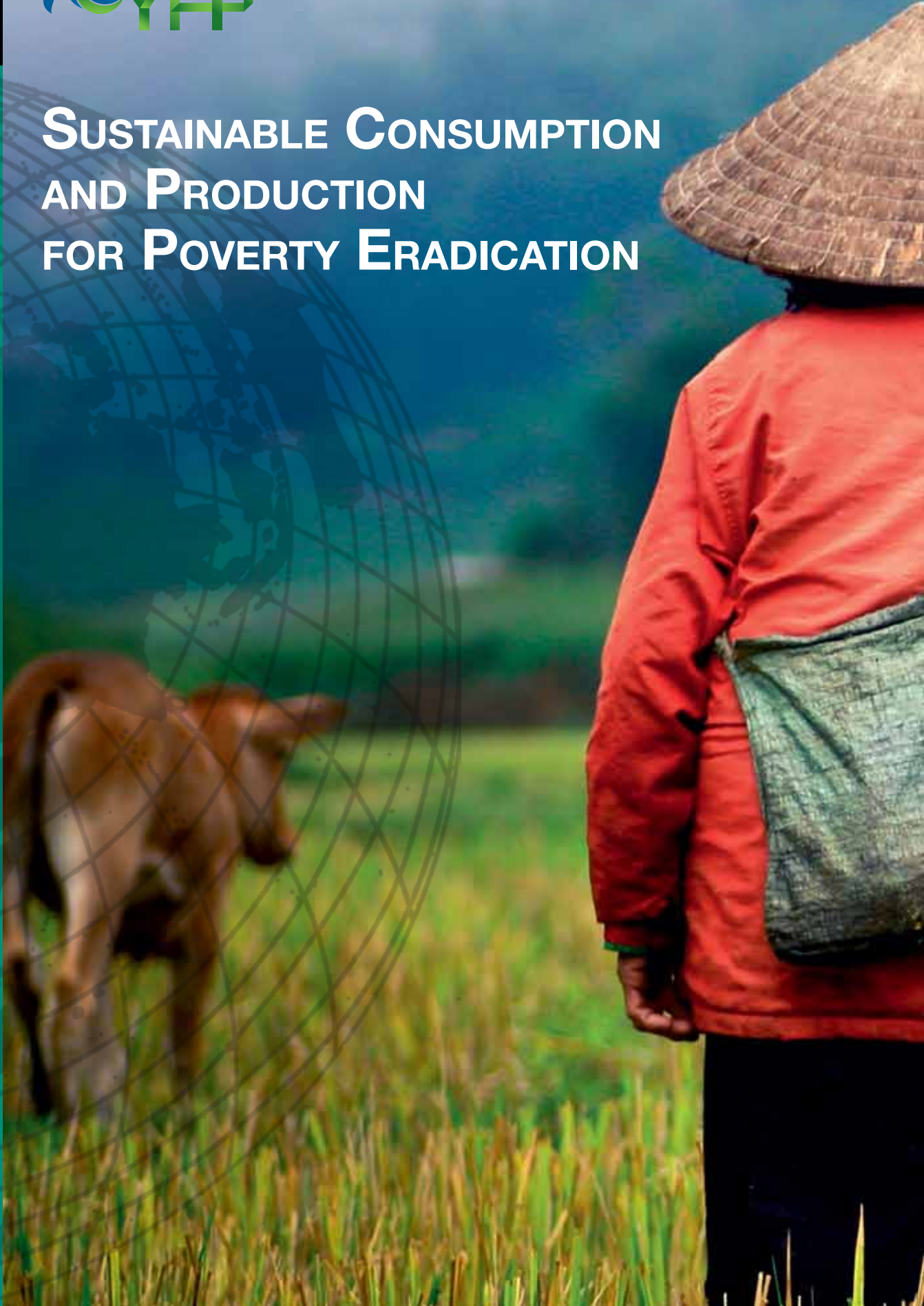




SUSTAINABLE CONSUMPTION AND PRODUCTION FOR POVERTY ERADICATION

United Nations Environment Programme





**SUSTAINABLE CONSUMPTION
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FOREWORD

The Rio+20 Conference reaffirmed that Sustainable Consumption and Production (SCP) is a cornerstone of sustainable development. The well-being of humanity, the environment, and the functioning of the economy, ultimately depend upon the responsible management of the planet's finite natural resources. These challenges are mounting as the world population is forecast to reach over 9 billion by 2050, with one billion people to be lifted out of absolute poverty and an additional 1 to 3 billion middle class consumers joining the global economy by 2030.

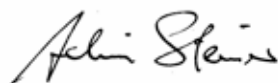
The International Resource Panel, hosted by UNEP estimates that natural resource consumption will triple by 2050 on current trajectories. Fortunately, initiatives like the recently adopted 10 Year Framework of Programmes on Sustainable Consumption and Production Patterns – the “10YFP” and work on the inclusive Green Economy are focused firmly on countering such trends. Ensuring future prosperity will rest in large part on decoupling economic growth from the rising rates of natural resource use and the environmental impacts across all stages of product life cycles.

Recognizing that environmental degradation and resource depletion can be detrimental to the poor, this publication highlights the links between SCP and Poverty Eradication. It shows how adopting SCP policies and initiatives contributes to sustainable development and makes a positive contribution to poverty reduction.

The energy sector is a striking example: The Sustainable Energy for All initiative (SE4All) focuses on energy access, energy efficiency and renewable energy. Currently, 1.3 billion people lack access to electricity, 2.7 billion people lack clean cooking facilities, and more than 95% of these people live either in sub-Saharan Africa or developing Asia and 84% live in rural areas. Cleaner affordable forms of energy and related energy services contribute to employment, economic growth, agriculture, education, commerce, and health – objectives and sectors that are all crucial to overcoming poverty. South Africa is a case in point: a solar photovoltaic system installed there is providing electricity to households with an initial investment cost of between 25-40 per cent of that required to deliver grid electricity. The systems can save 5,5 tonnes and up to 9 tonnes of CO₂ per household over a period of 20 years, reduced household monthly expenditures on energy by 20-30 per cent, improved indoor air quality, and created jobs in rural areas.

This is one of several case studies reviewed and analysed in this publication, which highlights the positive impact of SCP on poverty eradication and sustainable development. The “10YFP”, will support implementation of development and sectoral policies that promote SCP, resource efficiency and reduce environmental damage. Such policies, together with complementary actions and investments by business and civil society engaged in the 10YFP, have a huge potential to increase the net contribution of economic activities to human welfare and meeting basic needs.

These documented case studies offer an important foundation upon which countries and communities can establish policies and take action to build a more sustainable future. The report also provides insights and SCP good practices that could contribute not only to the 10YFP but also to the Post-2015 development agenda and the design and achievement of the future Sustainable Development Goals.



Achim Steiner,
UN Under-Secretary General and Executive Director UN Environment Programme (UNEP)



ADDENDUM

The first draft of this report was released in the first semester of 2012, immediately prior to the UNCSD "Rio+20" Summit. This report was part of UNEP's ongoing work under the extended Marrakech Process, and was intended to inform negotiations at the UNCSD "Rio+20" Summit on the existing draft Ten Year Framework of Programmes on Sustainable Consumption and Production (the "10YFP"). The formal adoption of the 10YFP at Rio+20 led UNEP to re-consider and slightly revise the report as a contribution towards developing a 10YFP that will contribute to poverty eradication.

The research and results set out in this report focus more on the contribution that achieving sustainable consumption and production (SCP) patterns makes to development generally, than to its contribution to poverty eradication specifically. Further research is required, and will be undertaken in the context of developing the programmes of the 10YFP, to identify the policies, actions and capacity building required to maximise poverty eradication gains from the shift to SCP patterns.

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1. EXECUTIVE SUMMARY

Sustainable consumption and production (SCP) was one of the priorities identified at the Rio Earth Summit in 1992, where it was recognized that sustainable development requires a transformation of consumption and production patterns in both developed and developing countries. In developed countries it would require an absolute decoupling of material resource use from growth in economic activities. Both here and in developing countries, where resource consumption may be expected to increase from its current low levels, far less wasteful use of the Earth's resources is required. A transformation in global production patterns in the direction of greatly increased resource efficiency and care and investment in the use of renewable resources, is also required to ensure that they are indeed renewed.

A little over ten years later, one of the outcomes of the Johannesburg World Summit on Sustainable Development (WWSD) was the recognition of the need for a 10-Year Framework of Programmes on Sustainable Consumption and Production (10YFP) to promote the shift to SCP patterns. At that same Summit, achieving SCP was recognized as a prerequisite for sustainable development. This was followed by the initiation of the Marrakech Process in 2003, which developed various mechanisms, including regional consultations, Task Forces, and dialogues with different stakeholders, in order both to refine the concept of SCP and to show how it could be made operational in very different countries, economic sectors and cultural contexts. This work has provided a major input for the development of the 10YFP, which was formally adopted at the UN Conference on Sustainable Development (Rio+20) in June, 2012.

Two of the central ideas and objectives of SCP that have been clarified over this period are decoupling and leapfrogging. Decoupling refers to the process of reducing the resource intensity of, and environmental damage relating to, economic activities. It is only through decoupling that continuing economic growth in the context of finite material, energy and ecosystem resources can be sustained. Leapfrogging expresses the obvious fact that societies do not need precisely to imitate each other in their processes of development. They can adopt modern technologies without following the development trajectories undertaken when those technologies were not available. Leapfrogging related to SCP is most obviously relevant to energy, where new renewable energy and energy efficient technologies that were either not available or affordable even ten years ago, are now providing a major new opportunity for endogenous growth and industrial development. Similarly, in food and agriculture, new low-input and organic techniques can yield higher returns than chemical-intensive farming and are often far better suited to the skills, knowledge and resource base of smaller farmers. Both leapfrogging and decoupling can be applied to all economic sectors where resource use and environmental impacts are problematic. This is because so many older technologies were developed in contexts where these issues were not considered to be economically and socially important, and many new technologies are now available which have much improved resource efficiency and environmental performance.

One of the elements of the Marrakech Process and other initiatives for SCP with different stakeholders has been the implementation of a large range of pilot projects, some of them on quite a large scale, to explore the practical implications and outcomes of SCP in the field. Many of these projects were implemented in developing countries, and an important part of their rationale was to see whether an approach based on the objective of SCP, as developed through the Marrakech Process, could contribute to the achievement both of sustainable development, and of the Millennium Development Goals (MDGs), adopted by the global community in 2000. The most obvious connection between the two agendas is MDG 7, the achievement of environmental sustainability.

The years since the concept of SCP was first identified as a global objective have seen dramatic developments in the global economy. From a developing country point of view, two of the most important of these developments have been the increase and volatility of commodity prices, especially of food and fossil fuels; and the continuing decline in many places of the extent, quality and productivity of their rural ecosystems – including water, soils, forest and fisheries – on which many of the poorest people in developing countries depend for their livelihoods. These two developments reinforce the importance of the two key messages of SCP: the need to improve the resource efficiency of consumption and production dramatically, to reduce the pressure on increasingly scarce resources and on the economies that need to import them; and the need to make more sustainable use of renewable resources, principally by ensuring that their use and management ensure that they are in fact renewed.

The connection between SCP and the MDGs, and the need jointly to achieve the objectives of both agendas, is also now located at the heart of modern development theory. This now recognises that development is a multi-dimensional process that involves social and environmental as well as economic outcomes, all of which need to be pursued and evaluated in order to ascertain whether development has both taken place and has been sustainable. The MDG and SCP indicator sets are in fact highly complementary, with MDGs 1 to 6 and 8 capturing the most important social and economic dimensions of development, and MDG 7 on environmental sustainability being defined in some detail by SCP indicators. In addition, recent work by both UNDP and UNEP has projected that it will be more difficult, if not impossible, to achieve the economic and social goals of developing countries without achieving the environmental objectives of SCP and MDG 7. Environmental and resource factors will increasingly act as constraints on economic development and prosperity, unless they come to be recognised

as key enablers and conditions of it. Given that poor people should be the principal beneficiaries of development, and because rural poor people are the group most dependent on the natural environments and the ecosystem services that they provide, these people will certainly be the worst affected by a continuing failure to reconcile the social and economic MDGs with the goals of MDG 7 and with environmental sustainability more generally. Put bluntly, the MDG 1 goal of ending hunger and poverty will not be met unless there is significant progress towards the MDG 7 goal of environmental sustainability as well.

The evidence for this, and the benefits to the poor which can be delivered by paying due attention to the environmental dimension, alongside the economic and social dimensions, of development, are starting to become apparent in the many case studies of SCP which have been generated by UNEP and others in recent years. The sectors where this is most obvious are food and energy. The new realities of resource limits and environmental degradation mean that countries that have learned how to grow their food while safeguarding the wider ecosystems that contribute to agricultural productivity, and countries that can increase yields while reducing the inputs of increasingly expensive chemicals, will be better able to thrive in a future of high commodity prices than countries that do not. Two case studies on food and agriculture from Latin America (Colombia, Nicaragua and Costa Rica) and Asia (the Philippines) show in very different ways how agriculture can be made more productive if it is properly integrated with, and reinforces, the natural systems within which it operates.

Related to energy, the IEA has demonstrated since 2004 the correlation between the Energy Development Index and the Human Development Index, showing that improving the energy landscape, could lift developing countries out of the poverty cycle. The Sustainable Energy for All (SE4All) initiative launched by the United Nations Secretary General is also responding to development needs, including by emphasizing renewable energy sources and enhancement of energy efficiency. In this publication, two case studies, on energy, from China and South Africa, show how different renewable energy technologies can give rural people access to modern renewable and efficient energy services in ways that support their businesses, incomes, health and education, and that would have been either too expensive or less effective if provided through non-renewable and inefficient means. The case study further displays the inter-linkages between sectors, such as the food-water-energy nexus, that require multidisciplinary planning at country level.

Different issues, of both environment and poverty, are raised by the ongoing process of urbanisation around the world. In urban areas people must be able to buy food that they cannot produce themselves and that has been produced sustainably, which demands increased attention to the environmental sustainability of agricultural processes. Moreover, high urban population densities create demand for water, sanitation, energy, waste -management and access to sustainable infrastructures that are affordable, non-polluting, and build social cohesion. A case study from Thailand shows how government support for civil society processes in low-income communities can deliver such infrastructure, greatly improving the lives of the communities involved, economically, socially and environmentally.

Similar evidence exists, and is cited below, across a range of other sectors: transport and tourism, water and waste, and manufacturing. These, with energy, food and urban development, are the core sectors for SCP, as well as for developing countries. The choices taken by developing countries in these sectors will largely determine whether they can face a future of volatile energy and other commodity prices with equanimity, and protect the wider environment which underpins development. This requires installing technology and infrastructure, and evolving policies, business methods and governance processes, that make the most efficient use of imported commodities and those countries' own natural resource base. The alternative will be playing perpetual catch up, having to replace resource-inefficient stranded assets that have become unaffordable, and undertaking costly environmental remediation to compensate for careless depletion or damage of resources and ecosystem services that could have been renewable.

All countries have the opportunity to go down the SCP path, which the work of recent years has elaborated increasingly clearly. Developing countries that choose this path can expect increasing returns from the sustainable use of their own energy and other natural resources. Those that do not can expect the development options to narrow in the future due to the high prices resulting from energy and resource constraints. The Rio+20 conference and its aftermath represent a crucial moment of choice for individual developing countries as well as for the global community as a whole.

This paper was initially developed in preparation for the Rio+20 Conference, and aims to provide further insights on SCP and poverty related issues. The paper will also contribute to the integration of poverty considerations into the newly adopted 10YFP, building on experience and best practices from the Marrakech Process and other initiatives. The paper by no means prescribes what the 10YFP should be in the future, but rather draws on past and existing initiatives and analysis, to enhance the contribution of future SCP policies and initiatives to poverty eradication.





2. INTRODUCTION

2.1 BACKGROUND TO THIS PAPER

The issue of sustainable consumption and production has been on the international agenda since the conclusion of the UN Conference on Environment and Development (UNCED) in 1992.¹ The Conference represented a defining moment in the international community's way of thinking. Chapter 4, entitled Changing Consumption Patterns, of Agenda 21, the action plan for sustainable development adopted at the Conference opens by stating that:

Poverty and environmental degradation are closely interrelated. While poverty results in certain kinds of environmental stress, the major cause of the continued deterioration of the global environment is the unsustainable pattern of consumption and production, particularly in industrialized countries, which is a matter of grave concern, aggravating poverty and imbalances. (UNDESA DSD, no date)

The Chapter goes on to say (4.8):

Developing countries should seek to achieve sustainable consumption patterns in their development process, guaranteeing the provision of basic needs for the poor, while avoiding those unsustainable patterns, particularly in industrialized countries, generally recognized as unduly hazardous to the environment, inefficient and wasteful, in their development processes.

These statements make clear that there are two main lines of interaction between processes of consumption and production, poverty eradication, and the environment and sustainable development. One line of interaction comes from the effects of industrialized country processes on the global environment, the most important of which is climate change. Since UNCED these processes have now spread widely to emerging economies as well, so that the negative effects on the global environment from this source have been intensified. The other line of interaction is the effect of 'hazardous, inefficient and wasteful' consumption and production processes in developing countries on their own environments, which can intensify poverty, damage the health of their populations and retard their development. The considerable challenges posed to industrial countries by the concept of sustainable consumption², which requires absolute reductions in the use of many resources and in many polluting emissions, will not be further considered here. It is the interaction between sustainable consumption and production, poverty eradication and sustainable development that is the main focus of this paper, recognizing that for many developing countries an increase in resource consumption to meet basic needs is a requirement of development.

As part of the UNCED follow-up process to define a policy agenda on sustainable consumption and production (SCP), two meetings held in Oslo contributed significantly to shape the discussion on SCP. First, the Oslo Symposium on Sustainable Consumption in January 1994 identified some of the key areas for action and proposed a working definition of sustainable consumption as:

the use of goods and services that respond to basic needs and bring a better quality of life, while minimizing the use of natural resources, toxic materials and emissions of waste and pollutants over the life cycle, so as not to jeopardise the needs of future generations. (IISD, no date a)

The Oslo Ministerial Roundtable on Sustainable Production and Consumption³ in 1995 developed further the definition of sustainable consumption thus: 'Sustainable consumption is an umbrella term that brings together a number of key issues, such as meeting needs, enhancing the quality of life, improving resource efficiency, increasing the use of renewable energy sources, minimising waste, taking a life cycle perspective and taking into account the equity dimension'.

The roundtable identified as a key issue 'the extent to which necessary improvements in environmental quality can be achieved through the substitution of more efficient and less polluting goods and services (patterns of consumption), rather than through reduction in the volumes of goods and services (levels of consumption).' (IISD, no date a) The emphasis of

¹ UNCED was held in Rio de Janeiro on 3-14 June 1992, and is known commonly as the Rio Earth Summit (<http://www.earthsummit.info/>). It addressed the issues of environment and sustainable development. To ensure effective follow-up of the UNCED, the UN Commission on Sustainable Development (CSD, http://www.un.org/esa/dsd/csd/csd_aboutcsd.shtml) was created in December 1992. The CSD is responsible for monitoring and reporting on implementation of the UNCED agreements and providing policy guidance to follow up the Johannesburg Plan of Implementation (JPOI) at the local, national, regional and international levels. It is a functional commission of the UN Economic and Social Council (ECOSOC) with 53 members.

² See the recent review of these challenges in Tukker, A., Cohen, M., Hubacek, K. and Mont, O. 2010 'The Impacts of Household Consumption and Options for Change', *Journal of Industrial Ecology*, Vol.14 No.1, pp.13-30

³ The Roundtable was mandated by the second session of the CSD in May 1994 to prepare elements for an international work programme on sustainable consumption and production.

the Roundtable on resource efficiency (RE) entailed an acknowledgement of the political reality that it would be much easier to change consumption patterns than consumption volumes. Thus OECD governments and businesses have largely approached the SCP agenda by accepting the need for changes in consumption and production patterns while retaining standards of living and enhancing economic competitiveness and performance. (IISD, no date b).

This approach to SCP, exhibiting the reluctance by Governments in the North to commit themselves to reducing the level of consumption, and focusing on consumption patterns, rather than on consumption levels, and seeking to improve the efficiency or sustainability of consumption largely through market approaches, has not been without its critics. They consider that such ecological modernisation to address consumption patterns through higher resource efficiency in the production process is not sufficient to address the challenges of sustainable consumption, not least because of the rebound effect, whereby increased consumption results from the lower costs delivered by resource efficiency. These critics advocate a more comprehensive approach embracing 'degrowth' in industrialized countries.⁴ These are important issues but, because the main focus of this paper is SCP and poverty eradication, they will not be further addressed here.

In 2002, the World Summit on Sustainable Development (WSSD)⁵ was held in Johannesburg in order to adopt concrete steps and identify quantifiable targets to improve implementation of Agenda 21. The WSSD recognised that changing unsustainable patterns of consumption and production is an overarching objective of and an essential requirement for sustainable development. Another important outcome of WSSD was the Johannesburg Plan of Implementation (JPOI), a framework for action to implement the commitments agreed at UNCED. The JPOI resolves to:

Encourage and promote the development of a 10-year framework of programmes in support of regional and national initiatives to accelerate the shift towards sustainable consumption and production to promote social and economic development within the carrying capacity of ecosystems by addressing and, where appropriate, delinking economic growth and environmental degradation through improving efficiency and sustainability in the use of resources and production processes and reducing resource degradation, pollution and waste. All countries should take action, with developed countries taking the lead, taking into account the development needs and capabilities of developing countries, through mobilization, from all sources, of financial and technical assistance and capacity-building for developing countries. (UNDESA DSD, 2002)



In response to the JPOI, the United Nations Environment Programme (UNEP) and the UN Department of Economic and Social Affairs (UN DESA) launched the Marrakech Process on Sustainable Consumption and Production (SCP), whose name originated from the place of its inception meeting in 2003. The Marrakech Process established 'a global multi-stakeholder process to promote cooperation and action on SCP, and operated with a bottom-up approach. It had two main objectives. The first one was to promote and support the development and implementation of SCP policies, programmes and projects at all levels. The second objective was to provide inputs for the development of the 10-Year Framework of Programmes on Sustainable Consumption and Production (10YFP). The proposed 10YFP was developed and negotiated at the Commission for Sustainable Development in its 18 and 19th sessions (CSD18/19) in 2010

and 2011. Despite full agreement on this draft framework at CSD 19, it was not adopted due to the failure of the session to reach agreement on an overall decision.⁶ However, at the United Nations Conference on Sustainable Development (Rio+20), the Heads of State reaffirmed the importance of SCP and did formally adopt the 10YFP. (UNCSD, 2012)

The Marrakech Process developed several mechanisms⁷ to take forward the SCP agenda. Among the most important of these were the seven Task Forces, each led by a different country, which are shown in Figure 1, with two each focusing on two important sectors, others on policy tools and programmes and on social and behavioural issues and another one with a regional focus on Africa. In addition to the Task Forces, the Marrakech Process, through its regional multi-stakeholder consultations identified global and regional priorities, with the following as 'priority sectors': energy, food

⁴ See, for example, Lorek, S. and Fuchs, D. (2011) 'Strong sustainable consumption governance – precondition for a degrowth path?', *Journal of Cleaner Production*, doi: 10.1016/j.jclepro.2011.08.008; Sanne, C. (2002) 'Willing consumers – or locked in? Policies for a sustainable consumption', *Analysis, Ecological Economics*, Vol. 42: pp.273-287.

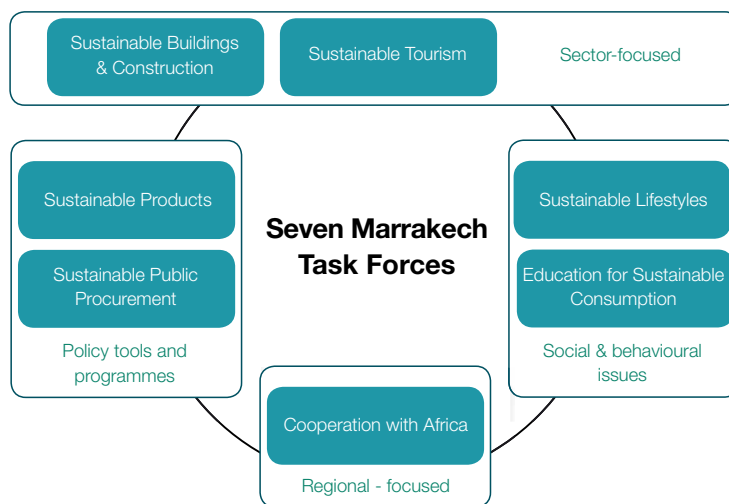
⁵ Johannesburg Summit 2002 (<http://www.un.org/jsummit/>).

⁶ UNEP DTIE SCP (<http://www.unep.fr/scp/marrakech/>)

⁷ The Marrakech Process developed various mechanisms such as: regional consultations, International Review Meetings, Task Forces, and Cooperation Dialogues variously with development cooperation agencies, UN agencies, the business sector and civil society. It was guided by an Advisory Committee.

and agriculture, transport/mobility, waste and water (UNEP 2010, p.14). In section 4 of this paper, longer case studies illustrate the SCP opportunities in three of these sectors – energy, food and agriculture, and housing – while reference to other case studies both provides a broader context for these sectors, and shows how SCP is being taken forward in the other priority sectors. There is also some discussion of SCP related to manufacturing.

FIGURE 1: THE SEVEN MARRAKECH TASK-FORCES



Source: UNEP 2010

Another important mechanism of the Marrakech Process was a series of four international meetings. The Second International Expert Meeting, held in Costa Rica in September 2005, was vital not only in shifting its focus from the consultation phase to the implementation of regional strategies and concrete SCP projects, but also in emphasising the importance of linking the work on SCP to poverty reduction, including the attainment of the UN Millennium Development Goals (MDGs) by 2015. The meeting concluded that policies on SCP should be developed and integrated into national sustainable development plans, including Poverty Reduction Strategies (PRSs) where applicable, and launched the Marrakech Task Forces and the Cooperation Dialogue to improve international cooperation and to support implementation of SCP projects and policies. (UNDESA and UNEP, 2005)

The Cooperation Dialogue is was an important platform for the Marrakech Process to engage development agencies, regional banks, and SCP experts from both developing and developed countries in order to promote SCP and explore the benefits of SCP for poverty reduction. One of the main objectives of the First Cooperation Dialogue Sessions held in Costa Rica was to identify the SCP benefits for poverty eradication. The Sessions identified that there are usually elements or objectives related to the achievement of SCP included in national development plans without specific references to this term, and recommended to include SCP in national development plans in order to effectively engage development agencies in the Marrakech Process.⁸

Following up the recommendations of the Costa Rica Meeting, UNEP carried out a review with development cooperation agencies to identify their SCP-related projects, find mechanisms for cooperation and better integrate SCP in their programmes. The study revealed that development agencies carry out activities linked to SCP, even if they are not always labelled as such. Most of the agencies (79%) are not familiar with and do not use the concept of SCP. However, most of them integrate SCP issues in their sectoral projects, such as energy and resource efficiency (86% of the agencies), waste management (75%) and water and sanitation (76%). Most of the agencies also perceive that SCP could help reduce future costs (79%), contribute to poverty reduction (63%) and contribute to addressing major environmental challenges (63%). Half of the agencies believe SCP could contribute to better access to basic services and enable more cost-effective practices, as well as providing new market opportunities and enabling developing countries to leapfrog to sustainability. 11% of the agencies think that SCP could help to reduce the cost of public management (UNEP, 2006).

The Second Cooperation Dialogue Sessions were held during the Third International Meeting in Stockholm, 2007, and resulted in recommendations to extend the dialogues beyond development cooperation agencies to wider stakeholders, to conduct research on the links between poverty and SCP and to document economic and social benefits of applying this approach.⁹

⁸ UNEP DTIE SCP (<http://www.unep.fr/scp/marrakech/consultations/international/05costarica.htm>)

⁹ UNEP DTIE SCP (<http://www.unep.fr/scp/marrakech/consultations/international/07stockholm.htm>)

The Third Cooperation Dialogue Session was jointly organised by the OECD-Development Assistance Committee (DAC)/ ENVIRONET and UNEP in June 2010 in Paris in order to find synergies between existing work streams under the broad title of 'SCP for development.' It recognised that notable progress had been made in terms of advancing the discussions on SCP through the UN Commission on Sustainable Development (CSD), the Marrakech Process, and in the preparations towards Rio +20, and agreed to highlight SCP contributions to achieving the MDGs and to explore the linkages between SCP and green economy/green growth as well as between SCP and climate change in a development context.

Since the WSSD two concepts have become central to the discourse on resource efficiency (RE) and SCP. The first, as noted above, is the 'delinking' of economic growth and environmental degradation. This is now more often referred to as decoupling the growth in production and consumption of goods and services from resource depletion and environmental degradation. This idea too can be traced back to Agenda 21's Chapter 4, when under the heading 'Encouraging greater efficiency in the use of energy and resources', it recommends (4.18) 'Reducing the amount of energy and materials used per unit in the production of goods and services'. This is sometimes referred to as 'relative decoupling'; 'absolute decoupling' is when the absolute amount of energy and materials falls in a context of economic growth.

The second concept, called 'leapfrogging', is the idea that developing countries do not need to follow sequentially the patterns of development, either of consumption or production, of industrial countries. Rather there may exist opportunities for developing countries to miss out some development stages, infrastructures or technologies utilised by industrial countries in their development, by moving straight to new technologies that do not need these infrastructures or old technological bases. In order to support SCP, these new technologies or consumption and production patterns would need to be more resource efficient and avoid the resource use and environmental damage that have characterised the development path of industrial countries¹⁰.

A review of the leapfrogging concept and possibilities for Africa, and for developing countries more generally, was commissioned by the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (Assefa, n.d.) as part of the Marrakech Process. It identified numerous possibilities, but also challenges, for leapfrogging in Africa and elsewhere. Another study (Switch-Asia, n.d.) identified three major areas as prime candidates for leapfrogging: mobile phones, which has already largely taken place in developing countries, organic and localised agriculture, and renewable energy systems. Energy efficiency is also a key element for leapfrogging; the Global Partnership on efficient lighting (En-lighten) demonstrates the potential for leapfrogging by developing countries using a more energy efficiency technology, in this case using CFL lamps to be followed by LED, as opposed to conventional bulbs¹¹. This topic is returned to in relation to food and agriculture in section 4.1 and in relation to energy in section 4.2.1.

2.2 OBJECTIVES OF THIS PAPER

It has been noted above that, from the beginning of the use of the concept, SCP has been related to both poverty eradication and sustainable development. The purpose of this paper is to explore the type and quality of these linkages, and investigate what evidence exists for them.

The next section constructs an outline theoretical framework within which these and related concepts can be considered. It notes the shifting language around these concepts. The conclusion of this section is the suggestion of an indicator framework, drawing on indicators of ecosystem goods and services, SCP indicators, and the Millennium Development Goals (MDGs), through which the nature and extent of these linkages may be assessed.

The following sections proceed through the analysis of a number of case studies in different areas, referring back to the theoretical framework and using the indicator framework where the case studies contain relevant data. The case studies have been chosen to give insights into some of the issues, challenges and opportunities relating to SCP in three of the priority sectors identified through the Marrakech Process, as noted above. In different ways they explore how SCP and the related concept of resource efficiency (RE) can advance development and sustainable livelihoods. The case studies also examine how scenarios for development in different sectors can lead to absolute decoupling; and they discuss how these scenarios may be brought about through new institutions, organisations and technologies. Insofar as is possible from the data given in relation to the case studies, their achievements are evaluated through the various indicators that are presented in the next section: environmental, socio-economic and the MDGs. The paper's conclusions set out the kinds of policies that will foster and develop these new directions for resource efficiency and sustainable consumption and production.

¹⁰ The leapfrogging concept is developed theoretically in Tukker, A. 2005 'Leapfrogging into the future: developing for sustainability', International Journal of Innovation and Sustainable Development, Vol. 1, Nos. 1/2, pp.65-84

¹¹ www.enlighten-initiative.org.





3. THEORETICAL FRAMEWORK

3.1 LINKING SCP AND POVERTY ERADICATION

Some of the key principles of SCP can be summarised as follows (UNEP, 2011a):

1. Improving quality of life without increasing environmental degradation, and without compromising the resource needs of future generations.
2. Decoupling economic growth from environmental degradation by:
 - a. reducing material / energy intensity of current economic activities, and reducing emissions and waste from extraction, production, consumption and disposal; and
 - b. promoting a shift of consumption patterns towards goods and services with lower energy and material intensity without compromising quality of life.
3. Applying life-cycle thinking, which considers the impacts from all life-cycle stages of production and consumption process.
4. Guarding against the rebound effect, where efficiency gains are cancelled out by resulting increases in consumption.

Based on these principles SCP may be summarised as a process of economic development that improves quality of life while reducing environmental impacts over the full life-cycle, and taking account of the full economic implications, of the economic activities involved. Given the low level of current consumption in many developing countries, in these countries at least improving their quality of life may be taken to require economic growth (i.e. increases in consumption¹²). This is indeed the over-riding concern of policy makers in developing countries. This clearly makes the shift in the consumption patterns in these, as in industrial, countries, even more important if environmental damage is not to be inflicted on a much larger scale. Consumption does need to increase in those developing countries, but it must do so in more resource efficient and less environmentally damaging than has been the case in the past.

It is with such considerations in mind that UNEP, having articulated the key principles of SCP as above, is clear that “meeting basic needs in a sustainable way” lies at the heart of SCP. Attaining the Millennium Development Goals (MDGs) requires the production and consumption of more goods and services to meet the basic needs and aspirations of the world’s poorest while keeping within the limits of our already stressed ecosystems. SCP offers opportunities to attain the Millennium Development Goals by delivering more products in a cleaner and safer way while using fewer materials and less energy” (UNEP, 2011a, p11).

The key question in the construction of a theoretical framework that links SCP and poverty eradication is: why should SCP as perceived through UNEP’s SCP key principles above contribute to poverty eradication and the meeting of currently unmet basic needs? The rest of this section seeks to provide answers to this question.

Having done so, a supplementary question is: through what mechanisms might these desirable outcomes of poverty eradication and meeting basic needs in a sustainable manner come about? UNEP has listed a number of possible mechanisms, expressing the view that the potential of SCP for low-income countries is that:

‘efforts and policies to stimulate more sustainable consumption and production offer numerous opportunities. These include as well the reduction of production costs, the addition of a price premium to products, the creation of new markets, the generation of jobs, pollution prevention (reducing environmental costs and health impacts) and the opportunity to leapfrog to modern environmentally-sound technologies, allowing developing countries to adopt more efficient and competitive technologies’¹³.

Subsequent sections in this paper briefly review, through case studies and examples from elsewhere, the evidence for UNEP’s view.

3.2 DEVELOPMENT AND GDP

It has been noted above that for many developing countries an increase in consumption to meet basic needs is a requirement of development and, indeed, all countries desire economic growth whether they are generally meeting basic needs or not. But that is not the same thing as saying that economic growth is the only, or is even the principal, characteristic of development. The fact that there are multiple goals and indicators of development, including the MDGs as discussed below, shows that this is not the case.

¹² This need for increased consumption in developing countries to enable them to meet their basic needs was recognised from the birth of the SCP concept.

¹³ See <http://www.unep.fr/scp/poverty/>

One of the most thoughtful and profound attempts to characterise development as much more than GDP growth is Amartya Sen's identification of 'development as freedom' (Sen 1999). Freedom is here broadly identified as including both 'process' and 'opportunity' dimensions (Sen 1999, pp.17ff.). The former dimension can be identified with freedom of people from various kinds of constraints, and would include political and civil freedoms, while the latter may be identified with the freedom of people to engage in the normal life of their society and community, and would include economic and social freedoms, including the ability to find employment or otherwise engage in productive work.

Freedom as Sen uses the term broadly reflects a person's 'capability', which is a concept that he has both developed and very much made his own throughout his academic life. The core message of the book is expressed and developed in the chapter entitled 'Poverty as Capability Deprivation', where Sen writes (ibid.,p.87): "poverty must be seen as the deprivation of basic capabilities rather than merely as lowness of incomes... [This] does not involve any denial of the sensible view that low income is clearly one of the major causes of poverty, since lack of income can be a principal reason for a person's capability deprivation. ... [but] There are influences on capability deprivation – and thus on real poverty – other than lowness of income (income is not the only instrument in generating capabilities)." It is also the case that not all uses of income actually contribute to the achievement or increase of capability, or development.

In other words, if capability (or freedom) is the end (or objective) of development, then income is certainly a very important means to that end, but it is not the end itself (something that is sometimes forgotten by those who are fixated on money measures such as GDP and its incremental growth), and there are other important elements of development that are as or more important as money. Two of those are health and education, because health and education are both direct constituents of capability (i.e. they help people to achieve it and increase it in and of themselves), as well as helping people



to be more productive, which can increase their income and enable them to increase their capability further. Because of this Sen clearly identifies the falsity of arguments that suggest that poor countries should delay the implementation of social arrangements to increase their population's health and education by concentrating on 'getting rich first'. This is an argument that is also often applied to the environment through such phrases as 'grow now, clean up later', or by regarding a clean and healthy environment as a luxury that only richer societies can afford. This argument is as invalid when it is applied to the environment as when it is applied to health and education, as will be seen.

Sen's ground-breaking book makes a number of mentions of environmental issues, but usually in passing and in no great depth. In the critical chapter in which Sen identifies the five 'instrumental freedoms' which contribute "to the overall freedom people have to live the way they would like to live" (ibid. p.38), the environment is not mentioned at all¹⁴. In fact, the only sub-section with 'environment' in the title is in the chapter entitled Social Choice and Individual Behaviour, and the sub-section lasts just one page.

This rather cursory treatment of the environment, despite its intuitively obvious importance to low-income, predominantly rural, people who largely depend directly on the food, fuel, fodder, fibre and fertiliser resources that it provides, is rather surprising. Barbier (2010) makes the point that 'The rural poor are often concentrated in fragile, or less favourable, environmental areas. Consequently, their livelihoods can be intimately dependent on natural resource use and ecosystem services'. UNEP estimates that 'Well over 600 million of the rural poor currently live on lands prone to degradation and water stress, and in upland areas, forest systems and drylands that are vulnerable to climatic and ecological disruptions' (UNEP, 2011b). It further estimates that this number is growing, that three quarters of the developing world's poor still live in rural areas, and that this is twice as many poor people as live in urban areas. For these people at the very least, who have among the lowest level of capabilities of any of the world's population and many of whom are living in 'emerging' rather than uniformly low-income countries, the productive capacity of their environment, and their ability to avail themselves of it, is of the most fundamental importance to their capability even to survive, the most basic freedom of all.

In a speech in 2006 Sen filled in this gap in his conceptual framework: 'If we are ready to recognise the need for seeing the world in this broader perspective [development as freedom], it becomes immediately clear that development cannot be divorced from ecological and environmental concerns. For example, since we have reasons to value the freedom to lead a pollution-free life, the preservation of a pollution-free atmosphere must be an important part of the objectives of development. Seeing development as enhancement of human freedom involves diverse concerns, but incorporating

¹⁴ The five instrumental freedoms are political freedoms, economic facilities, social opportunities, transparency guarantees and protective security.

expansion of social opportunities and the quality of life, which are integrally dependent on ecology and environmental preservation, must be among the central concerns in development thinking. Indeed, important components of human freedoms – and crucial ingredients of our quality of life – are thoroughly dependent on the integrity of the environment... The opportunity to live the kind of lives that people value – and have reason to value – depend inter alia on the nature and robustness of the environment. In this sense, development has to be environment-inclusive' (Sen, 2006).

There is thus very great reason to be concerned, on the grounds of its implications for poverty eradication, by the growing evidence of the increasing deterioration of the environment globally, threatening the ability of the biosphere to continue to deliver the most basic ecosystem services of climate stability, water and soil fertility, on which the world's poor, above all, depend to increase their consumption to meet their basic needs and improve their quality of life.

3.3 GLOBAL ENVIRONMENTAL DETERIORATION AND ECONOMIC GROWTH

The evidence of global environmental stress has continually increased in the years since the Rio Earth Summit in 1992. There is no space here, and this is not the place, to review this evidence in detail¹⁵, but its connection to SCP is fundamental. First, one reason for this continuing deterioration of the global environment is precisely that countries have not taken the issue of SCP adequately seriously, and made the necessary reforms to their patterns of consumption and production, nor have they seized the potential opportunities of leapfrogging and avoiding the same resource intensive economic development model. Second, continuing deterioration of the natural environment and its resource base will reduce the absolute level at which sustainable production and consumption can take place. And third, linked to this, this deterioration will reduce the baseline rate of economic growth which all countries can expect, but this especially applies to those which are most dependent on renewable natural resources, which tend to be the lower-income countries, with the highest concentration of the world's poor.

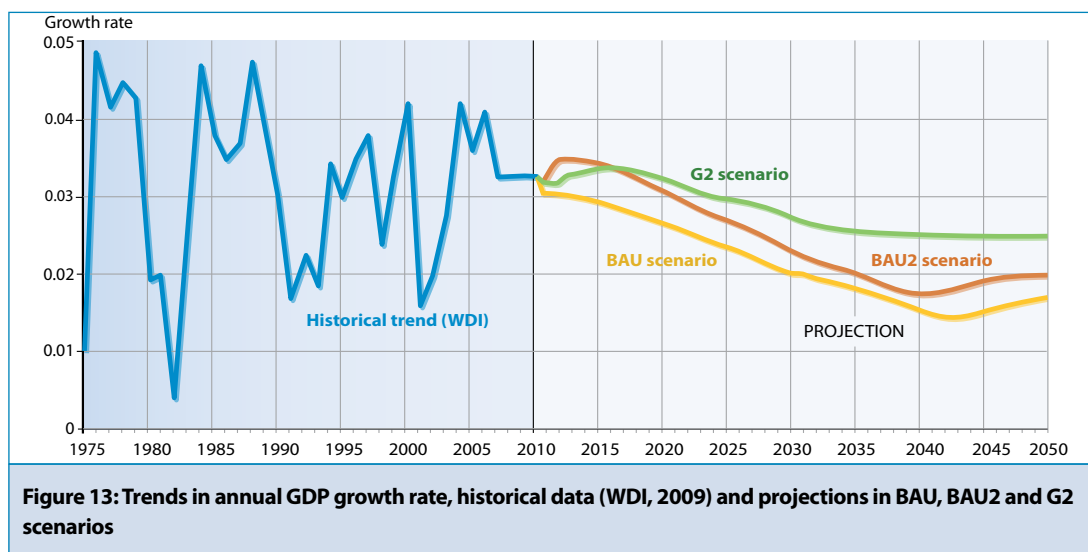
In a speech to the World Bank in 2003, Dasgupta criticised thus the way models of economic growth have tended to deal with environmental issues: "In their extreme form, growth models contain an assumed positive link between the creation of ideas (technological progress) and population growth in a world where the natural-resource base comprises a fixed, indestructible factor of production. The problem with the latter assumption is that it is wrong: the natural environment consists of degradable resources (agricultural soil, watersheds, fisheries, and sources of fresh water; more generally, ecological services). It may be sensible to make that wrong assumption for studying a period when natural-resource constraints did not bite, but it is not sensible when studying development possibilities open to today's poor regions." (Dasgupta, 2003)

This is a crucially important point which is still little understood. There is an implicit assumption in much discourse, which is reinforced by most economic modelling, that the essential economy-environment relationship can be represented as follows. If policy makers do nothing about environmental protection and restoration, then we can expect a trend rate of economic growth similar to that of recent decades, i.e. between 2% and 4% globally. If policy makers engage in environmental protection and restoration, on the other hand, then certainly some environmental improvement can be expected, but this will come at the cost of a lower rate of economic growth.

The burgeoning evidence of global environmental deterioration means that this kind of reasoning and presentation of the issue is now seriously misleading and out of date. This evidence raises the question as to how long environment-degrading growth can continue before it undermines the environmental conditions necessary for growth and slows down or comes to a halt (that, after all, is the meaning of the word 'unsustainable'). Modelling by UNEP (UNEP, 2011b) suggested that 'green growth', as shown in the G2 scenario in Figure 2, would become faster than that in two 'business-as-usual (BAU)' scenarios no later than 2017, when proper account was taken of the growth-harming environmental damage associated with the BAU scenarios. Such projections suggest that, far from SCP involving a trade-off between the environment and economic growth, achieving SCP will increasingly become a condition for economic growth. The urgency to start acting on such insights arises from the fact that much environmental damage is not reversible in short-term human time scales, so that proceeding too far down the environmentally damaging BAU curves, as we are doing at present, could permanently reduce the level of consumption and production which humanity is able to achieve.

¹⁵ See the reports and websites of the Intergovernmental Panel on Climate Change (IPCC) on climate change; of The Economics of Ecosystems and Biodiversity (TEEB) and the Millennium Ecosystem Assessment (MEA) on ecosystems and biodiversity; of the International Resource Panel on resources more generally; and any number of other reports from UNEP, other UN agencies and the relevant scientific community on water availability, land degradation, forest loss and other serious environment and resource issues.

FIGURE 2: PROJECTIONS OF BAU AND 'GREEN' SCENARIOS



Source: UNEP (2011b)

This brief discussion in this section so far has sought to make the following case:

1. SCP is concerned with improvements to both the environment and to quality of life
2. The quality of life of poor people is very dependent on increasing their consumption to satisfy their basic needs, i.e. on their economic growth.
3. The economic growth of poor people is often highly dependent on the productivity of their natural environments and resources, and their access to and ability to manage these.
4. The environmental protection and restoration envisaged by SCP is therefore of crucial importance especially to the world's poor – the SCP link to poverty eradication is very strong.
5. Continuing environmental deterioration is undermining the ability of natural environments and resources to contribute to economic growth, especially for poor people, in ways that risk becoming irreversible.
6. SCP has therefore become an imperative if global efforts at poverty eradication are not to be seriously undermined.

The conclusion is that changing patterns of consumption and production remains of great importance for rich countries if the global environment is to be protected and restored. Furthermore, it is also of great importance for poor countries if they are to succeed at poverty eradication and enable their populations to meet their basic needs.

If this conclusion is accepted, the question then remains as to how progress towards SCP should best be measured and indicated.

3.4 INDICATORS OF SCP AND DEVELOPMENT

The work of Sen and others have established beyond debate that development is about more than GDP and its growth. The Human Development Index (HDI), which combines measures of income, health (longevity) and education, is one concrete measure of this recognition of this 'GDP and beyond' nature of development. The 2011 Human Development Report (HDR) was entitled 'Sustainability and Equity: a Better Future for All' (UNDP, 2011), and covered many of the issues relevant to SCP without using the term¹⁶. HDR 2011 also had its own projection of how failure to protect and restore the natural environment would have an impact especially on the global poor, as shown in Figure 3.

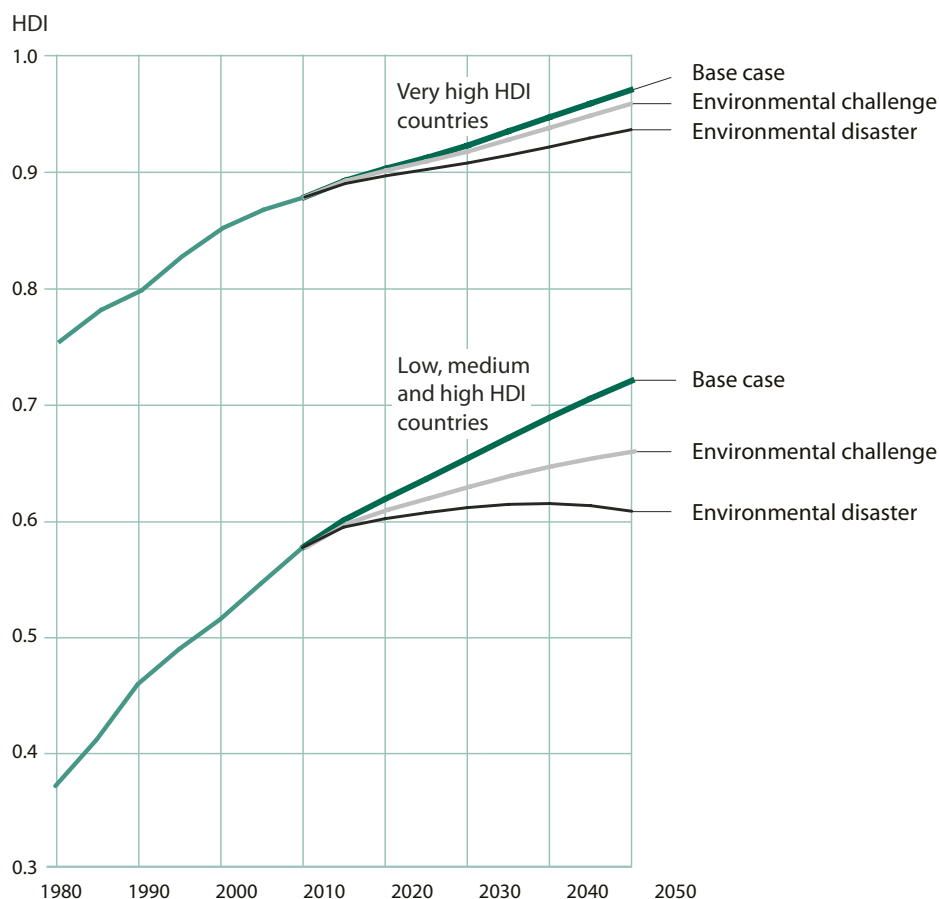
The Base Case scenario in Figure 3, which assumes limited changes in environmental threats and risks, shows developments in global HDI through to 2050 that are more or less in line with recent trends, for both high HDI and low HDI countries. This Base Case is unrealistic as a projection of the future, as noted above, because the scientific evidence shows clearly that environmental threats and risks are likely to increase dramatically and reduce increases in HDI below recent trends if there are not substantial changes in patterns of consumption and production.

These higher environmental threats and risks are modelled in the Environmental Challenge and Environmental Disaster scenarios, the latter of which assumes that biophysical and human systems are stressed by overuse of fossil fuels and

¹⁶ For example, Box 2.3, p.27 is entitled 'Consumption and Human Development' and begins 'Runaway growth in consumption among the best-off people in the world is putting unprecedented pressure on the environment.'

falling water tables, glacial melting, progressive deforestation and land degradation, dramatic declines in biodiversity, greater frequency of extreme weather events, peaking production of oil and gas, and increased civil conflict and other disruptions. All of these are consistent with current environmental trends and developments. Unsurprisingly these environmental deteriorations reduce the HDIs of both high and low HDI countries, but the latter are much more affected. Their HDI under the Environmental Disaster scenario is shown as flat-lining from 2030 to 2050, with little prospect of improvement thereafter. What is more in its HDI report UNDP warns: ‘The model does not exhaustively consider the potential for associated vicious [environmental] feedback loops, which would exacerbate these trends.’ The only way of avoiding these negative environmental feedbacks on GDP growth is through the systematic decoupling of environmental impacts from economic activity, which is, as has been seen, one of the key characteristics of SCP.

FIGURE 3: SCENARIOS PROJECTING IMPACTS OF ENVIRONMENTAL RISKS ON HUMAN DEVELOPMENT THROUGH 2050



Source: UNDP (2011)

The eight Millennium Development Goals (MDGs), which encompass the issues covered by, but go well beyond, the HDI are aimed at, by 2015: ending hunger and poverty, universal education, gender equality, child health, maternal health, combating HIV-AIDS, environmental sustainability and global partnership. The Official List of the MDG indicators is given in Table 1, with the advice that the indicators should be disaggregated by sex and urban/rural populations wherever possible¹⁷. Ominously for SCP, little progress seems to have been made on the environmental sustainability MDG 7. For example, deforestation in Africa and Latin America over 2000-2010 continued substantially to outpace the modest gains in forest area in Asia (mainly China) and Europe; global greenhouse gases continue to increase by 1.5 to 3 per cent per year; global marine resources continue to decline; the number of urban people living in slums continues to increase (though the proportion of the urban population in that condition is falling); and “the global tide of extinctions continues unabated” (UN, 2011, p.51). In line with the UNDP projections above, such developments may be expected to put at risk many of the gains against the other MDG by 2030, if not before, for the reasons set out above.

¹⁷ The Official List of MDG indicators is available at <http://mdgs.un.org/unsd/mdg/Host.aspx?Content=Indicators/OfficialList.htm>

TABLE 1: THE LIST OF THE MILLENNIUM DEVELOPMENT GOALS

Millennium Development Goals (MDGs)	
Goals and Targets (from the Millennium Declaration)	Indicators for monitoring progress
Goal 1: Eradicate extreme poverty and hunger	
Target 1.A: Halve, between 1990 and 2015, the proportion of people whose income is less than one dollar a day	1.1 Proportion of population below \$1 (PPP) per day ⁽ⁱ⁾ 1.2 Poverty gap ratio 1.3 Share of poorest quintile in national consumption
Target 1.B: Achieve full and productive employment and decent work for all, including women and young people	1.4 Growth rate of GDP per person employed 1.5 Employment-to-population ratio 1.6 Proportion of employed people living below \$1 (PPP) per day 1.7 Proportion of own-account and contributing family workers in total employment
Target 1.C: Halve, between 1990 and 2015, the proportion of people who suffer from hunger	1.8 Prevalence of underweight children under-five years of age 1.9 Proportion of population below minimum level of dietary energy consumption
Goal 2: Achieve universal primary education	
Target 2.A: Ensure that, by 2015, children everywhere, boys and girls alike, will be able to complete a full course of primary schooling	2.1 Net enrolment ratio in primary education 2.2 Proportion of pupils starting grade 1 who reach last grade of primary 2.3 Literacy rate of 15-24 year-olds, women and men
Goal 3: Promote gender equality and empower women	
Target 3.A: Eliminate gender disparity in primary and secondary education, preferably by 2005, and in all levels of education no later than 2015	3.1 Ratios of girls to boys in primary, secondary and tertiary education 3.2 Share of women in wage employment in the non-agricultural sector 3.3 Proportion of seats held by women in national parliament
Target 4.A: Reduce by two-thirds, between 1990 and 2015, the under-five mortality rate	4.1 Under-five mortality rate 4.2 Infant mortality rate 4.3 Proportion of 1 year-old children immunised against measles
Goal 5: Improve maternal health	
Target 5.A: Reduce by three quarters, between 1990 and 2015, the maternal mortality ratio	5.1 Maternal mortality ratio 5.2 Proportion of births attended by skilled health personnel
Target 5.B: Achieve, by 2015, universal access to reproductive health	5.3 Contraceptive prevalence rate 5.4 Adolescent birth rate 5.5 Antenatal care coverage (at least one visit and at least four visits) 5.6 Unmet need for family planning
Goal 6: Combat HIV/AIDS, malaria and other diseases	
Target 6.A: Have halted by 2015 and begun to reverse the spread of HIV/AIDS	6.1 HIV prevalence among population aged 15-24 years 6.2 Condom use at last high-risk sex 6.3 Proportion of population aged 15-24 years with comprehensive correct knowledge of HIV/AIDS 6.4 Ratio of school attendance of orphans to school attendance of non-orphans aged 10-14 years
Target 6.B: Achieve, by 2010, universal access to treatment for HIV/AIDS for all those who need it	6.5 Proportion of population with advanced HIV infection with access to antiretroviral drugs
Target 6.C: Have halted by 2015 and begun to reverse the incidence of malaria and other major diseases	6.6 Incidence and death rates associated with malaria 6.7 Proportion of children under 5 sleeping under insecticide-treated bednets 6.8 Proportion of children under 5 with fever who are treated with appropriate anti-malarial drugs 6.9 Incidence, prevalence and death rates associated with tuberculosis 6.10 Proportion of tuberculosis cases detected and cured under directly observed treatment short course

Goal 7: Ensure environmental sustainability	
Target 7.A: Integrate the principles of sustainable development into country policies and programmes and reverse the loss of environmental resources	7.1 Proportion of land area covered by forest 7.2 CO ₂ emissions, total, per capita and per \$1 GDP (PPP) 7.3 Consumption of ozone-depleting substances 7.4 Proportion of fish stocks within safe biological limits
Target 7.B: Reduce biodiversity loss, achieving, by 2010, a significant reduction in the rate of loss	7.5 Proportion of total water resources used 7.6 Proportion of terrestrial and marine areas protected 7.7 Proportion of species threatened with extinction
Target 7.C: Halve, by 2015, the proportion of people without sustainable access to safe drinking water and basic sanitation	7.8 Proportion of population using an improved drinking water source 7.9 Proportion of population using an improved sanitation facility
Target 7.D: By 2020, to have achieved a significant improvement in the lives of at least 100 million slum dwellers	7.10 Proportion of urban population living in slums ⁽ⁱⁱ⁾
Goal 8: Develop a global partnership for development	
Target 8.A: Develop further an open, rule-based, predictable, non-discriminatory trading and financial system Includes a commitment to good governance, development and poverty reduction – both nationally and internationally	<i>Some of the indicators listed below are monitored separately for the least developed countries (LDCs), Africa, landlocked developing countries and small island developing States.</i> <u>Official development assistance (ODA)</u> 8.1 Net ODA, total and to the least developed countries, as percentage of OECD/DAC donors' gross national income 8.2 Proportion of total bilateral, sector-allocable ODA of OECD/DAC donors to basic social services (basic education, primary health care, nutrition, safe water and sanitation) 8.3 Proportion of bilateral official development assistance of OECD/DAC donors that is untied 8.4 ODA received in landlocked developing countries as a proportion of their gross national incomes 8.5 ODA received in small island developing States as a proportion of their gross national incomes
Target 8.B: Address the special needs of the least developed countries Includes: tariff and quota free access for the least developed countries' exports; enhanced programme of debt relief for heavily indebted poor countries (HIPC) and cancellation of official bilateral debt; and more generous ODA for countries committed to poverty reduction	<u>Market access</u> 8.6 Proportion of total developed country imports (by value and excluding arms) from developing countries and least developed countries, admitted free of duty 8.7 Average tariffs imposed by developed countries on agricultural products and textiles and clothing from developing countries 8.8 Agricultural support estimate for OECD countries as a percentage of their gross domestic product 8.9 Proportion of ODA provided to help build trade capacity
Target 8.C: Address the special needs of landlocked developing countries and small island developing States (through the Programme of Action for the Sustainable Development of Small Island Developing States and the outcome of the twenty-second special session of the General Assembly)	<u>Debt sustainability</u> 8.10 Total number of countries that have reached their HIPC decision points and number that have reached their HIPC completion points (cumulative) 8.11 Debt relief committed under HIPC and MDRI Initiatives 8.12 Debt service as a percentage of exports of goods and services
Target 8.E: In cooperation with pharmaceutical companies, provide access to affordable essential drugs in developing countries	8.13 Proportion of population with access to affordable essential drugs on a sustainable basis
Target 8.F: In cooperation with the private sector, make available the benefits of new technologies, especially information and communications	8.14 Fixed telephone lines per 100 inhabitants 8.15 Mobile cellular subscriptions per 100 inhabitants 8.16 Internet users per 100 inhabitants

UN Statistics Division, MDG Indicators, <http://mdgs.un.org>

(i) For monitoring country poverty trends, indicators based on national poverty lines should be used, where available.

(ii) The actual proportion of people living in slums is measured by a proxy, represented by the urban population living in households with at least one of the four characteristics: (a) lack of access to improved water supply; (b) lack of access to improved sanitation; (c) overcrowding (3 or more persons per room); and (d) dwellings made of non-durable material.

The importance of the concept of decoupling to SCP has already been mentioned. The first set of decoupling indicators were developed by the OECD in 2002 (OECD, 2002) and are grouped according to economy-wide decoupling indicators (climate change, air pollution, water quality, waste management, material use and various natural resources [water, forests, fisheries and biodiversity]), and decoupling indicators for various sectors (energy, transport, agriculture and manufacturing). In line with the definition of decoupling, the decoupling indicators consist of an indicator of environmental pressure or resource use divided by one of economic output.

Finally, UNEP has put considerable effort into developing specific SCP indicators (UNEP, 2008). While the point is made that there is no universal set of SCP indicators that is equally appropriate for all countries, and to some extent different countries and SCP programmes will need to formulate their own indicators related to their own contexts and objectives, nevertheless there is inevitably wide overlap of common themes. In the indicator framework of the UN Commission for Sustainable Development (UNCSD) there are a number of specific SCP indicators, which are shown in Table 2.

TABLE 2: UNCSD INDICATORS OF CONSUMPTION AND PRODUCTION PATTERNS

Sub-theme	Core indicator	Other indicator
Material consumption	Material intensity of the economy	Domestic material consumption
Energy use	Annual energy consumption, total and main by main user category Intensity of energy use, total and by economic activity	Share of renewable energy sources in total energy use
Waste generation and management	Generation of hazardous waste Waste treatment and disposal	Generation of waste Management of radioactive waste
Transportation	Modal split of passenger transportation	Modal split of freight transport Energy intensity of transport

Source: UNEP (2008)

With respect to the energy efficiency indicator, it is worth noting that energy efficiency is often the cheapest and quickest way to mitigate climate change (IPCC, 2007), and is capable of reducing GHG emissions by up to 43% globally¹⁸.

SCP indicators have been proposed for developing countries. Examples are shown in Table 3. More detailed ad hoc indicators have been identified for 20 countries (appendix 1).

TABLE 3: EXAMPLES OF UNEP INDICATORS OF CONSUMPTION AND PRODUCTION FOR DEVELOPING COUNTRIES
Source: UNEP (2008)

Theme	International Indicator Sets		State (S) Driver (D) Response (R) Context (C)
	JPOI	MDG	
Material Consumption and Resource Use			
Average Water Consumption per Unit Product	IV.25 (d+e) / IV.26 (c)	(7.4 Total water)	D
Consumption of Ozone Depleting and Hazardous Substances per Unit Product	III.23 (c+d)	7.2	D
Ratio of Fertilizer & Pesticide Consumption to Agricultural Produce	(III.23 (a))	n/a	D
Agricultural Productivity (tonnes of product / ha of land)	IV.40	n/a	C
Materials Consumption per Capita (tonnes)	n/a	n/a	D
Depletion Rate of Minerals and Non-Renewable Resources	n/a	n/a	S / D

Direct Indicator Indirect Indicator

¹⁸ UNEP (2012), Increasing access to and demand for energy efficiency in a perspective of Sustainable Energy for All, UNEP, Paris, based on McKinsey (2009). Pathways to a low-carbon economy. McKinsey and Company

Theme	International Indicator Sets		State (S) Driver (D) Response (R) Context (C)
	JPOI	MDG	
Energy Use			
Energy Consumption per Capita / GDP	II.9/III.20	n/a	D
Average Energy Consumption per Unit Product	n/a	n/a	D
Electricity Generation per Capita	II.9/III.20	n/a	D
Proportion of Renewable Energy Sources of Total Supply of Primary Energy (%)	IV.38 (f)	n/a	S / D
Land Use and Biodiversity			
Annual Deforestation of Land (ha)	IV.45	(7.1 Forests)	S / D
Land Use by Category (%)	III.21/X.132	(7.1 Forests)	S / D
Land Affected by Land Degradation and Desertification (%)	IV.41	n/a	S
Number of Threatened and Extinct Species	V.44	7.6	S
Land Conservation (% Total Territory)	V.44	7.5	S / D
Waste and Pollution			
Average of Solid Waste Generated per Unit Product	(III.22)	n/a	S / D
Waste Recycling and Re-use (%)	III.22	n/a	D
General Waste Produced per Capita per Year (tonnes)	III.22	n/a	S / D
Hazardous Waste Produced by Sector per Year (tonnes)	III.23	n/a	D
Emissions of CO ₂ / Greenhouse Gases per GDP / per Capita	IV.38	7.2	S / D
Concentration of Criteria Air Pollutants in Urban Areas	IV.39	n/a	S / D
Water Quality of Fresh Water and Drinking Water Sources	IV 25, VIII.66	n/a	S
Socio-Economic			
GDP Growth per Annum (%) / per Capita	III.15	1.4 (GDP growth per employee)	C
GDP by Industry (% GDP) / GDP Agriculture (% GDP)	n/a	n/a	C / D
Investment Share in GDP	n/a	n/a	C
Imports / Exports by Product Group (tonnes and US\$)	V.47	n/a	D
Unemployment Rate (%)	II.7(e)/10(b)/11(c)	1.5 (Employment/population ratio)	C
Gini Coefficient	V.47	1.2 (Poverty gap ratio)	S
Population at Poverty Level (%)	II.7(a)	1.1	S / C
Population Growth	n/a	n/a	C / D
Literacy Rate (%)	X.123	2.3	S / D
Population with Access to Safe Water (%)	IV.25 (a)	7.7	S
Population with Access to Sanitation (%)	IV.25 (a)	7.8	S
Population with Access to Healthcare System (%)	VI.54	n/a	S
Kcal Consumed per Day per Adult (Food Security)	IV.40 (a)	1.9	S
Formal-Informal Housing Ratios (%)	II.11 (b)	7.9	S
Numbers of Professionals Participating in On-Job Training, Workshops and Seminars on Sustainable Buildings and Construction	n/a	n/a	D
Percentage of SMEs Contribution to GDP / Employment	IV.43 (e)	(1.7 Own Account)	S / D
No. of Working Children	(II.7 (g))	n/a	S
Institutional			
Number of Establishments Holding ISO 14001	III.18(a)	n/a	S
School Curriculum Containing Sustainable Consumption Concept	X.124	n/a	D
Change in Expenditure on Research and Development as a Percentage of GDP (%)	e.g. III.20(k)/28/33(a)/37(c)/40(g)/42(f)/44(q)	n/a	D
The Percentage of Total Environmental Protection Investment over GDP (%)	n/a	n/a	D
Others			
Change in Access to Public Transport (%)	III.21 (a)	n/a	S / D
Acreage of Land Used for Road Transport Infrastructure	III.21	n/a	S
Main Telephone Lines per 1000 Inhabitants	V.52	8.14	S
Number of Internet Subscribers per 1000 Inhabitants	V.52	6.16	S / D

It can be seen that the SCP indicators largely complement the MDG 7 indicators. The resource coverage of the latter focuses on the renewable resources of forests, fish and water; there is explicit mention of the conservation of habitats and species, and of the global pollutants CO₂ and ozone-depleting substances; and the social components of sustainability are reflected in the commitments to increase the provision of clean drinking, water and improved shelter.

The SCP indicators of Table 2 and Table 3 are concerned with the whole material resource base of the economy (not just renewables). For example, the extent to which countries are managing to reduce dependency on fossil fuels by shifting towards renewable energy sources, and dependency on energy-intensive private vehicles by shifting towards public transport; and how countries are turning their wastes back into resources and managing residual wastes. All in all, the SCP indicators allow for monitoring system change leading to reduction of resource use, including through efficiency improvements and renewable alternatives promoting sustainable lifestyles and production-consumption systems. Taken together the MDG 7 and SCP indicators provide a very good overall picture of how countries are responding to:

- The increasing scarcity of some resources, by reducing the intensity and increasing the efficiency of resource use;
- The need to manage renewable resources so that they are indeed renewed and or available; and
- The need to control both global atmospheric pollution and local pollution from solid waste.

There have also been a number of efforts to develop single, aggregate indicators both of economic welfare and human well-being that go beyond HDI, such as the Index of Sustainable Economic Welfare (ISEW) and the General Progress Indicator (GPI)¹⁹, and of environmental sustainability, such as the World Bank's Genuine Savings Indicator (World Bank, 2006) and the Ecological Footprint (EF) (WWF&al, 2006). However, these indicators have not so far achieved the kind of wide acceptance (or, in the case of the EF, scientific robustness) that have made the HDI so influential in broadening thinking about development. However, 'GDP and Beyond' is a theme that was on the agenda for the Rio+20 conference, and was referenced in the final declaration from this conference. (UNCSD, 2012, para 38).

In the case studies and other examples that follow in the next sections of this paper, the benefits arising from SCP are related to SCP indicators where the data allows, in order to show how SCP may enable poverty eradication and environmental sustainability objectives to be achieved together.

¹⁹ For recent work on ISEW and GPI see Posner, S. and Costanza, R. 2011 'A summary of ISEW and GPI studies at multiple scales and new estimates for Baltimore Coty, Baltimore County, and the State of Maryland', *Ecological Economics*, Vol.70, pp.1972-1980; issues related to the measurement of human well-being are fully discussed in Diener, E. and Seligman, M. 2004 'Beyond Money: Toward an Economy of Well-Being', *Psychological Science in the Public Interest*, Vol.5 No.1, pp.1-31, and Beaumont, J. 2011 'Measuring National Well-being - Discussion paper on domains and Measures', October, Office for National Statistics, London, http://www.ons.gov.uk/ons/dcp171766_240726.pdf





4. HOW DO SCP AND RE ADVANCE DEVELOPMENT AND SUSTAINABLE LIVELIHOODS?

In the nine years since the start of the Marrakech Process, UNEP and other organisations have generated a large number of case studies and other evidence that policies for SCP can deliver wide-ranging economic, social and environmental benefits, especially for the poor, many of whom, as has been noted, are especially dependent on the ecosystem goods and services from fragile environments. This section is organised according to the priority SCP sectors which in some cases were also identified by the Marrakech Process through its bottom-up multi-stakeholder consultations, and which also seem to be of direct relevance to the goal of poverty eradication. These are listed above as: food and agriculture, energy, housing (and construction), tourism, transport/mobility, water and waste.

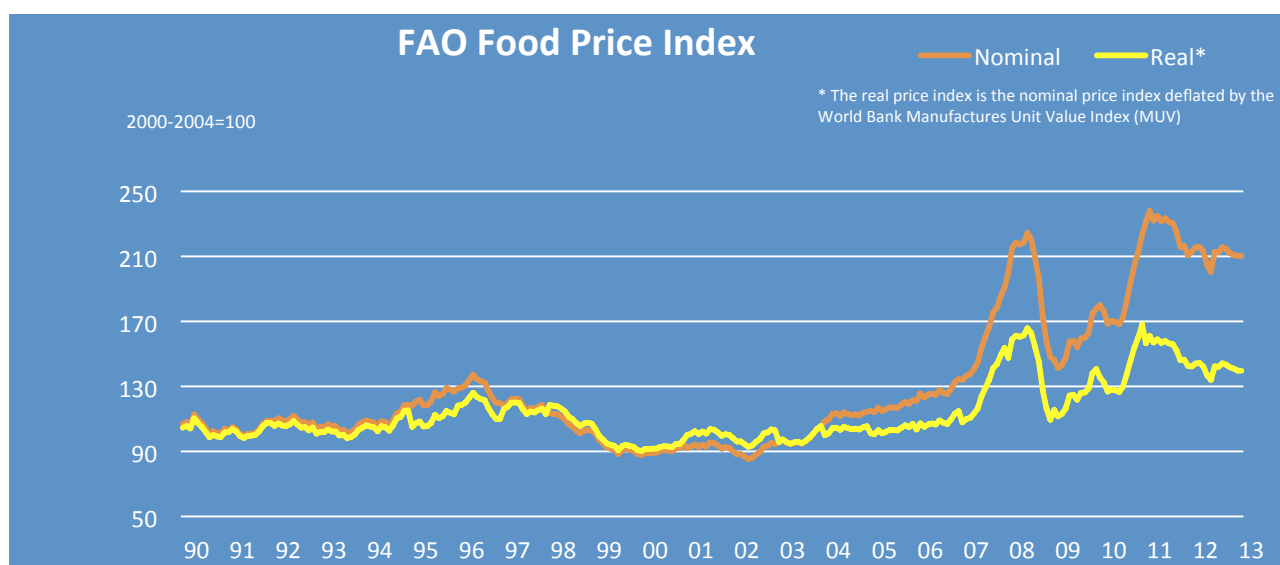
A range of case studies is presented for each sector, some very briefly simply by referring to the literature where it is discussed in more detail, others – only five in number for reasons of space – in much more detail so that the full range of benefits across all the dimensions of sustainable development can be identified. Most attention is given to food and energy, the two most fundamental physical needs for ‘development as freedom’, and housing, of crucial importance in a rapidly urbanising world. However, all the sectors are of course very important to development. The sometimes numerous sources for the case studies and other references in this section are given in the list of references, organised by the number of the section in which they appear, at the end of this paper.

What emerges from these case studies, long and short, is a rich picture of the potential for reinforcing economic, social and environmental benefits to be produced by shifting to SCP patterns. The necessary policies, investment and technologies required to make this shift deserve far more attention and priority than they have so far received from mainstream economic and development policy makers.

4.1 FOOD AND AGRICULTURE

One of the major challenges facing the global community is the sustainable provision of enough healthy, nutritious food for a human population that is expected to reach 9 billion by the middle of this century²⁰. The FAO food price index shown in Figure 4 shows that since 1990 world food prices have shown considerable volatility and at their peak in 2011 had increased by more than a factor of 2.

FIGURE 4: FAO FOOD PRICE INDEX



Source: <http://www.fao.org/worldfoodsituation/wfs-home/foodpricesindex/en/> (accessed May 7 2012)

²⁰ Other challenges related to food consumption, which are already major problems in industrial countries and becoming so for developing countries are food waste and obesity. These subjects are beginning to be reflected in the SCP agenda, but are not further discussed here.

In this context it is critical that, especially for poor people who include many small-scale and subsistence farmers, food production methods both conserve the soil fertility and water availability on which food production depends, and increase yields, so that poor people and farmers meet their nutritional needs and have better access to food, and are able to sell small scale production through access to existing or new markets. Following an exhaustive review of sustainable food production methods, UNEP (2011, pp.36-75) concludes: "Evidence shows that the application of green farming practices has increased yields, especially on small farms, between 54 and 179 per cent." UNEP (2011, p.36). Two such sustainable methods of food production are described in some detail in sections 4.1.2 and 4.1.3.

In addition to sustainably producing enough food, and where it is not going to be consumed locally, it may be necessary to conserve it for transport to distant markets. For financial sustainability, these markets need cover the full costs of sustainable production. There have been significant innovations in both these areas that are contributing to the sustainable consumption and production of food.

One of these innovations is the use of the sun, rather than expensive fossil fuels, to dry fruit and other food products in Burkina Faso and Mali. Solar energy can also be used, with PV panels, for irrigation.(Zacarias & al, 2005 p31). These case studies are given as practical examples of leapfrogging, whereby costly and polluting energy sources that might have been used in such cases are superseded by solar-powered technologies that are less polluting, and are or will be cheaper than the fossil fuel technologies they are replacing.

Food and agriculture also provide good examples of 'fair trade', another SCP phenomenon that has the potential significantly to increase the incomes of small-scale producers while at the same time decreasing the environmental impact of their food production. A UNEP report describes how this works with cocoa in the Dominican Republic, with a guaranteed price to organic growers that is above, and removes the volatility associated with, the world market price. Pre-financing of the harvest is also available, which can prevent farmers from getting into debt (Ibid, p30).

Of course, to deliver their full benefits to small-scale farmers, both organic production and fair trade require the development of consumer markets and certification, which can be costly for small farmers. As described in UNEP, 2006 (pp.20-21), two of the ways in which development agencies are supporting SCP are to help consumer markets to grow, and to develop and make more accessible certification schemes and bodies in developing countries. Development agencies are also involved in helping developing country female food producers make more efficient use of energy and water resources, for example in respect of shea nut harvesting and shea butter extraction in Northern Ghana (ibid, p.27). This increases their incomes, improves their health and working conditions, and much reduces the time they need to spend collecting fuelwood and water.

These are just a few of the many case studies that could be cited as to how SCP is improving the lives of poor people in developing countries. The next two sections give much more detail of two such initiatives, the success of both of which has enabled them to achieve considerable scale.

CASE STUDY 1 - The Regional Integrated Silvopastoral Approaches to Ecosystem Management Project

This section describes how resource efficiency and SCP can contribute to poverty eradication through the detailed case study of the introduction of silvopastoral systems (SPS) on previously degraded pastures. This case relates to a project supported by the World Bank in Colombia, Costa Rica and Nicaragua. This case shows that investment in the introduction of silvopastoral system creates jobs at a relatively low cost, restores ecosystem services which help to secure livelihoods, helps farmers to access currently growing markets for sustainable products and thus contribute to poverty eradication by providing a substantial increase of income compared to conventional ranching.

I. Context and description of the project

In 2002, the World Bank initiated a regional integrated silvopastoral project on a number of 'pilot' farms in three countries: Colombia, Costa Rica and Nicaragua (World Bank, 2008).

At that date, about 38% (94 million out of 248 million hectares) of Central America's total land area was used as permanent pasture, and this area had expanded over the previous decade in the three project countries at a rate of between 4% and 9% per year, mostly at the expense of tropical forest. Government-backed conversion of forest to other land uses, such as large-scale ranching, has been one of the leading causes of deforestation, poverty, joblessness and inequitable land distribution forcing many landless peasants to clear the forest for subsistence farming. The decline in productivity and the lack of appropriate technologies in the agricultural frontier forces many small farmers to sell cleared land to livestock farmers. Thus, ranching-induced deforestation has been one of the main causes of loss of some unique plant and animal species in the tropical rainforests of Central and South America.

Over the last years, progress has been made in reforestation, in particular in Costa Rica, providing an overall picture of increasing forest cover. However, the contribution of such replacement plantation forest to biodiversity and even carbon sequestration and biodiversity is less than that of the primary forest. Reducing the pressure on primary forest therefore remains important. Classical approaches to conservation, attempting to preserve pristine habitats within National Parks and other

protected areas are necessary, but insufficient in the face of growing pressure on land. The silvopastoral technology proposed under the project aimed to reduce the pressure, and complement the protected area management approach.

II. Objectives

The main objective of this project was to demonstrate and measure the effects of the introduction of payment incentives for environmental services to farmers on their adoption of integrated silvopastoral farming systems in degraded pasture lands in Colombia, Costa Rica and Nicaragua and the improvements in ecosystem functioning, global environmental benefits, and local socioeconomic gains resulting from the provision of said services through incremental local and global environmental benefits. The experience on farmers' reactions to the payment of environmental services and experiences in the management of payment incentive schemes required to produce global environmental benefits was assessed; and guidelines for the sustainable financing mechanisms for the promotion of silvopastoral systems to rehabilitate degraded pastures were also to be developed.

III. Outcomes

A total of 3673 hectares (ha) of improved silvopastoral system was established in the three countries in the duration of the project, which was 92% of the target. Some farms were sold in the process of project implementation and this was the reason why the target (4000 has) was not achieved. In the three countries the establishment of high-density trees in pastures and live fences were the main land use changes on farms, in Colombia intensive silvopastoral was established with *Leucaena* and multipurpose trees, while in Nicaragua and Costa Rica natural regeneration of trees in pastures were managed as a way to increase tree densities in pastures. The largest percentage increase in the area of fodder banks for dry season feeding was observed in Nicaragua (5%), perhaps because of cheaper labour prices than the other countries. The percentage area of forest (riparian, secondary forest etc) increased by an average of 1%.

The 3,673 ha of silvopastoral systems established have improved the ecosystem in 12,260 ha in which they are embedded, creating benefits in terms of carbon sequestration and biodiversity in three countries. A total of 14.2 %, 20.4 %, and 2.5 % of the total area of degraded pastures were converted to sustainable practices in Costa Rica, Nicaragua and Colombia respectively. In Colombia, a larger percentage of grass monoculture pastures was converted to intensive SPS.

The direct beneficiaries included small and medium-sized landowners (10-80 hectares farms), depending mostly on livestock and food crop production, with an average annual income from the farm of about USD \$3,000. The beneficiaries also included rural communities and nongovernment organizations.

Perhaps one of the most innovative outcomes of this project was the establishment of a differentiated payment scheme according to the degree of environmental service being provided (Payment for Environmental [or Ecosystem] Services - PES). The scheme eliminates the inefficiencies of paying a flat fee per hectare for conservation on a farm irrespective of the level of conservation effort applied by the farmer. PES allowed farmers to decide "how much" conservation they were willing to undertake. While the flat fee is easier to manage it is surely not economically efficient.

It is worth highlighting the project's successful introduction of adjustments to a cattle rancher's productive system as a change in cattle ranching production systems with PES support rather than a conservation land use change. Environmentally-friendly cattle ranching practices were promoted without the necessity of modifying their main cattle ranching activity.

The project showed that with SPS farmers can be significantly better off, as shown in Table 4. The introduced farming techniques reduced input requirements (including fertilizer and pesticides) and improved productivity.

TABLE 4: MEASURE ON SAMPLE OF 30 FARMS PER COUNTRY

Socio-economic Improvements	Baseline Value	Actual Value Achieved
Net income per hectare-livestock prod (US\$)	237.7	888.5
Mean soil erosion (tons/ha)	80.9	44.1
Avg. milk production (daily liters per cow during summer)	5.0	6.1
Avg. Stocking rate (animals per ha.)	1.8	2.5
Fire (% farms that use fire)	38.0	2.3
Labor demand (No. man per day)	52,719.5	69,423.6
Use of herbicides	13,913.6	7,899.9

Source: World Bank, 2008

However, the system requires a significantly higher investment, and sometimes significantly increased labour requirements, to implement. Not all the farmers have the capital necessary to accommodate these high initial costs. Table 5 shows that in the absence of payment for global environmental benefits, the Internal Rate of Return (IRR) is lower than the opportunity cost of capital in all cases. The PES component was instrumental in making the difference in “tipping” farmers into adopting the system.

TABLE 5: ESTIMATE OF IRR FOR DIFFERENT FARM MODELS IN THE THREE COUNTRIES

Table A - 5.1: Financial returns of different farm models (w/ & w/o) payment for environmental services - beginning of project.				
Farm model	Farm size	Increased labor requirement (% increase over base)	IRR (%), without payment for environmental services	IRR (%), with payment for environmental services
<i>Colombia</i>				
Extensive, beef	Medium (50-80 ha)	12	8	15
Semi-intensive beef	Small (15-30 ha)	13	13	15
Intensive beef	Small (15-30 ha)	8	13	19
<i>Costa rica</i>				
Dual-purpose: milk/beef	Small (15-30 ha)	34	7	16
<i>Nicaragua</i>				
Dual-purpose: milk/beef	Small (15-30 ha)	86	7	12
Dual-purpose: milk/beef	Small (15-30 ha)	59	9	14
Dual-purpose: milk/beef	Large (>60)	106	8	14

Source: World Bank, 2008

Regarding socioeconomic development, the final report prepared by CIPAV (Centre for Research on Sustainable Agricultural Production Systems) concluded that silvopastoral systems are the most profitable cattle ranching alternative when compared to traditional extensive ranching in Colombia. It generates higher income which was found to be sustainable in the short to medium term even though there is a need for high initial investment.

a) Economic Benefits

Accumulated PES per farm between 2003 and 2008 was US\$ 2,500, US\$ 2,400 and US\$ 2,300 for Costa Rica, Nicaragua and Colombia respectively.

- The adoption of SPS in cattle farms resulted in improvements in farm income and in all three countries the targets were reached; in Costa Rica income was increased by 55.5%, 66.9% in Nicaragua and 262.3% in Colombia.
 - US\$ 252 income per ha in Costa Rica (from US\$ 162 before the project)
 - US\$ 1,597 income per ha in Colombia (from US\$ 440.8 before the project)
 - US\$ 180 income per ha in Nicaragua (from US\$ 111.2 before the project)
- The average income in the farms has been increased by 10% during project’s duration.

The project shows that contrary to a common myth among farmers, a completely “clean” pasture (without trees) is not necessarily the most productive.

Table A - 5.3: Productivity indicators for farms with improved pasture with varying density of tree cover						
Indicator	Natural pasture	Improved pasture (IP)	IP + 10% tree cover	IP + 20% tree cover	IP+ 30% tree cover	IP + 40% tree cover
AU/ha/yr	0.8	1.4	1.4	1.3	1.1	0.8
lt milk/ha/yr	608	960	960	1017	860	704
kg meat/ha/yr	106	152	152	161	136	111
m ³ timber/ha	0	0	9	27	32	51

* - AU - Animal Unit

Source: World Bank, 2008.

b) Social Benefits

Payments for Ecosystem Services (PES):

This component evaluated farmer's reactions to incentive systems for global environmental benefits in terms of land use changes and socio-economic impacts.

- Larger farms received more for PES than small farms, but small and medium size farms had higher amount of PES/ha compared to larger farms in particular in Costa Rica and Colombia. A large percentage of income from PES was generated through land use changes with live fences and high density trees in pastures.
- Poor and extremely poor farmers made similar changes in land use with PES compared with non-poor farmers, and the results demonstrate that poor farmers can participate in PES schemes. The percentage area of degraded pastures decreased and the percentage area of high density trees in pastures and of fodder banks increased in all poverty class.

c) Environmental Benefits

The ability of the silvopastoral project to effectively integrate biodiversity conservation into cattle ranching was equally innovative. This has truly been a win-win situation. The live fences proved to provide a much enhanced habitat for a wide diversity of species and facilitate the genetic flow of species by providing a safe corridor through which to traverse larger landscapes. The planting of multi-strata live fences and riparian forest resulted in increased connectivity in the landscapes of the three pilot areas which is key for conservation of biodiversity. The project's environmental benefits included:

- increased biodiversity in the pilot zones in three project countries:
 - 42 forest dependent bird species in Costa Rica compared to 26 before intervention; 104 forest dependent bird species in Colombia compared to 74 before intervention; and 51 forest dependent bird species in Nicaragua compared to 40 before intervention
 - 130 butterfly species compared to 67 before intervention
 - 81 mollusc species compared to 35 before intervention
- increased carbon sequestration (about 19,558 incremental ton carbon sequestered by project end), and
- increased water quality in watersheds / improvement of water infiltration (reduction of Biochemical Oxygen Demand and Suspended Total Solids).

Farmers have been able to increase productivity, reclaim degraded soils and increase biodiversity conservation. This project has also contributed to:

- reduction of fossil fuel dependence (e.g. substitution of inorganic fertilizer with nitrogen fixing plants);
- diversification of farm benefits;
- scenic beauty enhancement; and
- land rehabilitation with reduction of degraded pasture from 17,5% of total area in 2003 to 5,6% in 2007.

The environmental benefits related to biodiversity conservation and reduction of greenhouse gases both accrued to the international community.

The impacts of land use changes on emissions of greenhouse gases are more striking when an analysis is made on impacts on emissions of methane and nitrous oxide. The use of forages of better quality than degraded pastures resulted in a reduction in emission of methane and the incorporation of leguminous trees and herbaceous legumes in pastures is associated in a reduction in the use of nitrogen fertilizers which results in emissions of relatively large amounts of nitrous oxide (note emissions of N₂O from leguminous pastures are insignificant). A case study on some of the farms indicate that those farms which planted *Leucaena* pastures in Colombia reduced emissions of methane by 21% and nitrous oxide by 36%, and therefore the overall impact on reduction of greenhouse gases is even greater when these emissions are taken into account.



The number of bird species in a productive SPS (multi-strata live fences and high density trees) was higher than that of traditional grass monoculture and low density pastures and comparable to some forest systems. The number of species registered in the different habitats increased over time and this may be partially explained by the increase in sampling intensity, and the fact that there was more complexity in the structure of the silvopastoral systems with increased growth. Of much importance was that some species of interest for conservation and/or forest dependent species were identified in silvopastoral habitats.

IV. Replicability

Ultimately, replicability and scaling up of the project have already been achieved. Colombia moved forward with an independent follow-up project through which FEDEGAN (Federación Colombiana de Ganaderos), a partner in this project, planned to scale silvopastoral system up to 62,000 ha in prominent cattle ranching areas throughout the country. In Costa Rica, the project created a demand for this type of payment scheme amongst cattle ranchers and payments for SPS-generated environmental services was recognized by FONAFIFO (Fondo Nacional de Financiamiento Forestal) under its national PES program. Nicaragua, through its FDL (Fondo de Desarrollo Local), also moved forward on scaling-up with a credit line to promote the adoption of silvopastoral systems that hundreds of farmers have already benefited from.

Guidance for future funding, lessons for replication/best practice, and policy requirements for environmental services in livestock production have been defined. The further development of the methodologies to measure carbon sequestration, biodiversity and water quality, as well as the lessons learned on the costs and benefits of SPS and the payment mechanisms for ecological services benefited several initiatives in other countries around the world.

V. Conclusion / evolution against SCP indicators and poverty eradication

This case study shows that for a limited investment of 4.5 million USD (including training), 12,260 ha of ecosystem can be improved, giving an average ratio of 367 USD/ha. This project had a direct impact on several categories of SCP indicators:

- a) Land use and biodiversity indicators
 - Increase of soil fertility
 - Annual deforestation of land
 - Number of threatened and extinct species
 - Land conservation
- b) Socio-economic indicators
 - Increase of the income of farmers
 - Increase in productivity
 - Increase in labour demand
- c) Waste and pollution
 - Reduction of CO₂ emissions
 - Water quality of fresh water and drinking water sources
- d) Material Consumption and Resource Use
 - Reduction of fertilizer and pesticide consumption

The project proved that PES is a useful tool to induce land use changes from simple, degraded pastures to a biodiversity-friendly silvopastoral system, providing a sustainable economic option for a more environmentally friendly cattle ranching. It was also shown that silvopastoral systems enhance biodiversity restoration and conservation, carbon sequestration, soil recovery and improve water quality.

In addition, the project showed that in order for land use changes to be more rapidly adopted, technical assistance and loan availability must be provided. The project has been instrumental in increasing the awareness of the potential of integrated ecosystem management to provide critical environmental services including the restoration of degraded pasture. This has been achieved through extensive training, capacity building and dissemination of knowledge generated through the project. This knowledge base is serving to provide guidance for replicating silvopastoral systems at all levels.

CASE STUDY 2 - The Philippine farmer network MASIPAG

This section describes how resource efficiency and SCP can contribute to poverty eradication through a detailed case study of the introduction of better practices of organic agriculture in the Philippines. This case shows that poor farmers, with the support of a network of scientists, can re-gain power over the management of their farm by re-converting to traditional varieties of rice.

I. Context, description and objectives of the project

About one third of the more than 85 million inhabitants in the Philippines are employed in the agricultural sector. Farmers comprised the second poorest sector in 2006 with a poverty incidence of 44%, i.e. 44% of all farmer families were not able to meet their basic food and non-food requirements. The staple crop of the Filipinos is rice. Although self-sufficiency in the production of rice is an explicit national policy, even stated in the Philippine constitution, rice imports had increased up to 8% of total rice supply in 2002.

MASIPAG is a network of small-scale farmers cultivating rice-based agricultural systems in the Philippines, associated with farmers' organizations, scientists and nongovernmental organizations. The network has been established in 1986 following a rice conference, which was initiated to discuss the negative impacts of the Green Revolution on Philippine farmers. The Green Revolution caused most Philippine small-scale farmers to convert their cultivation from traditional rice varieties to chemically-dependent, genetically uniform "high-yielding varieties". Subsequently, many farmers became indebted and lost their self-determination in their agricultural management. The aim of MASIPAG was and still is to improve the situation of resource poor small-scale farmers and to empower them (Glotzbach, 2012).

The ability to maintain a steady income is a major challenge for any farmer worldwide. Not only do farming families need to contend with weather variation, pests and crop diseases, but such environmental factors are compounded by ongoing price fluctuations for crop sales and increasing input costs. MASIPAG farmers are all small-scale and subsistence farmers. Any crisis, whether it is sickness in the family that needs medical treatment, or even unexpected educational costs, puts a major burden on the family budget. Indebtedness is an ongoing problem and one that can lead, in the worst cases, to landlessness. Farmers must struggle to find money to educate their children, treat sick family members, meet household needs and invest in the farm.

MASIPAG stands for Magsasaka at Siyentipiko Para sa Pag-unlad ng Agrikultura (Farmers and Scientists for the Advancement of Agriculture). The project sought to return control of the production process to the farmers themselves, including the development of traditional rice varieties that would not be dependent on chemical inputs (Roxas, 2006). The target beneficiaries are small farmers usually owning or leasing (or working the land as tenants) small plots (about one hectare) of irrigated rice land. Farmers who are tenants of big landowners generally are not able to control what kind of rice variety to grow as this is decided by the landowner.

Farmers join MASIPAG through their community associations or people's organizations such as their cooperatives. Nobody becomes a member unless they have undergone rigorous training (Roxas, 2006). To become a member of MASIPAG, farmers have to signify their intention and their willingness to comply with the MASIPAG management approach. The network is organized in approximately 20 provincial coordinating bodies and approximately 670 people's organizations (POs), which are groups of MASIPAG farming families. The POs develop their own local agendas and action plans, which are processed at provincial, regional and national levels and finally taken up within the work program of the entire organization. This institutional structure gives priority to farmers in decision making structures at all levels, including planning, research, implementation and evaluation (Glotzbach, 2012).

II. Outcomes

In 2009 the organization consisted of approximately 35,000 farmer members, tilling an average farm size of about 1.5 ha. Communal seed collection and free seed exchange are at the core of their management approach. MASIPAG farmers learn how to breed their own rice varieties from the old traditional rice varieties, and collect and share them. They enhance their on-farm diversity and farm without artificial fertilizers and pesticides. By 2012 they had cultivated more than 2,000 rice varieties, which are adapted to the specific local environmental conditions. A study in 2009 (Bosito 2009) found extensive benefits across the 'triple bottom line' of the economic, social and environmental dimensions of sustainable development.

a) Economic Benefits

The study found excellent outcomes overall although there are areas that could still be improved. Crucially, the results show that the positive impacts of engaging in farmer-led sustainable agriculture are most pronounced for the poorest farming families.

- The results [of a survey conducted between groups of farmers] show that yield differences for the full organic farmers, conversion farmers and conventional farmers are not statistically significant. The average yield among all farmers is 3,388 kg per hectare. The average yields for the different groups range from 3,287 kg for conversion farmers, 3,424 kg for organic farmers and 3,478 kg for conventional farmers.
- When shifting to MASIPAG from HYV (high yielding varieties) farming, there is a 15-20% decrease in yields in the first two cropping seasons, but yields become comparable or even higher, usually during the second or third year. The national average rice yield is 60 cavans, with prime irrigated rice lands yielding 100-120 cavans (1 cavan = 50 kg) (under chemical farming); MASIPAG attain comparable yields, averaging at 80 cavans, but farmers have also reached as high as 120 to 150 cavans.
- In terms of cost reduction in the purchase of chemical inputs, MASIPAG farmers spend 30-40% less than farmers on conventional systems (Masipag, 2012).

Changes in income are therefore positive for MASIPAG farmers. Over the past 7 years, 74% of full organic farmers report increasing income. Only 31% of conventional farmers cite an increase while 68% report stagnant or declining incomes.

- Net agricultural incomes are significantly higher for MASIPAG farmers. Net agricultural income is 36,093 pesos for full organic farmers and 30,819 for conventional farmers. Per hectare net incomes of the full organic farmers are one and a half times higher than those of conventional farmers.
- Livelihood calculations (net income plus subsistence) show major advantages to the full organic farmers. Differences in livelihood are highly statistically significant. Full organic farmers have an average livelihood income of 69,935 pesos, those in conversion 68,351 and conventional farmers 54,915 pesos per annum. Income per hectare for the poorest 25% of organic farmers is 1.5 times that of the poorest 25% conventional farmers.
- Annual household cash balance is positive for full organic farmers, negative for conventional farmers. Full organic farmers have, on average, a positive annual cash balance of +4,749 pesos. Conventional farmers have an average negative cash balance of -4,992 pesos.

b) Social Benefits

MASIPAG, as an organisation, focuses on participatory seed breeding and prioritises the role of farmers in the decision making structures of the organisation, and the research, design and implementation of its programs. Some indicators of a bottom-up approach are: involvement in seed selection and breeding, involvement in the organisation and the community, approaches to training, and social change at an individual and community level. The results show that the full organic farmers take key roles in the organisation, including through the breeding of rice. MASIPAG farmers are involved in a wide range of leadership activities in their community. Farmer-to-farmer education, the use of farmer leaders as trainers and cross-farm visits between farmers are also valued as effective methods of training that prioritise the knowledge and leadership qualities of farmers. In the community, more communal activities, such as shared communal work (bayanihan) and producer cooperatives are found among the MASIPAG farmers.

The farmer-led approach is central to the MASIPAG network at all levels of the organisation including planning, research, implementation and evaluation. The research is led and conducted by farmers and builds on local knowledge and farmers' innovations. Farmers, as members of people's organisations, analyse their needs and potential, and develop local agendas and action plans. These aspirations are taken up by the organisation and processed at provincial, regional and national levels to determine the work program for the entire organisation. Consolidation of planning at regional and national levels ensures that efforts can be focused and synergies created.

Implementation is then carried out in partnership with farmers and other NGOs. MASIPAG has developed a program that looks to farmers as active and knowledgeable. Farmers are not passive recipients of 'improved' varieties but are actively involved in selecting and creating new varieties and new forms of agriculture. The impressive yields and positive results from the program are a measure of the success of this approach and the creative work of the small-scale, resource poor farmers in the network.

- **Full organic farmers are actively involved in the organisation and the community.** Full organic farmers are represented in community level organisations, as farmer trainers and as innovators. Half of all full organic farmers are leaders in people's organisations, a third are farmer-trainers or committee members.
- **A grass-roots farmer-led approach leads to high rates of training and adoption of sustainable agriculture techniques.** 83% of full organic farmers are trained in cultural management of rice. MASIPAG farmer-trainers and extension workers are ranked highest by all groups, above government and other NGOs.
- **Full organic farmers feel empowered and positive.** Conventional farmers struggle to see scope for positive change. Full organic farmers list 67 positive outcomes. Conventional farmers list only 35 with the top impact cited as 'no change'.
- **Communal labour is used more often for full organic farmers.** 32% of full organic farmers but only 18% of conventional farmers use communal labour.
- **Marketing groups lead to higher economic returns.** Crop income is 47% higher and livestock income 46% higher for farmers that participate in marketing groups.

c) Environmental Benefits

The on-farm diversity of the MASIPAG farms in the study is much higher than for conventional farms. The full organic farmers have a higher diversity of rice varieties, crops, and livestock. Organic farmers grow and use on average 45 different kinds of crops compared to 30 for the conventional farmers, ie 50% more crops on average than conventional farmers. The study also looked at the number of varieties of rice grown on each farm. The results indicate a significantly higher number of rice varieties in the full organic group. Nationally, on average, organic farmers grow three times as many rice varieties than conventional farmers. In Luzon, the full organic farmers cultivate, on average, 6.5 varieties; in the Visayas, 5.1; and in Mindanao, 3.1. In comparison, conventional farmers in all three regions grow 1.5 to 1.8 varieties. This reflects a significant contribution to agro-diversity.

On-farm diversity increases are augmented by the emphasis on locally-adapted agricultural systems and diversity increases across the whole network. As a network, MASIPAG has been responsible for conserving and breeding thousands of

rice varieties. MASIPAG has collected 1,090 traditional rice varieties. From its participatory rice breeding activities, the network has also developed 1,069 varieties of rice that are locally adapted to specific agroecological conditions and performed 273 crosses resulting in 185 farmer-bred selections.

The farmers using farmer-led sustainable agriculture show a dramatic drop in the use of chemical fertilisers. This is a major environmental contribution. For the full organic farmers, the number of farmers using chemical fertilisers has dropped to zero. In the year 2000, 52% of the farmers now in the organic group were using chemical fertilisers. In contrast, the number of farmers using chemical fertilisers in the reference group remains constant at 85%. In the conversion group, the majority of farmers still use fertiliser, but a reduction is visible from 75% down to 64% using fertilisers. In terms of the average amount of fertiliser used per hectare of rice, similar trends were recorded. The full organic farmers have fully stopped application of chemical fertiliser so the rate of use has dropped to zero.

The conversion farmers have reduced their application rate from 3.9 to 2.9 bags (or 195 to 145 kgs) per ha of chemical fertilisers, while conventional farmers remain constant at 4.4 bags (220 kgs) per hectare. At first sight these application rates appear moderate. However, it needs to be noted that in general 2-3 harvests per year are possible. Thus, the annual fertiliser input per hectare is much higher. Furthermore, application rates vary strongly. This is shown in the high standard deviation of 4.7 bags (235 kgs). A good proportion of farmers use more than 8 bags (400 kgs) per season, while in one specific study on hybrid corn in the Visayas, MASIPAG (2008) revealed that farmers are using in the range of 10-15 bags (500-750 kgs) of chemical fertilisers per season (unfortunately the source does not provide data on the type of fertiliser used).

The reduction of chemical fertilisers through the use of farmer-led sustainable agriculture amounts to a very substantial impact on the environment. It reduces environmental damage, water and air pollution, reduces capital costs to the farmer and saves imports, and all these represent important economic gains to the farmer or more broadly. It also has significantly lower impacts on the climate.



In conclusion, full MASIPAG farmers have:

- **Increased on-farm diversity.** Organic farmers grow on average 50% more crop types and three times more varieties of rice than the conventional farmers
- **Decreased chemical fertiliser and pesticide use.** Organic farmers have eliminated the use of chemical fertilisers and pesticides and use a variety of organic methods. In contrast 85% of conventional farmers use fertiliser and 80% continue to use pesticides. 97% of the full organic group use alternative pest management.
- **Increased soil fertility, biodiversity and crop tolerance.** 84% of organic farmers but just 3% of conventional farmers report increases in soil fertility. 59% of organic farmers but just 6% of conventional farmers report a reduction in soil erosion. Increased tolerance of plant varieties to pests and diseases is reported by 81% of organic farmers. In contrast, 41% of conventional farmers see the tolerance to pests worsening.

III. Replicability

This approach continues to be upscaled in the Philippines, and by 2011 involved more than 37,000 farmers (compared to a total of more than 300,000 rice farmers in the Philippines), and could be applied to other crops in other countries. However, replicability elsewhere would seem to depend on the development of a similarly strong network of scientists, NGOs and farmers associations.

IV. Conclusion / evolution against SCP indicators and poverty eradication

This project had a direct impact on three categories of SCP indicators:

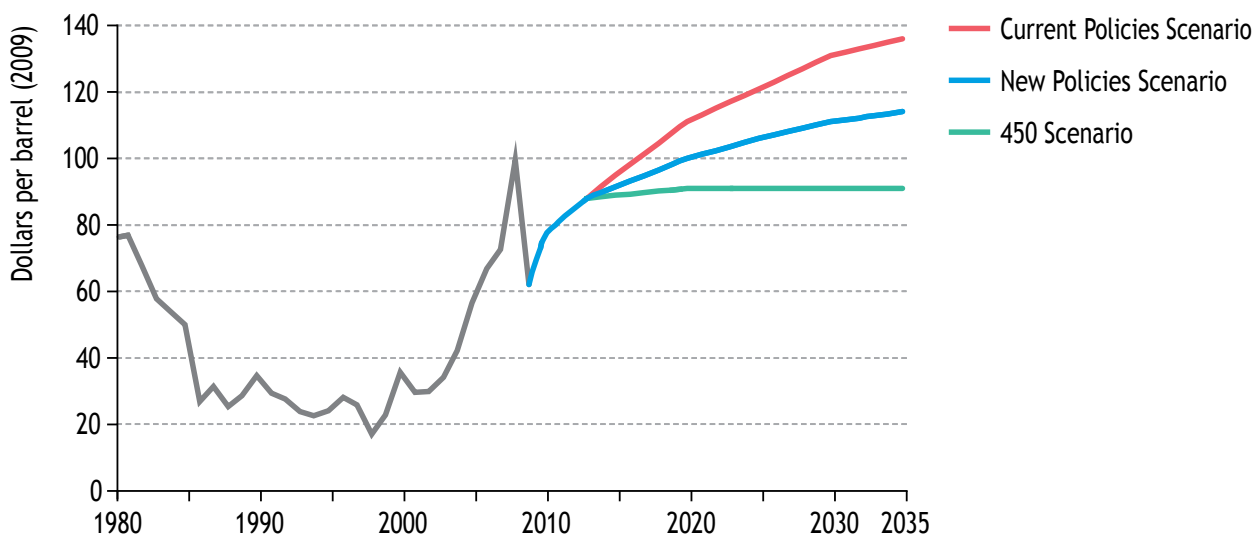
- a) Land use and biodiversity indicators
 - Increase of soil fertility
 - Increase of variety of rice cultivated
 - Increase use of organic farming methods
- b) Socio-economic indicators
 - Increase of income of farmers

- c) Material Consumption and Resource Use
- Reduction of fertiliser & pesticide consumption

4.2 ACCESS TO SUSTAINABLE ENERGY

No development is possible without access to modern, affordable energy services. Since the industrial revolution these have been provided by fossil fuels. However, we are at the tipping point of a major change in energy supply: the age of cheap fossil fuels now seems to be over. Figure 5 shows oil prices since 1980, and projections by the International Energy Agency (IEA) through to 2035. In the meantime, the IPCC report estimates the possible share of renewable energy as 70% of the global energy mix by 2050.

FIGURE 5: AVERAGE CRUDE OIL IMPORT PRICES, 1980-2009, AND IEA PROJECTIONS TO 2035



Source: IEA 2011

From a low of about \$20 per barrel in the late 1990s, oil prices increased through the 2000s to an average of over \$90 per barrel in 2008 (reaching a top price of \$145 per barrel, not shown in Figure 5). They are projected to stay above \$90 per barrel even in the 450 scenario, which envisages the global community taking urgent action to reduce CO₂ emissions in order to mitigate climate change. On current policies, world oil prices are projected to rise to an average of around \$140 per barrel, although, unlike the smooth increase in Figure 5, that rise is likely to be accompanied by great volatility.

While the new availability of unconventional natural gas resources brings some uncertainty about future gas prices, global (as opposed to US) gas prices remain high. It is hard to see low prices being sustained in the face of resurgent global demand if the global economy picks up, if gas becomes a serious competitor in transport markets, or if countries seek to switch out of coal into gas in order to reduce CO₂ emissions.

Many developing countries are blessed with abundant renewable energy sources – most obviously, solar, wind and biomass resources. The renewable energy technologies available on a large scale to human activities are still relatively immature and have received very little investment compared with the fossil fuels with which they are now competing. But their deployment globally is now at scale and their costs have fallen sharply in recent years, as a combined result of factors such as technological deployment, larger scale commercialization, research and development, policy support, access to financing by investors. They now offer easily the best prospect for future energy security to countries that have not yet locked themselves into fossil fuel infrastructures. Renewable energy sources offer one of the best opportunities for developing countries to leapfrog the high-carbon energy sources and infrastructures of earlier industrial ages. For planning purposes, the choice of any renewable energy technology should be science-based, using Renewable Energy Resource Assessments to determine the most appropriate technology for any particular location. An example in Northern Nigeria in Assefa (n.d., pp.35-37) shows how solar power, applied comprehensively to a village of 7,500 people, can deliver home lighting, a reliable water supply for home use and irrigation, health benefits (through evening lighting and refrigerated vaccines), improved education (through evening lighting in schools), increased income opportunities for women and small businesses, and more secure socialisation after dark. Looking beyond this example, he concludes: “Once an energy system that is based on renewable systems is set, clean or carbon-neutral industrialization can be developed.” (Assefa, n.d., p.39).

There is both great variety and a very large number of case study examples of developing countries that are starting to develop and take advantage of their renewable energy resources. UNEP (n.d. but after 2010) gives examples of a company seeking to replace 20 million kerosene lanterns solar rechargeable lamps, a biogas plant in Nigeria that runs off abattoir effluents, wind-powered water pumps that are used for irrigation in Senegal. UNEP (2010, pp.10,18) records the creation of 21 new solar enterprises, which between 2004 and 2009 installed nearly 300,000 m² of PV cell, supplying nearly 100,000 households with hot water, and creating 650 new jobs; of solar-powered drip irrigation in Benin, that greatly increased the production of high-value vegetables, and thereby the incomes of the women who produced them; and the installation of PV-diesel genset hybrid systems in Borneo that permit more flexible and trouble-free power generation in schools.

UNESCAP (2012) provides many examples of renewable energy projects in the Asia-Pacific region, including mini-grids in China, solar cooking stoves in Cambodia, solar lanterns in Laos, biogas in Samoa, micro-hydropower in Indonesia, and India's Solar Mission for heat and both on-grid and off-grid solar energy.

The Ashden Trust in the UK, through its Ashden Awards²¹, has supported more than 130 sustainable energy initiatives, many in developing countries, and utilising a wide range of renewable technologies, including biogas, biomass briquettes, micro-hydro, grid-connected, off-grid and thermal solar, water pumps, wind turbines and wood stoves.

UNEP's Rural Energy Enterprise Development (REED) project has developed biomass energy in Tanzania, small-scale hydropower in Honduras, energy-efficient lighting in Ghana, and solar home systems in Nicaragua (Napier-Moore 2004), through an innovative financing mechanism focusing on enterprise development for cleaner energy.

The following sections present two more extended case studies, one on the development of biogas in China, and one on off-grid electrification in South Africa. Both give examples of renewable energy developments that have already gone to scale, but still have considerable potential for further expansion. Both still face considerable challenges to achieve that potential. But in the light of what they have already achieved, the gains from doing appear very large.

CASE STUDY 3 - Waste and biogas in China

This section describes how resource efficiency can contribute to poverty eradication through a detailed case study of the large-scale dissemination of bio-digesters in China. This case shows that bio-digesters can help farmers reduce the environmental impact of their activity and increase their income, by reducing waste and generating their own supply of energy for cooking and heating.

I. Context and description of the project

80% of the 1.3 billion population of China live in rural areas (Ding et al., 2011). China's energy demand has doubled since 2000; and the country has become the world's largest energy consumer. The current energy structure, which is dominated by coal, creates serious environmental consequences (Wu et al., 2010). China has become the largest greenhouse gas emitter in the world in absolute terms, before the US and the European Union, but per-capita CO₂ emissions in China still remain just 63% of the OECD average (IEA, 2011). In rural areas of China, where the access to energy services from the grid is limited, the primary source of energy consists of agricultural residues at 35.4%, firewood at 22.0% and coal at 31.1% (Wang et al., 2010). With the arable land area of 124 Mha (Yan et al., 2007), or about 54.5% of the total land area, Chinese agriculture results in around 630 million tons of agricultural residues annually, of which only 23% is used for forage and 75% is used as livelihood energy or discarded or burnt in the field (Zhen, 2010). The combustion of agricultural residues in the fields emits a large amount of CO₂ and other harmful gases and particles (Li, 2009). According to a 2003 estimate, direct combustion of straw in rural China emitted 415.21 million ton of CO₂ (Ding et al, 2011). Similarly, an estimated 380,000 premature deaths per year are attributed to indoor smoke from solid fuels in China (Smith, 2007).

Moreover, purchasing commercial energy sources poses a financial burden for poor households; and using non-commercial energy sources costs poor households a significant amount of time, and hence deprives them of income generation opportunities (Li et al., 2009). The ratio of energy expenditure to livelihood expenditure in rural households has been increasing



²¹ See <http://www.ashden.org/winners>

steadily, for instance from 5.58% in 1985 to 9.15% in 1994 in Sichuan province (Wang and Feng, 2001). A rural household may spend between 164 yuan (USD 21) and 309 yuan (USD 39) per year for cooking and heating (Van Groenendaal and Gehua, 2010), or between 30 yuan (USD 4) and 1,000 yuan (USD 125) depending on their reliance on commercial fuels (Gregory, 2012). A household may spend 1-2 hours per day or 1-2 days per week to collect firewood (Feng et al., 2011) and an extra time between 20 and 40 minutes for cooking a meal (Van Groenendaal and Gehua, 2010).

The energy structure of rural households therefore shows numerous complex linkages between the issues of poverty, health and environment (Li and al., 2009) and has become the key issue for poverty eradication in this context (Fan et al., 2010).

II. Objectives

Anaerobic household biogas digesters have been widely installed in China, not only to provide energy but also to create a sustainable agricultural system by recycling biomass such as agricultural residues, livestock manure and human waste (Jiang, Sommer, and Christensen, 2011). The feedstock ferments in the digester tank to produce biogas, which contains mainly 50-70% methane (CH₄), 30-50% of carbon dioxide (CO₂) and a small amount of other gases, and has a typical calorific value of 21-24 MJ/m³ (Bond and Templeton, 2011). The process occurs with the aid of bacteria within a temperature range of 8-60° C.



In China, more elaborated eco-agricultural models such as 'three-in-one', 'four-in-one' and 'five-in-one' models have been largely installed (Chen et al. 2010). The 'three-in-one' model combines the biogas digester with a pigsty and toilet, and is popular in southern China. Installed with a small amount of investment, it provides biogas for cooking and lighting, improves household hygiene, and generates organic fertiliser for plants. The 'four-in-one' model adds a greenhouse to the 'three-in-one' model, and is prominent in northern China. The greenhouse can be used to increase the temperature of the biogas digester in order to enhance the digester efficiency in the cold season or can be used to increase the temperature so as to improve agricultural production. This model requires a larger amount of capital for building the solar greenhouse and more water for growing greenhouse vegetables/fruits. The 'five-in-one' model combines the biogas digester with solar-powered barns, a water saving irrigation system, a water cellar and a toilet, and is suitable in northwest China where water is scarce.

III. Outcomes

China is a leading country for the development of anaerobic digestion for the production of biogas (Wu et al., 2010) with the largest number of household gas plants in the world. By 2009, there were 30.5 million biogas plants producing 12.4 billion m³, which is equivalent to 19.0 million tons of standard coal (Jiang, Sommer, and Christensen, 2011). This rapid expansion of biogas in China is due to the accumulated knowledge and experience in developing biogas, the availability of large amounts of fermentation materials, and to state support in terms of funds (Chen et al. 2010).

The biogas technology for rural households has improved in the past 40 years (Jiang, Sommer, and Christensen, 2011); and the government has accelerated its support for rural biogas projects since 2003 (Chen et al. 2010). Following the introduction of commercial household biogas digesters that are made of glass fibre-reinforced plastic in the Chinese market in 2000, the number of household gas plants has been increasing dramatically (Chen et al. 2010). The financial subsidies for household biogas plants are stipulated in the Rural Biogas Construction State Debt Program Management Method as 1,200 yuan (USD 150) per household in the north western and north eastern areas, 1,000 yuan (USD 125) per household in the south western area, and 800 yuan (USD 100) per household in other areas (Chen et al. 2010).

The estimates of the amount of biogas produced by a typical 8-10 m³ household anaerobic biogas digester varies from between 0.1 and 0.3 m³ per m³ of digester volume per day (Jiang, Sommer, and Christensen, 2011) to between 0.3 and 0.9 m³ (Van Groenendaal and Gehua, 2010), or 385 m³ per year on average (Chenga et al., 2011). They confirm that the amount of biogas produced is more or less sufficient to supply for cooking and lighting for a family of 3-5 persons as the thermal efficiency of biogas is much higher than traditional biomass. The produced biogas can be equivalent to 0.605 tce

(total carbon equivalent per year) (Chen et al., 2010), 1,400 kg of firewood (Chenga et al., 2011), or 68% of coal and 74% of wood consumed by the household (Bond and Templeton, 2011). When comparing between users and non-users of biogas digesters, the users consume more than 10% less energy because of the high thermal efficiency of biogas (Ding et al., 2011). In monetary terms, the use of biogas for cooking can save 300-500 yuan (USD 38-63) per year for a household (Chenga et al., 2011).

a) Economic benefits

The cost for installing an anaerobic household biogas digester varies depending on the model and local conditions (Van Groenendaal and Gehua, 2010). To build a biogas digester may cost between 1,500 yuan (USD 188) and 2,200 yuan (USD 275); and for a typical 'three-in-one' model, the total cost was estimated to be between 3,600 yuan (USD 450) and 6,500 yuan (USD 813), including the costs of remodelling a kitchen, toilet and pigsty. The installation cost is covered by the government subsidies of 1,000 yuan (USD 125). According to some analyses, the costs can be recovered in 1-1.5 years (Gregory, 2012) or 2-3 years (Bond and Templeton, 2011) from fuel savings, increased income and freed-up time (Gregory, 2012). Another study suggests the cost between 3,483 yuan (USD 435) and 4,580 yuan (USD 573) and the payback period between 4-8 years and 5-10 years respectively, or 4-5 years and 4-6 years, depending on the estimate of income from the use of the biogas digester (Van Groenendaal and Gehua, 2010). With regard to the 'four-in-one' model, the cost varies from 30,000-80,000 yuan (USD 3,750-10,000) depending on the scale of the greenhouse, which accounts for the most of the cost (Chenga et al., 2011). Of the total investment, 50-60% of total investment can be borrowed from local banks, 30-40% is paid by the farmers, and 3,000 yuan (USD 375) is subsidised for the biogas digester and biogas accessories.

Evaluating the economic impact of biogas system is complex because of the calculation of the monetary value of fuels (Bond and Templeton, 2011), and there exist various estimates from different studies. For instance, according to the study on the 'four-in-one' model in Liaoning province (Chenga et al., 2011), 85% of the total agricultural revenue in the 'four-in-one' system is achieved by the production in the greenhouse as the quality of plant cultivation is enhanced by the use of the greenhouse and the biogas slurry. With a biogas system supplying more than 300 m³ biogas and 16 m³ organic fertilizers per year, the household can cultivate 5-15 pigs, produce 1,500 kg vegetables in winter and earn 5,000 yuan (USD 625) on average. The users of the 'four-in-one' system prefer to stay at home throughout the year as the income of the 'four-in-one' system is steady and better than working outside the village.

Because of differences in such factors as climate, the economic benefits of rural biogas vary by region. According to Sujuan Jiang et al. (2007) in the inland Sichuan Province, a biogas digester of 8 m³ can reduce fuel costs by 500 - 1200 yuan per annum, and reduce fertilizer and pesticide costs by around 100 yuan per annum. Including the economic benefits of raising agricultural, livestock, and poultry yields, every household can earn 800 - 1500 yuan per annum from a biogas digester (Jiang, Hu and Li, 2007). According to Haifeng Hui et al. (2006), in Northern Jiangsu (at the middle of China's coast), every household with a biogas digester can reduce fuel and electricity costs by 250 - 300 yuan per annum, reduce fertilizer and pesticide costs by 150 - 200 yuan per annum, and raise agricultural, livestock, and poultry yields by about 300 yuan per annum. In total, a biogas digester can directly bring a rural family about 1,000 yuan per annum in economic benefits (Hui, Jiang and Liu, 2006).

Furthermore, there is a significant need for trained biogas technicians as the service system for biogas is insufficient in China (Peidong et al., 2009). As a trained biogas technician can earn better than average wages (Gregory, 2012), there is a potential employment opportunity for people in rural areas.

b) Social benefits

Cooking and heating with biogas has reduced the emission of particles and improved indoor air quality, thereby decreasing illness associated with indoor pollution. Upgraded sanitation from the anaerobic digestion of animal and human waste has reduced the pollution of surface water and improved health conditions (Van Groenendaal and Gehua, 2010). Following biogas installation in rural China, reductions in schistosomiasis and tapeworm of 90-99% and 13% respectively were recorded (Bond and Templeton, 2011). The users of biogas also perceive improved health conditions of their families and appreciate enhanced indoor living conditions from the installation of biogas digester which accompanied the renovated kitchen and toilet (Van Groenendaal and Gehua, 2010).

Another study also noted that the users of biogas are pleased with the toilet included in the biogas system as it is much more pleasant and cleaner than traditional toilets. In addition to the improved indoor environment and health status, farmers' lives have become more stable without having to work outside their village during winter, owing to the steady and better revenue from cultivating vegetables and fruits in the greenhouse of the 'four-in-one' system (Chenga et al., 2011).

c) Environmental benefits

As biogas provides around 50% thermal efficiency, which is much higher than biomass and coal, biogas can reduce a significant amount of usage of biomass and coal, thereby preventing soil erosion and water loss (Chen et al., 2010). By

replacing 80% of the energy consumption with biogas, a household can save more than 2,000 kg of firewood, equivalent to a forest area of 2,331 m² and soil erosion of 3.2 tons (Ding et al., 2010). According to a study in Hunan province, the use of biogas has resulted in a decrease in the actual consumption of coal, firewood and straw, though the savings vary depending on the season (Chen et al., 2009). The savings of coal, firewood and straw were calculated to be between 42.7 kg to 419 kg per person in two seasons; hence 419 tons less firewood, 45.5 tons less straw and 42.7 tons less coal were burnt for 1,000 inhabitants in the village. The forest area which was saved from 419 tons of firewood is estimated to be 73.3 ha.

The anaerobic biogas digester produces a large amount of anaerobically digested slurry which carefully managed, can be used as organic fertilizer and as a pesticide; hence the household can save expenditures on commercial fertilizer and pesticides and also benefit from improved soil fertility (Lu et al, 2012). A study on the 'four-in-one' model in Liaoning province found that 16 m³ of high quality organic fertilizer per year was supplied from the biogas digester and perceived by the users as the best output from the biogas digester (Chenga et al., 2011). In a comparative study between users and non-users of biogas digesters, a reduction of 50.7% in the use of chemical fertilizers, or 30.18 yuan (USD 4) per mu (0.067 ha) was noted (Ding et al., 2011). This study observed that replacing the inorganic chemical fertilizer with the organic one had enhanced the activity of natural predators, resulting in 20% less destruction of crops by pests; and the use of the organic pesticide decreased the appearance of pests in the crop fields by 13%.

Biogas is clean energy as it is carbon neutral and does not discharge toxic components (Chen et al., 2009); the substitution of biogas with traditional biomass and coal reduces the emission of CO₂ and SO₂ (Ding et al., 2011). Based on the substitution of household biogas for traditional biomass energy and coal during the period from 1996-2003, the reduction of the annual discharge of CO₂ was estimated to be between 397.6 and 4,193.9 thousand tons and that of SO₂ to be between 21.3 and 62 thousand tons (Ding et al., 2011). The CO₂ savings from the estimate noted earlier that 30.5 million household biogas digesters produce 12.4 billion m³ biogas in China, which is equivalent to 19 million tons of standard coal (Jiang, Sommer, and Christensen, 2011).

IV. Replicability

China has so far achieved a significant expansion of the anaerobic household biogas digesters, owing to the accumulated technical knowledge and experience, the availability of fermentation materials and strong state support, including financial support (Bond and Templeton, 2011). Nonetheless, several studies point out the irregular quality of biogas digester construction, a lack of technical standards and the low service system coverage (Peidong et al., 2009). Insufficient provision of maintenance and repair of existing facilities has been observed in many developing countries (Bond and Templeton, 2011). In China, despite the target of 100% coverage of biogas service systems in rural areas, specified in the National Rural Biogas Service System Program, the current coverage of biogas service systems is 85.9% (Peidong et al., 2009). As a result, only about 26.5 million households were using biogas in 2007, while 139 million rural households were expected to install biogas digesters according to China's rural biogas planning project (2006–2010) (Chen et al. 2010). This means only about 19% of the biogas potential of rural China has been achieved so far.

As already noted, the potential of biogas development in China is considerable as there is a significant amount of biogas fermentation material available. Livestock and poultry manure was expected to be 2.5 billion tons in 2010, from which the collected amount can be translated to 120 million tons of standard coal (Chen et al. 2010). At present, only 0.5% of total agricultural residues are utilised for biogas generation (Bond and Templeton, 2011). As agricultural residues amount to about 681 million tons annually, of which about 290 million tons can be used as an energy resource, the saving of 145 million tons of standard coal could be realised (Chen et al. 2010). An estimate suggests that if the available agricultural residues and animal waste are transformed into biogas, 311.5 billion m³ of biogas can be produced and mitigate the energy shortage and environmental issues in rural areas (Tu et al., 2011). According to another assessment, if all the animal waste of 3 G t per year was treated to transform to biogas, the total energy of 3.77 EJ would be produced, which is equivalent of 5.23% of China's total energy consumption in 2006 (Lu et al., 2010). Yanli et al. (2010) estimate that this could lead to an annual reduction in CO₂ emissions of 612 to 753 million tonnes.

Furthermore, the scale of farms has been growing since 1980s following the government's economic reform and participation in the WTO (Jiang, Sommer, and Christensen, 2011). As small-scale farms are gradually decreasing and medium- and large-scale farms are emerging, the number of medium and large-scale biogas plants has been growing. The number of medium- and large-scale biogas plants increased from 748 in 1998 to 56,856 in 2009 with the total amount of 0.92 billion m³ biogas being produced. The medium- and large-scale biogas plants offer numerous potentials. For instance, they can treat a large amount of manure and agricultural residues from large-scale farms as well as municipal and industrial organic wastes which have become serious environmental problems in China. The larger biogas plants can utilise technology and apply management skills more efficiently with the higher degree of mechanisation. More importantly, they can produce a large amount of biogas which can be used for heat and power generation. The potential of biogas plants for power generation is notable as the power generated from large-scale biogas plants can be transferred into the national grid while that of small- and medium-scale biogas plants can only be used within the farms and enterprises.

V. Conclusion / evolution against SCP indicators and poverty eradication

This project had a direct impact on several categories of SCP indicators:

- a) Land use and biodiversity indicators
 - Increase of soil fertility
- b) Energy
 - Increased use of renewables
 - Increased electricity generation in rural areas
- c) Socio-economic indicators
 - Increase of income of farmers
- d) Waste and pollution
 - Reduction of CO₂ emissions
 - Improved air quality
- e) Material Consumption and Resource Use
 - Reduction of fertilizer & pesticide consumption



CASE STUDY 4 - Off-grid electrification concession with solar home systems in South Africa

In many developing countries the provision of a full electricity grid in rural areas is not likely to be economically feasible in the immediate future. This section, based on Lemaire 2011, describes a large-scale response to this challenge in South Africa.

I. Context, description and objectives of the project

After the first phase of the post-apartheid electrification program dealing mainly with urban areas (1994-1999), it became apparent that rural electrification with conventional means (grid extension) was not realistic, especially if it was to meet social objectives (Clarke, 2005; Gaunt 2005). Even with the tremendous electrification effort of the post-apartheid regime, there were more than 1.5 million households located in remote areas which were unlikely to be connected in the near future.

In 1999, South Africa launched one of the most ambitious projects of off-grid rural electrification using solar energy in Africa. Operating for more than 10 years as small-scale utilities, three solar fee-for-service concessionaires have facilitated the implementation and the maintenance on a large scale of more than 40,000 solar home systems (SHS) by 2012. This case will describe briefly the management of one of the concessions operated by the company NuRa located in Kwazulu-Natal with currently more than 14,000 customers; the two other concessions operate under similar regulations but with a different management.

The NuRa concession covers 10,000 km², but the company has focused on installation in a more limited area of eight energy stores, operating in the north-east region of the KwaZulu-Natal concession. The stores stock parts and sell not only small photovoltaic components but also Liquefied Petroleum Gas (LPG) at low cost (a so-called 'energisation' approach). Supplementing its provision of energy services to rural households, the sale of LPG generates 50% of the company's turnover. To guarantee a better territorial coverage, small local businesses have been selected to work as service agents.

The standard photovoltaic system currently proposed includes a 50-65 Watt peak panel with a 90-105 Ah battery to enable the connection of four high efficiency compact fluorescent lamps and an outlet for a small black and white TV or a radio, operated on direct current. The contract with the customer gives the solar company ten days to repair breakdown and thirty days to attend to any other complaints. Except any misuse from the end-users, the repairs are at the charge of the solar company and covered by the monthly fee.

A system of reporting has been put in place. The eight energy stores are central to the process. People come to the energy stores to charge a token which gives them a credit of electricity. The token also contains data on the functioning of the system, which can be transferred to a computer (engineering feedback). All the data can be manipulated at the energy store, but are also immediately centralised at the headquarters. Combined with this system of reporting, the company uses a software system, whereby all installations are located by means of GPS. The software groups the installations in reasonable proximity to each other, thereby allowing them to be visited in one day so to avoid unnecessary journeys for technicians.

To get connected, customers need to pay a small fee – initially 100 Rand in 1999 (16 USD in 1999), and now 500 Rand (68 USD dollars) – which represents only a small part of the cost of the system. The demand for solar home systems remains high with a large number of customers waiting to get an installation.

The customers have to pre-pay a monthly fee. The level of this fee has been revised only twice since the launch of the programme and now stands at 85 Rand (10 US dollars). Some municipalities agree to give a variable amount of the Free Basic Alternative Energy²² subsidy to cover part of the monthly fee for off-grid solar electricity (up to 40 Rand); other municipalities do not. Municipalities can also change their policy according to their priorities. This creates distortion between clients. The fee represents a high expense for some customers, even if not higher than the previous expense of buying candles, paraffin, kerosene, lead-acid car and dry cell batteries. Customers do get a better quality of service for the same domestic energy budget when using this renewable energy source. Recent studies also suggest that off-grid households that do not have the SHS have to spend more on candles, batteries and cellular phone charging (Aitken, 2012).

TABLE 6: AVERAGE DISPLACEABLE FUEL COSTS IN NON-CUSTOMER HOUSEHOLDS

Ave cost of candles	R 90.00
Ave cost of powering radios	R 54.52
Ave cost of charging cellular phones	R 55.56
Total	R 200.07

Aitken, 2012

Un-electrified non-customer households spend slightly over R200 a month on services that the SHS can provide. By choosing the current NuRa service option (Tariff 04) these non-customer households would reduce these service costs from marginally over R200 to approximately R85 a month. A saving of approximately R115 or 60% of what they currently spend.

II. Outcomes

The business plan approved by the regulator was based on a target of 50,000 installations by the end of 2005. By 2006, only 11,500 installations were in place. This gap is due mainly to the disruption of capital subsidies from the government at various stages up until 2006 and beyond. But in 2010 – new capital subsidies have been announced. In March 2011, 4,000 new systems were to be added following a grant from the government. Since November 2010, NuRa has installed over 6,500 systems (but has lost a number of customers through grid encroachment or ‘churn’ as well as non-payment). By April 2012, the number of NuRA clients had increased to 13,619 and the number of sale points had increased from 8 to 13. The revised target is to reach 29,000 clients by 2016²³.

The capital invested is of 550 USD per system. The subsidy is less than that given for on-grid electrification (see Table 7). Part of the capital grant is coming from a private foundation located in the Netherlands, the Foundation for Rural Energy Services. The Department of Energy provides a similar subsidy when the contract between the concessionaire and the government is active.

TABLE 7: SOLAR OFF-GRID AND ON-GRID CONNECTION COSTS

	Solar	Grid
Capital Cost per Household	R 4,000 (550 USD)	R 10,000 – 15,000 (with a cost for the utility Eskom of up to 11,000 Rand)
Subsidy per Household	R 3,500	R 4,000 (subsidy from the government)
Cost to utility per Household	R 500	R 6,000 – 11,000 (cost covered by the utility Eskom)

Lemaire, 2011

The cost of implementing solar home systems in the concession seems actually low compared to the cost of installing solar home systems in other African countries. For instance in Zambia, the cost of a similar PV system would have been around 900 USD instead of 550 USD. This in itself could be an interesting result of the large-scale concessions programme in South Africa.

a) Economic benefits

The concession has created 83 direct jobs employed by the solar company. All but two staff have been recruited from the local communities and have been trained. Under a “Black economic empowerment” inspired initiative, the staff bought shares in their company. A number of retailers can sell small components of a PV system.

²² The Free Basic Energy Policy was launched in 2003 by the government of South Africa and derived from government allocations and cross-subsidies. It is being piloted by municipalities and provides 50 kWh of grid electricity per connected household free of charge. In response to the subsidy provided to grid connected households, the FBAE policy was designed to provide off-grid households with a level of subsidy as well;

²³ Source: <http://www.fres.nl/en/how-fres-works/fres-in-south-africa/58-fres-in-south-africa.html>

The main economic benefit for individuals who get a PV system is that they can benefit from better lighting and a charging point for the same amount of money (or even less) they would have to spend on batteries, candles and, paraffin. The use of PV solar reduces the use of small dry cell batteries, kerosene and candles, and in some case replaces them completely. Another saving is cellular phone recharging – which costs R5 a charge, and most households have more than one phone.

For instance, an estimate conducted in Bangladesh considered that households with SHS successfully reduce their consumption of kerosene and dependency on rechargeable batteries, with the cost reductions accounting for some 20–30% of monthly expenditures (not including the expenditure on the repair of the batteries) on SHS paid to the solar company which maintain the systems (Komatsu, 2011). In a survey conducted on a sample of households with SHS in East Timor, households were found on average to avoid candle and kerosene expenditure of \$3.60 per month as a result of SHS use (Robert & Bond, 2009). In South Africa, according to Aitken 2012, the average household using a 50-65Wp SHS could save approximately R115 (\$12) compared to a similar household that relies on candles, dry-cell batteries and paying for cellular phone charging services.

b) Social benefits

The main social benefit is extended hours of lighting for schools, small shops and individuals and far better quality of light (800 lumens for a 13-15 Watts Compact Fluorescent Lamp compared to few lumens for a candle). Even if impacts on education are generally considered difficult to quantify, they nevertheless exist as schools with solar systems can offer night classes and a place to do homework, as documented in the case of Zambia (Gustavsson, 2007).

c) Environmental benefits

The use of PV solar saves CO₂ emissions (estimate can vary from 80 to 500 Kg of CO₂ per SHS per year according to the size of the system and its productivity) (Lee, 2001). The formula commonly used for the annual CO₂ reduction calculation is 75 kg CO₂ per SHS plus 4 kg CO₂ per Wp (Martens et al., 2001). For a 50 Wp system, this can produce savings of 5,5 tonnes of CO₂ on 20 years, but other authors quote higher figures of up to 9 tonnes of CO₂ savings on 20 years (Posorski, Bussmann, Benke, 2003).

The use of SHS for cooking replaces the use of more polluting fuel like kerosene/paraffin, woodfuel, coal, and other biomass fuels, fuels and batteries.

III. Replicability

Photovoltaic systems are the most efficient and cost-effective way of delivering continuous small amounts of electricity to remote households. Lighting, radio, TV, and charging a mobile are the main uses of solar electricity provided by small solar home systems. Innovative solutions are required to disseminate these systems on a very large scale and guarantee their long-term maintenance in locations which are by their nature remote and poorly served by administrations. Public-private partnerships as described in this case seem to be able to provide a sustainable solution. Small rural energy enterprises should be able to manage effectively their own business while public authorities focus on creating an enabling environment with a stable regulatory and institutional framework. However, fee-for service concessions are only one of the options to overcome the problem of the high up-front cost of solar home systems for rural populations in developing countries. Partnering with micro-finance institutions to set up a micro-credit scheme or to develop the cash sale of very small systems has also been successful in other countries and could be tried by solar companies in South Africa to complement their offer.

Due to the high initial costs of solar systems, rural electrification with solar energy needs some kind of institutional support often linked to international agencies, sponsors and government support. Fees collected by solar companies can only cover operating costs, rarely capital costs. The poorest households need to be subsidised. Even with subsidies, the financial viability of solar companies remains fragile. Nevertheless, even in a challenging local context, some well-managed South African operators have been able to reach their break-even point. Diversification of activity into Liquefied Petroleum Gas or solar water heaters contributes to income generation and actually contributes to greater rural energy services.

In the solar concession, 20% of customers are in arrears for more than one month; this can be due to a variation in the subsidy given by municipalities and/or to irregular sources of income. Clients stop paying when systems do not work which is an incentive for the solar company to intervene promptly. Micro-payment via mobile phone banking could give more flexibility to customers and reduce management costs for the solar company.

The design of the concession and its day-to-day management can still be improved. Implementing clusters of systems in a defined area served by a particular branch of the operator nearby and increasing the density of systems could enable a commercial network to emerge and give more effective support to clients. The recent decrease of the cost of solar panels of 50 % in 2011 may make it worthwhile to offer more systematically a 75 Wp panel instead of a 50 Wp panel. The Department of Energy is currently considering larger SHS in the order of 120-150Wp which will accommodate an

inverter and permit customers to operate a colour TV more effectively as well as additional lighting and other services. The subsidy formula will probably retain the 80/20% split which is currently employed²⁴.

IV. Conclusion / evolution against SCP indicators and poverty eradication

This project has a direct impact on several categories of SCP indicators: socio-economic indicators (with the creation of 1 job for every 143 installed solar home systems) and reduced energy use and pollution (with the decrease of the use of conventional fuel), a small reduction of CO₂ emissions per system installed and multiple non-measured indirect impacts (including a better quality of energy service for the same expenditure, increased hours of trade, and improved opportunities for education).

a) Energy

- Increased use of renewables
- Increased electricity generation in rural areas

b) Socio-economic indicators

- Job creation

c) Waste and pollution

- Reduction of CO₂ emissions
- Improved indoor air quality

4.3 SUSTAINABLE HOUSING

More than 50% of the world's population already lives in urban areas, and urbanisation in developing countries continues apace – the United Nations Population Division projects that the world's urban population will be nearly 70% by 2050²⁵. According to UNEP 2010 (p.19), buildings already are responsible for 20% of global water use, 25-40% of energy use and 30-40% of carbon emissions, and 30-40% of waste generation. And, of course, most of the world's food is consumed by urban populations. The poor in urban areas are the worst hit by rising food prices, because they cannot increase their food production for either sale or self-consumption, and they are absolutely dependent on the sustainable supply of food they can afford.

The quality of life and environmental impacts of urban areas are almost entirely dependent on their infrastructures. If the majority of current and prospective urban populations in developing countries are to benefit from warm or cool homes, clean air, water and energy sources, effective sanitation and efficient transport, it is clearly enormously important that new urban infrastructure – buildings, energy and transport networks, and water and sanitation systems – is constructed that maximises efficient use of natural resources and results in minimal pollution. The construction of the urban areas, and of their transport infrastructure, and the transformation of those already in existence, needs to be sustainable, and to facilitate sustainable consumption.

As with the areas of energy, food and agriculture, discussed in previous sections, there is no shortage of examples of how urban areas need to develop in order to provide a healthy and decent way of life for their inhabitants. The Marrakech Task Force on Sustainable Buildings and Construction²⁶ has produced a wide range of resources on addressing the challenges of sustainable construction. Similarly UNEP's Sustainable Buildings and Climate Initiative (SBCI), which is centred around close cooperation with the private sector and the associated Sustainable Social Housing Initiative (SUSHI), with projects in both Brazil and Thailand²⁷, demonstrate other possibilities to achieve these goals.

Roberts and Kalaney (2006) provide one of the most comprehensive, relatively recent surveys of good practice in sustainable buildings and construction in Asia. Their book contains three case studies in each of 12 Asian countries (Bangladesh, Cambodia, China, India, Indonesia, Laos, Malaysia, Pakistan, the Philippines, Sri Lanka, Thailand and Vietnam). Each case study addresses the issues of good governance, improved urban management, effective and efficient infrastructure and service provision, financing and cost recovery, social and environmental sustainability, innovation and change, and leveraging international development assistance. The final chapter is entitled 'Lessons and Strategies for Sustainable Urban Futures'.

Focusing particularly on buildings, UNEP (2011, p.350) quotes an estimate by McKinsey that in developing countries an investment of US\$90 billion in energy efficiency would reduce energy expenditures by US\$600 billion. As noted above, rather than seeking to transform high-energy to low-energy infrastructure, it is more cost effective to bypass the high-carbon

²⁴ R. Aitken, pers.comm., 2012

²⁵ See <http://esa.un.org/unup/p2k0data.asp>

²⁶ See <http://esa.un.org/marrakechprocess/tfsusbldings.shtm>

²⁷ See <http://www.unep.org/sustainablehousing/index.asp>

infrastructure altogether, and invest instead in low-energy, low-carbon buildings, energy and transport networks and water and waste management systems. Perhaps it is with such considerations in mind that China is seeking to pioneer low-carbon development in eight cities in five provinces (UNESCAP, 2012, pp.303-306).

Sustainable urban development, of course, needs to take particular account of the social dimension of sustainable development, giving due weight to issues of equity and community. In the case study that follows, stakeholders in the local community were essential in driving the sustainable transformation of a large canal community in Bangkok that has brought widespread and enduring economic and social, as well as environmental, gains.

CASE STUDY 5 - Bang Bua Canal Community Upgrading in Bangkok, Thailand

This section describes how upgrading of housing via a collective housing programme can contribute to poverty eradication through the detailed case study of a pilot project with a canal community in Thailand. This case shows that the improvement of informal settlements lead by local communities can substantially improve their quality of life and by providing better access to other communities provide more business opportunities.

I. Context, description and objectives of the project

The Bang Bua Canal Community Network is part of a larger, city-wide network of canal communities in Bangkok called “The Social Development and Canal Environment Network”. This network is active in working on issues of canal cleaning, environmental improvement, community upgrading, recycling, infrastructure and land tenure (ACHR, 2008).

Twelve informal settlements along the Bang Bua Canal in Bangkok faced the challenges and embedded vulnerabilities of insecure land tenure, risk of fire, threat of eviction, falling in the canal, and flooding. Squatters were regularly accused of polluting the canal by the Government of Thailand. In some of these communities, there was a problem with the sale and abuse of illegal drugs (ACHR, 2011).

In January 2003 the Thai Government launched the the Baan Mankong Collective Housing Programme, of which the Bang Bua Community Upgrading is a pilot , to address such problems. The Baan Mankong Programme provides infrastructure subsidies and soft housing and land loans directly to poor communities. The programme allowed communities to manage the planning and implementation stages of the upgrading process. It was implemented by the Community Organizations Development Institute (CODI) – a public organization established in 1992 under the Ministry of Social Development and Human Security.

In order to reduce vulnerability while gaining security of tenure, squatters living along the canal joined the Baan Mankong Programme to leverage their collective bargaining power with the land owner – the Treasury Department of Thailand. This also allowed the network of communities to save for payments on their leased land, to re-block the sites and upgrade their housing and infrastructure. The squatters convinced the authorities that in situ upgrading would create a mutually beneficial scenario for the communities and the wider city. They achieved this with the support of the larger network of 200 canal-side communities in Bangkok. The in situ upgrading solution also relieved the Government of finding new land for relocating the squatters.

The Bang Bua Community secured tenure with a long-term lease. Working with the authorities to fund and build a new canal-side walkway reduced health and safety risks and increased accessibility in key locations for the fire department, reducing the risk of fire. To initiate a Collective Housing project sponsored by CODI, a community must form a savings group and prove their financial responsibility. Over the course of 6 months to 2 years, the community must save enough money for a down payment of 10% of the estimated project costs. During the process, the community must form small groups to plan a strategy to negotiate a thirty-year renewable lease on the publicly owned land and design a new layout. The community then chooses one of five main types of upgrading²⁸ in response to the unique opportunities and constraints of their site:

- **On-site improvement:** These projects help solve land tenure problems, improve the physical environment and basic services in existing communities with minimal adjustments to layouts or plot sizes.
- **Reblocking:** Reblocking is a systematic way to improve infrastructure, physical conditions and land tenure security. Layouts of houses and roads are adjusted so that new sewers, drains, walkways and roads can be conveniently installed.



- **Land sharing:** Land-owners and the community agree to share the land. A portion of the land is either given, sold or leased to the community where housing is to be reconstructed, allowing both parties to settle their conflicts and occupy the land legally.
- **Reconstruction:** Existing communities are totally demolished and rebuilt, after the community has secured the land either under long-term leases or purchases. The land security encourages occupants to invest in new reconstruction.
- **Relocation:** Occupants are relocated through land use rights, ownership or long-term leases, all of which provide increased housing security. Communities ideally relocate to land that is within 5km of their current location. However, some rural communities establish new agricultural-based communities. Communities that choose to relocate face reconstruction costs and, in some cases, land costs.

The Baan Mankong programme provides subsidies which allow communities to upgrade their infrastructure and living environment, according to the priorities they set, using budgets they manage and technical assistance they select themselves. The size of each community's subsidy is calculated by multiplying the number of households by per-family infrastructure subsidies for different kinds of upgrading. A community of 200 houses, for example, which is going to upgrade on the same site, will get a total upgrading budget of 5 million Baht (\$142,857 USD) to work with (CODI, 2008).

The following subsidy types are available:

- **On-site Upgrading Subsidy:** 25,000 Baht (US\$715) per family for onsite-communities upgrades/repairs.
- **Reconstruction Subsidy:** 35,000 Baht (\$1000) per family for communities rebuilding their settlement on the land they now occupy or for communities relocating to different land and rebuilding there. In special cases where the cost of filling land or infrastructure is very high, the per family subsidy can go up to 45,000 baht (US \$1,285).
- **Additional Subsidies:** Additional subsidies are available on a case by case basis to help communities do heavy land filling if their land is low-lying, to install household sewage treatment systems, to landscape the newly upgraded settlement (20,000 Baht or \$600 per community), to liven up the visual character of the new community (200,000 Baht or \$6,000 per community), to construct temporary houses in case of fire or eviction (18,000 Baht or US \$500 per community), or to construct a community meeting house (18,000 Baht or US \$500 per community).
- **Administrative Subsidy:** A grant equal to 5% of the total infrastructure subsidy is provided to the community organization and their partners for administrative costs they incur.
- **Process Support Subsidy:** This subsidy supports the various activities that go along with the upgrading planning process, including exchange visits between cities, seminars at various scales, meetings, coordination costs, on-the-job training activities, support for the community network's involvement in the upgrading process and salaries (CODI, 2008).

II. Outcomes

The canal is approximately 40 meters wide, and as part of the redevelopment, all the houses that have encroached onto the canal (built on stilts over the water) were demolished and rebuilt on land. In some areas, this community, and most along the Bang Bua canal, now has two rows of housing lining the canal, with the back row having been moved further away from the water for safety and a clear definition of the waterfront. The back row was built first, with the front row following in the second phase of upgrading. A complex process for such re-blocking and reconstruction was necessary to reach consensus, which is negotiated between all individuals in the community. Between the two rows of housing a new path was constructed. In the third stage a connecting pathway was built along the canal edge and used as public space, while another public space, required by CODI to be planned and built, was finalised including a playground and community centre that strengthens social infrastructure and future community planning endeavours.

The 2-story rowhouses at Klong Bang Bua offer 90 square meters of living space, and were built in phases by the community's own construction team for an average of 322,000 Baht (US \$9,200) per unit. Average construction cost was 3,220 Baht (US \$92) per square meter. Design costs for the houses have been reduced by taking account of design knowledge and input from community architects, which can help achieve sustainable production and consumption patterns by: designing tight housing layouts; designing housing units of smaller size, which might be expanded upwards later; using community and household labour where appropriate; using alternative, recycled or cost-saving materials; and buying materials collectively.

The walkways along the canal were upgraded from ½ meter wide paths of wood or bamboo to 3 meter wide paths (in some locations 5 meters wide) of concrete. The community agreed to build the 3 meter walkway along the canal edge (using a Baan Mankong upgrading subsidy) and the District agreed to build a concrete retaining wall along the edge of the water. The people effectively "gave back" a large piece of their land to the city for public use, which provided access along the canal. Concrete was chosen as a material over wood because it needed less maintenance and was a safer surface for vendors with carts. In addition, drainage pipes were surveyed, demonstrating that the majority of pollutants in the canal did not originate from the squatters but from other regions and inhabitants of the city. A kitchen grease filtration system was developed by a community member, costing \$8 USD per unit to produce, and became a fixture of most new houses along the canal, further reducing pollution (ACHR, 2008).

²⁸ See <http://www.codi.or.th/housing/FrontpageHousing.html> accessed 18 March 2012

For the 3,400 households in the 12 communities along the Canal, although the Treasury Department continues to own the land, 30 year renewable leases have been granted to the Bang Bua community cooperative. The cooperative manages the loans and repays CODI, who repays the Treasury Department. A land rental rate of 1 Baht per square meter per month was negotiated in Bang Bua, with adjustment for inflation every 5 years. This translates into land rental rates, depending on plot size, of 40-70 Baht (\$2-3) per month per plot. For just two communities so far, the government has paid an infrastructure subsidy of 17.82 million Baht (US\$ 509,143), with the size of each community's subsidy calculated by multiplying the number of households by the per-family infrastructure subsidy (US\$ 780–1,100 per family) for different kinds of upgrading. CODI has so far lent these two communities 7.05 million Baht (US\$ 201,429).

The Bang Bua Canal Community Upgrading has contributed to positive changes in economic, social, and environmental aspects in both the construction and use phases. Some of the restrictions issued by CODI as conditions of receiving the loans ensure such sustainability. For instance, they encourage in situ redevelopment and upgrading (77% of CODI developments take place in situ), rather than displacement, which often results in the trauma of lost livelihoods and broken social capital. In addition, the land used must be collectively owned, which has two main benefits:

1. Collective ownership allows peer pressure to be applied to any individuals placing their own narrow interests over those of the community as a whole
2. Collective ownership and the prevention of sale in the first 15 years of ownership keeps the existing communities on the land, preventing the sale of the new units for profit

CODI places an emphasis on hiring local labour for the construction of the new houses, creating employment and keeping the economic return of the upgrading within the community. In most cases there are three basic design templates from which to choose. This simplicity and standardization aims to utilize appropriate technologies for the context while allowing the community to be involved in the construction, increasing personal investment in their own homes.

a) Economic benefits

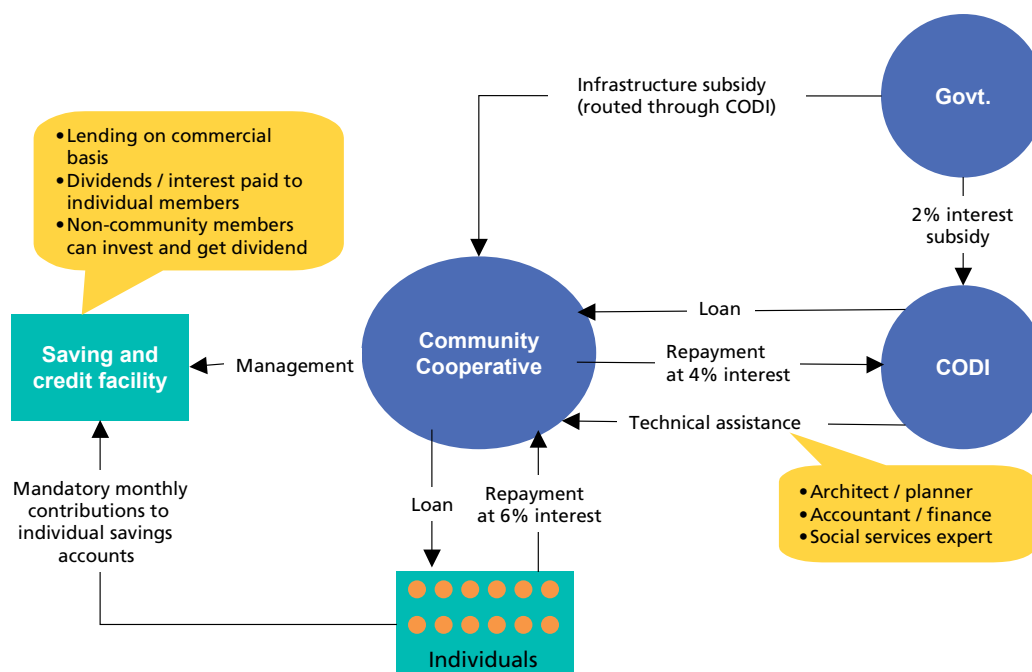
Due primarily to the community-led approach of Bang Bua's upgrading, the financial, environmental, and social returns have collectively reduced poverty in a sustainable way.

Loans are provided by CODI at an interest rate of 4%, after a 2% interest subsidy from the Government (see Figure 6 for a diagram of the CODI Financing Model for Slum Upgrading).

Employment is generated in the construction process, with a typical fixed rate salary of 250 Baht/day for skilled workers and 220 Baht/day for unskilled workers. This labour is funded by the Baan Mankong infrastructure budget for shared infrastructure. Individual household building budgets fund the labour on individual houses. Workers are provided free food and water during the day by the community members. It costs approximately 70,000 Baht in labour costs to build a detached (single) house, and about 65,000 Baht to build a semi-detached ("twin") house. Because of the common walls and common central columns in a pair of houses with a party wall, money is saved on the labour (ACHR, 2008).

An organization of savings groups that took form to fund housing now addresses other community financial issues. Their "welfare fund" now provides 10,000 – 20,000 Baht toward funeral costs for each death in the community. There also exists a children's savings group where each child saves 5 Baht per day, to introduce the next generation to the practice of saving (ACHR, 2008).

FIGURE 6: CODI FINANCING MODEL FOR SLUM UPGRADING: COMMUNITY COOPERATIVE AND SAVINGS AND CREDIT FACILITY CRITICAL TO SUCCESS.



Source: Community Organizations Development Institute (UN-HABITAT 2009).

b) Social benefits

The built infrastructure along the canal is improved with upgraded housing and the creation of a public canal-side walkway, used for pedestrian travel, recreation and mobile vendors. In addition, septic tanks are added along with central drains for the collection of grey water, improving sanitation and cleaning the canal.

c) Environmental benefits

Building materials are kept in material banks, usually on a vacant plot on site. The materials are then sorted and repaired when needed, and reused as possible in the new construction. In addition, through upgrading, sewerage is introduced for the new homes, so waste is treated rather than being dumped into the canal directly as before. However, the use of concrete as a primary building material is equipment and energy intensive and does generate pollution.

III. Replicability

This upgrading has already proven to be scalable to a large extent, having originated in the pilot scheme along the Bang Bua Canal in 2003. As part of the wider Baan Mankong programme, 1,546 communities have either finished or begun the upgrading process in 277 towns and cities, in 73 of Thailand's 76 provinces, involving 90,813 households²⁹.

Emphasis on the political process and long-term relationship building is a key aspect of the sustainability and scalability of this model of housing. The Municipality and Land Owning Department of the Government recognize that a people-driven process that empowers the communities is one in which these communities have fully invested their time and energy to strengthen the social and physical infrastructure of their neighbourhood. In addition, it is critical to view such upgrading programmes as part of inclusive, city-wide strategies to reach the poorest of the poor, rather than simply isolated and disconnected projects (Boonyabancha, 2005, 2009).

Reconsidering and lowering the Government's planning and building regulations standards is often needed to make the upgrading feasible and sustainable in situ. For example, in this case, regulations require roads to be 8 meters wide. Due to site constraints, following this regulation leaves no room for houses, and therefore the houses must be designed in a different way, taking into account unique site constraints. This contextual responsiveness and flexibility in planning regulations supports successful upgrading proposals.

²⁹ <http://www.codi.or.th/housing/results.html>, accessed 18 March 2012.

The Bang Bua Canal Upgrading is a positive model, which has proven successful in the alleviation of poverty. In addressing resource-poor citizens by leveraging collective capacity to save money, mobilise and plan upgrading, through the aid of infrastructure subsidies and loans, the programme has achieved remarkable results. A key component of poverty eradication in this case is strengthening non-tangible networks of the community – collective capacity – and building on this momentum to transform physical infrastructure and planning. As this process occurs, employment is generated, material wealth is increased and community trust and skills are strengthened. Thus continues a positive cycle of reinforcement and wealth creation that steadily alleviates the conditions of poverty.

A number of conditions need to be met for such a process to be successful:

- 1) A prerequisite level of community organization is needed prior to joining the programme (before joining Baan Mankong, the communities had 3 million Baht – US \$86,000 - in savings already (ACHR, 2008)).
- 2) All residents have to agree to the common consensus of demolishing and rebuilding their houses (some shops were boycotted to in essence force a consensus).
- 3) Land must be collectively owned or leased (collective asset ownership) to gain the support of CODI – this collective ownership remains in place for at least 15 years.

IV. Conclusion / evolution against SCP indicators and poverty eradication

This project has a direct impact on two categories of SCP indicators:

- a) Socio-economic indicators
 - Job creation during the duration of the project
 - Business opportunities due to better connection with neighbouring communities
 - Stability and reinforcement of the cohesion of local communities (no more risk of eviction, self-participatory approach)
- b) Improved living conditions
 - Lower health risk
 - Lower fire hazards
- c) Waste and pollution
 - Water quality of fresh water and drinking water sources improved
 - Recycling of building materials

4.4 OTHER SECTORS: TRANSPORT, WATER AND WASTE, TOURISM, MANUFACTURING

The global trend of urbanisation has already been noted. If the new arrivals in urban areas are not to be, and stay poor, urban infrastructure will need to be constructed in ways that gives them sustainable, affordable access to the facilities and services they will need to improve their lives.

Housing, discussed in the previous section, is obviously a crucial component of sustainable urbanisation, but so are three other essential elements of urban infrastructure: transport, to facilitate access and mobility, clean water and sanitation, essential to health and well-being, and waste management. Former methods of providing this infrastructure have focused on road infrastructure and involved water, sanitation and waste systems, many of which are polluting and both intensive and inefficient in their use of resources. There are now many possibilities, and experiences from around the world, of urban infrastructures that are cleaner, more health-promoting and more resource-efficient. These are more economical, than the old industrial-era infrastructures that the developed countries are now busy replacing. It would be a hugely wasteful and expensive mistake if developing countries were now to put in place urban systems that industrial countries now regard as obsolete and inefficient.

Related to **transport**, UNESCAP (2012) contains a number of impressive examples of developing country cities that have sought to strike a new balance between public and private transport, with a greater role for public transport. This approach produces substantial benefits in terms of reduced loss of time for commuters and businesses from congestion, more efficient journey planning, greater energy efficiency, and greatly reduced air pollution, with significant health benefits, with knock-on economic benefits in terms of increased productivity.

One of the best known examples of sustainable urban transport planning relates to the urban zoning and bus rapid transit system of Curitiba (UNESCAP, 2012, pp.331-332), the latter of which is now used by 85% of the town's population and is financially viable without public subsidy. But there are other impressive examples of sustainable urban transport in developing countries. In China, Beijing has introduced effective vehicle control measures that have increased the use of bicycles and public transport, with corresponding reductions in congestion. The bus rapid transit system of Guangzhou, which is estimated to have saved 30 million passenger hours in the city in its first year, shows how fast-growing cities can reduce the congestion costs that often accompany rapid growth. Bangkok in Thailand has opted for the provision of a

mass transit rail system through a public private partnership. The system now carries more than half a million daily riders. At a higher level of industrialisation, Korea's high-speed trains have cut rail travel times between Korea's two largest cities, Seoul and Bhusan, by more than 50%, and have substituted for both road and air transport, cutting CO₂ emissions from the latter by 87% over 2004-2008 (ibid., pp 290-293, 351-353, 409-410),

Water is fundamental to agriculture and industry, as well as to human life and health for drinking and sanitation, and to human well-being for washing. As UNEP (2011b, p.133) observes: "There are no single-shot solutions to the world's mounting water access and scarcity problems", but historically far more attention has been given to increasing supply than to restraining demand by making more efficient use of water. In China a detailed analysis of water options found that many of the most cost-effective measures to reduce a prospective water gap in 2030 entailed the more efficient use, or re-use, of water (UNEP, 2011b, pp.134-135). Effective institutions, and cross-sector collaborations, are crucial in realising these benefits, as shown in Bolivia, where local authority/local community partnerships have both increased the supply of water and sanitation while making water use more efficient (UNEP, n.d. but after 2010).

The provision of drinking water can be both expensive and energy intensive. It makes obvious economic and environmental sense not to use drinking water for non-drinking purposes, where this can be designed into buildings' water systems from the start. There are increasing uses of, for example, rainwater for non-drinking uses in industrial countries. Rainwater harvesting for multiple purposes can make even more sense in water-scarce developing countries. It can provide cost-effective drinking water, as in Chennai, where 70,000 buildings have installed simple technologies to turn harvested rainwater into safe and cheap drinking water (UNEP, 2006, p.15).

Waste management is another area that is critical for health and well-being, and there are many examples of developing countries starting to manage their waste in ways that conserves and delivers value from the materials involved, thereby generating new businesses and employment. For example, in Cairo the Integrated Solid Waste Management system promoted through the Marrakech Process project, has generated sufficient economic, social and environmental benefits to be rolled out to other cities in the region (UNEP 2011b, p.31). And the Integrated Resource Recovery Centre (IRRC) in Sri Lanka, working with the community and employing six former waste-pickers under better conditions, now recycles more than 80% of the community's waste, turning it mainly into compost for sale, without public subsidy (UNESCAP, 2012, pp.418-419). Brazil's recycling industry generates US\$2 billion per year, and according to the World Economic Forum (WEF 2012, p.15) has the potential to be three times that size (which would amount to 0.3% of its annual US\$2 trillion GDP).

The environmentally sound delivery of transport and waste management systems, and the availability of clean water and sanitation, and of unspoilt natural environments, are of great importance to Brazil. Not just to the health and well-being of the residents of a country, but also to the country's successful promotion of **tourism**, one of its fastest growing economic sectors – this is true for many other developing countries too. The Tour Operators' Initiative for Sustainable Tourism Development in Side, Turkey, has helped sustain the attractiveness to tourists of local destinations by helping local communities with solid waste separation and setting up recycling sites, closing illegal waste dumps, and opening new and upgrading old sewage and wastewater treatment plants (UNEP 2010, p.20). UNEP (2011, p.424) found that tourists are prepared to pay 25-40% more for environmentally friendly tourism. The Marketing Assistance to Nepal for Sustainable Tourism Products (MAST-Nepal) project worked with 30 Nepalese tourism companies to realise some of this extra value by linking up with the European sustainable tourism market (UNEP 2010, p.20).

Clearly, sustainable tourism is a two-way process, requiring appropriate behaviour and facilities from both tourists and the host country. South Africa's Green Passport initiative (UNEP, 2011b, pp.60-61) proved an effective way during the 2010 FIFA World Cup of fostering sustainable tourist behaviour for mutual benefit. Two case studies from different parts of Botswana show that eco-tourists contribute to both community-based natural resource management and to household poverty eradication (Lepper and Goebel, 2010, Mbaiwa and Stronza, 2010). The high proportion of tourism revenues remaining in the fishing village of Ta Din Daeng in Thailand has enabled the villagers to invest in local reforestation and biodiversity protection, to maintain the attractiveness of the village to tourists, and increase its bio-productivity (UNEP, n.d. but after 2010). Similarly, the villagers of Iwokrama in Guyana in Latin America manage the timber from their forests sustainably, and augment their incomes from ecotourism with a range of forest-products such as honey and oils, bio-prospecting and forestry research and training. Employing 70 members of staff, the Iwokrama International Centre had revenues in 2008 of \$2.4m and made a profit of \$800,000 (Iwokrama, financial report 2008).

If tourism is one of the most important service sectors in the economies of many developing countries, developing a **manufacturing base** remains a core concern for practically all of them, and is one of the ambitions most challenged by the new realities of high energy and resource prices. These realities put a premium on the kinds of manufacturing approaches that are promoted through SCP.

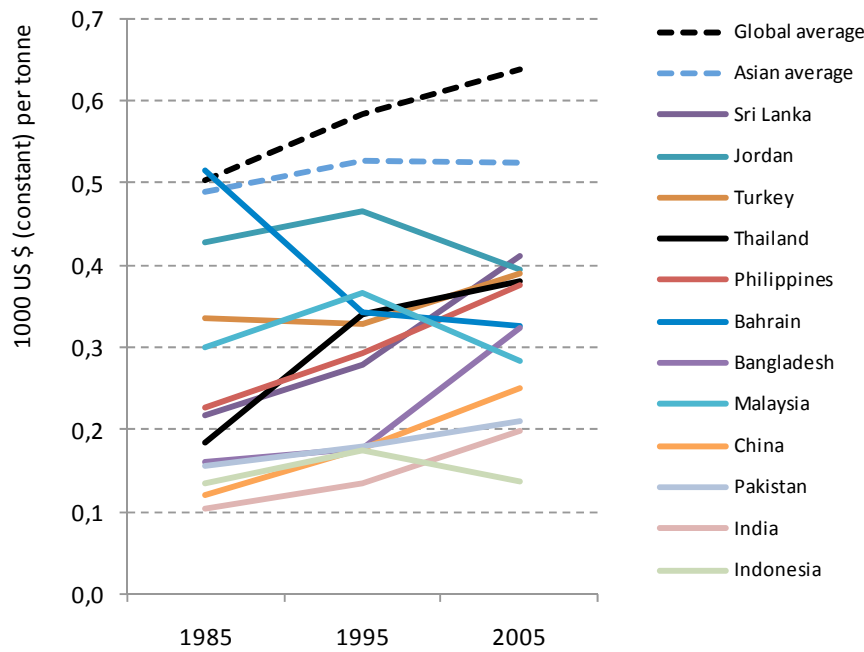
The challenge now facing the manufacturing sectors of all countries is the new global reality of resource scarcity. Figure 5 showed what has happened to energy prices since 1980. McKinsey Global Institute (2011, Exhibit 6, p.30) shows that this trend is reflected in commodity prices as a whole since 1900. In fact, commodity price increases since 2000 have completely offset the long established trend of falling commodity prices through the twentieth century.

Many developing countries have resource and energy productivities (GDP per unit of resource or energy used) that are far lower (with their corresponding inverses, resource and energy intensities, far higher) than in industrialised countries. For example, Figure 7 shows that many Asian countries have material productivities well below both the global and Asian average. For comparison, the material productivity of Japan, one of the world's major manufacturing economies, was around US\$2,400 per tonne of material used in 2005, over ten times that of China and India, and this is the main reason why the Asian average material productivity is only a little below the global average. Without Japan, it would have been far below it³⁰. Clearly much of this difference is explained by the fact that China, India and other developing countries are still putting in place the heavy infrastructure that Japan installed some years ago, and Figure 7 shows that for many of the countries (but not all) material productivity is increasing. But it is still true that, in a world of high and rising commodity prices, a low resource productivity represents a considerable drag on growth. Enhancing the resource efficiency of a country's industrial base also has the potential to provide a strong buffer against future commodity price rises, and their volatility generally.



³⁰ Singapore also has a higher material productivity than the Asian average, but affects the average much less as it is a relatively small economy.

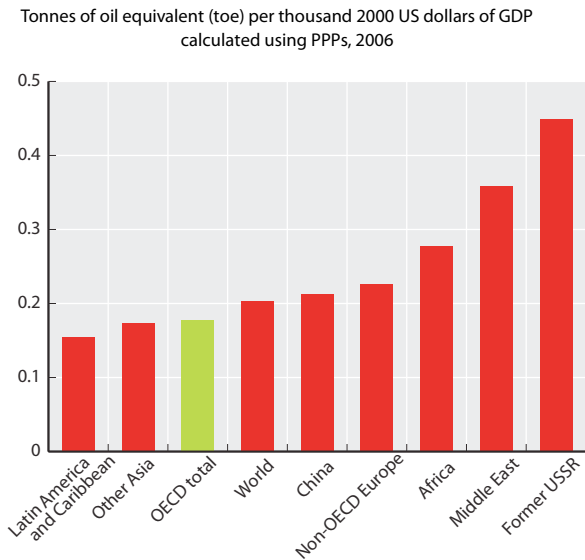
FIGURE 7: MATERIAL PRODUCTIVITY IN SELECTED ASIAN COUNTRIES, 1980-2005



Source: SERI 2010

However, the picture is not uniform. Figure 8 shows that not all resource intensities are higher in developing countries. In Latin America, for example, energy intensities are lower than the OECD average. But in China they are higher than the OECD average, and in Africa considerably higher than the world average. Reducing the intensity of use of energy and other resources remains a key challenge for all developing countries in an era of high and rising resource prices.

FIGURE 8: TOTAL PRIMARY ENERGY SUPPLY PER UNIT OF GDP, 2009



Source: OECD 2011

However, if low resource productivity represents a threat to future growth, the potential for its improvements represents an enormous economic opportunity. In its assessment of global resource demands for 2030, McKinsey Global Institute (2011, p.70) estimates that resource productivity improvements could save US\$2.9 trillion in 2030, with 70% of those savings yielding an annual rate of return of 10% or more. The countries that capture those opportunities in their own economies will be more competitive than those that do not. The countries that develop the technologies to capture the opportunities, which they can then export, will be more competitive still. The developing world cannot afford to miss out on these opportunities, and there is no reason why it should do so. Capturing them, however, will require access to financing and environmentally sound technologies, as well as appropriate public policies, and this is one of the themes of the next, concluding, section, which derives broad recommendations relating to SCP from the theoretical framework and evidence presented above.

³⁰ Singapore also has a higher material productivity than the Asian average, but affects the average much less as it is a relatively small economy.





5. CONCLUSIONS

Developing countries are now at a crossroads in their social and economic development. Many of them have made great strides in the last ten years in terms of poverty eradication and economic development more generally. But this development has in many cases come at a high environmental price, and there is now unmistakable evidence, some of which is presented above, that more of the same approach towards economic development will produce less and less economic and social benefit. Over time even the gains that have been achieved will become increasingly difficult to sustain. What is now required is a shift in development strategy that builds on and scales up the insights and experiences of the nearly twenty years of the experience on policies, private sector practices and partnerships which have fostered sustainable consumption and production (SCP) since the recognition of this need in Agenda 21.

SCP is, of course, very relevant to developed as well as to developing countries. But there are two reasons why it is now developing countries that have the most to gain from a new resource-efficient and environmentally sustainable approach to wealth creation.

The first reason has to do with the great increase in and volatility of commodity prices that has been experienced in recent years, with some of the most pronounced effects relating to food and fossil fuels. Developed country economies have relatively far larger service sectors, with lower dependence on energy, than economies in developing countries, and so tend to be less affected by upward energy price movements. Furthermore, food is a far larger share of the expenditure of poor countries, and especially of poor people in poor countries, than it is in rich countries. Both these factors mean that it is crucially important that developing countries respond decisively to the new price realities of commodities. In respect of energy this means becoming, through greater energy efficiency and greater use of indigenous renewables, much less dependent on imports of fossil fuels. In respect of food, this means making better use of nature's inputs and processes in place of purchased fossil fuel-based chemicals, and maintaining soil structure and fertility and water availability and quality, also by applying more holistic, integrated and lower input agricultural management techniques, so that food production can be sustainably increased.

Over time, increased market prices of energy and other commodities will generate a push towards greater resource efficiency. But those countries that can anticipate these trends, and be the first to develop the methods and technologies of sustainable production, will gain a double competitiveness benefit. They will make their own economies first movers to more resource-efficient production, and will be able to export these methods and technologies to countries that have lagged behind in this respect.

The second reason is that developing countries have far more people, who tend to be their poorest people, who are dependent for their livelihoods on the direct exploitation of ecosystem services: food from local soils or coasts, forest products from local forests, and water from local rivers. These are in many cases the resources that have fared worst in the environmentally damaging, rush to old-style industrialisation. Ecosystem services are becoming increasingly scarce, and the sustainability of their supply more threatened, making poor rural people poorer in numerous countries. One of the prime imperatives for poverty eradication in the future will be to turn round this widespread trend of environmental deterioration, which is undercutting development prospects.

These realities mean that the connection between SCP and the MDGs is now recognised to be central to modern development theory, which has for some time stressed that development is a multi-dimensional process. This theory now also recognises that progress towards environmental sustainability will be crucial in sustaining the social and economic development gains of recent years. The MDG and SCP indicator sets that have been developed jointly capture these new realities of development. Moving in the right direction on the goals of MDG 7 will help to lock in the economic and social gains of the other MDGs. Without progress on the MDG 7 objectives, these economic and social gains will become increasingly vulnerable to resource constraints and ecosystem disruption. And those who will suffer most from the constraints and the disruption will be poor people in both rural and urban areas. The new reality for poor people is that advancing towards the MDG 7 environmental sustainability goals, far from being a luxury that can wait for economic and social progress, will be a pre-condition for achieving that progress.

A small part of the evidence for this has been presented in the case studies above, with the major focus on food and energy. In countries of both Latin America and Asia, small farmers are showing how they can be better off if they learn from and reinforce the natural productive and regenerative powers of their ecosystems, rather than undermining them. In China and South Africa, new business models underpinned by government support have enabled different renewable energy technologies to go to scale and achieve economic viability in the delivery to poor people of modern energy services, which are of higher quality or lower cost or both than those which could have been provided by fossil fuels.

While different poverty and environment issues are raised by the ongoing process of global urbanisation, the principles for addressing them are the same and need to be rooted in the same drive for sustainable production and consumption.

The needs of large urban populations, and especially of poor people in such populations, for sustainable systems and infrastructures to deliver food, energy, water, sanitation, access and mobility, and waste management will become increasingly intense. The example above from Thailand shows how governments can help low-income communities to deliver such infrastructure, greatly improving their lives and the wider urban environment. The choices taken by developing countries in these sectors will largely determine whether their burgeoning urban populations will be able to cope with volatile commodity prices by increasing the efficiency of their use of all resources, or whether they will simply move from one resource and environmental crisis to another, undermining their economic and social progress in the process.

This paper has shown that the Marrakech Process of the last decade, and similar other development efforts that may have gone by other names but were of the same substance, have shown how SCP can reconcile the twin contemporary imperatives of poverty eradication and resource and environmental conservation. These experiences have yielded benefits right across the triple bottom line of sustainable development: economic benefits of increased incomes, employment and poverty eradication; social benefits of improved health and education and, through poverty eradication, reduced inequality; and environmental benefits that sustain nature's productive systems and the health of those that depend on them.

The Rio+20 follow up, including the Post 2015 development agenda and Sustainable Development Goals, and the newly adopted 10YFP need put in place a framework to build on these experiences that are in large part the result of sustained international cooperation through the global institutions of the UN system. The "Post 2015 development agenda" and the 10YFP can use these experiences, policies and partnerships as a springboard for action, replicating and scaling them up, in ways appropriate to different local contexts. The aim being that by Rio+30 much more energy in developing countries comes from new renewables technologies, much more food comes from land which is maintaining or increasing its productive capacity, and improvements in resource efficiency, in both production and consumption, have reduced the pressure on commodity prices more generally. This is the potential of SCP – and the principal beneficiaries of fulfilling its potential will be those who currently have least and are most at risk from unsustainability: the world's poor.





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ABOUT THE UNEP DIVISION OF TECHNOLOGY, INDUSTRY AND ECONOMICS

Set up in 1975, three years after UNEP was created, the Division of Technology, Economics (DTIE) provides solutions to policy-makers and helps change the business environment by offering platforms for dialogue and co-operation, innovative policy options, pilot projects and creative market mechanisms.

DTIE plays a leading role in three of the six UNEP strategic priorities: **climate change, harmful substances and hazardous waste, resource efficiency.**

DTIE is also actively contributing to the **Green Economy Initiative** launched by UNEP in 2008. This aims to shift national and world economies on to a new path, in which jobs and output growth are driven by increased investment in green sectors, and by a switch of consumers' preferences towards environmentally friendly goods and services.

Moreover, DTIE is responsible for **fulfilling UNEP's mandate as an implementing agency for the Montreal Protocol Multilateral Fund** and plays an executing role for a number of UNEP projects financed by the Global Environment Facility.

THE OFFICE OF THE DIRECTOR, LOCATED IN PARIS, COORDINATES ACTIVITIES THROUGH:

- The International Environmental Technology Centre - IETC (Osaka), which implements integrated waste, water and disaster management programmes, focusing in particular on Asia.
- Sustainable Consumption and Production (Paris), which promotes sustainable consumption and production patterns as a contribution to human development through global markets.
- Chemicals (Geneva), which catalyses global actions to bring about the sound management of chemicals and the improvement of chemical safety worldwide.
- Energy (Paris and Nairobi), which fosters energy and transport policies for sustainable development and encourages investment in renewable energy and energy efficiency.
- OzonAction (Paris), which supports the phase-out of ozone depleting substances in developing countries and countries with economies in transition to ensure implementation of the Montreal Protocol.
- Economics and Trade (Geneva), which helps countries to integrate environmental considerations into economic and trade policies, and works with the finance sector to incorporate sustainable development policies. This branch is also charged with producing green economy reports.

DTIE works with many partners (other UN agencies and programmes, international organizations, governments, non-governmental organizations, business, industry, the media and the public) to raise awareness, improve the transfer of knowledge and information, foster technological cooperation and implement international conventions and agreements.

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This paper explores the type and quality of linkages between the objective of achieving sustainable consumption and production (SCP) patterns, and those of poverty eradication and sustainable development. The paper constructs a theoretical framework based on the analysis of development specialists, as well as scenarios and empirical data which show how natural resources and the environment underpin development efforts. A number of case studies in key economic sectors, including energy, agriculture, waste management and urban development are provided, to validate this theoretical framework. These case studies identify and where possible quantify the combination of economic, social and environmental gains secured by shifting towards SCP patterns. The relationship between indicators of development and SCP is also explored, highlighting important overlaps and complementarities between them. The conclusions highlight the economic and social gains for developing countries from the shift to SCP, which also sustains nature's productive ecosystems. The adoption of the 10YFP at Rio was a crucial step towards a sustainable future. The Rio+20 follow up, including the Post 2015 development agenda and Sustainable Development Goals, and the implementation of the 10YFP need to build on the experiences and opportunities set out in this report, to realize the vital and central contribution that achieving SCP will make to securing sustainable development.