Alleviating climate change

Robert Goodland and Simon Counsell

Abstract. Addressing climate change will require dramatic policy shifts in the fields of energy, livestock production and forest management. The following paper summarises where we are now and what we need to do, with an emphasis on how multilateral organisations like The World Bank can help to address the challenges ahead.

Forty-six nations and 2.6 billion people are now at risk of being overwhelmed by armed conflict and war related to climate change. A further fifty-six countries face political destabilisation, affecting another 1.2 billion individuals.[1] Climate change is today's biggest threat to international security and will intensify North-South tensions.[2] The world has to end growth in greenhouse gas (GHG) emissions within seven years (by 2015) and reduce emissions by about 80 percent by 2050. At least two-thirds of energy demand over the next twenty-five years will come from developing countries. The world must reduce annual carbon emissions from today's 8 billion tons down to about 2 billion tons to balance the assimilation capacity of the world's carbon sinks (such as oceans, forests, and other biomass).

Climate change

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The Energy Sector

The energy industry calculates that several thousand billion tons of coal remain in the ground - 150 years' worth at current extraction rates. It is therefore clear that most of the remaining coal has to stay in the ground if we are to avoid climate catastrophe. Three-quarters of coal reserves are in five nations: the United States, Russia, China,

Ecological tax reform is a big part of the solution: a stiff severance tax on carbon levied at the wellhead and mine mouth, accompanied by equalizing tariffs on carbon-intensive imports and rebating the revenues by abolishing regressive taxes on low incomes. Such a policy would reduce carbon use, spur the development of less carbon-intensive technologies, and redistribute income progressively. Higher input price (on fossil fuels or carbon content) induces efficiency at all subsequent stages of the production process, and limiting depletion ultimately limits pollution.[4]

The transition to renewable energy should be accelerated as urgently as possible. Although most (such as geothermal) is site-specific, the potential is limitless. For example it has been calculated that wind energy in the Dakotas could supply adequate electricity to the whole USA. The entire world demand for electricity could be met from 254 x 254 km of Sahara desert. Desertic nations should be financially encouraged to export solar electricity and eventually hydrogen from water. Offshore wind, wave, current, and tidal power could become the backbone of the UK's electricity.[5]

Coal

There is increasing support for banning all new coal-fired power plants that do not have provisions for CO_2 capture and sequestration. Since wind-generated electricity is already economic relative to coal with sequestration, there is no reason to allow the building of new power plants that would emit large amounts of CO_2 for decades.[6] Care must be taken to ensure that all former coal industry employees are retrained for sustainable jobs or fully compensated. Boosting efficiency by retrofitting existing coal power plants should be accelerated, as should phase-out of the dirtiest coal plants.

Clean Coal

No reliance should be placed on "clean coal" because it does not yet exist. It could become available after 2020, too late for the climate crisis. In any event, if clean coal is achieved, it will be about 25 percent more expensive and nearly impossible to monitor. Carbon capture and sequestration (CCS) technology is being experimented with, but on 30 January 2008, the US government cancelled its first pilot CCS project (FutureGen in Matoon, Illinois) after fi coal with S) t1d4i43 0 or. Carbon capture scale. However, extreme caution is needed to ensure that such plantation schemes do not undermine the rights or livelihoods of poor people living in what are sometimes viewed as "degraded" forest environments, but which actually comprise occupied subsistence farmland. In addition, micro-algae have been demonstrated to sequester more than 80 percent of daytime CO_2 emissions from power plants and can be used to produce up to 10,000 gallons of liquid fuel per acre per year.[8]

Oil

It seems likely that the world cannot afford to burn its remaining oil. The era of cheap oil is already over; exploration for new deposits should be discouraged. Canadian tar sands should be left in place and re-vegetated.

Natural Gas

Natural gas is 'cleaner' than coal: It contains 70 percent less carbon per unit of energy than coal. As the transition to renewables will be wrenching, natural gas will have a role as a bridging fuel. But gas leaks are inevitable, it (methane) is 21 times more climate forcing than CO_2, and liquefaction, transport and regasification emit substantial quantities of GHG, so the gains are limited and temporary.

Nuclear Energy

Nuclear energy is not a panacea. Full environmental and social costing, including the risk of terrorism and accidents and the diversion of radioactive materials to weaponry, must be mandated. The industry must pay for permanent storage of nuclear wastes. All waste storage and insurance against accidents must be the responsibility of the nuclear industry from now on. All subsidies to the nuclear industry must cease and preferably be reallocated to renewable forms of energy.

Hydroprojects

Reservoirs are the largest single source of anthropogenic methane emissions, contributing around a quarter of these emissions, or more than 4 percent of global GHG emissions. The recommendations of the World Commission on Dams[9] should be followed. In particular, hydroelectric projects likely to emit substantial amounts of GHG should be banned. Carbon emissions from any dam should be subject to the proposed global carbon tax.

Hydrogen fuel cells to promote the "hydrogen economy" may prove to be among the best bets for temporary subsi

Hydrogen

Generating hydrogen from fully renewable energy systems (such as solar and wind) by electrolyzing water (even sea water) seems hopeful. This is one of the main technologies for research. Hydrogen fuel cells to promote the "hydrogen economy" may prove to be among the best bets for temporary subsidies.

Caveat on Carbon Trading

The *International Carbon Procurement Vehicles Investor's Guide* (2007)[10] notes that more than 50 carbon funds exist and nearly €6 billion of capital has already been invested in them. They offer investors a diverse menu of opportunities for participating in the carbon market. However, analysts argue that conclude that the carbon trading approach to the problem of rapid climate change is fraught at present and ineffective.[11]

Contraction and Convergence (C&C) is a global framework for reducing GHG emissions to a safe level. C&C was designed by the Global Commons Institute for the Intergovernmental Panel on Climate Change and the UN Framework Convention on Climate Change.[12] Longtime industrialised countries, which have produced the bulk of greenhouse gases, bear a much larger burden in preventing climate change; therefore they will have to play a leadership role, both regarding drastic emissions reduction and development of low- or no-carbon technologies to provide room to poor developing countries for economic development within the boundaries of a global carbon regime.

C&C is based on the science of limits and the principle of carbon justice, striving for convergence to equal-per-capita emissions rights, assisted by a medium-term, multistage approach accounting for differentiated national capacities. “Contraction” means global emissions are reduced in total over time so the concentration of greenhouse gas in the atmosphere stabilises at a level low enough and soon enough to prevent dangerous rates of climate change from taking hold. “Convergence” means that subject to this global limit, initial entitlements to emit carbon are distributed to all the countries or regions of the world with an agreed process of convergence to equalise per capita emissions entitlements across the planet.

During contraction and convergence, entitlements are assumed to be tradable and hence must be capped, with quotas initially distributed to the government, which then auctions them to users

Caveat on Cap-and-Trade Schemes

Cap-and-trade schemes do not reduce GHG emissions; they merely allocate emissions costs, depending on where the cap is set. Clearly the cap could and should be set well below current usage. Cap-and-trade history shows that allowances are perversely handed out to major carbon emitters, who can use them or sell them at market rates. A growing consensus warns that carbon trading, and in particular the idea of offsetting carbon emissions, may be hurting, not helping, efforts to ensure a safe climate future. Cap-and-trade proponents argue that trading the right to emit CO_2 allows firms and nations to decide whether they should spend money on cutting pollution or on buying the right to pollute by paying someone else to cut back.

Most of the carbon credits being sold to industrialised countries come from polluting projects. Projects should be net reducers of carbon to have a credit to sell. Burning methane from coal mines or waste dumps for energy does little to wean the world from fossil fuels, but do such activities result in reduction of GHG? The forestry and carbon sink projects proposed for inclusion in the Clean Development Mechanism are a way for industrialised countries, responsible for 75 percent of greenhouse gas emissions, to obtain access to cheap ways of buying emission rights without committing themselves to reducing their emissions. At least they have to pay more to emit, and what they pay goes to a country that has not used its quota. GHG emission reductions must become the overriding priority and are achieved by a low cap, not by trading. Almost all such reductions must come from the polluters, namely the industrial nations.

Climate Geo-engineering

Schemes to increase the earth's albedo to reflect more sunlight back into space would need thorough environmental assessments well beforehand. For a life form that lives on solar radiation to block more of it from the earth to permit more rapid consumption of nonrenewable energy seems perverse. The hope that iron fertilisation of oceans will boost C-sink capacity seems risky. None of these ideas seems at all attractive to date and may postpone reductions in GHG emissions.

Box 2. Sector Solutions to Reduce Climate Risks

Transportation: Pedestrianism (including moving walkways) and non-motorised transport (such as bicycles) must become the priority. Transportation will become almost entirely electricity-driven. Mopeds and other electric and fuel-cell vehicles should become common and feasible through urban planning. Mass transit (electric) systems should become the norm; modal shifts to inter- and intra-city (electric) rail, and water transport should be encouraged. New highways are problematic. Air transport is likely to decline until renewable low- or zero-carbon fuels (such as solar hydrogen) become available.

Buildings: Changes include rehabilitation of existing building stock, insulation, solar windows with high insulation (which reflect heat in the hot season and absorb heat in the cold season), new lighting technology (compact fluorescents, LED bulbs), efficiency standards for water heating, refrigeration and other appliances, rooftop and parking-lot solar systems.

Industry: The most energy-intensive industries should be phased down. Combined heat and power systems will become commonplace. Industry must facilitate recyclability of its products. Industry should progress toward closed-loop manufacturing in which there is no waste. Wastes and waste disposal should be taxed to provide incentives for industry to recycle.

Urban and Municipal Authorities: Telecommuting should become the norm; working from home would reduce congestion and transport costs. Urban design should prioritise pedestrianism and facilitate bicycles. Other developments include solar-roofed parking lots, district heating systems, combined heat and power, efficient street lighting, efficient water pumping, waterless composting sanitation (with no new water-based sewage systems), recycling of water, collection of rain, composting of all organics.

Agricultural: Innovations include efficient solar and wind irrigation pumps, solar and wind-powered desalination, rainwater harvesting, water conservation, trickle irrigation, irrigation of food crops only, with none for fodder or livestock. There may be a role for the lowest-impact irrigation reservoirs.

Agrifuels produce more GHG than the fossil fuel they displace. If all costs are internalised, agrifuels will become uneconomic.[13] Diversion of crops to fuel reduces food availability, the prices of which are therefore soaring worldwide. In addition, 9,000 liters of water are needed to produce about one liter of agrifuel. There may be some benefit in the future from cellulosic and algal fuels, but they are still experimental. Livestock contribute more to GHG emissions than any other form of agriculture, and forests are often burned or destroyed to make room for ranches. Livestock constitute the least efficient form of producing human food and consume more water than any other product.

Livestock

The agriculture sector is generally agreed to account for one-quarter of GHG emissions, of which deforestation and livestock are the main elements. One journal estimated that 23

would not require lowering nutritional standards; on the contrary, it would improve them.[18]

Forest Policy

More than 35 million acres of tropical forests are destroyed annually (particularly in developing countries), releasing more than 1.5 billion metric tons of CO_2, methane, and NOx into the atmosphere every year. Climate change is intensifying drought and the risk of forest fires. In some years, like the 1997-1998 El Niño year when fires released some 2 billion tons of carbon from peat swamps alone in Indonesia, emissions are more than twice that.

The omission of avoided deforestation from the Kyoto treaty resulted from concerns about the environmental effectiveness of the process, particularly since it would be difficult to enforce agreements by developing nations. Some environmentalists fear nations might sign up to secure one area, shifting deforestation elsewhere but bringing no net gain. Serious technical challenges remain to the inclusion of forest carbon issues in any binding agreement on climate, not least because monitoring of carbon balances and flux from forests is practically difficult and poorly developed.[19]

The World Bank reports that deforestation accounts for about 20 percent of global carbon emissions, mainly from fires set to clear land. In 2007 the Bank established a US$250m Forest Carbon Partnership Facility (FCPF), which aims to establish pilot activities to enable tropical countries to prepare for the inclusion of "avoided deforestation" in a post-Kyoto agreement in 2012. At the time of writing the FCPF had received the backing of the G8 and sign-off from the board, although many important details of the initiative are still under development. The Bank's BioCarbon Fund finances projects that sequester or conserve greenhouse gases in forest, agro, and other ecosystems. BioCarbon Fund projects have to fulfill criteria to ensure that the fund meets its own targets in the areas of climate and environment, poverty alleviation, project management and learning, and portfolio balance. Each BioCarbon Fund project is expected to deliver between 400,000 and 800,000 tons of CO_2 equivalents (CO_2e) over a period of ten to fifteen years. In return a typical project will receive about US$2-3 million in payments (US$3-4 per ton CO_2.[20] It is still too soon to judge the extent to which this can reduce atmospheric GHG.

However, the Bank's own policies sometimes seem to be at odds. The US$80m Amazon Region Protected Areas Project expands Brazil's protected areas system in the Amazon region as a first phase alone. But this is undermined by IFC's Bertincarbon

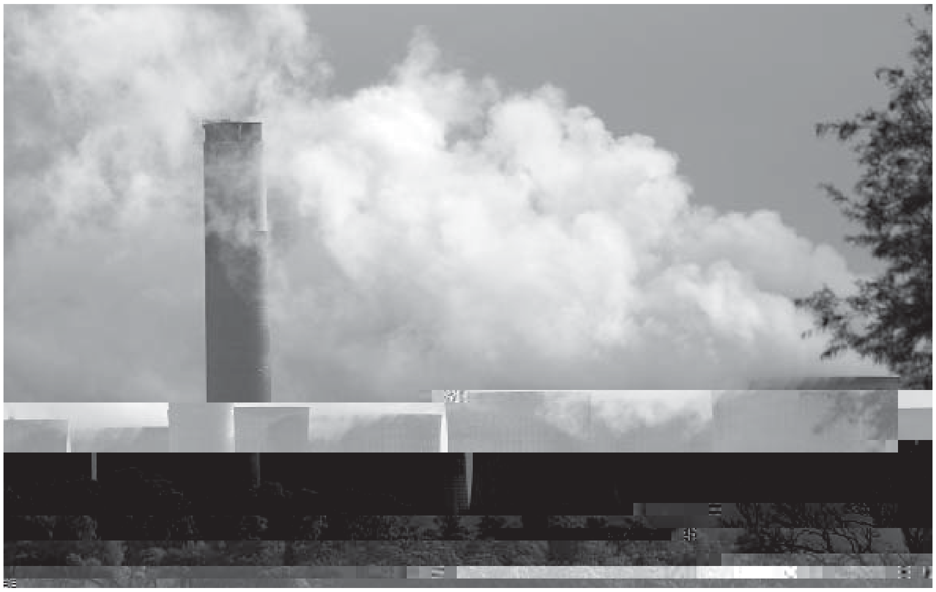

Photo 3. (*Courtesy Nigel Dudley, Equilibrium Research*)

ramped up. In 2007 the Bank's former chief economist and vice president, Lord Nicholas Stern, urged the Bank to desist from financing deforestation as the biggest and most immediate contribution it could make to reducing GHG emissions. However, the Bank has a long track record of funding industrialisation of natural forest areas in the tropics and, more recently, in the former communist countries.[21]

Outright conversion or fragmentation of natural forests for any purpose, such as oil palm plantations, cattle ranching, soy, logging, and mangrove shrimp ponds should cease immediately.

More than 2.5 million acres of Indonesian rainforests are cleared for oil palm plantations, and 3.5 million acres of Amazonian rainforest are cleared every year, primarily for enormous soy fields and cattle ranching.[22] IFC finances oil palm, soy, and cattle ranching in tropical rainforest regions and shrimp cultivation in mangrove forests. For IFC, destruction of tropical rainforest in general is insufficient reason for an Environmental Assessment (EA) Category "A." For example, IFC's US$80 million finance of Indonesia's Wilmar Oil Palm Project in 2006 is EA Category "C." IFC justifies this by writing, "It is anticipated that this project will have minimal or no direct, adverse social or environmental impacts." IFC omits emissions of greenhouse gas, risks to indigenous peoples, and loss of biodiversity.[23]

Outright conversion or fragmentation of natural forests for any purpose, such as oil palm plantations, cattle ranching, soy, logging, and mangrove shrimp ponds should cease immediately. Conservation of forests, prevention of forest burning, remote-sensing detection of logging and fires, and enforcement of laws should be emphasised. The In addition, the G8/ World Bank BioCarbon Fund should increase by orders of magnitude from today's few million dollars to several billion dollars within a very few years, especially in the Congo and Central Africa, Indonesia, Malaysia, Papua New Guinea, Cambodia, Laos, and the Amazon forest nations.

The risks are that incorporating forests into the carbon market would simply guarantee their passing into the hands of big private interests.

The Forest Carbon Partnership Facility should not directly or indirectly fund any activities connected to industrial forestry in any natural or semi-natural forests. It also should not necessarily focus on preparation of avoided-deforestation programs for entry into future forest carbon markets. Instead it should explore and support investigation of the most cost-effective means of protecting forests, particularly through changes to land-tenure and resource-access regimes. It should support the development of Fund-based forest carbon-financing mechanisms instead of only trading mechanisms. The risks are first that incorporating forests into the carbon market would simply guarantee their passing into the hands of big private interests. Second, such funds could trigger further displacement, conflict, and violence to Indigenous nation sees fit. The C-tax must be revenue neutral for the poor.

Contraction and Convergence: Finance, advise on and otherwise encourage contraction and convergence to reduce GHG emissions. Persuade borrowing member nations to adopt that principle. Support a physical limit (hard cap) that declines to zero before the threshold 2˚C rise in temperature occurs.

International Agreements: Vigorously support the process for the comprehensive post-Kyoto international agreement under the auspices of UN FCCC.

Stringent Energy Standards: Accelerate improvement of end-use standards commensurate with evolving science for vehicles, lighting, building codes, electric motors, and appliances.

GHG Sources and Sinks: Monitor GHG emissions and carbon-sink capacities, including oceanic (marine acidification). Implement agreements on deforestation and livestock.

4. ***Prioritise Poverty Reduction:***

Nuclear power, global warming and uranium supplies

David Fleming

Greenhouse gases

Every stage in the life-cycle of nuclear fission uses energy, and most of this energy is derived from fossil fuels. Nuclear power is therefore a substantial source of greenhouse gases. The delivery of electricity into the grid from nuclear power produces, at present, roughly one third as much carbon dioxide as the delivery of the same quantity of electricity from natural gas....[1]

... or, rather, it *would* do so, if the full energy cost of producing electricity from uranium were counted in— including the energy cost of all the waste-disposal commitments. Unfortunately (in part because of the need to allow high-level waste to cool off) that is not the case. Nuclear waste-disposal is being postponed until a later date. This means that the carbon emissions associated with nuclear energy look rather good at the moment: at about 60 grams per kWh they are approximately 16 per cent of the emissions produced by gas-powered electricity generation.[2] The catch is that this figure roughly doubles when the energy-cost of waste-disposal is taken into account, and it grows relentlessly as the industry is forced to turn to lower-grade ores. What lies ahead is the prospect of the remaining ores being of such poor quality that the gas and other fossil fuels used in the nuclear life-cycle would produce less carbon dioxide per kilowatt-hour if they were used directly as fuels to generate electricity.[3]

Carbon dioxide is not the only greenhouse gas released by the nuclear industry. The conversion of one tonne of uranium into an enriched form requires the addition of about half a tonne of fluorine, producing uranium hexafluoride gas (hex) to be used in the centrifuge process. At the end of the process, only the enriched fraction of the gas is actually used in the reactor: the remainder, depleted hex, is left as waste. Not all of this gas can by any means be prevented from escaping into the atmosphere, and most of it will eventually do so unless it is packed into secure containers and finally buried in deep repositories.[4] Hex is a halogenated compound (HC), one of several that are used at various stages of the cycle. HCs are potent greenhouse gases. The global warming potential of freon-114, for instance, is nearly 10,000 times greater than that of the same mass of carbon dioxide.[5] There is no published data on releases of HCs from nuclear energy. A reliable study of all releases of greenhouse gases from the nuclear fuel cycle, and their effect on the atmosphere, were commissioned and published without delay.

Ore quality

Both the quantity of greenhouse gases

released by nuclear energy per kilowatt hour and the net energy return of the nuclear industry are determined primarily by the quality (grade) of uranium ore being used. The lower the grade of ore, the more energy is needed to mine and mill it and to deal with the larger quantity of tailings. The limit, in theory, is reached with an ore grade of about 0.01 percent for soft rocks such as sandstone, and 0.02 percent for hard rocks such as granite. If grades lower than those limits were to be used, more carbon dioxide per kilowatt hour would be produced by the nuclear cycle than by the same amount of energy produced from gas. The energy return on energy invested (EREI) would be less than the energy return you would get if you generated the electricity directly in a gas turbine.[6]

But these are only "theoretical" limits, because in practice the turning-point to a negative energy return may be substantially sooner. There are five key reasons why ore which is theoretically rich enough to give a positive EREI may in fact not be rich enough to justify exploitation: to yield a *practical* return on energy investment (PREI): increasingly deep deposits; problems with water; difficulties in raising investments for what may be a long payback; local geological conditions; and the relatively small energy contribution from the ore

Where, then, does the practical turning point lie, below which the ore quality is too poor to be useful? We know that this varies with local conditions; but for a worldwide average above which uranium ore can still provide a positive PREI, a suggested guideline is *no lower than 0.1 percent.*[7]

Uranium supply

So— how much uranium ore with a

of thorium, an alternative fuel, in place of uranium."[22]

Lovelock urges that we have a readily-available stock of fuel in the plutonium that has been accumulated from the reactors that are shortly to be decommissioned. And he might have added that other candidates as sources of nuclear fuel are seawater and phosphates. So, if we put the supposed alternatives to uranium ore in order, this is what we have: (1) granite; (2) fast-breeder reactors using (a) plutonium and (b) thorium; (3) seawater; and (4) phosphates.

Lovelock's argument is persuasive. But there are three grounds on which it is open to criticism.

1. The nuclear fuel cycle

Uranium depletion is not a "flawed idea"; it is a reality that is just a little way ahead. Uranium ore is in increasingly short supply. Sources from granite or seawater are too inefficient to make practical sense. Phosphates might be possible but world production is already struggling to keep up with agricultural requirements. Fast breeder reactors have failed to live up to their promise and widely abandoned; it is highly unlikely that they can be developed quickly enough to address the immediate problems of global warming

2. Alternative energy strategies

Lovelock may underestimate the potential of the fourfold strategy which can be described as "Lean Energy":

1. Energy efficiency: to achieve the decisive improvements in the efficiency of energy-services made possible by the conservation and energy-saving technologies.
2. The proximity principle: to develop the potential for local provision of energy, goods and services. Deep reductions in travel and transport can be expected to come about rapidly and brutally as the oil market breaks down.
3. Renewable energy: to design and build renewable energy systems to match the needs and resources of the particular place and site.
4. Tradable Energy Quotas (TEQs): to define a secure energy budget for the whole economy, involving every energy-user in the common purpose of achieving deep reductions in energy demand.[23]

It cannot be expected that this strategy will fill the energy gap completely, or neatly, or in time, but nor is Lovelock suggesting that nuclear energy could do so. Even if there were neither a uranium-supply problem to restrain the use of nuclear energy, nor a waste-problem, and even if it were the overriding priority for governments around the world, nuclear energy would still fall far short of filling the gap. There are good reasons to believe that Lean Energy could do better. It would start to get results immediately. Per unit of energy-services produced, it would be about ten times cheaper.

3. The oil peak

Lovelock does not give enough weight to the significance of the oil peak. As this weighs in, it will establish conditions in which there is no choice but to conserve energy, whether the urgency of climate change is recognised or not.

world's final energy demand.[24] Nuclear power is not a solution to the energy famine brought on by the decline of oil and gas. Nor is it a means of reducing emissions of greenhouse gases. It cannot provide energy solutions, however much we may want it to do so.

Notes

1 Storm van Leeuwen and Smith 2006.

2 Storm van Leeuwen 2006a.

3 Oxford Research Group 2006a and 2006b.

4 Storm van Leeuwen 2006c.

5 Nuclear Fuel Energy Balance Calculator 2007.

6 SLS; Storm van Leeuwen 2006b.

7 Note that Rio Tinto (2005) announced a "cut-off grade" of 0.08 per cent for its existing stocks of ore at its Ranger mine in Namibia.

8 NEA/IAEA 2006.

9 Nuclear Energy Agency 2006; The World Nuclear Association 2007b.

10 Nuclear Energy Agency 2006.

11 Oxford Research Group 2006a.

12 Nuclear Energy Agency 2006; Fir eo0sv6.

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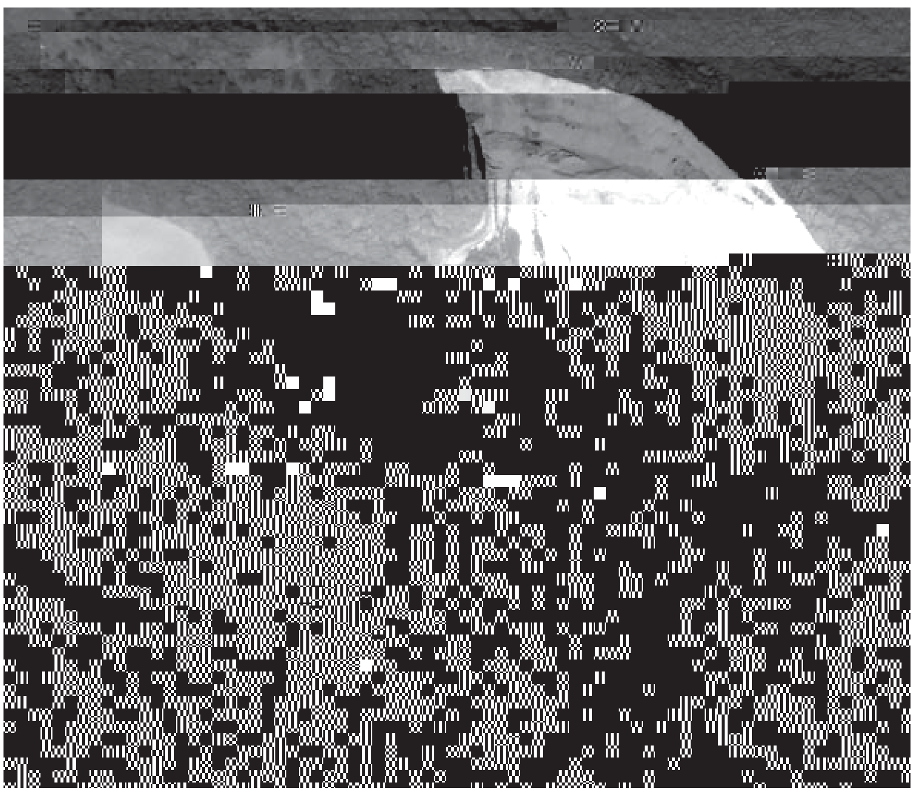
The differences between biotic and mineral resources and their implications for the conservation-climate debate

Rolf Steppacher and Pascal van Griethuysen

Résumé. Toute tentative de relier les enjeux de la conservation à la question climatique devrait partir d'une distinction préalable entre les ressources biotiques et les ressources minérales sur la base de leurs caractéristiques écologiques et économiques. Les ressources biotiques peuvent être utilisées de manière soutenable mais ne peuvent alimenter un processus de croissance économique exponentielle. Les ressources minérales (et en particulier les combustibles fossiles) permettent d'alimenter une croissance économique exponentielle, mais seulement pendant une période historiquement limitée et au prix de graves conséquences écologiques.



Picture 1. Resource use in France (*Courtesy Nigel Dudley, Equilibrium Research*)

Introduction

When jointly addressing issues such as natural resources, conservation or climate change, economic questions are prevalent. The manner in which these questions are formulated, presented and organised, depends on the preconceptions of economic theory, its cultural, philosophical and methodological foundations. This is the case with natural resources: while conventional economics tries to approach natural resources through their monetary counterpart,[1] ecological economics stresses the need to make the biogeochemical characteristics of these resources explicit. This allows distinguishing between the ecological and economic potential of resources, beginning with their differing capacity to meet social objectives such as economic growth and ecological sustainability. Given their radically different ecological and economic characteristics, erroneous conclusions tend to be drawn as the wide variety of natural processes is simplified down to an undifferentiated notion of natural resources. This article aims to help avoiding such erroneous approaches in the conservation-climate debate.

Distinguishing ecological characteristics of different kinds of natural resources

The main lesson of ecological economics concerns the biogeochemical nature of the economic process. It reminds us of the fact that economic processes are subject to the laws of thermodynamics, particularly the law of entropy[2]. In accordance with this law, economic activities (production, consumption, distribution) require high quality energy-matter resources (low entropy), that are qualitatively degraded in the economic transformation process. With production and services inevitably go together low quality energy-matter waste and dissipated energy-matter (high entropy).[3]

Such a perspective allows economic analysis to consider the biogeochemical preconditions and limitations of economic activities such as the unavoidable degradation of natural resources, the limited capacity of natural resources for renewal, and the fact that this limited capacity only relates to certain resources (so-called renewable resources). Proposing a classification that is valid both for economic and ecological analysis, Georgescu-Roegen and modern ecological economics define four analytical categories in order to take account of the potentials and limitations of natural resources: funds, services, stocks and flows[4]. *Ecological funds,* built up and maintained by solar radiation are able to renew themselves and provide both *ecological and economic services,* as long as the conditions necessary for their renewal are met.[5] *Stocks* constitute limited reservoirs of organised matter and mineralised energy resulting from biogeochemical processes on a geological and not a historical time scale, but from which it is possible to extract an energy-matter *flow*[6]. This flow can thus only be exploited for a relatively short period of human history, leaving stocks depleted and the environment degraded by its dissipated energy-matter.[7]

Distinguishing unequal economic potentials of different natural resources[8]

Natural resources can also be distinguished according to their economic potentials, starting with their capacity to respond to the imperative of economic growth. The growth potential of living or *biotic resources* is naturally limited[9] and therefore cannot fuel exponential economic growth.[10] However, the limited capacity of biotic resources to supply economic growth[11] is compensated by the different quality of being renewable. The lesson is: limited growth yet possible sustainability.

The case of non-renewable *mineral resources* is quite different. Since the time of thermo-industrial revolution mineral resources are capable of inducing a process of exponential growth: the stocked energy-matter can be used to develop machines and motors that allow an even quicker exploitation of the stocks. The process is therefore circular and cumulative. However, as the process quickens, stocks get irreversibly depleted at an increasing pace while the natural assimilation capacities are altered by the ever increasing of entropic degradation. Fuelled by a limited stock of mineral resources and taking place in a limited natural environment, such exponential economic growth is thus inexorably *limited to a given historical period*. The lesson is: exponential growth yet no sustainability. Table 1 illustrates the radically different potentials of biotic and mineral resources.

To distinguish between services of funds and flows of stocks makes us aware also that different natural resources have specific *temporal characteristics*. Given that biotic resources depend on ecological reproductive cycles, the availability of their services is subject to the natural calendar. Therefore, they do not allow for the continuous use of economic production funds (land, labour and equipment) *i.e.* exploit them to their full capacity.[12] That is why economic activities in agrarian economies are diversified and organised in accordance with the cyclical rhythms of nature. On the other hand, the flow of mineral resources from stocks allows an industrial organisation of production *in line*, which makes it possible to use economic production funds at their *full capacity.*[13] This characteristic reduces costs and makes specialisation possible, which along with the continuity of economic activity, is an essential element of industrial production.[14]

Given their radically different ecological and economic characteristics, erroneous perceptions, illusions, economic myths and biased conclusions may occur when the wide variety of natural processes are

Given their radically different ecological and economic characteristics, erroneous perceptions, illusions, economic myths and biased conclusions may occur when the wide variety of natural processes are simplified down to the undifferentiated notion of natural resources. This is the case, for instance, when attempts are made to maintain the illusion that it is possible to fuel an exponential growth process through the sustainable exploitation of biotic resources, or that the substitution of non-renewable by renewable resources would be as feasible as the inverse case. In fact, given the limited growth potential of living resources, only an exploitation of the services of these resources at a rate beyond the capacity for renewal of the funds providing them (fields, forests, lakes, seas) is able to fuel an albeit short time exponential growth process.[15]

Given the institutionalised growth dependency of western civilisation[16] it is not surprising therefore that nearly all technological progress over the last 150 years has been based on the substitution from renewable to non-renewable resources, in industry, agriculture and services alike. In such a context, an undifferentiated concept of natural resources is highly problematical also due to the fact that the per capita consumption of mineral resources is very unequally distributed. It hides the economic privilege that goes with a high per capita consumption of mineral resources as well as the particular difficulties that are inherent in the use of biotic and other renewable resources, particularly in combination with high population growth.

Conservation of living resources and exploitation of mineral resources

Bearing in mind the radical economic and ecological differences between mineral and biotic natural resources as conditions to be considered in respect to any reasoned decision of resource utilisation, it is equally important to insist on the close links that further exist between the exploitation of mineral resources (required for the growth of the global industrial structure) and any effort in favour of the conservation of biotic resources. Given the two basic types of biotic and mineral natural resources, any realistic conservation strategy of living resources (flora and fauna) needs to consider two complementary phenomena: overexploitation and disruption.

1. Overexploitation is a complex notion due to the fact that an ecological fund consists of a constellation of biotic resources (*e.g.* a forest) providing multifunctional economic and ecological services. Overexploitation often means harvesting *economic* services (wood or minor forest products) at a rate beyond their sustainable yield. Such economic overexploitation may reduce the capacity of the fund to provide *ecological* serv-

Picture 2. Quarry in a forest reserve in Senegal (*Courtesy Nigel Dudley, Equilibrium Research*)

and flows, where only the non-use will allow the maintenance of existing stocks. The contemporary approach to conservation— which focuses on the preservation of the regenerative capacities of natural ecosystems and the sustainable use of living resources—[17] corresponds to applying to biotic resources an approach that is adapted to their specific characteristics, *i.e.* specified in terms of environmental funds and multifunctional services. The new concept is thus a progress. At least the days are gone when scientists and politicians from industrial countries, living mainly from mineral resources (and therefore more easily able to protect their own biotic resources), directed people living mainly from biotic resources *not* to use their *only* available resources.

However, the progress is only partial. “Modern” conservation projects are often unable to provide enough employment to compensate for the loss of activities imposed by the project. In addition, biotic resources alone cannot provide the necessary economic services to growing populations. Moreover, such projects address neither the unequal per capita consumption of mineral resources nor its global ecological consequences that both remain unresolved. Understanding the economic and ecological differences between the two categories of natural resources and their reciprocal interaction is therefore no more than a preliminary requisite for any future conservation strategy.

The terminology developed by Georgescu-Roegen allows us to address these issues by making it possible to *formulate ecological sustainability imperatives* in a concise and coherent manner. According to this approach, three imperatives must be guaranteed simultaneously in order to ensure that the natural environment has the capacity to sustain human activities:[18]

1. The *preservation of the renewal capacity of multifunctional ecological funds* (forests, lakes, oceans, atmosphere, the Biosphere). This is the essence of conservation.
2. *A sustainable exploitation of economic services provided by the funds of biotic resources,* meaning that they do not endanger the reproduction of economic *and* ecological services of the same funds. This is the *sustainable use* defined in *Caring for the Earth,*[19] an understanding of natural resource use familiar to most traditional societies including the eighteenth century forestry science under the concept of *sustained yield.*[20]
3. *A more or less sustainable management of ecological stocks* (minerals, fossil energy

The goals of conservation and sustainable use of biotic resources have little hope of being reached unless complementary and priority actions are specifically aimed at reducing the consumption of mineral resources in countries with high per capita consumption.

sources), *i.e.* in such a manner that the flows extracted from the stocks and rejected in degraded form to the environment do not exceed the assimilation capacity of the global natural environment. This imperative can logically not be dissociated from conservation.

The issue of *climate change* illustrates how interdependent these three imperatives are. Induced by industrial development, human-induced climate alterations are not due to the over-exploitation of the "climatic services" but rather to anthropic disturbances in biogeochemical cycles caused by intensive exploitation of mineralised energy stocks.[21] Social and environmental repercussions induced by this perturbation, uncertain as they may be, endanger the capacity for renewal of many ecological funds and threaten the survival of many species. In such a context, the goals of conservation and sustainable use of biotic resources have little hope of being reached unless complementary and priority actions are specifically aimed at reducing the consumption of mineral resources in countries with high per capita consumption. This interaction is recognised by the conservation community, who points out that "*[a]ddressing the problem of climate change is central to efforts to conserve the integrity and diversity of nature and to ensure that natural resources are used equitably and sustainably*".[22]

Theoretical attempts to assign quantifiable monetary values to biological and cultural diversity.

How to satisfy the needs of poor populations through the sustainable use of biotic resources?

In an effort to conciliate ecological sustainability and social equity, recent approaches to conservation advocate for the granting and reinforcing of resources rights to local populations.[23] Apart from different institutional issues that cannot be addressed here,[24] such approaches should not overlook the essential fact that a sustainable use of biotic resources alone can be quite insufficient to cover basic needs of a growing population, even at a low level of *per capita* consumption.

come up with virtual values and are therefore purely fictive. They can neither be invested in the formation of productive capital nor be used as payment for import or debt service.

Development options within the limits of biotic resources are often disappointing from even essential economic and social point of views: Strategies of external aid (material and/or financial), more commercial exploitation of biotic resources, valuing traditional knowledge, tourist exploitation of "traditional" ways of life or whatever else are in reality often far more limited in economic returns than assumed. At the same time experience shows that they may create problems in terms of cultural identity, loss of autonomy and of distribution of economic return. Theoretical attempts to assign quantifiable monetary values to biological and cultural diversity (often in an effort to convince political decision-makers of the value of protecting nature) come up with virtual values and are therefore purely fictive. They can neither be invested in the formation of productive capital nor be used as payment for import or debt service.

Following industrial countries' development path of focussing on mineral resources is an alternative that allows, for some time, an autonomous process of economic growth and the satisfaction of the basic needs of poor populations. But such a path depends not only on the possibility to get access to mineral resources for the most impoverished; it also requires that they be granted the right to emit into the environment the inevitable wastes generated by a process of economic growth based on mineral resources. The political and institutional requirements and implications of this alternative on a global scale are considerable. In order not to overstretch global ecological limits, any increase in consumption of mineral resources by poor populations would have to be compensated by a drastic reduction of this consumption by the wealthiest.[25] The state of international negotiations on energy and climate illustrates how far away we are from such a world development.

Differentiating clearly between ecological and economic qualities (potentials and limits) of stocks and flows of mineral resources, and funds and multifunctional services of biotic resources is an imperative in order to understand the multiple double-binds and path dependencies of our actual conservation and sustainability crisis. Not to consider these differences does not only lead to erroneous perceptions or biased conclusions, it also means implicitly pursuing the economic interests of societies with the highest per capita consumption of mineral resources and actively ignoring those of less privileged societies.

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Notes

1 The development of methods to define monetary counterparts to environmental goods and services is an essential element of environmental economics. The best known are the contingent valuation method, the hedonic price method and the travel cost method (Baumol & Oates, 1975; Turner *et al.*, 1994).

2 The first law of thermodynamics, the law of conservation of energy, establishes that the quantity of energy-matter in an isolated system (with no exchange of energy-matter with its environment) remains constant; the second law, the law of qualitative degradation of energy or *entropy law*, states that the quality of energy-matter in all isolated systems is irreparably degraded over time. Open systems, such as economies, which exchange energy and matter with their environment, depend for the maintenance on a throughput of energy-matter that degrades in the process and leaves the environment qualitatively degraded (Georgescu-Roegen, 1971).

3 Georgescu-Roegen 1971.

4 Georgescu-Roegen 1966, 1971.

5 Ecosystems such as forests and lakes but also the global ecosystem, which constitutes the Biosphere, thus enter into the category of ecological funds.

6 Fossil fuel reserves stored in the lithosphere are the typical example of ecological stocks.

7 See Georgescu-Roegen (1971:209ss) for a more detailed analysis.

8 This section is based on Steppacher & Griethuysen 2002.

9 Beyond a certain development threshold, every biotic resource stops growing, unless it has an abnormal growth pattern (of a cancerous nature), the outcome of which is most often fatal.

10 Affecting some of the limiting factors (fertilising, irrigation) is often possible, but biotic production remains subject to overall limits.

11 Such a growth potential reflects progress in know-how and techniques.

12 Georgescu-Roegen 1965.

13 Georgescu-Roegen 1965.

14 For more details see Bieri, Moser & Steppacher 1999 and Steppacher & Griethuysen 2002.

15 This situation, which corresponds to the application of the stock rationale to ecological funds, is characteristic of debtor economies trying to pay for imports or debt service by exporting agricultural resources. Advocating for a rigidly preservationist approach to conservation (where no exploitation of biotic resources is allowed), a perspective that has until recently been common among conservationists (Fisher *et al.*, 2005), is another example of an erroneous application of a stock rationale to ecological funds.

16 See Bieri, Moser & Steppacher 1999, Steppacher & Griethuysen 2002 and Steppacher 2007.

17 IUCN/WWF/UNEP 1980, IUCN/UNEP/WWF 1991.

18 Based on a different terminology and enumeration of facts, these imperatives correspond to the three priority conditions identified in the World Conservation Strategy: maintenance of essential ecological processes, preservation of genetic diversity, sustainable use of species and ecosystems (IUCN/WWF/UNEP, 1980).

However, there are serious implications for land-use and forest management:

Very large land areas would be re-

The overall impacts of most will depend to a large extent on how they are applied, on what social and environmental safeguards can and will be attached, whether these will actually be applied and on the aspirations of the majority. What might seem an impossible compromise to environmental and social activist groups may not elicit the same response from other people. Sacrificing the Amazon rainforest for cheap fuel would be a done deal for many of today's drivers. The energy industry will be able to draw on powerful and apocalyptic images to make its case. If NGOs are going to oppose the worst excesses of the energy industry with any hope of success we will need to speak with one voice and be clear about the sacrifices as well as the potential gains.

IUCN could play an important facilitating role in this process. It will not be easy, because positions are in many cases already entrenched and time is short. But the current state of chaos will simply lead to lack of effective opposition against any energy supply, however damaging this might be.

Notes

1 Lovins 1973; Commoner 1976; Todd and Alty 1976; Leach 1979; Olivier *et al.* 1983.

of different approaches, then little or no progress can be made. It is very obvious to those like myself who have worked on energy, economic development and environment that a range of objectives needs to be satisfied through the types and rates of energy we consume as a society. Energy is needed to sustain existing economic activity and to stimulate new activity. Energy is needed for human survival and should have an aim of reducing poverty (and specially fuel poverty) and seeking to attain greater social harmony and the removal of social disparities. And energy must be obtained from sources and used in ways which will have the least damage to environmental systems and processes on land, in the air and at sea. These are not mutually exclusive and should not be traded one against the other.

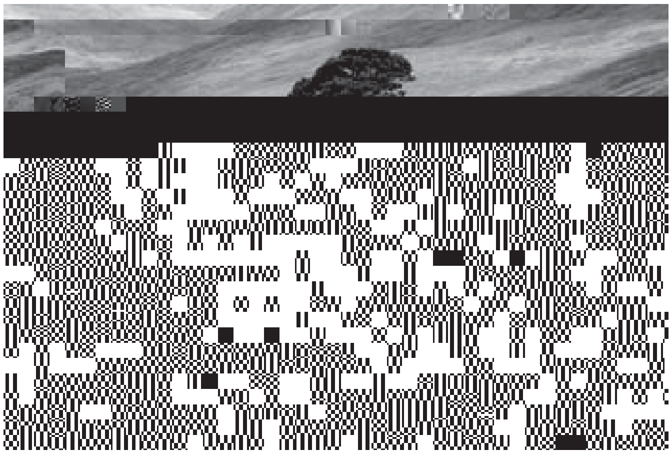
In our Scottish study, we concluded that "Scotland should think in a global context and act locally using natural resources at its disposal to provide social, economic and environmental benefits". Following from this statement, guided by the Brundtland commission's enduring statements of almost two decades ago; we determined that the strategic aim should be "a secure, competitive, socially equitable and low carbon emission supply of energy". Our interpretation of these elements was as follows:

'Secure': means having sufficiency of supply from a diversity of fuel types and geographical sources using a variety of technologies, encouraging new technological development to marketability and having the appropriate government framework and instruments.

'Competitive': means that the cost of energy will not result in Scotland being uncompetitive in world markets and will also be competitive in the use of technology and innovation.

'Socially equitable': means that all sectors of society should have access to energy at a price which they can afford, implying that some economically and socially poorer sections of society will be aided to rise out of 'fuel poverty'.

'Low carbon emissions': mean that throughout their lifecycle, technolo]TJT*(“Tf11 0 0 11 3
ts".



Picture 2. Scotland (*Courtesy Nigel Dudley, Equilibrium Research*)

In the schools discussions, there was a much greater degree of optimism. There was always a clear view that 'the lights will not go out' within a decade because of human ingenuity and a mixture of existing and new technologies being available. Furthermore, the polarities which existed in the public sessions with regard to technologies for electricity generation were much less evident in the school discussions. There was a strong view that a change in culture was needed to wean society off its dependency on fossil fuels. Alongside this, was an appreciation of the need for energy savings and greater information on what can be done to achieve these savings, and the need for alternative fuels for transport and heating. Most students recognised the link between global climate change and the use of fossil fuels and therefore the need for precautionary action to mitigate climate change. There was a perception amongst the students that their views and opinions were not being sought on energy issues and that meant they could not influence decisions.

It was clear from all of the debates that action was needed and the following specific issues for action were identified:

1. Higher priority and more funding to cleaner fossil fuel technologies and to alternative renewable technologies.
2. Decisions on new base load electricity supply, including decisions on fuel types and final decisions on whether nuclear or not.
3. More effective energy efficiency and energy savings measures and gadgets accessible to the public to stimulate higher levels of performance. Better designed and more affordable energy savings in 'white goods'. Break the circularity of save costs on energy/ buy more energy consuming devises through public education.
4. More financial support from government for bringing energy technologies from the laboratory to full-scale operation.

In order to test the local responses, we organised a conference to conclude our work and invited major figures in the international energy world to participate so that we could call for action with the support of public and industry opinion behind us. The consensus at the conference was that Scotland is no different from other countries and we needed to think in a global context as well as act locally. Claims that there were choices to be made between, for example, central and decentralised systems of electricity supply, between specific technologies or a mix, between supply led approaches or demand management, or concentration on Scotland as a net energy exporter or importer were not accepted. The general consensus emerging was that a mix of solutions, rather than selecting specific winners, was the most sensible course of action. The mix should comprise of old technologies with improved carbon sequestration, new technologies, energy efficiency and energy savings.

Pollution from aircraft

Mark Barrett

Abstract. Aircraft presently release some 2 or 3 per cent of global emissions of carbon dioxide and, together with the effect of other pollutants, contribute a large fraction of global warming that will increase rapidly because of demand growth, unless policies are changed. Aircraft emit a mixture of other pollutants including nitrogen oxides, soot, carbon monoxide and hydrocarbons, and about half of these emissions is injected into the atmosphere at an altitude of 8 to 12 km where they generally have more serious and enduring effects than at ground level— even water has adverse impacts. Nitrogen oxides and water emission bring about global warming and can also cause ozone depletion. Scientific uncertainty about the impacts is great, and will persist. A number of control options are available but reducing aviation demand growth is the only way so far known of creating a marked and immediate reduction.

This article summarises a complex issue; more details may be found in reports such as those by Barrett[1] and the Intergovernmental Panel on Climate Change.[2]

Introduction

The demand for air transport is continuing to grow rapidly, despite rising fuel costs, and the long term growth potential is potentially vast because of the low current per capita demand in poor populous countries. Budget airlines have transformed the sector over the last decade. Pollution emission will grow less rapidly than demand because of technological improvements, but with unchanged policies pollution from aircraft will double in two decades or so. A series of new or augmented policy measures is needed to moderate this increase.

The environmental impact of aircraft

In terms of atmospheric and climatic impacts, air transport has five main effects:

- The emission of carbon dioxide (CO_2) constitutes a small but fast growing contribution to global warming;
- The emission of nitrogen oxides (NO_x) leads to ozone increase near the tropopause and this causes global warming;
- Water emission may lead to increases in high altitude clouds, and these may contribute to global warming;
- The emission of water and NO_x may exacerbate stratospheric ozone loss;
- Other pollutants such as soot and trace chemicals may also have effects either synergistically or separately.

The global fuel burn of aircraft is only approximately known. The coefficients of emission per fuel burn for some pollutants (*e.g.* carbon dioxide and water) are known with accuracy and do not vary significantly with engine type and aircraft operation. The coefficients for others are not precisely known, and do vary with type and operation; for example, the estimate of total NOx emitted by civil aircraft may not be accurate to better than 50 per cent. Accordingly there are uncertainties in total emissions. Furthermore, the effects of pollutants apart from carbon dioxide can vary according to when and where, in terms of altitude, longitude and latitude, they are released in the atmosphere.

Aircraft presently release in excess of 2.5 per cent of the total global emissions of **carbon dioxide** as a result of the burning of fossil fuels. This is equivalent to approximately 12 per cent of the total emissions released by the transport industry according to a report from the Intergovernmental Panel on Climate Change (IPPC);[3] the proportion will have increased since.

Certain anthropogenic pollutants generate or destroy ozone in the atmosphere. Unfortunately the nitrogen oxide from aircraft probably generates ozone where it is not wanted, at low altitudes; and removes where it is wanted, at high altitudes. At low altitudes (less than 15 km or so), extra ozone increases global warming. Its warming impact is thought to be greatest at about 12 kilometres, the altitude at which large commercial jet aircraft typically cruise. Ozone at much greater altitudes decreases global warming.

Water vapour has two potential effects. First, through augmenting the formation of high altitude clouds, it can act as a potent global warming agent. Second, extra water vapour at high latitudes may increase the formation of polar stratospheric clouds that are implicated in ozone loss and the formation of the ozone hole.

Aircraft emit a number of other pollutants. This includes carbon monoxide, sulphur dioxide, metals, soot and lubricating oils. Although many of these are emitted in minute quantities which makes insignificant changes to pollution concentrations near ground level, at a high altitude the additions may be significant.

There are considerable uncertainties for pollutants other than carbon dioxide: first, in the amounts and spatial distribution of pollutants from aircraft; and second, in the precise functioning of many atmospheric processes and the impact of pollutants. Many pollutants act synergistically. Their marginal impact depends on the concentrations of other pollutants, and indeed of the pre-existing level of the pollutant being considered. It is therefore not generally possible to assign a particular unique value for the impact of any pollutant. Such is the uncertainty in some of the processes that, for example, some pollutants at certain altitudes are now thought to decrease global warming, rather than increase it.

The UK Royal Commission on Environmental Pollution
bricating oils. Alth.4 TD-.01 Tc[(The UK R)24.4(o)7.3(y)

The Commission noted the rapid increase in air travel and concluded that it had: "*particular concerns about the contribution that aircraft emissions will make to climate change if this growth goes unchecked. The total radiative forcing due to aviation is probably some three times that due to the carbon dioxide emissions alone*."

Controlling pollution from aircraft

Relating to the impact of air pollution from aircraft, there are two basic non per passenger kilometre than smaller aircraft ones and so. However it is difficult for large aircraft to meet noise limits, even though the larger the aircraft the fewer the aircraft movements.

There is scope for extending technological improvement to airframes and engines, and this might include the introduction of slower more fuel efficient aircraft optimised for passenger transport. Operational changes, especially increasing the load factor of aircraft, could reduce pollution substantially and rapidly by about 20 per cent. However, even if these two categories of measures are applied to a maximum, fuel use and pollution still double in three decades or so under current projections.

In consequence, if aviation is to stabilise or reduce its current emissions of

allowance of about 0.3 tonnes of carbon per person per year, equivalent to a person making one flight of a few thousand kilometres and doing nothto control greenhouse gas emissions. For aviation, it is particularly difficult given the growth and technical nature of aircraft and aviation fuels. However, governments and the aviation industry need to act urgently in order to develop low impact, sustainable, long distance communication and transport systems. If development is too slow, then the world will suffer worse global warming, and the industry itself will face a rapid and deep crisis because of pressure from emission targets and other, essential sectors.

The aviation industry needs to take a positive rather than a defensive posture. It can first push through technological and operational improvements as fast as possible. This will generally make the industry less vulnerable to fluctuations in fuel prices and environmental taxes or charges, thereby improving the stability of its cost base. As far as the aircraft and aeroengine manufacturing industries go, the recommendations for the rapid introduction of cleaner and more efficient aircraft should be good news because it means more sales. It will mean more costs for operators and consumers, but the impact would be quite gradual and not necessarily very large compared to the total cost of a holiday or business trip. Perhaps most important is for the aviation industry to seek a stable, long term future by diversifying into long distance transport and communication businesses. It can use its great expertise to help develop systems using multiple modes— air, sea and rail— that operate in an integrated fashion with low impact and at minimum cost. In the longer term, it could extend its expertise to address the management of demand; for example to integrate transport planning and systems into international manufacturing and services production systems.

Governments and the aviation industry need to act urgently in order to develop low impact, sustainable, long distance communication and transport systems.

Notes

1 Barrett 1994.
2 IPCC 1999.
3 IPCC 1999.
4 RCEP 2002.
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6 Barrett 2007: 74-75.
7 IPCC 2007: 44.
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A proposed contribution to an oil and gas strategy

Sandra Kloff, Emmanuel Obot, Richard Steiner and Clive Wicks

Abstract. The oil and gas industry dominates global energy supply, but is working with finite resources and also often carries high environmental and social costs. Key issues include the move into critical marine areas and the question of oil and gas extraction inside or beside protected areas. Numerous attempts have been made to address these problems, but they continue to be hampered not least by a lack of regulations on critical aspects of exploration and extraction. The paper finishes with a call for a revolution in energy supply, with a major shift to renewable sources (including a shift of subsidies from fossil fuels to renewable energy), reduction in wasteful practices such as gas flaring and elimination of decisions being made about major projects in the absence of Strategic Environmental and Social Assessments.

Background

Currently oil and gas extraction create most of the energy and resources needed to run our society. Unfortunately, they also result in a range of present and future environmental and social costs, both direct and indirect, which need to be balanced against the benefits they bring.

The world is highly dependent on oil— it powers our transport, heats or cools our homes, creates industrial and domestic chemicals and provides the feedstock for many of the materials we use and wear. Transport uses 60 per cent of oil production, mostly to fuel cars and trucks. Oil is a non-renewable resource that we use at a rate of 70 million barrels a day, at present and some estimates are that this will double by 2025. Other estimates, by some of the Industry's own geologists are that by 2025 there will be severe shortages of oil and gas as reservoirs are depleted. Already oil wells in Texas and the North Sea are drying up.

The oil and gas industry impacts on people and the environment in three ways, through climate change, through their operations on land and at sea and finally through positive or negative impacts on the economy, which can have for example also result in adverse social impacts such as corruption, (rent seekers) and civil disturbance.

Unregulated and irresponsible actions by the oil industry destroy habitats and damage biodiversity. "Low-energy habitats" such as mangroves, salt marshes and polar coastal wetlands can be seriously damaged by quite small amounts of oil. Onshore, drilling can harm ecology and open up wilderness areas. Offshore, drilling can damage some of the world's most important marine ecosystems.

Oil and gas industry impacts on people and the environment [illegible]

Oil spills at sea have damaged mangrove forests, coral reefs and fisheries, both through major accidents and regular leakage from tankers, loading buoys, drilling rigs and production platforms. Transport of oil is also implicated in ecological damage; for example, there were an estimated 16,000 spills during the construction of the Trans-Alaskan pipeline.[1] Oil tanker accidents

It is believed that Raymond is referring particularly to the Arctic Refuge in Alaska. Research by WWF and others has shown that even if all the extractable oil was pumped from under the Arctic Refuge it would only supply about nine months of US demand. It would damage one of the most critical ecosystems on earth, on which the "Gwitchen" people depend for survival. This kind of response is only delaying the end of the oil era not solving long-term energy needs.

In spite of this the US Senate approved, by a two vote majority, the report advising against the conversion of old single hulled tankers.

Some civil society organisations claim that there is even a lack of control over what is exported from offshore wells and therefore there is an opportunity for fraud/corruption.

Protected Areas and the oil industry: conflict and attempts at reconciliation

Claims by the industry that they can work in fragile vulnerable environments has not generally been born out in reality, as shown in the World Bank Extractive review and many other reports.

As with other extractive industries oil and gas companies pose many actual and potential threats to protected areas. The wide-ranging methods of extraction, on land and underwater, and the risks of pollution during transport, use and disposal of fossil fuels, mean that a wide range of impacts is possible. These impacts can range from air, land and water pollution to habitat loss and fragmentation, increased settlement and related impacts for instance as a result of roads, pipelines or seismic lines being cut through primary forest or disturbance from drilling camps.

Many governments clearly regard protected areas as suitable for oil and gas production, using arguments about the overall importance of energy supplies and the possibility that oil and gas extraction can take place in a relatively benign way. On the other hand, others prohibit such activities in protected areas absolutely. Even more common is exploration and exploitation near to protected areas, including within buffer zones. Whether near to or within officially protected areas, there have been increasing pressures on the companies that conduct these extraction activities to operate in a responsible manner, including keeping negative impacts to an absolute minimum and avoid undertaking operations in some specific areas and encouraging positive benefit wherever possible.

Industry and conservation groups have responded through a number of joint ventures to address environmental issues. In 1993, IUCN and the Oil Industry International Exploration and Production Forum (E&P Forum—now the Association of Oil and Gas Producers) jointly published guidelines "*to establish internationally acceptable goals and guidance*" for environmental protection for *Oil and Gas Exploration and Production in Arctic and Sub arctic Onshore Regions.*[5] The guidelines specifically recommended that selection of the drill site should be guided by a number of pointers, including the "*avoidance of protected and conservation areas"* and listed the "*awareness and avoidance of protected areas"* first in a list of general environmental protection measures that should guide activities.

IUCN sought to tackle the issue of extractive industries impacts on protected areas more generally through a recommendation (2.82) at the World Conservation Congress in Amman, Jordan in October 2000. The recommendation calls "*on all IUCN's State members to prohibit by law, all exploration and extraction of mineral resources in protected areas corresponding to IUCN protected area management*

tic Onshore Regions.

Lesson 2: National Sustainability

Both Rio and Johannesburg WCSD's proposed that National Sustainability plans should be developed. These should include National Environmental and Energy plans including renewable energy. All oil and gas projects should be developed within a Strategic Environmental Assessment as part of the framework of National Sustainability/Energy Plans. These plans should include the current and future energy needs for the country and the substitution of finite resources with renewables.

Lesson 3: Strategic Environmental Assessment (SEA)

A good model of an SEA has been prepared by the UK Department of Trade and Industry (DTI with support from staff from WWF and many other organisations). A key early step is an SEA scoping exercise to obtain external input to help define:

- The issues and concerns that the SEA should address
- Key information sources and perceived gaps in understanding of the natural environment
- Key information sources and perceived gaps in understanding of the effects of the activities that would result from oil and gas licensing

SEAs are vital for critical marine systems, on which millions of poor people depend for survival. These systems are going to be badly affected unless industry is forced to meet the highest international standards.

Lesson 4: Combined environmental and social studies

Oil and gas companies must complete all environmental and social studies including health impacts at the same time and have them checked by relevant government departments, civil society and an independent agency before giving them to the government for approval. This must be completed before investment decisions are made.

Lesson 5: International Standards

Oil and gas companies should follow the highest international standards both in construction methods and the equipment they use. The use of old (25 plus years) single hulled converted tankers as floating production platforms will cause concern particularly when they are stationed in areas of very high marine biodiversity.

Lesson 6: Treaties

International treaties are needed to control oil and gas operations when the impacts of their operations, including oil spills or discharged process water, may affect a number of countries.

Lack of international legislation for offshore oil and gas operations

Although some general principles exist in both Rio and United Nations Convention on the Law of the Sea (UNCLOS), as shown below, there is a serious lack of detailed international legislation for offshore oil and gas operations. The onus is primarily on states to develop legislation, even though the main impact of pollution may be on neighbouring countries.

This problem has been highlighted by the Canadian Maritime Environmental Law Association (CMLA): *The present plethora of national legal regimes and the individual contractual negotiations between the major oil companies* *and nation states, often with little or no bargaining power, has resulted in an assemblage of political and economic environments which resembles European medieval fiefdoms.*[9]

Principle 2 of the Rio Declaration provides: *States have, in accordance with the Charter of the United Nations and the principles of international law, the sovereign right to exploit their own resources pursuant to their own environmental and developmental policies, and the responsibility to ensure that activities within their jurisdiction or control do not cause damage to the environment of other States or of areas beyond the limits of national jurisdiction.*

UNCLOS states in Article 208 that: *Coastal States shall adopt laws to control marine pollution from offshore units and seabed activities no less effective than in international rules and standards. States shall establish global and regional rules for this purpose*.

A strategy for energy

In recognition of the severe problems arising from the oil and gas industry, and the finite nature of these resources, calls for an Energy Revolution on

Picture 2. West African marine environments could be at risk from increased oil and gas production (*Courtesy Nigel Dudley, Equilibrium Research*)

the scale of the industrial revolution to solve the world's energy and climate change crisis. Key elements of such a "revolution" would be:

By 2050 virtually all energy to come from environmentally-sound renewable, or decarbonised sources. This will also reduce the need for the oil and gas industry to move into areas of high biodiversity and low civil society and government capacity or areas, which are critical for human survival.

Governments and other key constituencies need to overcome the current unsustainable fossil-based energy system and take clear and decisive steps towards renewable energies and energy efficiency.

Industry should pay the real cost of their impacts on climate change and other environmental damage; this will also help to ensure that renewable energy sources are competitive and new technologies are developed.

All direct and indirect subsidies need to be stopped, except those supporting fuel for the poorest people.

The energy needs for future generations must not be wasted and gas flaring should be stopped; when it occurs it should be subject to financial penalties.

Countries should be helped to develop National Sustainability Plans including energy plans, which include renewable energy strategies. They should avoid exporting all their fossil fuels before they have developed renewable replacements.

All extractive industries and all governments should be encouraged to sign the Extractive Industries Transparency Initiative, (EITI) and respect the UN Convention on Corruption.

Industries should stop signing secre-