heats, manufactures or produces without a supply of energy. Energy supply is the life-blood of existence. We all have a responsibility to ensure that energy is available, without harm, for our families, our communities and our 'global' neighbours. Likewise governments and commerce must facilitate energy supply for the present and future sustainability of nations. We need not panic however, since ample supplies of clean energy are part of the sustainable processes within creation. If we understand how this occurs 'naturally', we will know how our technological life may operate now and 'for ever'.

Life on Earth depends on the Sun; and on being 150 million km from it! The Sun's surface temperature of 6,300 oC emits energy as visible and 'nearly visible' light radiation. Such radiation is ideal for initiating moderate electro-chemical processes, so enabling eyes to see and plants to grow. Also, solar radiation heats.

So the Earth is kept within the range of temperature necessary for life because of the amount of sunshine and the Sun-Earth distance. Therefore an appreciation of solar energy is vital to understand sustainability and wonder at mankind's place in ecology.

#### The essential role of the Atmosphere

#### Control

By itself, the Earth's surface cannot provide the controlled environment necessary for our ecology. Life would overheat beyond boiling in daytime and freeze to death at night. It is our Atmosphere that moderates the sunshine, controls that temperature regime and provides oxygen for the energy of metabolism and combustion. Moreover, the life that depends on this Atmosphere, itself maintains essential atmospheric components.

#### Content

Initially, over 4 billion years ago, the Earth's atmosphere was about 99% by volume carbon dioxide ( $Co_2$ ), with no oxygen gas ( $O_2$ ). Heat emitted from the Earth's surface as infrared radiation is absorbed by  $Co_2$ , and by other molecules with 3 or more atoms, and so this initial atmosphere kept the Earth too hot for life as we know it now. Then, in the next 3 billion years, anaerobic (i.e. not requiring oxygen) microbiological life removed almost all  $Co_2$  from the Atmosphere, binding the carbon within solids and solutions. Most carbon was therefore sequestered (removed) from the Atmosphere.

The previously inert atmosphere was replaced by the present active atmosphere of oxygen (19% by volume), nitrogen (80%) and certain trace gases. Co<sub>2</sub> was drastically reduced from 99% to nearly 0.025%, sufficient however to be absorbed by plants in photosynthetic growth and to be a key component in atmospheric temperature control. This renewed atmosphere could then sustain present life, including humans, by controlling temperature, so allowing water to be liquid, providing oxygen for energy and enabling other essential functions.

This situation was controlled by ecology, which constantly corrects for changes, but only within limits. It is arguable that mankind today may be causing these limits to be exceeded, so perturbing control mechanisms. For instance, in the last 150 years, fossil fuel use and forest burning has increased Co<sub>2</sub> by 40% to a concentration of 0.035%.

## Carbon removed

The removed carbon was sequestered mostly as dead plants and micro-organisms to become limestone, chalk and fossil fuels. It is essential for present life that the vast majority of 'buried carbon' remains out of the Atmosphere. If just 0.03% of 'buried carbon' is returned to remain in the atmosphere, atmospheric  $\text{Co}_2$  concentration would double, with damaging results from climate change and its control. Moreover, the combustion of fossil fuels produces pollutants other than carbon dioxide. It is clear therefore that ecological life, including humans, exists because the majority of the Earth's carbon, including fossil fuels, was buried billions of years ago; it is equally clear that returning excess carbon to the Atmosphere at present rates (mostly by escalating fossil fuel use, but also by forest burning) is a cause of Climate Change and a disruption to present life (see JRI Brief No 2 on Global Climate Change). The natural ecological control of atmospheric gases is now unable to correct for the rapidity of mankind's excesses.

**Discussion**: What are the benefits and disbenefits of utilising coal, oil and fossil gas? Have these factors changed over the last 200 years? Who really needs to use fossil fuels?

## **Energy from different sources**

#### What of nuclear power?

Radioactive materials dispersed within the Earth's structure, produce sufficient heat to prevent the inner core from cooling; however this important flux of heat is much less than solar heat. The dispersed and buried nature of the material overwhelmingly prevents the radioactivity from affecting organic life. Likewise the relatively small amounts used so beneficially in medicine and instrumentation may be controlled and used safely. However if the radioactive material has a long lifetime (perhaps many thousands of years) and is concentrated, as with a significant fraction of nuclear ores and wastes, biological organisms cannot continue in its presence.

Discarded radioactive material is likely to eventually 'leak' into the biosphere, to be absorbed and concentrated into food chains, with the higher forms of life accumulating radioactivity with subsequent danger of genetic harm. There is no known and certain way to safeguard radioactive waste from ultimately entering and harming the biosphere. To date, no form of containment is reliable against ingress of water over the thousands of years needed before the radioactivity becomes negligible.

When extracted, nuclear energy is used only for nuclear weapons and/or centralised electricity generation. Usually, as in the UK, these activities have been associated, so causing concern that weapons proliferation and terrorism may stem from nuclear power. In commercial terms, nuclear generated electricity is expensive and only undertaken with considerable government funding. Nuclear accidents are of major concern.

Nevertheless, a significant advantage of nuclear power is the significant abatement of CO2 and other emissions that might otherwise come from fossil fuels. Continued R&D on the political and technical difficulties and opportunities of nuclear power is justifiable, but only in relation to similar effort on fossil fuel and renewable energy. All such effort should be transparent and open to public scrutiny.

# Brown versus green energy supply

Therefore it is helpful to make 2 classifications of energy supply:

- 1. Brown Energy, derived from the underground sources of nuclear ores and fossil fuels, and
- 2. Green Energy, derived from ongoing energy supplies available in the natural environment.

One view from ecology is that Brown Energy sources are effectively 'removed pollution', so such fuels are, ab initio, already concentrated pollution. Clearly there is a duty to process and use such fuels efficiently with the minimum of adverse impacts (as is indeed is increasingly practised and the declared aim of ethical business). Nevertheless, the final emissions remain pollution, which is discharged wholly or in part into the air and water of our immediate environment.

In contrast, Green Energy supplies at source are intrinsically non-polluting, since life depends upon them. Most categories of Green Energy technology, as explained below, do not emit pollution. Clearly, as we move from Brown to Green energy, the efficient use of present energy and the minimisation of emitted pollution is vital.

#### Renewable (green) energy

Renewable energy is energy supplied from the natural and persistent flows of energy in the immediate environment. Obvious examples are sunshine that heats glasshouses and hydropower that generates electricity. Such technologies are called 'renewables' and are, by definition, sustainable. The generally benign ecological and environmental impacts of renewables contrasts with the adverse impacts of Brown Energy. By using Renewable Energy instead of Fossil Fuel Energy, buried carbon remains underground (its use is abated). Using carbon that is already circulating in the ecology of the biosphere, e.g. in plants, does not produce 'extra carbon' and so does not threaten long-term harm.

The total energy passing through our environment is enormous and predominantly arrives form the Sun; in one hour as much solar energy arrives as is used by the world economy in one year. In addition there are relatively smaller energy fluxes from tides and geothermal heat. Sunshine transforms into most of the renewable supplies.

#### Thus sunshine:

- heats the surface (solar water heaters, cookers, dryers, buildings);
- causes wind (wind turbines and pumps) which in turn causes sea waves (wave energy devices);
- evaporates water giving rainfall (hydropower);
- powers photosynthesis in plants (biomass, biofuels, gasifiers, landfill gas) from light (photovoltaic electricity);
- and, via plants, provides animals with food (hence biogas, sewage gas).

In addition tides (tidal power) and subterranean heat (geothermal power stations, heat pumps) give occasional and locally important energy supply possibilities. There is no shortage of renewable energy; the challenge is to develop, manufacture, and utilise the associated technology.

Left to rot, biomass decays to  $Co_2$  with slow heat emission. When burnt as fuel, a similar process occurs, but the heat can be used to substitute for Brown Energy, thus abating fossil  $Co_2$  emission. Therefore using sustained biomass for energy does not introduce extra carbon into the Atmosphere, as does the combustion of fossil fuels.

Compared with brown energy, renewables harness mild forms of energy and so the equipment is relatively large and visible. It tends to require expensive capital items, though the energy harnessed is free. The visual impact, in contrast to the ecological impact, can be considered adverse.

The more efficient the renewable energy systems, the smaller the equipment and therefore the cheaper the energy supplied; moreover, the visual impact is reduced. With Brown Energy, both the adverse impacts and the costs are reduced if the systems are efficient. Therefore, energy efficiency is of prime importance for both renewables and non-renewables.



#### Renewable technologies

There are many forms and types of renewables technology; most are now established and with rapidly increasing rates of commercial implementation, often at 30 to 40% growth per year. However, even at these rates, it will be 10 to 20 years before renewables become dominant supplies. Renewables are classified by immediate source, and then by technology and purpose.

The energy is used for heat, machines, electricity generation and transport. The variability of most renewables requires integration and storage, including amalgamation using electricity and heat grids.

The following is an approximate guide for use in the UK, with examples orientated to meaningful household use, either on site or via the purchase of electricity from a 'Green Electricity' Supplier. The benefit in the UK are indicated by the number of \*.

We note that the following is only a simple guide to the renewable energy technologies currently available to us and is for general guidance only. Each circumstance were renewable energy is being considered in fact has a distinctive environment and opportunities, e.g. with a suitable stream, hydroelectricity can be the best choice, however we have recognised that the number of situations where this will be the case are limited.

## Solar heating \*\*\*

Using sunshine for heat; the easiest use of solar heating is to design buildings so that they absorb solar heat directly through passive solar heating. This makes this form of green energy very affordable at zero to 10% extra cost of new-build, and opportunistically for building conversions and extensions; and can reduce up to 50% of conventional heating requirements.

It can also be transmitted to use, through active solar water heaters using 'solar thermal panels', the cost of this is about £2,000 per house, and this can be offset by the reduction in conventional water heating of 50%. Therefore we should consider adding a solar water heater to the cost of your home and where passive heating of your home is beneficial, in colder climates, let sunshine enter your otherwise insulated house.

#### Solar electricity \*\*

Sunshine can generate electricity. This can be an immediate source through photovoltaic solar modules or panels that interconnect with the grid or use battery storage. This costs around £15,000 per house and can achieve a 50% reduction in your annual electricity bill. Alternatively by running machines that use heat from 'solar thermal' devices, such as concentrating mirrors raising steam. However this is not a sensible solution in the UK were cloudy skies prevail.

## Wind power \*\*\*

Electricity from wind turbines. This industry is growing rapidly at 30 to 40% per year; each year world-wide there is more new wind power than nuclear or traditional coal power. Wind-electricity costs are less than from nuclear, oil or coal, and about equal to gas, even without considering the abatement benefits of CO2 and other pollution. The controversial impacts of wind power are mostly visual and sometimes noise. Most machines are large, perhaps up to 100 m in diameter and commercially grid-connected. Siting can be both on land and offshore at sea. Small machines with a diameter of 1 to 10 m can be used for autonomous electricity supply backed up with batteries and perhaps also integrated with other renewables. The capital cost for a wind turbine is about £700/kW for large machines, and more per kilowatt for smaller machines.

### Biomass \*\*\*

This is the generic name for dead and harvested biological matter and its products. There are many opportunities, often complex, for both energy and fertilising nutrients. The use of otherwise waste material, e.g. sewage, gives a cost advantage. Since humans always produce waste, such energy supplies may be considered 'renewable'. However care is needed to optimise systems and prevent inadvertent pollution. Specific examples are listed below:

#### Fire wood \*\*

There is a surprising surplus of fallen, waste and scrap wood that can be used dry for domestic, commercial and industrial heating. Purpose-designed stoves and boilers are essential for serious use. Fuel wood and waste is unlikely to be sufficiently 'smokeless' in towns and cities. In the country however, up to 100% of water and building heat can be supplied with sufficient wood availability, but the supporting effort to crop and store the wood can be significant.

# Urban waste \*\*

On average, at least 5% of a towns energy supply can come from the combustion of local organic wastes, e.g. from 'rubbish' collection, industry and agriculture. District heating, combined heat and power, energy efficient buildings and environmental taxes enable such strategies to be successful (as in Denmark and Sweden). However, firstly every opportunity should be taken to recycle actual parts and materials before resorting to combustion and also high quality combustion is needed to minimise resulting air pollution.

# Landfill gas \*\*

Purpose built rubbish-pits produce a combustible mix of methane and other gases that may fuel electricity generation at megawatt scale and/or provide commercial process heat. Sewage gas is similar. Likewise Biogas can be collected from animal manure. All such processes support the proper control and treatment of otherwise unhealthy wastes.

## Energy crops \*\*

Plants may be harvested commercially, dried and then burnt for heat. The heat is used immediately or can be used to generate electricity, hopefully combined with the use of the rejected heat. Partial combustion, in a gasifier, produces a combustible gas to be used as a convenient fuel. High quality equipment minimises smoke emission and ensures optimum combustion. Crop oils, such as rape seed can form the basis of transport biofuels at national scale.

#### Hydro\*

In Hydro power falling water turns a turbine for electricity generation. Large systems have stored water behind dams that can inundate valleys. In Scotland 10% of electricity is from commercial scale hydro power plants. On a more localised scale 'Run of the river' systems without storage can be implemented such as electricity generation at old water mill sites. These generally have less impact, as they are much smaller and the water sources are not always continuous, subject to seasonal variations.

In utilising hydro power we need to strike a balance between conservation of our aquatic habitats and sometimes terrestrial habitats where damns are used to flood dry valleys and the human demand for energy.

#### Wave power\*

Wave power is the electricity created by harnessing the natural energy of sea waves which travels in large, long-wavelengths. Atlantic sea-waves average about 50 kW/m, and then reduce as the waves become less extreme near to the shore. After many years of ongoing research, commercial devices are now operating into the grid and being built in Scotland. Early machines have been relatively small (about 150 kW peak electricity), but this capacity will increase with experience.

#### Geothermal\*

This is heat from the earth. Hot aquifers, as in Southampton and Paris, may be tapped for district heating, and some for powering turbines for electricity production, as in areas of Italy, New Zealand and California. Heat can also be extracted from large volumes of granite, a useful energy source in principle, but not yet in practice.

#### Tidal range?

This is hydroelectricity from the rise and fall of tidal height, as water flows through a tidal barrier. About 15% of UK electricity could come from the tidal range power of the Severn Estuary, and lesser amounts from other estuaries with such enhanced tidal range. However the consequent reduction of mud flats, without compensation, would harm wading and migratory birds. Cooperative benefits can be a road across the barrier, flood prevention, enhanced fisheries and leisure facilities.

# Tidal flow currents \*

This is similar to low-head hydro, but is not yet commercially proven. Currently only medium and small scale developments with low impact exist.

## So what more can be done?

## By governments.

Most renewable energy technologies have been researched and demonstrated. The need is now for markets, linked with ongoing research and development. Once there is competitive business from expanding demand, financiers, manufacturers and suppliers can make long term plans and prices fall. Governments can control appropriate markets by;

- 1. increasing or decreasing taxation,
- 2. awarding grants,
- 3. changing building and manufacturing standards,
- 4. transport policy, and
- 5. environmental legislation.

The potential for markets is learnt from research, which governments need to fund in cooperation with industry.

#### By individuals.

Each of us, and our businesses, clubs and churches, can also greatly change our lifestyle and practices that promote environmental improvement, especially through our spending and investments.

For example; insulating homes, contracting with a supplier of green energy; investing in ethical funds; considering energy use when purchasing white goods, housing, heating plant, lighting, vehicles, travel etc; voting appropriately at elections; studying information; learning from demonstrations of good practice etc. In general it is necessary to quantify and monitor such action so we maintain awareness and responsibility.

### By business and industry.

Obviously commerce requires continued cash flow, which arises from investment and enterprise, and is sustained by meeting market orders. Nevertheless, commerce should not blindly follow the market from others, but should operate within a code of honourable trade and innovation. This policy has an environmental dimension, which includes its own energy supplies, products and market development.

Such enterprise is essential for best technology and implementation, and for best practice and sustainability. Proper utilisation of Renewable Energy is at one with efficiency, low overheads, long-term investment and minimum adverse impacts. The world-wide 20 to 30% per year growth of renewable energy implementation and of energy efficiency procedures are market opportunities that sit well with environmental integrity

#### **Natural Gist**

- Without a supply of energy nothing lives, moves, communicates, cooks, heats, manufactures or produces.
- The scale of present day global energy demand is doing increasing environmental harm. The natural ecological controls of atmospheric gases are now unable to correct due to mankind's excesses. To ensure environmental and economic sustainability renewable energy must urgently replace most fossil fuel
- There is an <u>unfair distribution of energy</u> globally. People die from lack of heat and energy for cooking. People die from breathing carcinogenic smoke. Tourism and leisure squanders energy with abandon.
- The 2 classifications of energy are; brown energy from underground sources such as nuclear ores and fossil fuels and green energy derived from ongoing energy supplies available in the natural environment, which are intrinsically nonpolluting.
- Supplies of clean energy are already part of the sustainable processes of creation. In one hour as much solar energy arrives from the sun as is used by the world's economy in one year. The creates heat, wind, rain and powers photosynthesis.

The challenge is to develop manufacture and utilise the associated technology and therefore utilise the sources of renewable energy. Based on current growth in renewable technology it will be 10-20 years before renewable become dominant energy supplies. Governments, individuals and businesses all play a role in improving this statistic:

#### Renewable Energy, By Professor John Tidwell

This briefing was prepared for the JRI by Professor John Twidell (Director of the AMSET Centre and Visiting Professor in renewable energy engineering, University of Reading). Thanks are due to Sir John Houghton, Professor Colin Russell, Dr John Sale, Mr Peter Bright, Dr Mike Morecroft, Mr David Thistlethwaite and others within the JRI for their constructive comments.

The original article can be found at: http://jri.org.uk/brief/energy\_renewable.htm Last accessed August 2009



### **Water Security through Innovative Solutions**

By Sourabh Joshi, Swati Arunprasad Edited by Ranjit Barthakur & Samir Menon, NatureFirst

#### Impact of climate change on water security

Globally, climate change is threatening the security of food, water and eco-systems and creating a sustainability gap. Our rapidly expanding consumption footprint and indiscriminate natural resource conversion is widening this gap. Today water scarcity affects one in three people across every continent of the globe and the situation is becoming worse as water consumption escalates. A result of population growth, urbanisation and increases in household and industrial use.

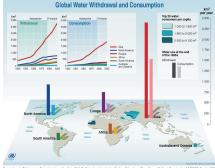
One fifth of the world's population, about 1.2 billion people, are now living in areas where water is scarce. This lack of water has consequences; driving up the use of waste water for agricultural production, particularly within the poor urban and rural communities. Worldwide more than 10% of people consume food irrigated with wastewater that can contain chemicals and carry disease.

A large concern for the world community today is the depletion of freshwater. Water is one of the most common resources on the planet, yet only 2.5% of global water can be consumed with the remainder salt water. Of that 2.5%, two thirds is confined to glaciers and permanent snow cover so that only a fraction of the world's water is liquid freshwater and it is increasingly a cause for conflict, as the availability reduces.

#### Global water challenges

At a global level there are many challenges regarding water security that face us, these include:

- 1.1 billion People, or 1 in every 6 of the world's population, are without access to clean water.
- The Nile in Egypt, The Ganges in India and Bangladesh. The Indus in Pakistan. The Yellow River in China and The Colorado River in the United States are among the rivers that no longer make it to the sea.
- According to a recent Global Environment Outlook (GEO) report, almost 1/3rd of the world's population live in countries suffering from moderate to high water stress.
- Poor people living in slums often pay 5-10 times more per litre of water than wealthy people.
- Emerging economies (such as India, China and Turkey) still have a rural population dependent on water supply for their food production.



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 Energy costs can account for 60% - 80% of water transportation and treatment costs and 14% of total water utility costs.

The UN estimates that by 2050 there will be an additional 3 billion people in our world, with most of the growth based in developing countries that already suffer water stress. Thus water demand will increase unless everyone finds a way to conserve and recycle this precious resource.

### Water challenges in India

Water is our national inheritance. Captured in the glaciers of the Himalayas, India and China are gifted to have about 40% of the earth's fresh water resources. In order to continue on India's growth path towards a world superpower, it is in our long term national interest that we protect, preserve and sustain our water resources. Yet there are many problems faced by India with regards to water supply that threaten our water security both in the urban and rural areas of India.

### Urban water challenges

From an urban perspective the key factors responsible for water scarcity in India are:

An unreliable supply; in most Indian cities, water is typically available for only 2 – 8 hours a day. Erratic and unreliable water supply is particularly problematic during summer months. With increasing urbanisation the demand-supply gap is growing as India's urban water supply fails to satisfy growing demand.

Old and poorly maintained infrastructure; results in a loss of 25-50% of water as it journeys from supply to destination, a result of leakage and pilferage during transmission, further exacerbating the inadequacy of water supply.

Contamination; due to back siphoning there is easy contamination of water and over extraction of ground water has led to salt water intrusion into coastal aquifers and quality deterioration. Such causes of contamination have resulted in excessive fluoride, iron, arsenic and salinity in water, which is now affecting about 44 million people in India.

Many of India's main cities are now suffering from a significant shortage in water supply, as illustrated in the table below. Such cities are the economic powerhouses of a country and we must consider that under supply of water can impact upon their performance as so this matter has to be addressed to protect their economic sustainability.

City	Water demand (MLD)	Water Supply (MLD)	Shortage (%)
Delhi	750	650	13
Mumbai	3450	2500	28
Chennai	971	675	30
Bangalore	840	705	16

According to a World Bank study, out of the 27 Asian cities with population more than a million Chennai, Delhi, Mumbai and Kolkata are ranked as the worst performers in terms of hours of water availability per day.

### Rural water challenges

In rural India there are many challenges that need to be addressed:

The demand of agriculture upon water sources; currently 70% of the fresh water available to India is used by agriculture. More than 85% of rural water supply systems rely on ground water sources. Of the ground water sources, about 85% is drawn for irrigation, whilst rural drinking water draws less than 3%. The overdraw on ground water and a recharge deficit, there is an imbalance between supply and demand. Consequentially there is a cumulative fall in the ground water table to the tune of 2-3 metres every year.

Lack of clean drinking water; overall there is a continuing lack of clean drinking water provision. In remote areas the maintenance of service delivery systems is a challenge, annually around 37.7 million Indians are affected by waterborne diseases, with 1.5 million children estimated to die of diarrhea alone. There is a non-availability of low cost water technologies that could cater to the poor and assist in providing rural water security for the rural communities. This together with a lack of awareness, surveillance, monitoring, testing, mitigation measures, availability of alternate water resources and adoption of hygienic practices all continue to be roadblocks to rural water security.

According to a world bank study, as much as 1% of India's GDP is lost through the inefficient application of water supply schemes that could assist rural households.

### Achieving water security the Naturenomics<sup>™</sup> way

Keeping all the issues on water security in mind Naturenomics™ has proposed a sequence of steps for effective water provision in both urban and rural areas, steps that will result in national water security. These steps are:

Delivering effective water resource management

- To achieve effective management of water resources through the creation of an 'Institutional Framework' that will help in developing mechanisms towards the identification and implementation of measures towards water security.
- · By promoting comprehensive sub-regional resource policies and strategies.
- Giving emphasis to wetland and watershed management projects that will help in the storage and maintenance of a continuous water supply.

Implementing effective flood & erosion management measures

- Developing and implementing operational plans to enable strategic investment in flood management.
- Developing a soil and water management plan (SWMP), listing steps to identify flood and erosion risks together with appropriate mitigation measures.
- Developing functional warning & community alert systems. Enabling a community to be kept up to date about natural calamities and providing advice on the appropriate steps to tackle them.

The introduction of eco-friendly measures

• Develop hydropower at basin level using mini/ micro hydel projects which can support rural infrastructure and ensure benefits such as rural electrification and job creation.

Use of alternate modes of transport focusing on inland water transport

• Invest in a multimodal transport infrastructure, improving access to markets and social infrastructure.

### NatureFirst-GEMS water audit methodology

Developing solutions addressing water scarcity at a national level, requires an understanding of the overall usage patterns and mapping the areas of concern that must be addressed. To do this one must calculate the national water footprint and analyse this; considering the types and sources of water usage and its wastage.

### Water accounting

Water accounting is the identification of water sources and the measurement of water usage patterns on a nationwide scale. The methodology involves mapping the water footprint, considering the source of the water and points of usage, based upon which areas of over use can be identified and steps towards achieving water security can be suggested.

Types of water; there are three basic types of water footprints, these are:

- A green water footprint; essentially the volume of water received through precipitation i.e. rainwater
- A blue water footprint; this covers the volume of surface or groundwater evaporated through natural and anthropogenic (man-made) activities.
- A grey water footprint; this is waste water generated through anthropogenic activities, such as sewage and effluent water coming from domestic and industrial activities.

Once the type of water and its footprint is known, we need to understand the sources of these. This can be understood by analysing the water usage in the following ways:

- The water footprint of a product; this covers the volume of freshwater used to produce the product across all steps of the production chain.
- The water footprint of a corporate; this covers the total volume of freshwater, used directly and indirectly, to run and support business and has 2 components namely an operational water footprint and a supply chain water footprint.
- The water footprint of a nation; this covers the total amount of water used to produce all the goods and services consumed by the inhabitants of a nation.

Based on the footprint available, the following steps can be taken to devise solutions:

- Raising awareness; by delivering an awareness campaign, such campaigns can highlight the link between levels of consumption and its impact on the water use patterns.
- Developing indicators/ promoting policy making; based on the patterns observed, indicators
  of water usage can be developed that will support the making of policies which promote water
  security.
- Identifying target group; the policies being developed must have target groups such as government, policy makers, corporate, international agencies, investors, who can participate in the implementation of the policy and help deliver a water secure nation.

#### Water footprints

A water footprint is an indicator of the volume of water consumed by direct and indirect use by an organisation in a year. It includes direct water use by the producer (the water required to produce, manufacture or support activities) plus indirect water use, all other water utilised in the producer's supply chain. Calculating a water footprint includes mapping the existing water consumption patterns across the facility, to include:

#### The sources of water:

To identify all the sources of water, an exhaustive list of all the possible sources of water supply should be prepared, to include:

- Sources of potable water: Municipal water, ground water, private suppliers of PET bottles, water cans
- Sources of process water and water for other non-potable purposes: such as gardening, washrooms and canteen use.

#### The storage systems:

Storage systems include overhead tanks, on-ground and underground storage reservoirs. All storage systems must be identified and counted and their capacities be noted down.

#### Utilisation patterns and quantification:

The utilisation patterns and the quantity of the water consumed should be recorded.

A direct and easy method for calculating overall water consumption is through monthly water bills or water meter readings. Although this method assumes that the total water supply is through a single government or private body.

If recorded data on the quantity of water utilised is not available, an estimate can be done by retrieving information on the number of trips made by the tanker trucks to the organisation together with the tankers capacity. Another method is to calculate water consumption by the capacity of the storage tanks or by measuring the rate at which water levels decrease over a period of time.

Information on the quantity of water consumed can also be obtained from the personnel in charge at the various points of consumption. For example:

- For drinking water; the number of PET bottles or water cans purchased annually as recorded in a company's purchase records.
- For hot & cold water consumption as used in a buildings heating and ventilation.
- For canteens; the quantity of water used for cooking and cleaning by the canteen staff.
- For housekeeping; the quantity of water used by housekeeping staff together with collating information on the number of flush tanks, taps etc within the property.
- For gardening, identifying the quantity of water used by the gardener.

## Wastewater outlets and quantification:

There are many sources of wastewater. Wastewater should be mapped back to its sources together with the processes involved. The wastewater must also be quantified and this can be done in the following ways:

- If there is already an existing sewage treatment plant (STP) or effluent treatment plant (ETP), data on waste water can be obtained from the personnel in charge of the treatment plant. The data recorded by them would be the volume filled within the collection tank.
- The data can also be obtained from audit reports, from audits that have already been conducted for the sewage treatment plant (STP) or effluent treatment plant (ETP).
- If no data is available then the quantity of waste water produced can be assumed to be 80% of all water consumed.

Existing water and waste water management practice:

Existing water and wastewater management practice can be mapped in the following areas:

- Rainwater harvesting (RWH); is the activity of collecting rainwater. This can be stored for direct use or can be recharged into the ground water. Rainwater harvesting is the collection of storm water runoff for productive purposes.
- Sewage treatment plant or an effluent treatment plant (STP/ETP); are treatment plants where sewage and waste water is treated by primary, secondary and tertiary treatment processes so that water can be recycled or at least meet the discharge standards to be let out to a receiving body.
- Recycling of treated water; the extent to which treated wastewater is recycled and the different ways by which the purified water is reused in the campus.
- Water efficient fixtures for other purposes; the use of water efficient fixtures such as sensor taps, water efficient flush and waterless urinals
- Water efficient fixtures for gardening; implementing water efficient fixtures such as drippers.

#### Water solutions

Using the above mentioned methodology, consumption patterns of the various sectors can be identified and from analysing their consumption patterns possible areas for improvement can be advised for the respective sector.

Based upon the gaps being identified, strategic initiatives for supply and demand side management can be developed. These, when implemented in-house, will help to make facilities move towards the goal of a water-neutral status, which in turn will help government to bridge the gap between ever increasing demands and the supply of water to meet these demands

In addressing water scarcity, governments can also promote large scale city based initiatives, helping to support measures taken by industries and housing complexes individually. The initiatives possible are listed in the following section.

## Rainwater harvesting (RWH) - a modern solution for tackling water scarcity

Water scarcity has become a persistent problem for many cities in India. In these cities, because of the shortage of the water, cuts in the water supply have been undertaken, causing inconvenience for the city population. The municipalities are finding it difficult to supply the water effectively as there is no constant water source, such as water reservoirs or other continuous natural supply and a cities infrastructure is dependent upon a good water supply to support the population living there.

On an average India receives 120 cm of rainfall during the monsoon season. Efficient harvesting of this rain would help reduce the dependence on municipal or ground water supply and could even solve the water crisis for the cities people.

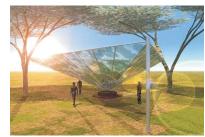
Here are some innovative technologies that are/can/ could be used to tackle the water scarcity problems in India.

Developing rainwater harvesting reservoirs for city infrastructure:

One such effective solution is the implementation of rainwater harvesting reservoirs, essentially the creation of a reservoir over a huge land area away from the city limits to enable the capture and storage of large volumes of rainwater. This RWH system needs to be built considering the contours of the existing land area so as to optimise the potential for rainwater collection.

Post collection, the water can be sent in 3 grades of water quality, to the city area.

 Tertiary treated water; this water is of drinking quality. A stream of the rainwater collected by the reservoir and diverted to drinking water treatment plants. These plants provide proper primary treatment including screening & clariflocculation followed by a secondary treatment by aerobic process followed by ACF and RO.



- Secondary treated water; this water can be used for all domestic purposes like cleaning & housekeeping purposes. A stream of water from the reservoir sent for primary water treatment of screening & clariflocculation followed by secondary treatment and then supplied to the city for domestic use by households. By supplying this water stream, there is a reduction in excess treatment costs, economically benefitting the city municipality.
- Primary water; water for flushing and gardening purposes only. This is a dedicated stream of
  water from the reservoir that undergoes primary treatment of screening & clariflocculation
  only. Additionally other new technologies are providing new RWH opportunities and could be
  incorporated into parts of the treatment process.

#### Watair:

Watair extracts water vapour from the air. It utilises a 96 square metre dew collecting pyramidal panel and delivers at least 48 litres of water per day. This product has been designed to work in almost any climate and can be used in remote places or places that do not have any existing clean water sources, either rural or urban. The panels are flexible, easy to collapse when not in use, and usefully provide shade and even a degree of shelter during inclement weather. The low-tech design was conceived by Joseph Cory of Geotectura and Eyal Malka of Malka Architects from Haifa, Israel.

## The Water Maker:

A new technology which uses a refrigeration technique optimised to condense and collect water from the air. Blower driven air is drawn into the system through an electrostatic filter. Within India this technology is being offered by Water Maker India Pvt. Ltd. They have carried out a pilot project at Jalimudi, a small village near Rajahmundry, East Godavari District on the basis of its location and climatic conditions. With the help of this



technology, people of Jalimudi now have acaccess to uncontaminated water.

Through the implementation of this system, dependence upon conventional water sources can be reduced and this could help solve the water crisis present within Indian cities. Additionally huge economic benefits will be availed by municipalities as the investment in creating and procuring water could be greatly reduced through such RWH systems.

## Johads:

Johads in Rajasthan. Johads are small earthen check dams that capture and conserve rainwater, improving percolation and groundwater recharge. Starting in 1984, the last sixteen years have seen the revival of some 3000 johads spread across more than 650 villages in Alwar district, Rajasthan.

This has resulted in a general rise of the groundwater level by almost 6 metres and a 33% increase in the forest cover in the area. Five rivers that used to go dry immediately following the monsoon have now become perennial, such as the River Arvari, which has come alive.



## The "121" Rainwater Catchment Project:

In the Gansu Province, China, The "121" Rainwater Catchment Project has been implemented by the Gansu Provincial Government and been supported farmers by building one rainwater collection field, two water storage tanks and providing one piece of land to grow cash crops. This project has proven successful in supplying drinking water for 1.3 million people and developing irrigated land for a courtyard economy. As of 2000, a total of 2,183,000 rainwater tanks had been built with a total capacity of 73.1 million m3 in the Gansu Province, supplying drinking water for 1.97 million people and supplementary irrigation for 236,400 ha of land.

## **Next Steps**

To tackle the current issues of water scarcity in urban as well as rural areas of India, we need to take immediate actions and start implementing appropriate solutions. We also need greater active support from government agencies to ensure a timelier handling of the problem. We need clear plans for implementation of the various measures around; Water Resource Management, Flood and Erosion management. These plans need carefully considered development, with key decisions for these plans taken at the appropriate level of authority to ensure the required actions can be taken and policies are in place to support them and so they can and will be enforced.

Adopting eco-friendly measures of mini and macro hydel projects can help to support the government aims for Social upliftment. Such measures will ensure rural employment generation, helping to make these areas of India self-sufficient. They also make a great contribution towards the reduction in India's contribution of GHG emissions. Generating clean source of energy and promoting newer, greener technologies and processes like WatAir and Watermaker.

All the solutions, identified within this article, must be implemented with the support of the key social, economic, political, and industrial constituencies and at a scalable level to be effective. We believe, however, that the most effective and immediate deployments out of the suggested solutions will be those implemented at the grass-roots level. It is these actions, we believe, that will provide one of the most conducive means of ensuring an effective resolution of water scarcity issues, guaranteeing social and economic development through sustained ecological action and to ensure India does not have to face water scarcity problems in future

### Natural Gist

- Water scarcity affects 1 in 3 people. The situation is worsening as water demands rise due to population growth, urbanisation and increasing household and industrial uses.
- Freshwater depletion is a worldwide concern today. Although one of the most common resources, only 2.5% of it can actually be consumed.
- Almost 1/3rd of the world's population live in countries suffering from moderate to high water stress.
- Water is our national inheritance; India and China are gifted to have 40% of the earth's fresh water resources captured in the glaciers of the Himalayas.
- Urban water scarcity in India is caused by; an unreliable supply, old and poorly maintained infrastructure, contamination.
- Key challenges for <u>rural water scarcity in India</u> are; high demand of agriculture on ground water sources, falling ground water tables, lack of clean drinking water, lack of awareness or availability of alternate water sources and adoption of hygienic practices
- Naturenomics™ water security can be implementation by the following steps; effective water resource management, flood & erosion management, introduction of eco-friendly measures (such as mini hydel & micro hydel projects), use of alternate mode of transport focusing on inland water transportation.
- Modern water security solutions include; rainwater harvesting reservoirs within city infrastructure, WatAir water vapour air extraction collecting 48L of water per day, Watermaker implementing refrigeration techniques optimising condensation of water from the air.



#### **Eutrophication: Sources and Drivers of Nutrient Pollution**

Mindy Selman and Suzie Greenhalgh, (June 2009)

## **Key findings**

Nutrient over-enrichment of freshwater and coastal ecosystems, or eutrophication, is a rapidly growing environmental crisis. Worldwide, the number of coastal areas impacted by eutrophication stands at over 500. In coastal areas, occurrences of dead zones, which are caused by eutrophic conditions, have increased from 10 documented cases in 1960 to 405 documented cases in 2008. In addition, many of the world's freshwater lakes, streams, and reservoirs suffer from eutrophication; in the United States, eutrophication is thought to be the primary cause of freshwater impairment. Many of our largest freshwater lakes are entrophic, including Lake Erie (United States), Lake Victoria (Tanzania/Uganda/Kenya), and Tai Lake (China).

The increase in eutrophication is the result of human activities. Major sources of nutrients to freshwater and coastal ecosystems include wastewater, agriculture, and atmospheric deposition of nitrogen from burning fossil fuels.

The drivers of eutrophication are expected to increase for the foreseeable future. Specifically:

- World population will continue to grow, reaching an estimated 9.2 billion by 2050, which will increase pressures on the productive capacity of agriculture and industry.
- Intensive agriculture and land use conversion—for crops, livestock, and aquaculture—will increase, especially in the developing world. In addition to population growth, intensification is driven by changing dietary patterns. For example, over the period from 2002 to 2030, global meat consumption is expected to increase by 54%.
- Energy consumption is expected to grow 50% from 2005 to 2030. Fossil fuels, which release nitrogen oxides (No,) into the environment when burned, will continue to be the dominant fuel source in this century.

As a result of these increasing global trends in population growth, energy use, and agricultural production, we expect that coastal and freshwater systems impacted by eutrophication and hypoxia will continue to increase, especially in the developing world.

Human-induced eutrophication, or nutrient over enrichment, is a rapidly growing environmental crisis in freshwater and marine systems worldwide. Nutrients that cause eutrophication include nitrogen and phosphorus. While nitrogen and phosphorus are critical to biological processes in aquatic ecosystems, increased runoff of these nutrients to aquatic ecosystems from land-based sources results in increased biomass production, upsetting the natural balance of these ecosystems. Eutrophication can ultimately result in harmful algal blooms, the formation of hypoxic1 or "dead" zones, and ecosystem collapse. Today, over 500 coastal areas have been

identified as suffering from the effects of eutrophication; of these, 405 have also been documented as hypoxic (compiled from Selman et al. 2008 and Diaz and Rosenberg 2008).

In freshwater systems, phosphorus is often the main cause of impairment, while nitrogen is generally linked with the impairment of coastal systems. In addition to contributing to eutrophication, nitrogen pollution also contributes to other environmental problems such as acid rain, climate change, and local air pollution. Nitrous oxide (N $_{\!\scriptscriptstyle 2}$ O)—a nitrogen-based greenhouse gas that contributes to climate change—is linked primarily to agriculture and is 310 times more powerful than carbon dioxide. Nitrogen oxides (No $_{\!\scriptscriptstyle N}$ ) are another family of nitrogen-based gases that are released into the atmosphere from fossil fuel combustion. No $_{\!\scriptscriptstyle N}$  is highly reactive and contributes to the formation of smog—which can have significant impacts on human health—and acid rain.

This policy note provides a snapshot of the sources of nutrient pollution and the corresponding socioeconomic drivers that are increasing nutrient levels in our waterways. It complements Eutrophication and Hypoxia in Coastal Areas: A Global Assessment of the State of Knowledge (Selman et al. 2008), a previously released publication on the extent of eutrophication worldwide.

#### Where do nutrients come from?

Sources of nutrient pollution released to freshwater and coastal areas are diverse, and include agriculture, aquaculture, septic tanks, urban wastewater, urban storm water runoff, industry, and fossil fuel combustion. Nutrients enter aquatic ecosystems via the air, surface water, or groundwater (Table 1). Among regions, there are significant variations in the relative importance of nutrient sources that contribute to eutrophication of local and coastal water bodies. For example, in the United States and the European Union, agricultural sources—commercial fertilisers and animal manure—are typically the primary sources of nutrient impairment in waterways, while urban wastewater is the primary source in Asia and Africa

Table 1: Primary sources and pathways of nutrients				
	Pathways			
Sources	Air	Surface water	Groundwater	
Sewage treatment		✓		
plants				
Industry	✓	✓		
Septic systems		✓	✓	
Urban storm water		✓		
runoff				
Agricultural fertilisers	✓	✓	✓	
Livestock operations	✓	✓	✓	
Aquaculture		<b>√</b>		
Fossil fuel combustion	✓		_	

#### Urban and industrial sources

Municipal wastewater treatment plants and industrial wastewater discharges, nitrogen leaching from below-ground septic tanks, and storm water runoff are some of the urban and industrial sources of nutrient losses. Municipal and industrial sources are considered "point sources" of nutrient pollution because they discharge nutrients directly to surface waters or groundwater via a pipe or other discrete conveyance. They are typically the most controllable sources of nutrients and are often regulated in developed countries.

	Pathways		
Sources	Air	Surface water	Groundwater
Sewage treatment plants		<b>~</b>	
Industry	✓	✓	
Septic systems		✓	✓
Urban storm water runoff		·	
Agricultural fertilisers	✓	✓	✓
Livestock operations	✓	✓	✓
Aquaculture		✓	
Fossil fuel combustion	✓		

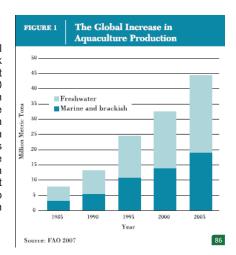
The most prevalent urban source of nutrient pollution is human sewage, though its importance varies by region and country. Sewage is estimated to contribute 12% of riverine nitrogen input in the United States, 25% in Western Europe, 33% in China, and 68% in the Republic of Korea (MA 2005). This variation is due, in large part, to differences in sewage treatment levels among countries (Table 2). In developing countries, fewer than 35% of cities have any form of sewage treatment (UNEP and WHRC 2007), and when sewage is treated, it is typically primary treatment aimed at removing solids, not nutrients. Where households are not connected to municipal wastewater treatment plants, septic systems are often used in developed countries. Septic systems are designed to purify waste by leaching it through soils. They leach, on average, 14 kilograms of nitrogen per system per year—much of which then conveys into groundwater or nearby surface waters (Anne Arundel County Maryland DPW 2008).

Storm water runoff is another significant source of nutrients from urban areas. Rainfall events flush nutrients from residential lawns and impervious surfaces into nearby rivers and streams. In some cities, combined sewer overflow (CSO) systems worsen storm water runoff problems. CSOs are designed to collect rainwater, domestic wastewater, and industrial wastewater in the same pipe. During heavy rain or snowmelt, wastewater volume can exceed the capacity of the CSO system, as well as that of the wastewater treatment plant receiving the flow. As a result, the excess wastewater, including raw sewage, is discharged directly into nearby streams and rivers. In the United States, over 772 cities had CSOs in 2007 (EPA 2007).

For industrial sources of nutrient pollution, certain industries are larger sources than others. Pulp and paper mills, food and meat processing, agro-industries, and direct discharge of sewage from maritime vessels are some of the larger sources of industrial nutrient pollution.

### Agriculture sources

Fertiliser leaching, runoff from agricultural fields, manure from concentrated livestock operations, and aquaculture are the largest agricultural nutrient sources. Between 1960 and 1990, global use of synthetic nitrogen fertiliser increased more than sevenfold, while phosphorus use more than tripled, with chemical fertilisers often being applied in excess of crop needs (MA 2005). The excess nutrients are lost through volatilisation, surface runoff, and leaching to groundwater. On average, about 20% of nitrogen fertiliser is lost through surface runoff or leaching into groundwater (MA 2005). Synthetic nitrogen



fertiliser and nitrogen in manure that is spread on fields is also subject to volatilisation. Volatilisation is where nitrogen in the form of ammonia is lost to the atmosphere. Under some conditions, up to 60% of the nitrogen applied to crops can be lost to the atmosphere by volatilisation (University of Delaware Cooperative Extension 2009); more commonly, volatilisation losses are 40% or less (MA 2005). A portion of the volatilised ammonia is redeposited in waterways through atmospheric deposition. Phosphorus, which binds to the soil, is generally lost through sheet and rill erosion from agricultural lands.

The rapidly changing nature of raising livestock has also contributed to a sharp increase in nutrient fluxes over the last century. Animal production is intensifying, with increasingly more production occurring further away from feedstock supplies. The large quantity of manure produced by these operations is applied to land as fertiliser, stacked in the feedlot, or stored in lagoons. Frequently, the rate and timing of land application of manure is dictated by the volume and availability of manure and not by crop needs. This leads to ill-timed or over application of manure, further exacerbating nutrient runoff and leaching. In China, meat production rose by 127% between 1990 and 2002 (FAO 2009a), but fewer than 10% of an estimated 14,000 intensive livestock operations have installed pollution controls (Ellis 2007). In the Black Sea region, one swine operation—which subsequently closed—had over 1 million pigs and generated sewage equivalent to a town of 5 million people (Mee 2006).

Aquaculture is another growing source of nutrient pollution. Annual aquaculture production worldwide increased by 600%, from 8 million tons in 1985 to 48.2 million tons in 2005 (Figure 1). Today nearly 43% of all aquaculture production is within marine or brackish environments, with the remainder in freshwater lakes, streams, and man-made ponds (FAO 2007). Marine fish and shrimp farming often occur in net pens or cages situated in enclosed bays. These farms generate concentrated amounts of nitrogen and phosphorus from excrement, uneaten food, and other organic waste. If improperly managed, aquaculture operations can have severe impacts on aquatic ecosystems as nutrient wastes are discharged directly into the surrounding waters. For every ton of fish, aquaculture operations produce between 42 and 66 kilograms of nitrogen waste and between 7.2 and 10.5 kilograms of phosphorus waste (Strain and Hargrave 2005).

### Fossil fuel sources

When fossil fuels are burned, they release nitrogen oxides  $(No_x)$  into the atmosphere.  $No_x$  contributes to the formation of smog and acid rain.  $No_x$  is redeposited to land and water through rain and snow (wet deposition), or can settle out of the air in a process called dry deposition. Coal-fired power plants and exhaust from cars, buses, and trucks are the primary sources of  $No_x$ . Fossil fuel combustion contributes approximately 22 teragrams of nitrogen pollution globally every year (Table 3), approximately one-fifth of the contribution of synthetic nitrogen fertilisers (MA 2005). In the Baltic Sea, atmospheric deposition, primarily from burning fossil fuels, accounts for 25% of nitrogen inputs (HELCOM 2005). Similarly, in the Chesapeake Bay, atmospheric deposition accounts for 30% of all nitrogen inputs, 3 in some areas, such as in the U.S. North Atlantic, atmospheric deposition of nitrogen can exceed riverine nitrogen inputs to coastal areas (Spokes and Jickells 2005).

Region	Nox emissions
Asia (excluding middle east)	37,722
Central America & Caribbean	3,881
Europe	25,536
Middle East & North Africa	7,572
North America	21,839
Oceania	3,381
South-America	11,748
Sub-Saharan Africa	14,926
Total	126,605

#### What drives the increasing eutrophication trends?

Complex and interrelated socioeconomic factors drive the increase in nutrient pollution, which is causing increased occurrences of eutrophication. Indirect drivers include population growth; economic growth in the developing world, which will impact consumer consumption; and the growth of intensive agriculture. Direct drivers of eutrophication include higher energy consumption, increased fertiliser consumption, and land-use change.

### Indirect drivers of eutrophication

#### Population growth

The global population is predicted to grow from 6.5 billion in 2005 to nearly 9.2 billion in 2050, with the majority of population growth occurring in less developed countries (UNPD 2008). Population growth will increase the demand for food, land, energy, and other natural resources, ultimately leading to greater agricultural production and increased burning of fossil fuels to heat homes, power cars, and fuel industry.

#### Economic Growth

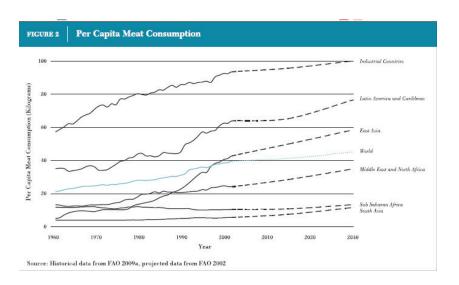
Global per capita income is projected to double between 2002 and 2030, with the greatest income growth occurring in developing countries (Dargay et al. 2007). Per capita income of developing countries is expected to grow by 2.2% annually between 2002 and 2030. In developed countries, per capita income is forecast to grow approximately 1.5 percent annually (Dargay et al. 2007).

Increasing incomes will lead to changes in consumption patterns, such as different dietary choices, increasing energy use, and increasing consumption of consumer goods. For example, worldwide, dietary trends are moving toward greater meat consumption as a result of increased purchasing power, especially in the case of lower to middle income populations (FAO 2002). Between 1961 and 2002, the average worldwide per capita meat consumption rose by 87%, from an average per capita consumption of 21.2 kilograms per person to 39.7 kilograms per person (FAO 2009a). Between 2002 and 2030, meat consumption is expected to increase by 44% in the Middle East and North Africa region, 36 percent in East Asia, and 28% in Latin America and the Caribbean. South Asia, which currently has the lowest per capita meat consumption, is expected to double its meat consumption by 2030. Worldwide, per capita meat consumption is expected to increase by 14% by 2030, to an estimated average consumption of 45.3 kilograms of meat per person (Figure 2). When population growth is included, this rise equates to an estimated increase of 53% in total meat consumed worldwide.

The increased livestock production that will be necessary to meet growing global demand for meat is expected to have significant implications for the severity of nutrient pollution worldwide. For example it is estimated that only 20% of the nitrogen used in swine production is actually consumed by humans; the remainder is excreted as manure or lost to the environment during the production of animal feed (UNEP and WHRC 2007). In contrast, one study of the Mississippi River Basin estimated that if feed cultivation for meat production were switched to crops that would support a lacto-ovo-vegetarian diet, nitrate exports to the Gulf of Mexico would decrease by 50% (Donner 2006).

## Agricultural intensification

In the past 70 years, the way in which we grow food has changed dramatically. The "Green Revolution," which began in the 1940s, made significant advances in agricultural production, introducing the widespread use of agrochemicals such as synthetic fertilisers and pesticides to improve crop yields. These chemicals and modern machinery allowed the intensification of agriculture. While the intensification of agriculture has led to economies of scale and improved food security, it has also led to significant unintended environmental impacts such as nutrient pollution. While agriculture in developed countries is already highly intensive, we expect to see greater agricultural intensification in developing countries in the coming decades.



### **Direct Drivers of Eutrophication**

#### **Energy Consumption**

Growing populations and expanding economies demand more energy. Total worldwide energy consumption rose by 33% between 1990 and 2005 (EIA 2008). Currently, more than 86 percent of the world's energy needs are being met by fossil fuel sources (coal, oil, and natural gas) (EIA 2008). Once combusted, fossil fuels discharge No<sub>x</sub> into the atmosphere. While alternative energy sources such as solar, wind, and geothermal are available, the heavy reliance on fossil fuels is expected to continue in the short to medium term. Between 2005 and 2030, experts estimate that per capita energy consumption will increase by approximately 18%, while total global energy consumption will rise by 50%; the developing world is projected to account for the majority of increased energy consumption (EIA 2008). Fossil fuels are expected to continue meeting approximately 86% of global energy needs (EIA 2008).

#### Fertiliser consumption

Growing populations, changing dietary trends that are increasing the demand for meat and the expanding use of bio fuels will necessitate increased agricultural production. As a result, fertiliser consumption is expected to increase 40% between 2002 and 2030 (Figure 3, base scenario) (FAO 2000). With genetic engineering to improve crop nutrient-use efficiency, this increase in fertiliser use is estimated to be only 17% over the same time period (Figure 3, nutrient efficiency scenario) (FAO 2000). The majority of the projected increase in global fertiliser consumption is attributed to the developing world where food production and adoption of intensive agricultural practices are expected to increase (FAO 2000).

## Land-use conversion

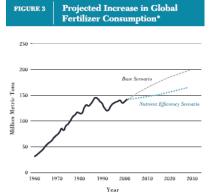
Tied to increased food production is the conversion of land from perennial vegetation to annual cropping. From 1995 to 2002, cropland has experienced a net increase globally of about 3 million hectares per year, with over 90% of the total cropland gains coming from forests (Holmgren 2006). Agriculture is also the single largest cause of wetland loss.

Approximately 50% of the world's wetlands have been lost since the 1950s. The majority of wetland loss occurred as a result of drainage for agricultural production (OECD/ IUCN 1996). The FAO predicts that land-use conversion for agriculture will continue, but at a slower pace than in the past (FAO 2002). Natural landscapes such as forests and wetlands are important for

capturing and cycling nutrients. Increasing land-use conversion reduces the ability of these landscapes to intercept nutrients and leads to greater nutrient losses to local waterways.

#### Conclusions and next steps

Population growth is driving increased demand for energy and food. This increase will further exacerbate nutrient losses from urban, industrial, and agricultural sources as well as those from combustion of fossil fuels. As a result, we expect to see increasing numbers of coastal and freshwater ecosystems impacted by eutrophication and hypoxia in the future. It is likely that eutrophication will increase most rapidly in the developing world, where population, meat consumption, and energy consumption are expected to increase more rapidly than in developed countries.



Source: Historical data from FAO 2009b, projected data from FAO 200. \* Fertilizer consumption includes nitrogen (N), phosphates  $(P_2O_2)$  and potash  $(K_2O)$ .

At its core, eutrophication is a by-product of unsustainable agricultural production and energy use. Because the pathways, sources, and drivers of nutrient pollution are varied and diverse, the policies that address eutrophication cannot be limited to traditional environmental regulations. Instead, policymakers must look more broadly at agricultural, energy, land use, and public health policies and find ways that these policies can be designed to mitigate nutrient pollution. Finally, there are strong linkages between the sources and drivers of eutrophication and those of climate change and other critical environmental issues like air pollution and acid rain. Developing a more robust understanding of the sources and drivers of eutrophication will allow policymakers to identify the linkages between eutrophication and other local, regional, and global environmental issues and identify those policies that minimise tradeoffs and maximise environmental benefits. A forthcoming publication in this series will focus on the types of institutions, actions, and policies that are critical for addressing eutrophication.

### Natural Gist

- Increased eutrophication is the result of increasing human activities; population growth, economic growth & agricultural intensification. Triggered from nitrogen enrichment of water.
- Nutrient pollution of freshwater and coastal areas comes from agriculture, aquaculture, septic tanks, urban wastewater, urban storm water runoff, industry, and fossil fuel combustion. While these activities increase and intensify, eutrophication incidents will also increase.
- Urban and industrial sources discharge nutrients directly through surface water run off or into the groundwater via pipes or other discrete conveyance.
- Sewage contributes to around 12% of riverine nitrogen input in the United States, 25% in Western Europe, 33% in China, and 68% in the Republic of Korea. This variation is due to the different sewage treatment levels.
- Agricultural sources: Fertiliser leaching, runoff from agricultural fields, manure from concentrated livestock operations, and aquaculture are the largest agricultural nutrient sources with chemical fertilisers often being applied in excess of crop needs. Between 1960 and 1990, global use of synthetic nitrogen fertiliser increased sevenfold, while phosphorus use tripled.
- Fossil fuel combustion contributes approximately 22 teragrams of nitrogen pollution globally every year.
- Policymakers must look broadly at agricultural, energy, land use, and public health policies and find ways that these policies can be designed to mitigate nutrient pollution.



### Rethinking 'Garbage' for India - Deriving Economic Sense from Waste

By Rati Bhattacharya

#### What is waste?

Currently there is no definitive list distinguishing and categorising waste from non–waste items and it is this question that remains the most debatable for both national and international regulators, in their drive to govern waste management and its economics in the world markets.

The term waste has multifaceted definitions that vary between countries. Nations like France, UK and the USA combine an Objective Physical Definition a list of defined substances that are nationally recognised as waste, with a Subjective Legal Definition, where waste is defined as all substances that the holder; producer or owner disposes of or is obliged to dispose of.

Between countries, there are both cultural and economic differences in how waste management is approached. It was identified by the World Waste Survey 2006, undertaken by the Veolia Institute, that developed countries are more likely to treat waste as a secondary resource and put effort into the treatment of waste and ways to recover it from disposal. However, many developing countries unfortunately view potentially useful discarded items such as recovered metals, paper and plastic bottles simply as waste.

# Waste economics

All waste has an initial cost of collection, plus a process cost based on the route of treatment / disposal that it follows. New up and coming markets have now distinguished two fundamental types of waste, according to the economic routes that they follow post collection.

Type 1: Positive Waste. Waste whose end product (material or energy) does not cover the associated site remediation or treatment costs, costs including elements like tax deductions.

Type 2: Negative Waste. Waste whose end product (material or energy) does cover the associated site remediation or treatment costs, including any elements like tax deductions.

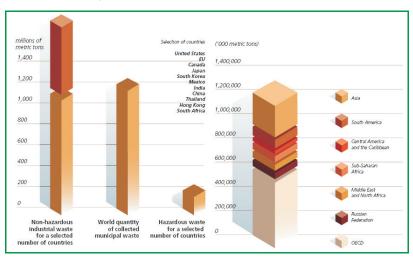
The definition of what constitutes negative waste and what positive waste does vary country to country and between industries. So that paper is generally considered a positive waste element for the information and technology industry, which gets 40% of their raw materials from waste products. However paper is a negative waste for the metal mining industry, where it is simply discarded.

Generally such market development trends show how waste is having an increasingly positive exchange value enabling it to become a resource and a secondary material. In evidence of this there is a growing quantity of type 2 negative waste products, as type 1, the positive waste elements are re-evaluated and being moved across into the type 2 categories. This is a significant step towards the recovery of lost energy, a step towards promoting selective collection and even towards the recovery of our landfill waste.

#### The waste footprint for developed and developing countries

Identifying the scale of the problem; initial assessments enable us to estimate the world's deposit of collected waste (which includes industrial, municipal and hazardous waste) at between 2.5 and 4 billion metric tons, and this does not include construction, demolition, mining and agricultural waste. With the total municipal waste collected worldwide in 2004 estimated at 1.2 billion metric tons.

The figure below illustrates the scale of problem summarising the volume of worldwide waste, the volume of waste each region contributes and the variation between the 3 categories of waste; Industrial, municipal and hazardous waste.



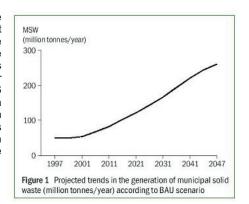
Source: National Environmental Agencies, OECD, Eurostat, Cyclope

The waste volume figures for Asian countries are contributing significantly to these numbers, plus Asia's outputs are growing quickly. Today, the urban areas of Asia produce about 760,000 tonnes of municipal solid waste (MSW) per day, or approximately 2.7 million m3 per day. In 2025, this figure are projected to increase to 1.8 million tonnes of waste per day, or 5.2 million m3 per day and these estimates are conservative. The real values are likely to be more than double this amount. Local governments in Asia currently spend around \$25 billion (US) per year on urban solid waste management. This amount is used to collect over 90% of the waste in the high income countries, between 50-80% in the middle income countries, and only 30-60% in the low income countries. Moving forward, in 2025, Asian governments should anticipate spending at least double this amount on solid waste management activities.

### The Indian 'waste' perspective

India contributes 11% of the total per day municipal solid waste generated for all Asian countries. Within India its 23 metro cities generate around 30,000 tonnes of waste per day while around 50,000 tonnes are generated daily from the class I cities (cities with a population size of 1 million and above). The Indian Municipal agencies spend about 5-25% of their budget on Municipal Solid Waste (MSW) management. Out of the funds spent on MSW management, 65% is typically spent on collection, 30% on transportation and a mere 5% on waste disposal.

The annual growth of per capita waste generation in India is expected to increase at a rate of 1.33% annually. Figure 1 depicts the rising quantities of municipal solid waste between 1997 to 2047 under a business as usual scenario on the basis that the daily per capita waste generation in 1995 was 0.456 kg (EPTRI 1995) and assuming a per capita increase in waste generation at 1.33%. From Figure 1 it is evident from these baselines that the total waste quantity generated in 2047 may be over 260 million tonnes—more than five times the present level.



## **Current and Future Challenges for India**

Such an enormous increase in solid waste generation will have a significant impact for government and municipalities. In terms of the land required for disposing this waste, the environmental considerations, which includes methane emissions and the health impacts if adequate waste management measures are not established and implemented.

#### Land concerns

Using current waste management practices, future land fill requirements will make a significant component of future land use in India. As indicated by a study conducted by The Energy and Resources Institute (TERI), the cumulative requirement of land for the disposal of municipal solid waste is projected to amount to around 1400 km2 by the year 2047. A significant growth, as this area of land is 7 times greater than the space currently utilised for waste disposal in India. Indicative of the growing levels of waste being generated in India; many of our existing land fill sites are already frequently filled to overflowing.

However it is the dense (and growing) cities that are predicted to produce the highest waste levels; these areas are also where there is the greatest scarcity of land for new landfill. For example in Delhi currently 3 of the 5 land fill sites are full and additional sites are being sought, but are not yet been found. If such new sites cannot be found within the urban areas additional resources like transportation must be found to take the growing volumes of waste out of the city, which is both impractical and costly. So if current methods of waste disposal continue, municipalities must find significant additional funds to create the transportation facilities to carry our growing volumes of garbage to new landfill sites away from our cities.

# Environmental degradation

Improper and inadequate solid waste management causes many types of pollution including: air, soil, and water, which affects neighbourhoods in the vicinity of these sites and has an adverse impact on the health of people living nearby. Water; poorly managed landfill or unregulated dumping of waste contaminates both surface and ground water supplies from the leachates it produces. Solid waste clogs drains and creates stagnant water allowing insects to breed and proliferate (Anderson and Smith, 1997) it also exacerbates floods during the rainy seasons. Air; the uncontrolled burning of wastes and improper incineration practices contributes greatly to urban air pollution. Soil; waste also causes bad odours, and can be a significant fire risk as accumulated methane within dumped waste and landfill can explode without warning. Such negative environmental impacts are a result only of poor solid waste disposal practices; it does not include the substantial environmental degradation caused by the extraction and processing of materials at the beginning of a products life cycle. In fact, as much as 95% of an item's environmental impact occurs before it is discarded as MSW.

#### Global warming

Through the decomposition of organic wastes landfill generates greenhouse gases. In fact landfill sites are the biggest contributor of Methane gas, accounting for 50–60% of all methane gas produced. It is estimated that in 1997, landfills around the world, released around 7 million tonnes of methane into the atmosphere, and this is predicted to increase to 39 million tonnes by 2047.

### Urban poverty and livelihood challenges

The issue of urban poverty is inextricably linked with waste. In India alone, over a million people find livelihood opportunities in the area of waste. They are engaged in waste collection, popularly known as rag pickers, and undertaking recycling utilising well organised and established systems. In other developing countries there are also substantial populations of urban poor earning their livelihood through the product of waste. It is important to understand issues of waste in this context.

An informal sector of work is dealing with waste, engaging in various types of work like waste picking, sorting, recycling and at a more organised level, door-to-door; collection, composting and recycling recovery is undertaken. In none of the developing countries do municipalities manage the recovery of waste for recycling on their own.

#### Health and safety

Many health issues arise from improper solid waste management. Human faecal matter is commonly found in municipal waste and is a ready way of spreading disease and infection. Insect and rodent vectors are attracted to waste for food and shelter, proliferating within such conditions carrying and spreading disease such as cholera and dengue fever. Water polluted by solid waste is used for bathing, food irrigation, and drinking water, typically by the poorer sectors of society, which exposes these individuals to disease organisms and other contaminants.

The U.S. Public Health Service identified 22 human diseases that are linked to improper solid waste management (Hanks, 1967. cited in Tchobanoglous et al., 1993). Waste workers and pickers in developing countries are seldom protected from direct contact and injury; and the codisposal of hazardous and medical wastes with municipal wastes poses a serious health threat. Exhaust fumes from waste collection vehicles, dust stemming from disposal practices, and open burning of waste also contribute to overall health problems.

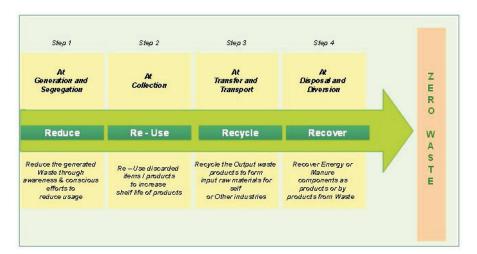
## The Integrated Approach to Waste Management

The integrated approach to waste management is defined by Tchobanoglous et al. (1993) as the selection and application of appropriate techniques, technologies, and management programs to achieve specific waste management objectives and goals.

Understanding the inter-relationships among the various waste activities makes it possible to create an integrated solid waste management plan where individual components can complement one another.

# The Integrated Waste Management Model (IWMM)

This is a comprehensive waste Measurement, Monitoring and Management model developed by NatureFirstTM. It focuses on the redesign of the entire waste management system to ensure a closed loop disposal of each waste stream so that a Zero Waste System is delivere.



A key purpose of the IWMM is to improve upon current poor practices of waste management. It utilises a multi-disciplinary approach, embracing waste collection, transfer, haulage and disposal and the impact of this approach is wide. It gives particular emphasis to the principle of building upon the existing capacity of waste management authorities. Creating a framework for the efficient planning of waste management, involving the following key components:

## Source Segregation

Source segregation of waste creating clear waste streams as is an integral component of IWMM. This can be simply achieved by providing colour coded bins, a different colour for each type of waste it needs to collect, such as red for plastics, yellow for metals, blue for paper and so on. This key stage needs to be supported by extensive training of the municipalities and education of the population who must use the bins effectively. The choice of well designed, sustainable waste collection systems has risen greatly in recent years. Governments and municipalities realise the benefits of implementing effective measures both for future recycling/ reuse opportunities from pre-separated waste and also through the reduction in health and other environmental problems, caused by poorly managed waste.

Considerable attention needs to be paid to the potential of programs that will divert materials away from unnecessary disposal. Growing demand means now there are many alternative and low-cost methods available. Municipalities are experimenting with alternative collection systems such as "wet/dry" collection systems, three stream collection systems and "co-collection" of waste and recyclables in attempt to investigate the most cost effective solutions for them.

Hazardous waste collection systems and waste depots are also being established in many Indian cities, to reduce and eliminate the amount of waste that is currently being improperly disposed of. Both Delhi and Mumbai now have separate government approved hazardous waste treatment facilities such as the Taloja Waste Management Facility in Mumbai.

The IWMM adopts a 5 level waste segregation based on colour coding for different waste items like, organic, paper, plastics, metals and hazardous wastes. The level of source segregation and the number of bins required needs to be retrofitted to both the quantities and type of waste generated.



### • Efficient Transfer and Transportation systems

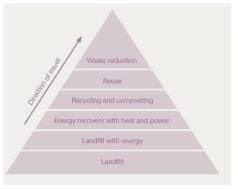
The sustainable management of waste requires rationalisation of waste transfer and transportation. Given the quantum of waste generated, the transportation systems need to be planned efficiently, optimising costs for urban set ups. The IWMM approach focuses on optimising the collection frequency and mode of transportation for waste produced by key commercial sectors like hospitality, banking, offices, housing societies and major events. The collection frequencies for dry garbage like plastics, papers, metals etc. (end collection - out of the facility) should be a maximum of 2–3 times a week (depending on the quantum produced), reducing fuel costs and the emitted carbon due to vehicular transportation. Wet garbage, however, needs to be transferred and transported to the appropriate disposal sites on a more regular basis. In light of this the end disposal sites for the wet garbage should be located as near as possible to the facilities to enhance the commercial economics and reduce the carbon footprint of the transportation process.

## • Efficient Disposal: Application of the 4R's

The conventional waste hierarchy for waste disposal / treatment methodologies is depicted in the figure below. The IWMM model applies these 4R's – Reduce, Recycle, Reuse and Recover in its goal of delivering a zero waste footprint.

The concept of the 4R's is to move away from the traditional "cowboy" approach of waste management to a new "cosmonaut" approach. A 'cowboy approach exploits all available resources, whilst the new 'cosmonaut' approach to waste management seeks to restrict to a minimum the quantities on board (within the system) and prolong for as long as possible the duration (productivity lifespan).

Waste Reduction and Reuse: Sits at the top of the hierarchy as it conserves not only the materials themselves, but also



their form. Waste recycling: Sits on the second level, putting waste materials back into productive use by recycling them, manufacturing new products from the non-virgin materials. Waste Recovery: Yields useful energy or materials as a by-product of waste. This vertical of the hierarchy is mainly focused on deriving energy and fuel substitutes from the waste materials.

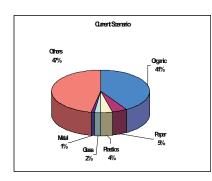
Landfill with energy and Landfill alone: Landfill supported by energy extraction forms the most widely applied waste process across the developed countries of the world. This forms an attractive business proposition utilising the production of methane gas. However, in the developing countries like India the production of energy is proving less commercially successful and the concept of landfill is still to come into existence.

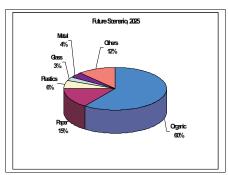
Open land dumping predominates in India and currently is the most applied waste disposal mechanism. There needs to be a fundamental and urgent shift away from such last resort methods as identified at the base of the 4R's pyramid and instead a move towards applying more productive and proactive methods of waste management, listed at the top of the hierarchy.

### The scope for implementing the 4R's in India

The categorisation of Indian waste is faced with difficulties due to a complete absence of source segregation and lack of state level data. A preliminary estimate from the World Bank suggests that mixed waste constitutes 47% of all Indian waste followed by organic & food waste at 41%. Recyclables constitute around 12% of the total waste stream.

The low percentage of recyclables is attributed primarily to the ongoing economic development of the country as well as the currently poor state of waste segregation. However waste categorisation is expected to change substantially by 2025, with a growth in the organic component closely followed by the paper and plastics. The following figures outline the waste categorisation trends for India; it demonstrates that since we are able to predict the growth in certain categories of waste, that we can also establish new systems to recycle these elements of waste. Emphasising that our waste disposal strategies should be designed and implemented keeping in mind both generation trends and emerging market mechanisms. We simply need to be pro active and to think ahead.





Under NatureFirst's Integrated Waste Management Model, waste disposal options are proposed if they deliver the 4R's and are also:

## • Technically viable -

Solutions which consider the characteristics and components of India's waste. This ensures that the Indian waste scenario does not blindly adopt pre-existing international waste treatment methodologies when they are not technologically or commercially viable considering the high organic content of the Indian waste.

Incineration as a waste treatment technology should not be considered for India, as the high moisture content of our waste means the overall process becomes endothermic (an energy absorbing process) rather than exothermic (an energy giving process) as it is intended to be.

#### Financial feasible

Converting "negative externalities" (an impact on a party who is not directly involved in the transaction) linked to waste into profitable business centres.

- A 30% reduction in garbage volume leads to a Rs. 3 Crore saving / month or Rs. 36 Crore / annum.
- Diverting organic waste (comprising 41% of the total waste footprint of India) to biomethanation can offer attractive savings on cooking gas and cut down on harmful methane gas production.
- A typical biomethanation project for 12 tonnes of waste / day can help achieve savings up to 97 lacs with a potential payback within 11 months.

#### Socially beneficial

Creating new jobs through better waste management practices. Ensuring environmentally sound methodologies are implemented together with practices that ensure the health and safety of the workers.

- The recycling of 100 metric tons of electrical and electronic waste can create 250 jobs, whilst composting and incineration can both create 20 to 40 jobs for every 100 metric tons of waste. In comparison utilising land fills only creates 10 jobs for every 100 metric tons of waste disposed of.
- Delivering a closed loop disposal system

In a closed loop system each waste stream is treated and processed to provide viable secondary outputs, such as materials or energy.

#### Reduce

Reduction in primary resource consumption needs to be one of the first lines of attack to reduce our levels of waste generation and to lower our waste footprint. As the peak of the 4R's waste hierarchy it is not only the most important goal, but also the same most difficult to achieve.

Utilising material and energy balances is key, it help us to understand the economic viability of waste treatment, making it possible to identify and quantify previously unknown losses or emissions and is therefore an important tool in any waste reduction programme. They are also useful for monitoring the progress achieved in a prevention programme and evaluating the costs and benefits of this.

Recycling is closely interlinked with the process of waste reduction. It can be further classified as follows:

- On-site recovery and reuse: Reuse of wasted materials in the same process or for another useful application within the industry.
- Production of useful by-products: Modification of the waste generation process in order to transform a wasted material into a material that can be reused or recycled for another application within or outside the company.

#### Reuse

As mentioned earlier, re-use is at the top of the hierarchy. It conserves not only the potential waste materials themselves, but also their form. It is an important waste management strategy as it seeks to retain the element in productive use for as long as possible thus minimising energy consumption either from transportation for waste processing and also by removing energy that would otherwise be used to manufacture a replacement item. The exhaustive consumption of primary resources together with the depletion of our globes non-renewable resources emphasises the importance of promoting re-use in the waste management hierarchy.

An example of effective re-use is the collection, cleansing and then re-filling of glass bottles for re sale by drinks companies. Another example is by the hotel industries who implement the practice of reusing floral decorative pieces by trimming them and enhancing with fresh flowers, rather than disposing all the flowers on day to day basis. However, this trend is not witnessed in luxury hotel chain, as they give a higher level of importance to the aesthetics over cost over waste reduction.

## Recycle

It is stated that 20% of the richest members of the global populations consume 80% of all that is produced. Therefore if everyone seeks to live life like an American, even if we recycle 100% (which remains a utopian goal) it will simply not be possible to meet everyone's material requirements.

Gerard Bertoni an economist and waste expert at the French National Research Centre talks about 2 types of economic structures; the cowboy and the cosmonaut. The concept of the Cosmonaut Economy promotes the idea that in order to achieve an autonomous system in a small closed circuit; we need to constantly recycle via an interconnected circuit.

A circuit that involves the consumption of power, water, air and possibly certain types of materials, in the case of recycling these materials may include elements such as bleaching agents that improve the quality and marketability of the final paper product.

In recent years the recycling industry has begun to grow significantly in scale, driven by a growing global economy and the surge in demand for raw materials. With an increasing number of emerging countries now developing at an accelerated pace, global GDP is reaching record levels unseen since the 1960s, so the average annual growth of 4.4% from 2001 to 2006 was over 5% in 2006. At the head of this growth are the Asian countries, led by China (annual growth of 10-10.7% from 2003 to 2006), followed by India (annual growth of 7-9% since 2003), but Central and Eastern European countries and Turkey are not far behind (+6.8%, on average, in 2006).

The recycling market has greatly benefited from increased global industrial production, with secondary materials now an essential requirement for many manufacturing industries. This has resulted in a growth in the number of products possible and also advancement in our recycling technologies. The economic results for these new resources often also proves quite favourable to further Industrial success.

For example: recycled cellulose fibres are less expensive than virgin pulp, plus using them to manufacture one ton of new paper leads to energy savings of 67%, a further financial saving in the manufacturing process.

Our waste = a	Uses	Volumes recycled	Indian market			
potential resource		worldwide	potential			
	Scrap iron					
Recycled iron comes mainly from end-of-life automobiles and consumer goods (large domestic appliances, tin cans etc.), demolished building waste and off cuts from manufacturing.	Steel can be recycled without any deterioration of its qualities and thus can be reused for its usual uses: automobiles, appliances, packaging etc.	In 2005, the world-wide steel industry recycled some 434 million tons of iron. About 60% of steel produced in the United States comes from scrap, For Europe the figure is more than 50% For China it is about 20%.				
Plastics			<u> </u>			
A high proportion of recycled plastics are derived from packaging waste from commerce, industry and households.      The rest comes from end-of life agricultural film, vehicles and construction waste.      The complexity of plastics used in electrical and electronic equipment still limits their recycling.	The thermoplastics the most abundant class (polystyrene, polyamides, polyethylene, polypropylene and polyvinyl chloride), are easier to recycle than thermosetting plastics, and have multiple applications: automobile parts with no particular safety requirements (casings, door panels, carpets ), computer screens, electric cable sheathing, polar fleece, building insulation, manufacture of small bottles etc.	A very small proportion of the 230 million tons of plastics produced each year is recovered.      In Europe, 4 million tons of plastic waste was recycled in 2005 (18% of the plastic waste collected).      The volume increases by about 10% per year.	Generation Rate: 5600 Tones/ Day      Market Prices: Rs.15/kgs (end sales)      Average daily volume of recycling: 2 million tonnes			
ROF comes mainly from companies (off cuts from printers and manufacturers, packaging waste from commerce and industry, paper from	It is used in the production of cardboard, wrapping paper and all qualities of printing paper.      Paper can be	Some 185 million tons of paper/cardboard were recycled world-wide in 2005; about half of new paper/cardboard is produced from	In India, out of the 8.5 million tonnes of paper is consumed, only 1.4 million tonnes gets recycled back to industry.			

#### Recover

Recovery of waste focuses on deriving secondary useful substitutes from the waste materials by converting them into energy. Waste-to-energy is part of the development in the use of renewable resources. Now seen as part of the drive to reduce our greenhouse gases and the development of a Clean Development Market (CDM)/ carbon market as instructed by the Kyoto Protocol we are able to take advantage of the Carbon Credits offered for projects that seek to transform waste to energy, such as biomethanation, which makes this approach now attractive to many countries.

Several further options that recover energy from our waste are available to the Indian scenario, such as:

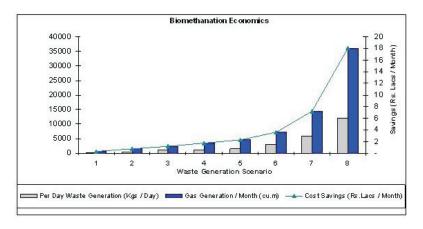
#### Biomethanation

Energy consumption in the developed countries has been more or less stabilised whereas in developing countries like India it is increasing at a high rate. The Government is looking towards Biomethanation Technology (BT) as a secondary source of energy by utilising industrial, agricultural and municipal wastes. Vegetables, fruits and flowers are produced in large quantities in markets, and these wastes are currently disposed alongside municipal solid waste in landfills and dumpsites, creating a place for pests, disease, bad odours and green house gas (GHG) emission into the atmosphere. In India under a waste-to-energy programme promoted by the Ministry of New Renewable Energy Sources (MNRE) (Formerly the Ministry of Non-Conventional Energy Sources), has developed demonstration projects for the creation of bioenergy from Industrial and Municipal solid waste.

The process: Biogas is generated, through the stabilisation of waste in the digester; it then leaves the digester and moves into a dry typed gas holder. After removal of H2S, the biogas can be used as fuel in the production of electricity. The residue from the digester can also be converted into manure through composting. For safety, when gas generation exceeds the storage capacity of the gas holder, the excess biogas is burnt in a flare.

Biomethanation is often considered a costly and financially non-viable option for many commercial sectors. However we believe this is a myth and can be overcome by looking at statistics that are based on the Indian waste scenario:

- As daily waste inputs rise, gas generation outputs increase exponentially.
- Higher waste volumes also provide an additional benefit of higher manure and sustained gas outputs.
- The paybacks:
  - o For a smaller plant up to 260 kgs of waste input can save Rs. 2 Lacs / annum of LPG costs and offer a payback within 21 months.
  - o For a larger plant 12 tonnes / day can generate savings of up to Rs. 97 Lacs / Annum with a payback within 11 months.
- •Installed plant capacities > 10 tonnes / day are applicable for CDM projects.



#### Composting

The principal component of composted bio waste is plant material (grass cuttings, leaves), food waste from households, public establishments, industrial agribusiness companies and supermarkets (unsold food, peelings, remains of meals), and the sludge from urban water treatment. These materials contain cellulose, lignin, sugars, lipids and proteins which decompose into calcium, nitrogen, phosphor, sulphur, oxygen or other simple elements that can be used by plants.



(crushing, fermentation, maturation) results in a product rich in minerals and organic matter which continues to decompose slowly thus continuing to release essential elements for plant growth. It allows the soil to remain in good condition as it can recoup its reserves during cropping. In addition the healthy plants that result are able to fight infection, disease and eliminate contagious pathogens from crops.

"Composting does not make you rich", has been stated by various composting plant operators, it sums up appropriately the current situation of organic waste treatment within Indian cities. However, most plant managers or initiators interviewed recognised that with the support of municipal authorities (such as via help with land provision), the operation of decentralised composting combined with a collection service can recover costs and even yield a profit.

However, we do assume that cost recovery through composting is viable as many of the assessed initiatives have been operating continuously for the last few years. Although making a profit by compost sales will remain low for as long as the national compost market is not expanded and promoted further. The integration of private initiatives into existing structures prevents the development of parallel waste management systems and helps enhance efficiency of the overall municipal system. Commitment of the private sector; i.e. of citizens and enterprises, offers an opportunity particularly to smaller Indian cities to redistribute and use existing resources more effectively.

#### Refused Dried Fuels

This method of waste disposal primarily views waste as a resource. After separation and size reduction, the combustibles can be pelletised. An integrated waste management project at Bombay attempts to do just that. Due to local conditions, product off-take and price realisation was estimated to be good. This avoided earlier problem faced by composting plants. The large scale garbage processing is supposed to considerably slow down exhaustion of landfill space in the vicinity of the city, mitigating the need to spend much larger amounts on waste transportation costs.

This pilot development effort also offered the prospect of totally indigenous and cheap technology. The cost of 80 TPD plant was Rs 15 million or nearly half million US dollars (May 94), which compares very favourably to N. Delhi's incineration plant (300 TPD, Rs 220 million). As it was the first attempt of its kind, it required experimentation and modifications to zero down on specific waste handling, size reduction and separation processes along with optimisation of system parameters.

Despite the promise of RDF, it is limited in its application due to the need to have large industrial areas in close proximity to the final fuel market. The cost differential between the cost of coal and RDF should however be attractive in the promotion of sales.

At NatureFirst, with successful application of the IWMM with our key clients, across the hospitality, BPO, financial and other commercial sectors, we truly believe that an integrated approach to waste management will form the way forward in the promotion of a more sustainable economy and an environment that can conserve more of our key resources. By incorporating an Integrated Waste Management Model there are 3 key benefits to the Indian waste management situation:

- Creating a closed loop disposal system, integrating top to bottom waste segregation and waste reduction initiatives, resulting in both increased revenue and increased savings in our waste economy.
- Delivering a reduced Green House Gas emissions footprint through managed organic waste disposal streams and potential Certified Emission Reduction benefits (CER), a market entity in CDM.
- Introduction of sustainable waste management practices in all staff and departments, where the IWMM model is implemented, to ensure a continued effort towards on–site segregation and the application of the 4R's in the waste management system.

### Conclusions and recommendations

In terms of waste management trends, no region of the world faces a greater need to break the inextricable link between waste generation rates and affluence than Asia. For example, if Asia follows the life style trends of the US and Canada (as Hong Kong already seems to be doing) versus the more typical European urban resident, the world would need to supply about 500 million tones more resources by 2025. Considering the current growth rate of 1.33%, by 2047 India's waste footprint will be 5 times the present level.

The urban areas of Asia now spend about US\$25 billion on solid waste management per year; this figure will increase to at least US\$50 billion in 2025. Today's daily waste generation rate is about 760,000 tonnes. By 2025, this rate will increase to about 1.8 million tonnes per day. In India, municipal bodies spend 65% of their total revenues on the collection, 30% on transportation and 5% on actual waste disposal.

As we have demonstrated in this article due to both the rapidly growing demands for land needed to accommodate new landfill under our current waste management approach, plus the rising costs to manage our waste, India needs to adopt a 'zero land fill' approach. A more focused approach towards waste treatment & disposal, rather than our current waste diversion tactic.

We believe the solution to India's waste management problems lies in the implementation of the proposed Integrated Waste Management Model (IWMM). This will enable the redesigning of the entire waste management system, creating a closed loop disposal system for each waste stream with the potential and goal of achieving a zero waste India.

The IWMM for the Indian waste scenario comprises of the following key components:

- Source segregation
- Efficient transfer and transportation systems and
- Efficient disposal through application of the 4R's Reduce, Reuse, Recycle and Recover

The 4R's waste management hierarchy puts land fill at the bottom of the pyramid and waste reduction at the apex. Traditionally India has favoured utilising only the bottom tier of this pyramid, which has proven to be economically beneficial for India, considering only 5% of the costs are spent on the end disposal, but with growing concerns about localised land scarcity (with demands ever increasing on our space for urbanisation and industrialisation), environmental degradation, urban poverty and global warming, this approach needs to be turned upside down.

The IWMM, with its 4R's approach, focuses waste reduction & reuse methodologies, closely followed by methodologies around waste recycling & recovery which makes business sense in terms of their economic returns. This also ensures that waste management is a revenue based model helping its expansion across all spectrums of society and industries.

- The concept of Reduce & Reuse, occupies the top of the hierarchy as it conserves not only the
  materials themselves but also their form. Where the former helps in reduction of the waste
  footprint, the later helps in reduction of both the input materials costs as well as end disposal
  costs.
- The concept of recycling is now beginning to take on a whole new scale, driven by the momentum of the global economy and the surge in the demand of the raw materials. The recycling market in India for waste products like, scrap iron, paper, plastics and non ferrous metals promises a substantial growth leading to revenue streams and jobs.
- The concept of Recovery focuses on deriving secondary useful substitutes from the waste materials by converting them into energy. The latest technologies around biomethanation, composting and refused dried fuels will help change the negative externality related to waste into business profit centres.

## Key benefits of the IWMM under the Indian Scenario will lead to the followings benefits:

#### **Ecological benefits**

Waste reduction, reuse and recycling helping to conserve resources and also save on the cost of further manufacture:

- Recycled cellulose fibres are less expensive than virgin pulp, and using them to manufacture one ton of new paper leads to energy savings of 67%.
- Every ton of recycled paper prevents 17 trees from being felled and saves 7000 gallons of water.

## Economic savings

- A 30% reduction in Garbage volume leads to Rs. 3 Crore savings / month or Rs. 36 Crore
   / annum
- A typical biomethanation project for 12 tonnes of waste / day can help achieve savings up to 97 lacs with a payback within 11 months.
- A 95% energy savings is derived from recycling aluminium cans, a 50% energy savings from re melting waste or broken glass, with an 85% energy savings from reusing glass containers and bottles, than producing comparative products from raw materials.
- There is a 45% energy savings through recycling polyethylene and polypropylene, 40% savings by recycling PVC's and polystyrene, and 68% energy savings from recycling paper pulp.
- A closed loop disposal system, integrated with top to bottom waste segregation and waste reduction initiatives. Results in additional revenue and additional savings through the model
- Delivering reduced GHG emissions footprint through managed organic waste disposal streams and potential CER benefits.

With an integrated approach to waste management, from garbage we can deliver revenue, employment and technological innovation ultimately leading to the creation of a zero waste India.

106

#### Natural Gist

- Nearly half of all municipal waste generated remains unattended in Indian cities, with waste management both unscientific and chaotic, this brings with it social and health risks. With Indian cities growing urban waste is increasing and the problem is too.
- Poor waste management brings with it land and water pollution, degradation of our natural capital and associated health problems.
- Production-Consumption-Recovery Cycle: Treating waste holistically is the solution. Currently India has no policy for considering waste as part of a prism of overall sustainability.
- A variety of contextual solutions to be developed. Currently sustainable solutions remain largely untapped for the treatment of either organic or non-organic waste
- Incineration is not an effective solution for India. Being expensive, ineffective and introducing further health and pollution hazards.
- Waste can be a source of wealth, generating livelihoods and making land more productive through composting and recycling.
- High organic content of waste makes composting a viable waste management solution within municipalities.
- An Integrated Waste Management Model (IWMM) is a comprehensive waste measurement, monitoring and management model ensuring closed loop disposal for each waste stream and is promoted by NatureFirst.



### Secured Landfills: The Bucket at the End of the Solid Waste Management Chain

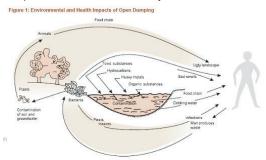
By Vandana Bhatnagar and Sanjay K. Gupta, (April 2008)

Clean streets, clean localities, clean markets...this is what most people look for from an efficient solid waste management system. Not much thought is given to where the waste has gone once it is out of sight. In other words: out of sight, out of mind! In India, currently over 80 % of the municipal solid waste generated is dumped out in the open. At current estimates, that is almost 100,000 tons being added to our environment every day, and it is responsible for serious public health and environmental concerns including soil, water and air pollution, and accidents such as fire explosions, aeroplane crashes(1) and so on.

## What are the Impacts of Open Dumping?

- Water pollution—Surface and groundwater bodies can get contaminated by leachates(2) and hazardous substances released from the dumpsite. Potable groundwater may become toxic.
- Soil pollution—Toxic substances released into the soil are absorbed by surrounding vegetation and move into the food chain.
- Dump fires—When waste decomposes at dumpsites, methane is released; this gas is
  inflammable and can result in explosions or dump fires. The smoke from such fires
  contains toxic substances and is inhaled by the surrounding populace.
- Global warming—Methane released from dumpsites is one of the main contributors to global warming.
- Source of disease—Dumpsites breed flies, rodents, and pests which carry diseases into the surrounding population.
- Other impacts—Foul smell; visual ugliness; bird menace which can be a hazard to aeroplane.

The primary goal of any solid waste management system is to safeguard public health and the environment. This is achieved by ensuring proper collection, transportation, recycling or processing and, finally, safe disposal of waste. The last step is lacking in most solid waste management systems implemented across the country



Secured Landfills: The Bucket at the End of the Solid Waste Management Chain

Figure 2: Secured Landfill





#### What is a Secured Landfill?

A secured landfill is an engineered facility designed for the safe disposal of waste. 'Landfilling' means disposal of residual solid wastes on land in a facility designed with protective measures against pollution of groundwater, surface water and air including control of dust, wind-blown litter, bad odor, fire hazard, bird menace, pests or rodents, greenhouse gas emissions, slope instability, and erosion. It is a site where urban local bodies can take waste to be buried and compacted in a manner that ensures safe containment and degradation of waste over a period of time, ultimately becoming a part of nature.

#### What are the Essential Components of a Secured Landfill?

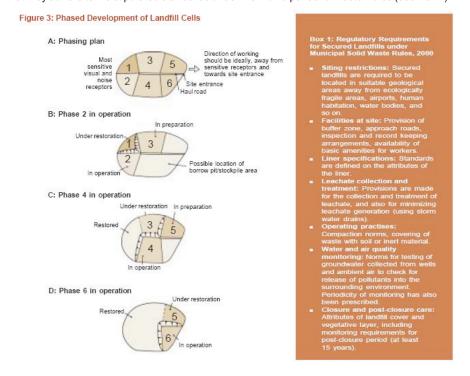
- 1. Liner system at the base and sides to prevent migration of leachate or landfill gas (largely methane) to the surrounding environment. Typically consists of a high-density polyethylene (HDPE) membrane, layers of clay, and sand or gravel (see Figure 2).
- 2. Leachate collection and treatment facility.
- 3. Landfill gas(3) collection and control facility.
- 4. Fenced buffer zone and green belt around the landfill facility to serve as a visual and protective barrier.
- On closure of a landfill cell, a final cover system at the top to prevent infiltration of water and support surface vegetation.
- 6. An environmental and waste monitoring system (including a weighbridge).
- Safety provisions and basic amenities (for example, roads, lighting arrangements, water supply, protective gear, toilets, and health checks).

#### Landfilling

Landfilling Is the process by which residual waste is placed in a landfill in a planned manner. It primarily consists of (a) placing incoming waste in a landfill cell using various equipment such as tractors, dozers, and so on; (b) compaction of waste, and (c) a daily cover (soil, debris, and so on) on the waste to prevent flies, birds, and odor. Landfilling is a technical operation requiring appropriate expertise and equipment (such as bulldozers or compactors). With proper compaction a lot more waste can be disposed per unit area of land. For a well-designed and operated facility, waste can be landfilled up to 50 meters high (internationally, landfill heights can be over 100 meters), thus offering immense capacity for waste disposal per unit area of land.

A secured landfill is developed in phases or cells. Landfilling is carried out in a particular cell; once filled to capacity the cell is closed and landfilling starts in a new cell. See Figure 3 for a typical phasing plan.

A landfill can be developed on flat plain land, sloping land (hilly area), in abandoned quarries, or even on an existing dumpsite. While municipalities are responsible for developing a secured landfill to meet their disposal requirements, the State Pollution Control Boards are required to authorise the landfills' development as well as regulate the operation of landfill sites to ensure that they adhere to the stipulated standards under the Municipal Solid Waste Rules (see Box 1).



#### What type of waste does a municipal secured landfill site contain?

'Municipal solid waste' includes commercial and residential wastes generated in a municipal or notified area. By regulation, municipal secured landfills can also receive nonhazardous industrial solid waste. Construction and demolition debris may also be landfilled, or else used in place of the daily soil cover. Industrial hazardous wastes and biomedical wastes, however, cannot be disposed at municipal secured landfills, for which separate landfills are required in compliance with a different set of laws.

As per the Municipal Solid Waste Rules, 2000, landfilling shall be restricted to nonbiodegradable, inert waste and other waste that are not suitable either for recycling or for biological processing. Landfilling shall also be carried out for residues from waste processing facilities as well as pre processing rejects from such waste facilities.

The rules, however, also stipulate that landfilling of mixed waste may be undertaken if the same is found unsuitable for waste processing, or until installation of alternate facilities. The underlying premise is that open dumping should be stopped on a priority basis.

#### Can we treat or recycle all waste, and do without a secured landfill?

Experience in India and across the world has shown that it is not possible to treat or recycle all the waste. Landfill sites are required to dispose of rejects, that is, waste that cannot be reused, composted or recycled. There are many waste processing methods such as composting, biomethanation, and incineration which help to reduce the amount of waste. Ultimately, however, there is a remaining waste stream consisting of rejects or residues (for instance, non biodegradable rejects from a compost facility, ash from a Refuse Derived Fuel facility) that needs to be disposed safely at a landfill.

In addition, secured landfills serve as a necessary backup to other components of a waste management system. For instance, in case of a malfunction in the treatment facility or unusual peaks in the waste stream (festivals, public events, heavy rains, natural disasters), the excess waste can be safely disposed of at the secured landfill.



Figure 5: Increase in Landfill Height for Bigger Landfill Area

#### Is a secured landfill a wasteful use of land?

Secured landfills are a necessary requirement for any urban area. However, making land available for such a landfill does not imply that thereafter it cannot be used for any other purpose. As mentioned earlier, landfills are developed in phases. If the efficiency of recycling and waste treatment improves over time, it is possible to reduce the land provided for subsequent landfill cells, or reallocate it for additional treatment capacity. After closure, the landfill area can be restored for other uses, for example, parks, golf courses, and even human habitation (if the necessary safeguards have been taken).

#### Do we have secured landfills in India?

There are only a few secured landfill sites in India. These too came up after the Municipal Solid Waste Rules, 2000, came into being. The first few secured landfills in India were built around 2004–05 in cities like Navi Mumbai, Bangalore, Surat, and Ahmedabad. Most cities, including the metros — Delhi, Mumbai, and Kolkata — still do not have proper and scientifically designed secured landfills. Instead the norm is uncontrolled disposal at open dumpsites (typically in low lying areas) which are a source of severe pollution. Several landfills are now being developed across the country, not only in the metros but also in smaller cities such as Gwalior, Chandigarh, and Dehradun.

#### Is it possible to make secured landfills more cost effective and land use efficient?

In a country such as India, it is extremely difficult for each small town to develop its own separate secured landfill. They do not have the necessary financial and human resources nor is it feasible to find available land sites to develop the number of landfills required. Most countries across the world have addressed this challenge by developing regional landfills.

#### What is a regional landfill?

A 'regional landfill' refers to a common landfill for a cluster of municipalities. It allows for the development of a single, large facility instead of many small landfills dotting the landscape. A single regional landfill could cater to as many as 15–20 municipalities.

Being relatively large in size, regional landfills offer several advantages:

- Significant lowering of construction and operating costs per ton of waste (by as much as 60–80%).
- Sharing of fixed costs across a larger number of municipalities.
- Better quality of operations using modern equipment (typically usable only in large facilities).
- Hiring of appropriate professional expertise.
- Development of a proper green belt around the facility to serve as a visual barrier.
- Significant lowering in land requirement per ton of waste (because with a larger land area, it is possible to landfill up to a greater height—up to 40–50 metres and even higher in some cases). Figure 5 provides an illustration of this point.

While large tracts of land may not be available within or near municipal boundaries, these may be acquired in relatively less developed areas located at some distance from municipalities, up to even 50–60 km. away. The additional transportation costs are usually offset by the cost savings as described in the advantages.

Regional landfills are being used not only in developed countries such as the United States, the United Kingdom, Germany, Sweden, and Poland, but also in developing countries such as Argentina, Brazil, Mexico, Palestine, and Egypt. In India, the approach is being adopted in the states of Gujarat, West Bengal, and Andhra Pradesh; others, such as Tamil Nadu, Kerala, and Maharashtra are also considering adopting this approach.

#### **The Bottom Line**

India is growing rapidly, and waste generation is growing at between two or three times the rate of population growth. The 'out of sight, out of mind' approach has to be replaced by a mature understanding of the ill effects of poor waste management. Along with necessary efforts to reduce, recycle, and reuse waste, citisens and decision makers need to urgently understand that secured landfills are an essential element of a complete solid waste management chain. They need to work towards introducing well-designed and efficiently managed secured landfills that are not seen as an environmental evil but as an essential means for safeguarding public health and the environment.

## Footnotes

- 1. Improper storage of waste, especially hazardous waste, could lead to accidental spills, thereby increasing the risk of fires or explosions. Flight safety is affected because the garbage also attracts birds, increasing the risk of bird-hits and aeroplane crashes.
- 2. Leachates is a toxic liquid that seeps through solid waste in a landfill and, in the process, extracts soluble dissolved and suspended materials from the waste. It contains waste, bacteria, toxic substances, heavy metals, among other things. In towns where biomedical or hazardous waste (for instance, batteries, bulbs, thermometers) mixes with the municipal waste stream, the leachate can cause serious health and environmental damage.
- 3. Landfill gas contains methane and carbon dioxide plus small amounts of some other gases. Methane being inflammable can cause fires or explosions. Accordingly, at most secured landfills this gas is collected and either burnt in a controlled manner or used to generate electricity. The gas is released over a long period of time as the waste degrades. Consequently, gas emissions from landfill sites must be monitored for many years even after the sites have stopped accepting waste.

 Biomedical Wastes (Management and Handling) Rules, 1998, and Hazardous Wastes (Management and Handling) Rules, 1989.

#### ...... Natural Gist

- ✓ In India, 80% of municipal solid waste is dumped in the open.
- Open dumping has many negative environmental impacts; resulting in water pollution from leachates, soil pollution, fires, global warming methane gas, foul smells, visual ugliness and is a source of vermin and disease.
- To safeguard public health and the environment we need successful solid waste management systems. This requires; timely collection, transportation, recycling and processing, and finally safe disposal of the limited resulting solid waste.
- In India, we need more secured landfills, engineered facilities designed especially for the safe disposal of commercial, residential and non-hazardous industrial waste in a planned manner. It requires regular compaction of waste, and daily covering to prevent flies, birds, and odour.
- Reducing the volumes of solid waste that goes to landfill, by implementing effective waste processing methods, including composting, biomethanation & incinerations.
- Promote efficient land through 'regional landfill', a common landfill servicing a cluster of municipalities, allowing the development of a single, large facility replacing many small landfills across our landscape.
- Commit to restoration after use, turning full landfills into gardens, parks, golf courses, and even uses for human habitation, as long as the necessary safeguards have been undertaken. A larger regional landfill may be more effective to redevelop in this way.
- Alongside efforts to reduce, recycle, and reuse waste, citisens and decision makers must urgently understand that secured landfills are an essential element of a complete solid waste management chain.

Secured Landfills: The Bucket at the End of the Solid Waste Management Chain. By Vandana Bhatnagar and Sanjay K. Gupta, (April 2008)

Published by the Water and Sanitation Program (WSP). The water and sanitation program is an international partnership for improving water and sanitation sector policies, practices, and capacities to serve poor people.

The original article can be found at: http://www.wsp.org/UserFiles/file/Landsfill\_Print\_8Oct08.pdf



## Urban Air Quality management: Co-ordinating Transport, Environment, and Energy Policies in Developing Countries

By Masami Kojima & Magda Lovei (Sept. 2001). Abridged

#### **Executive summary**

Air pollution is one of the most serious environmental concerns in urban areas, especially in view of its adverse effects on human health. In developing countries around the world, an estimated 0.5 million-1.0 million people die prematurely each year as a result of exposure to urban air pollution, and millions of cases of respiratory illness are associated with air pollution in large cities. Among the greatest environmental health concerns are exposure to lead, which contributes to behavioural problems and learning disabilities of young children even at low levels of exposure, and exposure to fine particles, which are known to cause serious health damage due to their penetration deep into the lungs. The economic damage to their penetration deep into the lungs. The economic damage from urban air pollution (including its effects on structures, crops, and vegetation and forests) is estimated to amount to US\$1 billion-US\$4 billion annually in cities in Asia and to US\$6 billion in urban areas in the newly independent states (NIS). Air pollution also contributes to the accumulation of stratospheric greenhouse gases, with implications for global climate change.

This paper discusses the growing air pollution problem in developing countries and outlines approaches to urban air quality management in the transport sector. As countries become motorised, vehicles will contribute increasingly to urban air pollution. Tackling air pollution arising from the use of vehicles in turn calls for coordinating urban transport, environment, and energy policies. Although the broader issues of long-term urban planning and measures to induce significant shifts in transport mode are important in influencing urban environmental trends, they are beyond the scope of this paper.

#### Developing strategies for improving air quality

Anthropogenic air pollution originates from a variety of sources, including households; vehicles; large stationary sources; small and medium-size industries; construction; fugitive emissions as a result of mechanical breakup, abrasion, and erosion of road surfaces, brake linings, and tyres; agriculture; and forest burning. Motor emissions can contribute as much as 80-90 % of atmospheric lead in cities where leaded gasoline is still used, and traffic is also a large contributor to fine particulate matter. Next to the elimination of lead from gasoline, which is an effective measure for reducing human exposure, the reduction of fine particulate matter is by far the highest priority. Vehicle emissions, together with stationary and natural level zone, which causes health as well as damage to vegetation and crops. Mobile stationary combustion sources are significant contributors to ambient concentrations of a range of other pollutants.

A priori assumptions about which sources should be targeted for pollution reduction can result in choices of measures that are not cost-effective or do not have a significant impact on air quality. A systematic approach, therefore, is needed to formulate a strategy for improving urban air quality. Such an approach should:

- Identify the main environmental concerns on the basis of assessment of risks to human health and to environmental resources, and relative source contributions.
- Use cost-effectiveness as the primary criterion for selecting optimal strategies across various sources and sectors.
- Harmonise policies and measures across sectors and help implement the selected strategies.

Industrial countries have made significant progress in improving their air quality by applying a combination of environmental and sectoral regulations, incentives and fiscal measures, and advanced technologies. In many developing countries, choices about the feasibility, sequencing, and timing of similar measures have serious fiscal and economic consequences. The guiding principles for selection of strategies and regulations should be the balancing of costs and benefits and the institutional feasibility of the measures. The transfer of advanced technologies without consideration of their applicability, or the use of strictly sectoral approaches to improving air quality may fail to produce the desired effects if not based on a comprehensive strategy. For example, advanced fuel and vehicle technologies used in industrial countries are expensive and are designed to make already clean vehicles cleaner. Importing these standards in a situation with large numbers of highly polluting vehicles and an inadequate repair infrastructure would require a large allocation of resources and is unlikely to be cost-effective. The development community has to consider these issues in helping developing countries address their environmental issues effectively.

#### Vehicle emissions abatement measures and their cost effectiveness

Vehicle emissions, which occur near ground level and in densely populated areas, cause much greater human exposure to harmful pollutants in the immediately locality than do emissions from sources such as power plants that are situated at elevated levels and farther away from dense population centres. In addition, vehicle exhausts particles, being small and numerous, can be expected to have considerable health impacts. Pollution abatement in the transport sector is therefore likely to become increasingly important in urban air quality management strategies in the coming years.

## Potential win-win measures

A number of measures that are typically undertaken to pursue other primary objectives are likely to generate environmental benefits as well:

- Improved traffic flow management For coordinating traffic lights, is aimed at decreasing
  congestion and improving intensity of traffic, but also confers environmental benefits because
  of the resulting lower emissions. It should be noted, however, that some congestion-relieving
  efforts, such as road construction, can invite greater levels of motorisation in the long run.
- Traffic demand management For example through the provision of public transport, promotion of non motorised transport, application of fuel taxes, and other fiscal measures, area wide, licensing, electronic road pricing in urban areas, and preferential treatment of high occupancy vehicles is aimed at inducing a behavioural change in the use of vehicles and has beneficial environmental impacts.
- Some vehicle use and maintenance practices Such as using the correct type and amount of lubricant in two-stroke engine vehicles, avoiding over fuelling diesel engines, and correcting injection timing all can have positive economic and environmental impacts.

## Targeted pollution abatement measures

In addition to encouraging the above win-win measures several options for targeting pollution from vehicles are widely used, but their effective applications depends on a number of conditions:

- Tightened vehicle missions standards The conditions for effectively controlling emissions
  through standards are reliable vehicle registration, emissions that differentiate vehicles by
  type and age, means of measuring emissions levels accurately and methods for enforcing
  the emissions standards. Where concentrate on enforcement than to tighten the
  standards
- Improved vehicle technology. Three-way catalytic converters, if properly operated and maintained, can significantly reduce emissions of exhaust carbon monoxide (CO), hydrocarbons, and nitrogen oxides (NO) from gasoline vehicles. Modern diesel engines are much cleaner than those produced in the past, but they require proper fuel quality.
- Inspection and maintenance (I/M) programs I/M programs can mitigate transport pollution by strengthening the enforcement of emissions standards and can stimulate demand for vehicle repair and maintenance services, if such programs are properly operated and are corruptionfree.
- Vehicle retirement and scrappage programs These programs must be used with care.
   Income constraints make cash-for-replacement particularly difficult to design in developing countries; owners of gross emitters with high annual vehicle kilometres travelled are often not in a position to purchase much newer vehicles.
- Improved fuel quality. Improvements in fuel quality can contribute to better air quality if they are closely coordinated with improvements in vehicle technology. For the World Bank's client countries, the first step in improving the quality of transport fuels is to phase out lead in gasoline. A number of developing countries have already banned leaded gasoline, and several others are planning to do so in the near future. At the same time, it is important to address other fuel parameters that may have adverse health impacts. For countries that have domestic refineries, it has to be kept in mind that refinery processes are integrated so that changes in the specifications of different fuels should be coordinated to optimise refinery modernisation schemes. Although there are benefits from the regional harmonisation of fuel specifications, these specifications have to reflect national and local conditions.
- Use of alternative fuels Alternative fuels have both strong advantages and disadvantages. Vehicles using liquefied petroleum gas (LPG) and compressed natural gas (CNG) emit considerably less particulate matter than do conventional diesel, and vehicles powered by electricity have no tail pipe emissions at all. The required investments in LPG distribution and refuelling stations have not been made in most developing countries, constraining the widespread use of this fuel. CNG yields essentially no reactive organic compounds or sulphur oxide (SOx) emissions but it is much more expensive to distribute and store than LPG. The basic requirements for the long-term viability of CNG vehicles are a natural gas distribution network that is already in place, retail fuel prices that favour CNG substantially over the fuels that CNG is intended to replace, and a favourable legislative and regulatory atmosphere.

The existing diesel and natural gas pricing structure in most countries provides little incentive for switching from diesel to CNG. The major disadvantages of electric vehicles, in comparison with other alternative-fuel vehicles, are the length of time needed for recharging them, their short ranges, and their considerably higher purchase costs. The long-term viability of electric vehicles should be evaluated from the standpoint of market-based energy pricing. While pure electric vehicles may not be expected to have widespread application, hybrid electric-internal combustion engines may play a greater role in the future.

#### Cross-sectoral coordination of policies

Policies in various sectors have close linkages and should be coordinated and harmonised to achieve optimal results. Coordination is especially important for policies that target vehicle technology and fuel quality.

#### Vehicle technology, fuel quality, and related policies

A number of fuel-related issues need to be considered in formulating transport, environment, and energy policies:

- Emissions levels of lead depend solely on fuel combustion and lead is extremely toxic. Its
  phase-out from gasoline is technically feasible and is an effective measure for reducing
  pollution and health impacts.
- In many developing countries the vehicle fleet is dominated by poorly maintained, often
  old, vehicles. As long as large numbers of these vehicles are on the road, the costeffectiveness of tightening fuel specifications to North American or European Union (EU)
  standards is questionable.
- In countries where the carbonaceous component of vehicular particulate matter is still high, it may not make economic sense to target sulphur in diesel to match North American and EU fuel standards if the goal is to mitigate particulate emissions from diesel engines.
- It is not enough to regulate fuel quality. In a number of countries transport fuels are
  routinely adulterated by adding (lower-cost) kerosene or lead to gasoline downstream of
  refineries or terminals. Regular fuel quality monitoring, together with costly penalties for
  noncompliance, could help enforce fuel standards more effectively.
- The promotion of modern vehicle technology has to be harmonised with measures for fuel
  quality improvement. Modern engines often require a certain fuel quality that may not be
  readily available in developing countries.
- A number of conditions need to be satisfied for catalytic converters to function effectively, including wide availability of unleaded gasoline, a reasonably low level of sulphur in vehicle fuels, and an effective inspection and maintenance system, including the existence of appropriate standards. The promotion of catalytic converters provides a striking example of the interdependence of transport, energy, and environmental policies.

#### Targeting gross emitters

The share of emissions is not uniformly distributed over the vehicle fleet. A fraction of ill-maintained, often old, vehicles are typically responsible for a disproportionate amount of pollution from the transport sector. If these "high emitters" can be repaired or permanently eliminated, a considerable reduction in pollution can be achieved at a relatively small cost. Policies targeting certain types of vehicles should take into consideration their distributional impacts on the poor.

## Fiscal policies

Fiscal policies include higher taxes on more polluting fuels and vehicles. A good example is a policy of pricing unleaded gasoline lower than leaded gasoline during the transition period when lead in gasoline is being phased out.

Prevailing fuel subsidies and taxation can have adverse environmental impacts. For example, gasoline is taxed to a considerable extent in many developing countries, but diesel and kerosene are either less taxed or subsidised. A large price differential between kerosene and gasoline leads to illegal addition of kerosene to gasoline, resulting in higher pollutant emissions. Similarly, a large price differential between gasoline and diesel encourages a shift from gasoline-powered to diesel vehicles in the light-duty category a shift that is unfavourable from the environmental point of view because of the emerging epidemiological evidence that diesel emissions are more toxic than gasoline emissions. A policy of narrowing the price gap by

taxation is not necessarily the best approach, however, because of the expected impact of such taxation on other uses of diesel - in the heavy-duty vehicle category, rail transport, agriculture, and industry, for example. An alternative is to increase vehicle taxes on diesel vehicles typically used in intracity transport (that is, light-duty diesel vehicles) or to give rebates on the diesel tax to industrial and agricultural users of diesel.

Tax structures that discourage the purchase of new vehicles - for example, registration fees or excise taxes based on the market value of the vehicle- should be carefully reviewed and, if possible, revised, since they do not capture the cost of pollution. In considering fiscal measures, the socioeconomic impact of making the ownership of old vehicles more costly should be considered.

#### Trade liberalisation

The removal of barriers that hinder access to the technology available in the rest of the world enable consumers to meet tighter emissions standards at least cost. Rules such as local content requirements often result in inefficiency. Higher import tariffs on new vehicles, rigid licensing schemes for imports, and quotas are all likely to slow the rate of vehicle renewal with potentially adverse impacts on air pollution.

Free trade in used cars can have mixed results. Exports of gross emitters would be a classic case of environmental dumping. In the interest of environmental protection, governments may limit the age of the vehicles that can be imported, levy higher import duties, or impose other restrictions on such vehicles. The purchasing pattern of vehicle owners should be carefully balanced against the expected environmental advantages of restricting the import of old vehicles. If, for example, consumers cannot buy relatively new vehicles, an import restriction based on age would postpone the replacement of the high emitters. Several industrial countries levy a fee to cover the final disposal of vehicles, and countries that import used vehicles could negotiate the transfer of such funds to cover disposal costs.

Liberalised trade, by enabling the use of superior fuels produced in other countries, makes it much easier to phase out gasoline lead and to implement other fuel quality improvement measures. In some regions there is a move toward harmonising fuel specifications to ensure minimal environmental standards, foster intraregional trade, and enhance the efficiency of supply. Fuel specifications in North America, the EU, and the countries of the former Soviet Union are already harmonised for the most part, and similar measures have been proposed in Latin America.

Many refineries in developing countries are owned by the government, and some of them are not operated economically. In a number of developing countries, the net cost to society of improving fuel quality by importing superior fuels would be lower than the cost of supplying domestically manufactured fuels with less stringent fuel specifications. Downstream petroleum sector reform through transfer of ownership from the government to the private sector, coupled with liberalisation of petroleum product trade and the introduction of competition, is therefore an important condition for improving fuel quality and, ultimately, urban air quality.

## Greenhouse gas emissions

Most environmental externalities from transport- such as those affecting human health impose immediate social costs and require national and local action. By contrast, emissions of greenhouse gases (GHGs), including carbon dioxide (CO2), methane, and nitrous oxide(N20), contribute to a global externality, the impacts of which will accrue in the more distant future. Solutions to this problem require concerted international efforts.

#### Global trends in C02 emissions

For most countries, the share of emissions arising from transport has increased in recent decades. Although the share of GHG emissions from developing countries is small compared with that of member countries of the OECD (Organisation for Economic Co-operation and Development), especially in the transport sector, there are concerns about future trends. If OECD countries begin to restrain their emissions while developing countries - whose economies are growing more rapidly than those of the OECD do not, total emissions from the developing countries are forecast to overtake those from the OECD within a fairly short time period.

#### Options for reducing GHG emissions

Politically, suggestions for GHG mitigation measures in developing countries are often received warily and can be perceived as a denial of these countries' basic right to economic growth and improvement of human well-being. Some measures that reduce local pollution, however, also reduce GHG emissions.

One area of overlap between local and global benefits is increased fuel economy. The enormous gains made in improving fuel economy in the 1970s and the first half of the 1980s have contributed to decreasing both local and global pollution in industrial countries. In developing countries fuel economy is often low because of such factors as poor vehicle maintenance, fuel adulteration, and low engine compression ratio, although the small engine sizes typically found help to offset the low fuel economy.

Another area of overlap between local and global pollution-reduction goals is traffic management. Traffic congestion worsens emissions of both local and global pollutants. It has been reported that increasing the average speed in city traffic from 10 kilometres per hour (km/h) to 20 km/h can cut CO2 emissions by nearly 40 %.

It is important to recognise, however, that there is not always a synergy between measures to reduce local pollution and measures to mitigate GHG emissions. Locally motivated air quality improvement programs for urban transport in such middle-income countries as Mexico and Chile have been shown to have limited collateral benefits for reduction of GHG emissions.

The worldwide move to mitigate local pollution by progressively reformulating transport fuels through severe hydro treating is making refinery processes increasingly, energy-intensive thus increasing GHG emissions. Diesel fuel is particularly efficient and helps reduce GHG emissions, but its emissions may be more detrimental to human health than those of other fuels. An area that merits examination is the role of fuel pricing in encouraging better fuel economy and optimising fuel usage. In some countries diesel is hardly taxed, making its retail price low. Such a pricing policy encourages excessive use of diesel.

## Decision making levels in transport-related air quality management

Decisions made at different levels affect policies designed to combat transport emissions. At the global level, moves are being made to address issues such as GHG emissions that can be tackled only globally, and vehicle manufacturers are leading initiatives to harmonise fuel quality and vehicle emissions standards worldwide.

At the regional level, pollutants such as sulphur dioxide (SO2) require solutions that transcend country boundaries. There are also initiatives to harmonise fuel specifications and vehicle emissions standards on a regional basis, notably in the EU. In the NIS these standards are already harmonised by virtue of the countries' history. In some regions standards are increasingly integrated on account of extensive trade. All these trends affect decision-making at the national level.

The national government typically sets air quality standards, fuel specifications (with geographic differentiation if the distribution infrastructure can support it), vehicle emissions standards, and definitions of what constitutes noncompliance. Air pollution problems, however, are location specific, and it is the state and municipal governments that monitor air and fuel quality and vehicle emissions; integrate transport considerations into overall city development plans; develop traffic flow, demand management, and other strategies for dealing with traffic congestion and emissions; and, where appropriate and fiscally possible, offer financial and other incentives for vehicle renewal non motorised transport, and other means of mitigating traffic emissions.

These considerations are important in determining the proper instruments and frameworks for assisting client countries in their efforts to improve their environments and strengthen their environmental policy and regulatory frameworks. The World Bank, through its policy dialogue with client governments at the national level and through sectoral programs and projects at the urban level, can be effective in forging cross-sectoral coordination of policies and supporting measures that can contribute to improved environmental conditions in developing countries.

#### World Bank experience supporting air quality management projects

In recent years the World Bank has started to address urban air quality management and its interlinkages with the transport sector, primarily through analytical work, non lending services, regional initiatives, and partnerships. A coherent and consistent strategy, however, does not yet exist, and examples of good practice are only starting to emerge. Coordination, within the Bank and in client countries, among the transport, environment, and energy sectors is an essential condition for air quality management but has only now begun to develop.

## Analytical work

In connection with its assistance to the governments of Indonesia and Chile, the World Bank developed a methodology for estimating the health impacts of key air pollutants. Analytical resources were geared to ward obtaining estimates of the benefits of pollution reduction by employing models of health effects, pollutant exposure, and dispersion. In Mexico City an analysis of pollution abatement measures in the transport sector evaluated and ranked in terms of cost-effectiveness 26 technical measures for making vehicles and fuels less polluting. Analyses in Santiago and Mexico City showed that the measures studied could reduce local pollution by about two-thirds but that the effect on greenhouse gases was only 5 to 6 %.

Another study estimated the social costs, including health and non health damages and climate change impacts, associated with the different types of fuels and a variety of sources in six developing country cities. The findings indicate large health effects from vehicles and small stationary sources, whereas large sources contribute the most to climate change impacts. The implication is that the overlap between measures for addressing local and global issues is likely to be limited. Diesel powered urban vehicles and small stoves and boilers that burn coal, wood, or heavy oil impose the highest social costs per ton of fuel. The large range of environmental damages for different combinations of fuels, sources, and locations limits the efficacy of simple fuel-pricing measures. A skilful mix of policy instruments able to send highly differentiated signals to various users of fuels is required.

## Non lending services

Among the Bank's major non lending activities are the Urban Air Quality Management Strategy (URBAIR) in Asia, lead phase-out, clean transport fuel studies and programs, the South Asia two-stroke engine initiative, and regional clean air initiatives. URBAIR. The objective of the URBAIR program was to assist in the design and implementation of policies, monitoring, and management aimed at restoring air quality in Asian metropolitan areas. It combined air quality analysis with economic evaluation (calculations of health damages and of the costs of

mitigation measures) in four participating cities: Jakarta, Mumbai, Kathmandu, and Metro Manila. The findings and results of URBAIR are being followed up in the World Bank's Mumbai Urban Transport Project and in other programs.

?Lead phase-out - The Bank has called for the complete phase-out of lead in gasoline in developing countries and has undertaken a number of activities to that end. It has supported health and feasibility studies, worked with bilateral and multilateral partners and nongovernmental organisations (NGOs) to raise awareness and build political commitment. The Bank has also assisted individual countries with studies and implementation and has worked to build consensus and dispel myths about lead phase-out. Elimination of gasoline lead raises complex technical and fuel quality issues that have to be addressed as part of a comprehensive, cost-effective approach to air quality management. Accordingly, lead phase-out initiatives have led to broader programs and studies that address cost-effective ways of improving transport fuel quality in specific countries or in entire regions.

- Clean transport fuels Vehicle fleet characteristics, fuel consumption patterns, and the downstream petroleum sector often have many similarities in a given region. A regional approach not only ensures that minimal environmental standards will be maintained but also significantly reduces illegal smuggling of lower- priced, poor-quality fuels by setting minimal fuel and vehicle emissions standards, which individual countries can choose to exceed to meet by setting their own air quality objectives. It offers the potential for reducing the incremental cost of improving fuel quality and vehicle technology and also facilitates intraregional trade. The World Bank has supported regional initiatives in Latin America and the Caribbean and in Central Asia and the Caucasus.
- Two-stroke-engine initiative In South Asia a World Bank study examined the options for reducing emissions from the two-stroke engines commonly used in two- and three-wheeler vehicles in the region. The findings from this initiative are being applied in several projects. Encouraging replacement of two-stroke with four-stroke engines at the time of vehicle retirement is a cost-effective mitigation measure. For existing vehicles, use of the proper quality and quantity of lubricant is a win-win action that can reduce emissions at no extra cost to the owner and that makes for better engine maintenance.
- Regional clean air initiatives The World Bank Institute (WBI) has undertaken 'Clean Air Initiatives' that focus on major Latin American and Sub-Saharan African cities and has started similar programs in East and South Asia and in Europe and Central Asia. The goals of the initiatives are to promote the integrated development or enhancement of clean air city action plans, with participation by all relevant stakeholders; to advance exchange of information; and to foster public participation and the active involvement of the private sector in implementing recommendations as appropriate. The approach includes workshops, distance learning training, network support, and information and outreach activities.

#### The urban transport portfolio

In some Bank urban transport projects, there is a fair amount of overlap between transport and environmental objectives. Examples include replacing old buses, constructing light rail systems, and improving traffic management to reduce congestion and increase road safety. Relatively few projects or components, however, have explicit air quality improvement objectives. Some projects have financed studies to prepare action plans for addressing vehicular air pollution in urban areas. The China Liaoning Urban Transport Project supports improvements in the environmental sustainability of project investments by developing sustainability of project investments by developing and implementing a motor vehicle emissions control strategy. Many urban transport projects seek to promote Non Motorised Transport (NMT) - for example, by constructing overpasses and bicycle paths and creating pedestrian and restricted traffic zones. An NMT program within the Second Shanghai Metro Transport Project includes establishment of an exclusive 19.4 kilometre network of non motorised vehicle routes in and around the central business district.

Active projects in Brazil and Bangladesh allocate funds for I/M components, and projects in Argentina and Bangladesh include air quality monitoring components. Two projects in Brazil (in Belo Horizonte and Recife) emphasise the need for appropriate pricing and parking policies to deter automobile growth in city centres. In the Budapest Urban Transport Project, a proposal was made for the introduction of entry use charges for motor vehicles in the inner city, with a dual objective of traffic restraint and generation of funds; the political aspects of such a decision are, however, sensitive.

Some projects have attempted to curb demand for polluting vehicles by, for example, banning out right certain vehicles, such as three wheelers with two stroke engines. Measures for traffic restriction have also been proposed.

Except for the China Guangzhou city centre Transport Project, urban transport projects typically have not attempted to address fuel quality issues such as the phase-out of lead from gasoline. One reason is that such issues are generally under the control of the energy sector at the national level, which adds to the complexity of the projects.

#### Other relevant portfolios

Financial support for paving and rehabilitating roads - which reduces dust and the associated health effects-have typically been included in urban development projects rather than urban transport projects. Activities that improve traffic flow (repair of streets and sidewalks, installation of street signs and traffic lights, and creation of bus routes) confer health benefits. Some transport projects include components for NMT, air quality, elimination of gasoline lead, and pollution reduction.

#### Conclusions and recommendations

Urban air quality management is a relatively new area of focus for the Bank. This paper summarises some of the key technical and policy issues of relevance to the Bank's activities in the transport-environment-energy interface, it describes non lending activities, and re-views the urban transport portfolio with an emphasis on air pollution management activities in projects. The following conclusions can be drawn from this assessment

- 1.The Bank has supported analytical work, but as yet no lending activities that emphasise integrated approaches to urban air quality management. Linking these activities with lending specifically targeted to improving air quality, remains a challenge.
- 2.Several urban transport projects have adopted "win-win" measures that reduce both congestion and air pollution, particularly through transport management. In general, however, interventions designed to improve urban air by reducing transport emissions do not feature strongly in the Bank's urban transport portfolio. The overall amount located specifically to air quality improvement objectives is typically around 1 % of total project cost.
- 3.Environmental measures in urban transport projects often include the introduction of air quality monitoring and vehicle inspection and maintenance. Experience suggests that the sustainability and optimal design of such monitoring systems are a major concern. In the face of widespread corruption, lack of adequate repair and service facilities, and poor cultural acceptance of regular vehicle maintenance, enforcement of existing vehicle emissions standards remains a serious challenge.
- 4.The responsibility for many environmental regulations rests with the central government limiting what can be achieved in the framework of urban projects. Most urban transport projects focus on local interventions such as improving traffic management segregating non motorised transport routes, and strengthening local monitoring systems.

- 5.Measures with explicit environmental objectives are not always assessed in terms of their cost-effectiveness, the presence of necessary conditions (such as fuels that match certain vehicle technologies), and linkages with policies in other sectors such as energy.
- 6.The transport sector is primarily concerned with improving people's lives and contributing to economic efficiency through better mobility, better access to transport services, and increased efficiency in goods transport. The environmental implications of transport policies as well as their social and equity implications should therefore be an integral part of sustainable transport strategies.

On the basis of the above observations, the following recommendations can be made for the Bank's urban transport and environment can be made for the Bank's urban transport and environment strategies:

- Properly implement environmental safeguard policies In most cases, proper implementation
  of environmental safeguard policies -based on environmental assessments of projects and
  the execution of environmental management plans, where appropriate -are sufficient to
  ensure that urban transport projects do not cause undue harm to people's health and the
  environment.
- Integrate environmental externalities into economic analysis of transport strategies The
  environment community has improved the analytical tools and methodologies for the
  economic assessment of environmental externalities, and such methodologies should be
  more widely used.
- Focus on win-win measures Transport sector interventions should build on the synergies between reducing negative environmental impacts and reducing other negative externalities in the transport sector. Areas of such synergies include improvements in traffic and demand management, non motorised and public transport infrastructure, and fuel efficiency.
- Improve the environmental outcome of projects Although most of the Bank's transport
  interventions are not primarily environmentally oriented, it may be useful to think
  opportunistically about what can be achieved through marginal adjustments to the projects for
  the benefit of the environment. The analogy is the concept of "global overlays," in which local
  and global pollution is considered together. How and where such a concept can be effectively
  utilised is an area that should be investigated.
- Develop a proactive approach toward improving air quality Although win-win measures have positive environmental benefits, improving the development effectiveness of Bank assistance would require a proactive approach, especially in areas where deteriorating urban air quality causes great social damage and constrains future growth. Such an approach could include the identification of cities in which air quality is a serious problem; agreements with national and city governments to work on solutions to the problem; strategic environmental assessments to identify key sources of pollution and cost-effective sectoral interventions; and a long-term framework for Bank assistance.
- Coordinate among sectors The Bank should ensure that the policies it recommends in the transport, energy, and environment areas are technically sound and internally consistent. Areas for coordination include setting fuel and vehicle emissions standards and improving fuel quality monitoring and vehicle emissions inspection feasible for developing countries. Even the most modern engines will pollute a great deal if the gasoline with which they are fuelled is adulterated with kerosene. Which fuel parameters to monitor, how often, by whom, and when are issues that the Bank is only now beginning to address.
- Develop strategic long-term programs Urban air quality management involves interactions
  with a large number of agencies and stakeholders. In addition, a number of donors are
  increasingly active in this area in many of the cities in which the Bank operates. Coordination
  Urban Air Quality management: Coordinating Transport, Environment, and Energy Policies in Developing Countries

with various players requires significant resources. The Bank could lead such efforts in selected cases when governments are committed, clear targets can be set, and proper monitoring of efforts can be undertaken. Programmatic lending instruments could be utilised for such efforts.

In addition to these generic recommendations, some specific issues need to be considered:

- Reassessment of air quality monitoring activities Attempts to introduce complex air quality
  monitoring systems have often failed in our client countries. In some cases it is recommended
  that only one or two pollutants be monitored, using the technology that the country has the
  technical capacity to operate and maintain. Air quality monitoring activities undertaken in
  urban transport projects should, in any case, be coordinated with the environmental
  authorities and with existing monitoring networks.
- Identification of heavily polluting vehicles and design of cost-effective interventions that target them - In most client countries, targeting gross polluters is likely to be an effective pollution reduction measure. Such interventions should consider a range of options, including incentives for regular repair and maintenance.
- The institutional feasibility of pollution abatement measures While several pollution abatement measures may have promising potentials, the institutional aspects of implementing such measures in client countries have to be considered.
- The social implications of pollution abatement measures Urban pollution disproportionately
  affects the poor, and improvements in living conditions therefore generally benefit them.
   Specific choices and strategies for pollution abatement, however, have direct and indirect
  impacts on the poor that have to be assessed.

#### Natural Gist

- 0.5 million-1.0 million people die prematurely, per year, a result of exposure to urban air pollution in developing countries around the world. Plus millions of cases of respiratory illness are associated with air pollution in cities.
- There is <u>significant economic damage from urban air pollution</u>, including its effects on structures, crops, and vegetation and forests. It is estimated to amount to US \$1 billion-US \$4 billion annually for Asia cities.
- We must formulate a strategy towards improving urban air quality. Identifying the main environmental concerns, harmonising policies and measures across sectors. Many industrial countries have made significant progress in improving urban air quality by applying a combination of environmental and sectoral regulations, incentives and fiscal measures, and implementing advanced technologies.
- Vehicle emission abatement measures are increasingly important. Win-win measures include; improving traffic management, public transport provision, promotion of non motorised transport, fuel taxes, area wide, licensing. Other measures include; improved vehicle technology, effective inspection and maintenance programs, improved fuel quality and use of alternative fuels.
- We need <u>coordinatation among sectors</u> to ensure policies recommended in the transport, energy, and environment areas are technically sound and internally consistent.
- We need to implement fiscal policies such as higher taxes on more polluting fuels and vehicles; this would include the pricing of unleaded gasoline lower than leaded gasoline, whilst lead in gasoline is phased out. This in turn will likely require trade liberalisation.
- To date the World Bank has supported only analytical work, but as yet no lending activities. There is a need for an integrated approach to urban air quality management; to <u>link pollution reducing activities with effective financial support</u> specifically targeted to improving urban air quality

# Urban Air Quality management: Coordinating Transport, Environment, and Energy Policies in Developing Countries

By Masami Kojima & Magda Lovei (Sept. 2001). Abridged A World Bank Technical Paper No. 508, pollution Management Series

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For further reading the full article can be accessed here on the World Bank website: http://www-



## INDOOR AIR POLLUTION IN INDIA – A MAJOR ENVIRONMENTAL AND PUBLIC HEALTH CONCERN

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In many people's minds air pollution is associated with the contamination of urban air from automobile exhausts and industrial effluents. However, in developing countries, the problem of indoor air pollution far outweighs the ambient air pollution. There are four principal sources of pollutants of indoor air: (i) combustion, (ii) building material, (iii) the ground under the building, and (iv) bioaerosols. In developed countries the most important indoor air pollutants are radon, asbestos, volatile organic compounds, pesticides, heavy metals, animal dander, mites, moulds and environmental tobacco smoke. However, in developing countries the most important indoor air pollutants are the combustion products of unprocessed solid biomass fuels used by the poor urban and rural folk for cooking and heating.

Approximately half the world's population and up to 90% of rural households in developing countries still rely on unprocessed biomass fuels such as wood, dung and crop residues. A recent report of the World Health Organisation (WHO) asserts the rule of 1000 which states that a pollutant released indoors is one thousand times more likely to reach people's lung than a pollutant released outdoors. It has been estimated that about half a million women and children die each year from indoor air pollution in India. Compared to other countries, India has among the largest burden of disease due to the use of dirty household fuels and 28% of all deaths due to indoor air pollution in developing countries occurs in India.

The type of fuels used by a household is determined mainly by its economic status. In the energy ladder, biomass fuels namely animal dung, crop residues and wood, which are the dirtiest fuels, lie at the bottom and are used mostly by very poor people. Electricity, which is the most expensive, lies at the top of ladder and it, is also the cleanest fuel. The 1991 National Census for the first time inquired about the fuel used for coking. It revealed that about 90% of the rural population relied upon the biomass fuels like animal dung, crop residues and wood. A small portion used coal. Nation-wide about 78% of the population relied upon the biomass fuels and 3% on coal.

#### Major air pollutants released from biomass combustion

It has been estimated that more than half world's households cook their food on the unprocessed solid fuels that typically release at least 50 times more noxious pollutants than gas. The stoves or chullah used for cooking are not energy efficient. The fuels re not burned completely. The incomplete combustion of biomass releases complex mixture of organic compounds, which include suspended particulate matter, carbon monoxide, poly organic material (POM), poly aromatic hydrocarbons (PAH), formaldehyde, etc. The biomass may also contain intrinsic contaminants such as sulphur, trace metals, etc.

#### **Particulates**

In recent years a large number of studies of health impact of suspended particulate air pollution have been undertaken in developing countries. These studies show remarkable consistency in

the relationship observed between changes in daily ambient suspended particulate levels and changes in mortality. Smith estimated the health risk from exposure to particulate air pollution by applying the mean risk per unit ambient concentrations based on the results of some urban epidemiological studies. The range of risk was found to be 1.2 - 4.4% increased mortality per 10 mg/m3 incremental increase in concentration of respirable suspended particles (PM10). For the calculations of estimates, it was assumed that the health risk has linear relationship to exposure, the risk factors determined for urban centres of developed nations were used as standards; where the PM10 data were not available, 50% of suspended particulate matter (SPM) levels were considered as equivalent. The above assumptions may add to inaccuracy already inherent in such estimates.

#### **Carbon Monoxide**

Incomplete combustion of fuels produces carbon monoxide (Co). The Co and particle emission pose a serious problem when biomass fuels are used. Smith11 has estimated that about 38, 17, 5 and 2 g/meal carbon monoxide is released during the household cooking, using dung, crop residues, wood and kerosene respectively. During the use of liquid petroleum gas (LPG) a negligible amount of Co is released. A study by the National Institute of Occupational Health (NIOH), Ahmedabad reported indoor air Co levels of 144, 156, 94, 108 and 14 mg/m3 air during cooking by dung, wood, coal, kerosene and LPG respectively. The short-term health effects of Co exposure are dizziness, headache, nausea, feeling of weakness, etc. The association between long-term exposure to carbon monoxide from cigarette smoke and heart disease and foetal development has been described by several authors.

#### Poly Organic Material and Poly Aromatic Hydrocarbons

Poly organic material is a loose term used to depict a group of chemicals having two or more rings. Of several chemicals included in this group, the PAHs have attracted interest for their possible carcinogenic effects. In addition to PAH, azo and arino compounds have also been found to be potentially carcinogenic15. Most other categories of POM are of less environmental interest or are not found in large amounts in organic combustion products.

Polycyclic aromatic hydrocarbons constitute a large class of compounds released during the incomplete combustion or pyrolysis of organic matter. They are often called polynuclear aromatic (PNA) because they contain three or more aromatic rings that share carbon atoms. Benzo(a)pyrene (BaP) is one of the most important carcinogen of the group. Often it is measured to indicate the presence or absence of PAHs although the relationship between BaP content and actual carcinogenicity may be weak. Anthracene and phenanthracene are not carcinogens but methyl additions may render them carcinogenic. PAHs are activated by the hepatic microsomal enzyme system to carcinogenic forms that bind covalently to DNA.

### Formaldehyde

Patel and Raiyani12 measured levels of formaldehyde in indoor environment during cooking by different fuels. The formaldehyde mean levels were 670, 652, 109, 112 and 68 µg/m3 of air for cattle dung, wood, coal, kerosene and LPG respectively. The formaldehyde is well recognised to be an acute irritant and long-term exposure can cause a reduction in vital capacity and chronic bronchitis. The formaldehyde is well known to form crosslinks with biologic macromolecules. Inhaled formaldehyde forms DNA and DNA-protein cross-links in the nasal respiratory mucosa20. The formaldehyde has been shown to be carcinogenic in a dose dependent fashion in rodents. The studies done in workers occupationally exposed to formaldehyde have consistently (11 of 13 studies reviewed) shown higher incidence of leukaemia. In an epidemiological study in U.K., significantly excess mortality from lung cancer was observed in workers exposed to high levels of formaldehyde.

### Mutagenic Activity of the Smoke Particulate Extract

Microbial tests are widely used as a screening tool for assessing mutagenic potential of chemical substances. The particulate matter in the smoke generated as a result of incomplete combustion of biomass fuels contains a number of organic compounds. To evaluate their

carcinogenic potential, it is necessary to screen their mutagenicity through simple and rapid microbial assay as a first step.

Ames assay is simple and sensitive enough to measure mutagenicity of air-borne particulates, so that many researchers have applied this assay to demonstrate the ambient carcinogenic and mutagenic compounds in the extractable organic matter from air-borne particulates. Mutagenic response of complex mixtures of polycyclic organic matter from the combustion of biomass energy fuels was studied using tester strains TA 98 and TA 100 of Salmonella typhimurium which can detect the presence of frame-shift and base-pair mutagens25. The results indicated that the organic residues of smoke particulates of wood and cattle dung fuels contained direct acting frame shift mutagens and cattle dung contained only direct acting base-pair mutagens while indirect acting frame-shift and base-pair mutagens were found to present in smoke particulates of both the energy fuels

#### Specific Diseases Associated with Indoor Air Pollutant Exposure

Respiratory illness, cancer, tuberculosis, perinatal outcomes including low birth weight, and eye diseases are the morbidities associated with indoor air pollution

#### Respiratory Illness

The effect of air pollutants in general would depend on the composition of the air that is inhaled which will depend on the type of fuel used and the conditions of combustion, ventilation and duration for which the inhalation occur. The most commonly reported and obvious health effect of indoor air pollutants is the increase in the incidence of respiratory morbidity. Studies by the NIOH28 on the prevalence of respiratory symptoms in women using traditional fuels (biomass) (n=175) and LPG (n=99), matched for economic status and age, indicated that the relative risk (with 95% C.I.) for cough, and shortness of breath (dyspnoea) was 3.2 (1.6-6.7), and 4.6 (1.2-18.2) respectively.

#### Childhood acute respiratory infections

Acute lower respiratory infections

Acute respiratory infections (ARIs) are the single most important cause of mortality in children aged less than 5 years, accounting for around 3-5 million deaths annually in this age group 30. Many studies in developing countries have reported on the association between exposure to indoor air pollution and acute lower respiratory infections. The studies on indoor air pollution from household biomass fuel are reasonably consistent and, as a group, show a significant increase in risk for exposed young children compared with those living in households using cleaner fuels or being otherwise less exposed. Some of the studies carried out in India have reported no association between use of biomass fuels and ARI in children. In a case-control study in children under five years of age in south Kerala, where children with severe pneumonia as ascertained by WHO criteria were compared with those having nonsevere ARI attending out patient department, the fuel used for cooking was not a significant risk factor for severe ARI. Non-severe ARI controls may represent the continuum (predecessor) of the cases themselves. Sharma et al35 in a cross-sectional study in 642 infants dwelling in urban slums of Delhi and using wood and kerosene respectively, did not find a significant difference in the prevalence of acute lower respiratory tract infections and the fuel type.

## Upper respiratory tract infections and otitis media

Studies on the relationship between indoor air pollution and acute upper respiratory infections in children both from developed and developing nations have not been able to demonstrate the relationship between the two. However, there is strong evidence that exposure to environmental tobacco smoke causes middle ear disease. A recent meta-analysis reported an odds ratio of 1.48 (1.08-2.04) for recurrent otitis media if either parent smoked, and one of 1.38 (1.23-1.55) for middle ear effusion in the same circumstances. A clinic based case-control study of children in rural New York state reported an adjusted odds ratio for otitis media, involving two or more separate episodes, of 1.73 (1.03-2.89) for exposure to wood burning stoves

#### Chronic pulmonary diseases

Chronic obstructive pulmonary disease and chronic cor pulmonale

In developed countries, smoking is responsible for over 80% of cases of chronic bronchitis and for most cases of emphysema and chronic obstructive pulmonary disease. Padmavati and colleagues pointed out to the relationship between exposure to indoor air pollutants and chronic obstructive lung disease leading to chronic corpulmonale. These studies showed that in India, the incidence of chronic corpulmonale is similar in men and women despite the fact that 75% of the men and only 10% women are smokers. Further analysis of the cases of chronic cor pulmonale in men and women showed that chronic corpulmonale was more common in younger women. Chronic cor pulmonale seemed to occur 10-15 years earlier in women. The prevalence of chronic cor pulmonale was lower in the southern states than the northern states of India. This is attributed to higher ambient temperatures during most part of the year allowing for greater ventilation in the houses during cooking. The authors attributed this higher prevalence of chronic corpulmonale in women to domestic air pollution as a result of the burning of solid biomass fuels leading to chronic bronchitis and emphysema which result in chronic corpulmonale. Subsequent studies in India confirmed these findings, Numerous studies from other countries, including ones with cross-sectional and case-control designs, have reported on the association between exposure to biomass smoke and chronic bronchitis or chronic obstructive pulmonary disease.

#### Pneumoconiosis

Pneumoconiosis is a disease of industrial workers occupationally exposed to fine mineral dust particles over a long time. The disease is most frequently seen in miners. Cases of respiratory morbidity who did not respond to routine treatment and whose radiological picture resembled pneumoconiosis have been reported in Ladakh. However, there are no industries or mines in any part of Ladakh and therefore exposure to dust from these sources was ruled out. Two factors considered responsible for the development of this respiratory morbidity were (i) Exposure to dust from dust storms. In the spring dust storms occur in many parts of Ladakh. During these storms the affected villages are covered by a thick blanket of fine dust, and the inhabitants are exposed to a considerable amount of dust for several days. The frequency, duration and severity of these dust storms vary considerably from village to village; (ii) Exposure to soot – due to the severe cold in Ladakh, ventilation in the houses is kept at a minimum. The fire place is used for both cooking and heating purposes. To conserve fuel during non-cooking periods, the wood is not allowed to burn quickly but is kept smouldering to prolong its slow heating effect. The inmates are thus exposed to high concentrations of soot.

The clinico-radiological investigations of 449 randomly selected villagers from three villages having mild, moderate and severe dust storms showed prevalence of pneumoconiosis of 2.0, 20.1 and 45.3% respectively. The chest radiographs of the villagers showed radiological characteristics which were indistinguishable from those found in miners and industrial workers suffering from pneumoconiosis. The dust concentrations in the kitchens without chimneys varied from 3.22 to 11.30 mg/m3 with a mean of 7.50 mg/m3. The free silica content of these dust samples was below 1%. Dust samples sufficient to allow measurement of the dust concentrations could not be collected during the periods of dust storms. A preliminary analysis of the settled dust samples collected immediately after the storms indicated that about 80% of the dust was respirable and the free silica content ranged between 60 and 70%. Detailed statistical analysis of the data showed that the frequency of dust storms, use of chimney in the houses and age were the most important factors related to the development of pneumoconiosis. Thus, the results of medical and radiological investigations positively established the occurrence of pneumoconiosis in epidemic proportion. Exposure to free silica from dust storms and soot from domestic fuel were suggested as the causes of pneumoconiosis. Low oxygen levels or some other factor associated with high altitude may be an important contributory factor in causation of pneumoconiosis because it has been reported that the miners working at high altitude are more prone to develop pneumoconiosis than their counterparts exposed to the same levels of dust and working in the mines at normal altitude.

#### **Lung Cancer**

The link between lung cancer in Chinese women and cooking on an open coal stove has been well established. Smoking is a major risk factor for lung cancer; however, about two-thirds of the lung cancers were reported in nonsmoking women in China, India and Mexico. The presence of previous lung disease, for example tuberculosis which is common in Indian women, is a risk factor for development of lung cancer in non-smokers. The smoke from biomass fuels contain a large number of compounds such as poly aromatic hydrocarbons, formaldehyde, etc. known for their mutagenic and carcinogenic activities, but there is a general lack of epidemiological evidence connecting lung cancer with biomass fuel exposure. The factors associated with rural environment may have a modulating effect on the occurrence of lung cancer and therefore the low incidence of lung cancer in Indian women should not lead to a final conclusion of no link between biomass exposure and lung cancer. It may be concluded that at present there is limited evidence of indoor exposure from coal fires leading to lung cancer and there is no evidence for the biomass fuels. Further investigations are needed to reach definite conclusions.

#### **Pulmonary Tuberculosis**

Mishra et al recently reported the association between use of biomass fuels and pulmonary tuberculosis on the basis of analysis of data collected on 260,000 Indian adults interviewed during the 1992-93 National Family Health Survey. Persons living in households burning biomass fuels were reported to have odd ratio of 2.58 (1.98-3.37) compared to the persons using cleaner fuel, with an adjustment for confounding factors such as separate kitchen, indoor overcrowding, age, gender, urban or rural residence and caste. The analysis further indicated that, among persons aged 20 years and above, 51% of the prevalence of active tuberculosis was attributed to smoke from cooking fuel. However, this study has inherent weakness that the cases of tuberculosis were self reported. There is strong possibility of false reporting as no investigation was done to confirm the reliability of the reporting. Gupta and Mathur have reported similar findings from northern India. This study did not control for the confounding factors except for age.

There is experimental evidence to show that the exposure to wood smoke may increases susceptibility of the lungs to infections. Exposure to smoke interferes with the mucociliary defences of the lungs and decreases several antibacterial properties of lung macrophages, such as adherence to glass, phagocytic rate and the number of bacteria phagocytosed. Chronic exposure to tobacco smoke also decreases cellular immunity, antibody production and local bronchial immunity, and there is increased susceptibility to infection and cancer. Indeed, tobacco smoke has been associated with tuberculosis. Although the evidence in favour of tuberculosis associated with biomass fuel exposure is extremely weak, there is a theoretical possibility of such an association and considering the public health importance of the problem further experimental and epidemiological studies are necessary.

## Cataract

During cooking particularly with biomass fuels, air has to be blown into the fire from time to time especially when the fuel is moist and the fire is smouldering. This causes considerable exposure of the eyes to the emanating smoke. In a hospital-based case-control study in Delhi the use of liquefied petroleum gas was associated with an adjusted odds ratio of 0.62 (0.4-0.98) for cortical, nuclear and mixed, but not posterior sub capsular cataracts in comparison with the use of cow dung and wood. An analysis of over 170,000 people in India yielded an adjusted odds ratio for reported partial or complete blindness of 1.32 (1.16-1.50) in respect of persons mainly using biomass fuel compared with other fuels after adjusting for socio-economic, housing and geographical variables; there was a lack of information on smoking, nutritional state, and other factors that might have influenced the prevalence of cataract. It is believed that the toxins from biomass fuel smoke are absorbed systematically and accumulate in the lens resulting in its opacity. The growing evidence that environmental tobacco smoke causes cataracts is supportive.

#### Adverse Pregnancy Outcome

Low birth weight (LBW) is an important public health problem in developing nations attributed mainly to under nutrition in pregnant women. Low birth weight has serious consequences including increased possibility of death during infancy. Exposure to carbon monoxide from tobacco smoke during pregnancy has been associated with LBW. Levels of carbon monoxide in the houses using biomass fuels are high enough to result in carboxyhaemoglobin levels comparable to those in smokers. In rural Guatemala, babies born to women using wood fuel were 63 g lighter than those born to women using gas and electricity, after adjustment for socioeconomic and maternal factors. A study carried out in Ahmedabad reported an excess risk of 50% of stillbirth among women using biomass fuels during pregnancy81. An association between exposure to ambient air pollution and adverse pregnancy outcome has been widely reported. Considering the association of LBW with a number of disease conditions later in life, there is a need for further studies.

#### Intervention

Adequate evidence exists to indicate that indoor air pollution in India is responsible for a high degree of morbidity and mortality warranting immediate steps for intervention. The intervention programme should include (i) Public awareness; (ii) Change in pattern of fuel use; (iii) Modification in stove design; (iv) Improvement in the ventilation; and (v) Multisectoral approach.

#### **Public Awareness**

The first and the most important step in the prevention of illnesses resulting from biomass fuels is to educate the public, administrators and politicians to ensure their commitment and promoting awareness of the long-term health effects on the part of users. This may lead to people finding ways of minimising exposure through better kitchen management and infant protection.

#### Change in Pattern of Fuel Use

The choice of fuel is mainly a matter of availability, affordability and habit. The gobar gas plant which uses biomass mainly dung has been successfully demonstrated to produce economically viable quantities of cooking gas and manure. Recently, the Government of Andhra Pradesh has introduced a programme called the Deepam Scheme to subsidise the cylinder deposit fee for women from households with incomes below the poverty line to facilitate the switch from biomass to LPG. Such schemes will encourage the rural poor to use cleaner fuels. The use of solar energy for cooking is also recommended.

## Modification in Stove Design

Use of cleaner fuels should be the long-term goal for the intervention. Till this goal is achieved, efforts should be made to modify the stoves to make them fuel efficient and provide them with a mechanism (eg chimney) to remove pollutants from the indoor environment. Several designs of such stoves have been produced. NIOH study showed significant decrease in levels of SPM, SO2, NOx and formaldehyde with specially designed smokeless stoves in comparison with traditional cooking stoves. However, they have not been accepted widely. Large scale acceptance of improved stoves would require determined efforts. The most important barriers to new stove introduction are not technical but social.

## Improvement in Ventilation

In many parts of the country poor rural folk are provided with subsidised houses under various government/international agencies aided schemes. Ventilation in the kitchen should be given due priority in the design of the houses. In existing houses, measures such as putting a window above the cooking stove and providing cross ventilation through the door may help in diluting the pollution load.

### **Multisectoral Approach**

Effective tackling of indoor air pollution requires collaboration and commitment between agencies responsible for health, energy, environment, housing and rural development.

#### Conclusions

Indoor air pollution caused by burning traditional fuels such as dung, wood and crop residues causes' considerable damage to the health of particularly women and children. There is evidence associating the use of biomass fuel with acute respiratory tract infections in children, chronic obstructive lung diseases, and pneumoconiosis in the residents of Ladakh villages. Lung cancer has been found to be associated with the use of coal in China, however, there is no evidence associating it with the use of biomass fuels.

Cataract and adverse pregnancy outcome are the other conditions shown to be associated with the use of biomass fuels. The association of tuberculosis and chronic lung infections with the use of biomass fuels has not been proved.

Finally, there is enough evidence to accept that indoor air pollution in India is responsible for a high degree of morbidity and mortality warranting immediate steps for intervention. The first and the most important step in the prevention of illnesses resulting from the use of biomass fuels is to educate the public, administrators and politicians to ensure their commitment for the improvement of public health.

There is utmost requirement to collect better and systematic information about actual exposure levels experienced by households in different districts and climatic zones and develop a model for predicting the exposure levels based on fuel use and other household data therein (exposure atlas) to protect the health of children, women and elderly persons.

#### Natural Gist

- Countries like India are more vulnerable to disease due to the use of dirty household fuels. 28% of disease occurs due to indoor air pollution. In developing countries the principal sources of indoor air pollutants include: combustion, building material, the ground under the building and bio aerosols.
- A recent report of the World Health Organisation (WHO) asserts the rule of 1000 which states that a pollutant released indoors is one thousand times more likely to reach a person's lung than a pollutant released outdoors.
- Over half of the world's households cook their food on <u>unprocessed solid fuels</u>, <u>releasing 50 times more noxious pollutants than gas</u>. The incomplete combustion of this biomass releases a complex mixture of organic compounds, including suspended particulate matter, carbon monoxide, poly organic material (POM), poly aromatic hydrocarbons (PAH) and formaldehyde.
- Disease and sickness associated with indoor air pollution exposure includes: respiratory illnesses, cancer, tuberculosis, low birth weight, eye disease and fatalities. India requires an intervention programme that needs to include: public awareness, changes in fuel use, modified stove designs and improved building ventilation.
- The most important step in the prevention of illnesses from biomass fuel use is the education of the public, administrators and politicians, ensuring their commitment to both improved public health and living standards.

## INDOOR AIR POLLUTION IN INDIA – A MAJOR ENVIRONMENTAL AND PUBLIC HEALTH CONCERN

The original article is an ICMR (Indian Council of Medical Research) Bulletin, Vol. 31, No.5,(May 2001)

It can be found at: http://icmr.nic.in/bumay01.pdf



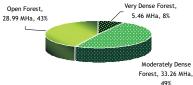
## Forest, Carbon and Climate Change - Evaluating the true value of our forests

By Swati Arunprasad Edited by Ranjit Barthakur and Samir Menon

#### Indian forests - a call for action

Forests are a country's natural assets. According to the Forest Survey of India(1), Indian forest cover spreads over an area of 67.71 million hectares (Mha) and covers 21.81% of the total geographical area of the country. As part of this survey forest cover has been categorised into three types: Open forest (10-40% canopy cover), moderately dense forest (40-70% canopy cover) and very dense forest (70% canopy cover) forests. In India it is the moderately dense forest cover that occupies the major fraction (49%) of our forest, followed by open forest (43%) with very dense forest being the most scarce.

The forest rich North Eastern states account for 25.11% of the country's total forest cover. Whilst National Parks, Wildlife Sanctuaries and Conservation Reserves, created to nurture parts of this vast forest cover, occupy 4.74% of the country's geographical area.



However these figures are a significant reduction in India's level of forest cover present 200 years ago. Since the turn of the 19th century India has suffered a serious dilapidation of forest resources.

Large-scale destruction of Indian forests has been blamed on extensive agricultural expansion, particularly since Indian independence (which was often state sponsored) together with commercially oriented forest use and ownership policies, inherited from the British government, where much timber was used by the British navy for ship building and also for the extensive expansion of railway lines and in more recent times programs of development; rapid industrialisation, urbanisation and growing consumerism have promoted further deforestation.

Our forests are in fact one of the most valuable eco-systems of the world, with forest cover providing many vital eco-system services, which include:

- Reducing flooding and low flow events
- Improving surface and ground water quality and quantity
- Sustaining soil and aquatic organisms
- Breaking down/ capture toxins
- Improving air quality
- Helping to counteract the greenhouse effect and global climate change
- Reducing erosion and help the soil recuperate
- Increasing crop and livestock productivity and soil sustainability
- Diversifying the rural economy by providing income or savings
- Sheltering wildlife
- Preserving bio-diversity in turn improves the overall health of the community ecosystem
- Increasing the beauty of the environment

We should therefore not underestimate the value of our forest cover, and should seek to protect and preserve them, but what is the true value of our forests and what is the true cost and impact of its loss?

#### Establishment of the Naturenomics™- Eco-Bank

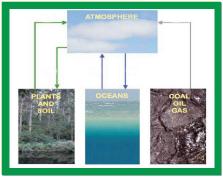
A European Union commissioned study has established that the global economy is losing more money from the disappearance of forests than through the current banking crisis. It puts the annual cost of forest loss at between \$2 trillion and \$5 trillion. Efficient management of forest covers calls for legislative action required at the global, national and regional levels. We envisage that such an action should principally include creation of a "Naturenomics™ Eco-Bank" to manage natural assets. Eco Banks cannot be successful without the corporate involvement.

Currently all the rewards of development are scaled through the measurement of economic growth. This approach has resulted in the creation of major bubbles. New measurement systems are required to estimate the true value of nature and its assets. Such a measurement system must target towards creating "Eco Balance Sheets" for the existing forests. The practice of paying interest on borrowed natural capital and receiving interest for natural assets banked will therefore be an innate component of the system. Eco Banks, in essence, would prove that existing assets are more valuable as the new assets will take a long time to give the same returns as the existing ones. Ecology needs to leverage economic models that still hold.

In this paper, we have attempted to estimate the carbon value of the Indian forests as a first move towards estimating the true value of our forests. We believe that it is significant to develop and collate the ecological worth of natural assets to set the path for a sustainable future.

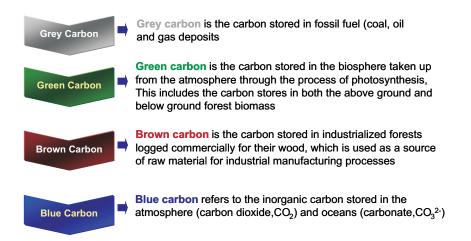
## The role of the forest sink in the global carbon cycle

Carbon, like water, changes state while moving through the four eco zones, viz., atmosphere, biosphere, lithosphere and hydrosphere. The atmosphere, the plants and the soil, the oceans and the fossil fuels (coal, oil and gas) are the four major reservoirs of carbon. Carbon stocked in the above and below ground biomass of the plants is called the green carbon while the carbon stored in the industrialised forests commercially logged for wood is termed as the brown carbon.



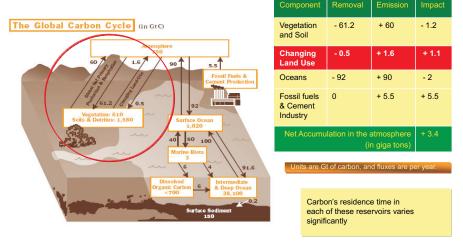
(Adapted from Houghton 2007(2))

Carbon stored in the fossil fuels is termed as the grey carbon and the carbon stored in the atmosphere and vast oceanic reserves is referred to as the blue carbon. Carbon's residence time in each of these reservoirs varies significantly.



The level of carbon in the atmosphere remains constant as far as the carbon stocks and fluxes are functioning harmoniously and are absorbing more carbon than they are emitting. However, two major human activities, viz., extraction and burning of fossil fuels and the depletion of forests, have been identified to disturb this balance and are resulting in a net increase in the atmospheric carbon levels.

The flow of carbon across the primary stocks depicted below shows a steady increase in atmospheric carbon by a net accumulation of 3.4 gigatons per year (3). While fossil fuel burning is a primary cause of this rise (adding up 5.5 gigatons to the atmosphere every year), change in land-use due to factors such as deforestation has resulted in an addition of 1.1 gigatons every year. In contrast, the oceans absorb from the atmosphere approximately 2.0 more gigatons of carbon than they release and the earth's ecosystems appear to be accumulating another 1.2 gigatons annually.



Source: Met office (4)

#### The impact of past deforestation on climate change

The majority of biomass carbon in natural forest resides in the woody biomass of large old trees. Commercial logging, therefore, changes the age, structure of forests resulting in major alterations in the carbon content. A striking reduction in the long term average standing stock of biomass carbon has been documented in logged forests as compared to an untouched and unlogged forest. A recent Australian study states that untouched forests could store about 640 tonnes per hectare, 3 times more than the Inter-governmental Panel of Climate Change (IPCC) estimate of 217 tonnes per hectare. About 35 % of greenhouse gases in the atmosphere is a result of "past deforestation" and 18 % of annual global emissions is from "continued deforestation". Emission of carbon from tropical deforestation has been reported to be 1100 Mt/yr. India has been losing its forest cover at the rate of 1.897 Mha/yr. This has lead to a rate of stored carbon loss of 314 Mt/yr according to our calculations that has been detailed in section 5. If the trend continues, deforestation will account for 50% as much carbon as emitted from world-wide emission of fossil fuels since industrial revolution.

The Stern Review has calculated the opportunity cost of forest protection in 8 countries responsible for 70 % of emissions from land use to be around \$5 billion per annum initially, although over time marginal costs would rise (5). The report however points out that curbing deforestation is a highly cost-effective way of reducing greenhouse gas emissions.

#### 'Preservation' Vs "Afforestation and Reforestation'

Creating forest sinks through 'afforestation and reforestation' activities is a reactive measure to control enhanced greenhouse effect. However, 'preservation' of the existing forest sinks can prove to be both a proactive and a prudent measure to achieve the same. There is broad agreement that tropical nations need some form of economic incentive to reduce deforestation, and that developed countries should compensate countries that control deforestation (6).

Carbon sequestration is the process by which carbon dioxide sinks such as forests remove CO2 from the atmosphere as the biomass content of a tree augments over the period its growth. According to Kyoto, Afforestation and Reforestation are eligible to produce CERs in the first commitment period (2008–2012). 500 hectares of afforested land would approximately generate 7500 numbers of Certified Emission Reductions (CERs) per year. This equals to an offset potential of 15 tons of carbon per hectare per year and hence generates 225,000 CERs for 30 years (7).

Forestry projects are evaluated using the Climate Change and Biodiversity Standards (CCBS) developed by Climate Change and Biodiversity Alliance (8). The CCBS is a stringent standard customised for forestry projects, and focuses on the contribution to local economies and integration with local communities. This standard is explored internally and the whole exercise must be verified by a UNFCCC approved third party (like TUV) to qualify for Certified Emission Reductions (CERs) or Voluntary Emission Reductions (VERs). While CERs can be earned through the Clean Development Mechanism (CDM) route, VERs can be registered and sold at voluntary markets such as the Chicago Climate Exchange (CCX). Once verified, there are brokers who can be approached who can support this trading. So far, there only two projects have been able to satisfy the CCBS requirements. China: Almost 500 hectares (1,200 acres) of degraded land will be reforested under this project, with native trees species, which over 30 years will remove nearly 160,000 tons of CO2 from the atmosphere. In addition, the project will create sustainable livelihoods for local communities and contribute to poverty alleviation in the region.

Panama: This Futuro Forestal/CO2OL-USA reforestation project in Panama is working to reforest degraded and abandoned lands on the Pacific Coast of Panama in the Chiriqui and Veraguas provinces. This FSC-certified project currently encompasses approximately 700 hectares (1,700 acres) of reforested lands, with more than 4,000 hectares (10,600 acres) planned to be managed by 2019, when about 700,000 tons of CO2 will have been sequestered.

The range of technologies used in the compliance regime are eligible in the voluntary market, as well as others not currently accepted, such as certain forestry, land use and transport methodologies. VER projects also have no geographical limitation, and can be generated form projects globally, although there this is dictated by buyer preference for local (e.g. Buyers from Canada and the United States may prefer locally-based projects) or international (focused on developing countries) emissions reductions. Forestry project have high community and environmental sustainability. They can therefore command twice as much price as the ERs from large-scale industrial projects

#### Climate Change and Biodiversity Standards (CCBS)

Forestry projects are evaluated using the Climate Change and Biodiversity Standards (CCBS) developed by non-profit organisations. The CCBS is a stringent standard customised for forestry projects, and focuses on the contribution to local economies and integration with local communities. It is essential to note that preservation of existing forests have not been positioned to earn carbon credits by the Kyoto. Through this paper, we would like to draw attention to the scale of existing carbon storage and the potential for carbon sequestration of the existing forests and hence demonstrate that it is worthwhile to channel funds to preserve them on the first place and then focus on any additional forestation activities.

Stern's report also emphasises the fact that Carbon markets could play an important role in providing such incentives in the longer term. But there are short-term risks of destabilising the crucial process of strengthening existing strong carbon markets if deforestation is integrated without agreements that strongly increase demand for emissions reductions. These agreements must be based on an understanding of the scale of transfers likely to be involved.

#### The methodology to estimate the carbon value of Indian forests

The calculations and assumptions involved to calculate the stocked and sequestered carbon in the Indian forests have been listed below. It should be noted that all calculations are on a rule of thumb basis.

The total carbon stored in the forests in tonnes was calculated using the following formulae

```
Total carbon stored (tons) = Forest Area (hectare) x
Growing stock value (in cu.m / ha) x
Conversion and expansion factor x
Carbon content factor of biomass (1)
```

Growing stock values are the living tree components of standing volume of biomass in the trees (FSI 2005). Values of growing stock value for India differ from state to state but the average value is 74.42 cu.m/ha. The values for tiger reserves have been taken to be 99.71 cu.m/ha, 9.84 cu.m/ha and 51.56 cu.m/ha for Corbett, Ranthambore and Bandhavgarh, respectively. Conversion and expansion factor for forests has been assumed to be 0.95 (Source: IPCC). Conversion factor is used for converting volume in cu.m to dry matter of biomass in tonnes and the expansion factor is used to account for small branches of vegetation that remain undetected during volume estimation. Carbon content factor of biomass has been assumed to be 0.45 (Source: IPCC).

The total carbon sequestered in the forests in tonnes was calculated using the following formulae

```
Total carbon sequestered (tons) = Forest Area (hectare) x
Mean Annual Increment (in cu.m/ha) x
Conversion and expansion factor x
Carbon content factor of biomass (2)
```

Mean Annual Increment (MAI) is the amount of living tree component added every year. These values have ben sources from the FSI site. Values of MAI for India differ from state to state but the average value is 1.33 cu.m/hectare. MAI values for tiger reserves have been taken to be 1.71 cu.m/ha, 0.22 cu.m/ha and 1.04 cu.m/ ha, for Corbett, Ranthambore and Bandhavgarh, respectively.

## The carbon value of Indian forests

The carbon storing and the carbon sequestering capacity of the forest types are influenced by the environmental conditions of the site and the inherent properties of the dominant tree varieties.

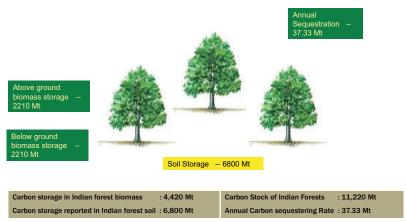
A conservative estimate calculated from the growing stock values and mean annual increment value of the biomass by formula (1) and (2) above, gives the carbon stored in the forest covers in the different Indian states as follows:

S.No.	State	Total Forest Area (Mha)	Carbon storage (Mt)	Percentage of total
1.	Arunachal Pradesh	6.78	326.83	15
2.	Jammu & Kashmir	2.13	204.16	9
3.	Chattisgarh	5.59	177.73	8
4.	Madhya Pradesh	7.60	167.55	8
5.	Assam	2.76	146.78	7
6.	Karnataka	3.53	126.93	6
7.	Himachal Pradesh	1.44	125.00	6
8.	Andhra Pradesh	4.44	116.96	5
9.	Orissa	4.84	107.97	5
10.	Maharashtra	4.75	104.38	5
11.	Uttarakhand	2.44	77.76	4
12.	Jarkhand	2.26	71.87	3
13.	Kerala	1.56	63.78	3
14.	Manipur	1.71	39.52	2
15.	Meghalaya	1.70	47.93	2
16.	Nagaland	1.37	38.77	2
17.	Andaman & Nicobar Island	0.66	33.90	2
18.	Others	11.01	193.85	6

Arunachal Pradesh stores almost 15% of the total forest carbon reserve and is followed by Jammu and Kashmir (9%), Chattisgarh (8%), Madhya Pradesh (7%) and Assam (7%).

The Indian carbon stock of the existing forests amounts to 11,220 million tons at the rate of 165.7 T/ha of which 4,420 million tons are stored in the above-ground and below-ground biomass and 6800 million tons are stored in the forest soil. The annual carbon sequestration rate amounts to 37.33 million tons per year at the rate of 0.55 T/ha.

#### Carbon flux in Indian forests



To create a store of carbon at the current sequestering rate will require over 300 years

Assuming the price of carbon to be 30 USD per ton, the value of stored carbon in the country's forest covers is estimated to be 336 billion USD and the value of sequestered carbon is 1.1 billion USD. The time required to recreate a lost hectare of forest cover in terms of its carbon value is therefore over 300 years.

#### The carbon value of major tiger reserves in India

The total carbon stored and sequestered at Corbett, Ranthambore and Bandhavgarh, revealed that together these three tiger reserves store 13.38 million tons of carbon and sequester 242 kilotons per year.

## Corbett tiger reserve

Corbett is located in south central part of Uttaranchal. It harbours a wide array of forests, viz., Northern moist Deciduous Forest, Moist Shiwalik Sal Forest, Moist Bhabar Dun Sal Forest, Western Gangotri Moist Mixed Deciduous Forest, Alluvial Savannah Woodland, Northern tropical Dry Deciduous Forest, Dry Shiwalik Sal Forest, Northern Dry Mixed Deciduous Forest, Khair Sissoo Forest, Himalayan subtropical Pine Forest and Lower Shiwalik Chir Pine Forest and 110 types of tree species.

The total area under forest cover is 1197 sq. km and this is 91% of the geographical area of the reserve. The forest cover in the outer area surrounding the reserve spreads to 1047 sq.km. The total carbon storage of forest cover in and around the reserve is 19,130 kilotons. The carbon sequestering rate of the reserves' forest cover is 164 kilotons per year. The stored carbon in the reserve is worth 573 Million USD and the sequestered carbon is worth 4.9 Million USD. From the period from 1997 to 2002, the loss of forest cover has been reported to be 2 km2. The cause of the loss was attributed to rotational felling in plantation areas and the carbon emission due to loss of forest cover is estimated to be 17,050 tons.

#### Ranthambore tiger reserve

Ranthambore is located in Sawai Madhopur and Karauli districts of Rajasthan and the main forest type in the area is Northern Tropical Dry Deciduous Forests. The total areas under forest cover has been reported to be 740 sq.km (53% of the geographical area of the reserve).

The forest cover in the outer area surrounding the reserve is 363 sq. km. The total Carbon storage capacity of forest cover in and around the reserve is estimated to be 928 kilotons and the carbon sequestering rate is 10 kilotons per year. The value of stored carbon in this reserve is 27 Million USD and the value of sequestered carbon is 0.3 Million USD

#### Bandhavgarh tiger reserve

Bandhavgarh is located in Central India between Vindhya and Eastern Flanks of Satpura ranges in Madhya Pradesh. The main forest types of Bandhavgarh are Moist Peninsular Low level Sal Forests and Wet Gangetic Moist Mixed Deciduous Forests.

The forest cover spreads to an area of 861 sq.km (74% of the geographical area of the reserve) and the forest cover in the outer area surrounding the reserve is 661 sq.km . The total Carbon storage capacity of forest cover in and around the reserve is 6,710 kt and the carbon sequestering rate is 68 kt per year. The value of stored carbon is 201 Million USD and the value of sequestered carbon is 2 Million USD.

The following table gives the projected value of carbon for the 95 National Parks, 500 Wildlife Sanctuaries and 2 Conservation Reserves in India. The 507 sites together contribute to 23% of the total carbon value of forests in India.

S.No.	Particulars	Nos.		Carbon stored	Value (in million USD)	sequestered	Value (in million USD)
1.	National Parks	95	3.8 Mha	630	18,900	2.09	62.7
2.	Wildlife Sanctuaries	500	11.79 Mha	1953	58,590	6.49	194.7
3.	Conservation Reserves	2	4.3 Mha	0.7	21	0.002	0.06
4.	Total for 957 sites	597	15.59 Mha	2,584	77,511	8.58	257
5.	Total for Indian Forest Cover	-	67.71Mha	11,220	336,600	37.33	1,120

Existing forest covers have more valuable carbon content than the ones to be newly created. This fact needs to be rightly exploited by creating Eco Banks. Rewards and incentives need to be channelled to the communities occupying the forest-proper and the vicinity, for refraining from activities that endanger the continued existence of forests. On the other side, any occupant who flouts, should be made to bear the consequence of the ecological damage in accordance with the "Polluter Pays" principle. Sparking such an effort will give immense impetus to the conservation drive on our natural assets through a systematic involvement of the community.

#### Compensatory mechanisms to preserve forest sinks

Compensatory mechanisms help neutralise carbon emissions from business activities through two types of compensatory mechanisms.

- Biodiversity Management
   Creating bio diverse forests through plantation activities is a reactive measure to control enhanced greenhouse effect
- Preservation of existing tree plantations
   'Preservation' of the existing forest sinks can prove to be both a proactive and a prudent measure to achieve the same. There is broad agreement that tropical nations need some form of economic incentive to reduce deforestation, and that developed countries should compensate countries that control deforestation.

#### **Biodiversity conservation**

Biodiversity conservation within or in the vicinity of the urban environment has many constraints. Most of the time sites available are highly degraded and are vulnerable to urban encroachment due to high land values. A conventional park cannot be protected from urban encroachment, but 'Biodiversity Parks' have the same legal backing as wildlife protected area and can therefore avoid development.

As a rule, hardcore conservationists believe true conservation is possible only when the site is totally secure from human intervention and left to nature to restore itself through natural succession. Unfortunately normally sites available are highly degraded and so leaving them to nature is impractical; it would take an age before tangible results can be seen plus chances of domination by weeds cannot be ruled out defeating the aim of improving biodiversity. In addition the project should have scope for community participation as a site located within the urban area and isolated from human interaction is always counter productive. In our experience communities accepts ideas that provide immediate benefits and hence the project must have some components that are community friendly. The concept of Biodiversity Parks has evolved from these concerns.

#### What is Biodiversity?

"Biological diversity" encompasses all species of plants, animals and microorganisms and the ecosystems and ecological processes of which they are part. It is an umbrella term for the extent of nature's variety, including both the number and frequency of ecosystems, species, or genes in a given assemblage.

OR

Biological diversity means the variability among living organisms from all sources and the ecological complexes of which they are part and includes diversity within species or between species and of ecosystems.

Diverse biotic components meaningfully interact to ensure a healthy balance of nature enabling it to render complete ecological services:

- Carbon sequestration
- Regulate water regime
- Regulate oxygen, nitrogen and carbon cycle
- Climate amelioration
- Control pollution
- Home for endangered and threatened species
- Guarantee for bioresources and food security
- Enhance aesthetic values and serve as recreational
- Educational tool

#### **Biodiversity Parks**

A Biodiversity Park has to consider space for every possible organism that is found in the type of ecosystem the habitat represents. This cannot be achieved in one go and hence things need to be developed in a systematic manner starting from soil micro-organisms to the higher canopy level. The plants are the basic building blocks that sustain animal diversity. But healthy plant growth is dependent on diversity of soil microorganisms that create requisite chemical compositions for plant to absorb. The plants are also dependent on healthy interaction with diverse animal forms to support in pollination, seed dispersal and on occasions even germination. These organisms in turn have their own needs for healthy growth and hence need to be considered while planning. As biodiversity is a very dynamic phenomenon, constant monitoring and adjustments are essential.

The planning of Biodiversity Park requires in-depth understanding of the site profile, biodiversity history of the area, local community and its aspirations etc.

Based on this information a long-term plan has to be worked out in a phased manner. The basic idea is to create ideal conditions for all biodiversity components to rejuvenate and then flourish. The project should have special consideration for community participation with recreational and educational inputs. The project should aim to create a healthy ecosystem having capacity to render full ecological services. To ensure a healthy, complete ecosystem the plant composition needs to be worked out on the basis of distinct plant communities to enable the park to continue development (evolving) through natural succession for generations to come.

Critically the success of such a project is always dependent upon whole hearted support of the scientific community and local administration together with strong voluntary support from the local community

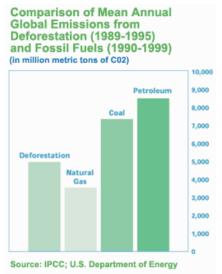
### **Reducing Emissions from Deforestation**

Human-induced climate change has been found responsible for adverse impacts on ecosystems, productivity and the global economy. Increasing green house gas (GHG) emissions has been proved to have drastic socio economic impacts on the human civilisation. There are broadly two components to reduce GHGs:

- Decreasing the release of green house gases (GHG) and
- Sequestering the GHGs, of which CO2 is the major component, from atmosphere.

While the former has been receiving enough emphasis after Kyoto, the latter also needs to be addressed since it is highly challenging to halt any further emission of GHGs in the developing world.

Total carbon content of forest ecosystem is estimated to be about 638 Gt (in 2005, FAO), which is more than the amount of carbon in the atmosphere. Tropical forests store, on average, about 50% more Cper unit area, than forests outside the tropics. Global deforestation was estimated at 13 million ha/yr for 1990-2005. IPCC Working Group 1 estimated emissions from deforestation since 1990s to be 5.8 GtCO2/yr. Deforestation and forest degradation have resulted in substantial reduction in forest carbon stocks and hence increase in emissions. The first commitment period of the Kyoto Protocol excluded forest conservation/avoided deforestation from the CDM for a variety of political, practical and ethical reasons. However, carbon emissions from deforestation represent 18-25% of all emissions.



A European Union commissioned study has established that the global economy is losing more money from the disappearance of forests than through the current banking crisis. It puts the annual cost of forest loss at between \$2 trillion and \$5 trillion. There has been a growing pressure on Kyoto to include forest conservation in CDM schemes for the second commitment period from a variety of sectors, under the leadership of the Coalition for Rainforest Nations, brought together under the Forests Now Declaration signed by over 300 NGOs, business leaders, and policy makers.

# Saving the forests

Both mitigation and adaptation measures need to be actioned to save the forests. Such measures can be short term or long term. Preserving forests and reclaiming the lost forest cover can be both a mitigative and adaptive. In both cases, active participation from the industries, government, non governmental organisation and communities would be crucial for success.

# Short term mitigation measures

Compensatory mechanisms helps neutralise carbon emissions from business activities through two types of compensatory mechanisms. Afforestation and reforestation to create tree plantations - Creating forest sinks through 'afforestation and reforestation' activities is a reactive measure to control enhanced greenhouse effect. Preservation of existing tree plantations - 'Preservation' of the existing forest sinks can prove to be both a proactive and a prudent measure to achieve the same. There is broad agreement that tropical nations need some form of economic incentive to reduce deforestation, and that developed countries should compensate countries that control deforestation.

Reduced Emissions from Deforestation in Developing Countries (REDD) is a mitigation initiative that dwells into the aspect of cutting greenhouse gas (GHG) emissions associated with forest clearing by the inclusion of "avoided deforestation" in carbon market mechanisms. In simple terms this would mean payment in return for the active preservation of existing forests. According to IPCC, mitigation costs of reduced deforestation depend on the cause of deforestation (e.g. timber, agriculture or infrastructure), returns from alternative forest/ nonforest uses and any compensation paid to landowners to change land use practices. Costs vary by country and region, but on average costs are low. This makes REDD a high priority mitigation option for tropical countries.

# Long term mitigation measures - the paradigm shift required for the effective valuation of ecological assets.

Government need to develop a long term holistic action plan involving industries, NGOs and communities to address the issue of forest cover loss. Specific action in this regard has been highlighted below. Currently ecological assets have a higher value "dead" rather than alive e.g. the cut lumber is considered to be more valuable than as part of a standing pristine forest and the rare frog in the Amazon is less valued than the plate of frog legs in a fancy French restaurant. This imbalance needs to be rectified if we are able to preserve our natural assets effectively.

E@dodiogleat Assets higher higher Deadlier aller at Deadlian afther than "Alive"



Forest, Carbon and Climate Change - Evaluating the true value of our forests

India needs to take the lead in developing a rating system, platform and mechanism to value natural capital starting with Forest Carbon. Enhancing existing verification and validation techniques and providing key input to the development of an effective rating system based on the ecological sustainability of the nation, this needs to include both the economic and ecological assets of the country. In conclusion we are recommending, rather than ecological compliance, a good and effective management of our natural assets, which should begin with our forests.

### **Credits**

The thoughtful comments and valuable support extended by Mr. Bittu Sahgal, Editor, Sanctuary Magazine for this article are thankfully acknowledged.

# Natural Gist

- Indian forests cover an area of 67.71 million hectares (Mha) and 21.81% of the total country. The forest rich North Eastern states account for 25.11% of the country's total forest cover.
- Indian forests offer a wide array of vital <u>ecological services</u> including: flood control, capture of toxins, oxygen production, counteracting climate change, aiding soil repair, habitat provision, preserving bio-diversity.
- ¥ The efficient management of forests should include the creation of a
  "Naturenomics™ Eco-Bank".
- Through 'Eco balance sheets', we can quantify the value of our existing forests, pay interest on our borrowed natural capital and receive interest for natural assets.
- A conservative estimate, is that the <u>Indian carbon stock from existing forests</u> amounts to 11,220 megatons (165.7 T/ha) and the annual carbon sequestration rate amounts to 37.33 megatons per year (0.55 T/ha).
- The value of conservation: An account of the total carbon stored and sequestered at Corbett, Ranthambore and Bandhavgarh, revealed that together these three tiger reserves store 13.38 megatons of carbon and sequester 242 kilotons of carbon per year.



### **Green Jobs: Towards Sustainable Work in a Low-Carbon World**

By Michael Renner, Sean Sweeney and Jill Kubit. (21 Dec. 2007), Abridged.

### Green jobs: Now & in the future

This report presents a series of quantifications, estimates, and projections of green jobs around the world. There are, of course, many remaining data gaps. Governments must establish statistical reporting categories that recognise and help capture relevant employment in both newly emerging industries and green employment in established sectors. As the German government has done, governments should also commission in depth modelling and econometric efforts to analyse not just direct green jobs but also those that are related in a more indirect manner. Business associations and trade unions can play a useful part as well. They have begun to do job surveys and profiles, but far more of these kinds of efforts are needed.

Below, we summarise key findings in the field of renewable energy, buildings, transportation, and agriculture. Renewables and energy efficiency are key ingredients in efforts to create a low carbon economy and help stabilise the global climate system. However, the climate crisis has already crossed the threshold where mitigation alone would suffice. Adaptation to climate change has become an equally pressing need. Adaptive efforts could in coming years and decades become a major source of employment. Projects to protect against rising sea levels and storm surges, flood shelter construction, reforestation initiatives, measures to enhance the resilience of infrastructure and industries, and research into more hardy, drought resistant and saline tolerant crops are among the many important tasks. With adequate funding, they can become a source of millions of jobs, most of them in the developing world.

# **Energy Supply Alternatives**

Employment in renewable energy is growing at a very fast pace, and the growth seems likely to accelerate in the years ahead. Moreover, compared to fossil fuel power plants, renewable energy generates more jobs both per unit of capacity and per dollar invested. Globally around 300,000 workers are employed in wind power and more than 100,000 in solar photovoltaics. In China, the U.S. and Europe more than 600,000 are employed in solar thermal — by far most of theses are in China. Almost 1.2 million workers are estimated to be employed in biomass in just four leading countries, namely Brazil, the U.S., Germany and China. Overall, in countries where data is available, the number of people employed in renewables is presently around 2.3 million. (See Table ES-1) Given the gaps in employment information, this is no doubt a conservative figure.

Half of these jobs are in bio fuels — mostly in agriculture (involving the growing and collecting of feedstock), but also in (better paying) processing industries. There is vigorous and contentious debate over their economic and environmental cost and merits, their energy content and energy net balance and the question whether bio fuels used to power inefficient cars directly compete with food production. (The Economist comments in its December 6, 2007 edition: "Fill up an SUV's fuel tank with ethanol and you have used enough maize to feed a person for a year.") The answers vary strongly, depending on the feedstock's and production methods used, although corn-based ethanol is increasingly recognised to be a particularly poor choice.

Green Jobs: Towards Sustainable Work in a Low-Carbon World

Table ES-1: Employment estimates in the renewable energy sector, global and selected countries, 2006.

Renewable energy source	World/ Selected countries	Employment
Wind	World	300,000
Solar PV	World	115,000
Solar Thermal	China. Europe, USA	624,000+
Biomass/Bio fuels	Brazil. USA, China, Germany	1,174,000
Hydropower	Europe, USA	39,000
Geothermal	USA, Germany	25,000
Renewables combined	-	2,277,000

### Countries for which information is available

The spurt in employment in renewables is driven by a more than six fold increase in investment from 1998-2007, growing from \$10 billion to \$66 billion. By 2003, renewables accounted for about one-sixth of world investment in power generation facilities and equipment. Some estimate that investment could quadruple to \$210 billion in 2016.

To date, a small group of countries accounts for the bulk of renewables investments, technology development, production, and installations. Germany, Japan, China, Brazil, and the United

States play particularly prominent roles in renewable technology development, and they have so far garnered the bulk of renewables jobs worldwide. China's employment numbers are particularly high because the country continues to rely on large numbers of cheap labour, in contrast with the higher labour productivities found in Western industrialised countries.

In Germany, a leader in wind and solar technology, direct and indirect employment in renewables was estimated at 260,000 in 2006 and could reach 400,000 to 500,000 by 2020 and 710,000 by 2030. In the United States, there are about 446,000 direct and indirect jobs in renewables. (Some 390,000 if jobs involved in ethanol production of questionable environmental and social merit are subtracted.) Rough estimates for China indicate that there may be close to 1 million renewables jobs, close to two thirds of which are in the solar thermal industry. Brazil's sugar cane-based ethanol industry is said to employ about half a million people, and it is hoped that its biodiesel program, launched in 2006, may eventually generate an additional 400,000 jobs.

There is broad job potential for many other countries (especially developing countries) as well— if not in manufacturing wind turbines or solar panels, then in installing and maintaining them or in gathering and processing feedstock for bio fuels. There is a need for mechanisms to ensure timely diffusion of renewables technologies and related job skills around the world. But national policies are important as well. Germany's experience in particular can serve as a model for many other countries: the government enacted legislation to ensure that electricity generated from renewables has equal access to the national grid at guaranteed minimal rates.

Given strong and rapidly rising interest in energy alternatives, future years may well see worldwide employment soar—possibly as high as 2.1 million in wind energy and 6.3 million in solar PVs by 2030, and on the order of 12 million jobs in bio fuels-related agriculture and industry. Projections for individual countries all indicate strong potential for large job creation incoming years and decades. Installations and maintenance of solar PV and solar thermal systems in particular offer tremendous job growth.

In addition to renewables, much attention has been directed towards the mitigation potential of carbon capture and storage (CCS). Even though coal-fired power plants are not a sustainable energy option, a pragmatic strategy has to find ways to limit the carbon emissions associated with the coal plants that already exist, not to mention the larger number in the pipeline.

However, the employment implications of CCS have received scant consideration. CCS is not yet capable of large scale deployment and "CCS jobs" are themselves not clearly distinct from those in conventional coal fired base load power stations. Many of the subsurface operations are likely to be conducted by workers who are already in the oil and gas industry, although some are technically more complex and will involve workers with a very different skill set to those found at conventional power stations. CCS can also be expected to generate employment through the construction of carbon dioxide pipeline networks. But overall, CCS will be capital intensive, analogous to the oil and gas industry. Therefore the jobs created per million dollars of investment can be expected to be low. Some projections suggest that ultimately, the CCS industry could be on the same scale as the petroleum industry.

# **Energy Efficient Buildings**

The 2007 IPCC report identifies buildings as having the single largest potential of any sector for the reduction of greenhouse gases, the capacity to reduce projected emissions 29% by 2020. Efficiency measures in the building sector includes green buildings and retrofitting as well as improving the efficiency of individual building components including: water heaters, cooking equipment, domestic appliances, office equipment, electronic appliances, heating, ventilation and air conditioning systems and lighting. Macroeconomic studies, most of which have occurred in the US and Europe, show that energy efficiency measures lead to an overall net increase in jobs. The positive result of both environmental improvements and employment increases from energy efficiency measures is known as the 'double dividend'.

The IPCC states "most studies agree that energy-efficiency will have positive effects on employment, directly by creating new business opportunities and indirectly through the economic multiplier effects of spending the money saved on energy costs in other ways." Several general energy efficiency studies were conducted in North America and Europe during the 1990s and concluded that for every petajoule of energy saved between 40 and 100 jobs were created.

Types of jobs that are likely to be directly created in green building and the retrofitting process are green designers and architects, auditors, engineers, estimators, project managers and various jobs in the constructions trades including: pipe fitters, sheet metal workers, HVAC (heating, ventilation and cooling) technicians, engineers, electricians, and general construction workers. Most of these jobs are created during the initial construction or investment period and are likely to be local jobs, which is especially beneficial for developing regions as well as areas of high unemployment. Jobs are not only created in the building design, operations and construction, but also in administration and consulting for these green building and energy efficiency projects.

Jobs in the green building sector are likely to stimulate jobs in the manufacturing of green building components and systems including efficient waste, lighting, HVAC, water filtration, insulation systems and energy efficient appliances

Photovoltaic panels, solar water heaters, small wind turbines or geothermal heat pumps are often used to provide alternative energy sources for green buildings and will add to green manufacturing jobs. Energy efficient appliances and building components use more skilled labour than manufacturing inefficient ones, which not only leads to larger number of jobs but also higher paying, higher skilled employment.

Induced jobs are created as money that would have previously been spent on energy services is freed up and re-spent back into the community. Money is shifted away from energy intensive sectors, which are generally low in labour intensity. Sectors such as manufacturing, construction, education, services, finance and agriculture, which are more labour intensive than traditional energy services, stand to benefit from the re-spending effects associated with energy efficiency. Workers in coal, oil, gas extraction, and fuel refining industries are likely to see a reduction of jobs in these sectors. This shift from energy intensive and producing fields to other sectors requires a just transition for workers.

Some data on current levels of green employment specific to the building sector already exists, but they tend to be small snapshots of a particular project or country, rather than a more comprehensive picture of the sector. A recent analysis of the German building retrofitting project showed that 140,000 jobs were either saved or created in the building sector to retrofit approximately 200,000 homes. The US Green Building Council reports there are currently over 40,000 LEED Accredited Professionals trained in green building design and construction or operations and maintenance. ESCOs (Energy Service Companies) have provided funding for \$20 billion worth of energy efficiency projects worldwide since the 1970s and report that approximately \$7 billion has gone for labour employment.

Energy efficiency programs in the building sector are possible but will require enormous amounts of investment and major efforts to ensure available natural, technical and human resources. Fortunately, most of the changes required to shift from to greening the building sector can primarily be done with existing technology with little or no net cost. They also have an enormous potential to create millions of jobs in the building, manufacturing and other sectors. The results of investing in energy efficient buildings are positive economic and employment growth as well as the reduction of emissions, waste, energy and water use. Greening the building sector is critical for sustainable development and climate change mitigation and adaptation.

# Transportation

Leadership in pursuing fuel economy and cleaner cars is essential to the future viability and employment in the automobile industry. Companies that lag in this regard run the risk that their vehicles will increasingly fall short of fuel economy mandates and, as fuel prices rise, lose favour with consumers.

The global employment implications of greener cars—fuel efficiency determines how much carbon a vehicle emits but does not necessarily have a direct influence on other air pollutants—are difficult to estimate. This is due to limited availability of relevant data and incompatible standards and reporting categories among different nations, but also because fuel efficiency is far from a static concept, and there are no unambiguous thresholds that separate gas sippers from gas guzzlers.

An assessment of the most efficient cars available globally today suggests that relatively green auto industry jobs may number about a quarter million. Using somewhat more lenient definitions, the number rises to about 800,000. This estimate is based on data from Europe, Japan, South Korea, and the United States, which together account for more than 4 million car manufacturing jobs, or half the global total.

To create large numbers of greener jobs in the auto industry, a concerted international fuel efficiency strategy is needed—with mandatory targets, accelerated technology diffusion mechanisms so that the most–efficient and cleanest engine designs are introduced in timely fashion, incentives for consumers to purchase the most efficient models, and large-scale investment to generate additional breakthroughs in cleaner engine technologies and fuels.

Hybrid vehicles can be an important part of the solution, provided the added electric motor is used to reduce gasoline consumption instead of adding to a vehicle's power and acceleration. The pursuit of plug-in electric and hydrogen/fuel cell-powered vehicles promises greener jobs in future years (however, the environmental acceptability of plug-ins depends critically on changing the mix of fuels used to generate electricity, relying less on coal).

There are broader employment benefits: Studies show that fuel efficiency adds to employment both in the automotive industry itself and more broadly throughout the economy when consumers, purchasing less fuel, are able to purchase other goods and services from more labour intensive industries.

The onslaught of ever-growing motorised transportation threatens to overwhelm the gains derived from per-vehicle efficiency measures. A more sustainable system will have to be based on shorter distances and thus reduced transportation needs and less driving. Reduced distances and greater density of human settlements enables a re-balancing of transportation modes—giving greater weight to public transit systems, as well as walking and biking. A thoroughgoing modal shift away from private vehicles towards rail and other public transport can generate considerable net employment gains, reducing emissions, and improving air quality.

Railways are more labour intensive than the car industry. But the trend over the last few decades has been away from railways in many countries, and employment—both in running rail lines and in manufacturing locomotives and rolling stock—has fallen accordingly. A sustainable transport policy needs to reverse this trend. High-speed rail can compete well with both automobiles and trucks and, over certain distances, with aviation. But it is important to build or rebuild rail networks that integrate high-speed lines connecting major cities with regional and local lines.

Buses, trams, and railways use far less energy per passenger- or freight-kilometre. Jobs in manufacturing the requisite vehicles and equipment and in operating these systems are, in principle, green jobs. Still, improvements are needed especially with regard to emissions of air pollutants. Older diesel buses are notorious polluters. There are substantial green employment opportunities in retrofitting buses to reduce particulate matter and nitrogen oxides emissions, and in manufacturing new buses that run on alternative fuels including CNG or hybrid-electric buses. China, India, and Pakistan are among the countries that have invested heavily in CNG. For instance, in India's capital New Delhi, the introduction of 6,100 CNG buses by 2009 is expected to lead to the creation of 18,000 new jobs.

Similar retrofits are needed for the highly-polluting two-stroke engines that are ubiquitous in two- and three-wheelers in developing countries, and particularly in Asia. Pilot projects in the Philippines suggest that retrofits cut fuel consumption by 35–50 % and emissions of air pollutants by as much as 90 %. Jobs can be created through installing and servicing the kits.

Hundreds of millions of people in developing countries suffer from insufficient mobility. They will never be able to afford an automobile, and may not even have access to public transit. Yet, bicycles and modern bicycle rickshaws offer a sustainable alternative and create employment in manufacturing and transportation services. Nevertheless, their growing essential mobility needs must be met and this will require the development of innovative approaches that should also generate new employment opportunities.

### Agriculture and the Global Food System

The future of green jobs in agriculture and the food system is uncertain. In key parts of the economy such as renewables, energy conservation, and transportation, win-win and double dividend employment scenarios are encouragingly evident. In the case of agriculture, however, a green jobs scenario will require policy interventions to overcome a series of formidable obstacles. These obstacles to green employment can be located at all points of the global food system, from the threatened livelihoods of small farmers; the energy and chemical inputs used in intensive farming; the expansion of certain plantation crops; the growth of intensive livestock systems as a result of rising meat consumption; the globalisation of food and "food miles"; the rising market power of large retailers; and the problem of vast amounts of GHG-producing food waste in the developed world.

Perhaps more than in any other economic sector, the future of green jobs in agriculture and the global food industry is inseparable from the question of the system's overall sustainability. However, sharp disagreements exist as to what actually constitutes sustainability. Can the existing system be made more sustainable over time by, as the World Bank has proposed, changes here and there? Or is the present agro industrial model fundamentally unsustainable and in need of a radical overhaul, as small farmers and workers organisations frequently claim?

One thing is clear: the employment trend in food and agriculture is actually moving away from sustainability and decent work. At the base of the supply chain, low input and relatively sustainable forms of smallholder agriculture is being squeezed on all sides, a process that is accelerating urbanisation, informality, and thus social and environmental stress all across the developing world in particular. The drivers of this squeeze include trade liberalisation supported by the WTO and rich-country subsidies to agribusiness and the rising market power of large producers and retailers.

Another factor squeezing smallholders is the rise of plantation crops like soy and palm oil. The expansion of plantations both displaces farmers as it advances deforestation, sometimes pushing the displaced into illegal logging which makes the problem worse. Then there is the rise of the higher value "New Agriculture" where export-oriented production of tropical fruits, vegetables, wine and cut flowers is rising dramatically, as are the levels of energy and chemical inputs required for their production and transportation. For those fortunate enough to become integrated into these new global supply chains the rewards are considerable, although the working conditions in these industries are often extremely poor and disproportionately affect women. For those producers who fail to become integrated there is often nowhere else to go except away from farming and rural life altogether.

Farmers are basically being expunged from the global food system. The proportion of the world's population making their main living from agriculture is in sharp decline. In 2006, 36.1 % of the earth's population, or around to 1.3 billion people, made their living from growing food and raising livestock. In 1995, however, a quite higher proportion—44.4 %—had worked in agriculture.

Another important factor is the levels of consolidation taking place. In recent years the horizontal and vertical integration of the global food industry has seen the emergence of a group of large retailers and producers. The dynamic of the industry is towards more and more efficiencies that in turn drive workers and farmers from large parts of the global food system. The market power of the large companies allows them to dictate "take it or leave it" terms on those who actually grow the food.

Given these circumstances, a green jobs agenda for agriculture will require bold policy interventions that will need to both confront market trends, rich-country consumption patterns, and powerful business interests.

First and foremost, and as a core component of an overall strategy to achieve sustainability, there needs to be a long term commitment made to the preservation of the green, or relatively green, livelihoods that already exist by ensuring the long term viability of small farming systems. Acting on this commitment over a two or three decade time frame could preserve existing green livelihoods and improve their quality and their level of greenness over time. It would also make a major contribution to preserving and repairing the world's natural resources and reducing the enormous amount of GHGs generated by agriculture (roughly 15 %) and deforestation (around 14 %).

The evidence suggests that considerable green employment benefits are embedded within this vision of sustainability. Small farming systems can be as productive (and sometimes more productive) than intensive farming systems that rely on high energy and chemical inputs. Indeed, a high proportion of the food that is consumed in the larger developing countries is grown locally, and with the right incentives and efforts to help farmers raise the ecological literacy still further, yields can rise within a sustainable framework.

Policies supporting the expansion of urban agriculture are also needed. Already 800 million people are engaged in growing food in urban areas. The employment benefits of sustainable urban agriculture are potentially enormous. While this work seldom accrues wages, this expansion promises to generate much-needed urban employment that can produce cash income, particularly in areas with high levels of underemployment and informality.

The jobs dividend associated with local food systems in the developed world is also becoming clear. These systems help sustain local economies while returning a larger share of the proceeds to the producers—reducing emissions from "food miles" at the same time.

A study for the Food and Agriculture Organisation confirms that organic farming requires additional manpower compared with high-input conventional systems, although the precise outcome depends on climate, crops, and farm size.

Studies conducted in developing countries (such as India and Turkey) are consistent with these findings. Reduced reliance on machinery and chemicals in weeding, cultivating, and plant and animal maintenance activities requires more labour for planting cover crops, spreading manure, and producing compost. The knowledge and skills required for organic farming cannot be easily replaced by mechanisation.

Policies that are aimed at rebuilding rural communities in the developed world and restricting the expansion of superstores will preserve jobs in smaller food retail establishments. In many cities across the U.S. citisens groups and unions have successfully mobilised to halt Wal-Mart moving in to their communities, thus protecting small high street businesses. There is evidence that food superstores lead to serious net job losses in the food retail sector. The UK-based National Retail Planning Forum reports that many of the new superstore jobs are also part-time, lower paying and generally of poorer quality. Another report from the UK notes that a job that is lost at an independent store cannot simply be replaced by one job at a supermarket. Superstores benefit from economies of scale and computerisation, and are designed that the individual employee can shift the maximum number of products per customer visit. Asda has the highest number of sales per employee, at £104,490 pa. This is compared to Tesco £91,591, Sainsbury's -£85,986, and Safeway, £94, 897. Large retail is also extremely energy intensive, so in this respect jobs in smaller stores are probably greener than those in large supermarkets and superstores. Today's large retail establishments consume an estimated six times as much electricity as factories as a result of lighting and refrigeration.

Other policies to advance sustainability have shown to create green jobs, such as payment for environmental services (PES). In the UK, the English Countryside Stewardship Scheme has created jobs for farmers, contractors and other small rural businesses. The Tir Cymen scheme in Wales was created to promote sustainable farming in 3 rural areas.

This scheme produced 204 casual jobs and 62 person years of environmental work. A government study found that if the scheme were replicated across Wales it would generate 1,230 years in full time jobs. In Central and South America silvopastoral practices have developed in Columbia, Costa Rica and Nicaragua to conserve forests that raised farmer income by 10-15 %. These examples suggest that a global shift toward PES could generate very large numbers of jobs, especially when administered as public works projects. An impressive example of job creation is South Africa's "Working for Water" program which has provided work for 25,000 previously unemployed people.

Proposed improvements in natural resource management appear to have employment-creating potential. For example, activities like terracing or contouring of land, building irrigation structures, etc., are labour intensive and are urgently needed to prevent further depletion and degradation. Additional investments will be required to store and save water, thus creating employment in producing, installing and maintaining the necessary equipment. The move towards integrated water management, which involves canal lining and micro irrigation, also involves labour inputs. Other sources of work include rehabilitating dams, barrages and embankments which improve the flow of rivers. Employment could also be generated as part of the broad effort to raise water productivity. The World Bank notes that substantial public investments in off-farm infrastructure are also required, supported by water management institutions staffed by people with the necessary background in hydrology. There also appears to be employment potential in combating soil erosion involving tree planting and straightforward stone bunding.

The main policy challenge here concerns the lack of finance made available to support adaptation in the developing world thus far, as the UNDP's Human Development Report for 2008 notes. The lack of funding is having a particularly negative impact on agriculture in the developing world where climate change is already having an effect. As for the mitigation measures needed in agriculture, the IPCC also observes that little progress in implementation has been made because of the costs involved. In its Fourth Assessment Report, the IPCC states that the mitigation potential of the world's forests is also being impeded by the lack of institutional capacity, investment capital, technology, and R&D and technology transfer. The potential for green jobs and green livelihoods in a system of sustainable agriculture are difficult to estimate. However, given the fact that 1.3 billion people are presently involved in agriculture, a truly global transition towards more labour intensive sustainable methods could create many millions of new jobs and preserve those green or relatively green livelihoods that already exist. The political and cultural obstacles to such a transition to sustainability are presently enormous, but this opposition may itself be unsustainable over the medium to long term as the environmental crisis deepens and farmers, workers and consumers organise for a sustainable future.

# Policies for a Green Jobs Strategy

The obstacles to a sustainable world are primarily political and financial and have little to do with the lack of technology or knowledge. And while these obstacles have been identified and discussed by others, the main ones bear repeating if only to underscore the fact that the barriers to sustainability are, in the final analysis, also barriers to a qualitative growth in green employment at the global level.

# A Green Investment Agenda

Investment creates employment. Without adequate investment the number of new green jobs, or the greening of existing ones, will be impaired. Investment in renewables has grown exponentially in recent years to an estimated \$66-85 billion in 2007. This represents about 18 % of all investment in power generation facilities and equipment and is a major accomplishment. Yet huge sums continue to be directed towards further fossil fuel extraction and towards conventional utility projects. Meanwhile, the Stern review notes that investment

levels in energy-saving technology have actually declined by as much as  $50\,\%$  over the last two decades in real terms.

The level of investment is also highly inadequate with regard to fuel efficient vehicles and energy retrofits of homes and buildings. Meanwhile, funds for climate change adaptation in the countries and regions of the developing world that will suffer the most from its consequences are abysmally small.

Yet, adequate public and private funding in a number of priority areas could create innumerable jobs. These include continued, accelerated development of wind, solar, and other renewable energy technologies; fuel economy technologies, including second-generation hybrids, plug-in electrics, and fuel cell vehicles; sustainable urban transportation (including BRT systems, alternative fuel buses, etc.), closely linked to urban revitalisation; advanced building materials and technologies; increased appliance efficiency; organic and drought-resistant (water-efficient) farming methods; land conservation; and flood prevention and climate protection infrastructure.

# The Need for Government & Action

Timely action on the scale needed will occur only with a strong set of targets and mandates, and policy changes that will put an end to today's unsustainable business practices. As current experience in various areas—from vehicle fuel economy to carbon trading—demonstrates, a purely voluntary, market-driven process alone will not deliver. An ambitious mix of regulations, business incentives, and genuine public private partnerships is required.

While private companies have an important role to play in terms of investments and green job creation, their risk and profit appraisal and their time horizon does not necessarily match with the scale, urgency, and long-term perspective of the public agenda emerging in response to then climate challenge. In assessing such factors as risk and return on investment, private companies will tend to focus on certain countries but disregard other parts of the world, perhaps especially those most affected by climate change and in need of job creation.

# International Cooperation and Aid

The development of green employment across the developing world is being seriously hindered by the abysmally low levels of financial assistance being made available by the developed countries, and the continued bias of multilateral development agencies and national export credit agencies in favour of fossil fuels and large-scale hydropower. Regarding adaptation to climate change, the commitments made by rich-country governments as signatories to the UNFCCC back in 1992 have not been met. The 2007/2008 edition of the Human Development Report laments rightly that "To date, international cooperation on adaptation has been characterised by chronic under-financing, weak coordination and a failure to look beyond project-based responses."

The contrast between the money being spent on climate change adaptation efforts in rich countries and the amounts spent in poor countries could not be more stark. The UK, Germany, the Netherlands, Italy and the United States have spent billions of dollars on flood defences and other protection measures, creating thousands of jobs in the process. However, currently only \$26 million has been spent multilaterally for adaptation measures—a figure that, notes UNDP, is the equivalent of one week's worth of spending on flood defences in the UK. The lack of adaptation spending not only impedes the development of green jobs, it can lead to many existing jobs being lost and livelihoods wrecked (particularly in agriculture) as a result of climate disaster events.

An effective global adaptation financing strategy is clearly needed. UNDP has estimated that to adequately finance "climate proofing" development investments and infrastructure will require

\$44 billion per annum by 2015. A further \$40 billion per year will be needed to adapt poverty reduction programs to climate change, and thus strengthen human resilience. Climate related disaster response could add another \$2 billion. This total of \$86 billion would require developed countries to mobilise around 0.2 % of GDP in 2015—or roughly one tenth of what they currently spend on defence.

A reorientation toward renewables could make a huge difference with regard to poverty eradication and job creation, particularly if it were directed toward micro-lending that poorer families and communities can access and afford. Countries like China, Nepal, and Bangladesh have successfully used low-interest (subsidised) loans and micro-lending to introduce biogas, solar energy, small hydro and wind projects.

# The Clean Development Mechanism and Carbon Trading

The Clean Development Mechanism (CDM) and Joint Implementation (JI) instruments included in the Kyoto Protocol—under which companies and governments can acquire carbon credits by supporting specific emissions reduction projects—have been cited as potential funding mechanisms for green projects. In 2006, the combined value of CDM and JI projects amounted to about \$4.4 billion (out of about \$30 billion worth of global carbon transactions). According to UNFCC estimates, international carbon finance flows to developing countries could eventually climb as high as \$100 billion a year in coming decades.

It is tempting to regard CDM-related flows as a way to overcome international financing strictures. But some major problems need to be addressed. First is the highly slanted distribution of CDM projects. Among projects slated for 2002-2012, China alone garners more than half of all associated funds. Most of Latin America is largely losing out, and Sub-Saharan Africa weighs in with an abysmal 2 %. Second, the costs of certifying a project under CDM have so far been exorbitant (amounting on average to 14-22 % of projected revenue from selling project carbon credits), and thus are a major barrier for poorer countries and smaller projects. Third, the CDM approach has been piecemeal, driven more by the needs of private companies looking for cheap carbon credits than by a strategic assessment of the investment needed in moving toward sustainability. Green employment generation does not appear to be an express objective of current CDM projects.

Beyond CDM, if carbon trading is to become a major funding source for climate mitigation and adaptation, then it is important that emissions rights be sold. But in the first phase of the European Union's Emissions Trading Scheme (EU-ETS)—which currently accounts for the bulk of all carbon trading—95 % of the permits were distributed for free to large emitters. Corporate lobbying led to a situation where allocated carbon permits surpassed actual emissions, causing carbon prices to fall to nearly zero before recovering somewhat. The cap set for 2008 to

2012 is just 2 % below actual emissions for 2005, and at most 10 % of permits can be distributed via auction. Revenue generation will thus remain extremely limited.

# **Just Transition**

Green employment gains need to be balanced against significant and unavoidable job losses incurred as a result of the movement towards a low-carbon and sustainable society. Overall, far more green jobs will be created in the move toward a sustainable economy than jobs lost. But for affected workers, as well as their families and communities, transition assistance is needed.

Employment numbers in extractive industries and related sectors such as oil refining are limited—and falling. This is particularly true for coal mining—despite the fact that coal production continues to grow. (In the United States, for example, coal production rose by close to one third during the past two decades, but mining employment fell by 50 %.).

In most instances the decline in fossil fuel-based employment is primarily being driven by increased mechanisation and labour productivity increases and not by a policy shift away from fossil fuels. These declines are expected to continue irrespective of any significant shift in energy policy towards renewables. But they can be expected to accelerate under a climate stabilisation policy.

Employment in other industries, too, may suffer from substantial efforts to move toward a low carbon, high-efficiency economy. For example, while greater vehicle fuel efficiency does not necessarily harm auto industry jobs, a far-reaching modal shift would. Especially where industries are highly concentrated in one or a handful of regions, these impacts can have serious consequences for the local economy and the viability of communities. These regions will need pro-active assistance in creating alternative jobs and livelihoods, acquiring new skills, and weathering the transition to new industries.

The transition to new and sustainable patterns of production and consumption and a low carbon future will entail major shifts in employments patterns and skill profiles. Active labour market policies and broad social protections are therefore essential to ensure a fair and just transition for workers and their communities. This must involve income protection as well as adequate retraining and educational opportunities and, where necessary, resources for relocation. However, "just transition" is still more principle than reality.

Today's turbulent labour markets are characterised by growing informality, precariousness, and a tendency to replace stable terms of employment with fixed-term contracts and casual arrangements. As already noted, employment in extractive industries, chemical and allied products, shipping, food, and elsewhere in manufacturing is trending downwards as a result of technological change, efficiencies, and also off shoring. Agreen jobs strategy must therefore be situated within a just transition framework, but this framework must extend far beyond the needs of specific groups of directly impacted workers to include all workers.

This underscores the importance of the Decent Work Agenda and for a global approach to social protection where every society establishes a social floor.

### Natural Gist

- Employment in green jobs is growing and accelerating.
- In the renewable energy sector alone 2.3 million people are globally employed. Compared to fossil fuel power plants, the renewable energy sector generates more jobs per unit and per dollar invested. However, in real terms, investment in energy-saving technology has declined over the last two decade by as much as 50%
- Government incentives are required to empower our renewables industry. In Germany legislation was implemented to ensure that electricity generated from renewables had equal access to the national grid at guaranteed minimal rates.
- Currently Germany, Japan, China, Brazil and United states account for the bulk of renewable sector jobs, which includes renewables investments, technological development, production and installations. There is potential for developing countries to follow suit, by installing and maintaining or gathering wind turbines and processing feedstock for bio fuels.
- Creating green jobs in India needs to be from the development and construction of energy efficient buildings, promotion of green industry, promotion of green agricultural practices, and development of renewable energy industry.
- <u>Carbon capture and storage (CCS)</u> is not yet capable of providing a significant number of jobs. It is capital intensive so the jobs created per million dollars of investment are low.
- There is a need for effective government action, implementing a strong set of targets and mandates and policy changes putting an end to today's unsustainable business practices.
- A global financing strategy is needed as development of green employment in developing countries is severely hindered by abysmally low levels of financial assistance from developed countries.

Green Jobs: Towards Sustainable Work in a Low-Carbon World, (21 Dec, 2007), By Michael Renner, Sean Sweeney and Jill Kubit

This preliminary report prepared by the Worldwatch Institute with technical assistance by Cornell University Global Labour Institute. A joint collaboration between; UNEP, ILO, ITUC and funded by UNEP.

This is an abridged version of the article, NatueFirst-Green Ecological Managed Services having taken key extracts from this article for our Naturenomics 2.0 publication.

The full article can be found at: http://www.unep.org/labour\_environment/pdfs/green-jobs-preliminary-report-18-01-08.pdf



### Talking Solutions towards Copenhagen and Beyond...

A World Wildlife Fund Initiative supported by NatureFirst-Green Ecological Managed Services

# **Background and context**

After decades of debate and discordance the world is finally moving towards a common consensus that the climate is changing; the earth is warming up, and overwhelming evidence indicates that human activities have a major part to play in this transformation. The greatest challenge the world now faces is that something needs to be done to stop global warming and climate change.

A proactive environmental sustainability policy and its implementation is a sound answer to climate change. The best way to develop a sustainable climate policy is via a collaboration of natural and social scientists, planners and managers and the local people. Environmental suitability policies can be implemented at a global level as well as at national, regional and local levels.

Worldwide, it is currently the Kyoto Protocol that regulates the generated part of the world's CO2 emissions. However, it is about to expire and if the world's nations are to decide upon a new agreement to enter into force before the Kyoto Protocol expires, 2009 is the final opportunity to do so.

To address this, Copenhagen in Denmark is due to host the United Nations Climate Change Conference (COP15), during December 2009, and events around this conference are taking place throughout the year. The key goal of COP15 is to establish an ambitious global climate agreement for the period from 2012. Ministers and officials from 189 countries are due to take part, together with participants from a large number of other organisations.

### The Indian national action plan on climate change (NAPCC)

On June 30, 2008, Prime Minister Manmohan Singh released India's first National Action Plan on Climate Change (NAPCC) outlining existing and future policies and programs addressing climate mitigation and adaptation. This plan identifies eight core "national missions" running through to 2017 and has required ministries to submit detailed implementation plans to the Prime Minister's Council on Climate Change by December 2008.

Although emphasising an overriding priority of maintaining high economic growth rates to raise living standards, the NAPCC plan "identifies measures that promote our development objectives while also yielding co-benefits for addressing climate change effectively." It says these national measures would be more successful with assistance from developed countries, and pledges that India's per capita greenhouse gas emissions "will at no point exceed that of developed countries even as we pursue our development objectives."

Mission	Objective	
National solar mission	Promote the development and use of solar energy for power generation and other uses with the ultimate objective of making solar energy competitive with fossil-based energy options.	
National mission for enhanced energy efficiency	Current initiatives are expected to yield savings of 10,000 MW by 2012. Building on the Energy Conservation Act 2001, the plan recommends:  •Mandating specific energy consumption decreases in the large energy consuming industries, with a system for companies to trade energy savings certificates;  •Energy incentives, including reduced taxes on energy efficient appliances; and  •Financing for public-private partnerships to reduce energy consumption through demand side management programs in the municipal, buildings and agricultural sectors.	
National mission on sustainable habitat	To promote energy efficiency as a core component of urban planning.	
National water mission	With water scarcity projected to worsen as a result of climate change, the plan sets a goal of a 20% improvement in water use efficiency through pricing and other measures.	
National mission for sustaining Himalayan ecosystems	The plan aims to conserve biodiversity, forest cover, and other ecological values in the Himalayan region, where glaciers that are a major source of India's water supply are projected to recede as a result of global warming.	
National mission for sustainable agriculture	The plan aims to support climate adaptation in agriculture through the development of climate-resilient crops, expansion of weather insurance mechanisms, and agricultural practices.	
National mission for a "green India"	Goals include the afforestation of 6 million hectares of degraded forest lands and expanding forest cover from 23% to 33% of India's territory.	
National mission for strategic knowledge for climate change	To gain a better understanding of climate science, impacts and challenges, the plan envisions a new Climate Science Research Fund, improved climate modelling, and increased international collaboration. It also encourages private sector initiatives to develop adaptation and mitigation technologies through venture capital funds.	

Talking solutions: Forging a coordinated proactive response to climate change Governmental intervention to achieve an effective emission reduction program is an extremely important part of the process, but there is an equal and parallel requirement to mobilise the resources of civilians and industry leaders towards these initiatives. In this way we can ensure the development of synergies between theoretical policy and practical implementation.

NatureFirst-Green Ecological Managed Services, in conjunction with WWF-India hosted a conference 'Talking Solutions' where various key constituencies from all across India came together to develop insights into India's new climate change policy and agree on suitable actions that various constituencies across India could undertake. The objective was to build an understanding, between the key constituents, of the problems associated with climate change and to form differentiated roles and agendas in addressing and targeting short, medium and long term solutions, in preparation for Copenhagen and beyond.

As all sectors of society contribute to Green House Gas (GHG) Emissions, there is immense scope to implement infrastructural, behavioural, and strategic change in order to curb these emissions. By getting together key policy-makers from industries, government, NGOs and environmental organisations, we were able to undertake a constructive discussion about delivering pro-active solutions to climate change and also to the ecological problems faced by India and the world, at large.

'Talking Solutions' - a synopsis:

- Attendees: Key policy-makers and thought leaders from industries, government, NGOs and environmental organisations gathered together and worked in focus groups to determine a pro-active solution towards climate change and the ecological problems faced by India and the world, at large.
- Agenda: The focus group attendees identified key mitigation and adaptation strategies for India, covering the following key topics:
- Application of green technology to enhance efficiencies.
- Establishing food security, energy security & water security by bridging the existing sustainability gaps.
- Biodiversity management promoting the establishment and preservation of forest cover across India.
- Delivering ecologically & economically sustainable projects at a community level – providing immediate and long-term benefits to local communities and also Indian society.

# Talking solutions through mitigation and adaptation

Given the complex scope of activities proposed by the NAPCC and developed through the mission, it is clear that we must concentrate resources towards developing concrete mitigation and adaptation action plans in areas that are critical to both national development and to the issues of climate change. Taking such an approach will result in a more focused and effective implementation plan for India.

The NAPCC has already emphasised the need for developing both adaptation and mitigation plans the following where the main adaptation and mitigation measures discussed and agreed upon at the Talking solutions conference.

# **Elements of Adaptation**

- Mainstreaming climate change risks into national programmes and priorities:
  - o Modifying current agricultural practices; promote use of drought resistant crops or better if possible the use of lower lying areas for crops.
  - o Developing infrastructure to sustain impacts of climate change.
- Implement community level adaptation systems across all strata.
- Understand existing vulnerabilities to climate change and identify their critical thresholds.

# **Elements of Mitigation**

- Efforts to curtail Greenhouse Gas Emissions:
  - o Decarbonisation.
  - o Enhanced efficiency of the energy system.
  - o Increasing the fuel efficiency of vehicles, individual-lifestyle changes and changing business practices.
- Development of new technologies to support the curtailment efforts:
  - o Planetary engineering techniques such as solar shades.
- Use of carbon sinks, carbon credits, and taxation to lower Greenhouse Gas Emissions.



While there has been a lot of talk and debate on mitigation measures, adaption measures have not been given the same level of focus or resources. For a developing nation like India, with a significant part of the population below the poverty line, the latter needs to be a critical area of focus and action.

It was clear from discussions that reactive measure currently prevail in India and we believe that India needs to promote measures that are more proactive in order to effectively address issues affecting India today and climate change issues that will affect us in the future.

### Naturenomics™ Ecological Sustainability Wheel Statutory and voluntary Determine Baselines ecological information management Establish Funding options to implement the initiatives - green funds, debt, Framework and Policies to reward ecological compliance incentives, etc Certification & Implement & Sustain LEED facilitation and mplementation of sustainability initiatives, manage and maintain the consumption of CDM and compensatory mechanisms initiatives 6 forces of ecological competitiveness Energy Water Waste Air Carbon

Adaption and mitigation utilising the Naturenomics™ Ecological Sustainability Wheel

We believe the most effective adaptation and mitigation initiatives can be implemented by utilising the Naturenomics™ Ecological Sustainable Wheel (NESW). This illustrates a process that starts with advocacy and takes the process through to implementation and monetisation. Covering the six forces of ecological competitiveness, Land, Energy, Waste, Water, Air and Carbon (LEWWAC), the NESW is a robust approach that can deliver sustainability in India

# **Talking Solutions to Implementing Solutions**

From workshops and in depth discussions at the conference three distinct areas where identified which require the greatest and most immediate action. These priority areas were:

- Energy security to ensure we have sufficient energy resources, now and in the future, reducing our dependency on non-renewable sources and availability to support all projected developmental plans.
- Water Security protection of current sources of fresh water, reducing the impact of climate change on glacial melting and provisions of sufficient water to urban and rural populace.
- Compensatory mechanisms promoting bio-diverse forestation financial funding and support to undertake programs that protect the current forest cover, and maintain the ecobalance of endemic species.
- It is in these areas where we must leverage our current understandings and develop clear and effective solution strategies. Such concentrated efforts are required with immediate effect in the following ways:

# A.Energy security

Through a concentrated effort on reducing emissions, it is imperative for India and other developing nations to develop an energy security agenda that curbs emissions in the following sectors:

- Transportation which contributes to 6.5% of GHG emissions across India.
- Industrial sector 46% of the GHG emissions can be attributed to the industrial segment, with energy-intensive industries contributing 28% of these emissions, and other industrial processes 18%.
- Residential sector & urban buildings 7.9% of the national GHG emissions can be attributed to residential and commercial buildings, campuses and urban establishments.

# **Transportation related emissions**

New efficiency and fuel standards will mean vehicles can go further on less gas and so emit less carbon per kilometre. These benefits, however, will be neutralised if vehicle use continues to soar. Better mass transit and smarter urban growth are needed to ensure that tens of millions of new cars stay parked.

# Key Measures:

- Develop protocols to increase vehicle efficiency Leapfrog guidelines and efficiency standards.
- Decarbonise fuels.
- Contain growth in Vehicle Miles Travelled (VMT).

### Industrial emissions

National and/or sector-specific carbon caps are absolutely essential for reining in top emitters, such as steel mills and cement plants. Improving the emissions profile of mid-market companies – which are collectively as dirty as top emitters – demands utility reform, adoption of international "best-practice" technology, and new standards for the motors, pumps, boilers and other "universal" equipment systems commonly found in the commercial sector.

### Key Measures:

- Set up emission reduction targets from the largest emitters and sectors.
- Improve efficiency of universal equipment to reach both large and small emitters.

### Residential emissions

New buildings and appliances, properly engineered, offer three times the carbon reduction potential as retrofits. Realising this potential will require broad adoption of national and provincial building codes and appliance standards that are adequately enforced. New, low-cost technologies now available in the U.S. and E.U. must become prevalent around the developing world. Utility reform will accelerate retrofits and turnover of existing buildings and appliances.

### Key Measures:

- Aim to avoid lock-in of energy-intensive new buildings and appliances.
- Retrofit existing urban structures and accelerate appliance turnover.

The Obama Administration in the U.S. is in the process of passing 'The American Clean Energy and Security Act of 2009' (ACES), which will establish a variant of a cap-and-trade plan for greenhouse gases to address climate change. To combat global warming, a cap-and-trade bill will set a limit on greenhouse gas emissions and charge companies allowances for further emissions. Initially, however, allowances would be handed out at no cost. The ACES bill would require a 17% reduction in carbon dioxide and other greenhouse gases by 2020 and by more than 80% by 2050.

### In Summary: Key actions for energy security

- Setting Incentives and targets for industry Provide energy tax credits or rebates to certain industries and sectors off setting the impact of higher energy-related prices. On the contrary, we should also employ means to penalise sectors and companies that do not meet emission reduction targets and those that fall under high emission brackets. In order to encourage investment in clean energy technologies, the government must provide tax incentives and subsidies to organisations that develop and transact in technological innovations towards a reduction in carbon emissions.
- Promoting Clean Energy We need to consider India's economic growth prospects, and the subsequent increase in requirement for electricity and other energy sources such as coal. Illustrated below are some of the key components of taking a clean energy route to provide this growing energy demand in India.

#### Clean Energy Partnering Renewable Carbon Clean fuels Smart Grid Purchase of energy Capture & and and with other renewable Sequestravehicles States **Electricity** electricity CCS early Fuel Standard to Facilitate the Promoting Program to allow Guarantee renewable demonstration promote deployment of a each state purchase of advanced bio energy office to energy and program, Smart Grid renewable incentives for the fuels and other establish for replacing a Federal Energy energy at set certain wide scale Regulatory federal financial cap rates to Commission to commercial percentage of transportation assistance for ensure deployment of load from fuels reform the clean energy profitability of the renewable CCS and regional planning and energy ventures during sources such as performance process to efficiency the first few wind, hydro, standards for modernise the years. projects biomass, solar new coal fired electric grid and Provide and geothermal power plants provide for new subsidies to transmission parties that use lines to carry renewable electricity energy. generated from renewable sources

• Developing and Promoting Energy Efficiency Standards and Technologies - In commercial and residential infrastructure development, towards energy efficiency in buildings, we need to establish building codes achieving 25% and 50% higher energy efficiency targets in 2012 and 2016 respectively. The government and industry should further promote energy efficiency in new buildings by providing training and funding assistance to states that adopt advanced building efficiency codes. In the case of manufactured homes establish a program to provide rebates towards the purchase of new BEE star manufactured homes for low income families. We need a national energy efficiency standard and compliance systems that mandates deployment of the best in class energy efficiency, especially in the lighting sector.

Industrial Energy Efficiency can be established by deploying standards for industrial energy efficiency and recognising state-of-the-art energy management by recognition and awards programs, especially for innovation in increasing efficiency of the thermal electric generation process. Similarly in the case of the utilities segment, the establishment of a new energy efficiency resource standard that will enlist electricity and natural gas distribution companies will promote the creation of a more energy efficient nation. Transportation Efficiency remains a key parameter and the goal of this provision is to preserve the environmental benefits that could be achieved, but do so in a way that simplifies compliance by the auto companies.

• Optimising the energy derived from Coal - Coal is an important energy resource and we need measures to ensure efficient usage of coal. India's coal production is around 500 million tones, which has been projected to increase to 1 billion tones within seven years. India's power production plants depend heavily on coal reserves, derived from states which also have relatively higher forest cover. We need to determine ways to ensure protection of the forest cover, whilst addressing the aggressive demands of energy intensive industries.

### **B.** Water Security

The UN estimates that by 2050 there will be an additional 3 billion people with most of the growth in developing countries, which are the places that already suffer the greatest degree of water stress. Thus water demand will increase unless everyone finds ways to conserve and recycle this precious resource.

Worldwide, 1 in every 6 people currently does not have access to clean water. According to the recent Global Environment Outlook, almost 1/3rd of the world's population lives in countries suffering from moderate to high water stress, which could elevate as climate change challenges accelerate. As of now, the Nile in Egypt, the Ganges in India and Bangladesh, the Indus in Pakistan, the Yellow River in China and the Colorado in the United States are among rivers that no longer make it to the sea.

Poor people living in slums often pay 5-10 times more per litre of water than wealthy people living in the same urban areas. Emerging economies (such as India, China and Turkey) still have an important rural population dependent on water supply for food production. Within India the water security issue can be divided between urban water security and rural water security. Asummary of water security issues is illustrated in the table below.

### **Urban Water Challenges**

- o Typically water is available for only 2 8 hours a day in most Indian cities.
- o Erratic and unreliable water supply, particularly in summer.
- o Increasing demand supply gap.
- o Old and poorly maintained distribution networks resulting in a transmission loss of 25- 50%.
- o Leakage and pilferage during transmission
- o Inadequate water supply service.
- o Easy contamination of water due to back siphoning.
- Over extraction of ground water has led to salt water intrusion into coastal aquifers and quality deterioration.
- o Excessive fluoride, iron, arsenic and salinity in water affects about 44 million people in India.

# **Rural Water Challenges**

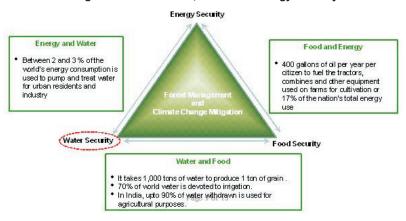
- o More than 85% of rural water supply systems are based on ground water sources
- About 85% of the ground water sources are drawn for irrigation and rural drinking water draws under 3%.
- An imbalance between over-withdrawal of ground water and deficit recharge is resulting in a reducing water table.
- o There is a permanent fall in the water table every year to the tune of 2 -3 meters.
- o A lack of adequate provision for clean drinking water
- o A lack of awareness, surveillance, monitoring and testing, mitigation measures, availability of alternate water resources and adoption of hygienic practices continue to be roadblocks.
- o Maintenance of the service delivery systems is still a challenge especially in remote locations.
- o Around 37.7 million Indians are affected by waterborne diseases annually.
- o 1.5 million Children are estimated to die of diarrhoea alone.
- o A non-availability of low cost water technologies to cater to the poor.

According to a World Bank study, out of the 27 Asian cities with population more than a million Chennai, Delhi, Mumbai and Kolkata are ranked as the worst performers in terms of hours of water availability per day.

According to a World Bank study, as much as 1% of India's GDP is lost through the inefficiency of water supply schemes for rural households.

As depicted in the chart below, energy security, food security, and water security are interconnected, and so resolving this issue in a holistic way is fundamental to ensuring our socioeconomic development. Currently 70% of available water in the world is used for irrigation purposes, which emphasises the need to ensure efficient use of water and effective water management in our agricultural practices to ensure long-term water-security.

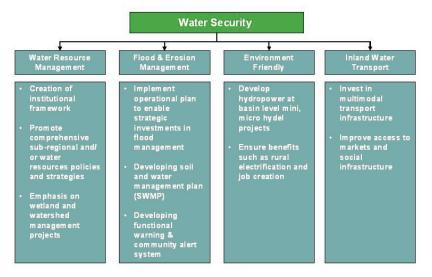
### Strong Link between Food, Water and Energy Security:



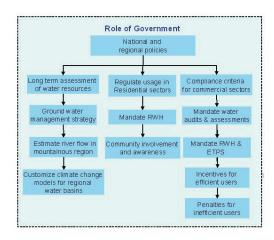
There are four distinct areas requiring action in order for Indian water security to be assured at a national level. These four areas are:

- 1. Stringent Resource Management
- 2. Effective Flood and erosion management
- 3. Development of environmentally friendly systems of water capture and usage
- 4. Enhance inland water transportation systems

The actions relating to each of these are illustrated in the diagram below:



Government and Industry both have a huge role to play to ensure water security and action the long-term goals towards 2020. We identify below the clear roles and responsibilities of Government and the roles and responsibilities required by Industry to achieve these targets.





# C. Compensatory mechanisms promoting bio-diverse forestation.

Compensatory mechanisms help to neutralise carbon emissions from business activities through delivering carbon offsetting activities. Such compensatory mechanisms include; biodiversity management for the reforestation of degraded land, the establishment of new forest cover and the preservation of existing forest cover.

The Ministry of Environment and Forest has repeatedly maintained that the target of the government in the next 10 yrs to ensure at least 1/3rd of our geographical area is under forest and tree cover. There are several other measures such as forest sinks and reduced deforestation that need to be undertaken on a priority basis. Creating forest sinks through biodiversity activities is a reactive measure to control the enhanced greenhouse gas effect. The overall target should be to Increase forest cover to 33% through compensatory mechanisms.

Preservation of the existing forest sinks can prove to be both a proactive and a prudent measure to achieving the same target. There is broad agreement that tropical nations need some form of economic incentive to reduce deforestation, and that developed countries should compensate countries that control deforestation. The key target is to maintain carbon sink levels at 23%, nationally. If forest covers needs to be uprooted for mining of resources such as coal, then the industry should work in tandem with the MoEF to ensure re-plantation at distinct and appropriate locations, which also protects the local flora and fauna, through bio-diverse plantations.

Reduced Emissions from Deforestation in Developing Countries (REDD) is a mitigation initiative that dwells into the aspect of cutting greenhouse gas (GHG) emissions associated with forest clearing by the inclusion of "avoided deforestation" in carbon market mechanisms. In simple terms this means payment in return for the active preservation of existing forests. According to the IPCC, mitigation costs of reduced deforestation depend on the cause of deforestation (e.g. timber, agriculture or infrastructure), returns from alternative forest/ nonforest uses and any compensation paid to landowners to change land use practices. Costs vary by country and by region, but on average such costs are low.

It is imperative to engage international and specifically national governments towards Reduced Emissions from Deforestation in Developing Countries (REDD) and further nationally incorporate the concept of bio-diversity in the REDD program to ensure ecological balance. Some of the other important steps that need to be undertaken are:

- Develop and implement mechanisms for payment towards active preservation of existing forest cover.
- Support and implementation systems towards reclamation of forest land through reforestation programs, ensuring compensatory payments for the same.
- Direct funds to the source and user of technology.
- Revise the regulatory framework for land use.

Government needs to develop a long term holistic action plan involving industries, NGOs and communities to address the issue of forest cover loss. Creating forest sinks through 'Biodiversity Management' activities needs to be a long term reactive measure to control and mitigate the continuing greenhouse effect.

# **Next Steps:**

So in summary the key actions for Copenhagen and Beyond were agreed as:

# **Action Items**

### **Towards Copenhagen Internationally**

- Maintaining per capita GHG emissions commitment
  - a. Will remain below the Annex 1 countries.
  - Require technology transfer and support to leaf frog existing efficiency standards.
- Energy security harness global innovation, funds towards addressing the energy security.
- Renewable energy Develop global partnerships towards harnessing renewable energy.
- 4. Compensatory mechanisms for biodiverse forestry projects - develop and present our position towards avoided deforestation in compensatory mechanism that is more representative of India's conditions, and ensure bio-diversity is incorporated as part of the forestation program to maintain critical ecological balance.
- Study glacial melt to determine the impact of climate change on glaciers and define compensatory mechanism to address the loss of this fresh water reserve.

### Beyond Copenhagen in India

- Government and Regulatory involvement Generate National involvement at all levels, engage all State Governments in policy making and implementation on climate change issues.
- Implement concrete adaptation solutions towards achieving:
  - o Energy Security.
  - o Water Security.
  - o Food Security.
- Compensatory mechanisms for Biodiverse forestation projects.
- R&D Support research and development and create human capital towards supplementing 'green' implementations.
- Channel capital for R&D
- Focus on simple yet effective technological and commercial innovations for energy, food and water security.

There needs to be an effective utilisation of technology to deliver these solutions, there is also a need to leapfrog current technologies and be more aligned with natural solutions. Financing mechanisms also has to be in place to support these R&D efforts with incentives to deliver a "low carbon" growth development model.

Given the complexities of drafting solution plans towards all the above mentioned causes, the primary focus does need to be on the following subjects, with specific targets of:

# A. Energy Security

- 60% of all energy requirements supplied by renewable energy and co-generation options, of which at least 75% should be from solar and wind.
- 50% savings in energy consumption through energy efficiency initiatives.

### **B.Water Security**

- Target 100% water neutrality, so for example water consumed is replaced by ground water recharge system (cradle to cradle).
- Target 80% recycling of water through implementing appropriate treatment mechanisms.

### C.Compensatory mechanisms promoting bio-diverse forestation.

- Maintain carbon sinks level at 23%, nationally.
- Increase existing forest cover by 23-33%.
- 30% of total areas planted with bio-diverse endemic species of carbon, dust and noise buffers.

### In conclusion

In order for us to address the challenges posed by climate change, we need to deliver much needed capacity building which requires the allocation of appropriate and sufficient resources with immediate effect. In order to create substantial economic and ecological benefits for all developing nations there is a need for free transfer of technological innovations, human resource development, education and training. Irrespective of the outcome at Copenhagen, we will have a pro-active action plan towards mitigating the most urgent issues, at an academic, industrial and community level.

As a nation, our focus should remain on the primary issues of compensatory mechanisms, energy security and water security, with an emphasis on the development of adaptation plans. A more accurate valuation of natural resources will lead to more realistic and practical plans for the compensatory mechanism system.

By developing thought-leadership and demonstrating concrete actions on these three critical issues, we can lead by example. Developing the solutions with the support of key social, economic, political, and industrial constituencies in a scalable level will have to be the primary focus, since it will guarantee social and economic growth through sustained ecological action. Through the use of the best technology, and implementation mechanisms, we aim to identify and execute solutions that go beyond Copenhagen for all developing nations, and the world at large.

We also believe that by solving these problems there is a great opportunity for us to build a healthy, prosperous and more sustainable future.

### Natural Gist

- The greatest challenge the world faces is to stop global warming and climate change.
- The 2009 United Nations Climate Change Conference (COP15) is to be hosted by Denmark in Copenhagen, with the overall goal of establishing an ambitious global climate agreement for the period from 2012.
- India's first National Action Plan on Climate Change (NAPCC) was released on June 30, 2008 by Prime Minister Manmohan Singh.
- NatureFirst- Green Ecological Managed Services, in conjunction with WWF- India hosted a platform 'Talking Solutions' where, from all across India, <u>key</u> <u>constituencies came together to agree their actions</u> for the NAPCC.
- The key action items towards Copenhagen internationally- Demonstrate sustainability commitment by black carbon emissions reduction, nitrous oxide usage reduction, improve food and water security, implement compensatory mechanisms, direct funds and finances encouraging low emission lifestyles, develop global partnership for renewable energy and technology transfer to promote sustainable agricultural practices.
- The key action items to be embarked within India Government and regulatory involvement, implement solutions towards energy security, land/food security, water security, reducing black carbon emissions, R&D support towards creating human capital, innovative technological and commercial innovations for energy, food and water security, focus on simple yet effective technological and commercial innovations for energy, food and water security.

### Ch. 2. Design for sustainable economics Robert Gilman

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<u>Name</u>	<u>Organisation</u>	<u>Website</u>
Andreas Ernst	UBS Philanthropy	www.ubs.com
Andrew Pidden	Clean Resources Asia	www.clsacapital.com
R. E. Turner	United Nations Foundation	www.unfoundation.org
Barry Appleton	Appleton Foundation	www.appletonfoundation.org
Bryan Martel	Environmental Capital Group	www.environmentalcapitalgroup.
Charlotte Perra	Energy Foundation	www.ef.org
Craig Appel	Energy Foundation	www.ef.org
Chet Tchozewski	Global Green Grants Fund	www.greengrants.org
Dana Lanza	Environmental Grantmakers Association	www.ega.org
Danyal Sattar	Esmee Fairbain Foundation	www.esmeefairbain.org.uk
Denise Lee	Khemka Foundation	-
Dr. Michael Koeberlein	Heinrich Boll Foundation	www.boell.org
Frederick Mulder	The Funding Network	www.thefundingnetwork.org.uk
George Polk	The Catalyst Project	www.catalystproject.info
Jon Cracknell	JMG Foundation	-
Herschel Post	EarthWatch Institute	www.earthwatch.org
Jeremy Grantham	Grantham Foundation	www.granthamfoundation.org
Stephen B Heintz	Rockefeller Brothers Fund	www.rbf.org
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Michele Grennon	Threshold Foundation	www.thresholdfoundation.org
Kadoorie Family	Kadoorie Family	-
John Sauven	Greenpeace	www.greenpeace.org
Laurence Lien	Lien Foundation	www.lienfoundation.org
Liz Hosken	Gaia Foundation	www.gaiafoundation.org
His Royal highness The	Alliance of Religions and	www.arcworld.org
Prince Philip	Conservation	-
Melissa A Berman	Rockefeller Philanthropy Advisors	www.rockpa.org
Peter Chenoweth	CH Group	-
Peter Wheeler	New Philanthropy Capital	www.philanthropycapital.org
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Steve Howard	The Climate Group	www.theclimategroup.org
Victoria Garchitorena	Ayala Foundation	www.ayalafoundation.org
l Jean Oelwang	Virgin Unite	www.virginunite.com
Nicholas Ferguson	Institute for Philanthropy	www.instituteforphilanthropy.org
Dr. Salvatore LaSpada	Institute for Philanthropy	www.instituteforphilanthropy.org
Sarah Teacher	Institute for Philanthropy	www.instituteforphilanthropy.org
Uday Khemka	Nand & Jeet Khemka Foundation	www.khemkafoundation.org

# Some Philanthropic Organisation / NGOs

<u>Name</u>	<u>Organisation</u>	Website
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H .S.H Prince Albert II of	Prince Albert II of Monaco	www.princealbertiiofmonacofo
Monaco	Foundation	undation.com
Rebecca W. Rimel	The Pew Charitable Trusts	www.pewtrusts.org
Rupert Myer Foundation	Myer Foundation	www.myerfoundation.org,au
Robert S. Harrison	Clinton Foundation	www.clintonglobalinitiative.org
Robert E. Denham	McArthur Foundation	www.macfound.org
Dr. David T. Suzuki	David Suzuki Foundation	www.davidsuzuki.org
Sue Gillie	New Economics Foundation Google Foundation	www.neweconomics.org
Kathryn S. Fuller	Ford Foundation	www.fordfoundation.org
Bill Gates	Bill & Melinda Foundation	www.gatesfoundation.org
Walter B. Hewlett	The William and Flora Hewlett Foundation	www.hewlett.org
Carol S. Larson	The David and Lucile Foundation	www.packard.org
Frances Seymour	Center for International Forestry Research	www.cifor.cgiar.org
Steve McCormick	Gordon & Betty Moore Foundation	www.moore.rog
Kartikeya Sarabhai	Centre for Environment Education	www.ceeindia.org
Chris West	Shell Foundation	www.shellfoundation.org
Dr. K. S. Bawa	Ashoka Trust for Research in Ecology and the Environment	www.atree.org
Dr. Archana Godbole	Applied Environmental Research Foundation	www.aerfindia.org
Brooks Browne	WinRock International	www.winrock.org
Ashok Khosla	Development Alternatives	www.devalt.org
Rohini Nilekani	Arghyam	www.arghyam.org
Sunita Narain	Centre for Science and Environment	www.cseindia.org
Prof. M S Swaminathan	M S Swaminathan Research Foundation	www.mssrf.org
Ashok Khosla	International Union for Conservation of Nature (IUCN)	www.iucn.org
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Michael Finley	Turner Foundation	www.turnerfoundation.org
Jacqui Reisner Bostrom	Rivers Foundation	www.riversfoundation.org
Jo temple	The Sainsbury Family Charitable Trusts	www.sfct.org.uk



# "I WANDERED LONELY AS A CLOUD"

I wandered lonely as a cloud
That floats on high o'er vales and hills,
When all at once I saw a crowd,
A host of golden daffodils;
Beside the lake, beneath the trees,
Fluttering and dancing in the breeze.

Continuous as the stars that shine and twinkle on the Milky Way, They stretched in never-ending line along the margin of a bay: Ten thousand saw I at a glance, tossing their heads in sprightly dance.

The waves beside them danced; but they
Out-did the sparkling waves in glee:
A poet could not but be gay,
in such a jocund company:
I gazed - and gazed - but little thought
what wealth the show to me had brought:

For oft, when on my couch I lie In vacant or in pensive mood, They flash upon that inward eye Which is the bliss of solitude; And then my heart with pleasure fills, And dances with the daffodils.

- William Wordsworth

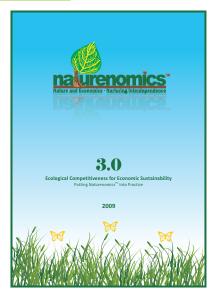


2007



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- The book is about practicing Naturenomics<sup>™</sup>, the new paradigm for the world economics, a transformation to ensure true sustainability and a low-carbon future.
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