Background paper

Integrating socio-economic information in assessments of impact, vulnerability and adaptation to climate change

I. Introduction

A. Mandate

1. Activities under the Nairobi work programme on impacts, vulnerability and adaptation to climate change (Nairobi work programme) in the area of socio-economic information are undertaken in line with the objective in the annex to decision 2/CP.11 to advance subtheme a (v), "Promoting the availability of information on the socio-economic aspects of climate change and improving the integration of socio-economic information into impact and vulnerability assessments".

2. Activities in this area are envisioned to contribute to efforts by Parties and organizations, *inter alia*, to undertake stocktaking on what socio-economic information and approaches are available and in use, and what are the gaps and needs to ensure better integration of socio-economic information into impact and vulnerability assessments.

3. The Subsidiary Body on Scientific and Technological Advice (SBSTA), at its twenty-fifth session, requested the secretariat to organize, under the guidance of the Chair of the SBSTA, an expert meeting, before its twenty-eighth session, on ways and means to improve the integration of socio-economic information into impact and vulnerability assessments, including as they relate to adaptation planning.

B. Purpose and scope of the background paper

4. The purpose of this background paper is to facilitate the discussion on ways and means to enhance the availability and integration of socio-economic information into impact and vulnerability assessments, and subsequently adaptation planning.[1]

5. Following the mandate in the annex to decision 2/CP.11, and the subsequent request by the SBSTA,[2] this document provides an overview of existing approaches with respect to the use of socio-economic information in assessments of climate change impacts and vulnerability, and in adaptation planning, as well as information on the development of socio-economic scenarios and estimates of costs and benefits. It identifies needs and barriers and concludes by raising questions and issues to be discussed at the expert meeting.

6. The paper draws on information submitted by Parties and organizations, as well as relevant information included in Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC), in National Communications and National Adaptation Programmes of Action (NAPAs), as well as other sources (as referenced).

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[1] The IPCC Third Assessment Report provides the following working definitions for impacts, vulnerability, adaptation and adaptive capacity:

- Impacts are the effects of climate change on natural and human systems.
- Vulnerability is the degree to which a system is susceptible to, and unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate change and variation to which a system is exposed, its sensitivity, and its adaptive capacity.
- Adaptation is an adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities. Various types of adaptation can be distinguished, including anticipatory, autonomous and planned adaptation.
- Adaptive capacity is the ability of a system to adjust to climate change (including climate variability and extremes) to moderate potential damages, to take advantage of opportunities, or to cope with the consequences.

[2] Document FCCC/SBSTA/2006/11, paragraphs 51-53; available on <www.unfccc.int>.

7. Submissions were received from seven Parties, two intergovernmental and two non-governmental organizations. The Parties were Australia, Jamaica, Japan, Mexico, Portugal on behalf of the European Community and its Member States, the United States of America and Uzbekistan. The intergovernmental organizations were the Secretariats of the United Nations International Strategy for Disaster Reduction (ISDR) and the Intergovernmental Panel on Climate Change (IPCC). The NGO submissions were from the International Research Institute for Climate and Society (IRI) and SustainUS.

C. Key concepts and framework

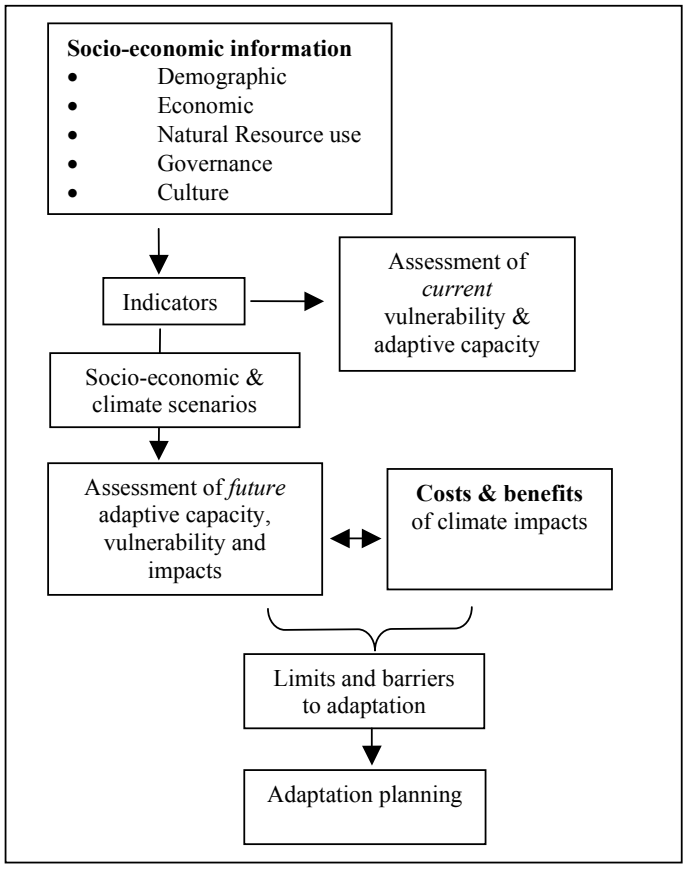
8. There are two main approaches for impact and vulnerability assessment: the 'top-down' and the 'bottom-up' approach. These two terms indicate differences in viewpoints, purpose and informational requirements. Broadly speaking, top-down assessments are geared toward assessing long-term future impacts, whereas bottom-up assessments address localized vulnerabilities and dynamics.

9. The most commonly applied assessment approach in the climate change community has been the impact approach, developed by the IPCC (1994). It has been described as top-down because it employs scenarios downscaled from general circulation models (GCMs) to the national and sub-national scale, aiming to determine the likely impacts of climate change under alternative future scenarios. Impacts assessments take an aggregated view of the subject of study. They tend to be quantitative and provide scenarios of future climate impacts for an entire country or region using GCM. Projections derived from GCMs are usually combined with biophysical analyses and socio-economic scenarios in order to assess sector-specific impacts. Spatial and temporal differences are often averaged out and trend curves are generally smooth, so that short-term changes, threshold effects, and localized costs are not easily identified. Undertaken in isolation, top-down impacts assessments may be disconnected from reality and fail to reach stakeholders, as there may be too much uncertainty with regard to the local impacts of climate change. In short, top-down approaches make strong use of biophysical aspects of climate impacts and aggregate socio-economic data and are often excellent at problem/issue scoping and first line questions, but they do not fare well in capturing human interaction and local abilities to adapt.

10. Bottom-up approaches, on the other hand, focus on the local level, the community, specific circumstances and short-term effects. They tend to be qualitative and place-based and they employ participatory approaches extensively. Vulnerability assessments gather information on a wide range of socio-economic issues that reflect exposure and vulnerability, as well as local options, coping strategies and adaptive capacities. They can assess the vulnerability of a system, such as a region or population group, to a range of existing or hypothetical hazards based on an analysis of the factors that determine how the system is likely to be affected should it be faced with the hazards in question.

The severity of climate change impacts depends not only on the nature of climate hazards and the resilience of natural ecosystems, but also on factors such as the degree of socio-economic development, social inequalities, human adaptive capacities, health status and health services, demographic characteristics, economic livelihood alternatives, etc. Therefore, socio-economic information is an integral part of assessing impacts and vulnerability to climate change, as well as in adaptation planning. Socio-economic information can highlight the differential exposure to climate threats of regions, countries, locales and communities with different socio-economic endowments. It is also a crucial ingredient for any assessment of vulnerabilities and adaptive capacities of different economic sectors and communities and for understanding how they will be affected by climate change, with the aim of taking appropriate adaptation actions. For example: subsistence farmers in drought prone regions may be ill-prepared to cope with prolonged spells of drought but have abilities to cope through off-farm employment, and family and network supports; whereas market-oriented farmers are usually wealthier and can thus afford more expensive deep-well pumps but may be ill-prepared to cope with market changes such as sudden price drops. Residents in urban neighbourhoods that are well served by public utilities and health facilities, or have additional economic and technical resources, are better set to deal with weather extremes (except, perhaps, heat waves) than people residing in poor and informal settlement areas (de Sherbinin, et al, 2007). Few societies are bereft of adaptive capacity, and al societies may be vulnerable to large or sudden changes.

Figure 1



11. In the context of impact and vulnerability assessments (including adaptation planning), the demand for socio-economic information is wide-ranging, and includes economic and demographic data, such as GDP and population distribution, analyses of land use and land-use changes, as well as estimates of costs and benefits, direct and indirect, of climate impacts and policy measures. Other socio-economic factors that are somewhat less tangible yet equally important in assessing impacts, vulnerabilities and adaptation policies are human and social capital, institutional capacity, governance structures as well as cultural factors, such as traditional norms of reciprocity and cooperation. Figure 1 above, expanding on the work by Malone and La Rovere (2005), gives an illustration of the main types of socio-economic information and how it can be used in assessing vulnerability, impacts and adaptation.

II. Socio-economic information in impact and vulnerability assessments

12. Socio-economic information is operationalised in impact and vulnerability assessments mainly through the construction of indicators (Figure 1). These indicators aim to describe socio-economic conditions in the case of impacts assessments and to highlight drivers and determinants of vulnerability and adaptive capacity. As a guiding principle, selection of indicators should fulfill three criteria: (1) summarize, quantify and simplify relevant information, (2) capture phenomena of interest; and (3) communicate relevant information (UNDP, 2005).

A. Impacts assessments

13. In recognition of the fact that the impacts of future climate change will occur in the context of an evolving socio-economic baseline, impacts assessments have increasingly made use of socio-economic scenarios, which in turn employ socio-economic indicators. To construct quantitative scenarios of the future relevant to climate impacts assessments, analysts select relevant proxies, collect or locate appropriate data, and estimate future values for those proxies. The need for quantitative indicators results in the majority of impacts assessments focusing on a limited number of variables, which lend themselves to quantification. Moreover, as time and resources are usually in scarce supply, impacts assessments tend to focus on key sectors that are of special economic importance or are particularly vulnerable (Figure 2).

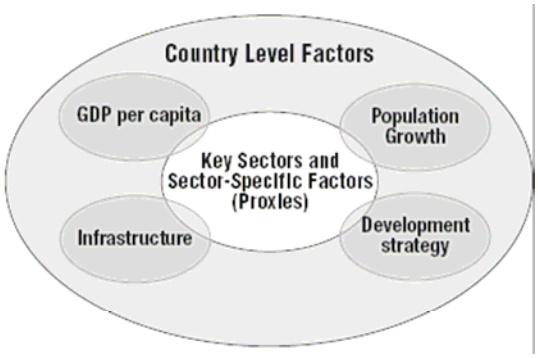


Figure 2. (Malone and La Rovere, 2005)

14. The first step in developing socio-economic scenarios is the formulation of alternative storylines, which are qualitative and internally consistent narratives of how the future may evolve. They describe the principal trends in socio-political-economic drivers of change and the relationships between these drivers. IPCC's *Special Report on Emission Scenarios* (SRES) has developed four such storylines on a global scale. SRES uses socio-economic information in the form of quantitative assumptions on population, gross domestic product (GDP), land use and different types of energy use, and rates of technological progress. These data are available in a highly aggregate form, consisting of four world regions: OECD-1990, Reforming Economies, Africa & Latin America & Middle East, and Asia (Carter et al., 2007). However, connections between the storylines and quantitative scenarios have not been fully thought out or developed in tandem (Clarke et al. 2007).

15. Once the relevant indicators for a socio-economic scenario have been selected, the next step is to calculate possible future trajectories of their value. This is done by first estimating future trends of certain key socio-economic variables and relating these variables to indicators, or estimate changes in other variables that can be used to estimate changes in indicators. These key socio-economic variables are usually population growth and GDP growth. In the SRES scenarios, for instance, these are the variables used because of data availability, although each has serious drawbacks as representing human well-being.

16. To date, many of the socio-economic scenarios used in impacts assessments have taken the scenarios developed by the IPCC SRES as a basis for developing storylines and quantitative scenarios at national and sub-national levels. Methods for downscaling quantitative socio-economic information have focused on GDP and population growth, mostly adjusting the values on these two variables estimated by the SRES. Recent downscaling methods have done away with earlier unrealistic assumption that rates of population change are uniform over an entire world region (Gaffin et al., 2004). Instead, they account for differing demographic conditions and prospects at the national level (van Vuuren et al., 2007). Other recent methods of downscaling to the sub-national level employ simple rules for preferential growth in coastal areas and urban areas (Nicholls, 2004), by extrapolating recent trends at the local level and by using algorithms (Carter et al., 2007; Reginster and Rounsevell, 2006). Few population scenarios, however, take into account the impact that changing climatic regimes or sea-level rise will have on future population distributions, an area in need of further work (Adamo and de Sherbinin, forthcoming).

17. The United Kingdom's Climate Impacts Programme (UKCIP) provides some of the most comprehensive socio-economic scenarios for use in impacts assessment at the national and sub-national level. Although not based on the SRES, the storylines developed followed a similar logic by analyzing future socio-economic conditions along four dimensions of governance and political and social values. Groups of indicators were selected to describe each of the following categories/sectors: economic development, planning and built environment, agriculture, water, biodiversity and coastal zone management.

18. Socio-economic scenarios have been developed by a number of other countries, as mentioned in the submissions by the Parties, including Australia, Japan, Mexico and several European Union countries. The use of scenarios for sectoral impacts assessment is the main approach for all of these countries, focusing on sectors that are of particular importance to each country.

19. The United States' submission outlined the activities undertaken by some of its agencies/programmes. The Climate Change Science Programme (CCSP) uses socio-economic aspects to model emissions pathways and costs of stabilization. Socio-economic research examines a wide range of potential impacts on societal needs such as water and agriculture, as well as potential impacts on human health. The National Oceanic and Atmospheric Administration (NOAA) conducts its research through programmes such as the Sectoral Applications Research Program (SARP). SARP considers social, economic, health, and welfare effects of changing climatic conditions for specified sectors, defined by resources (such as coastal or water resources, forests, or agricultural lands) or by decision domains (such as emergency management or urban planning). The aim is to "integrate the complex array of socio-economic issues influenced by climate and develop linkages with specific decision makers and partners".

B. Economic estimates of climate impacts

20. Impact assessments make use of socio-economic information also in the form of economic estimates of climate impacts. Monetization of climate impacts is crucial as it enables comparison of impacts across sectors, regions and timescales, thereby facilitating decision-making with respect to allocating funds for appropriate responses. Money is indeed the most commonly used quantitative metric for climate impacts, usually expressed in welfare changes, income or revenue losses (Nordhaus and Boyer, 2000), costs of adapting to certain impacts such as sea-level rise (Nicholls et al., 2005, Stern, 2006), and estimates of people's willingness to pay to avoid certain climate impacts (Li et al., 2004). There are also numerous studies of the social cost of carbon but it is beyond the remit of this paper to review their findings.

C. Vulnerability assessments

21. Methods of vulnerability assessment have been developed in the fields of natural hazards, poverty analysis, food security and sustainable livelihoods. Vulnerability assessments examine the underlying socio-economic, institutional, and, to a lesser extent, political and cultural factors, that determine how people cope with climate hazards.

22. Like impact assessments, vulnerability assessments make use of indicators. Downing et al. (2001) state that vulnerability indicators can help identify and target vulnerable regions, sectors or populations, raise awareness, and be part of a monitoring strategy. Adger et al. (2004) distinguish between generic and specific vulnerability indicators. Factors such as poverty and inequality can be seen as indicators representing generic vulnerability and adaptive capacity, i.e. as factors that determine vulnerability and the capacity to adapt to a wide range of hazards. Specific indicators, on the other hand, relate to particular types of hazard as they occur in specific local contexts: for example, where tropical storms represent the principal climate hazard, one measure of vulnerability might be the availability of storm shelters (Adger et al., 2004). Brooks et al. (2004) offer a list of potential proxy indicators of vulnerability to climate change at the national level, including health, governance and technology indicators.

23. Assessments of vulnerability may be carried out without a detailed knowledge of how climate will vary over time and therefore, unlike impacts assessments, they do not require detailed climate information generated by models. In this sense, socio-economic information employed by the disaster risk management (DRM) community in studies of climate hazards, can provide valuable input to vulnerability assessments. ISDR's submission lists reports, online resources, national agencies and global initiatives in the field of DRM that make use of socio-economic information. This information can be of use to the climate change community as it helps highlight populations, sectors and communities at risk from climate-related disasters similar in nature to the disasters studied by ISDR. Socio-economic information in the DRM sector is used mainly for the construction of risk indicators and the economic estimation of disaster losses.

24. The Americas programme by the Inter-American Development Bank has produced four indices that describe individual components of national disaster risk and applied them to 12 countries in the Americas. The Disaster Deficit Index examined financial exposure and gaps in capacity to finance disaster losses. The Local Disaster Index describes the national accumulation of disaster risk from locally and nationally recognized events and can indicate uneven geographies of development and disaster risk through the spatial concentration of losses. The Prevalent Vulnerability Index calculates socio-economic vulnerability at the national level while the Risk Management Index measures DRM performance using the self-evaluation of national experts.

25. It should be noted that the use of quantitative indicators is not universal in vulnerability assessments. This is especially the case for assessments analyzing local vulnerabilities, coping capacities and strategies of different communities or demographic groups. Instead, these approaches to vulnerability assessment make extensive use of information generated by participatory methods of stakeholder consultation, and by drawing on local and traditional knowledge.

26. The USAID Global Climate Change Adaptation Program is the only initiative identified in the submissions that adopts such an approach to assessing vulnerabilities. It uses socio-economic information, within a general livelihoods framework, to understand adaptive capacity in targeted communities. Information on livelihoods is gathered through surveys and remotely sensed data in order to assess food insecurity and vulnerability to famine.

Essentially, livelihoods analysis offers a tool for exploring what types of internal adaptations and external intervention opportunities are available to achieve food and livelihood security.

27. A study identified in ISDR's submission follows a similar approach. *Working with Women at Risk: Practical Guidelines for Assessing Local Disaster Risk* by the International Hurricane Center of the Florida International University presents a new way of studying community capacity and vulnerability in the face of hazards and disasters by collaborating with grassroots women's groups to develop and test a research model based on the expertise of local women. Data are collected by local women through the use of questionnaires. The final output is a Community Vulnerability Profile which focuses on social vulnerabilities and capacities and highlights the factors that increase risk for girls and women.

28. UNFCCC's National Adaptation Programmes of Actions (NAPAs) aim to help least developed countries identify urgent adaptation needs and priorities through the use of participatory assessments of vulnerability. They constitute a bottom-up approach in that they rely on community-level input as an important source of information, recognizing that grassroots communities are the main stakeholders. Although they are not intended to produce any new socio-economic information, they draw on traditional knowledge and local coping strategies, as well as any previous assessments that may have already been undertaken in the country.

D. Socio-economic information and adaptation planning

29. Once key vulnerabilities and future climate impacts have been identified and analyzed, adaptation measures need to be designed and assessed. In this sense, any socio-economic information that is relevant for impact and vulnerability assessments can be effective in the design of adaptation measures. Particularly important for any assessment of different adaptation options are reliable estimates of the associated economic costs and benefits. Costs include direct financial outlays, implementation costs and social costs, such as market distortions and other external effects (Niang-Diop and Bosch, 2005). In the literature, adaptation costs are usually expressed in monetary terms, while benefits are typically quantified in terms of avoided climate impacts.

30. For any adaptation option to be viable, however, information is needed on factors other than economic estimates of direct and indirect costs and benefits. Limits and barriers to adaptation need to be taken into account, as adaptation policies cannot be pursued in a vacuum but depend on and are influenced by factors that may render them ineffective. For example, the intended beneficiaries of adaptation policies may not respond well to proposed policies and incentives, due to financial and institutional constraints, informational and cognitive barriers, as well as social and cultural hurdles (Adger et al. 2007). These potential hindrances need to be identified and taken into account in the adaptation planning process.

E. Dissemination of socio-economic information

31. Currently, there are few entities that focus on disseminating socio-economic information, tailor-made for use in impact, vulnerability and adaptation assessments. The IPCC reports on the role of the Data Distribution Centre, established by the Task Group on Data and Scenario Support for Impact and Climate Analysis (TGICA) to facilitate the distribution of up-to-date climate and socio-economic scenarios for use in impact, vulnerability and adaptation assessments. TGICA has published Guidelines on the Use of Scenario Data for Climate Impact and Adaptation Assessment[3] in order to provide user

[3] http://www.ipcc-data.org.

support and to improve consistency in the selection, interpretation, and application of scenarios.

32. A few online resources by the DRM community offer access to socio-economic information in the form of GIS (Geographic Information System) maps. These are the Preview project[4], the SAHIM GIS Library[5] and the GEO Data Portal[6]. These websites enable the viewing of socio-economic data, such as population, GDP and the Human Development Index, in combination with environmental and natural disaster data in various formats such as GIS maps and graphs. Beyond these DRM web portals, global-scale spatial data on poverty, population, hazards, health, and sustainability can be accessed through the World Data Center on Human Interactions in the Environment.[7]

33. Useful socio-economic information on vulnerability and coping strategies is contained in the National Communications and NAPA documents submitted to the UNFCCC by Parties, as well as in the UNFCCC's Local Coping Strategies Database. This database is intended to facilitate the transfer of long-standing coping strategies and mechanisms, knowledge and experience, from communities with prior experience of adapting to specific hazards or climatic conditions, to communities that may just be starting to experience such conditions.

III. Gaps, barriers and issues for discussion

A. Gaps and barriers

34. Socio-economic information still lags behind biophysical and climate information in terms of quality, availability and accessibility. A major constraint, as identified in submissions by Parties and organizations, is the lack of sufficient and spatially detailed socio-economic information in order to understand vulnerability at the subnational level.

35. Although various social data sets exist, they are not generally available in the spatial forms that are necessary for localized assessment of impacts, vulnerability and adaptation – the same issues that modelers of climate and other biophysical data face. As noted in the submission by the United States, more work is needed to generate data sets that include both climate-related human and environmental data at the same spatial and temporal resolution. This would improve the accuracy of model projections. Moreover, downscaled socio-economic data are still scarce and of doubtful quality. For instance, information on future GDP and population distribution, even when downscaled to the national level, does not suffice to address the multidimensional aspects of impacts and vulnerability to climate threats, which call for a multitude of socio-economic indicators on a more spatially detailed level. The downscaling methodologies themselves are not problem-free as they are based on somewhat simplistic assumptions that may lead to unrealistic estimates. As a result, socio-economic scenarios cannot easily assess future impacts and vulnerability at the local level and across different social groups and sectors.

36. An issue brought up in some of the submissions pertains to the quality and breadth of estimates of costs and benefits used in impact and adaptation assessments. In the case of impacts assessment it was noted that the focus has been mainly on estimation of market-driven effects, while non-market effects, such as damages to health and the environment have been neglected. In addition, "second round", socially contingent impacts such as social and political instability have not been quantified. This is due to the lack of a commonly agreed-upon methodology on how to value non-market impacts that subsequently leads to doubts

[4] http://preview-risk.web.cern.ch/preview-risk/preview.aspx.

[5] http://www.sahims.net/gis/GIS%20input/GIS_library_Zimbabwe.asp.

[6] http://geodata.grid.unep.ch.

[7] http://sedac.ciesin.columbia.edu/wdc.

over the reliability of such estimates. Moreover, non-market valuation is context specific, a value assigned to, for example, a certain environmental or natural resource cannot be easily applied to a resource of similar nature but in a different geographic and social context.

37. The submission from Portugal mentions that assessments of adaptation planning often rely on optimistic assumptions, while ignoring transition costs associated with poor adaptive capacity due to poverty, cultural barriers, behavioral lock-in, etc. This, in conjunction with the shortcomings in measuring economic costs of climate impacts, may lead to insufficient or inappropriate adaptation policies by underestimating the costs of climate change and overselling the potential of specific adaptation measures.

38. Capacity constraints also feature high on the list of limitations to utilizing socio-economic information. This is especially true for developing countries, such as small island developing States and least developed countries (LDCs). Currently, the expertise required to generate and/or manage the available data is lacking in many countries.

39. Another problem highlighted in the submissions is the applicability and usefulness of socio-economic information in decision-making. That is, even when socio-economic information is available, it may not be in a form that can be readily understood by decision makers, and there is no guarantee that it will be taken into account in decision-making. It will be important to disseminate "best" practices in information for decision-making and in transparency and accountability (see for example Petrovka, 2002). The point has been made elsewhere that if the same top-down paradigm is used in climate change adaptation as has been prevalent in the development processes over the past half-century, then the world has little reason to expect more equitable or beneficial results for the intended targets of these interventions (PERN, 2007, Satterthwaite et al., 2007).

B. Potential issues for discussion

40. The following questions and associated issues for possible consideration are designed to help identify ways of overcoming the aforementioned gaps and barriers and improving the availability and integration of socio-economic information in impact and vulnerability assessments, and adaptation planning.

41. **What can be done to enhance the use of existing socio-economic information in impact and vulnerability assessments?**

> Ways to facilitate the use of socio-economic information into impact and vulnerability assessments include capacity building in the collection and processing of data, sharing of information through the creation of relevant databases, and demonstration of best practice approaches. For example, Australia proposed the inclusion of relevant information in the Greenhouse Gas Data Interface for sharing with other Parties. Models and good practices in the area of information use and accountability in development decision-making should be evaluated and disseminated.

42. **How can socio-economic information be tailored to suit the needs of decision makers?**

> Participation and consultation of end users needs to be strengthened in order to ensure information is straightforward, standardized, and comprehensible by decision makers.

43. **What further socio-economic information is required?**

As adaptation often takes place at the local level, decision-making needs to make use of more disaggregated, localized socio-economic information. Better downscaling techniques can go some way to fulfilling this need. However, what is really needed is to generate a more extensive set of socio-economic indicators that can not only identify a broader range of vulnerabilities at the local level, but can also be used in scenario development.

Work is also needed to identify what socio-economic data and information is needed for local versus national assessments, vulnerability versus impact assessment and for adaptation planning. In addition, there is a need to identify the types of information on governance and public policy that could be generated and used for vulnerability and adaptation assessments.

44. **What can be done to enhance the appropriateness and compatibility of socio-economic information employed by the DRM community?**

Currently, a lot of the socio-economic information used in climate change impact and vulnerability assessments is borrowed from the field of DRM, which deals with current and past climatic phenomena. Closer collaboration is needed between the DRM and climate change communities in order to use the current data and assess and address potential shortcomings with this data.

45. **What can be done to improve the quality and availability of economic estimates of climate impacts?**

Estimates of costs and benefits of non-market climate impacts are not well integrated in impact, vulnerability and adaptation assessments. Reasons include uncertainties, dubious quality, and insufficient and/or scattered information. Options include promoting, through funding, further research in this field in order to expand the knowledge base; creating a compendium of economic estimates of non-market impacts; and identifying best practices and the potential for benefits-transfer, i.e. transfer economic estimates from one setting to another.

46. **What geospatial data integration techniques are most useful in assessing vulnerabilities, and what novel data sources might be used?**

Most socioeconomic data traditionally come from surveys and censuses, or, in the case of participatory techniques, from communities themselves. However, as satellite technology advances, there are potentially exciting ways to derive socioeconomic information, such as income (from night-time lights), housing type, health risks (garbage tips or water bodies), etc., from remote sensing imagery. In addition, data on socioeconomic and biophysical parameters can be integrated in a GIS to generate new information and understanding that is of use in adaptation planning.

47. **Is it feasible to develop universal indicators or should they be developed for various income groups or types of locations or based on sectors at risk?**

48. **Can we come up with policy indicators that would help with vulnerability and adaptation assessments.**

IV. References

Adamo, S.B., and A de Sherbinin (forthcoming), The Impact of Climate Change on the Spatial Distribution of Populations and Migration. Report prepared for the Population Division of the United Nations Department of Economic and Social Affairs.

Adger, W.N., N. Brooks, G. Bentham, A, Agnew, and S. Eriksen (2004), New Indicators of Vulnerability and Adaptive Capacity, *Technical Report 7*, Tyndal Centre for Climate Change Research.

Adger, W.N., S. Agrawala, M.M.Q. Mirza, C. Conde, K. O'Brien, J. Pulhin, R. Pulwarty, B. Smit and K. Takahashi, (2007), Assessment of adaptation practices, options, constraints and capacity. *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change,* M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds., pp.717-743, Cambridge University Press, Cambridge, UK.

Brooks, N., W.N. Adger, and P.M. Kelly, (2004), The determinants of vulnerability and adaptive capacity at the national level and the implications for adaptation, *Global Environmental Change*, 15, 151-163.

Carter, T.R., R.N. Jones, X. Lu, S. Bhadwal, C. Conde, L.O. Mearns, B.C. O'Neill, M.D.A. Rounsevell, and M.B. Zurek (2007), New Assessment Methods and the Characterization of Future Conditions. *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change,* M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds., pp.133-171, Cambridge University Press, Cambridge, UK.

Clarke, L., J. Edmonds, H. Jacoby, H. Pitcher, J. Reilly, and R. Richels (2007), *Climate Change Science Program Synthesis and Assessment Product 2.1, Part A: Scenarios of Greenhouse Gas Emissions and Atmospheric Concentrations*. U.S. Government Printing Office, Washington, DC.

de Sherbinin, A., A. Schiller, and A. Pulsipher (2007), The vulnerability of global cities to climate hazards. *Environ. Urban.*, 12, pp.93-102.

Downing, T.E. et al. (2001), Vulnerability indices: Climate change impacts and adaptation. *Policy Series, 3*, Nairobi: UNEP.

Gaffin, S.R., C. Rosenzweig, X. Xing and G. Yetman (2004), Downscaling and geospatial gridding of socio-economic projections from the IPCC Special Report on Emissions Scenarios (SRES). *Global Environnemental Change*, 14, pp.105-123.

IPCC (1994), *Technical Guidelines for Assessing Climate Change Impacts and Adaptations with a Summary for Policy Makers and a Technical Summary,* Department of Geography, University College London, United Kingdom, and the Center for Global Environmental Research, National Institute for Environmental Studies, Japan.

Li, H., R.P. Berrens, A.K. Bohara, H.C. Jenkins-Smith, C.L. Silva and D.L. Weimer (2004), Would developing country commitments affect US households' support for a modified Kyoto Protocol? *Ecological Economics*, 48, pp. 329-343.

Malone, E.L. and E.L. La Rovere, (2005), Assessing current and changing socio-economic conditions. *Adaptation Policy Frameworks for Climate Change: Developing Strategies,*

Policies and Measures, B. Lim, E. Spanger-Siegfried, I. Burton, E. Malone and S. Huq, Eds. pp. 145-163 Cambridge University Press, Cambridge and New York.

Nordhaus, W.D. and Boyer, J., (2000) *Warming the world: economic models of global warming,* MIT Press, Cambridge MA

Nicholls, R.J., Hansen, S.E., Lowe, J., Vaughan, D.A., Lenton, T., Ganopolski, A., Tol, R.S.A. and Vafeidis, A.T., (2006), *Metrics for assessing the economic benefits of climate change policies: sea level rise*, Organization for Economic Co-operation and Development

Niang-Diop, I, and Bosch, H, (2005), Formulating an Adaptation Strategy, *Adaptation Policy Frameworks for Climate Change: Developing Strategies, Policies and Measures*, B. Lim, E. Spanger-Siegfried, I. Burton, E.Malone and S. Huq, Eds. pp. 183-204, Cambridge University Press, Cambridge and New York

PERN (Population-Environment Research Network) (2007), Cyber seminar on Population and Natural Hazards, 5-19 November 2007. Available at <http://www.populationenvironmentresearch.org/seminars.jsp> (accessed 21 Feb 2008).

Petrovka, E., C. Maurer, N. Henninger, and F. Irwin (2007), *Closing the Gap: Information, Participation, and Justice in Decision-making for the Environment*, Washington, DC: World Resources Institute.

Satterthwaite, D., S. Huq, H. Reid, M. Pelling, and P. Romero Lankao (2007), Adapting to climate change in urban areas: the possibilities and constraints in low- and middle-income nations. *IIED Human Settlements Discussion Paper Series, Climate Change and Cities 1.*

Reginster, I. and M.D.A. Rounsevell (2006), Future scenarios of urban land use in Europe. *Environmental Planning,* 33, pp. 619-636.

Stern, N. (2006), *The Economics of Climate Change: The Stern Review*. Cambridge, UK: Cambridge University Press. Available at <http://www.hm-treasury.gov.uk/ independent_reviews/stern_review_economics_climate_change/stern_review_report.cfm> (accessed 29 Jan 2008)

UNDP, (2005), *Adaptation Policy Frameworks for Climate Change: Developing Strategies, Policies and Measures*. B. Lim, E. Spanger-Siegfried, I. Burton, E. Malone and S. Huq, Eds., Cambridge University Press, Cambridge and New York.

van Vuuren, D.P., P. Lucas and H. Hilderink, 2007: Downscaling drivers of global environmental change scenarios: enabling use of the IPCC SRES scenarios at the national and grid level, *Global Environmental Change*, 17, pp114-130.