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Editorial

We present, in this issue of Tiempo, the third and final part of our selected excerpts from the IPCC's 2001 Third Assessment Report. This detailed extract is from the Policymakers Summary of Working Group III's review of the scientific, technical, environmental, economic and social aspects of the mitigation of climate change.

Manuel Winograd describes a set of mapping techniques for risk and vulnerability assessment employed in a research project undertaken in Honduras. The work was concerned with the impact of natural disasters and lessons that can be drawn regarding reducing the effects of longer-term climate change.

Siri Eriksen, Ane Schjolden and Julie Silva discuss the findings of research on climate vulnerability undertaken in Africa. They explore the interaction between climate impacts and economic trends and show how these linkages create vulnerabilities at the local level.

The United States has announced its unilateral alternative to the Kyoto Protocol to the climate treaty. We describe the main elements of the Bush administration's programme and present international comment on these plans.

The warming and cooling of the tropical Pacific brings climate disruption to many part of the tropics and subtropics. We report on evidence that a new El Niño event may be developing during the early months of 2002 and describe the outcome of a capacity-strengthening workshop on El Niño forecasting held recently in Hanoi, Vietnam.

Finally, we present in this issue the global temperature average for 2001, the second warmest year on record.

The next issue of Tiempo will be a double issue, out in September, as a lead-up to the UNFCCC Eighth Conference of the Parties in late October.

Cover photo: Siri Eriksen

The IPCC Third Assessment: Mitigation

The role of the Intergovernmental Panel on Climate Change is to provide the international community with expert guidance regarding scientific and technical aspects of the climate problem.

Since 1990, the Intergovernmental Panel on Climate Change (IPCC) has, at five-yearly intervals, assessed and reported on the current state of knowledge and understanding of the climate issue. These reports are intended to be used to provide policy makers with an objective assessment and review of the information available on climate change.

Given the importance of the IPCC reports as a global consensus on our understanding of the climate issue, we considered it to be appropriate and useful that *Tiempo* presents a summary of each Working Group Report.

Selected excerpts from the IPCC Working Group I Summary for Policymakers concerning the basic science of the climate issue were

presented in *Tiempo*, Issue 38/39, June 2001. Selected excerpts from the Working Group II Summary for Policymakers on Impacts, Adaptation, and Vulnerability were presented in *Tiempo*, Issue 40/41, September 2001. (These summaries are available at: www.cru.uea.ac.uk/tiempo/floor0/archive/reports.htm.)

Finally, in this issue, we present selected extracts from the Working Group III Summary for Policymakers which reports on the mitigation options relating to climate change. The following text is taken verbatim from the Policymakers Summary. All main conclusions are covered, though, where indicated, some detail has been omitted.

SUMMARY FOR POLICYMAKERS

Introduction

1. *This report assesses the scientific, technical, environmental, economic and social aspects of the mitigation of climate change.* Research in climate change mitigation has continued since

the publication of the IPCC Second Assessment Report (SAR), taking into account political changes such as the agreement on the Kyoto Protocol of the UNFCCC in 1997, and is reported on here. The Report also draws on a number of IPCC Special Reports, notably the Special Report on Aviation and the Global Atmosphere, the Special Report on Methodological and Technological Issues in Technology Transfer (SRTT), the Special Report on Emissions Scenarios, and the Special Report on Land Use, Land Use Change and Forestry (LULUCF).

The nature of the mitigation challenge

2. *Climate change is a problem with unique characteristics.* It is global, long-term (up to several centuries), and involves complex interactions between climatic, environmental, economic, political, institutional, social and technological processes. This may have significant international and intergenerational implications in the context of broader societal

goals such as equity and sustainable development. Developing a response to climate change is characterized by decision-making under uncertainty and risk, including the possibility of non-linear and/or irreversible changes.

3. *Alternative development paths can result in very different greenhouse gas emissions.* The SRES and the mitigation scenarios assessed in this report suggest that the type, magnitude, timing and costs of mitigation depend on different national circumstances and socio-economic, and technological development paths and the desired level of greenhouse gas concentration stabilization in the atmosphere... Development paths leading to low emissions depend on a wide range of policy choices and require major policy changes in areas other than climate change.

4. *Climate change mitigation will both be affected by, and have impacts on, broader socio-economic policies and trends, such as those relating to development, sustainability and equity.* Climate mitigation policies may promote sustainable development when they are consistent with such broader societal

objectives. Some mitigation actions may yield extensive benefits in areas outside of climate change: for example, they may reduce health problems; increase employment; reduce negative environmental impacts (like air pollution); protect and enhance forests, soils and watersheds; reduce those subsidies and taxes which enhance greenhouse gas emissions; and induce technological change and diffusion, contributing to wider goals of sustainable development. Similarly, development paths that meet sustainable development objectives may result in lower levels of greenhouse gas emissions.

5. *Differences in the distribution of technological, natural and financial resources among and within nations and regions, and between generations, as well as differences in mitigation costs, are often key considerations in the analysis of climate change mitigation options.* Much of the debate about the future differentiation of contributions of countries to mitigation and related equity issues also considers these circumstances. The challenge of addressing climate change raises an important issue of equity, namely the extent to which the impacts of climate change or mitigation policies

The following key words and phrases are used by the IPCC:

"Mitigation" is defined as an anthropogenic intervention to reduce the sources of greenhouse gases or enhance their sinks.

"Alternative development paths" refer to a variety of possible scenarios for societal values and consumption and production patterns in all countries, including but not limited to a continuation of today's trends. These paths do not include additional climate initiatives which means that no scenarios are included that explicitly assume implementation of the United Nations Framework Convention on Climate Change or the emissions targets of the Kyoto Protocol.

"Known technological options" refer to technologies that exist in operation or pilot plant stage today, as discussed in the report. It does not include any new technologies that will require drastic technological breakthroughs. In this way it can be considered to be a conservative estimate, considering the length of the scenario period.

or exacerbate inequities both within and across nations and regions. Greenhouse gas stabilization scenarios assessed in this report (except those where stabilization occurs without new climate policies,...) assume that developed countries and countries with economies in transition limit and reduce their greenhouse gas emissions first.

6. Lower emissions scenarios require different patterns of energy resource development.

...There are abundant fossil fuel resources that will not limit carbon emissions during the 21st century. However, different from the relatively large coal and unconventional oil and gas deposits, the carbon in proven conventional oil and gas reserves, or in conventional oil resources, is much less than the cumulative carbon emissions associated with stabilization of carbon dioxide at levels of 450 ppmv or higher (the reference to a particular concentration level does not imply an agreed-upon desirability of stabilization at this level). These resource data may imply a change in the energy mix and the introduction of new sources of energy during the 21st century. The choice of energy mix and associated investment will determine whether, and if so, at what level and cost, greenhouse

concentrations can be stabilized. Currently most such investment is directed towards discovering and developing more conventional and unconventional fossil resources.

Options to limit or reduce greenhouse gas emissions and enhance sinks

7. Significant technical progress relevant to greenhouse gas emission reduction has been made since the SAR in 1995 and has been faster than anticipated. Advances are taking place in a wide range of technologies at different stages of development, e.g., the market introduction of wind turbines, the rapid elimination of industrial by-product gases such as N₂O from adipic acid production and perfluorocarbons from aluminium production, efficient hybrid engine cars, the advancement of fuel cell technology, and the demonstration of underground carbon dioxide storage. Technological options for emission reduction include improved efficiency of end use devices and energy conversion technologies, shift to low-carbon and renewable biomass fuels, zero-emissions technologies, improved energy management, reduction of industrial by-product and process gas emissions, and carbon removal and storage...

8. Forests, agricultural lands, and other terrestrial ecosystems offer significant carbon mitigation potential. Although not necessarily permanent, conservation and sequestration of carbon may allow time for other options to be further developed and implemented. Biological mitigation can occur by three strategies: a) conservation of existing carbon pools, b) sequestration by increasing the size of carbon pools, and c) substitution of sustainably produced biological products, e.g. wood for energy intensive construction products and biomass for fossil fuels. Conservation of threatened carbon pools may help to avoid emissions, if leakage can be prevented, and can only become sustainable if the socio-economic drivers for deforestation and other losses of carbon pools can be addressed. Sequestration reflects the biological dynamics of growth, often starting slowly, passing through a maximum, and then declining over decades to centuries...

9. There is no single path to a low emission future and countries and regions will have to choose their own path. Most model results indicate that known technological options could achieve a broad range of atmospheric CO₂

stabilization levels, such as 550 ppmv, 450 ppmv or below over the next 100 years or more, but implementation would require associated socio-economic and institutional changes. To achieve stabilization at these levels, the scenarios suggest that a very significant reduction in world carbon emissions per unit of GDP from 1990 levels will be necessary. Technological improvement and technology transfer play a critical role in the stabilization scenarios assessed in this report. For the crucial energy sector, almost all greenhouse gas mitigation and concentration stabilization scenarios are characterized by the introduction of efficient technologies for both energy use and supply, and of low- or no-carbon energy. However, no single technology option will provide all of the emissions reductions needed. Reduction options in non-energy sources and non-CO₂ greenhouse gases will also provide significant potential for reducing emissions. Transfer of technologies between countries and regions will widen the choice of options at the regional level and economies of scale and learning will lower the costs of their adoption.

10. *Social learning and innovation, and changes in institutional structure could*

contribute to climate change mitigation. Changes in collective rules and individual behaviours may have significant effects on greenhouse gas emissions, but take place within a complex institutional, regulatory and legal setting. Several studies suggest that current incentive systems can encourage resource intensive production and consumption patterns that increase greenhouse gas emissions in all sectors, e.g. transport and housing. In the shorter term, there are opportunities to influence through social innovations individual and organizational behaviours. In the longer term such innovations, in combination with technological change, may further enhance socio-economic potential, particularly if preferences and cultural norms shift towards a lower emitting and sustainable behaviours. These innovations frequently meet with resistance, which may be addressed by encouraging greater public participation in the decision making processes. This can help contribute to new approaches to sustainability and equity...

11. *Estimates of cost and benefits of mitigation actions differ because of (i) how welfare is measured, (ii) the scope and methodology of the analysis, and (iii) the underlying assumptions*

built into the analysis. As a result, estimated costs and benefits may not reflect the actual costs and benefits of implementing mitigation actions. With respect to (i) and (ii), costs and benefits estimates, *inter alia*, depend on revenue recycling, and whether and how the following are considered: implementation and transaction cost, distributional impacts, multiple gases, land-use change options, benefits of avoided climate change, ancillary benefits, no regrets opportunities and valuation of externalities and non-market impacts. Assumptions include, *inter alia*:

- Demographic change, the rate and structure of economic growth; increases in personal mobility, technological innovation such as improvements in energy efficiency and the availability of low-cost energy sources, flexibility of capital investments and labour markets, prices, fiscal distortions in the no-policy (baseline) scenario.
- The level and timing of the mitigation target.
- Assumptions regarding implementation measures, e.g. the extent of emissions trading, the Clean Development Mechanism (CDM) and Joint Implementation (JI), regulation, and voluntary agreements and the associated transaction costs.
- Discount rates: the long time scales make

discounting assumptions critical and there is still no consensus on appropriate long-term rates, though the literature shows increasing attention to rates that decline over time and hence give more weight to benefits that occur in the long term. These discount rates should be distinguished from the higher rates that private agents generally use in market transactions.

12. *Some sources of greenhouse gas emissions can be limited at no or negative net social cost to the extent that policies can exploit no regret opportunities:*

- **Market imperfections.** Reduction of existing market or institutional failures and other barriers that impede adoption of cost-effective emission reduction measures, can lower private costs compared to current practice. This can also reduce private costs overall.
- **Ancillary benefits.** Climate change mitigation measures will have effects on other societal issues. For example, reducing carbon emissions in many cases will result in the simultaneous reduction in local and regional air pollution. It is likely that mitigation strategies will also affect transportation, agriculture, land-use practices and waste management and will

have an impact on other issues of social concern, such as employment, and energy security. However, not all of the effects will be positive... In some cases, the magnitude of ancillary benefits of mitigation may be comparable to the costs of the mitigating measures, adding to the no regret potential, although estimates are difficult to make and vary widely.

- **Double dividend.** Instruments (such as taxes or auctioned permits) provide revenues to the government. If used to finance reductions in existing distortionary taxes (“revenue recycling”), these revenues reduce the economic cost of achieving greenhouse gas reductions. The magnitude of this offset depends on the existing tax structure, type of tax cuts, labour market conditions, and method of recycling. Under some circumstances, it is possible that the economic benefits may exceed the costs of mitigation.

13. *The cost estimates for Annex B countries to implement the Kyoto Protocol vary between studies and regions as indicated in Paragraph 10, and depend strongly upon the assumptions regarding the use of the Kyoto mechanisms, and their interactions with domestic measures.* The great majority of global studies reporting and

comparing these costs use international energy-economic models. Nine of these studies suggest the following GDP impacts:

Annex II countries: In the absence of emissions trade between Annex B countries, the majority of global studies show reductions in projected GDP of about 0.2 to 2% in 2010 for different Annex II regions. With full emissions trading between Annex B countries, the estimated reductions in 2010 are between 0.1 and 1.1% of projected GDP.. Models whose results are reported in this paragraph assume full use of emissions trading without transaction cost. Results for cases that do not allow Annex B trading assume full domestic trading within each region. Models do not include sinks or non-CO₂ greenhouse gases. They do not include the CDM, negative cost options, ancillary benefits, or targeted revenue recycling.

For all regions costs are also influenced by the following factors:

- Constraints on the use of Annex B trading, high transaction costs in implementing the mechanisms, and inefficient domestic implementation could raise costs.
- Inclusion in domestic policy and measures of the no regret possibilities identified in Paragraph 12, use of the CDM, sinks, and

inclusion of non-CO₂ greenhouse gases, could lower costs...

The models show that the Kyoto mechanisms are important in controlling risks of high costs in given countries, and thus can complement domestic policy mechanisms. Similarly, they can minimize risks of inequitable international impacts and help to level marginal costs.

Economies in transition: For most of these countries, GDP effects range from negligible to a several percent increase. This reflects opportunities for energy efficiency improvements not available to Annex II countries. Under assumptions of drastic energy efficiency improvement and/or continuing economic recessions in some countries, the assigned amounts may exceed projected emissions in the first commitment period. In this case, models show increased GDP due to revenues from trading assigned amounts. However, for some economies in transition, implementing the Kyoto Protocol will have similar impact on GDP as for Annex II countries.

14. *Cost-effectiveness studies with a century timescale estimate that the costs of stabilizing CO₂ concentrations in the atmosphere increase*

as the concentration stabilization level declines. Different baselines can have a strong influence on absolute costs. While there is a moderate increase in the costs when passing from a 750 ppmv to a 550 ppmv concentration stabilization level, there is a larger increase in costs passing from 550 ppmv to 450 ppmv unless the emissions in the baseline scenario are very low. These results, however, do not incorporate carbon sequestration, gases other than CO₂ and did not examine the possible effect of more ambitious targets on induced technological change. Costs associated with each concentration level depend on numerous factors including the rate of discount, distribution of emission reductions over time, policies and measures employed, and particularly the choice of the baseline scenario: for scenarios characterized by a focus on local and regional sustainable development for example, total costs of stabilizing at a particular level are significantly lower than for other scenarios.

15. *Under any greenhouse gas mitigation effort, the economic costs and benefits are distributed unevenly between sectors; to a varying degree, the costs of mitigation actions could be reduced by appropriate policies.* In

general, it is easier to identify activities, which stand to suffer economic costs compared to those which may benefit, and the economic costs are more immediate, more concentrated and more certain. Under mitigation policies, coal, possibly oil and gas, and certain energy-intensive sectors, such as steel production, are most likely to suffer an economic disadvantage. Other industries including renewable energy industries and services can be expected to benefit in the long term from price changes and the availability of financial and other resources that would otherwise have been devoted to carbon-intensive sectors. Policies such as the removal of subsidies from fossil fuels may increase total societal benefits through gains in economic efficiency, while use of the Kyoto mechanisms could be expected to reduce the net economic cost of meeting Annex B targets. Other types of policies, for example exempting carbon-intensive industries, redistribute the costs but increase total societal costs at the same time. Most studies show that the distributional effects of a carbon tax can have negative income effects on low-income groups unless the tax revenues are used directly or indirectly to compensate such effects.

16. *Emission constraints in Annex I countries have well established, albeit varied "spill over" effects on non-Annex I countries.*

Oil-exporting, non-Annex I countries: Analyses report costs differently, including, *inter alia*, reductions in projected GDP and reductions in projected oil revenues. The study reporting the lowest costs shows reductions of 0.2% of projected GDP with no emissions trading, and less than 0.05% of projected GDP with Annex B emissions trading in 2010. The study reporting the highest costs shows reductions of 25% of projected oil revenues with no emissions trading, and 13% of projected oil revenues with Annex B emissions trading in 2010. These studies do not consider policies and measures other than Annex B emissions trading, that could lessen the impact on non-Annex I, oil-exporting countries, and therefore tend to overstate both the costs to these countries and overall costs. The effects on these countries can be further reduced by removal of subsidies for fossil fuels, energy tax restructuring according to carbon content, increased use of natural gas, and diversification of the economies of non-Annex I, oil-exporting countries.

Other non-Annex I countries: They may be adversely affected by reductions in demand for

their exports to OECD nations and by the price increase of those carbon-intensive and other products they continue to import. These countries may benefit from the reduction in fuel prices, increased exports of carbon-intensive products and the transfer of environmentally sound technologies and know-how. The net balance for a given country depends on which of these factors dominates. Because of these complexities, the breakdown of winners and losers remains uncertain.

Carbon leakage. The possible relocation of some carbon-intensive industries to non-Annex I countries and wider impacts on trade flows in response to changing prices may lead to leakage in the order of 5-20%. Exemptions, for example for energy-intensive industries, make the higher model estimates for carbon leakage unlikely, but would raise aggregate costs. The transfer of environmentally sound technologies and know-how, not included in models, may lead to lower leakage and especially on the longer term may more than offset the leakage.

Ways and means for mitigation

17. *The successful implementation of greenhouse gas mitigation options needs to*

overcome many technical, economic, political, cultural, social, behavioural and/or institutional barriers which prevent the full exploitation of the technological, economic and social opportunities of these mitigation options. The potential mitigation opportunities and types of barriers vary by region and sector, and over time. This is caused by the wide variation in mitigation capacity. The poor in any country are faced with limited opportunities to adopt technologies or change their social behaviour, particularly if they are not part of a cash economy, and most countries could benefit from innovative financing and institutional reform and removing barriers to trade. In the industrialized countries, future opportunities lie primarily in removing social and behavioural barriers, in countries with economies in transition, in price rationalization; and in developing countries, in price rationalization, increased access to data and information, availability of advanced technologies, financial resources, and training and capacity building. Opportunities for any given country, however, might be found in the removal of any combination of barriers.

18. *National responses to climate change can be more effective if deployed as a portfolio of*

policy instruments to limit or reduce greenhouse gas emissions. The portfolio of national climate policy instruments may include – according to national circumstances – emissions/carbon/energy taxes, tradable or non-tradable permits, provision and/or removal of subsidies, deposit/refund systems, technology or performance standards, energy mix requirements, product bans, voluntary agreements, government spending and investment, and support for research and development. Each government may apply different evaluation criteria, which may lead to different portfolios of instruments. The literature in general gives no preference for any particular policy instrument. Market based instruments may be cost effective in many cases, especially where capacity to administer them is developed. Energy efficiency standards and performance regulations are widely used, and may be effective in many countries, and sometimes precede market based instruments. Voluntary agreements have recently been used more frequently, sometimes preceding the introduction of more stringent measures. Information campaigns, environmental labelling, and green marketing, alone or in combination with incentive subsidies, are

increasingly emphasized to inform and shape consumer or producer behaviour. Government and/or privately supported research and development is important in advancing the long-term application and transfer of mitigation technologies beyond the current market or economic potential.

19. *The effectiveness of climate change mitigation can be enhanced when climate policies are integrated with the non-climate objectives of national and sectorial policy development and be turned into broad transition strategies to achieve the long-term social and technological changes required by both sustainable development and climate change mitigation.* Just as climate policies can yield ancillary benefits that improve well being, non-climate policies may produce climate benefits. It may be possible to significantly reduce greenhouse gas emissions by pursuing climate objectives through general socio-economic policies. In many countries, the carbon intensity of energy systems may vary depending on broader programs for energy infrastructure development, pricing, and tax policies. Adopting state-of-the-art environmentally sound technologies may offer particular opportunity for

environmentally sound development while avoiding greenhouse gas intensive activities. Specific attention can foster the transfer of those technologies to small and medium size enterprises. Moreover, taking ancillary benefits into account in comprehensive national development strategies can lower political and institutional barriers for climate-specific actions.

20. *Co-ordinated actions among countries and sectors may help to reduce mitigation cost, address competitiveness concerns, potential conflicts with international trade rules, and carbon leakage. A group of countries that wants to limit its collective greenhouse gas emissions could agree to implement well-designed international instruments.* Instruments assessed in this report and being developed in the Kyoto Protocol are emissions trading; Joint Implementation (JI); the Clean Development Mechanism (CDM); other international instruments also assessed in this report include co-ordinated or harmonized emission/carbon/energy taxes; an emission/carbon/energy tax; technology and product standards; voluntary agreements with industries; direct transfers of financial resources and technology; and co-

ordinated creation of enabling environments such as reduction of fossil fuel subsidies. Some of these have been considered only in some regions to date.

21. *Climate change decision-making is essentially a sequential process under general uncertainty.* The literature suggests that a prudent risk management strategy requires a careful consideration of the consequences (both environmental and economic), their likelihood and society's attitude toward risk. The latter is likely to vary from country to country and perhaps even from generation to generation. This report therefore confirms the SAR finding that the value of better information about climate change processes and impacts and society's responses to them is likely to be great. Decisions about near-term climate policies are in the process of being made while the concentration stabilization target is still being debated. The literature suggests a step-by-step resolution aimed at stabilizing greenhouse gas concentrations. This will also involve balancing the risks of either insufficient or excessive action. The relevant question is not "what is the best course for the next 100 years", but rather "what is the best course for the near term given

the expected long-term climate change and accompanying uncertainties".

22. *This report confirms the finding in the SAR that earlier actions, including a portfolio of emissions mitigation, technology development and reduction of scientific uncertainty, increase flexibility in moving towards stabilization of atmospheric concentrations of greenhouse gases. The desired mix of options varies with time and place.* Economic modelling studies completed since the SAR indicate that a gradual near-term transition from the world's present energy system towards a less carbon-emitting economy minimizes costs associated with premature retirement of existing capital stock. It also provides time for technology development, and avoids premature lock-in to early versions of rapidly developing low-emission technology. On the other hand, more rapid near-term action would decrease environmental and human risks associated with rapid climatic changes. It would also stimulate more rapid deployment of existing low-emission technologies, provide strong near-term incentives to future technological changes that may help to avoid lock-in to carbon-intensive technologies, and allow for later tightening of targets should that

be deemed desirable in light of evolving scientific understanding.

23. *There is an inter-relationship between the environmental effectiveness of an international regime, the cost-effectiveness of climate policies and the equity of the agreement.* Any international regime can be designed in a way that enhances both its efficiency and its equity. The literature assessed in this report on coalition formation in international regimes presents different strategies that support these objectives, including how to make it more attractive to join a regime through appropriate distribution of efforts and provision of incentives. While analysis and negotiation often focus on reducing system costs, the literature also recognizes that the development of an effective regime on climate change must give attention to sustainable development and non-economic issues.

Gaps in knowledge

24. *Advances have been made since previous IPCC assessments in the understanding of the scientific, technical, environmental, and economic and social aspects of mitigation of*

climate change. Further research is required, however, to strengthen future assessments and to reduce uncertainties as far as possible in order that sufficient information is available for policy making about responses to climate change, including research in developing countries.

The following are high priorities for further narrowing gaps between current knowledge and policy making needs:

- *Further exploration of the regional, country and sector specific potentials of technological and social innovation options.* This includes research on the short, medium and long-term potential and costs of both CO₂ and non-CO₂, non-energy mitigation options; understanding of technology diffusion across different regions; identifying opportunities in the area of social innovation leading to decreased greenhouse gas emissions; comprehensive analysis of the impact of mitigation measures on carbon flows in and out of the terrestrial system; and some basic inquiry in the area of geo-engineering.
- *Economic, social and institutional issues related to climate change mitigation in all countries.* Priority areas include: analysis of regionally specific mitigation options and barriers; the implications of equity

assessments; appropriate methodologies and improved data sources for climate change mitigation and capacity building in the area of integrated assessment; strengthening future research and assessments, especially in the developing countries.

- *Methodologies for analysis of the potential of mitigation options and their cost, with special attention to comparability of results* Examples include: characterizing and measuring barriers that inhibit greenhouse gas-reducing action; making mitigation modelling techniques more consistent, reproducible, and accessible; modelling technology learning; improving analytical tools for evaluating ancillary benefits, e.g. assigning the costs of abatement to greenhouse gases and to other pollutants; systematically analyzing the dependency of costs on baseline assumptions for various greenhouse gas stabilization scenarios; developing decision analytical frameworks for dealing with uncertainty as well as socio-economic and ecological risk in climate policy making; improving global models and studies, their assumptions and their consistency in the treatment and reporting of non-Annex I countries and regions.

- *Evaluating climate mitigation options in the context of development, sustainability and equity.* Examples include: exploration of alternative development paths, including sustainable consumption patterns in all sectors, including the transportation sector; integrated analysis of mitigation and adaptation; identifying opportunities for synergy between explicit climate policies and general policies promoting sustainable development; integration of intra- and intergenerational equity in climate change mitigation analysis; implications of equity assessments; analysis of scientific, technical and economic implications of options under a wide variety of stabilization regimes.

Further information: The Working Group III "Summary for Policymakers" and the Policymakers Summaries for the other Working Group assessments are available in electronic and printed format from the IPCC. Contact information is given on page 25. The full Working Group III report, "Climate Change 2001: Mitigation," has been published by Cambridge University Press. See [uk.cambridge.org/earthsciences/climate change/](http://uk.cambridge.org/earthsciences/climate_change/) for further details.

During the past thirty years, Central America has experienced economic losses due to natural events equivalent to two per cent of the region's GDP per year. The countries of Central America are affected every three or four years by drought and fires, and/or floods and landslides which have important effects on environmental, social and infrastructure vulnerability.

Natural disasters in Honduras

As a result of climate change, extreme events such as storms, droughts, and floods are expected to increase even more in the future. After Hurricane Mitch in 1998, awareness of the high environmental impacts and socio-economic costs of natural events rose. Manuel Winograd of the International Center for Tropical Agriculture in Cali, Colombia reports on a project on vulnerability and risk assessment of natural disasters in one country of the region, Honduras.

Vulnerability and risk assessment frameworks and methods need to be developed to improve the decision-making and planning processes in order to move from dealing with consequences to preventing the causes and mitigating the effects of natural disasters. The absence of methodology and data commonly results in the limited use of information and analysis for decision-making and planning. This results in more descriptive, anecdotal and non-systematic assessments of vulnerability and risk. In general, the institutions of Central America either do not have access to data and information or their databases are still unconsolidated, making it difficult to use and exchange information.

A vulnerability assessment framework concerns the physiology (that is, functions, dynamics, synergies) of changes on the environment and society. This vulnerability assessment framework aims to determine the risk of adverse outcomes for a specific unit or group faced with a variety of perturbations or stresses, identifying factors that reduce the capacity to respond and adapt to stresses.

The products of such a framework are analyses of specific effects as caused by multiple factors which can be used for strategic guidance for policy and decision-making. The framework and methods need to take into consideration the differential nature of risk and vulnerability because perturbations, stresses and impacts are distributed heterogeneously in space and time. Responses, options and strategies are, therefore, applied differently at regional, national and local levels. At the same time, uncertainty needs to be taken into account due to factors such as natural variability, our ignorance, and the unknowable and indeterminable nature of some phenomenon.

Thus, the main objective of this project is to provide guidance on how to assess vulnerability and risk in order to

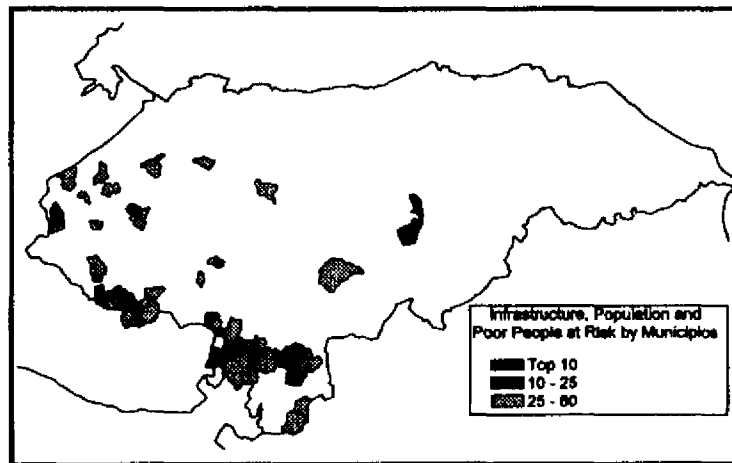


Figure 1: Municipios most at risk according to the combined vulnerability index

identify areas where prevention, reconstruction and mitigation options could have the greatest social, economic and environmental benefits. This objective is being fulfilled by providing decision makers at different levels with research on the means for assessing vulnerability and risk, and actions on how to reduce vulnerability and risk, as well as information to reduce uncertainty in decision making and policy making.

The effects of natural disasters on the economy, the society and the environment should be analysed not only in respect of their direct impacts but also in relation to the closely-linked indirect impacts. For example, the importance of infrastructure, such as road networks, in the development process, and the investment needed to develop and reconstruct it, is well known. Road networks allow access to markets, goods and services, the disruption of which can be considered an indirect effect of a natural disaster.

But it is not only the direct and indirect impacts of a natural disaster that should be analysed. The underlying causes, such as land use, agricultural practices, watershed management and urbanization, of both types of impacts should also be considered. For example, in hillside areas suffering from watershed deforestation and erosion, the likelihood and severity of landslides and mudslides and overflow of rivers in flat areas will increase, thus affecting basic infrastructure and urban areas as well devastating important agricultural areas.

What does this vulnerability and risk mean for a country like Honduras? The project took into account the function of the probability and magnitude of natural events such as Hurricane Mitch and the exposure and susceptibility of the environment.

We designed an environmental vulnerability index for Honduras, covering vulnerability to landslides as well as flooding by overflow and by poor soil drainage. Only the risk of landslides and flooding are highlighted in this index consistent with the impacts suffered in Honduras in the wake of Hurricane Mitch. The situation in the country is clearly alarming. The results show that more than 60 per cent of the territory has some type of risk from flooding or landslides, in particular the more populated and agricultural areas such as the axis of San Pedro Sula-Tegucigalpa-Choluteca

The next step was to overlap the environmental vulnerability index with population data in order to obtain a Combined Vulnerability Index that could help to identify the priority areas affected by natural events (Figure 1). This index took into account three main factors

- The first is a population vulnerability index: total population by "village" at risk of flooding + total population by "village" at risk of landslides.

- The second is a social vulnerability index: total population by "village" by poverty levels at risk of flood + total population by "village" by poverty level at risk of landslides.
- The third is an infrastructure vulnerability index: roads type at risk of flood + roads type at risk of landslide + electricity lines type at risk of flood + electricity lines type at risk of landslides.

What did this analysis mean in terms of direct and indirect effects of Hurricane Mitch? The direct effects of Hurricane Mitch on the infrastructure were huge. This was particularly notable in the high impacts on the strategic road network of the San Pedro Sula-Tegucigalpa, Tegucigalpa-Choluteca, Pan-American Highway, as well as on the secondary road network, due to landslides, flooding and destroyed or damaged bridges.

Although the poor in Honduras would appear to be the most vulnerable population group when faced with natural disasters, when considering only the direct effects of Hurricane Mitch the poor do not necessarily seem to be any harder hit than other groups in society. However, if the indirect effects, that is, in the form of loss of accessibility, are taken into account the picture looks a bit different.

We proceeded to devise a map which showed areas that lost more than ten per cent of accessibility to markets together with the location of villages with severe and critical poverty levels.

The resulting mapping shows that there were some areas that only suffered indirectly. This was as a result of the damage to infrastructure, in particular the difficulty of access between population centres and rural areas which caused serious delays in the arrival of medical aid, food and seeds.

What did the vulnerability analysis mean in terms of prioritization for reconstruction? We considered the case of

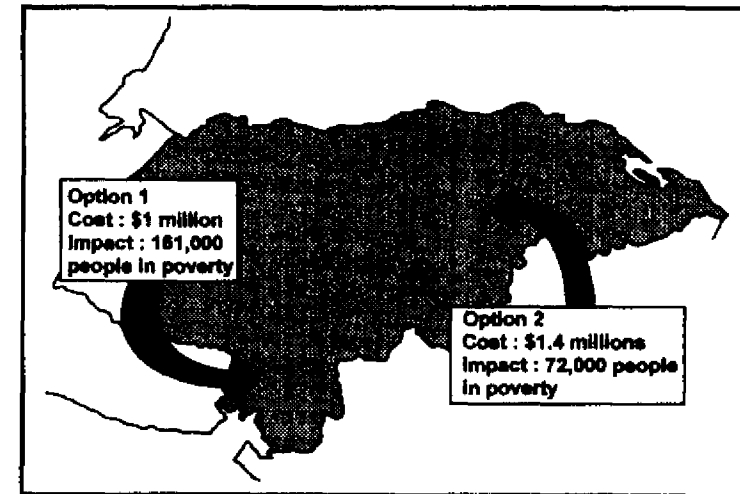


Figure 2: Costs and benefits of the two reconstruction options. The arrows locate the priority areas, see Figure 1.

two potential reconstruction options that would help alleviate the impacts on Honduras' poorer population. The first option is orientated toward reconstructing the strategic road axis in Honduras, grouping priority *municipios* by vulnerability, and recovering the accessibility between the most important cities, ports and productive areas. The second option is orientated toward reconstructing the road network that allows access to villages with high levels of poverty at the same time as isolating priority *municipios* by vulnerability.

We were then able to clearly show the costs and benefits of these two options (Figure 2). It was notable that in the first option not only is the cost lower but the number of poor people who benefit is higher than in the second option. Obviously, these two options are exploratory and not exclusive. The analysis was made with the goal of showing the importance of

Additional illustrations resulting from this project are available with the electronic version of this article on the Tiempo Climate Cyberlibrary web site at: www.cru.uea.ac.uk/tiempo/floor0/recent/issue43/index.htm.

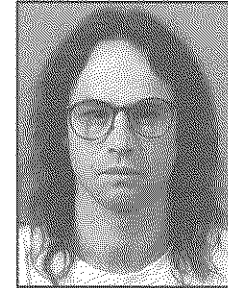
information for decision making, to explore planning strategies and to prioritize reconstruction options for the sectors most affected.

But the use of information for decision making and planning needs to go beyond simply monitoring the catastrophic effects of natural disasters on the economy, the society and the environment and planning reconstruction after the catastrophe has already occurred. What is needed is the possibility to go from short-term reaction to the immediate consequences on to the prevention of the direct and indirect causes in order to mitigate against future possible effects.

A first step toward this is to analyse the underlying causes of the situation caused by Hurricane Mitch, which does not only include abnormal amounts of rain during October 1998. A combination of past problems, in fact, had an influence on the severity of the impacts of the hurricane. These problems include inappropriate land-use practices, high deforestation rates in the watersheds, and a lack of urban planning, early warning systems and investment in works to prevent and mitigate natural events.

Analysing patterns of impact and environmental change, it was shown that the flooding in the north, centre and south of the country could be due, in part, to the low forest coverage and land use changes in the watersheds. This land cover could exacerbate extremely erosive processes in the hillside areas resulting in a high risk of landslides and dammed rivers in the headwaters with inundation in the lower part of the river.

This type of information on the underlying causes of the observed effects could be potentially crucial in helping to prioritize interventions such as identifying the financial aid and investment needed, the people and sectors that would benefit, and finally to plan mitigation and prevention actions.



In conclusion, we can say that the absence of planning in where a population is located, in land use and infrastructure together with the lack of application of any precautionary principles are the main causes of the increase in risk and vulnerability.

Generally, policies, strategies and actions are oriented toward solving consequences rather than preventing the causes. In consequence, "natural events" become "natural disasters." It is easier to blame climate change or "natural events uncertainty" for the high impacts, consequences and effects of natural disasters rather than to plan, prevent and mitigate.

Taking into account the risk and vulnerability to natural events, the challenges confronting us are the need to explore and develop our adaptive capacity, take advantage of any emerging opportunities and learn to cope with the consequences.

✍ Manuel Winograd is a senior researcher in the Land Use Programme and coordinator of the Sustainability Indicators Project at the International Center for Tropical Agriculture (CIAT) in Cali, Colombia.

Human Dimensions of Urbanisation & the Transition to Sustainability

Bonn, Germany:

03-06-2002 to 14-06-2002

Workshop will focus on providing young researchers with an intensive learning experience in the interdisciplinary field of Human Dimensions of Global Environmental Change (GEC). Will cover the different aspects of urbanization with the aim of integrating the participants into the international GEC network thus providing a forum for strengthening the input from developing countries as well as Central and Eastern European countries into the IHDP agenda. **Details:** Maarit Thiem, IHDP Secretariat, Walter-Flex-Str.3 D-53113 Bonn, Germany. Fax: +49-228-739054. Email: thiem.ihdp@uni-bonn.de.

Managing International Shared Waters: Towards Sustainable Transboundary Coastal Ecosystems

Hamilton, Canada:

24-06-2002 to 28-06-2002

Conference intended to bring together a broad spectrum of representatives from those working in the field of transboundary coastal management. Participants from government, academia, non-governmental organizations and business will discuss potential solutions to integrated coastal management. **Details:** Ralph Daley, UNU/UNWEH, McMaster University, JHE Bldg., 1280 Main Street West, Hamilton, Ontario L8S 4K1, Canada Fax: +1-905-5259140. Email: contact@inweh.unu.edu Web: www.inweh.unu.edu/inweh/msw.htm

World Renewable Energy Congress VII

Cologne, Germany:

29-06-2002 to 05-07-2002

The main theme of this seventh congress organized by The World Renewable Energy Network is "Renewables: World's Best Energy Option." The congress topics include: low energy architecture;

photovoltaics, solar-thermal applications; wind energy; biomass conversion; solar materials; fuel cell systems, and energy and gender. **Details:** Ali Sayigh, Congress Chairman, 147 Hilmanton, Lower Earley, Reading RG6 4HN, UK. Fax: +44-118-9611365. Email: asayigh@netcomuk.co.uk. Web: www.wrenuk.co.uk.

1st World Wind Energy Conference & Exhibition

Berlin, Germany:

04-07-2002 to 08-07-2002

Conference programme will include plenary lectures focusing on the state-of-the-art in wind energy, targeted international workshops; and a global exhibition of products and services. Main paper subjects include: global policies and markets; integration and implementation; technology development and certification, capacity building; and economic, social and environmental issues amongst others. **Details:** Conference Organizer, WIP, Sylvesterstr 2, D-81369 Munich, Germany. Fax: +49-89-7201291. Email: wip@wip-munich.de. Web: www.wip-munich.de.

7th Western Pacific Geophysics Meeting

Wellington, New Zealand:

09-07-2002 to 12-07-2002

Meeting is open to geophysicists and interested parties worldwide but is intended to focus on the needs specific to the western Pacific region. Main themes will include: climate change and variability; climate change and implications for the Antarctic and Pacific, and the impacts and prediction of space weather. **Details:** AGU Meetings Dept., 2002 Western Pacific Meeting, 2000 Florida Avenue NW, Washington DC 20009, USA. Fax: +1-202-3280566 Email: meetinginfo@agu.org. Web: www.agu.org/meetings/wp02top.html.

**Stockholm Water Symposium:
Balancing Competing Water Uses with Present Status & New Prospects**
Stockholm, Sweden: 12-08-2002 to 15-08-2002

An international conference aimed at highlighting the present status of water use in different parts of the world. Participants will also debate what is needed to address the necessary balancing of water use as well as improving water use performance. New prospects, in terms of cases where balancing is already practised or planned, will also be discussed. **Details:** Symposium Secretariat, Stockholm International Water Institute, Sveavagen 59, SE-113 59 Stockholm, Sweden Fax: +46-8-52213961. Email: sympos@siwi.org. Web: www.siwi.org/sws2002/sws2002.html.

2002 ACEEE Summer Study on Energy Efficiency In Buildings

Pacific Grove, USA:

18-08-2002 to 23-08-2002

This annual study event is organized by the American Council for an Energy-Efficient Economy (ACEEE). The principal subjects this year will include: design and performance of buildings; energy and information technologies; human and social dimensions of energy use; role of energy service companies; and programme design, implementation and evaluation. The 2002 course will also include a technology showcase and roundtable sessions on specific topics. **Details:** ACEEE Summer Study Office, Rebecca Lunetta, PO Box 7586, Newark, DE 19714-7586, USA. Fax: +1-302-2923965. Email: rlunetta@erols.com. Web: aceee.org.

Conference on Fisheries in the Global Economy

Wellington, New Zealand:

19-08-2002 to 22-08-2002

Organized by the International Institute of Fisheries, Economics and Trade (IIFET), the meeting is aimed at discussing and considering the future management of fisheries. Main themes include: ecosystem and oceans policy approaches to fisheries management, co-management, rules-based reform; future paths for rights-based fisheries management, and economic solutions to customary, aboriginal and traditional fishing rights issues. **Details:** Bruce Shallard and Associates,

conferences

PO Box 27409, Wellington, New Zealand. Fax: +64-4-3893457. Email: bruce.shallard@xtra.co.nz. Web: www.lifet2002.com

3rd International Conference & Exhibition on Integrated Environmental Management in Southern Africa

**Johannesburg, South Africa:
27-08-2002 to 30-08-2002**

Organized by the University of the Witwatersrand, SCIAM Centre for Innovative Environmental Management, Johannesburg, South Africa, and Gerhard-Mercator University of Duisburg, Instrumental Analytical Chemistry, Germany. It will contribute to the development and implementation of new and innovative environmental management policies and approaches for Africa as well as providing a platform for discussing methods, tools and technologies. **Details:** Bridget McBean, The MELISSA Program/World Bank in South Africa, PO Box 12629, Hatfield, 0028 Pretoria, South Africa. Fax: +27-12-3492080. Email: bridget@melissa.org. Web: www.melissa.org.

Earth Summit 2002

**Johannesburg, South Africa:
02-09-2002 to 11-09-2002**

The World Summit on Sustainable Development or Rio+10 as it is otherwise known will review that progress which has been made over the past decade since the Rio Summit. Regional and sub-regional preparatory meetings will take place late 2001. These Prepcoms will cover the South Pacific, held in Samoa, South Asia, held in Sri Lanka, Southeast Asia, held in the Philippines and a regional meeting to be held in Cambodia. **Details:** Charles Nouhan, UNED UK, 3 Whitehall Court, London SW1A 2EL, UK. Fax: +44-20-7-9305893. Email: cnouhan@earthsummit2002.org.

International Conference on Sustainable Agriculture for Dry Areas for the 2nd Millennium

**Shijiazhuang, PR China:
15-09-2002 to 19-09-2002**

Will consider how to integrate sound crop production technologies, water saving and irrigation, tillage method, optimum fertilization and reduction of agrochemicals in the environment for the dry regions of the world. Aims to formulate recommendations for innovative procedures for technology transfer in sustainable agriculture. **Details:** Catherine Vachon, Lethbridge Research Centre, Agriculture & Agri-Food Canada, Lethbridge, Alberta T1J 4B1, Canada. Fax: +1-403-3823158. Email: vachonc@em.agr.ca. Web: res2.agr.ca/lethbridge/hebei/confindex.htm

4th International Conference on Environmental Problems in Coastal Regions Rhodes, Greece:

16-09-2002 to 18-09-2002

Conference aimed at researchers, government officials, academics and scientists interested in the field of environmental quality. Main themes will focus on the need to prevent, alleviate and/or minimize environmental problems so as to ensure the balanced use of coastal regions as a common resource around the world. **Details:** Gabriella Cossutta, Conference Secretariat, Coastal Environment 2002, Wessex Institute of Technology, Ashurst Lodge, Ashurst, Southampton SO40 7AA, UK. Fax: +44-1238-292853. Email: gcossutta@wessex.ac.uk. Web: www.wessex.ac.uk/conferences/2002/coastal02/.

LITTORAL 2002

Porto, Portugal: 22-09-2002 to 26-09-2002

This sixth international conference on the changing coast will include a series of workshops and plenary sessions. Main themes will include: biodiversity, land use conflicts; medium and long term predictions; and integrated coastal zone management. **Details:** Associacao EUROCOAST-PORTUGAL, c/o Instituto de Hidraulica e Recursos Hdricos, Faculdade de Engenharia da Universidade do Porto, 4200-465 Porto,

Portugal. Fax: +351-22-5081952. Email: fpinto@fe.up.pt. Web: www.fe.up.pt/eurcoast/littoral2002/index.html.

Sixth International Conference on Greenhouse Gas Control Technologies Kyoto, Japan:

01-10-2002 to 04-10-2002

Main aim of the conference is to provide a forum for the discussion of latest advances in the field of Greenhouse Gas Control Technologies, including capture, storage and utilization of carbon dioxide. Will also include discussion on mitigation options such as efficiency increase, use of renewable sources of energy and social impacts. **Details:** GHGT-6 Secretariat, Norifumi Matsumiya, Planning and Survey Dept. RITE, 9-2 Kizugawadai, Kizu-cho-Soraku-gun, Kyoto 619-0292, Japan. Fax: +81-774-752314. Email: ghgt@rite.or.jp. Web: www.rite.or.jp/GHGT6/.

GLOBEC Second Open Science Meeting Qingdao, PR China:

15-10-2002 to 18-10-2002

The Second Open Science Meeting will focus on the activities and the multidisciplinary relevance of the Global Ocean Ecosystem Dynamics (GLOBEC) programme. Aims to synthesize better the increasing number of national, multinational and regional GLOBEC activities. The theme is "Comparative Ecosystems and Climate Change". **Details:** GLOBEC IPO, Plymouth Marine Laboratory, Prospect Place, Plymouth PL1 3DH, UK. Fax: +44-1752-633101. Email: globec@pml.ac.uk. Web: www.globec.org.

Eighth Conference of the Parties to the UNFCCC

New Delhi, India: 23-10-2002 to 01-11-2002

Both the dates and venue for the UNFCCC's COP-8 are provisional at this time. **Details:** COP-8, UNFCCC Secretariat, PO Box 260 124 D-53153 Bonn, Germany. Fax: +49-228-8151999. Email: secretariat@unfccc.int. Web: www.unfccc.int