Resource Material in a Nutshell

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Climate Change is one of the most pervading issues in contemporary environmental studies- there isn't a single element of society or ecology that it does not adversely impact. The nature, quality and quantity of water resources are hugely affected by changing climatic conditions, and this is the recurring theme, that runs throughout the compendium. The document also consist of papers dealing with sea level changes, how coastal lands are affected, and climate change effects on flood and drought prone lands. Climate change also has a profound implication on the social aspect of human lives, the nature of people's health issues and how they get affected has changed drastically, as has food and water security. Climate change also has direct relationship with poverty and other socio-economic indicators such as education. One of the sections in the compendium analyses how climate change specially affects minorities such as women and tribals, whose lifestyles and gender and biological roles make them more vulnerable to climate change than others. There are also some geographic characteristics that make a certain place more vulnerable than others, the section on measuring vulnerability and risk to climate change captures some of these location specific vulnerabilities and how they are determined. Adaptation and mitigation- in that order of priority are experiences that need to be shared among different nations, and this section provides an overview of how the world is adapting to climate change with a special focus on people living in hilly regions and urban areas in developing nations. Responses to Climate Change are multifaceted and come from governments, civil society and industry, and the last section is dedicated to this. One of the features of the compendium is that it strives to focus on climate change and related issues that are South Asia specific.

Module 1: Climate Change and Water Linkages

1.1 Climate Change and Water

The document is based on the findings of the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. The paper is focussed on freshwater, and how it is impacted by the climate change phenomenon. Globally, freshwater resources will face negative changes because of changing climate. The percentage of land affected by water stress will double by 2050. Decrease in water quality and quantity will have an adverse effect on food security and on agriculture, as a whole. This document addresses the mitigation efforts that can be taken and what gaps of knowledge exist in this sector.

Reference: Bates, Bryson, Zbigniew W. Kundzewicz, Shaohong Wu and Jean Palutikof (eds). 2008. 'Climate Change and Water'. Intergovernmental Panel on Climate Change (IPCC) Technical Paper VI. Geneva: IPCC. Available online at http://www.ipcc.ch/pdf/technical-papers/climate-change-water-en.pdf (accessed in October 2011).

1.2 Water Resources and Climate Change: An Indian Perspective

This paper explores the effect climate change has on water resources in India. The availability of freshwater is likely to be impacted. Apart from climate change, the other factors that affect water resources are rapid urbanisation, industrialisation, population increase and economic changes. The hydrological cycle in rivers and basins in India are undergoing a massive change because of cropping patterns, land use methods and changing water storage methods. Water resources should be critically analysed, keeping in mind national and local requirements and taking into account climate change factors. This article provides an overview of the potential for sustainable development of surface and groundwater and traces potential research needs in India.

Reference: Mall, R. K., Akhilesh Gupta, Ranjeet Singh, R. S. Singh and L. S. Rathore. 2006. 'Water Resources and Climate Change: An Indian Perspective', *Current Science*, Vol. 90, No. 12, pp. 1610-1626. Available online at http://jpkc.swu.edu.cn/data/gjzrzygl/web%20prepare20110608/paper/Water%20Climate%20Change%20India.pdf (accessed in October 2011).

1.3 Summary for Policy Makers

This document lists out the key policy findings of the Fourth Assessment of the Intergovernmental Panel on Climate Change. It elaborates on the impacts of climate change of human, natural and managed systems. It also analyses their capacity to adapt and their vulnerability. Specific information is given on the impact of systems like freshwater resources, ecosystems, food, fibre and forest products, coastal systems and Health. Region specific information is also given, viz, Africa, South Asia, Europe, Latin America, Australia and New Zealand and small islands.

Reference: IPCC (Intergovernmental Panel on Climate Change). 2007. 'Summary for Policy Makers', in M. L. Parry, O. F. Canziani, J. P. Palutikof, P. J. van der Linden and C. E. Hanson (eds), *Climate Change 2007: Impacts, Adaptation and Vulnerability, Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, pp. 7-22. Cambridge: Cambridge University Press. Available online at http://www.ipcc.ch/pdf/assessment-report/ar4/wg2/ar4-wg2-spm.pdf (accessed in October 2011).

1.3 Climate Change and Global Water Resources

It has been estimated that by the year 2025, 5 billion out of the total global population of 8 billion will reside in regions experiencing water stress. These would be countries which would be using more than 20% of their available water resources. The impact of Climate Change is expected to impose additional pressure on some regions. This paper discusses an assessment of climate change implications for global hydrological regimes and water resources. Climate change scenarios from the Hadley Centre Climate simulations (HadCM2 and HadCM3), is used, and it simulates global river flows at a spatial resolution of 0.5x0.53 using a macro-scale hydrological model. The first part of the paper outlines the methodology used, then subsequently discusses the indices of water resources stress which have been employed. The remaining part of the paper initially describes the changes in hydrological characteristics globally and then considers effects on water resource stresses.

Reference: Arnell, Nigel W. 1999. 'Climate Change and Global Water Resources', *Global Environmental Change*, Vol. 9, pp. 31-49. Available online at http://bscw.ihe.nl/pub/nj_bscw.cgi/d2835298/Climate%20change%20and%20global%20water%20resources:%20Nigel%20W.%20Arnell.pdf (accessed in October 2011).

1.4 Nepal Climate Change and Security Factsheet

This factsheet sets the context of examining climate change and security together in Nepal. The country is particularly vulnerable to climate change because of ecological and topographic factors and its governing institutions are fragile after years of civil war and are not equipped with resources to tackle the challenge of climate change. Some of the key issues examined in the fact sheet are: increase of flash floods, glacier lakes outbursts, temperature changes in higher altitudes, changes in runoff of major streams and policy responses.

Reference: Webersik, Christian and Manish Thapa. 2008. 'Nepal Climate Change and Security Factsheet', Climate Change Facts Sheets Series 1. United Nations University- Institute of Advanced Studies. Available online at http://www.ias.unu.edu/resource_centre/Nepal_Climate%20Change%20Facts%20Sheets%20Series_2008_1_lowres.pdf (accessed in October 2011).

1.5 India Climate Change Factsheet

This factsheet is an introduction to climate change in India. It provides a snapshot of current policies, adaptation information and an index of current papers and NGOs in India working on climate change. It also provides a short introduction to country specific effects and impacts of climate change.

Reference: NIDOS (Network of International Development Organisations in Scotland). 2009. 'India Climate Change Factsheet'. Edinburg: NIDOS. Available online at http://www.nidos.org.uk/downloads/IndiaFactsheet.pdf (accessed in October 2011).

1.6 Climate Change Impacts on Water Resources in India

This document is based on a study by Indian Institute of Tropical Meteorology to analyse spatio-temporal variability of precipitation over major river basins, assess surface water sensitivty to climate variability, estimate change in water quality in selected sites, to prepare scenarios of water availability under climate change. Some of the predicted impacts on water is that the hydrological cycle will be more intense bringing higher rainfall and an increase in drought. Surface water is expected to increase. Policy changes in agriculture, forestry and waste water treatment will have to be sensitive to climate change impacts.

Reference: DECC (Department of Energy and Climate Change). n.d. 'Climate Change Impacts on Agriculture in India', Keysheet 5. London: DECC. Available online at http://www.decc.gov.uk/assets/decc/what%20we%20do/global%20climate%20change%20and%20ener gy/tackling%20climate%20change/intl_strategy/dev_countries/india/india-climate-5-water.pdf (accessed in October 2011).

Module 2: Impacts of Climate Change

2.1 Analysis of Sea Level Rise and its Impact on Coastal Wetlands of India

Sea Level Rise is caused by the concentration of gases such as carbon dioxide, carbon monoxide, methane and CFCs, and is thus a by product of the global warming process. The factors related to sea level rise are thermal expansion of oceans, glacier and mountain ice cap melting and melting of ice sheets in the polar regions. This paper studies intricately the sea level data from tidal gauge stations across India, from data collected from Calcutta, Mangalore and Vishakhapatnam. Shoreline retreat and coastal wetland loss are the most tangible impacts of sea level rise. This paper documents the trend of monitoring stations in India and estimates and projects the total wetland loss.

Reference: Dweivedi, Dwijendra Nath and Vinod Kumar Sharma. 2005. 'Analysis of Sea Level Rise and its Impact on Coastal Wetlands of India', Proceedings of the '14th Biennial Coastal Zone Conference' held between 17th to 21st July, 2005 at New Orleans, Louisiana. Available online at http://www.csc.noaa.gov/cz/CZ05_Proceedings/pdf%20files/Dwivedy.pdf (accessed in October 2011).

2.2 Impacts of Climate Change on Water Resources of Nepal: The Physical and Socioeconomic Dimensions

Scientific data has shown that climate in Nepal is changing at a pace well above the global average. The changes are particularly striking at higher altitudes compared to lower altitudes. Research has shown that only 11% of the current ice reserve will be left by the end of the century. This will cause an unprecedented increase and then a drastic decrease in water supply, and will widen the gap between water supply and demand. These physical dimensions have profound socioeconomic implications. Nepal's hydropower potential and agricultural productivity and hence rural and peri-urban livelihoods will suffer. Food security and calorie consumption will also suffer the paper reports.

Reference: Chaulagain, Narayan Prasad. 2006. 'Impacts of Climate Change on Water Resources of Nepal: The Physical and Socioeconomic Dimensions', Phd Dissertation: University of Flensburg. Available online at http://www.zhb-flensburg.de/dissert/chaulagain/Dissertation-Chaulagain.pdf (accessed in October 2011).

2.3 Estimating the Economic Cost of Sea-Level Rise

In order to improve the overall estimate of economic costs, a fall out of future sea-level rise associated with global climate change, this report generalizes the sea-level rise cost function proposed originally by Fankhauser and applies it to a new database on coastal vulnerability which has been developed as part of the Dynamic Interactive Vulnerability Assessment (DIVA) tool. This report describes various facets viz., the general methodology used, especially datasets which are repeatedly used, (a) DIVA: a sea-level rise impact database, (b) GEcon: a geographic economic database, (c) EPPA Model: a computable general equilibrium economic model, and (d) the IGSM. It also attempts to derive and extend the sea-level rise cost function, originally developed by F95a and then applies the cost function to the models and datasets.

Reference: Sugiyama, Masahiro, Robert J. Nicholls and Athanasios Vafeidis. 2008. 'Estimating the Economic Cost of Sea-Level Rise', Report No. 156. Cambridge: Massachusetts Institute of Technology. Available online at mit.edu/globalchange/www/MITJPSPGC_Rpt156.pdf (accessed in October 2011).

2.4 Climate Change Impacts in Drought and Flood Affected Areas: Case Studies in India

This document is a collection of case studies on how climate change has impacted certain areas in India. This study strives to bring to the mainstream climate change challenges and realities to developmental policies. The report focuses on how natural resources and rural livelihoods are particularly vulnerable to climate change impacts. The study areas include the flood and drought-prone regions of Orissa and Andhra Pradesh and Maharashtra respectively. The study also reviews governmental programs and mainly identifies gaps in them. Future climate risks and vulnerabilities are also evaluated in the study region. The document ends with notes on adaptation and resilience to climate change with a special focus on rural areas.

Reference: World Bank. 2008. 'Climate Change Impacts in Drought and Flood Affected Areas: Case Studies in India', Report No. 43946-IN. New Delhi : World Bank. Available online at http://www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2008/08/01/000333038_20080801065948/Rendered/PDF/439460ESW0P0841sclosed0July03002008.pdf (accessed in October 2011).

2.5 Impacts of Present and Future Climate Variability and Change on Agriculture and Forestry in the Arid and Semi-Arid Tropics

Climate change and its consequences in arid and semi-arid areas are particularly crucial, as they are inhabited by 20% of the total world population. This paper discusses the impact of climate change in arid and semi-arid regions of Asia, Africa and Latin America. In Asia, rainfall has decreased in many countries in the past three decades. Similarly, African rainfall has changed substantially in the last 60 years. Asian Agriculture is affected not just by temperature changes, but also to the changing characteristics of monsoon. In Africa too, cultivable land is the worst sufferer of drought. Latin America's water resources and crop production is likely to undergo massive changes in the light of temperature fluctuation and rainfall patterns. The adaptation potential in each of the regions is also described with the help of suitable examples.

Reference: Sivakumar, M. V. K., H. P. Das and O. Brunini. 2005. 'Impacts of Present and Future Climate Variability and Change on Agriculture and Forestry in the Arid and Semi-Arid Tropics', *Climate Change*, Vol. 70, pp. 31-72. Available online at http://dev.thegncs.org/sitefiles/file/Tropical_Agriculture_Sivakumar_2005.pdf (accessed in October 2011).

2.6 Climate Change Impacts and Adaptation Assessment in Bangladesh

Bangladesh is one of the most vulnerable countries to climate change. The paper predicts that every aspect of life in Bangladesh will be affected by climate change. The paper concentrates on tropical cyclone, storm surges, coastal erosion and backwater effect on floods. It also puts forth some adaptation procedures that could be undertaken. The paper has a dual approach, covering both qualitative and quantitative data. It advocates involving people are the grass-root in the battle against climate change.

Reference: Ali, Anwar. 1999. 'Climate Change Impacts and Adaptation Assessment in Bangladesh', *Climate Research*, Vol. 12, pp. 109-116. Available online at http://www.int-res.com/articles/cr/12/c012p109.pdf (accessed in October 2011).

2.7 Climate Change Impacts on Agriculture in India

This document is based on research conducted by the Indian Agricultural Research Institute. It is based on the fact that India is primarily an agrarian economy, and the agriculture sector represents 35% of India's Gross National product. Climate change could have an overwhelming impact on India's agriculture, with problems in food security, crop yields, water for irrigation, pests etc. Wheat and rice production are to suffer dearly. This document also calls for changes in policy in food security, trade, livelihood, adaptation and water.

Reference: Department of Energy and Climate Change (DECC). n.d. 'Climate Change Impacts on Agriculture in India', Keysheet 6. London: DECC. Available online at http://www.decc.gov.uk/assets/decc/what%20we%20do/global%20climate%20change%20and%20ener gy/tackling%20climate%20change/intl_strategy/dev_countries/india/india-climate-6-agriculture.pdf (accessed in October 2011).

2.8 Climate Change Impacts on Sea Level in India

Climate change is predicted to increase the average sea level in India, and consequently increase the frequency and intensity of cyclones and other disaster causing surges. This document is based on a study conducted by the National Institute of Oceanography (NIO). The results of the study shows a definite prediction for mean sea level increase and more storm surges. This in turn implies doom for vulnerable coastal population and loss to the state in terms of infrastructure and power. It will also cause changes in livelihoods such as fishing. Policies will have to evolve to address challenges in infrastructure damage, disaster prepareness and response etc.

Reference: Department of Energy and Climate Change (DECC). n.d. 'Climate Change Impacts on Sea Level in India', Keysheet 3. London: DECC. Available online at http://www.decc.gov.uk/assets/decc/what%20we%20do/global%20climate%20change%20and%20ener gy/tackling%20climate%20change/intl_strategy/dev_countries/india/india-climate-4-sealevel.pdf (accessed in October 2011).

2.9 Climate Change Impacts on Forestry in India

Climate change is expected to have an adverse impact on forests in India, which cover about 20% of the total area in the country. Forests are important for biodiversity, water, livelihoods and livelihoods of certain communities.

Climate change is expected to change the dominant forest cover from savanna to tropical. This projected shift will lead to dieback and loss of biodiversity, and the net primary productivity is expected to suffer. The document also describes the case studies conducted in the Western Ghats and Central Himalayas, that studied the effect of climate change on communities depending on the forest ecosystem.

Reference: Department of Energy and Climate Change (DECC). n.d. 'Climate Change Impacts on Forestry in India', Keysheet 7. London: DECC. Available online at http://www.decc.gov.uk/assets/decc/what%20we%20do/global%20climate%20change%20and%20ener gy/tackling%20climate%20change/intl_strategy/dev_countries/india/india-climate-7-forestry.pdf (accessed in October 2011).

Module 3: Impacts of Climate Change on Society

3.1 Development and Climate Change in Bangladesh: Focus on Coastal Flooding and the Sundurbans

This report presents a case study of the impacts of Climate Change on Bangladesh, with a focus on coastal flooding and the Sundurbans. Between 30-70% of the country gets flooded every year and this is further exacerbated by the sediment brought by rivers and drainage congestion problems. Bangladesh's high population and population density increases the exposure to such risks. Water and coastal resources of Bangladesh are the most vulnerable and face the worst impacts. This report highlights the trans-boundary dimension in the battle against climate change. Adaptation to climate change requires trans-boundary cooperation, such as river treaties. The paper also points out that governments constantly need to address affiliated issues such as afforestation, wildlife poaching and pollution, as these have a critical impact on fragile ecosystems like the Sundarban rainforests.

Reference: Agarwala, Shardul, Tomoko Ota, Ahsan Uddin Ahmed, Joel Smith and Maarten van Aalst. 2003. 'Development and Climate Change in Bangladesh: Focus on Coastal Flooding and the Sundurbans'. Paris: Organisation for Economic Co-operation and Development. Available online at http://www.oecd.org/dataoecd/46/55/21055658.pdf (accessed in October 2011).

3.2 South Asian Regional Study on Climate Change Impacts and Adaptation: Implications for Human Development

Climate Change Impacts are likely to be felt most by the poor living in developing countries. This paper addresses what impacts climate change will have on the South Asian countries, especially with respect to human development. Climate change is likely to have an adverse impact on food security and farm livelihoods, increase risks to human health, face an increased risk of natural disasters, and deal with shifting forest patterns. The document is interspersed with individual risks for each country in the South Asian region, along with specialised case studies in specific districts where climate change impacts have already been witnessed. In the light of socio-economic consequences, current policies are analysed in the light of climate change impacts for each country.

Reference: Kelkar, Ulka and Suruchi Bhadwal. 2007. 'South Asian Regional Study on Climate Change Impacts and Adaptation: Implications for Human Development', Paper prepared by The Energy and Resource Institute for Human Development Report 2007. Available online at http://hdr.undp.org/en/reports/global/hdr2007-8/papers/Kelkar_Ulka%20and%20Bhadwal_Suruchi.pdf (accessed in October 2011).

3.3 Socio-Economic Implications of Climate Change for Bangladesh

The paper analyses the socio-economic effects of Climate Change on Bangladesh. Climate Change is likely to increase the rate of social erosion and leaching, which in turn will affect agricultural production. As Bangladesh is an agrarian economy, this will dent the country's overall economic growth. Population and migration dynamics will play a role in Bangladesh's vulnerability and exposure to climate change. As migrants lack supportive infrastructure and secure employment, they are likely to bear the brunt of socio-economic impacts of climate and sea level changes. Climate change will also have a qualitative and quantitative effect on health care and education. The climatic conditions are likely to increase incidences of water-borne and air-borne diseases.

Reference: Ericksen, N. J., Q. K. Ahmad and A. R. Chowdhury. 1993. 'Socio-Economic Implications of Climate Change for Bangladesh', Briefing Document No. 4. Dhaka: Bangladesh Unnayan Parishad. Available online at http://www.waikato.ac.nz/igci/downloads/BriefingDoc4.pdf (accessed in October 2011).

3.4 Case Study: Gender and Climate Change in the Hindu Kush Himalayas of Nepal

This paper explains the need for a gender perspective in studying climate change impact and adaptation. Women are likely to suffer more from climate change because they assume the primary role in collecting scarce resources like water and fuel wood. Women's limited access to information on new agricultural practices and cropping pattern will affect their agricultural production. Women in the mountainous regions of Nepal are likely to be affected by climate change because of inherent gender discrimination in the society, unequal division of labour, vulnerability to natural disasters, impending food security issues and because they're not involved in policy making. The paper presents case studies that highlight cultural factors that come into play while studying Nepali women.

Reference: Leduc, Brigitte, Arun Shrestha and Basundhara Bhattarai. 2008. 'Case Study: Gender and Climate Change in the Hindu Kush Himalayas of Nepal'. New York: Women's Environment and Development Organization. Available online at http://www.wedo.org/wp-content/uploads/nepalcasestudy.pdf (accessed in October 2011).

3.5 Impacts of Climate Change on Public Health in India: Future Research Directions

The paper studies increase in climate variability and how it may exacerbate global health disparities. It is essentially a review of literature, in which it has identified what India's future research priorities in health must be. India's public health problems are multifaceted. It further exacerbates the risk of contracting endemic diseases like malaria, dengue, yellow fever, cholera and chikungunya, of which a proportion of the population in India is already vulnerable to, because of poor sanitation, drinking water quality, malnutrition and rampant pollution. The paper concludes that India will have to invest in building a large body of information and work on interdisciplinary research while working on adaptation. India also needs to work on building human and technical capacities for risk communication and promote adaptive behaviour.

Reference: Bush, Kathleen F., George Luber, S. Rani Kotha, R. S. Dhaliwal, Vikas Kapil, Mercedes Pascual, Daniel G. Brown, Howard Frumkin, R. C. Dhiman, Jeremy Hess, Mark L. Wlson, Kalapana Balakrishnan, Joseph Eisenberg, Tanvir Kaur, Richard Rood, Stuart Batterman, Aley Joseph, Carina J. Gronlund, Arun Agarwal and Howard Hu. 2011. 'Impacts of Climate Change on Public Health in India: Future Research Directions', Environmental Health Perspectives, Vol. 119, No. 6, pp. 765-771. Available online at http://ehp03.niehs.nih.gov/article/fetchArticle.action?articleURI=info%3Adoi%2F10.1289%2Fehp.1003000 (accessed in October 2011).

3.6 Climate Change and Women

This is a factsheet that describes how climate change affects and impacts women and how they adapt. Women are more vulnerable to climate change because their access to resources is hampered. It is a statistic that women are more likely to die than men during disasters. The factsheet also shows a graphic image accompanied by short notes of cases on how women are impacted by climate change induced disasters. There is also a section that describes how women are change agents in different parts of the globe, spearheading and participating in different movements.

Reference: Oxfam America and WEDO (Women's Environment and Development Organization).2008. 'Climate Change and Women', Factsheet. Boston: Oxfam and New York: WEDO. Available online at http://www.oxfamamerica.org/files/climatechangewomen-factsheet.pdf (accessed in October 2011).

3.7 Socio-Economic Scenario for Climate Change Impacts in India

As the second most populous nation in the world, increase in greenhouse gas emission will heavily impact India's population, social and economic dynamics, and its imperative that policy makers learn to deal with them. This research by The Energy and Resources Institute outlines for probable socio-economic scenarios for India. The study also assessed inputs for six topics, such as sea level, water, agriculture, forests, industry and health. The study concluded that there was scope for further research in demography, economy, governance and technology to understand the impacts at the grass roots level and to identify strategies to adapt to climate change.

Reference: Department of Energy and Climate Change (DECC). n.d. 'Socio-Economic Scenario for Climate Change in India', Keysheet 3. London: DECC. Available online at http://www.decc.gov.uk/assets/decc/what%20we%20do/global%20climate%20change%20and%20ener gy/tackling%20climate%20change/intl_strategy/dev_countries/india/india-climate-3-socio-econ.pdf (accessed in October 2011).

Module 4: Measuring Vulnerability and Risk to Climate Change

4.1 Assessing Key Vulnerabilities and The Risk from Climate Change

This paper discusses the various social, biological and geophysical systems that are at risk from climate change. It synthesises and presents information from two working groups of the Intergovernmental Panel for Climate Change. The paper identifies key vulnerabilities based on seven criteria and discusses an approach for risk management. The chapter also reviews literature focusing on adaptation and mitigation response strategies. The criteria for vulnerability are magnitude, time, persistence, reversibility and likelihood of impacts, potential for adaptation, distributional aspects of impacts and vulnerabilities and importance of the system at risk. The paper concludes with the listing of some research priorities from different domains.

Reference: Schneider, Stephen H., Serguei Semenov, Anand Patwardhan, Ian Burton, Chris H. D. Magadza, Michael Oppenheimer, A. Barrie Pittock, Atiq Rahman, Joel B. Smith, Avelino Suarez and Farhana Yamin. 2007. 'Assessing Key Vulnerabilities and The Risk from Climate Change', in M. L. Parry, O. F. Canziani, J. P. Palutikof, P. J. van der Linden and C. E. Hanson (eds), *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change,* pp. 779-810. Cambridge: Cambridge University Press. Available online at http://www.ipcc.ch/pdf/assessment-report/ar4/wg2/ar4-wg2-chapter19.pdf (accessed in October 2011).

4.2 Modelling Vulnerability and Resilience to Climate Change: A Case Study of India and Indian States

The paper analyses India's vulnerability and resilience to climate change as a whole and independently, in terms of its different states. The vulnerability was studied using the Vulnerability-Resilience Indicator Prototype, adapted to take local dietary practices and state of freshwater resources into consideration. The study ranks India as very vulnerable to climate change, and much of the vulnerability is due to governance failures and development issues. The study concludes that nine Indian states show moderate resilience against climate change and that the vulnerability of six states is higher than the national average. Protein intake and water availability in India contribute to high vulnerability in India. Unless the population drastically shrinks, India is heading towards massive water stress and scarcity.

Reference: Brenkert, Antoinette L. and Elizabeth L. Malone. 2005. 'Modelling Vulnerability and Resilience to Climate Change: A Case Study of India and Indian States', *Climate Change,* Vol. 72, No.2, pp. 57-102. Available online at http://www.springerlink.com/content/y53343287mh57057/fulltext.pdf (accessed in October 2011).

4.3 The Determinants of Vulnerability and Adaptive Capacity at the National Level and the Implications for Adaptation

The available set of indicators on vulnerability and the capacity to adapt to climate variability, and necessarily climate change, is derived at by using a novel empirical analysis of data aggregated nationally over a decade. This analysis is based on a conceptual framework in which risk is measured as an outcome and is a function of physically defined climate hazards and socially constructed vulnerability. The outcomes of climate are represented in terms of mortality from climate-related disasters, using emergency events database dataset, statistical relationships between mortality and a shortlist of potential proxies for vulnerability, which are used to identify key vulnerability indicators. It is found that there are 11 key indicators which exhibit a strong relationship with aggregated mortality associated with climate-related disasters, over a decade. Various parameters viz., validation of indicators, relationships between vulnerability and adaptive capacity, sensitivity of subsequent vulnerability assessments to different sets of weightings are explored using expert judgement data, collected through a focus group discussion exercise. The analysis indicates that the most vulnerable nations are situated in Sub-Saharan Africa as well as those that have experienced conflict recently. Adaptive capacity, which includes the element of vulnerability, is associated predominantly with governance, civil and political rights, and literacy.

Reference: Brooks, Nick, W. Neil Adger and P. Mick Kelly. 2005. 'The Determinants of Vulnerability and Adaptive Capacity at the National Level and Implications for Adaptation', *Global Environmental Change,* Vol. 15, pp. 151-163. Available online at http://www.uea.ac.uk/~f030/papers/gec2005.pdf (accessed in October 2011).

4.4 Assessing Vulnerability to Climate Change: The Link between Objectives and Assessment

Continued vulnerability of developing economies to potential impacts of climate change and various adaptation options to address to these impacts, are rapidly emerging as central issues in debates surrounding policy responses on climate change.

To prioritize, design and implement climate change adaption models, it is only too important to adopt a coherent and consistent set of definitions and frameworks for examining vulnerability, adaptation and adaptive capacity. A number of definitions on vulnerability and adaptation are found in available literature. The paper uses the available literature base from the context of these coastal impacts of climate change to infer some explicit linkages between objectives of vulnerability and adaptation assessment and definitions used for the analysis. It has been found that such a linkage is helpful for identifying the nature of assessment required, as well as the data and required information. The paper concludes with some thoughts on directions for research with regards to vulnerability and adaptation assessment.

Reference: Patwardhan, Anand. 2006. 'Assessing Vulnerability to Climate Change: The Link Between Objectives and Assessment', *Current Science*, Vol. 90, No. 3. pp. 376-383. Available online at http://www.ias.ac.in/currsci/feb102006/376.pdf (accessed in October 2011).

Module 5: Adaptation and Mitigation to Climate Change

5.1 Climate Change Risk: An Adaptation and Mitigation Agenda for Indian Cities

India is among the most urbanising nations in the world, and the urban population is likely to grow by 500 million in the next five decades. In that context, this paper discusses the climate change adaptation and mitigation agenda for urban India. Climate change is likely to bring fluctuation in temperature, precipitation and rainfall, drought, floods, storms, sea-level rise and environmental health risks. The paper underlines infrastructure investments to combat climate change. Further, it describes a multi-level climate change adaptation framework that brigs the governmental, private and civil society sectors together for change needed at local, regional and national levels. The paper calls for a shift in public policy from mitigation to adaptation grounded in social, cultural and political realities of the country.

Reference: Revi, Aromar. 2008. 'Climate Change Risk: An Adaptation and Mitigation Agenda for Indian Cities', Environment and Urbanization, Vol. 20, No. 1, pp. 207-229. Available online at http://pubs.iied.org/pdfs/G02275.pdf (accessed in October 2011).

5.2 Adapting to Climate Change: Water Management for Urban Resilience

Climate change increases the risks of human settlements, their social and economic structures being exposed to the dangers of climatic disasters and turning into 'failed cities'. The most vulnerable are the urban poor, and their capacities need to be built to adapt, as against mitigate. This paper explores financial and physical consequences of climate change, especially, for urban areas. It uses sketches from sub-Saharan Africa. Water management has been identified as a major affected impact of climate change, and if proper water management is done, this could initiate structured responses to climate change. The paper also states that adaptation measures are integral to the process of achieving some of the Millenium Development Goals.

Reference: Muller, Mike. 2007. 'Adapting to Climate Change: Water Management for Urban Resilience', *Environment and Urbanization*, Vol. 19, No. 1, pp. 99-113. Available online at http://eau.sagepub.com/content/19/1/99.full.pdf (accessed in October 2011).

5.3 An Anatomy of Adaptation to Climate Change and Variability

What entails adaptation to Climate Change? Who are the people adaptating to climate change and how do they do it? What is the process through which adaptation occurs? To diagnose such issues, the authors of this article contribute to the conceptual and numerical models and empirical data of adaptation. Further, it outlines the normative evaluation of strategies and measures of adaptation. The paper concludes that policy makers treat adaptation and mitigation as one and the same, and plan their policy responses as if they're addressing the same issue. Adaptation to climate change is inclusive of responses to extreme environmental conditions, climate variability and changes in long term conditions.

Reference: Smit, Barry, Ian Burton, Richard J. T. Klein and J. Wandel. 2000. 'An Anatomy of Adaptation to Climate Change and Variability', *Climate Change*, Vol. 45, No.1, pp. 223-251. Available online at http://www.uoguelph.ca/gecg/images/userimages/Smit%20et%20al.%20(2000)_Climatic%20Change.pdf (accessed in October 2011).

5.4 Integrated Water Resources Management and Strategic Environmental Assessment- Joining forces for Climate Proofing

This paper provides a global analysis of the impact of climate change on water and agriculture. Recent food production and security trends and how they're affected by changing global hydrology systems have been explained at length.

The paper also describes key drivers and possible responses, including prescribed policy responses. Strategic Environmental Assessment (SEA), a tool for environmental considerations in climate change is also described at length. This assessment simply asks policy makers to study projected social and economic consequences before making a decision. The paper concludes that climate change adaptation has linkages with the water sector. It prescribes a combination of IWRM (Integrated Water Resources Management) and SEA principles in adapting to climate change.

Reference: Slootweg, Roel. n.d. 'Integrated Water Resources Management and Strategic Environmental Assessment-Joining forces for Climate Proofing', Perspectives on Water and Climate Change Adaptation. Istanbul: World Water Forum 5. Available online at http://www.worldwaterforum5.org/fileadmin/wwc/Library/Publications_and_reports/Climate_Change/PersPap_16._IWRM_and_SEA.pdf (accessed in October 2011).

5.5 Local People's Perception on Climate Change, its Impact and Adaptation Practices in Himalaya to Terai Regions of Nepal

This paper is based on a research study that evaluated long-term data on precipitation and temperature to determinate climatic variation in different altitudes in Nepal. The study also documents the perception and experiences of farmers and other local people. It finally seeks to identify adaptive measures being taken to combat climate change in the country. The study found that farmers were able to recognise climate change, and temperature and rainfall fluctuation patterns. One of their ways of adapting to climate change was going back to traditional practices on harvesting and crop production. Locally relevant technologies were also found to be useful. One of the important things was doing a pilot study or thorough assessment before implementing new interventions. This paper is extremely useful for policy planning as it provides a rare insight into the attitudes, needs and wants of local stakeholders.

Reference: Tiwari, Krishna R., Kashab D. Awasthi, Mohan K. Balla and Bishal K. Sitaula. n.d. 'Local People's Perception on Climate Change, its Impact and Adaptation Practices in Himalaya to Terai Regions of Nepal'. Available online at http://repository.unm.edu/bitstream/handle/1928/11324/Tiwari%20et%20al_Local%20people%E2%80%99s%20perception%20on%20Climate%20Change.pdf (accessed in October 2011).

5.6 Community-based Adaptation to Climate Change through Coastal Afforestation

This document is about a UNDP adaptation project in Bangladesh. The project seeks to reduce vulnerability of coastal areas to climate change impacts and strengthen institutional bodies in their adaptation response to climate change. UNDP is working with the Government Forestry Department and local communities in the four project sites over 14kms. Some of the key areas in which the project is focussed on is on building resilience among local communities by enhancing ecosystem protection, working with planners to understand and tackle climate risks, reviewing and reworking on governmental policies and laws and documentating and dissemination knowledge on climate change and how it affects livelihoods. One of the major impacts of the project will be felt on the mangrove forests.

Reference: UNDP (United Nations Development Program) Bangladesh. 2011. 'Community-based Adaptation to Climate Change through Coastal Afforestation', Project Factsheet. Dhaka: UNDP Bangladesh. Available online at http://www.undp.org.bd/projects/prodocs/Coastal%20Afforestration/FINAL%20Coastal%20Afforestation%20factsheet%20Mar%202011.pdf (accessed in October 2011).

5.7 Climate Change in Nepal: Impacts and Adaptive Strategies

This perspective document describes the adaptive strategies of Nepal in dealing with climate change. On the premise that Nepal has complicated climate change issues thanks to its geography and is one of the worst affected nations, already, the authors begins to list adaptation responses, with a tabular column on factors enabling adaptation. Factors such as communications, transportation, economic diversification with details are listed. The vulnerability of Nepal to climate change is shown under headings such as disaster onset, flooding, aridity and drought and forest fires. There is also a section devoted to how policy making can contribute to adaptation. The document concludes that Nepal's approach must strive to be plural and reflexive.

Reference: Dixit, Ajaya. n.d. 'Climate Change in Nepal: Impacts and Adaptive Strategies', World Resources Report. Washington, D.C: World Resources Institute. Available online at http://www.worldresourcesreport.org/responses/climate-change-nepal-impacts-and-adaptive-strategies (accessed in October 2011).

Module 6: Responses to Climate Change

6.1 Mitigation Technology Challenges: Considerations for National Policy Makers to Address Climate Change

Meant for policy makers who take decisions at the country level, this paper reviews the important role technology can play in mitigating climate change. It classifies existing technologies on the basis of differential developmental needs by different nations. The preliminary section of this document is devoted to mitigation options and costs, in which no-cost mitigation is a major concept explored. The section on trends in financing of clean energy show us that investments in this sector are growing and that European Union is the world leader in sustainable energy investment. The paper also covers issues relating to international agreements in climate change mitigation technology. Some of the key renewable energy areas that have been covered in the paper include fossil fuel generation, biomass and bio energy and wind power.

Reference: Chidiak, Martina and Dennis Tirpak. 2008. 'Mitigation Technology Challenges: Considerations for National Policy Makers to Address Climate Change'. An Environmental and Energy Group Publication. United Nations Development Program. Available online at http://www.undp.org/climatechange/docs/English/UNDP_Mitigation_Technology_Challenges_final.pdf (accessed in October 2011).

6.2 Climate Change in South Asia: Strong Responses for Building a Sustainable Future

This publication is a comprehensive guide to Climate Change response in the South Asian region. It critically looks at projected impacts in specific cases of the region (sea level rise, soil erosion, glacier melt and floods). It then lists out Asian Development Bank's strategies to deal with climate change, i.e., Expanding the use of Clean and Renewable Energy, Encouraging sustainable urban development and transport, promoting climate-resilient development, strengthening policies, governance and capacities and Managing land use and forests for Carbon Sequestration. It then lays out some climate change responses at the regional and national levels by various countries in the region.

Reference: ADB (Asian Development Bank). n.d. 'Climate Change in South Asia: Strong Responses for Building a Sustainable Future'. Manila: ADB. Available online at http://www.adb.org/documents/reports/climate-change-sa/climate-change-sa.pdf (accessed in October 2011).

6.3 Vulnerabilities and Responses to Climate Change for Dhaka

This paper provides a comprehensive overview of Climate Change in Dhaka, and its responses. Dhaka is the world's eight largest city and makes a good case study for climate change, as a significant proportion of Bangladesh's greenhouse gas emission is generated here. This is bound to increase because of increasing urbanisation and pollution, economic changes, increase in population and fuel and power consumption. Dhaka is also a flood prone zone, as it is bound by rivers and has high rainfall, with low drainage security. The city has had three major floods in a span of two decades. The paper provides a sector-by-sector breakdown of climate change impact. It also tracks response measures in Dhaka under the following headings, viz, Improving air quality, measures for flood protection, drainage system improvement and role of civil society organizations.

Reference: Alam, Mozaharul and M. D. Golam Rabbani. 2007. 'Vulnerabilities and Responses to Climate Change for Dhaka', *Environment and Urbanization*, Vol. 19, No. 1, pp. 81-97. Available online at http://eau.sagepub.com/content/19/1/81.full.pdf+html (accessed in October 2011).

6.4 Environmental and Technology Policies for Climate Change and Renewable Energy

The paper analyses various environmental policy options that will eventually lead to a reduction in greenhouse gas emissions and promote renewable energy technology. The policy options analysed are putting a price for carbon emission, subsidies for renewable energy, taxing fossil fuel emissions, incentives for clean energy investments, funding more research and development etc. The policies are evaluated in several criteria, viz, emissions reduction, renewable energy production, research and development, sustainable development etc. The policies are also judged by the nature of technological progress, and whether it affects the inclination of policy makers.

Reference: Fischer, Carolyn and Richard Newell. 2004. 'Environmental and Technology Policies for Climate Change and Renewable Energy', Discussion Paper 04-05. Washington, D. C: Resources for the Future. Available online at http://www.rff.org/rff/documents/rff-dp-04-05.pdf (accessed in October 2011).

6.5 Asia's Response to Climate Change and Natural Disasters: Implications for an Evolving Regional Architecture

This volume documents Asia's response to climate change and natural disasters. One of the characteristics of Asia's response to climate change has been not viewing climate change as a threat to security or livelihoods or treating it as an urgent issue, but instead looking to industrial nations to come up with solutions and response plans. This volume tracks some pan Asian treaties, conferences and cooperation forums signed, conducted and built to address climate change, particularly in connection with natural disasters. Written by a multitude of authors, the document also tracks how regional, national and local politics has affected the response to climate change in Asia. It also has a country wise summary of how each nation has coped with climate change and its effects. The US' role in shaping and aiding climate change response in Asia is also discussed in great detail.

Reference: Cha, Victor D., Charles W. Freeman III, Michael J. Green, Sarah O. Ladislaw, David Pumphrey, Teresita Schaffer, Amy Searight, Robert S. Wang and Stacey White. 2010. 'Asia's Response to Climate Change and Natural Disasters: Implications for an Evolving Regional Architecture', Report of the CSIS (Centre for Strategic and International Studies) Asian Regionalism Initiative. Washington, D. C: CSIS. Available online at http://csis.org/files/publication/100708_Freeman_AsiasResponse_WEB.pdf (accessed in October 2011).

6.6 Cognitive and Behavioral Challenges in Responding to Climate Change

This paper draws from psychology, social psychology and sociology to explain gaps in knowledge and concern of and for climate change, and public failure in responding properly to climate change. No nation has mobilised its citizens and engaged them in a wholesome political and social response to climate change. There seems to be a major disconnect between information dissemination on climate change and concern and action. The paper's key findings emphasize that while there is a global fear about climate change, the motive to act on it and build on an affective action plan is not seen universally. The barriers in responding to climate change fall under (1) psychological/ conceptual, (2) social and cultural and (3) structural.

Reference: Norgaard, Kari Marie. 2009. 'Cognitive and Behavioural Challenges in Responding to Climate Change', Background Paper to the 2010 World Development Report. Policy Research Working Paper 4940. Washington, D. C: World Bank. Available online at http://www-wds.worldbank.org/servlet/WDSContentServer/WDSP/IB/2009/05/19/000158349_20090519142931/Rendered/PDF/WPS4940.pdf (accessed in October 2011).