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Keynote Speech

Integrated and local responses to global and local environmental change –contributions of universities and research

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Summary
Serious environmental problems are facing the world . Governments, business and civil society are beginning to find solutions .But these are complex and controversial. Universities and research are playing a key role through new ideas and the advances in scientific and technological research. The main areas of application are firstly the analysis , prediction and technical solutions to the problems , secondly helping with formulation of policies, and thirdly ,through education and dialogue, enabling the public to support and participate in the practical implementation of these policies. An important policy issue is that in local areas the environment is changing faster than it is globally,(such as the artificial evening heat island in urban areas , flooding and anomalous warming in polar regions) . At the same time the vulnerability of communities to environmental risk is increasing rapidly because of economic and social pressures. Local action to reduce these risks to communities is urgently needed . But it is essential that a sustainable integrated approach is developed so that these actions (eg cooling buildings, flood prevention) complement actions to mitigate damage to the global environment , particularly by minimizing global warming and lessening threats to biodiversity . A holistic strategy for attaining this overall goal is needed. There has to be a balance between ,on the one hand ,policies and technologies that are integrated , and on the other hand those that are based on informing and empowering people and organizations .Then , as some cities have already shown, everyone can begin to contribute their own solutions for reducing risks from global and local environmental change , but within an overall framework . A multi-generational economic strategy is needed in which investments to increase a nation's wealth should also reduce the environmental risks through the integration of sustainable technology and planning .This is now the policy objective in some of the World Bank's energy and sustainable development projects.

(This is a shortened version of the full paper with references available from julian.hunt@asu.edu)

1.. Concepts for dealing with environmental risk

As we grapple at this conference with the intellectual , practical and political aspects of dealing with environmental risk and climate change, the most momentous challenge of our time (cf UN 2007), we need to focus on the concepts that will illuminate the problems and help provide solutions.

The guiding concept that emerged during the UN decade for Natural Disaster Reduction was that planning, science and action needs to distinguish between hazards measured by the severity of natural or accidental events, and vulnerability , which is a measure of the severity of how environmental events impact on communities.(eg Crichton 2007) As one disaster follows another with progressively more damage (as recorded by the insurance industry) , and also more damage to poorer communities (as UN statistics have recorded) ,it is clear that increasing vulnerability is the main cause; much more than increasing hazard (Pielke2007)

Environmental risks are also increasing because of the changing nature of the environment both locally and globally. During the past 20 years , the results of scientific research, coordinated very effectively by the UN International Panel on Climate Change (2007), has shown that as a result of changes to the world climate ,caused largely by human activities , environmental risks associated with natural hazards and their consequences such as diseases and crop failure, are likely to become more progressively more serious over the next few hundred years .(Schellenhuber et al 2006)Within the time period of about 30 years in which the global climate responds to human influence it is essential to start mitigating the human effects on the global environment . Local action could be effective on a shorter period for example in cities , deserts and forests. See fig1.

Although the roles of education and research in helping to achieve these bold objectives have to be considered in relation to the strategies of governments and industry, universities also have a unique responsibility to come up with new perspectives and new solutions; perhaps with some reinterpretations of the current concepts of Gaia, sustainability and the precautionary principle.?

There are many dimensions to understanding and dealing with changing environmental risks. The roles of disciplines and organizations involved can be schematically plotted in relation to three axes corresponding to the science ,action to reduce risks , and the societal aspects and formulation of policy. . (See fig2)

2 Integrating the Science

Despite the connections between the science and technology of natural hazards and their impacts (which were indeed emphasized during IDNDR) ,in most countries research in this field is not well coordinated .The notable exception is Japan where specialized centres at universities and government agencies have been charged with working closely together and are pushing forward all aspects of the science, technology and policy , with a high degree of integration.(www.dpri.kyoto-u.ac.jp and www.jma.go.jp)

By contrast climate change research ,in which there is a growing focus on predicting the magnitude and frequency of atmospheric and oceanic hazard-events (IPCC2007) , is well coordinated , and driven by the desire of scientists from every branch of natural and social science from meteorology and earth sciences to chemistry ,botany and economics , to make their contribution. Because of the great spatial variability of the phenomena and impacts of climate change (eg Dash & Hunt 2007), it is essential that every country of the world engages in research and education about its own situation.(Nature 2007)

There should be more research and education on natural disasters (with 70,000 lives lost globally per year, www.em-dat.net)and other environmental risks (such as air pollution more than 1million per year www.who.int) . These risks should surely have a comparable level of national and international focus, as the Kobe conference makes clear (eg ISDR 2005).

3. Integrating Practical Responses

The first task of response is for local organizations and experts to inform affected communities about the hazards and their consequences.(Fig2) Particularly in the 'global village' , information also has to be specific to local areas, with focused warnings about volcanoes or urban flood/ pollution/heat island risks, and also cover global climate change The experience of weather services is that only through its repetition is information taken seriously , which is the reason for publicizing annual statistics of rising global temperatures (see www.WMO.ch) ,casualties of natural disasters, and other impacts . Technology can help by using the universally available mobile phones (eg www.vodafone.com) such as in India where warnings are automatically translated onto 14 languages.. Street scale air pollution warnings to the mobile phones of individuals suffering from breathing difficulties are now provided in London (www.cerc.co.uk/YourAir, part of the GMES programme of ESA).In China, India and South Africa environmental information services connected to universities are growing fast (eg www.hku.hk, www.iitb.in and www.ukzn.ac.za) Cosmar is a network of agencies in the coastal zones of Africa that provided vital warnings of the tsunamis in 2004(www.nepadcosmar.org)

Scientifically based predictions and forecasts are becoming more accurate and leading to better warnings. For certain types of environmental hazard over limited periods from minutes up to a few months ,real time forecasts can be made in time to be useful and with an accuracy that is increasingly useful.

.These are usually based on computations of the hazard phenomena in the particular environment .The most accurate forecasts for atmospheric , ocean and rivers are based on computing mathematical models with thousands of computers operating in' parallel' with each other.(Hunt et al 2007). For example the track of tropical cyclones or major storms can now be predicted with an error of less than 130km for 24 hours (double that for 2 days etc).Also for earthquakes the sudden, rapid and localized jerking

movements of the tectonic plates followed by elastic waves propagating in the earth's crust at about 3000m/s, predictive models may already be useful for periods of a few seconds .With fast enough and prioritized communication systems earthquakes, the new Japanese system of very short period warnings of earthquakes could be used world wide to save many lives in transportation systems, hospitals and buildings (www.jma.go.jp)

For predicting the changes in the climate over the next hundreds of years ,for the entire atmosphere, ocean and land surface processes , similar computations based on the laws of physics and chemistry are used .,(eg Houghton J. 1994)

To help decisions governments , communities and business , forecasts about hazards need to go beyond their physical nature and should provide predictions about the social and economic impacts , which as already explained are highly dependent on the vulnerability of the communities affected.). (Kintisch 2005) For the predicting the impacts of changing environmental risk associated with global warming ,even more complex and controversial assumptions are needed about the interactions between the climate and the changing economy and society . (Stern 2006).

4. Impact reduction and adaptation

Turning to how the impacts of environmental hazards can be reduced , and also the adverse effects of changing climate , there are three main phases. First protective measures have to be taken before the hazards arrive ; second after major hazard events occur practical steps are taken to reduce the immediate and long term impacts on the affected communities , including protection against secondary hazards that often follow. Thirdly plans for the future , for example by improving resilience to deal with such events, or in extreme cases deciding to move communities to areas with lower environmental risks. .

Hazards associated with environmental change are increasing in frequency and intensity , such as higher temperatures ,more flash floods , and perhaps hurricane force winds (WMO 2006). New responses are needed.

One can differentiate between 'technical' policies that are based on a set of directed and separate responses from more 'sustainable' policies that are based on integrated , longer term and often indirect responses . Typically they involve changing the habits of communities , and may even involve accepting a higher level of environmental risk in future. These solutions ought to contribute towards the mitigation of global effects and also reducing the social inequality of local impacts. Fig1.

These two approaches lead to different policies for dealing with artificially high temperatures and high levels of air pollution that now occur in most of the largest urban areas, exacerbated by global warming (eg Pope et al 2007). 'Technical' solutions are being introduced ; such the use of new reflective materials on buildings and roads and the use of air conditioning to lower the temperature within buildings and vehicles. But the air conditioning ,which leads to high energy use and raises temperatures in the streets, could be replaced by more sustainable 'green' buildings and cooling systems. Japan is pursuing an even more sustainable policy; by allowing the temperatures to rise by about 5degrees the summer months and by adopting a cooler clothes style appropriate to the higher temperature , less energy is used in cooling public buildings .

Similar policy choices are being considered in dealing with flooding . Remarkable technical progress has been made with temporary structures that can protect cities against floods with only 24 hours warning (as in Prague) . But for the longer term buildings in flood plains may have to withstand flooding-a radical and uncomfortable departure in urban planning, but one which China has faced for many years already. (CABE 2007)

In developing countries government and community organizations have very limited resources for providing information and for dealing with environmental risks , even local hazards. Along the coasts of Africa and Asia many communities have become more vulnerable to hazards and are often unaware of the reasons.; cutting down mangrove trees for fuel exposes nearby villages to infestation from insects that formerly inhabited the mangrove forests.(Acops 2006) It also exposes the communities to damage from tsunami waves . (Fernando et al 2007;) Lives were lost following the tsunami in dec 2004 in areas where coastal protection had been damaged by the removal of coral reefs and sand dunes to provide cheap building materials

5. Hazard reduction and mitigation

Can we reduce natural hazards directly ? Over short periods increasing or decreasing precipitation by artificially seeding clouds may be possible.This continues to be part of the official programme of the World Meteorological Organisation (www.wmo.ch) The main focus of international efforts to reduce environmental risks are focused on the hazards associated with climate change caused primarily by emission of green house gases from industry ,agriculture and naturally . To prevent the rise in global average temperature from rising more than 2-2.5 deg will require a very substantial decrease in GHG emissions; the action will have to be taken in each country , but in total will have to reduce the emissions by more than 50% below present levels over the next 50 years and not grow any further. See fig1 .These enormous changes can only be achieved by applying a range of technologies and also social, political and economic organization (discussed below)

Some technologies are already demonstrating how energy use can be reduced (eg at least by 50% in many buildings), while others are focused on supplying energy without GHG emissions . Other adverse impacts on the environment have to be minimizedin all solutions (from nuclear waste , to construction materials ,to aesthetic impact of wind turbines). With the international consensus now emerging that every possible existing method is needed to provide carbon free energy over the next 50 years , there are many important and uncontroversial challenges for research . However research must also be taking a longer term and wider view by investigating methods that are not necessarily deemed to be practical or favoured at this time, as with fusion (www.mofa.go.jp/iter) or hybrid fusio-fission technology (IAEA 2006) .Government funding on energy research would need to rise to its former levels to enable new possibilities to be explored .

The even greater conceptual challenge for these programmes of mitigation is whether they can be integrated with programmes of adaptation and reduction of

environmental risk .This may be possible if the economic case for adaptation is accepted (see below).

6. Establishing policies and a philosophy for reducing environmental risk

It still needs stating that, because of its importance for the entire population, environmental risk is a responsibility for national governments as well as for industry and local communities. As recent events have shown ,when major hazards impact on governments which deny this responsibility, they have had to reverse their position.

Government roles are critical when policies on new types of environmental risk have to be established. This process is depicted schematically as a set of influence lines below the societal axis diagram in fig2 Since politicians and governments always want to hear about solutions when they are faced with problems, advice has to focus on how to reduce the impacts of the hazard and what can be done to eliminate or lessen the hazard itself . Dealing with climate change is proving considerably more difficult for governments than other types of environmental risk . In some of the countries emitting the largest volumes of ghg , both governments and legislators have still not accepted the need to make substantial cuts in emissions required to limit climate change , because they believe that this could be damaging to their economies .(www.globeinternational.org)

Recently the Stern report (2006) on the economics of climate change has reviewed this hypothesis in detail. The UK government agrees with its conclusions , which go well beyond the limited range of the Kyoto protocol, namely that investments are indeed required to reduce emissions and to reduce impacts of environmental change (i.e. adaptation) .This will cost of the order of 1-2% of GDP (for the whole world) over the next 20-30 years ,money which might otherwise be used for public programmes (eg health and education) or private consumption .Accepting the contrary view of Dasgupta(www.econ.cam.ac.uk) and Noordhaus (1962) ,that this expenditure should be delayed and passed on to later and richer generations, implies that current governments should neither be attempting to limit green house gases , nor to conserve species (which are under threat).This would be inconsistent with their obligations under the UN climate change and biodiversity treaties of 1992.

These big differences of opinion about economic and environmental strategy will have to be settled before the major countries of the world can agree about how to replace the Kyoto protocol before 2012.

The development of policies by government agencies about reducing hazards extends well beyond economics, and involves consultations with for example industry, local communities and research. Consultations are particularly important when governments are experiencing serious practical and political difficulties in meeting their objectives, which is now happening in all the countries which have accepted the need to make large reductions in emissions (by more than 50%) For example despite the achievement in Singapore and London in limiting the overall use of cars powered by fossil fuels other cities in Europe have baulked at this proposal , despite the additional benefits of. reduced air pollution. Architects and planners (Rogers 2002) while supporting these measures are also recommending that there should be a higher

density of housing in city centres with much less use of private cars , and possibly less need of unpopular restrictions

. Practical policies for mitigation and adaptation have often been initiated by local leaders with innovative pilot projects. This helps national politicians to make their environmental decisions through the usual loop process of information-consultation-pilot stage –policy -action.. which is shown schematically in fig2. Governments are also using new technology to learning about complex environmental risks and determine policy , for example affecting a whole city. In ' decision theatres' (Crow 2004;www.asu.edu/stardust) they can now explore the 'future' with interactive and overlapping displays based on data, maps, and back-up computations in real time.

Above all politicians rely on ideas to explain and promote important policies, especially when recommending that people should change the patterns of their lives , and even their ways of thinking , revolutionary steps that climate change will force on society.Politicians, commentators and academics engaged in public debate on this topic currently draw on various themes. Gore (2007) has made an educational film aimed at frightening the audience ; Lovelock (1979)introduced the idea of the Earth as a self correcting system-Gaia. But this does not work at the current levels of human interference with the system. . Brundtland (1987) introduced sustainability to the UN and many governments around the world.

Another message is needed ,if , as we have argued in this paper, integration is to be a central in policies for ensuring secure and effective reduction of environmental risks. This idea causes some Orwellian nervousness in politicians and officials who recall the clumsy use of power in Europe and the Americas by state and monopoly industries and the danger of erroneous policies following a party line. However in countries like India and China whose the rapid economic development has benefited from centralized planning and self sufficiency ,are in a strong position to adopt integrated solutions. It is significant that for the economically least developed countries , the UNDevelop Programme(www.undp.org) and the World Bank are now certainly promoting integration of their sustainable development projects . Academic communities , which tend to prize individual scholarship above all else, are only now beginning to develop multi and interdisciplinary centres of research and teaching (eg Lorenzoni et al 2005) .They may next move on to studying the merits of integrated solutions, based perhaps on research on integrated assessments of climate change policies.

If integration is to be a theme that politicians might take up again , perhaps it might resonate with most people's observations as well as their philosophical and religious convictions about the holistic nature of physical and living systems . (eg Bergson 1907, Smuts 1926,who was also a Prime Minister).Such an approach can be supported by current scientific understanding of the adaptive , protective and creative strengths of complex systems and societies, and how paradoxically they are reinforced by internal tensions between competition, cooperation and self interest(Bertalanffy 1968 who incidentally quotes another Premier ,E.C. Manning of Alberta,Canada). Effective and popular policies for dealing in an integrated way with environmental risks probably have similar characteristics .

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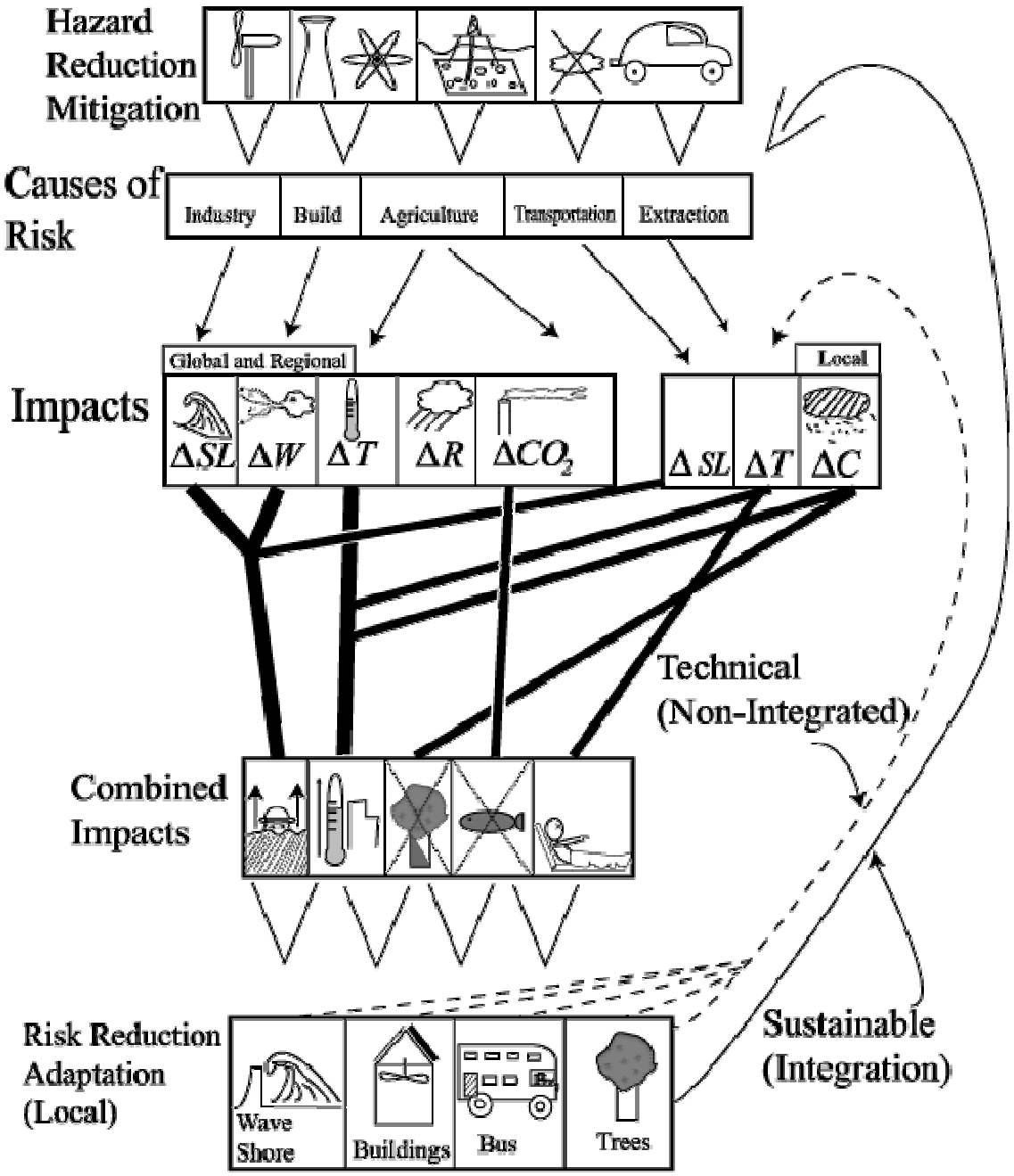

Figure 1: Integrated responses to environmental risk showing they are connected; Causes of risk have global and local impacts, leading to reductions and adaptations that are 'technical', which may add to the global hazards, or 'sustainable', which are complementary to the reduction and mitigation of hazard.

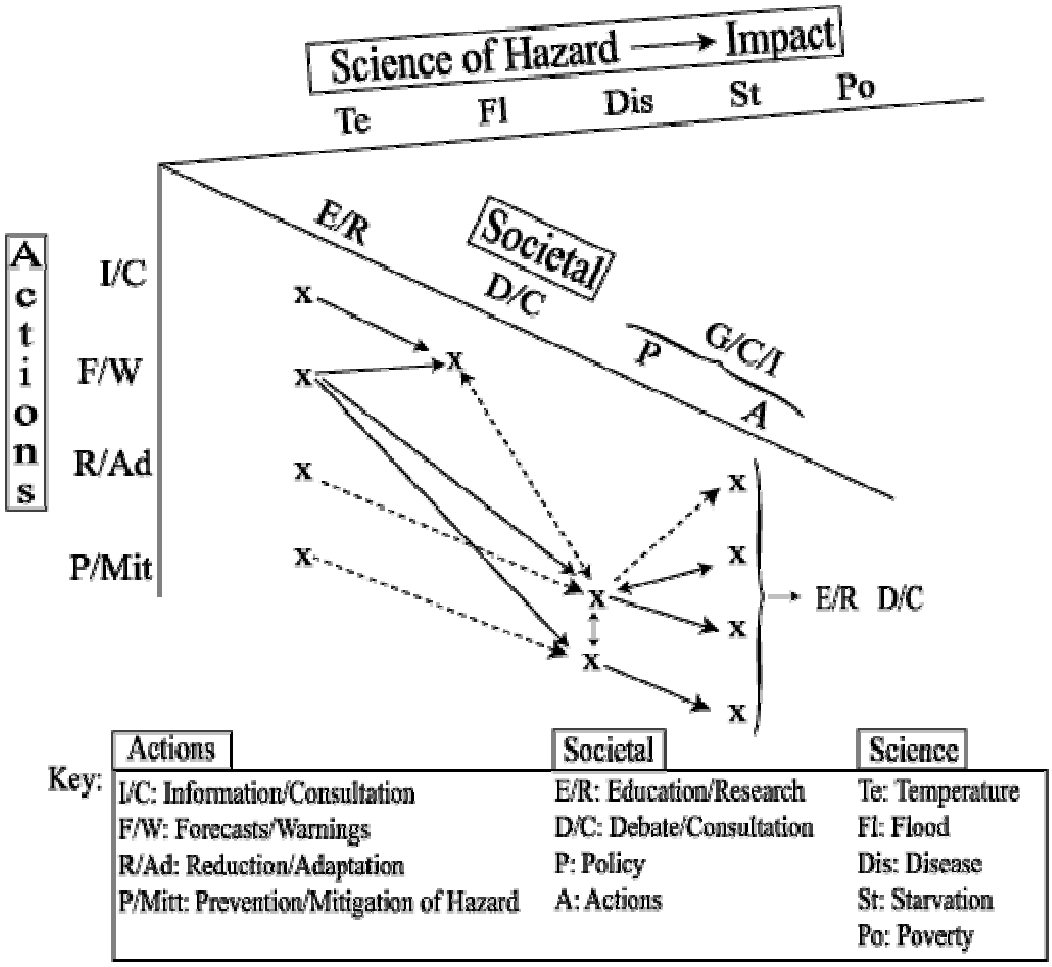

Figure 2: Three policy axes for dealing with environmental risk to show how the elements of societal engagement lead to policies for government, communities and industry; from education and research (E/R), to the debate and consultation (D/C), to policy (P) and action (A), followed by further iteration (E/R), (D/C) . . .