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International Resource Panel

Responsible Resource Management for a Sustainable World:

Findings from the International Resource Panel

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Responsible Resource Management for a Sustainable World:

Findings from the International Resource Panel

This synopsis highlights key findings from the following reports of the International Resource Panel: *A) Priority products and materials: assessing the environmental impacts of consumption and production; B) Decoupling natural resource use and environmental impacts from economic growth; C) Metal Stocks in Society; D) Recycling Rates of Metals; and E) Assessing biofuels: towards sustainable production and use of resources.*

This synopsis and all the above-mentioned reports can be downloaded at: **www.unep.org/resourcepanel**

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preface

Natural resources rose to prominence at the turn of the millennium. The world saw a steady rise of their prices, reversing a trend that prevailed in fact since the early 19th century.

Mandated by the United Nations Environment Programme, the International Resource Panel (IRP) engages in studying the new situation and exploring options for nations and business dealing with challenges and grip with opportunities with regard to sustainable management of natural resources.
Take metals as an example. What is already there and in use? How can metals be recovered after use? Which are the present rates of recycling? Which technologies are available for improving the situation? And how is the geological reach of different metals? Users of metals want to know the answers to such questions. And countries rich in mineral resources would like to know at which stage recycling could "beat" the lucrative mining of ores. Two metals reports have been published already, on metal now in stock, and on recycling rates. Two more exist in a draft form and are undergoing a peer review process, on environmental impacts of metal use and on recycling opportunities. Some more reports are under preparation or in a stage of planning.

Metals are just one example. The spectrum of resources reaches much wider. Land and soils are hot issues in the present day world, for many people more vitally important than metals. Water is one of the most essential resources. How can it be used more efficiently so that the obvious scarcity can be overcome? What can be said about "carbon free" technologies that are portrayed as the answer to the challenge of global warming? Are there not mantraps of unforeseen damages? How is trade helpful in solving resource problems? But also: How are trade and burden shifting also disguising or distorting the environmental performance of countries? Finally, what is the specific role of cities regarding resources? They absorb the lions' share of resource but they are also the kitchens for new ideas and great solutions to resource problems. The IRP is gradually addressing more and more of such questions, using scientific expertise inside the Panel and inviting outsiders to join and help.

On a more generic and fundamental level, the IRP is addressing the question of Decoupling. How can humanity learn to be more efficient and successful in creating human well-being from a limited stock of resources? Facts have been collected and published about the steady increase of resource consumption but also about success stories of countries reducing resource intensity and in some cases even reducing absolute resource consumption. A new report will address opportunities of even more successful decoupling strategies.

This Synopsis is presented at the occasion of the Rio + 20 United Nations Conference on Sustainable Development, held in Rio de Janeiro in June, 2012. We at the IRP welcome any comments on the Synopsis and on the individual reports that are quoted therein.

Dr. Ernst Ulrich von Weizsäcker, Emmendingen, Germany
Dr. Ashok Khosla, New Delhi, India
Co-Chairs of the International Resource Panel

June 2012


LITTLE BOBDOG
WONDER IN PACE AND TIME
SPORT

foreword

Rapid urban and industrial growth in recent decades have placed huge pressure on the world's natural resources, leading to threats of resource scarcity, price inflation, and degraded ecosystems. Current patterns of resource use and emissions are out of step with what the planet can sustain in the medium to long term. Problems of resource scarcity are related to changing patterns of consumption and production, with developing countries moving from agricultural to industrial ways of life, while wealthy countries continue to consume more and more natural resources. Alongside these issues there is still much poverty and inequality in the world which needs to be addressed. There is an urgent need for more knowledge and capacity on how to balance economic development and poverty reduction with sustainability issues.

Resource productivity is essential to future economic success, sustainability and prosperity. Significant potential exists for improved resource productivity through technological innovation and demand changes over the whole resource life cycle -from raw materials to eventual disposal. Efficiency gains in the construction, transport, agriculture and heavy industry sectors could lift resource productivity markedly. This will require enormous political commitment and financial investment. If the situation is not addressed, however, actual costs to nations will be much higher.

The United Nations Environment Programme (UNEP) is tackling these challenges in a twofold manner. Firstly, the UN has adopted the notion of a 'Green Economy', aiming to shift investment away from resource and carbon intensive economic activities in a balanced and inclusive way, focusing on human and social development. Secondly, the UNEP-hosted International Resource Panel (IRP) has been established to provide authoritative scientific assessments on how sustainable resource use can be achieved and environmental impacts reduced over the life cycle of resources. The IRP is contributing to a better knowledge base on how to decouple human development and economic growth from environmental degradation.

The assessments of the IRP to date make a convincing case for sustainable natural resource management, and decoupling economic growth from resource use and environmental impacts. There are many opportunities for governments and businesses to work together to create and implement policies to encourage sustainable resource management. Better planning, more investment, technological innovation and strategic incentives are all vital. Demand management and waste reduction policies need to supplement supply side activities. The IRP continues to provide knowledge and information to policy makers. In the next five years it plans to both deepen its assessments of consumption and production, decoupling and biomass, and to deliver additional assessments on water, soil and land use, and the environmental impacts of trade. Only with the full, complete and impartial picture can governments make the defining choices that might lead the world to a sustainable century.

Achim Steiner, UN Under-Secretary General and Executive Director UNEP

Nairobi, Kenya, June 2012

Introduction

about

This synopsis of the work of the UNEP International Resource Panel is addressed to policy makers, the business community and academics. It summarizes the International Resource Panel's five reports to date, and provides a glimpse into the future work of the panel.

Scarcity is a concern. The availability and accessibility of resources that are critically important to meet human needs and support green economies are becoming unreliable. In particular, biomass and minerals are facing significant fluctuations.

Resources are fundamental for the wellbeing of people and planet.

The wellbeing of humanity, environmental health, and economic prosperity depend on the way in which society uses and cares for natural resources, including water, land, energy and materials such as minerals, biomass and fossil fuels.

Urban and industrial growth in the early 21st century is placing vast pressure on the world's supply of natural resources, raising threats of increased scarcity, price inflation and posing a threat to the life supporting systems of the Earth. The 20th century saw episodes of supply scarcity for key resources, such as the oil shock of the 1970s. Today, there is a more fundamental mismatch between demand and current supply systems for natural resources, combined with degrading ecosystem services and climate change. The problem is systemic and includes resources such as energy carriers, metals, water, soils and food crops. Current patterns of resource use and emissions are out of step with what the planet can sustain. Resource scarcity problems are growing rapidly, driven by developing economies moving from agricultural to industrial consumption and production while wealthy countries continue to consume more resources too.

While the standard of living of millions of people has been raised substantially in recent decades, poverty and inequality still needs to be addressed. Sustainable resource use and equity are complex issues and often contested. Better knowledge and stronger institutions are urgently needed to confront these issues.

Resource productivity is pivotal to future economic success, sustainability and prosperity. Significant potential exists to improve resource productivity through socio-technological innovation and demand changes, across the whole life cycle from primary resources to disposal. There is great potential for efficiency gains in construction, transport, agriculture and heavy industry and integrated systems of production and services that, taken together, could lift resource efficiency by 80% in some economic sub-sectors

introduction

Resource use is increasingly inequitable. Resource use per capita varies by a factor of 10 between nations. The shift to sustainable resource management will hence be different depending on each country's resource endowments and development levels.

with technologies that are readily available. Higher resource prices may create an economic climate in which the necessary transformation is hastened, if a supportive environment for sustainability oriented innovations is created, including significant up-scaling of investments. Nevertheless the challenge of lifting world resource productivity is enormous. The political commitment and financial cost of further developing and distributing better technologies will be very large.

Rising and more volatile resource prices and increased risk in accessing resources also create opportunities to increase political commitment and trigger investment into new technologies and infrastructure to help raise resource productivity. By contrast, if the current situation is not addressed the cost to nations will be much higher than the investment required to support changing to a more resource efficient economy that produces lower emissions whilst maintaining and raising material standards of living.

The United Nations Environment Programme has recognized the importance of understanding the relationship between economic activities, which provide goods, services and jobs and the associated natural resources use and emissions, so that decision makers can make progress towards sustainable consumption and production and green economy frameworks. The notion of 'Green Economy' has been adopted across the United Nations and the need for financing, technology development and capacity building to help countries adapt to a changing economic context of reduced supply security and rising and more volatile resource prices has been recognized. The UNEP's Green Economy initiative aims to shift investment towards resource efficient and low carbon economic activities in a balanced and inclusive way, enabled by focusing on human and social development.

The International Resource Panel was established to provide independent, coherent and authoritative scientific assessment on the sustainable use of natural resources and the environmental impacts of resource use over the full life cycle. By providing up-to-date information and best science available, the International Resource Panel contributes to a better understanding of how to decouple human development and economic growth from environmental degradation. The information contained in the International Resource Panel's reports is intended to be policy relevant and support policy framing, policy and

The United Nations is taking the lead in building a knowledge base for a sustainable use of natural resources and a transition towards a Green Economy

programme planning, and enable evaluation and monitoring of policy effectiveness.

Between the International Resource Panel's launch in November 2007 and March 2012, five reports have been completed. This first series of reports covered biofuels, priority economic sectors and materials for sustainable resource management, metals already in use and their rates of recycling, and finally the unsatisfactory state of untapped potential for decoupling resource use and related environmental impacts from economic growth. These reports looked at two important groups of materials, namely metals and biomass.

Over the next couple of years, the IRP will continue to address critical resources and their impacts on the environment. It will also more systematically explore opportunities, chiefly for developing countries, of reducing dependencies on scarce resources. Reports currently in the pipeline will deepen the knowledge base about priority sectors, decoupling, environmental impacts and strategic natural resource groups such as metals and biomass but will also engage in new assessments, including:

- Water productivity;
- Water footprints and accounting;
- Technologies to reduce greenhouse gas emissions and their environmental impacts (two reports, one on supply side technologies, one on demand side);
- The Embodied resources and impacts in traded materials;
- The environmental challenge of metals;
- Metals recycling opportunities and technologies;
- Cities and Decoupling;
- Technologies and Policies of Decoupling.

Several new ideas for further assessments are under discussion.

The forthcoming reports of the International Resource Panel will be based on identified knowledge gaps. For instance, a new report on recycling opportunities and technologies will provide decision makers with information on how to improve the current low recycling rates for certain metals, and the new reports on water productivity will address scarcity and pollution issues in water stretched countries and regions. For a complete list of upcoming reports, please refer to pages 32 and 33 of this report.

How to set

Priority products & materials

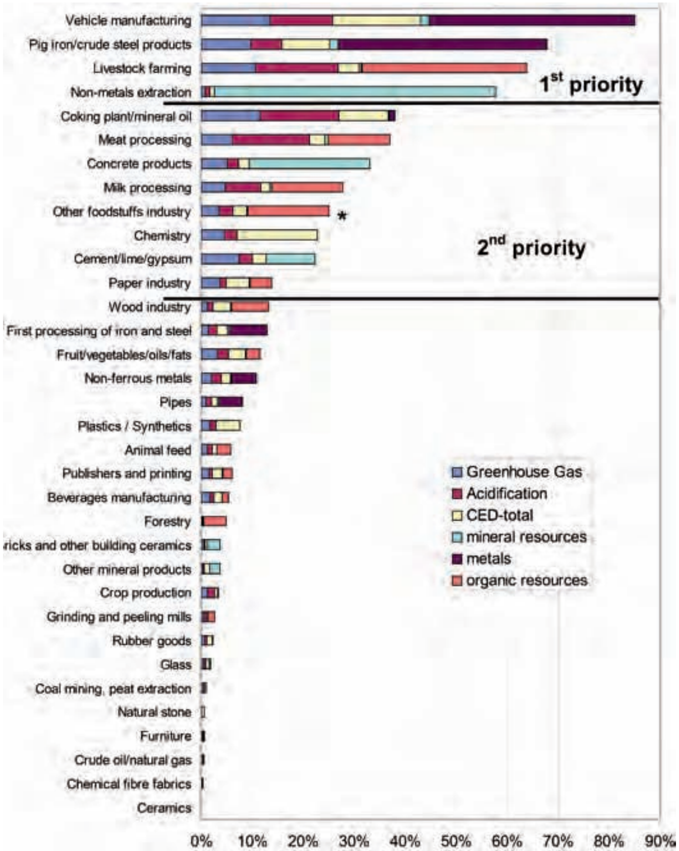
priorities

One important issue in formulating sustainable resource use policies is how to set priorities and where to invest effort and funding.

The IRP report entitled *Priority Products and Materials: assessing the environmental impacts of consumption and production,* identified economic activities causing the highest environmental impact so that decision makers can know where to focus their attention. Since different decision makers have varying perspectives and possibilities of intervention, the report provided priorities from a number of entry points to the global economy: production sectors, consumption categories and materials categories.

It is important to conceptualize production and consumption as co-evolving activities that reinforce each other. The influence of households goes beyond the immediate environmental effect of their purchasing decisions and use patterns, but does not determine the way the whole economy operates. For sustainable consumption and production (SCP) policies this means policies need to intervene in a complex co-evolving relationship, therefore moving from simplistic intervention approaches to more systemic interventions.

Figure 1: Environmental impacts of goods produced.



* ignored produced goods

From a material perspective, agricultural goods, biotic materials and fossil fuels have the most important impact. This figure by Dehoust et al. 2004 illustrates some of these impacts.

how to set priorities

The assessment identified the priority interim environmental impacts and their interaction leading to 'end-point' impacts on ecosystem health, human health and natural resource depletion. These included climate change, acidification and eutrophication of water and soils, eco-toxicity and related human health effects, as well as overuse of natural resource reserves. By starting with these environmental priorities, it was possible to pinpoint the hotspots along the interface between the economy and the physical environment, by identifying economic activities that are most associated with the resource and emissions pressures causing these environmental problems.

Little global data exists on the environmental impacts of production activities so the IRP assessment used US data, which showed that economic activities using fossil fuels, and the agriculture and fishery sectors, are critical because of their contributions to global warming, freshwater use, land use and fish stock depletion.

The energy sector, manufacturing, agriculture and forestry (through land use change and emissions from livestock), the transport sector and residential buildings are the largest contributors to global warming. These sectors also drive acidification processes. Eutrophication and freshwater eco-toxicity are mainly caused by agricultural production, through emissions and pesticide use.

Agriculture consumes many renewable resources, accounting for 50% of global land use and 70% of global water use. While renewable resources could, in principle, be used sustainably this has not been the case for forestry and fishing resources, with deforestation occurring in many countries and overexploitation of fish stocks.

Non-renewable resources are a more complicated issue, with abundant geological reserves of metal ores and fossil fuels still available in parts of the globe. It has, however, become more difficult to access and more expensive to extract these resources as ore grades have declined. Surging demand and slow development of new reserves has led to supply security issues for fossil energy carriers, metal ores and industrial minerals, foreshadowing future supply problems.

The IRP assessment used two methods to attribute environmental impacts to consumption clusters, namely Life Cycle Assessment (LCA) and Environmentally Extended Input–Output Analysis (EE IOA). The report assessed household and government consumption, and investment into capital goods and infrastructure.

In most countries, household consumption accounts for 60% or more of the life cycle impacts of final consumption. This may be different for fast growing developing economies which show high investment in infrastructure and production capacity, such as for example China, where government consumption and investment contribute more to overall environmental impact than households do.

The most important household consumption activities are food consumption, transport, and housing, including energy use for heating, cooling and electrical appliances. In developing countries, food and housing dominate greenhouse gas (GHG) emissions. In industrialized countries, housing, mobility, food and electrical appliances contribute to over 70% of the environmental impacts of household consumption.

Housing, mobility, food and electricity contribute most to the environmental impacts of consumption

The environmental impacts of government consumption are driven by energy use in public buildings, schools and hospitals. Resource use driven by government consumption can be substantial, and can create new market opportunities for products and services with less environmental impact through green public procurement.

For capital investment, a comparative study for some European economies indicates that construction, transport and machinery cause the greatest environmental impacts. In non-Asian developing economies the public sector is often a very large part of the economy and may account considerably for environmental pressures. Some emerging economies in Asia are making large investments in building up their infrastructure and manufacturing capacity, with significant environmental impacts.

Trade has grown in importance for environmental impact as many countries produce goods and services for consumers abroad. Asian economies, especially, have become the manufacturing powerhouse of the world. Trade causes a translocation of environmental impacts of consumption as a large share of the impacts occurring in Asia (20% to 40%) can be attributed to consumption in developed economies. Trade in itself is neither good nor bad for the environment, but more information is needed as to what extent it shifts environmental burdens to areas that are more vulnerable or resilient with respect to their local environmental thresholds. The IRP has launched work to provide more information about the embedded resource use and emissions in traded products for decision makers.

The environmental impact of consumption grows as per capita incomes rise. The IRP assessment assumes there will be further increases in energy use and GHG emissions from final consumption with rising wealth and changing lifestyles. This indicates that policy makers may need to consider mainstreaming sustainable consumption policies at earlier stages of their countries development trajectories.

decoupling strategies

Decoupling natural resource use and environmental impacts from economic growth

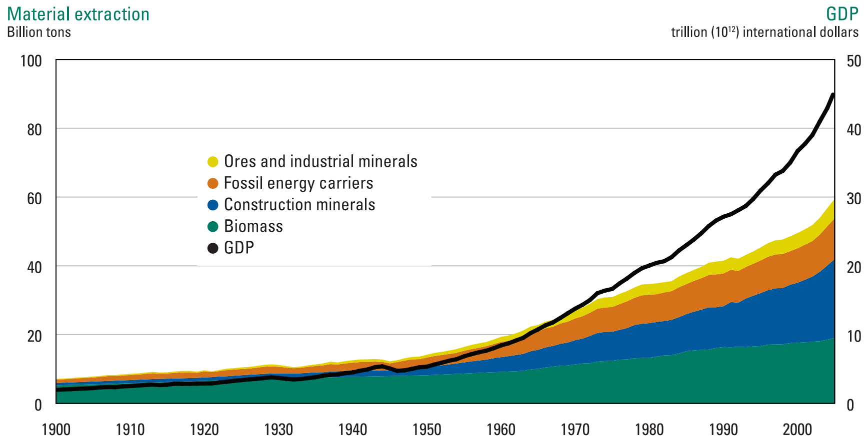
for a sustainable future

The last century saw significant global GDP growth, with increases in the standard of living and poverty reduction in many countries. There has also been, however, rising natural resource consumption, and increased emissions and waste.

Global extraction of natural resources including biomass, fossil energy carriers, metal ores and construction materials has increased to 60 billion tonnes annually. Without decoupling, if each person consumed resources in the same volume as current developed countries rates, this would lead to an attempt to almost triple resource extraction rates to about 140 billion tonnes by 2050.

While resource use per capita in developed economies remains high and continues to rise, accelerated economic growth and urbanization in developing economies is rapidly creating another 1 to 3 billion middle class consumers who will 'aspire' to consume at the same level. International trade has made it possible to displace resource extraction and production to countries where the bulk of manufacturing for global markets now takes place. Processes of modernization, industrialization and urbanization have contributed to rising levels of resource consumption for building new infrastructure

Figure2: Global material extraction in billion tons, 1900 to 2005.



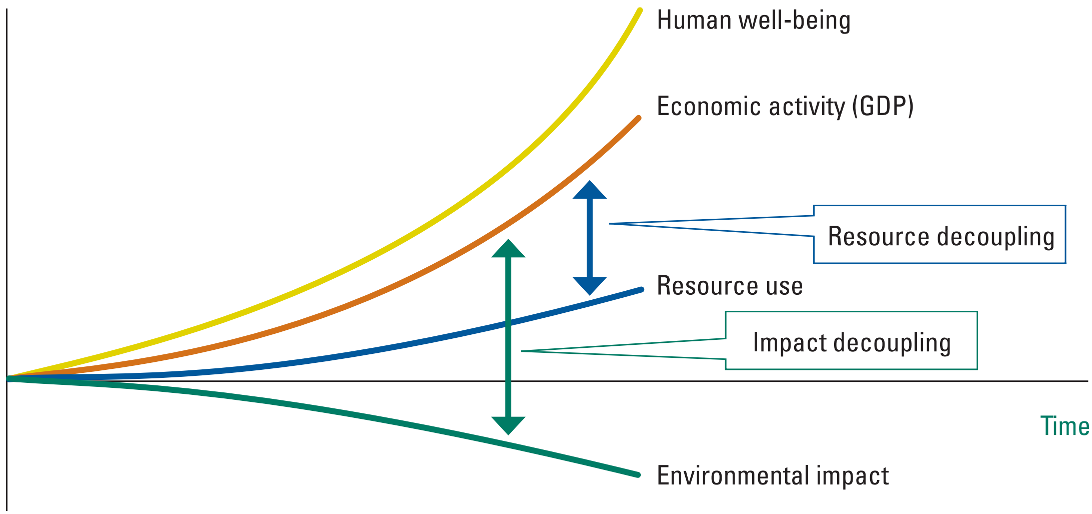
Source: Krausmannet al., 2009

During the 20th century the annual extraction of construction minerals grew by a factor of 34, ores and minerals by a factor of 27, fossil fuels by a factor of 12, biomass by a factor of 3.6, and total material extraction by a factor of about eight, while GDP rose 23-fold.

and increasing productive capacity and fuelling the lifestyles of new middle-class consumers. These trends in developed and developing economies are ongoing but there are serious risks associated with the assumption that the supply of natural resources will continue to grow in order to keep up accordance with demand for biomass, water, metal ores and fossil fuels.

The most promising strategy for ensuring future prosperity lies in **decoupling** future economic growth from the rising rates of natural resource use and the environmental impacts that occur across the production–consumption continuum. Decoupling economic growth from (a) growth in resource use and (b) environmental impact, however, follow different dynamics and hence require different policy responses depending on each country's consumption and resource endowment levels. While relative decoupling of economic growth and resource use has occurred in many countries, there is little evidence of absolute decoupling, i.e. reduced overall resource use, even for the richest nations. In many instances the environmental externalities of resource use can increase, for example, as ore grades decline, or

Figure 3: Two aspects of 'decoupling'



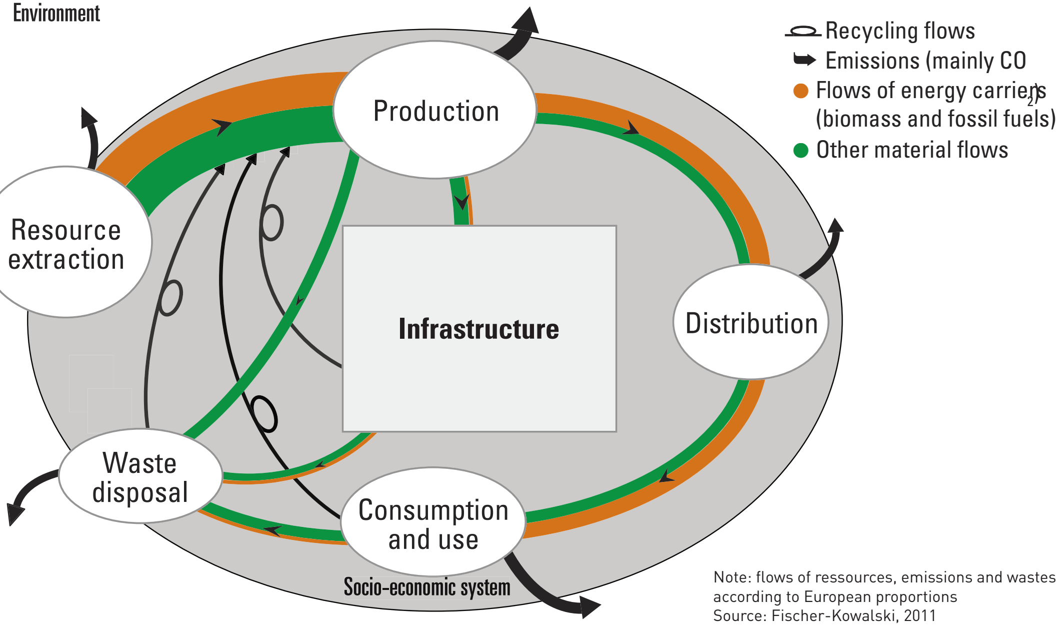
Resource decoupling refers to when fewer resources are used per unit of economic output, while impact decoupling is when negative impacts on the environment are reduced.

Decoupling of economic activity from environmental pressure is a necessary but insufficient strategy for a sustainable level of natural resource use

soil is depleted. There is, however, clear evidence that absolute decoupling of wealth from pollution is achievable and becoming routine practice in industrial countries through the use of pollution control technologies. These technologies for pollution control should always be assessed for trade offs and unintended consequences.

The IRP report on *Decoupling* argues the necessity of a new economic model involving reduced resource use, emission and waste intensity of production and consumption. **Economy-wide resource decoupling can be said to occur when resource productivity improves at a rate that is faster than the economic growth rate.** This means that more economic value and a greater level of well-being can be created by using the same amount of - or less - resources. Economy-wide impact decoupling refers to achieving more well-being and (if necessary) economic growth

Figure 4: The life cycle of resource extraction and use



Note: flows of ressources, emissions and wastes according to European proportions
Source: Fischer-Kowalski, 2011

Undesirable environmental impacts can arise from any stage in the life cycle of resource use: in the phases of extraction, production/manufacture, consumption/use, or post-consumption disposal.

with few negative environmental impacts or, indeed, even restoration of eco-system services.

Over the past decade the world has faced a new economic context of rising prices for many natural resources caused by demand outpacing supply, and increased challenges in extracting natural resources in an affordable and timely manner. Past strategies where national policy frameworks and business plans have focused on labor productivity at the cost of increasing use of materials, energy, land and water require rethinking. **Rising prices and greater price volatility for natural resources, combined with new supply risks, make resource productivity investments a new imperative**. Indeed, this may become the primary driver of the next long-term industrial development cycle.

Resource efficiency at the product level and economy-wide resource productivity is an important political and business objective, especially for developing countries which are facing the dual challenge of delivering infrastructure and raising living standards while living within environmental means. In the past there has been a strong relationship between growing incomes and growth in resource use in developing countries. The relationship between natural resource use and economic growth, however, has become non-linear. At lower income levels the correlation between income and resource use is very strong. Above a certain threshold of development a further increase in natural resources and emissions does not necessarily enable greater economic development and wellbeing.

The report identifies an important relationship between per capita resource use, per capita emissions and population density. Greater density, as found in cities and in many countries in Europe and Asia, enables lower per capita resource use rates. On the other hand, cities and densely populated nations have often externalized resource and emission intensive production to other parts of the world. Therefore their apparent resource efficiency may be somewhat artificial. The IRP used these observations to engage in a new report studying the relations between urbanization and decoupling more systematically.

Physical trade balances can help to indicate to what extent domestic resource use and emission accounts is linked to consumption abroad (and conversely, to what extent domestic consumption is linked to resource use and emissions abroad). These observations have triggered interest and engagement in a new assessment systematically investigating the effects of burden shifting and trade.

Investing in resource efficiency is necessary but not sufficient for sustainable natural resource use. Because of the size of the global challenge, resource efficiency needs to be complemented by systems sustainability–oriented innovation to enable the rates of decoupling that will be necessary to align development and environmental objectives. The IRP *Decoupling* report identifies the need for fast and radical improvements in reducing global resource use and greenhouse gas emissions, to reduce the risk of resource scarcity and accelerated climate change. The question of how to decouple will be taken up in the second decoupling report.

Innovation and decoupling are closely linked. The report noted that finance, technology and capacity building will be core elements in enabling decoupling. Investment into supply systems for food, housing and mobility needs to shift from 'brown' to 'green' sectors to allow for a fast transition from current systems of production and consumption. Innovation and technology development, in principle, could produce 80% reductions in resource and emissions intensity in some crucial activities (such as cement production) within these sectors. Decoupling economic activity and wellbeing from resource use and environmental impacts will depend on governments that provide enabling frameworks for businesses and workforce training and up-skilling existing and new workers across many industries.

Well-designed policies and institutional innovation, as well as new forms of governance, are identified as critical in the report. The report identifies Germany, China, South Africa and Japan as examples of countries that have addressed decoupling in their policy frameworks.

The report stresses that countries and economic processes are increasingly interconnected through trade relations. Trade in natural resources is growing much faster than domestic extraction, implying growing environmental pressures and impacts. Trade has direct environmental impacts of transportation and indirect (embodied) impacts that occur when a country produces goods or services for consumption abroad. The report shows that CO_2 emissions embodied in internationally traded products account for 27% of total energy-related CO_2 emissions. Embodied water was around 16% of total water use and materials extraction embodied in global trade has been estimated at about 20% of global extraction.

the critical role

Metal Stocks in society
& Recycling Rates

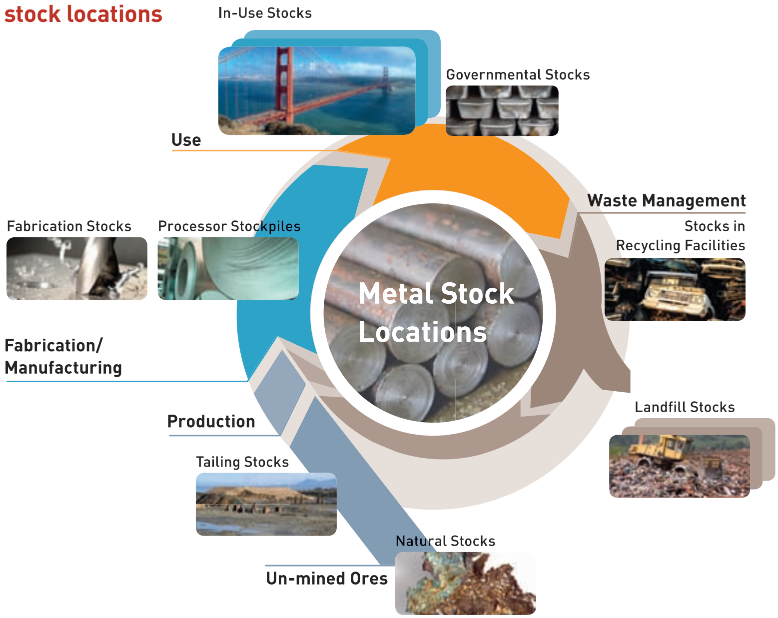
of recycling

Economic development is closely linked to the use of metals for construction, transport and communication systems, and for machinery and appliances.

A modern economy without iron and steel, copper and aluminum seems unthinkable and in fact, metal applications grew rapidly during the 20th century. In 2009, more than 1.2 billion tonnes of steel were produced globally. Aluminum and copper have the second and third largest production figures at about 30 million and 24 million tonnes respectively.

While in the past industrialized countries have dominated the use of metals, more recently developing countries have markedly increased their use of metals to build modern infrastructure, manufacturing facilities and transport systems. The fast growing demand implies a permanent pressure upon existing production systems and has contributed to issues of supply

Figure 5: Metal stock locations



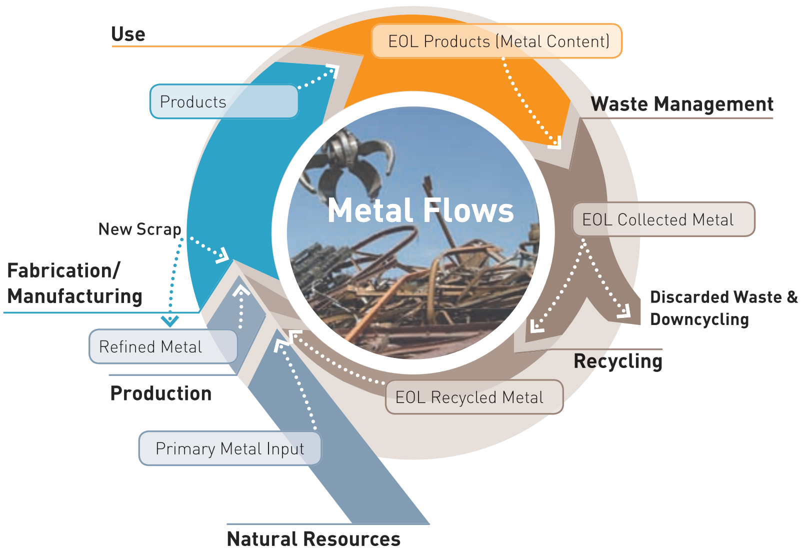
The lifetime of different metal products and the different metals within them varies, from weeks in the case of a beverage can, to decades or centuries, in the case on construction and infrastructure. Different kinds of stocks develop along the life cycle of metals.

the critical role of recycling

security and rising metal prices. Investment in mining and metal refining has been growing accordingly and new projects have increased the environmental and social impacts of mining in many parts of the world.

Growing metal inputs have also created large metal stocks in society. **Understanding stocks in society can help decision makers know where their future secondary supplies will come from**. The IRP reports entitled *Metal Stocks in Society and Recycling Rates of Metals* finds that the increased use of metals over the 20th century led to a shift in metal stocks from natural reserves to applications in society. The copper stock per US citizen, for example, has quadrupled over the last 70 years and differences in per capita in-use stocks between industrial and developing countries for most metals are marked. As technologies and lifestyles in developing economies converge with those in industrial countries the global in-use stocks of metal are expected to grow three- to nine-fold.

Figure 6: Metal flows



For some metals there is a long tradition of recycling, whereas for others almost no recycling infrastructure exists.

Metal recycling is an important strategy to increase the economic benefit of extracted metals and to reduce pressure on primary metals and the environment. Despite metals having excellent properties for recycling the end-of-life recycling rates for many metals are far too low because of a lack of recycling infrastructure and technologies, especially in developing countries, though it depends on the metal and how it is used. Recycling of iron and steel, aluminum and copper have a long tradition and well-established infrastructure and so recycling rates are quite high, 70% to 90% for iron and steel, and above 50% for aluminum and copper.

Precious metals including gold, silver and platinum are valuable enough to have high recycling rates, except in some applications and when used in very small amounts. Platinum group metals currently have recycling rates of 60% to 70%, while gold and silver are above 50%. These rates signal a large amount of wasted metal and point to the need for strengthening institutional frameworks, and the logistics and technologies for metal recycling in many countries in the world. Consumer applications are much harder to address by recycling than industrial applications. Enhancing recycling for consumer applications needs to be a priority in developing policy, and practical solutions are required.

Metal recycling is a key opportunity, since current recycling rates for many metals are very low

The increased use of specialty metals is a fairly recent phenomenon and has occurred with many new applications such as the use of lithium for batteries, gallium, germanium, indium and tellurium for solar cells, and rare earth metals for catalysts, as battery constituents and as permanent magnets for power drives and wind turbines. The demand for specialty metals will grow rapidly due to innovative technologies and their increasing market potential. The recycling rates of specialty metals, however, are extraordinarily low, often below 1%, because of the lack of recycling logistics, technologies and suitable legal frameworks. The concentration of specialty metals in products is often very low and would require suitable sorting and pre-treatment infrastructure, which is rare. **As a consequence, the recycling of specialty metals is in its infancy and deserves special attention from policy makers and industry in the future. As such it is a major opportunity for investment**.

The IRP report advocates investment into research and development to establish a knowledge base on the amounts of recyclable metals in various stocks in society, as well as to develop improved recycling technologies. Efforts could focus on recycling demonstration projects, closed-loop recycling of rare earths from batteries, and tantalum recycling from electronic scraps. Current legislative systems and frameworks for metal recycling need further strengthening, especially in developing countries and at provincial and local levels, to make recycling a significant solution.

There are important social and human health issues related to using and recycling metals, which need to be addressed by policy frameworks. These include illegal waste transport and trade, and the regulation of the informal recycling sector in developing countries, which often operates with inferior technologies and creates severe risks for human health and environmental toxicity.

towards sustainable

Assesing Biofuels

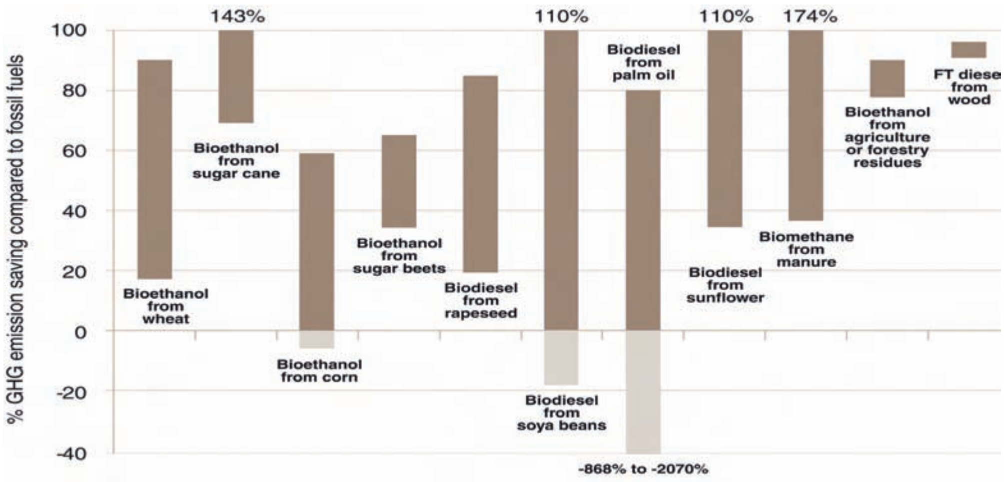
production and use of resources

The long-term sustainability of the bioenergy sector can only be achieved with sound policies and planning that take into consideration global trends including population growth, yield improvements, changing diets and climate change.

Not all biofuels perform equally well in terms of their impact on climate, energy security, and on rural livelihoods and ecosystems. Land and water are two key inputs not only for biofuels development, but also food, feed, fibre and other materials. These competing uses are interdependent, and, therefore, ways to address the constraints need to factor in and build on this interdependency.

The IRP report *Assessing Biofuels: towards sustainable production and use of resources* highlights these two potentially limiting factors for bioenergy development, land and water. The report also shows that yield increases will probably not compensate for the growing and changing food demand, which means cropland would have to be expanded already to feed the world's population. Further land requirements for fuel crops would come on top of that.

Figure 7: Greenhouse gas savings of biofuels compared to fossil fuels



Source: own compilation based on data from Menichetti/Otto 2008 for bioethanol and biodiesel, IFEU (2007) for sugar cane ethanol, and Liska et al. (2009) for corn ethanol; RFA 2008 for biomethane, bioethanol from residues and FT diesel

Life cycle assessments (LCA) of biofuels show a wide range of net greenhouse gas balances compared to fossil fuels, depending on feedstock, conversion technology, and other factors.

towards sustainable production and use of resources

Land use changes can come with negative consequences. For instance, redirecting agricultural land to production of feedstocks for biofuels may represent a risk for food security. Conversion of natural land for production of feedstocks for biofuels may reduce biodiversity and increase green house gas (GHG) emissions. Land use change can take place directly or indirectly, for instance, when biofuel feedstocks are produced on existing cropland and existing production is displaced into natural lands.

Water is already a scarce resource in many places. Agriculture uses about 70% of freshwater globally. This has led to the overexploitation of important groundwater as well as the deterioration of water quality in river basins due to nitrogen and phosphorus run off. Expansion of crop production for biofuels would be adding pressure on water resources. Furthermore, climate change and extreme weather events increase uncertainty of available water resources and large-scale investment in biofuels production adds pressure on freshwater availability. In water scarce regions, this large-scale investment could create a competing land use to food production.

Food security is an important issue in the policy debate around bioenergy. Risk for food security comes from land use change for biofuel feedstock production (using food or non-food crops). When bio-energy is produced from food (or fodder) crops, there can be localized impacts on food availability and global impacts on food prices. However, biofuel use can also help strengthen food and energy security, by improving food storage and cooking; as well as access to modern energy services for the 1.4 billion people who are currently dependent on traditional biomass use for cooking and heating.

The production of biofuels for transport has been mainly triggered by blending mandates introduced by a number of countries to mitigate greenhouse gas emissions and improve energy security. Strengthening rural development may be an additional policy objective. By 2006 at least 36 states/provinces and 15 countries at the national level had enacted blending mandates. In 2007, liquid biofuels represented 1.8% of the world's total transport fuels, with ethanol and biodiesel being the most widespread applications. Investment in new capacity for biofuels production exceeded $4 billion in 2007 and is expected to grow rapidly.

Biofuels may make a difference in achieving the different policy objectives pursued. However, environmental and social impacts need to be assessed throughout the entire life-cycle. An analysis of existing life cycle assessments of biofuels showed varied greenhouse gas savings when compared to fossil fuels. Differences depend on the feedstock, production methods, conversion technology and location. Negative GHG savings (increased emissions) occur when

The demands on biomass are manifold, and trade-offs between food security and energy need to be managed carefully by well-designed policies production takes place on converted natural land because of the mobilization of carbon stocks. Highest GHG savings come from biogas produced from manure and ethanol produced from agricultural and forestry residues, and from biodiesel from wood.

While the impact of biofuels production on GHG emissions has been relatively well captured in existing life cycle assessments, other impacts such as the impact on water and biodiversity, eutrophication and acidification, trade-offs with food security, or social and livelihood impacts for rural smallholders, are usually not considered. Many studies suggest that these impacts are considerable and often more negative for biofuels than fossil fuels. Impacts need to be assessed at the project level and at a broader regional and/or global level. A single project may be acceptable in terms of impacts, but cumulative effects of several projects may be significant.

Many governments have responded to these impacts with sustainability requirements that complement blending mandates. However, the impacts of a growing demand for biofuels on land use change deserve special policy attention. Countries have started to introduce mapping and zoning of suitable and available land as a means to reduce risks related to global expansion of cropland.

The IRP report highlights options for more resource-efficient and sustainable production and use of biomass that can help reduce environmental pressures and impacts. Options include optimizing agricultural production systems, restoring degraded land, more efficient biomass use including using waste and residues, cascading use of biomass, and stationary use of bio-energy.

Potential for yield increases is higher in developing countries, especially those in Sub-Saharan Africa. Such improvements depend on the availability of agricultural inputs, machinery, biological quality of the soils, skills and knowledge, as well as financing. Climate change impacts such as flooding, drought and extreme heat and winds add to the risk of agricultural production failure compromising efforts to achieve higher output.

Like biomass, solar energy systems transform solar radiation into useful energy, albeit more efficiently. Solar installations require significantly less land for the same amount of energy and often have fewer environmental impacts. Solar power is rapidly becoming an economically viable alternative to fossil fuels, especially for off-grid applications. Also, technologies such as solar cookers can substitute for traditional biomass use in developing countries. Such applications may replace biofuels and have potential to be more beneficial in regards to local livelihoods and the environment.

addressing the need for

Conclusions & Outlook

sustainable resource management

The International Resource Panel's reports make a scientific case for sustainable natural resource management and decoupling economic growth from natural resource use and environmental impacts.

Governments and businesses need to work together to create an innovation culture for resource efficiency to support sustainability

The assessments are based on the best available scientific information and aim to inform policy makers and business leaders about new opportunities and challenges they face in regard to economic development, human wellbeing, equity, resource scarcity and climate change.

There are many opportunities for governments and businesses to work together to create policy to encourage sustainable resource management, and for business practices to make it happen. Countries and companies need to plan for and invest in better use of natural resources, and to reduce the environmental impacts of resource use. While technological innovation and efficiency are important they are not sufficient to achieve the required decoupling between economic growth, resource use and emissions. In many cases, efficiency improvements will need to go hand in hand with systems innovation in activities that have high resource use and emissions. New systems of provision for these essential services are necessary and human ingenuity and appropriate institutional frameworks will help them to occur.

The assessment on priority sectors and materials provided by the International Resource Panel is pivotal to helping governments and businesses decide on investment priorities that will yield the greatest return upon investment in regard to saving resources, reducing pressure on ecosystem services, and avoiding emissions and pollution.

The need for systems innovation in providing essential services such as housing, mobility, food, energy and water especially applies to growing cities in developing countries, where wise investments today will pay off in decades to come. The need for greater resource productivity and systems innovation, as well as for more resources to fuel the transition in the developing world, must be aligned with climate change mitigation strategies, poverty alleviation and equitable access to resources.

To provide an affordable, equitable and timely supply of natural resources while reducing greenhouse gas emissions and waste will require a steep change in investment and innovation, well beyond current models. To achieve this, governments need to set appropriate price

addressing the need for sustainable resource management

Resource efficiency is an opportunity. With today's understanding and technologies, massive improvements in resource efficiency are possible and could enable improved economic **productivity**, improved resource **security**, and reduced **environmental** burdens. Innovation will need stimulation for resource efficiency to reach sustainable levels.

signals and incentives, support innovation, intervene in cases of market failure, and invest in urban design, infrastructure and education.

One priority for governments is to reset budget and tax systems and remove resource price subsidies; this would provide incentives to raise resource productivity. Specific measures include resource taxes and cap and trade systems, with compensation for lower income groups via subsidies or tax relief.

Secondly, resource innovation will depend on investment schemes, incentives and legal frameworks that encourage green businesses, infrastructure, buildings and public transport as well as more efficient energy and water supply systems. Government procurement will play an important role in encouraging a shift to products and services that have been produced with lower levels of resource use and emissions.

Finally, governments can directly influence training and skills that underpin the transition to sustainable resource use by investing in education systems and improved curricula, and by facilitating knowledge transfer. There is also a need to redesign cities and their infrastructure in ways that are less resource and emissions intensive and which create a cleaner, healthier and more efficient future for their residents.

Different uses of biomass for food, feed and fuel need to be balanced within an overall resource strategy, considering energy, climate, and water and assessing the overall costs and benefits to society, economy and the environment. This may lead to reconsideration of current biofuels mandates, targets, quotas and subsidies, to guide the contribution of biofuels to sustainable levels. On the supply side, the potential for degraded land to be put into production would go hand in hand with activities to sustainably increase yields in low-yield countries and regions such as Africa. Demand management policies that encourage public transport and higher fuel efficiency standards, as well as policies that help reduce food waste across the whole production life cycle, need to complement supply side activities.

For materials that are strategic for the production of goods and services and infrastructure, such as metals, recycling rates need to increase substantially to reduce resource pressure. As the world transitions to low carbon economic activities, metals will be pivotal in underpinning new green technologies and any additional demand for metals for new technologies should be buffered by much higher recycling rates.

In the resource-scarce world of the 21st century, businesses will need to switch from their traditional focus on labor productivity, in favor of resource productivity. This will require new information and monitoring, as well as business strategies to conserve resources and reduce emissions. This can reduce costs, in a situation where taxation has shifted the focus from labor to pricing of natural resources at source.

The International Resource Panel continues to provide knowledge and information to policy makers, business leaders and the public on how to move to sustainable resource management. Over the next two years, the IRP will deepen its assessments of consumption and production, decoupling, metals and biomass. It will deliver further reports on water, soil and land use and environmental impacts of trade.

The knowledge base that the IRP provides supports policy makers and business leaders as they embark on the journey of decoupling economic activity from resource use and emissions to enable the global economy to operate within the limits of the Earth's resources, climate and ecosystems, while providing equal opportunity and wellbeing to a projected nine billion people on this planet.

The International Resource Panel

has established seven working groups to assess different aspects of decoupling economic growth from resource use and environmental impacts. The working groups have been producing a series of reports and the following table provides an overview of forthcoming reports.

IRP Working Groups	Forthcoming reports
Decoupling Working Group	Decoupling in Practice: Technology and Policy This report outlines the opportunities technological innovation offer for increasing resource productivity and suggests policies that would provide incentives for economic systems to transition to these new technologies. It focuses on important sectors such as agriculture, manufacturing, heavy industry, construction and transport. Decoupling in Practice: Innovation This report focuses on the instrumental role of innovation in achieving decoupling and covers institutional aspects, financing and capacity building for innovation, national innovation culture and changes in social-technological systems of energy, water, housing, mobility and food.
Cities Working Group	Cities and Decoupling This report focuses on the importance of urban planning and design, and investment into urban infrastructure and buildings a as key element of decoupling.
Environmental Impacts Working Group	Supply side GHG mitigation technologies This report focuses on supply side options for reducing GHG emissions through greater eco-efficiency and cleaner production. Demand side technologies for GHG mitigation This report describes the importance of the role of private and public consumers in reducing GHG emissions from consumption, including the importance of changing lifestyles and public and corporate procurement. The embodied material use and environmental impacts of traded products This report looks at the translocation of environmental impacts caused by international trade.

Water Efficiency Working Group	Water Productivity This report outlines options for enhancing the productivity of water use in agriculture, manufacturing and households. Water Footprint and Accounting This report looks at improving the quality of water accounts, and considers the important differences between territorial and consumption based water accounting.
Metals Working Group	Recycling technologies This report highlights recycling technologies and the logistics that underpin recycling systems. Environmental impacts of metal flows This report focuses on the environmental impacts that occur across the whole life cycle of metal flows. Demand scenarios for metals This report provides alternative scenarios for the future of metal demand. Policy options for metal stocks and flows This report identifies the policy levers and barriers for sustainable metal use, and discusses decoupling metal use from economic growth.
Land and Soils Working Group	Land and Soils This report looks at the important role of land for production and consumption and identifies options for improving the efficiency of land use.
Food Working Group	Food pricing This report focuses on the issue of food security, improvements in the food system and the market mechanisms that may provide incentives for sustainable food production and consumption.

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About **the International Resource Panel**

The International Resource Panel (IRP) was established to provide decision makers and other interested parties with independent and authoritative policy-relevant scientific assessments on the sustainable use of natural resources and, in particular, on their environmental impacts over their full life cycles. It aims to contribute to a better understanding of how to decouple economic growth from environmental degradation.

For more information, please visit:
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