Proceeding
Report of National Workshop on

Climate Change and Human Health:
Potential Impact, Vulnerability and
Adaptation in Nepal

Organized by
Nepal Health Research Council (NHRC)

Supported by
WHO Country Office, Nepal

December 2007
Proceeding Report of
National Workshop on Climate Change and Human Health: Potential Impact, Vulnerability and Adaptation in Nepal

Hotel Shanker, Lazimpat, Kathmandu, Nepal
December 19-21, 2007

Prepared by
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Environmental Health Research Officer, NHRC
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Acknowledgements

We perceive a sense of gratification to accomplish the National Workshop on "Climate Change and Human Health: Potential Impact, Vulnerability and Adaptation in Nepal". NHRC acknowledges the contribution of all those inputs and support were vital for the event.

First of all we wish to acknowledge immense contribution of all the technical committee members formed for organizing the national workshop from the conception of workshop to its completion. We express our heart felt appreciation to the paper presenters who prepared the presentations with important facts about the issue in a short notice. We feel pleased to extend our sincere thank to the chairpersons of the sessions for conducting the sessions and making them interactive and effective. NHRC would also like to express its sincere gratitude to all the individuals, who participated and contributed their time and effort in making this workshop a success.

We are thankful to the World Health Organization Country Office Nepal for financial and technical support without which the workshop would not have been possible. NHRC would like to extend sincere thanks to Mr. Han Heijnen, Environmental Health Advisor, WHO Country Office Nepal for his invaluable support and guidance for the workshop.

It is with deep appreciation that NHRC acknowledges the contribution and support of Dr. Mahesh Kumar Maskey, Chairman of NHRC.

Tireless work of NHRC staff for several weeks was key to success of the workshop. Effort of Mr. Meghnath Dhimal, NHRC Environmental Health Research officer was outstanding. Sincere thank goes to him and all the staff for their dedication.

We are particularly pleased to extend our special thank with gratitude to Honorable State Minister for Health and Population Ms. Shashi Shrestha for accepting our invitation as Chief Guest for inaugurating the workshop and delivering the remarks with encouragement and guidance.

Dr. Sharad Raj Onta
Member-Secretary
Nepal Health Research Council
ORGANIZING COMMITTEE
ORGANIZING COMMITTEE

Advisor          Dr. Mahesh Kumar Maskey,  Chairman NHRC
Coordinator      Dr. Sharad Raj Onta,  Member – Secretary, NHRC

Members
Dr. Shainendra Uprety Focal Person Environmental Health, Ministry of Health and Population
Mr. Han Heijnen, Environmental Health Advisor, WHO Country Office, Nepal
Dr. Hari Dahal, Joint-Secretary, Gender Equity and Environment Division, Ministry of Agriculture and Cooperative
Mr. Pravin Aryal, Chief/Senior Divisional Engineer, Environment section, Ministry of Water Resources
Mrs. Meena Khanal, Joint-Secretary, Environment Division, Ministry of Environment, Science and Technology

Director General
Department of Hydrology and Meteorology, Ministry of Environment, Science and Technology

Director
Epidemiology and Disease Control Division
Department of Health Services, Ministry of Health and Population

Dr. Hirakaji Manandhar, Chief, Planning Division, Nepal Agriculture Research Council

Dr. Bandana Pradhan, Associate Professor, Department of Family Health and Community Medicine, Institute of Medicine
Dr. Fang Jing, Eco-Health Specialist, ICIMOD
Representative WIN ROCK International
Mr. Meghnath Dhimal, Environmental Health Research Officer, NHRC

Persons who attended the meeting(s) as representative on behalf of concerned institutes are

Mr. Sunil Nath Lohani, Senior Agriculture Economist, Gender Equity and Environment Division Ministry of Agriculture and Cooperatives
Mr. Kumar Dahal, Public Health Inspector, EDCD, Ministry of Health and Population
Mr. Suman Basnet, Director, WIN ROCK International
Mr. Prem Sagar Subedi, Micro-Finance Specialist, WIN ROCK International
Mr. Sarju Kumar Baidya, Senior Divisional Meterologist, Department of Hydrology and Meteorology, Ministry of Environment, Science and Technology
Mr. Jagadishwor Karmacharya, Senior Divisional Meterologist, Department of Hydrology and Meteorology, Ministry of Environment, Science and Technology
Mr. Sagar Raj Gautam, Engineer, Ministry of Water Resources
SECTION 2

PROGRAMME SCHEDULE
SECTION 2
PROGRAMME SCHEDULE

National Workshop
On
Climate Change and Human Health: Potential Impact, Vulnerability and Adaptation in Nepal
Venue: Hotel Shanker, Lazimpat
Date: December 19, 20, 21, 2007

Objective: -
• To review and share the experiences of the impacts of climate change in Nepal and the South-East Asia region
• To discuss and share about methodologies and tools for vulnerability assessment, and possible options for adaptation to changing climate that would minimize health impacts; and
• To recommend a framework for a national approach to promote country adaptation mechanisms to address key health and environment issues resulting from climatic variability and change.

Program Schedule

Day First
9.00 - 10.00 Am Registration and Tea/Coffee
10.00 – 11.00 Am Inauguration Ceremony
   Welcome Address: Dr. Sharad Raj Onta , Member –Secretary, NHRC
   Remarks: Mr. Han Heijnen, Environmental Health Advisor, WHO
   Remarks from Chief Guest: Honorable State Miniter for Health and Population, Shashi Shrestha
   Guest: Dr. Dirga Singh Bam, Chief Curative Division, MOHP
   Chair person: Dr. Mahesh Kumar Maskey, Chairman, NHRC

11.00 - 11.30 Am Hi Tea

Technical Session –I Introductory Session on Climate Change and Health

Chairperson: Mr. Adarsah Pokhrel, National Consultant, Climate Change Project, MOEST

11.50- 12.10 Pm Paper 1 – Observed and future climate change in Nepal
Mr. Saraju Kumar Baidya, and Mr. Jagadishwor Karmacharya
Senior Divisional Meteorologist, DHM

12.10- 12.30 Pm Paper 2 – Overview of Health Impact of Climate Change in Nepal
Dr. Sharad Raj Onta, Member-Secretary, NHRC

12.30 – 12.50Pm Paper 3- Sharing the experiences of Climate Change and Human Health Related Activities in South –East Asia
Mr. Han Heijnen, Environmental Health Advisor, WHO Country Office Nepal
12.50-1.10 PM  
**Discussion and Interaction**

1.10 - 2.00 PM  
**Lunch**

**Technical Session - II  Climate Change, Agriculture, Water Resources, Energy and Health**

*Chairperson:*  
Mr. Han Heijnen, Environmental Health Advisor, WHO

2.00 – 2.20 PM  
**Paper 4** Impact of Climate Change on Water Resources in Nepal  
Mr. Adarsha Pokhrel, National Consultant Climate Change Project, MOEST

2.20 - 2.40 PM  
**Paper 5** Climate Change and its Impact on Agriculture of Nepal  
Mr. Ghan Shyam Malla and Dr. Anand Kumar Gautam  
Agricultural Environmental Unit, NARC

2.40 - 3.00 PM  
**Tea/Coffee Break**

3.00 – 3.20 PM  
**Paper 6** Energy, Human Health and Climate Change: Relationship, Consequences and Opportunities  
Mr. Suman Basnet and Mr. Prem Sagar Subedi, Win Rock International

3.20 - 4.00 PM  
**Discussion and Interaction and Formation of Groups for Group work**

**Day Second**

**Technical Session – III Climate Change and Human Health, Vulnerability and Adaptation**

*Chairperson:*  
Dr. Sharad Raj Onta, Member-Secretary, NHRC

10.00 - 10.20 AM  
**Paper 7** Impact of climate change on water quality, quantity and human health in Nepal.  
Dr. Bandana Pradhan, Associate Professor, IOM

11.20 - 11.40 AM  
**Paper 8** Climatic Determinants in Malaria and Kala-azar in Nepal  
Mr. Sagar Dahal, Public Health Administrator, EDCD, DOHS

11.40 – 12.00 AM  
**Tea/Coffee Break**

Technical Session – IV Climate Change, Vulnerability and Adaptation

*Chairperson:*  
Dr. Dirga Singh Bam, Chief Curative Division, MOHP

12.00 – 12.20 AM  
**Paper 9** Assessing Human Health Vulnerability and Public Health Adaptation to Climate Variability and Change  
Mr. Meghnath Dhimal, Environmental Health Research Officer, NHRC
12.20 – 12.40 Pm  Paper-10 Climate Change and Human Well Being.
   Dr. Fang Jing, ICIMOD

12.40 – 1.00 PM  Paper-11 Climate Change Impacts and Community Based Adaptation Measures in Nepal
   Mr. Gehendra Gurung, Practical Action Nepal

12.30—1.00 Pm  Discussion and Interaction

1.00 -2.00 Pm  Lunch

2.00- 4.00 Pm  Group Work

Day Third
Technical Session –V Climate Change and Policy

Chairperson:  Mr. Balkrishna Prasi, Former Secretary, MOEST

10.00 – 10.20 Am  Paper -12 Setting Climate Change Adaptation Policies in Nepal
   Mr. Ngamindra Dahal, National Trust for Nature Conservation

10.20 -10.40 Am  Paper-13 Review of Climate Change Related Plans, Programs and Policies in Nepal and Future Plan
   Mr. Batu Krishna Uprety, Environmental Officer (Under-Secretary Tech.), MOEST

10.40- 11.00 Am  Paper-14 Report from “Regional Workshop on Climate Change and Human Health in Asia: From Evidence to Action”
   Mats Eriksson, PhD

10.40 – 11.40 Am  Group Presentation and Generation of Recommendation

11.40 – 12.00 Am  Tea/Coffee Break

12.00 – 1.00 Pm  Closing Session

1.00 - 2.00 Pm  Lunch

The End
SECTION 3
BACKGROUND OF WORKSHOP
SECTION 3
BACKGROUND OF WORKSHOP

There is now a clear scientific consensus that the Earth’s atmosphere is warming due to emissions of greenhouse gases, most of which are originated by human activities. The outcome of global warming is the onset of rapid climate change that is reflected by increased frequency and intensity of extreme events such as heat waves, floods and droughts. The international policy emphasis is now on the actions that are necessary to reduce human impacts on the atmosphere, and to adapt to climate changes that are now inevitable. Inherent properties of the climate system mean that the world is committed to several decades of climate change, no matter how rapidly greenhouse gas emissions are reduced. Adaptation and mitigation will be dominant themes in international negotiations, development, and aid, in coming decades.

Climate change brings major new challenges to health security, and will increase the costs and difficulties of disease control. Climate change mitigation and adaptation decisions implemented in other sectors will also have important health consequences. The health sector will ultimately be expected to bear responsibility for the resulting financial and human costs.

The most basic role of the health sector is in supporting health systems in the face of the major global threat to health security that is posed by climate change. This will need to include the capacity to respond both to gradual changes, and to sudden shocks, ranging from more severe weather events, vector and water borne disease outbreaks, to the eventual interruption of freshwater and food supplies.

The Inter-regional Workshop on Human Health Impacts from Climate Variability and Climate Change in the Hindu-Kush-Himalaya Region in October 2005, brought together some 35 participants from all over Asia and from specialized agencies to debate ‘Assessing Human Health Vulnerability and Public Health Adaptation to Climate Variability and Change”. It discussed the issues of the Hindu Kush-Himalaya Region in some detail and not surprisingly had good representation from Nepal.

Internationally and nationally Climate Change discussions and workshops have only increased in number. Even then, the Asia-wide meeting WHO organized in Kuala Lumpur in July 2007 concluded
that … there was still limited political commitment of the health, meteorology, and environment sectors to mitigate and adapt to climate change at national and international levels. There was also insufficient awareness among the general public about climate change and its health impacts. The availability of weather, climate, water, air quality, socioeconomic and health data is limited, and available data are often not well integrated. Furthermore, there is insufficient capacity for assessment, research, and communication on climate sensitive health risks in many countries.

Studies and reports have however made it clear that in addition to the direct impacts of extreme events and disasters on the health and safety of people, the shift in weather patterns would introduce vector borne diseases, e.g. malaria and dengue fever to areas where vectors were not previously present, create changes in water supply and agriculture, and increase a.o. the occurrence of photochemical smog. The changes in temperature and rainfall (patterns) will affect water quantity and food production affecting the livelihood and food security of communities.

The national assessment of vulnerability and adaptation, including health aspects, to climate change has been done through the preparation of national communication reports by most countries that ratified the United Nations Framework Convention on Climate Change (UNFCCC) including Nepal. More specific assessment of actual and potential impacts of climate change on health has been done in some countries, including Australia, Japan and New Zealand. However, in most developing countries in the region including Nepal, such assessment has not been undertaken.

Clearly Nepal is facing climate change-induced consequences in many spheres of society and development. While some have been studied, data are still scarce and it is difficult to draw clear conclusions for future adaptation measures. How climate change will affect health is also not clear and often missing in all sectoral studies. In some instance the link can be made with climate change, e.g. due to the link with a rise in temperature while others may be more a consequence of changing settlement patterns, e.g. urbanization in combination with lagging environmental service development.

On September 1, 2007 the Health Ministers from 11 Member States of WHO’s South East Asia Region adopted the “Thimphu Declaration on International Health Security in the South-East Asia Region”. The Thimphu Declaration recognizes natural and manmade health emergencies, emerging infectious diseases
and climate change as threats to international health security. The Declaration calls on countries to develop national mitigation and adaptation plans to address the health impact of global warming and climate change.

To give follow-up to the Thimpu Declaration, WHO supported to Nepal Health Research Council (Under Ministry of Health and Population) for organizing a "National Workshop on Climate Change and Human Health: Potential Impact, Vulnerability and Adaptation in Kathmandu, Nepal (19-21 December, 2007". The workshop was really a unique and probably first time in Nepal bringing together concerned sectors together and placing the health impact at the center of discussion. The workshop was attended by more than 80 people from health, education, environment, agriculture, water resources, energy sectors represented by Minister, High level Government officers, Universities Faculties, I/NGOs representatives and Journalists.
SECTION 4

PROCEEDING OF THE WORKSHOP
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PROCEEDING OF THE WORKSHOP

OPENING SESSION

Dr. Sharad Raj Onta, Member-Secretary of Nepal Health Research Council welcomed Honorable State Ministry for Health and Population Ms. Shahshi Shrestha, Chairman of Nepal Health Research Council Dr. Mahesh Kumar Maskey, Chief Curative Division, Ministry of Health and Population, Dr. Dirga Singh Bom, Environmental Health Advisor, WHO Country Office Nepal Mr. Han Heijnen on the dais and all the participants from different sectors in the "National Workshop on Climate Change and Human Health: Potential Impact, Vulnerability and Adaptation in Nepal." He informed the participants that during the workshop the discussion regarding the impact of climate change in the health would be held though the knowledge regarding the impact of climate in the health is known very little. He pointed out the lack of facts that affects the health due to the climate change needed to be finding out. He expressed that climate change and potential impact on human health is one of the major issues requiring concern but we are ignoring it, not because we are unable to deal it only because we have too many problems to resolve. Now time has come to talk about impact of climate change on human health. He pointed out that we have little evidences and need to know more about it. So, NHRC in coordination with WHO has organized this workshop. He highlighted the objectives of the workshop as

- To review and share the experiences of the impacts of climate change in Nepal and SEAR
- To discuss and share about methodologies and tools for vulnerability assessment and possible options for adaptations to charging climate that would minimize health impacts.
- To recommend a framework for a national approach to promote country adaptation mechanism to address key health and environment issues resulting from climatic variability change

He also expressed that the three days workshop would be the unique meeting represented by different sectors like water, energy, agriculture, forestry, education, health and environment etc. and during the workshop there would be lot of different discussions and interactions and they will be looked at implications on health in different perspectives and can be draw a framework to create action to inform
government. He concluded that despite there are many there issue, we can't ignore impact of climate change on human health. Otherwise it will be late.

Mr. Han Heijnen, Environmental Health Advisor of WHO Country office Nepal started his remark reminding the participants about news published everyday in the newspaper regarding the climate change. He expressed his happiness for the effort made by different sectors focusing on the climate change though the health sector has taken step lately. He also informed that climate change is induced by various sectors emitting greenhouse gases. Therefore, there should be integrated and coordinated effort of every sectors to know the health impact of climate change and their mitigation and adaptation accordingly. He suggested that the health sector should have to come up and start to advocate for reducing health impact and strengthening the health system for adaptation. He mainly focused on the research to be conducted to know the fact of the impact of the climate change on human health in Nepalese context with the involvement of the different sectors. In the end, he said that we need to learn more and seek the way to prevent from the effect of the climate change.

Chief Guest Honorable State Minister for Health and Population, Shashi Shrestha expressed that the program on climate change and human health in Nepal was relevant and timely. Although activities and lifestyle of people in the developed countries are mainly responsible for inducing climate change, developing countries are facing its adverse impacts. We do not have strong evidence of the effects of climate change in health in Nepal. However, changing trend of some of the diseases like malaria, kala-azar and encephalitis and other may have links with the climate change. Similarly, depletion of water source may have contribution to higher incidence of diseases like diarrhea, hepatitis and cholera posing higher pressure on the health service system and increasing financial burden on it. Ms. Shrestha said that climate change was multisectoral issue. Hence, she emphasized on strengthening inter sectoral coordination for developing a national plan to respond to it. She indicated towards the need to form a network at regional and national level and share information and experiences and support with each other. Honorable State Minister made clear that impact of climate change is different across the population even within a country. Like in other issues, it is also true in the case of climate change that the poorest of the poor is worst hit by this phenomenon. Therefore, we should be sensitive to this fact while designing adaptation strategies.

Finally, she thanked the organizer and sponsor of the programme and wished success of the program.
Dr. Mahesh Kumar Maskey, Chairman of Nepal Health Research Council delivered his closing remarks thanking the State Minister Ms Shahi Shreatha, WHO representative Mr. Han Heijen, Chief Curative Division of Ministry of Health and Population Dr. Dirga Singh Bom, Member Secretary of Nepal Health Research Council Dr. Sharad Raj Onta and all the participants for the active participation in the workshop. He said that global warming and climate change are global problems and need international efforts and negotiation. He further said that developed countries are mainly responsible for enhancing the problems, while as developing countries are more susceptible to the problems due to low adaptive capacity and resource constraints. He also reminded that we already have experienced the problems of global warming and health impact. However, we are not being able to measure the health impact. He alarmed the participants by saying that in Nepal, time has come to identify and magnify the problem and prepare accordingly the services to establish early detection and warning systems for the potential outbreaks of disease, strengthening public health surveillance and monitoring, preparedness for disease outbreaks and response systems and developing an awareness programmes for the general public and policy makers for providing health services to them. He also shared the programme of September 1, 2007, the health ministers from 11 member states of WHO's SEAR, adopted "Thimpu Declaration on International Health Security in the South East Asia Region". And the Thimpu meeting recognized natural and manmade health emergencies, emerging infections, diseases and climate change threats to international health security. He pointed out the International panel on Climate Change (IPCC) has highlighted following key research priority areas:

- Development of methods to quantify the current impacts of climate and weather on a range of health outcomes, particularly in low- and middle-income countries.
- Development of health-impacts models for projecting climate-change-related impacts under different climate and socio-economic scenarios.
- Investigations on the costs of the projected health impacts of climate change; effectiveness of adaptation; and the limiting forces, major drivers and costs of adaptation

In the end he hoped the workshop would have effective discussion for the future program.
Technical Sessions
Technical Session –I
Introductory Session on Climate Change and Health

Chairperson: Mr. Adarsah Pokhrel, National Consultant, Climate Change Project, MOEST

Paper 1 – Observed and future climate change in Nepal
Mr. Saraju Kumar Baidya, and Mr. Jagdishwor Karmacharya
Senior Divisional Meteorologist, DHM

Paper 2 – Overview of Health Impact of Climate Change in Nepal
Dr. Sharad Raj Onta, Member-Secretary, NHRC

Paper 3- Sharing the experiences of Climate Change and Human Health Related Activities in South –East Asia
Mr. Han Heijnen, Environmental Health Advisor, WHO Country Office Nepal
Observed and Future Climate Change in Nepal

Saraju K. Baidya
Jagadishwor Karmacharya
Department of Hydrology and Meteorology
Government of Nepal

Observed and Future Climate Change in Nepal

- Climate Key Issues
- Observed Climate Change
- Future Projection
- Climate Change impacts

Observed and Future Climate Change

- Climate is NOT constant
  - Changes in Climate occur on all time and space scales characteristic of the Earth System

Climate Change

- Climate change refers to the variation in the Earth's global climate or in regional climates over time.
- It describes changes in the variability or average state of the atmosphere over time scales ranging from decades to millions of years.
- These changes can be caused by processes internal to the Earth, external forces or, more recently, human activities.
Evidence for Anthropogenic Change

Natural origin

- external: land-sea distribution, orography, solar constant, orbital variations, volcano
- internal variability of the climate system: (e.g., air-sea interaction,)

Source: IPCC, 2007

Source of Greenhouse Gases

“Warming of the Climate System is Unequivocal”

“It is likely that there has been significant anthropogenic warming over the past 50 years.” (IPCC, 2007)

Global Temperature is Rising at Faster Rate

Source: IPCC, 2007

All Nepal Temperature Trend

- All Nepal Temperature is increasing steadily
- About 1.8°C increase from 1975 - 2006
All Nepal Rainfall Trend

All Nepal monsoon rainfall trend (1971-2006)

- All Nepal Rainfall also shows a slightly increasing trend.

Change in Climatic Extremes

- Changes in the frequency or intensity of extreme climate events would have profound impacts on nature and society.

Temperature Extremes

- Increase in warm days
- Increase in warm nights

Rainfall Extremes

- Increase in number of heavy rainfall events (rainfall > 50 mm/day)
- Increase in max. 24 hour rainfall
**Observed Climate Change**

- **Rainfall**
  - Total rainfall and heavy rainfall events are increasing
  - Maximum 24 hour rainfall is also increasing

- **Temperature**
  - Days and nights are both becoming warmer.
  - Warm spell duration (Long hot days) is increasing
  - Cool nights and cool days are becoming less frequent

**Extreme weather ahead!**

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**Climate Change Projection - Late 21st Century**

**Change in Annual Temperature**

*Warmer Future*

Model output from PRECIS run at IITM, India

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**Change in Seasonal Temperature**

*Warmer Winter*

*Warm Summer*

Model output from PRECIS run at IITM, India

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**Rainfall Extremes ……**

**All Nepal Total**

Number of days with rain >= 100 mm

- Increase in number of heavy rainfall events (> 100 mm/day)

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**Change in Annual Temperature**

Model output from PRECIS run at IITM, India
• Climate change, particularly the increasing surface temperature, is already affecting both natural and human-managed systems.

• All major socio-economic sectors will be affected, with a wide range of regional impacts:
  - Increases in malnutrition and consequent disorders, with implications for child growth and development;
  - increased deaths, disease and injury due to heat waves, floods, storms, fires and droughts;
  - the increased burden of diarrhoeal disease;
  - the increased frequency of cardio-respiratory diseases (due to higher concentrations of ground level ozone related to climate change) and,
  - the altered spatial distribution of some infectious disease vectors.

Projected climate change-related exposures are likely to affect the health status of millions of people, particularly those with low adaptive capacity, through:

• Increases in malnutrition and consequent disorders, with implications for child growth and development;
• increased deaths, disease and injury due to heat waves, floods, storms, fires and droughts;
• the increased burden of diarrhoeal disease;
• the increased frequency of cardio-respiratory diseases (due to higher concentrations of ground level ozone related to climate change) and,
• reduced human mortality from decreased cold exposure.

Source: IPCC, 2007
Development Challenges

Adaptation is the way forward by Building Adaptive Capacity and Taking Actions

- Creating the Information through: Research, Data collection and monitoring
- Awareness-raising
- Adjust Social Structure - empowerment
- Develop Governance
- Set up Programmes and projects to reduce vulnerability to climate risks or to exploit opportunities

Source: WMO

Climate change and health: an overview

Sharad Onta
NHRC

Climate change

An established fact beyond the debate

The global climate change has multiple implications

Impact on almost all sphere of life
HEALTH is not an exception
Nepal context: Agenda for discussion

2. How do we know about the impact of climate change on health

- Adequate know how about the methodological issues of assessment of impact

- Technical capacity to assess the impact

Climate change and health

World Health Organization (WHO) has recognized as one of the major challenges for health policy makers, planners, managers as well as for scientists

WHO urges

Issues related to climate change and health should be addressed NOW, before it becomes too late.

The presentation

Aims to set some of agenda for discussion on issues of climate change and health

- It is NOT based on evidences and empirical observations

- It is rather based on some theoretical frameworks, assumptions and speculations

- It raises questions than offers answers

Health impact of climate change: the causal pathway

- Change in disease pattern
- Food and nutrition
- Water sources depletion
- Natural disaster

Health
**Causal pathway**

- Climate change
- Disease
- Change in agent
- Change in carrier
- Change in host

**Causal pathway**

- Agent → Resistant species
- Carrier → Survival, Multiplication, Behaviour
- Host → Immunity

**Nepal context: Agenda for discussion**

1. How much do we know about the impact of climate change on health?
   - Impacts are Universal or specific to the region or country
   - Specific impacts in Nepal
   - Changes in disease pattern
   - Changes in patient profile
   - Other changes

**Nepal context: Agenda for discussion**

- Do we know enough about these issues?
  - They have not yet received priority in research agenda
Technical capacity

Link the health problems with climate change
Tracing causal pathway

Nepal context: Agenda for discussion

3. How should we move forward?

Initiatives are taken by different sectors
Health sector?

Any more agenda!

Thank you
WHO SEARO

Thimphu, 1 September 2007:

Health Ministers from 11 Member States of WHO’s South East Asia Region adopted the “Thimphu Declaration on International Health Security in the South-East Asia Region”.

The Thimphu Declaration recognizes natural and manmade health emergencies, emerging infectious diseases and climate change as threats to international health security.

In a nutshell, IPCC AR4

- Emerging evidence of climate change impacts:
  - Altered distribution of some vectors
  - Altered seasonal distribution of some pollen species
  - Increased risk of heatwave deaths
In a nutshell, IPCC AR4

- Projected trends:
  - Increase in undernutrition and related disorders
  - Increase in morbidity and mortality due to heat waves, floods, droughts, windstorms, and fires
  - Mixed effects on malaria
  - Increase burden of diarrheal diseases
  - Increase CVD due to increases in ground-level ozone
  - Increase number of people at risk of dengue
  - Bring some health benefits

Global perspective of the health impacts of climate variability and change

- Climate – both ancient and modern phenomenon
- “There are two things that we can and must do to respond to this challenge. First, we need to strengthen public health systems, which are the first line of defense… Second, we need to remember that prevention is just as important as cure…”
- Protecting health while reducing Greenhouse gas emissions

Malaysia Country Reports (August 2007) on experiences with health impacts of climate variability and mitigation action

- To review and share experiences of the health impacts of climate variability and long term climate change in the South-east and East Asia regions and actions to mitigate them;
- To learn available methodologies and tools for vulnerability assessment and possible options for adaptation to changing climate which minimize health impacts; and

Malaysia Country Reports (August 2007) on experiences with health impacts of climate variability and mitigation action

> Country description

>> Climate related health issues

>>> National programmes and projects

>>>> Institutional organization

>>>>> Issues and challenges
Countries in the Region

- Confirmed that countries have been experiencing the health impacts of climate change;
- Showed to an extent political will to tackling and acting on climate change;
- Demonstrated initiatives at multisectoral programmes (vision, mission, goal) in reducing GHG emissions; and
- Have initiated some vulnerability assessment, adaptation and mitigation options with expression of assistance (e.g. baseline data/info on GHG emissions, institutional, financial, etc).

Actions in South East Asia region

- India: Prime Minister’s Council on Climate Change
- The Royal Thai Government established a National Climate Change Committee
- Sri Lanka: Inter-Ministerial Committee on Climate
- Regional awareness workshops on climate vulnerability in low-lying areas (Maldives 2003) and in the Himalayas (India, 2005).
- MoH Bhutan to implement a project addressing climate change (2007, UNDP/GEF)

Incident and CFR Dengue

Indonesia, 1968-2007

CHIKUNGUNYA FEVER

2006

Affected districts: 188,
Suspected Cases 1.39 million
Confirmed Cases 1985 out of 15504 tested (12.8%)
Trend of climate factors and different diseases in Rajshahi study location for the period of 1996-2005.

Positive correlation between climate factors and diseases in Satkhira.

Impact of Salinity

Industrial units suffered a progressive damage due to increased corrosion.

Industrial operation needed to carry fresh water from a long distance.

Top-dying of Sundari trees

Severe Environmental Degradation in Southwest Region of Bangladesh

Drought

About 25% of the country suffer water stress in dry season.

China: Climate Change & Disease Vectors

Vector-borne diseases are the most climate sensitive infectious diseases in the world. Global warming has enlarged the area for the vector, Aedes aegypti, from 22° N to 25° N in China in recent 24 years. however, the exact change for A. albopictus is still unclear.

Climate change affects on the distribution of dengue fever vectors of A. aegypti and A. albopictus.
Singapore: Adaptation to Current and Projected Climate-Related Health Burdens

- Dengue
  - Different alert levels for vector control action coordination

- Flooding
  - Storm water management system in place
  - Reducing amount of flood-prone area
  - Pumped drainage system where not possible to raise platform level

- Heat stress
  - Increased greenery (streetscape, vertical, rooftop, city parks) which reduce ambient temperature

Thailand: research needs....

- Studies on the effects of air pollution and climate change on health
  - Develop database on the effects of air pollution on health
  - Study the impacts of air pollution on health
  - Develop mathematical models to simulate relationship of air pollution, climate change and health
  - Search for the most efficient procedures to manage air pollution and air quality
### Malaysia: Issues & Challenges (Health)

- **Data availability**
  - Climatic parameters not available for all stations
  - Incomplete dengue data, available only for the last 7 years (1997-2004)
  - Data mining: manual key-in from hard copy (1997-2001)

- **Data quality**
  - Many missing data: 40% of the epidemiological week for 1997 and 1998
  - Double entry and wrong zoning of dengue cases

- **Differences in diagnostic methods and reporting system**

- **Meteorological station representativeness & disease transmission dynamics**

### Priorities

1. Improve the understanding of public health authorities on the linkages between climate change/variability and health, through health and population research; data analysis for advisories.
2. Identify adaptation needs and options derived from the challenges posed by future sudden and/or large climate changes.
3. Implement these, maintaining or improving current public health programmes in conjunction with other sectors (water, agriculture, urban development, etc.)

---

**Thank you**
Technical Session-II
Climate Change, Agriculture, Water Resources, Energy and Health

Chairperson: Mr. Han Heijnen, Environmental Health Advisor, WHO

Paper-4 Impact of Climate Change on Water Resources in Nepal
   Mr. Adarsha Pokhrel, National Consultant Climate Change Project,
   Ministry of Environment, Science and Technology

Paper-5 Climate Change and its Impact on Agriculture of Nepal
   Mr. Ghan Shyam Malla and Dr. Anand Kumar Gautam
   Agricultural Environmental Unit, Nepal Agriculture Research Council

Paper-6 Energy, Human Health and Climate Change: Relationship, Consequences and Opportunities
   Mr. Suman Basnet and Mr. Prem Sagar Subedi, Win Rock International, Nepal
Namaste
And
Good Afternoon

Impact of Climate Change on Water Resources in Nepal
By
Adarsha P. Pokhrel

December 19-21, 2007
Kathmandu Nepal

Water is Life

The earlier civilization grew up along the river banks:

• Sumerians in Mesopotamia along river Tigris and Euphrates;
• Egyptians along the river Nile in Nile Valley;
• Harappans along river Indus in India;
• Chinese along river Hwang-Ho in China

आपोऽ नारा वेदव्यास (विष्णु पुराण ९.४.६)

Water is Life
They constructed dams and levees, improved Channels for water supply and dug canals for irrigation;

They tried to understand the nature and tried to manipulate the nature to heighten their LIFE STYLE;

Their thirst to beautify the life never quenched and the resulting effect at the dawn of 21st century took the shape of CLIMATE CHANGE.

Sun is the creator of Rain wrote VYASA, the ancient Sage of Hindu Mythology. Sun is responsible for the climate of the earth

Sun and GHG

- Solar Energy enters into the earth in the form of visible light.
- 30% of it is scattered back to space
- Remaining 70% reaches to the earth surface through the atmosphere
- Part of the energy radiates back into the space in the form of infra red radiation
- GHG block the escape of infra red radiation causing climate change effect

Solar Energy and the GHG Mechanism

- Solar Energy enters into the earth in the form of visible light.
- 30% of it is scattered back to space
- Remaining 70% reaches to the earth surface through the atmosphere
- Part of the energy radiates back into the space in the form of infra red radiation
- GHG block the escape of infra red radiation causing climate change effect
<table>
<thead>
<tr>
<th>GHG</th>
<th>GHG Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Carbon dioxide (CO₂)</td>
<td>• Energy (fuel combustion and fugitive emissions from fuels)</td>
</tr>
<tr>
<td>• Methane (CH₄)</td>
<td>• Industrial processes (mineral, chemical, metal production etc.)</td>
</tr>
<tr>
<td>• Nitrous oxide (N₂O)</td>
<td>• Solvent and other products</td>
</tr>
<tr>
<td>• Hydrofluorocarbons (HCFs)</td>
<td>• Agriculture (rice cultivation, irrigation, manure management etc.)</td>
</tr>
<tr>
<td>• Perfluorocarbons (PFCs)</td>
<td>• Wastes (disposal, incineration etc.)</td>
</tr>
<tr>
<td>• Sulphur hexafluoride (SF₆)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Temperature Trend</th>
<th>Observed effects in Nepal</th>
</tr>
</thead>
<tbody>
<tr>
<td>• IPCC AR4 projects the global temperature to rise by 1.1 to 6.4 degrees celsius, in an average 1.8 to 4 degree celsius</td>
<td>• Days and nights are becoming more warmer</td>
</tr>
<tr>
<td>• Analysis of 32 years observed data (1975 – 2006) in Nepal shows a temperature increase of 1.8 degrees celsius</td>
<td>• Cool days and nights are turning less</td>
</tr>
<tr>
<td></td>
<td>• The future:</td>
</tr>
<tr>
<td></td>
<td>• Higher maximum temperature and more hot days</td>
</tr>
<tr>
<td></td>
<td>• Higher minimum temperature and fewer cool days</td>
</tr>
</tbody>
</table>
**Precipitation Trend**

- Precipitation trend is not as apparent as temperature but increased trend is indicated
- Number of rainy days with >= 100 mm are increasing
- Number of rainy days are decreasing
- Extreme events are increasing

**Water Resources**

- Our planet has an estimated volume of 1370 million cubic kilometers of water
- 97.25% of water is stored in the ocean
- Rivers, the source of potable water share only 0.0001% of the globally available water
- Water contained in the different elements of the biosphere is circulated through the Hydrological Cycle mechanism

**Hydrological Cycle**

**Water availability in Nepal**

- Nepal has 225 billion cubic meters of annually available water
- Only 15 billion cubic meter is used for economic and social purpose
- Only 72% of the population has access to water
- Only 25% of the population has sanitation facility
Water in the Himalayas

- Nepal Himalayas enjoy the possession of 7 mountain peaks higher than 8,000 meters
- 30% of the global glaciers
- 3,252 glaciers covering an area of 5,323 sq. km
- 2,323 identified glacial lakes covering an area of 75.7 sq. km

Impact of Climate Change

Potential Climate Change Impacts

- Temperature
- Precipitation
- Impact on Health
- Agriculture
- Forest
- Water resources
- Coastal areas
- Economic and national areas
- Emission of heat, temperature rise, coastal flood, additional costs, lost coastal constructions, loss of habitat and species, diminishing glaciers
Impact on Glaciers

- Glaciers in the Himalayas are retreating fast: Rikha Samba glacier, AX010, Yala are some of the observed ones
- Himalayan glaciers are thinning by 0.3 – 1 m per year
- Nepalese glaciers are retreating from several meters to 20 meters per year

Retreating Process of Nepalese Glaciers

How Fast They Are Shrinking?
- Faster than the other glaciers
- Faster than the previous estimate

Neighboring glaciers

- 82% of glaciers in western China have retreated
- The rate of Gangotri glacier retreat in India over the last 3 decades was more than 3 times the rate during the preceding 200 years
- Glaciers in Pakistan are also retreating
- On the Tibetan Plateau, the glacial area has decreased by 4.5% over the last 20 years and by 7% over the last 40 years

Glacial lakes and GLOF

- Already several glacial lakes (2,323) have been formed and are extending in size
- Many more are in the process of formation
- Many glacial lakes are vulnerable with potential GLOF risk
- GLOF is a catastrophic discharge of water that rushes along the channel downstream in the form of dangerous flood waves
The development process of Tsho Rolpa Glacial Lake

Tsho Rolpa GLOF Mitigation Activity
<table>
<thead>
<tr>
<th>Impact on river water availability</th>
<th>Impact on Hydropower</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Increase in Extreme events (temperature, precipitation) pose a great threat to the river flow.</td>
<td>• Extreme weather conditions make the hydropower projects more vulnerable</td>
</tr>
<tr>
<td>• Scenario of <em>too much, too little</em></td>
<td>• Increased rainfall intensity questions the safety of hydraulic structures</td>
</tr>
<tr>
<td>• DHM study showed an increase of 13% more flow on Karnali on a 4 degree temperature rise and 20% precipitation increase.</td>
<td>• The dry period will invite more uncertainties on power generation capacity</td>
</tr>
<tr>
<td></td>
<td>• Sediment load will also cause problems</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>IPCC Projection</th>
<th>Impacts on other water sectors</th>
</tr>
</thead>
<tbody>
<tr>
<td>• The IPCC 4AR (2007) states:</td>
<td></td>
</tr>
<tr>
<td>Dry regions to get drier and wet regions to get wetter. Drought affected areas will become larger. Heavy precipitation events are very likely to become more common and will increase flood risk. Water supplies stored in glaciers and snow covers will be reduced over the course of century</td>
<td>• Drinking water supply will be critical</td>
</tr>
<tr>
<td></td>
<td>• Rural women will be highly affected</td>
</tr>
<tr>
<td></td>
<td>• Intense precipitation, a great threat: floods of catastrophic nature, long inundation period, land degradation, land slides, mass wasting, heavy sediment load</td>
</tr>
<tr>
<td></td>
<td>• Dry spell: springs dry up, water for irrigation will be affected and the traditional KULO will get dry</td>
</tr>
</tbody>
</table>
### Summary of probable Impacts

- **Higher maximum temperature, more hot days:**
  - Increased endemic morbidity and mortality because of diarrheal and vector borne diseases, such as malaria, primarily associated with flood and droughts
  - Increased deaths and serious illness in older age groups and urban poor;
  - Increased heat stress in livestock and wildlife;
  - Increased damage to a number of crops;

### More Intense Precipitation and monsoon variability events:

- Increased flood, landslide, avalanche and mudslide damage;
- Increased soil erosion;
- Increased flood runoff;
- Increasing recharge of some floodplains aquifers;
- Increase in flood and drought magnitude and damages;

### Higher minimum temperatures, fewer cold days:

- Decreased cold-related human morbidity and mortality;
- Decreased risk of damage to a number of crops, and increased risk to others;
- Extended range and activity of some pest and disease vectors;

### Polluted Stagnant Wetlands

- Warm and polluted stagnant wetlands - a paradise to mosquitoes
- Increasing trend of Malaria, Kala-azar and Japanese Encephalitis
<table>
<thead>
<tr>
<th>Increased summer drying and associated risk of drought:</th>
<th>Social Impacts</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Decreased crop yields;</td>
<td>• Rural women and Urban poor will be under high stress</td>
</tr>
<tr>
<td>- Decreased water resources quality and quantity;</td>
<td>• Increased psychiatric cases??</td>
</tr>
<tr>
<td>- Increased risk of forest fire;</td>
<td>• Increase in diseases seriously disturb the social structure</td>
</tr>
<tr>
<td></td>
<td>• Poverty is likely to increase</td>
</tr>
<tr>
<td></td>
<td>• Migration</td>
</tr>
<tr>
<td></td>
<td>• Possible conflicts</td>
</tr>
</tbody>
</table>

**Conclusion and Recommendations**

- IPCC 4AR (2007) projects with virtual certainty that:
  - Warmer and more frequent hot days and nights over most of land areas
  - Warmer and fewer cold days and nights over most land areas

IPCC further states that:

“warming of the ecosystem is unequivocal, as is now evident from observations of increase in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level”
Similar results are found in Nepal and hence Nepal needs to immediately address the following issues:

- Identification of Vulnerable areas
- Development of Adaptive measures
- Mitigation options
- Formulation of National Health Policy under Climate Change Scenario

Path to Health Care without the climate change parameter incorporation!!! is it not really scary??

LASTLY

But a dedicated and strong will to combat the hardship ahead to improve the public health concern under the Climate Change Scenario and with a purpose to make everyone happy and smiling will ultimately lead us to SUCCESS

SARVE BHAVANTU SUKHINA .............

THANK YOU !
Introduction

Climate is a long term average of the weather in a certain location.

Climate change is a natural phenomena that occurs gradually and often attributed to variation in solar energy, temperature and precipitation.

• Avg. temp. increased by 1°C on world basis since 1860, Predicted the Earth would warm by 1.4 to 5.8°C by 2100 (IPCC, 1996).
• Nepal’s temp. is increasing rapidly 1.7°C during last 30 years (1975 to 2005).
• Increase in avg. temp. in Nepal is 0.06 °C per year (0.04°C/year in Terai, and 0.08°C/year in high mountain.)
Global warming /Climate change can disrupt human society

Victim through floods and drought

Evidences of Climate Change in Nepal

- Twelve warmest years since 1987 to 2006
- Pre-monsoon, unusual precipitation, decreased rainy days and intense rainfall events increased
- Heavy rain in mid western Terai, resulting in floods, erosion
- More land slide events in western region
- Receding snowfall retreating the Glaciers (AX010 Small glacier mountain shrinking at alarming rate)
- KTM valley frost decreasing, snowfall in Katmandu (in Feb 2007, after 60 years).
- Climate zones shifting up ward (Maize, Chilly, Tomato and Cucumber now adapting in Mustang)

Evidences of Climate Change and Its Impacts in Nepalese Agricultural

- Adverse crop yield due to winter cold wave (Potato, Toria, Sarson, Rayo, Lentil and Chickpea).
- Tree lines (apple trees) and livestock (Chauri) have been shifting upward.
- Maturity of the crops has been shortened (Rice:- 6 days, Wheat:- 14 days) Off season flowering is observed in horticultural crops (peach and pear).
- Drought in Eastern Terai - decreased rice production by 30% in 2006.
- Dry days has increased, Evapotranspiration increased (Mid Western Terai, Mustang.)
- Nitrogen content of the rice was increased by 16.3 percent due to rise in temperature but decreased by 9.8 percent due to doubling of CO2
Recent Erratic rainfall events in Nepal

- Eastern Terai and western regions faced rain deficit in 2006 thereby reduced crop production by 12.5% on national basis.
- In Eastern Terai only production reduced by 30% and 9.6% of agricultural land left fallow
- Mid western – heavy rain created floods inundation and crop land destroyed in 2007.

### Impact of Cold wave on winter crops yields estimated in the Terai, 1997/98.

<table>
<thead>
<tr>
<th>Year</th>
<th>Potato (t/ha)</th>
<th>Toria (kg/ha)</th>
<th>Sarson (kg/ha)</th>
<th>Rayo (kg/ha)</th>
<th>Lentil (kg/ha)</th>
<th>Chickpea (kg/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1987/88</td>
<td>539</td>
<td>1320</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1988/89</td>
<td>703</td>
<td>563</td>
<td>728</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1989/90</td>
<td>25.54</td>
<td>503</td>
<td>844</td>
<td>819</td>
<td>709</td>
<td></td>
</tr>
<tr>
<td>1990/91</td>
<td>19.72</td>
<td>570</td>
<td></td>
<td>912</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1991/92</td>
<td>22.28</td>
<td>949</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1992/93</td>
<td>17.36</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1993/94</td>
<td>22.13</td>
<td>712</td>
<td>785</td>
<td>601</td>
<td>1044</td>
<td></td>
</tr>
<tr>
<td>1994/95</td>
<td>23.76</td>
<td>718</td>
<td>524</td>
<td>548</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1995/96</td>
<td>17.21</td>
<td>760</td>
<td>636</td>
<td>565</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1996/97</td>
<td>22.63</td>
<td>815</td>
<td>803</td>
<td>887</td>
<td>959</td>
<td>922</td>
</tr>
<tr>
<td>Mean</td>
<td>21.33</td>
<td>747</td>
<td>569</td>
<td>733</td>
<td>807</td>
<td>999</td>
</tr>
<tr>
<td>1997/98</td>
<td>15.39</td>
<td>474</td>
<td>505</td>
<td>513</td>
<td>504</td>
<td>619</td>
</tr>
<tr>
<td>Reduction(%)</td>
<td>27.8</td>
<td>36.5</td>
<td>11.2</td>
<td>30</td>
<td>37.6</td>
<td>38</td>
</tr>
</tbody>
</table>

Source: Sample survey and annual reports from 1987/88 to 1997/98, NARC

### Relative contribution of agriculture to greenhouse gas emission

<table>
<thead>
<tr>
<th>Item</th>
<th>CH₄ (Gg)</th>
<th>CH₄ (% of the world)</th>
<th>N₂O (Gg)</th>
<th>N₂O (% of the world)</th>
</tr>
</thead>
<tbody>
<tr>
<td>World</td>
<td>535000</td>
<td>100</td>
<td>9000</td>
<td>100</td>
</tr>
<tr>
<td>Nepal</td>
<td>984</td>
<td>0.18</td>
<td>58</td>
<td>0.64</td>
</tr>
<tr>
<td>World Agriculture</td>
<td>167500</td>
<td>31.31</td>
<td>3500</td>
<td>38.89</td>
</tr>
<tr>
<td>Nepali Agriculture</td>
<td>867</td>
<td>0.51</td>
<td>29</td>
<td>0.83</td>
</tr>
<tr>
<td>Enteric Fermentation</td>
<td>527</td>
<td>0.31</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Manure Management</td>
<td>34</td>
<td>0.02</td>
<td>2</td>
<td>0.05</td>
</tr>
<tr>
<td>Agricultural soils</td>
<td>306</td>
<td>0.18</td>
<td>27</td>
<td>0.77</td>
</tr>
</tbody>
</table>


### Seasonal Methane Emission from Rice fields in different countries

<table>
<thead>
<tr>
<th>Country</th>
<th>Average (kg ha⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Korea</td>
<td>367</td>
</tr>
<tr>
<td>Vietnam</td>
<td>336</td>
</tr>
<tr>
<td>China</td>
<td>256</td>
</tr>
<tr>
<td>Japan</td>
<td>182</td>
</tr>
<tr>
<td>Philippines</td>
<td>175</td>
</tr>
<tr>
<td>Indonesia</td>
<td>161</td>
</tr>
<tr>
<td>Thailand</td>
<td>49</td>
</tr>
<tr>
<td>India</td>
<td>45</td>
</tr>
<tr>
<td>Nepal</td>
<td>28</td>
</tr>
</tbody>
</table>

Source: Gupta and Mitra, 1999 and Malla, 2006
Carbon dioxide and Methane Emission Study, NARC

1. Field experiment
   - Carbon dioxide
     - Open Top Chamber
     - Closed Chamber
   - Methane Emission

2. Modeling approach
   - A Decision Support System for Agrotechnology Transfer (DSSAT) Model Used.

Methodology of Carbon dioxide Enrichment Technology

- Treatments:
  - Double CO₂ (580-600 ppm)
  - Ambient
  - Field

- Fertilizer:
  - 100:40:20 (NPK) Rice
  - 120:60:30 (NPK) Wheat

- Variety:
  - Chainung-242 Rice
  - BL 1473 Wheat

Carbon Emission from different crop fields in Nepal at Khumaltar

<table>
<thead>
<tr>
<th>crops</th>
<th>Average (mg ha⁻¹/hr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rice</td>
<td>84-157</td>
</tr>
<tr>
<td>Wheat</td>
<td>31-70</td>
</tr>
<tr>
<td>Onion</td>
<td>36-155</td>
</tr>
<tr>
<td>Potato</td>
<td>48-194</td>
</tr>
</tbody>
</table>

AEU/NARC 2006
### Percentage Change of Rice yield with increase of CO₂ and temperature

<table>
<thead>
<tr>
<th>Treatment</th>
<th>2001</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
<th>Average</th>
<th>% Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elevated CO₂</td>
<td>10857</td>
<td>11966</td>
<td>9861</td>
<td>8918</td>
<td>10401</td>
<td>26.58</td>
</tr>
<tr>
<td>Ambient</td>
<td>6860</td>
<td>11392</td>
<td>9395</td>
<td>8110</td>
<td>8939</td>
<td>17.07</td>
</tr>
<tr>
<td>Field</td>
<td>6386</td>
<td>10334</td>
<td>6794</td>
<td>7028</td>
<td>7636</td>
<td></td>
</tr>
</tbody>
</table>

### Difference in temperature with chamber and rice field

<table>
<thead>
<tr>
<th>Treatment</th>
<th>2001</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
<th>Average</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO₂ Enriched</td>
<td>35.84</td>
<td>31.59</td>
<td>35.76</td>
<td>35.34</td>
<td>35.10</td>
<td>34.73</td>
<td>7.36</td>
</tr>
<tr>
<td>Ambient</td>
<td>34.29</td>
<td>30.50</td>
<td>34.43</td>
<td>34.50</td>
<td>34.10</td>
<td>33.56</td>
<td>6.2</td>
</tr>
<tr>
<td>Field</td>
<td>27.43</td>
<td>26.16</td>
<td>28.63</td>
<td>27.20</td>
<td>27.40</td>
<td>27.36</td>
<td></td>
</tr>
</tbody>
</table>

### Percentage Change of Wheat yield with increase of CO₂ and Temperature

<table>
<thead>
<tr>
<th>Treatment</th>
<th>2001/02</th>
<th>2002/03</th>
<th>2003/04</th>
<th>2004/05</th>
<th>Average</th>
<th>% Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elevated CO₂</td>
<td>3059</td>
<td>5644</td>
<td>4100</td>
<td>4296</td>
<td>4268</td>
<td>18.37</td>
</tr>
<tr>
<td>Ambient</td>
<td>2235</td>
<td>5420</td>
<td>2800</td>
<td>4897</td>
<td>3838</td>
<td>8.63</td>
</tr>
<tr>
<td>Field</td>
<td>1132</td>
<td>5037</td>
<td>3100</td>
<td>4758</td>
<td>3507</td>
<td></td>
</tr>
</tbody>
</table>

### Difference in temperature with chamber and wheat field

<table>
<thead>
<tr>
<th>Treatment</th>
<th>2002/03</th>
<th>2003/04</th>
<th>2004/05</th>
<th>Average</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO₂ Enriched</td>
<td>24.91</td>
<td>30.06</td>
<td>28.1</td>
<td>27.69</td>
<td>7.12</td>
</tr>
<tr>
<td>Ambient</td>
<td>26.06</td>
<td>29.07</td>
<td>27.4</td>
<td>27.51</td>
<td>6.94</td>
</tr>
<tr>
<td>Field</td>
<td>20.42</td>
<td>21.18</td>
<td>20.1</td>
<td>20.57</td>
<td></td>
</tr>
</tbody>
</table>

### % Change in Tomato yield by doubling CO₂ and rise of temperature

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Fruit Wt. (kg/ha)</th>
<th>Fruit Wt. %</th>
<th>Fruit No. %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elevated CO₂</td>
<td>22451</td>
<td>279</td>
<td>205</td>
</tr>
<tr>
<td>Ambient</td>
<td>15785</td>
<td>196</td>
<td>165</td>
</tr>
<tr>
<td>Field</td>
<td>8032</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

### Methodology of Simulation Modeling

**DSSAT Ver. 4.0**

- **Data**
  - Weather
  - Soil
  - Crop management data

- **Zoning**
  - Terai, Hill and Mountain
  - Five development regions

- **Climate Parameters**
  - Ambient (as usual)
  - Doubling Carbon dioxide
  - Temperature rise (1°C, 2°C, 4°C)
  - Rain: ± 20%

- **Crop yield**: Actual and Potential
% change in rice yield

- Rice actual yield increased under elevated CO2 in the Terai, Hills and Mountains.
- Yield was found to increase by 3.4% in the Terai, 17.9% in the hills and 36.1% in the mountains at 4°C rise.

% change in wheat yield with Co2 and Temperature

- Increase of wheat production by 41.5% in the Terai plain, 24.4% in the hill and 21.2% in the mountain under the elevated CO2.
- Decreased by 1.8% in the Terai but increased by 5.3% in the hill and 33.3% in the mountain at 4°C rise.

% change in maize yield

- Yield under the elevated CO2 increased by 9.0% in the Terai, 4.9% in the hills and 15.5% in the mountains.
- Maize yield declined by 26.4% in the Terai, 9.3% in the hills but increased by 26.8% in the mountains at 4°C rise.

Research findings from other countries in agriculture

- Increase in mean yield due to increase in CO2
  - C3 cereals: 70%
  - C4 cereals: 28%
  - Fruits and melons: 33%
  - Legumes: 62%
  - Roots and tubers: 67%
  - Vegetables: 51%

(Source: Science and technology news service, vol. 176, issue 2371, Nov, 2002)

If so, should we be worry about food security in future?
Research findings from other countries

- Doubling of CO₂ in potato decrease the elements content like iron, zinc, manganese and sulphur (Andres, 2002)
- Doubling of CO₂ doubled the plant vitamin C contents in bean over 7 days periods (Tajari, 1985)
- 159 studies on CO₂ carried out between 1993 and 2000 showed 14 per cent decline in nitrogen content of seeds compared with plants grown in ambient air (Curtis)
- 75 percent increase in CO₂ increased vitamin C (antioxidant) concentration approximately by 5 percent in orange (Kimball and Mitchell, 1981)
- In strawberries, vitamin C and glutathione increased by 13 and 171 percent, respectively from ambient to ambient + 600 ppm CO₂ (Agriculture Research Service)
- In soybean seed, Oleic acid concentration increases with increasing temperature whereas linolenic acid decreases with increase in temperature (Thomas et. Al., 2003)

Vulnerabilities in agricultural sector due to Climate Change

- Rapid shifting of climatic Zones – extinction of biodiversity, cold water fish, herbs, pasture lands
- Decrease water table in Terai – irrigation problem
- Increase evapo transpiration – require more irrigation,
- Immense soil erosion, land slides and floods – disrupt agricultural productivity
- Decrease organic carbon in soil – effect soil health

Vulnerabilities in agricultural sector due to Climate Change Contd...

- Increase reproductive cycle of insect and pest – (Grasshopper) damage more crops – more use of pesticides (3 million cases of pesticide poisoning occur worldwide/yr - with 220,000 deaths – poisonings is more in developing countries)
- Increase in temperature – increase population of insects and pest
- Increase pesticide poisoning (dizziness, vomiting, diarrhea, cancers, disruption in the endocrine, reproductive, immune systems and mutagenicity)

Adaptation Strategies

1. Trans boundary cooperation and coordination within neighboring country to cope vulnerabilities.
3. Agricultural insurance mechanism for standing crops which help to encourage to invest in the sector.
4. Better irrigation infrastructure for reducing drought hazards
5. Insect pest and diseases
   Integrated Pest Management (IPM) and developing resistant varieties for minimizing agrochemicals uses and human health hazard)

6. Resource conservation technology
   Minimum tillage and Zero tillage in the rice-wheat and maize can reduce carbon and water loss from soil.

7. Develop drought resistant cultivars/breeds
   Heat and drought resistant cultivars/breeds for rainfed and heat stress condition.

Conclusion

1. Doubling of CO$_2$ shows positive impact on yield of major crops in all eco-zone, but negative in wheat and maize due to increased temperature.

2. Mountain environment will be more favorable than the tropical flat lands, which may cause extinction in biodiversity.

3. Increased in CO$_2$ levels may bring the hidden-hunger problem in human due to decrease in the essential nutritional elements those are supplied from food crops.

4. Long-term fluctuation in weather impact on agricultural production, slashing crop yields and forcing farmers to adopt new agricultural practices.

5. Climate change is already underway, there is a need to assess vulnerabilities and identify interventions/adoption options.
Outline of the Presentation

- Energy Use Pattern in Nepal
- Impact of Energy on Human Health
- Opportunities to promote Renewable Energy in Nepal
- Linkage between Climate Change and Energy
- Clean Development Mechanism as an opportunity

Use of Energy Resources in Nepal

<table>
<thead>
<tr>
<th>Energy Source</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Commercial</td>
<td>8%</td>
</tr>
<tr>
<td>Renewables</td>
<td>0.5%</td>
</tr>
<tr>
<td>Traditional</td>
<td>88%</td>
</tr>
<tr>
<td>Traditional fuels</td>
<td>6%</td>
</tr>
<tr>
<td>Commercial fuels</td>
<td>1.75%</td>
</tr>
<tr>
<td>Renewables fuels</td>
<td>1.75%</td>
</tr>
</tbody>
</table>

Use of Traditional Fuels

- Indoor Air Pollution
- Loss of Agricultural Productivity
- Environmental Degradation
- Non-versatile forms of energy
Impact of Energy on Human Health

Indoor Air Pollution (IAP)
- Indoor PM10 concentrations of 1,000 - 5,000µg/m³ in poorly ventilated rural houses in Nepal significantly worse than the worst cities in the world (100-300µg/m³)
- Comparative Risk Assessment Study of WHO shows that the attributable burden of Acute Lower Respiratory Infection due to indoor air pollution is substantial
- IAP ranks third among all major health risk factors in the region after malnutrition and poor water

Health Effects of Indoor Air Pollution
- COLD – Chronic Bronchitis, Emphysema and associated heart condition (Cor-Pulmonale)
- Acute Respiratory Infections in infants and children
- Asthma
- Pulmonary Tuberculosis
- Interstitial Lung diseases
- Lung Cancer
- Low birth Weight baby and increased perinatal morbidity and mortality
- Cataract

Source: Dr. M. R. Pandey's presentation at a Workshop on "Household Energy, Indoor Air Pollution and Health Impacts", organized by Winrock in August 2004

Use of Fossil Fuels

Outdoor Air Pollution
- In the dry months, along the busy road sides the PM10 level is above acceptable limits on 99% of the days in Kathmandu
- Vehicle emissions, construction and emissions from the industries are the major sources for outdoor air pollution
- Indications are that a mere 10µg/m³ increase in PM2.5 can increase risk of lung cancer by 8%, cardiopulmonary deaths by 6% and all deaths by 4%
- Children, elderly and people with lung and heart diseases are more vulnerable to the health effect of the air pollution

Source: Foundation for Sustainable Technologies Website

Air Pollution

- Reducing the annual average PM10 level in Kathmandu Valley to international standards (50 µg/m3) will avoid:
  - over 2000 hospital admissions
  - over 40,000 emergency room visits,
  - over 135,000 cases of acute bronchitis in children,
  - over 4,000 cases of chronic bronchitis
  - About half a million asthma attacks
  - 5 million restricted activity days
  - 32 million days with respiratory symptoms

Source: "Health Impacts of Kathmandu’s Air Pollution", a presentation by Bhushan Tuladhar & Prof. Dr. Bimala Shrestha, September 2003

Energy and Climate Change

- Worldwide, GHG emissions from various sources of energy are the major contributors of climate change
- Nepal has negligible contribution of GHG emission
- Use of clean energy: climate change mitigation measure
- Impact of climate change on water resources will affect hydropower generation
- Nepal can benefit from worldwide climate change mitigation initiatives by developing Clean Development Mechanism (CDM) projects

CDM Concept: An Opportunity to Reduce the Climate Change Impacts

A transfer of finances and contribution to sustainable development in the Host Country

Flow of Finances

Developed Country

Flow of Carbon Credits

Clean energy and other projects

Developing Country (Nepal)
CDM Potential Sector in Nepal

- Decentralized renewable energy for rural areas - biogas, micro-hydro, Solar PV etc.
- Fuel substitution from fossil fuels to clean hydropower electricity in transportation, industrial sector, residential sector, agriculture etc.
- Energy Efficiency in Industries
- Forestry and agriculture

An Example

Nepal Biogas CDM projects
- Registered on 27 December 2005
- Net emission reductions of around 94,000 tons of CO2 per year from 19,000 plants (5 tons/plants/year)
- Project developer: Alternative Energy Promotion Center (AEPC)
- Buyer: Community Development Carbon Fund of the World Bank at $7 per ton
- Annual revenue: $658,000 for 7 years

Conclusions

- Present energy use pattern has negative impact on human health
- Nepal has abundance of renewable hydro power and solar energy resources
- Replacement of current energy sources with clean, renewable energy in households, transport, industries etc. can improve human health and reduce GHG emissions
- CDM can generate revenues for further clean and renewable energy development
- Clean energy development helps in improving human health

Thank You
Technical Session –III
Climate Change and Human Health, Vulnerability and Adaptation

Chairperson: Dr. Sharad Raj Onta, Member-Secretary, NHRC

   Dr. Bandana Pradhan, Associate Professor, Institute of Medicine, Maharajgunj

Paper 8 – Climatic Determinants in Malaria and Kala-azar in Nepal
   Mr. Sagar Dahal, Public Health Administrator, Epidemiology and Disease Control
   Department of Health Services, Ministry of Health and Population
1. Climate Change Phenomena

- Temperature increased by 0 to 0.6 °C per decade and will increase by 1° to 3.5°C in coming century
- Monsoon rainfall - less predictable and less dependable in terms of distribution and amount
- Glacier retreat - with reduction in area and volume
- Weather change
  - fog persists until late morning in Tarai; short stay in Kathmandu
- Increase in cold and hot waves events in Tarai
- Increase in flash floods, intensity decrease

### Regional Mean Temperature Trends for the period 1977-2000 (°C per year)

<table>
<thead>
<tr>
<th>Regions</th>
<th>Winter</th>
<th>Pre-monsoon</th>
<th>Monsoon</th>
<th>Post-monsoon</th>
<th>Jan-Dec</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Dec-Feb</td>
<td>Mar-May</td>
<td>Jun-Sep</td>
<td>Oct-Nov</td>
<td>Jan-Dec</td>
</tr>
<tr>
<td>Trans-Himalaya</td>
<td>0.12</td>
<td>0.01</td>
<td>0.11</td>
<td>0.10</td>
<td>0.09</td>
</tr>
<tr>
<td>Himalaya</td>
<td>0.09</td>
<td>0.05</td>
<td>0.06</td>
<td>0.08</td>
<td>0.06</td>
</tr>
<tr>
<td>Middle Mountains</td>
<td>0.06</td>
<td>0.05</td>
<td>0.06</td>
<td>0.09</td>
<td>0.08</td>
</tr>
<tr>
<td>Siwalik</td>
<td>0.02</td>
<td>0.01</td>
<td>0.02</td>
<td>0.08</td>
<td>0.04</td>
</tr>
<tr>
<td>Terai</td>
<td>0.01</td>
<td>0.00</td>
<td>0.01</td>
<td>0.07</td>
<td>0.04</td>
</tr>
<tr>
<td>All-Nepal</td>
<td>0.06</td>
<td>0.03</td>
<td>0.051</td>
<td>0.08</td>
<td>0.06</td>
</tr>
</tbody>
</table>

Update after Shrestha et al., 1999
2. State of quantity and quality of water bodies (rivers, lakes and pond)

WATER QUANTITY

- Volume availability by surface water (rivers, lakes) - fluctuation due to rain fed
- Groundwater (shallow tube wells and deep tube wells) drinking, irrigation

Water Availability and Use by Sector, Nepal

<table>
<thead>
<tr>
<th>Description</th>
<th>1995</th>
<th>2001</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Total annual renewable water resource (km³/year)</td>
<td>224</td>
<td>224</td>
</tr>
<tr>
<td>2. Per capita renewable water resource (000m³/year)</td>
<td>11.0</td>
<td>9.6</td>
</tr>
<tr>
<td>3. Total annual withdrawal (million m³/y)</td>
<td>13.97</td>
<td>18.5</td>
</tr>
<tr>
<td>4. Per capita annual withdrawal (000 m³/y)</td>
<td>0.69</td>
<td>0.8</td>
</tr>
<tr>
<td>5. Withdrawal (%) from:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.1 Domestic</td>
<td>3.8</td>
<td>3.6</td>
</tr>
<tr>
<td>5.2 Industry</td>
<td>0.3</td>
<td>0.3</td>
</tr>
<tr>
<td>5.3 Agriculture</td>
<td>95.9</td>
<td>96.1</td>
</tr>
</tbody>
</table>

Source: MOPE/UNEP/ICIMOD (2001)

Household Access to Drinking Water Sources

<table>
<thead>
<tr>
<th>Source CBS 2002</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pipe</td>
</tr>
<tr>
<td>Well</td>
</tr>
<tr>
<td>Tube Well</td>
</tr>
<tr>
<td>Stone Spout</td>
</tr>
<tr>
<td>Rivers/ Stream</td>
</tr>
<tr>
<td>Others</td>
</tr>
</tbody>
</table>

Water Sources such as well, tube well, spring (stone spout), & streams/ponds depend on monsoon rainfall.

WATER QUALITY

- Anthropogenic activities -
- Natural factors - floods, landslides, etc.
- Limno-bacteria characteristics
  - Heterotrophic bacterial count - Total bacterial count
  - Indicator bacteria - faecal streptococcus, coliform, faecal coliform and E. coli
  - Temperature rise favourable for survival of these bacteria
  - Benthic macro invertebrates - abundance & diversity

Note that the Water Sources such as well, tube well, spring (stone spout), & streams/ponds depend on monsoon rainfall.
Climate Change and Water Quality

- Decrease in dissolved oxygen concentration
- Eutrophication - oxygen depletion
- Climate change responds to thermal stratification
- Warmer & drier conditions promote mineralization of organic nitrogen and thus increase the potential supply to river or groundwater
- Flash floods affect water quality – transporting contaminants into water bodies and overload storm & wastewater systems

Water Quality of Major Rivers, Dry Season

<table>
<thead>
<tr>
<th>Sample Sites of Major Rivers in Different Parts of Nepal</th>
<th>pH</th>
<th>TDS mg/l</th>
<th>DO mg/l</th>
<th>BOD mg/l</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mahakali at Pancheswar</td>
<td>8.8</td>
<td>110.0</td>
<td>5.0</td>
<td>&lt;2</td>
</tr>
<tr>
<td>Karnali at Chisapani</td>
<td>8.9</td>
<td>264.0</td>
<td>10.5</td>
<td>1.5</td>
</tr>
<tr>
<td>Bheri at Chatgaon</td>
<td>7.8</td>
<td>208.0</td>
<td>9.3</td>
<td>1.1</td>
</tr>
<tr>
<td>Seti at Ramghat, Pokhara</td>
<td>8.2</td>
<td>2.2</td>
<td>9.3</td>
<td>&lt;2.5</td>
</tr>
<tr>
<td>Rapti at Sauraha, Chitwan</td>
<td>7.8</td>
<td>213.0</td>
<td>8.7</td>
<td>-</td>
</tr>
<tr>
<td>Arun</td>
<td>6.5</td>
<td>200.0</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Kankai</td>
<td>7.7</td>
<td>60.0</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Mechi</td>
<td>8.3</td>
<td>30.0</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>WHO Guidelines</td>
<td>6.5-8.5</td>
<td>100.0</td>
<td>&gt;5.0</td>
<td>3.0</td>
</tr>
</tbody>
</table>

Drinking Water Quality

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Water sources</th>
<th>WHO GV</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>Pr Tap</td>
<td>Pu Tap</td>
</tr>
<tr>
<td>Iron (mg/l)</td>
<td>ND-0.2</td>
<td>0.2</td>
</tr>
<tr>
<td>Chlorine mg/l</td>
<td>ND</td>
<td>ND</td>
</tr>
<tr>
<td>Chloride mg/l</td>
<td>10-30</td>
<td>22-45</td>
</tr>
<tr>
<td>N-NH4 (mg/l)</td>
<td>ND-0.2</td>
<td>0.2</td>
</tr>
<tr>
<td>PO4 - P (mg/l)</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>Coliform bacteria (source)</td>
<td>+/-</td>
<td>+</td>
</tr>
<tr>
<td>Coliform bacteria (consumption point)</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>E. coli cfu/100 ml</td>
<td>10-131</td>
<td>3-20</td>
</tr>
</tbody>
</table>
Water Quality Deterioration due to Relative Volume of Waste Water Discharged into River

- Domestic waste
- Industrial waste

3. Climate Change and Livelihood Patterns

- Water based activities - fishing and boating (navigation), watermill based, hydropower, irrigation
- Land based activities - crop cultivation, pottery,
  - Tourism (rafting, camping, trekking, mountaineering - avalanches, wind storms)
- Agriculture production 720 thousand tones
  330 thousand tones from irrigated land (46%)
- 1°C rise in temp, 10% decrease in irrigation

Diseases Burden

1. Water related disease
2. Natural hazards induced diseases
Water borne diseases

Top Ten OPD Diseases in 2005 (n = 9,552,307)

Disease Types

Skin
ARI
Diarrhoeal
Worms
Pyrexia
Gastrointestinal
Ear
Eye
Bronchitis
Tooth

Monthly Trends in OPD Visits

Trend of Diarrhoeal Disease Total OPD Visit

Patients visits (000)

<table>
<thead>
<tr>
<th>Month</th>
<th>J</th>
<th>F</th>
<th>M</th>
<th>A</th>
<th>M</th>
<th>J</th>
<th>A</th>
<th>S</th>
<th>O</th>
<th>N</th>
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<td>1200</td>
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<tr>
<td>2004</td>
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<td>650</td>
<td>750</td>
<td>850</td>
<td>950</td>
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<td>1450</td>
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<td>2005</td>
<td>500</td>
<td>600</td>
<td>700</td>
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<td>1000</td>
<td>1100</td>
<td>1200</td>
<td>1300</td>
<td>1400</td>
<td>1500</td>
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</tbody>
</table>

Number (000)

<table>
<thead>
<tr>
<th>Month</th>
<th>J</th>
<th>F</th>
<th>M</th>
<th>A</th>
<th>M</th>
<th>J</th>
<th>A</th>
<th>S</th>
<th>O</th>
<th>N</th>
<th>D</th>
</tr>
</thead>
<tbody>
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<td>1995</td>
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<td>200</td>
<td>300</td>
<td>400</td>
<td>500</td>
<td>600</td>
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<td>1996</td>
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<td>210</td>
<td>310</td>
<td>410</td>
<td>510</td>
<td>610</td>
<td>710</td>
<td>810</td>
<td>910</td>
<td>1010</td>
<td>1110</td>
</tr>
<tr>
<td>1997</td>
<td>120</td>
<td>220</td>
<td>320</td>
<td>420</td>
<td>520</td>
<td>620</td>
<td>720</td>
<td>820</td>
<td>920</td>
<td>1020</td>
<td>1120</td>
</tr>
<tr>
<td>2003</td>
<td>130</td>
<td>230</td>
<td>330</td>
<td>430</td>
<td>530</td>
<td>630</td>
<td>730</td>
<td>830</td>
<td>930</td>
<td>1030</td>
<td>1130</td>
</tr>
<tr>
<td>2004</td>
<td>140</td>
<td>240</td>
<td>340</td>
<td>440</td>
<td>540</td>
<td>640</td>
<td>740</td>
<td>840</td>
<td>940</td>
<td>1040</td>
<td>1140</td>
</tr>
<tr>
<td>2005</td>
<td>150</td>
<td>250</td>
<td>350</td>
<td>450</td>
<td>550</td>
<td>650</td>
<td>750</td>
<td>850</td>
<td>950</td>
<td>1050</td>
<td>1150</td>
</tr>
</tbody>
</table>
Drinking Water versus Diarrhoeal Diseases

Rota virus infection among diarrhoeal children attending Kanti Children Hospital, Kathmandu

- Rotavirus is one of the causative agents of diarrhoea among children <5 years of age
- Predominant in winter season
- Transmits through faecal oral route and poor sanitation

Typhoid fever - indirect effect of climate

- Occurs where water supply and sanitation is substandard

Mosquito

Four distinct stages: Egg, Larva, pupa, and adult.

The common groups of mosquitoes are Aedes, Anopheles, Culex, and Culiseta

Average time for life cycle 10-14 days

Precipitation and Typhoid cases from Patan hospital

Agent – S. typhi, S. paratyphi
Reservoirs of infection – Cases & Carrier
Carrier: (i) temporary (6-8 weeks), about 4% one year, and (ii) Chronic - Person who excrete bacilli for more than a year to 50 years

Poor drainage condition – favorable environment for mosquito breeding
**Malaria Parasite**

- Malaria endemic in 65 districts
- Malaria eradication program in 1958
- Malaria control program 1978
- Most common species is *Plasmodium vivax*

**Natural hazards induced diseases**

- Increasing trend of *P. falciparum*
- *Anopheles minimus* is common vector

**Insecticide Dose /M² (gm)**

<table>
<thead>
<tr>
<th>Insecticide</th>
<th>Dose /M² (gm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>α Cypermethrin</td>
<td>0.025</td>
</tr>
</tbody>
</table>

**Human Deaths due to Natural Hazards**

- FLOODS = valleys and plain
- LANDSLIDES = hills
- AVALANCHES = Himalaya

**Vulnerable Populations**

- Children and women - pregnant
- Squatters - large cities
- Slum dwellers - large cities
- Dwellers of Flood plain & River banks & Hill slopes
- Internally Displaced Persons, “IDPs” (due to political, socioeconomic, natural)
- Commercial sex workers
- Prisoners
- Refugees (Bhutanese, Tibetan)
- Rag pickers, street children & child workers
Adaptation Measures

- Climate change study within DHM/MOEST - cross cutting disciplines and sectors
- Conflicts in water use - priority on drinking water, and use in irrigation, hydropower and others - local & regional conflicts
- More focus on preventive measures for typhoid, diarrhoea diseases through providing potable water
- Imparting awareness programme about water pollution and diseases across the country by adopting school level curriculum

Adaptation Measures - Climate Change

- Conservation of water reservoirs through increasing forest coverage with extending community forestry programme
- Understanding of increase in water-borne diseases and establishing links between climatic elements (temp, rainfall, flood) and their health problems/diseases
- Establish and updating database on climate change and health relationships through researches
Climatic Determinants in Malaria and Kala-azar in Nepal

Sagar Dahal
Epidemiology and Disease Control Division
Department of Health Service

Vector Borne Diseases of Public Health Importance

- Distribution of malaria from forest fringe and plains (< 200m MSL) to 67 districts up to an altitude of 2000m MSL
- Prevalence of Kala-azar since 1980 and its distribution to 12 districts of eastern and central terai.
- First indication of transmission of JE from Rupandehi and Morang in 1978 to 24 districts by 2006
- Presence of vector of Dengue in some districts and outbreak reported in 2006.
- Lymphatic Filariasis endemic districts 60.
Control Strategies

- Early Diagnosis and prompt treatment
- Integrated vector management (IRS and LLIN)
- Protecting the susceptible
- Mass drug administration in Lymphatic Filariasis
- Educating the public and community based environmental modifications
- Enhanced surveillance of vector and the disease
- Emergency preparedness

Malaria in Nepal

- Malaria: one of the most important cause of economic misfortune with high mortality
- No documentation of its prevalence in the 19th century
- First epidemiological survey dates back to 1925 in Makwanpur and Chitwan Valley
- Estimated cases 2 million cases with 10-15% deaths

Malaria in Nepal...

- 1954, Insect Borne Disease control project started in southern belt of central terai.
- 1956-58, malaria control project in Rapti valley
- National malaria eradication program: 1958
- In 70s shifting from eradication to control strategy and integration into health system
- Curtailing of cases to 5000 to 7000 per year

DISTRIBUTION OF MALARIA CASES

- Malaria Endemic Districts (67)
- Malaria Free Districts (8)
- Highly Endemic District (12)
Malaria Distribution by topography

1. Transect of Nepal (Schematic) Showing Main Topographical Features
   - Malarious Belts: Cultivated Terai
   - Forested Terai
   - Inner Terai
   - Mountains & Upper River Valleys

Rice & Malaria
Forests
People
Pasture
India
Mahabharat mountains
Churia hills
Himalayan mountains
Nepal Border
China
Nepal Border
Mountains and upper river valleys
Inner Terai
Forest
Cultivated Terai
Outer Terai
Plain Terai

Malaria Positive Cases and Epidemics (1964-2006)

Major epidemics observed after 70s
- 1974: 14647 cases, Kapilvastu, Rupandehi, and Nawalparasi
- 1985–1988: FWDR and Central Region, maximum in 1985 with 42231 cases
- 1991–epidemics in FWDR and Central Region with total cases reaching 29000
- 2002: Kanchanpur
- 2005: Jhapa
- 2006: Banke

Kala-azar Endemic Districts, Nepal

KA Endemic District
Jhapa, Morang, Sunsari, Saptari, Siraha, Dhanusha, Mahottari, Udayapur Sarlahi, Rautahat, Bara, Parsa

Population at risk- Approx. 7.5 Million

Kala-azar

- Known to be endemic in southern terai in the past
- In 1960s and 70s ceased to be a public health problem
- In 1980 came up with an incidence rate of 1.5/100000 and CFR 5.8%
- Highest case fatality was observed in 1982 and highest incidence in 2006
- Mainly confined to the southern plains of eastern and Central region (12 Districts)
Kala-azar cases and CFR (1973-2006)

Climate Change and VBD

Can these events be associated with climate change?

If yes, what is the level of its contribution in the occurrence and distribution?

Do we have the evidences?

Critical temperatures in malaria epidemiology

Are the diseases sensitive to climatic factors?

- minimum temperature for mosquito development
- minimum temperature for parasite development
  - \( P. vivax < P. falciparum \)
- optimum temperature for mosquitoes
  - 25 26 27 . . . 40
- maximum temperature for parasites and mosquitoes

Adapted from WHO
Mean Annual Temperature, 1975 to 2005

Temperature and Malaria Cases 1975 to 2005

Malaria cases and average precipitation during monsoon in 11 Highly Endemic Districts

Malaria Cases and Precipitation Jhapa 2005
Conclusion

- Appropriate time to strive for full understanding the effect of climate change on malaria and kala-azar epidemiology or VBDs
- Will help us in addressing the problem with better adaptation measures.
- Enhances our preparedness....

Thank You
For Your Kind Attention
Technical Session – IV
Climate Change, Vulnerability and Adaptation

Chairperson: Dr. Dirga Singh Bam, Chief Curative Division, Ministry of Health and Population

Paper -9 Assessing Human Health Vulnerability and Public Health Adaptation to Climate Variability and Change
   Mr. Meghnath Dhimal, Environmental Health Research Officer, NHRC

Paper-10 Climate Change and Human Well Being.
   Dr. Fang Jing, Eco-health Specialist, ICIMOD

Paper-11 Climate Change Impacts and Community Based Adaptation Measures in Nepal
   Mr. Gehendra Gurung, Practical Action Nepal
Assessing Human Health Vulnerability and Public Health Adaptation to Climate Change and Variability

Meghnath Dhimal
Environmental Health Research Officer
NHRC

December 20, 2007

Outline of Presentation

- Concept of Vulnerability and Adaptation
- Framework for Vulnerability and Adaptation
- Steps in Assessing Vulnerability and Adaptation
- Framework for Assessment
- IPCC AR4 Criteria for Identifying Vulnerabilities and Identified Potential Key Vulnerabilities
- IPCC AR4 Health Chapter
Concept of Vulnerability and Adaptation

- IPCC defines vulnerability as the degree to which individuals and systems are susceptible to or unable to cope with the adverse effects of climate change, including climate variability and extremes.
- Adaptation to climate change refers to adjustment in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial communities.

Fig. Framework for vulnerability and adaptation

Source: Ebi et al. 2005

- Individual, community and geographical factors determine vulnerability.
- Adaptation includes the strategies, policies and measures undertaken now and in the future to reduce potential adverse health effects.
- Adaptive capacity describes the general ability of institutions, systems and individuals to adjust to potential damages, to take advantage of opportunities and to cope with the consequences.

- Coping capacity describes what could be implemented now to minimize negative effects of climate variability and change.
- Specific adaptation interventions arise from the coping capacity of a community, country or region.
Steps in Assessing Vulnerability and Adaptation

1. Determine the scope of the assessment.
2. Describe the current distribution and burden of climate-sensitive diseases.
3. Identify and describe current strategies, policies and measures that reduce the burden of climate-sensitive diseases.
4. Review the health implications of the potential impact of climate variability and change on other sectors.
5. Estimate the future potential health impact using scenarios of future climate change, population growth and other factors and describe the uncertainty.
6. Synthesize the result and draft a scientific assessment report.
7. Identify additional adaptation policies and measures to reduce potential negative health effects, including procedures for evaluation after implementation.

The Framework for the Assessment

- Involvement of Stakeholders
- Management Structure
- Levels of Assessment
- Peer Review Process and
- Dissemination and Risk Communication

Fig: Tasks for public health science
The five main tasks for researchers

1. Establishing baseline relationships between weather and health
2. Seeking evidence of early effects of climate change
3. Scenario-based predictive models
4. Evaluating adaptation options
5. Estimating the co-incidental benefits and costs of mitigation and adaptation

The Criteria used in IPCC AR4 to Identify Key Vulnerabilities

- Magnitude of impacts,
- Timing of impacts,
- Persistence and reversibility of impacts,
- Likelihood (estimates of uncertainty) of impacts and vulnerabilities, and confidence in those estimates,
- Potential for adaptation,
- Distributional aspects of impacts and vulnerabilities,
- Importance of the system (s) at risk

Health Impact of Climate Change (IPCC AR4)

Climate change currently contributes to the global burden of disease and premature deaths (very high confidence).

- Human beings are exposed to climate change through changing weather patterns (temperature, precipitation, sea-level rise and more frequent extreme events) and
- indirectly through changes in water, air and food quality and changes in ecosystems, agriculture, industry and settlements and the economy.
- At this early stage the effects are small but are projected to progressively increase in all countries and regions.

Emerging evidence of climate change effects on human health shows that climate change has:

- altered the distribution of some infectious disease vectors (medium confidence)
- altered the seasonal distribution of some allergenic pollen species (high confidence)
- increased heatwave-related deaths (medium confidence)
Projected trends in climate change-related exposures of importance to human health will:

- Increase malnutrition and consequent disorders, including those relating to child growth and development (high confidence)

- Increase the number of people suffering from death, disease and injury from heatwaves, floods, storms, fires and droughts (high confidence)

- Continue to change the range of some infectious disease vectors (high confidence)

- Have mixed effects on malaria; in some places the geographical range will contract, elsewhere the geographical range will expand and the transmission season may be changed (very high confidence)

- Increase the burden of diarrhoeal diseases (medium confidence)

- Increase cardio-respiratory morbidity and mortality associated with ground-level ozone (high confidence)

- Increase the number of people at risk of dengue (low confidence)

- Bring some benefits to health, including fewer deaths from cold, although it is expected that these will be outweighed by the negative effects of rising temperatures worldwide, especially in developing countries (high confidence)

Adaptive capacity needs to be improved everywhere; impacts of recent hurricanes and heatwaves show that even high-income countries are not well prepared to cope with extreme weather events (high confidence).

Adverse health impacts will be greatest in low-income countries. Those at greater risk include, in all countries, the urban poor, the elderly and children, traditional societies, subsistence farmers, and coastal populations (high confidence).

Economic development is an important component of adaptation, but on its own will not insulate the world’s population from disease and injury due to climate change (very high confidence).

Methods Used for Health in IPCC AR4

The evidence for the current sensitivity of population health to weather and climate is based on five main types of empirical study:

- Health impacts of individual extreme events (e.g., heat waves, floods, storms, droughts, extreme cold)

- Spatial studies where climate is an explanatory variable in the distribution of the disease or the disease vector

- Temporal studies assessing the health effects of interannual climate variability, of short-term (daily, weekly) changes in temperature or rainfall, and of longer-term (decadal) changes in the context of detecting early effects of climate change

- Experimental laboratory and field studies of vector, pathogen, or plant (allergen) biology

- Intervention studies that investigate the effectiveness of public-health measures to protect people from climate hazards
Key research priorities include addressing the major challenges for research on climate change and health in the following ways.

- Development of methods to quantify the current impacts of climate and weather on a range of health outcomes, particularly in low- and middle-income countries.
- Development of health-impacts models for projecting climate-change-related impacts under different climate and socio-economic scenarios.
- Investigations on the costs of the projected health impacts of climate change; effectiveness of adaptation; and the limiting forces, major drivers and costs of adaptation.

Any Questions ............

Thank you!

Climate Change and Human Wellbeing

Dr. Fang Jing
ICIMOD
2007.12

Contents

- Climate change: a undoubtedly fact
- Human wellbeing: definition and measurement
- The current situation of human wellbeing in Nepal
- How does climate change affect human welling? particularly human health?
- What to do next to respond to climate change?
Climate Change

• Temperature rising: 0.8°C over the past century and 0.6°C in the last three decades and will increase 1.1-6.4°C during 21 century
• Extreme weather events
  – Heatwaves will increase
  – Cold days decrease over mid to low latitudes
  – More hurricanes, cyclones and storms—floods
  – Change in the frequency and magnitude of droughts
• Change of precipitation
  – Proportion of heavy precipitation events will increase with differences in the spatial distribution of the changes, water availability will be affected in rainy and dry season

Human Wellbeing

• A multidimensional concept
• Various definitions.
  E.g. Quality of life; living standards; human development; welfare; social welfare; well-being; utility; life satisfaction; prosperity; needs fulfillment; development; empowerment; capability expansion, poverty; human poverty; and happiness.
• Various indicators for measurement of human wellbeing.
  E.g. income; GDP; HDI (human development index), human wellbeing index (HWI), ecosystem wellbeing index (EWI)

Human Wellbeing (continued)

• Human wellbeing definition adopted by MA
  – Basic material for a good life
  – Freedom and choice
  – Health
  – Good social relations
  – Security

Some Indicators of Human Wellbeing in Nepal

• GDP per capita: $224 (2002). The total share of agriculture in GDP is about 37.27%.
• Life expectancy: 60.1 (males) and 60.7 (females) (Census in 2001).
• MMR, IMR and under 5 mortality: 281 per 100,000 live births, 48/1000 and 61/1000 live births respectively (1999-2005, NDHS, 2006)
• Other health indicators:
  – 75% of pregnant women in Nepal are anemic (NDF 2004_health.pdf).
  – Every ten children in Nepal, only one is free of malnutrition. More than 50% of women are anemic (Nutrition Programme in Nepal, USAID).
  – Poor and other marginalized groups such as indigenous people will suffer from these problems disproportionately. For example, Chepang community has more severe malnutrition compared with other people.
• HDI: 0.332, ranked 151 among 174 countries (HRD, 2001)
How does Climate Change Affect Human Wellbeing?

- Material minimum for a good life. E.g. reduction or extinction of some animal and plant species
- Social relations. E.g. increasing conflicts over reduced natural resources and diminishing cultural and spiritual services provided by ecosystems
- Security. E.g. food security; increasing hazard and disasters
- Freedom and choice

The Impact of Climate Change on Human Health

- Direct impact
  - Health conditions (heatstroke, injuries, death) associated with extreme weather events. E.g. heatwaves, storms, droughts, extreme cold, and displacement, which can be measured by heat-related or cold related morbidity and mortality
  - Diseases. Vector borne disease: malaria, Dengue, schistosomiasis; aeroallergens and disease: allergic rhinitis

- Indirect impact
  - Water. Quality and quantity. Water and food borne diseases;
  - Biodiversity
  - Air pollution
  - Agricultural production. Energy and protein malnutrition
  - the growth and distribution of the disease vectors
  - Industry, settlements and economy.
The Impact of Climate Change on Human Health

• The observed impact
  – Seasonality of some allergenic species and the seasonal activity and distribution of some disease vectors
  – Seasonal pattern or temporal distribution of Malaria, dengue, tick-born diseases (tick-born encephalitis and lyme disease), cholera and some other diarrhoeal diseases
  – The health outcomes caused by Heatwaves and flooding

• The projected impact
  – Increase in cardiovascular disease mortality in tropical region; increase the burden of diarrhoeal diseases in low income regions
  – Increase in heat-related mortality and morbidity

The Reported Number of Major Infection Diseases in Yuanmou, Yunnan, China from 1991 to 2005

<table>
<thead>
<tr>
<th>Year</th>
<th>Diarrhea</th>
<th>Typhoid</th>
<th>Tuberculosis</th>
<th>Malaria</th>
<th>Measles</th>
</tr>
</thead>
<tbody>
<tr>
<td>1991</td>
<td>197</td>
<td>140</td>
<td>/</td>
<td>79</td>
<td>95</td>
</tr>
<tr>
<td>1992</td>
<td>258</td>
<td>48</td>
<td>/</td>
<td>48</td>
<td>78</td>
</tr>
<tr>
<td>1993</td>
<td>129</td>
<td>13</td>
<td>/</td>
<td>62</td>
<td>7</td>
</tr>
<tr>
<td>1994</td>
<td>99</td>
<td>398</td>
<td>/</td>
<td>22</td>
<td>128</td>
</tr>
<tr>
<td>1995</td>
<td>146</td>
<td>91</td>
<td>/</td>
<td>18</td>
<td>40</td>
</tr>
<tr>
<td>1996</td>
<td>276</td>
<td>134</td>
<td>/</td>
<td>10</td>
<td>91</td>
</tr>
<tr>
<td>1997</td>
<td>346</td>
<td>78</td>
<td>226</td>
<td>3</td>
<td>7</td>
</tr>
<tr>
<td>1998</td>
<td>254</td>
<td>26</td>
<td>164</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>1999</td>
<td>265</td>
<td>71</td>
<td>188</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>2000</td>
<td>177</td>
<td>61</td>
<td>223</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>2001</td>
<td>157</td>
<td>79</td>
<td>184</td>
<td>1</td>
<td>14</td>
</tr>
<tr>
<td>2002</td>
<td>71</td>
<td>39</td>
<td>155</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>2003</td>
<td>153</td>
<td>162</td>
<td>171</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>2004</td>
<td>309</td>
<td>115</td>
<td>207</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2005</td>
<td>200</td>
<td>133</td>
<td>190</td>
<td>2</td>
<td>0</td>
</tr>
</tbody>
</table>

The Reported Water Borne Disease in Yuanmou County, Yunnan China from 1991-2005

The Reported Water malaria and measles in Yuanmou County, Yunnan China from 1991-2005
### Trend of Vector Borne Diseases in Nepal

![Trend of Vector Borne Diseases in Nepal](image)

- **Viral Encephalitis**
- **Filariasis**
- **Dengue Fever**
- **Kala-azar**
- **Clinical Malaria**

#### Encephalitis Cases in Nepal (Source: DOHS, 2006)

![Acute Encephalitis Syndrome (JE)](image)

- **2001**: 227 cases, 10 deaths
- **2002**: 180 cases, 8 deaths
- **2003**: 464 cases, 11 deaths
- **2004**: 131 cases, 1 death
- **2005**: 310 cases, 0 deaths

### Casualties by Climate-Related Events in Nepal, 2002

(MOH (2002): Disaster Review, Department of Narcotics Control and Disaster Management)

<table>
<thead>
<tr>
<th>Events</th>
<th>Killed</th>
<th>Injured</th>
<th>Homeless</th>
<th>Affected</th>
<th>Damage US $</th>
</tr>
</thead>
<tbody>
<tr>
<td>All disasters</td>
<td>20,927</td>
<td>7,794</td>
<td>155,590</td>
<td>7,053,754</td>
<td>1,316,413</td>
</tr>
<tr>
<td>Floods</td>
<td>5,003</td>
<td>725</td>
<td>69,350</td>
<td>1,531,125</td>
<td>990,813</td>
</tr>
<tr>
<td>Drought</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>4,400,000</td>
<td>1,000</td>
</tr>
<tr>
<td>Extreme Tem</td>
<td>60</td>
<td>210</td>
<td>0</td>
<td>210</td>
<td></td>
</tr>
<tr>
<td>Windstorms</td>
<td>97</td>
<td>19</td>
<td>0</td>
<td>164</td>
<td>1,000</td>
</tr>
<tr>
<td>Climate related</td>
<td>5100</td>
<td>954</td>
<td>69,350</td>
<td>5,931,519</td>
<td>1,004,213</td>
</tr>
<tr>
<td>As % of all disasters</td>
<td>24.7%</td>
<td>12.2%</td>
<td>45.2%</td>
<td>84.1%</td>
<td>76.3%</td>
</tr>
</tbody>
</table>

### Challenges in Studying Climate Change and Human Health

- **Temporal scale**: decades
- **Spatial scale**: geographic/ecological areas rather than administrative/management territory
- **Availability and quality of data**: data on disease, climate, socioeconomic conditions at the same temporal and spatial scales
- **Difficulties in attribution**: due to the multiple determinants of health outcomes
What to Do Next to Respond to Climate Change?

• Mitigation

• Strengthening adaptation
  – the health of population is an important element of adaptive capacity
  – Preventive environmental health interventions. E.g. safe drinking water and sanitation facilities
  – Establishing or strengthening Infectious disease surveillance, reporting and response system
  – Building capacity of health sector for responses. E.g. Training of health professionals to understand the threats posed by climate change
  – Conducting research to fill out the knowledge gaps and reduce uncertainties

• Promoting cooperation and coordination of different sectors and strengthening alliances for sustainable development

• Reducing vulnerability
  – poverty reduction: poverty is the biggest vulnerability factor to climate change
  – improving infrastructure, e.g. water and sanitation, health facilities

Thank you very much for your attention!
Average temperature trend of Nepal

\[ y = 0.0274x + 19.26 \]
\[ R^2 = 0.3263 \]

Recent years becoming hotter

<table>
<thead>
<tr>
<th>S. No</th>
<th>Year</th>
<th>Anomaly (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1998</td>
<td>0.52</td>
</tr>
<tr>
<td>2</td>
<td>2005</td>
<td>0.48</td>
</tr>
<tr>
<td>3</td>
<td>2003</td>
<td>0.46</td>
</tr>
<tr>
<td>4</td>
<td>2002</td>
<td>0.46</td>
</tr>
<tr>
<td>5</td>
<td>2004</td>
<td>0.43</td>
</tr>
<tr>
<td>6</td>
<td>2006</td>
<td>0.42</td>
</tr>
<tr>
<td>7</td>
<td>2001</td>
<td>0.40</td>
</tr>
<tr>
<td>8</td>
<td>1997</td>
<td>0.36</td>
</tr>
<tr>
<td>9</td>
<td>1995</td>
<td>0.28</td>
</tr>
<tr>
<td>10</td>
<td>1999</td>
<td>0.26</td>
</tr>
</tbody>
</table>

All Nepal average precipitation trend

\[ y = 5.1775x + 538.9 \]
\[ R^2 = 0.3088 \]

Above 300 mm rainfall events in 24 hours

\[ y = 1.0614x + 343.7 \]
\[ R^2 = 0.0689 \]
Nepal monsoon trend

- June
- September

Rainfall (mm)

Source DHM

Impacts of warming on glaciers

AX010 Glacier

Disappearance predicted by 2060

Increasing trend in size and no. of glacial lakes
Incidence of floods and landslides

Trends of some diseases

Vulnerability and wellbeing indicators of the communities

<table>
<thead>
<tr>
<th>Wellbeing indicator</th>
<th>Good / enough farm land</th>
<th>Irrigation facility</th>
<th>Drinking water</th>
<th>Enough fuel / fodder</th>
<th>Livestock</th>
<th>Health</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vulnerability context</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deforestation</td>
<td>XX</td>
<td>XX</td>
<td>XX</td>
<td>XXX</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Flood</td>
<td>XX</td>
<td>XX</td>
<td>XX</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Land slide</td>
<td>XXX</td>
<td>XX</td>
<td>XX</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lack of livelihood options</td>
<td>XXX</td>
<td></td>
<td></td>
<td>XX</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Forest encroachment</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lack of irrigation facility</td>
<td>XX</td>
<td></td>
<td></td>
<td>XXX</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Slope land agriculture</td>
<td>XX</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Seasonal drought</td>
<td>XX</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total score</td>
<td>15</td>
<td>14</td>
<td>8</td>
<td>7</td>
<td>6</td>
<td>5</td>
</tr>
</tbody>
</table>

Flash flood events in the project area

<table>
<thead>
<tr>
<th>Year</th>
<th>Events</th>
<th>Effects</th>
<th>Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>17 years</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2023 (1966)</td>
<td>People were washed away by floods in Jugedi khola</td>
<td>Human loss</td>
<td>No. support from any organization</td>
</tr>
<tr>
<td>10 years</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2040 Shrawan (Jul/Aug 1983)</td>
<td>Productive irrigated land (Khet) and water turbine damaged by the floods of Kholaghati river</td>
<td>Land and water turbine loss</td>
<td>No. support from any organization</td>
</tr>
<tr>
<td>10 years</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2050 Bhadra (Aug/Sep 1993)</td>
<td>Productive irrigated land (Khet) damaged and 3 persons killed by Jugedi khola</td>
<td>Productive land loss</td>
<td>No. support from any organization</td>
</tr>
<tr>
<td>3 years</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2060 Bhadra (Aug/Sep 2003)</td>
<td>5 persons, 25 goats and some buffaloes killed due to flooding in Fathi-khola, About 12 bighas (7.8 ha) cultivated land destroyed by the over flood of Bhatlang khola, 8 persons, 55 goats, 3 buffaloes, 3 bulls killed and 5 homes and about 4 bighas (2.6 ha) cultivated land was destroyed by flooding in Jugedi Khola</td>
<td>Massive Property losses</td>
<td>District Development Committee and Red Cross Supported the victims.</td>
</tr>
<tr>
<td>2065 Bhadra (Aug/Sep 2005)</td>
<td>Loss of 12.33 ha of land with a minimum value of NRs5.55 million by flood and landslides.</td>
<td>Massive land loss and wash away of</td>
<td>None from other organizations, rehabilitation of</td>
</tr>
</tbody>
</table>
Nepal is highly vulnerable to impacts of climate change

- Average climate change is above global average
- Nepal is exposed to all types of climate
- Steep and fragile mountains
- Nature based livelihoods
- Lack of awareness and education
- Poor human and technical capacity
- Poor economic condition

Overall impacts of Climate Change

Overall impacts on livelihood assets
↓ N – Natural resources
↓ H – Human resources
↓ P – Physical resources
↓ F – Economic resources
↓ S – Social structure

Increase in vulnerability
↓
Deeper poverty

Framework strategy for climate change adaptation

GHG (CO₂, CH₄, N₂O)

GHG mitigation

Climate Change
- Increase in temperature
- Change in precipitation pattern
- Increase in storms, cyclone

Impacts on human and nature
- Ecosystem and biodiversity
- Food security and water resources
- Health and migration

Impacts on social and economic development
- Economic development
- Population
- Technology
- Governance, etc.

Adaptation

Integrated approach for climate change adaptation

- Agriculture technologies
- Livelihood diversification
- Water resources management
- Disaster risk reduction
- Conservation of natural resources
- Health program

Use of clean energy
- Awareness and education
- Research and studies
- Personal attitudes
- Appropriate policy
Adaptation to climate change

- Agriculture technologies
  - Crop species and varieties
  - Cropping pattern, cultivation practices, pests and diseases
  - Aware of changing climate

- Livelihood diversification
  - Enterprising the agriculture
  - Income diversification

- Conservation and management of water resources
  - Conservation of micro-watershed
  - Protection of water sources
  - Effective use of water resources

- Disaster risk reduction
  - Assessment of climate change induced disasters
  - Programs for DRR
  - Aware to likely hazards due to climate change

- Forest and biodiversity conservation
  - Forest as “carbon sink”
  - Community forestry
  - Multipurpose nurseries

- Promotion of clean energy
  - Microhydro, solar energy, wind energy, biogas etc.

Adaptation to climate change

- Awareness and education
  - Individual, community, organizations
  - Schools and higher education institutions
  - Research and studies
  - Climate change and its impacts at local level
  - Technology development for community adaptation

- Individual attitude
  - Use of technologies that do not emit / reduce GHG
  - Adaptation to changed climate

- Health program
  - Vector borne diseases
  - Disaster and disease
  - Sanitation and health
  - Preventive measures

- Appropriate policies
  - Imbedding climate change in all sectoral development programs
  - Timely formulation of appropriate policies
  - Influencing the global communities
Thank you

Setting climate change adaptation policy

Ngamindra Dahal
National Trust for Nature Conservation (NTNC)
&
Member, Climate Change Network Nepal (CCNN)

December 21, 2007

IPCC Report and Nepal

- IPCC’s 4th assessment report (Nov 2007) revealed that
  - Warming of climate system is unequivocal and now evidently observed from temperature increase, snow and ice melting, and sea level rising
  - CC is happening now and will affect everyone and everywhere, making some area more vulnerable than others
- IPCC R4 gave a new dimension to global climate debates from gathering ‘evidences’ of climate change to ‘act’ urgently on adaptation and mitigation fronts.
- To Nepal, climate change will affect like a double edges sword.
- Geographically Nepal falls in highly vulnerable conditions to climate change.
- Socio-economically Nepali society highly vulnerable for the lack of adaptation capacity and poor institutional support systems.
Multiple impacts of climate change

- Effects of global warming are cross-cutting as they encompass all vital systems supporting world populations,
- Multi-facet impacts on human health
  - Implications of increased natural hazards on life and livelihoods (more loss of lives and properties)
  - Agrarian livelihoods (e.g. farming) to suffer more,
  - Food insecurity/nutritional deficiency
  - Meeting needs of water and sanitation
  - Stresses on natural resources and biodiversity

Local impacts of global warming: Observations from Annapurna Region

<table>
<thead>
<tr>
<th>Climate hazards</th>
<th>Impacts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature</td>
<td>Winter is less cold and frosty, The river valleys of Kali Gandaki are getting windier.</td>
</tr>
<tr>
<td>Precipitation</td>
<td>Less snowfall in winter. Increased rain and snowfall in post winter; Unusually intense rainfalls in summer,</td>
</tr>
<tr>
<td>Weather</td>
<td>Increased frequency of avalanches, flash floods, windstorms and hailstorms; Rainfall pattern getting more erratic (longer drought and sudden heavy rains etc), and Increased losses of lives and property due to harsh weather incidents.</td>
</tr>
</tbody>
</table>

Local impacts of global warming ...

<table>
<thead>
<tr>
<th>Water supply</th>
<th>Reduced flow in local streams and springs. Unpredictably high fluctuation in flow levels and timing for recharging seasonal spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>Housing</td>
<td>Increased cases of roof leakage and wall erosion in traditional mud-build houses. Water supply a major problem behind the ruining and abandonment of some old settlements in Mustang.</td>
</tr>
<tr>
<td>Lifestyle/business</td>
<td>Elder people find their villages more comfortable due to less chilly winter. Emergence of mosquitos. Tourism business more profitable due to longer period of drought in post monsoon months. Agricultural businesses suffer loss due to irrigation and variation in precipitation pattern.</td>
</tr>
</tbody>
</table>

Local impacts of global warming ...

<table>
<thead>
<tr>
<th>Vegetation composition</th>
<th>Change in species composition and increased altitude of tree line</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grasslands</td>
<td>Declining productivity of grasslands. Less snow deposits a major reason for moisture deficiency and less grass production.</td>
</tr>
<tr>
<td>Apple farming</td>
<td>Bigger and tasty apples at even at higher altitudes where climate used to be too cold for farming the apples. Emerging apple orchards and nursery farms.</td>
</tr>
<tr>
<td>Vegetable farming</td>
<td>Successful farming of cabbage, cauliflower, cucumber, chilly and tomato in open garden (without greenhouse).</td>
</tr>
</tbody>
</table>
Local strategy...

- The key strategy of adaptation is diversification of income involving a mixture of agricultural practice, animal husbandry, forest utilization, indigenous health practice, out-migration, cash income through tourism and selling forest products as well as strong social management practice.

- Indigenous knowledge and traditional resource management practices are important to sustain livelihoods and production.

Firewood for frosty winter days

Some questions with policy implications

- Global to local evidences show that Nepal is highly vulnerable to climate change, but little is known about who, where, how and to what extent. How to generate funds for research on public interest?

- Building capacity at different levels to implement adaptation and mitigation measures is a commonly prescribed recommendation to address climate change challenges. What are the role models to address CC challenges?

Some questions ...

- What types of initiatives will help Nepal enhance her bargaining power in international climate policy negotiation so that she can access equitable share of global fundings meant for developing nations or LDCs?

- Nepal can fetch significant amount of climate funds through bundling up of environmental services such as carbon sequestration by community managed forests and organic farming. How to address the issue of equitable distribution of these funds?
Knowledge gaps

- Lack of information on specific impacts of CC and subsequent implications to health, livelihoods, natural resources, environment and economy
- Inadequate database on climate change impacts and precautionary measures
- Under-utilization of climate database in planning and implementing development programmes & infrastructures
- Inadequate awareness among general public, politicians, legislative members and planners on climate change risks and precautionary measures

Suggested actions to address gaps

- To involve communities in CC impacts monitoring and help them to employ appropriate measures
- To assess compatibility of development infrastructures in changed context of climate risks,
- To build capacity of national and local institutions including of negotiation skills,
- To take urgent actions for protecting communities who are critically vulnerable to CC
- To incorporate CC risks in disaster management

Three key priorities for way ahead

- Risk assessment:
  - Categorization of critically vulnerable regions, communities, national heritage sites;
  - Identification of risk management modalities at different scales
  - Understanding risks at local to global contexts.
- Adaptation measures
  - Cost effective tools, techniques and policies
  - Integration of CC response measures in development planning
  - Support to bottom up approach
- Nepal’s roles in international policy:
  - To enhance situation of low profile in climate policy
  - To ensure Nepal’s access to climate funds

Finally, a joint step to address climate change

- Climate Change Network Nepal (CCNN), established in 2003, is an informal alliance of NGOs and INGOs working in climate change field in Nepal.
- CCNN plays active roles in mainstreaming climate change issues in public dialogues and national policy.
- CCNN works with or supports to concerned government agencies in planning and implementing climate change policy and programmes.
- Currently CCNN consists of 9 member organizations, namely, CEN, NTNC, Practical Action, UNDP, WWF, Winrock International, ICIMOD and JICA.
Thank you for your attention!

Climate Change Related Activities in Nepal

Batu Uprety
Chief, Environment Assessment Section
Ministry of Environment, Science and Technology
21 December 2007, Friday

Greenhouse Gases and Source

Greenhouse gases
- Carbon dioxide (CO₂)
- Methane (CH₄)
- Nitrous oxide (N₂O)
- Hydrofluorocarbons (HCFs)
- Perfluorocarbons (PFCs)
- Sulphur hexafluoride (SF₆)

Sources
- Energy (fuel combustion and emissions)
- Industrial processes (mineral, chemical, metal production etc.)
- Solvent and other products
- Agriculture (rice cultivation, field burning, manure management etc.)
- Wastes (disposal, incineration etc.)
**UN Framework Convention on Climate Change**

- **Objectives** - Achieve stabilisation of greenhouse gas concentration in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system; and also achieve such level within a time frame sufficient to allow ecosystems to adapt naturally to climate change, and ensure that food production is not threatened, and enable economic development to proceed in a sustainable manner
  - Annex 1 countries – 40 developed countries
  - Convention adopted on 11 May 1992 in New York
  - Convention opened for signature during Rio Earth Summit
  - Being the framework convention, Kyoto Protocol adopted

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**Kyoto Protocol**

- Emission limitation and reduction commitments for Annex 1 countries specified to reduce GHG emissions by at least 5 per cent below 1990 levels
- Emission reduction commitment period – 2008 to 2012
- Provision for Protocol’s entry into force – after 90 days on ratification or accession on which not less that 55 Parties to the Convention and at least 55 % of the total carbon dioxide emission for 1990 of the Parties included in Annex 1
- Provision for **Clean Development Mechanism** – to assist Parties (non-Annex 1) in achieving sustainable development objectives, and assist Parties (Annex 1) to achieve compliance with their quantified emission limitation and reduction commitments
- Protocol adopted on 11 December 1997 in Kyoto, Japan

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**Nepal’s Participation**

**UNFCCC**
- Adoption: 11 May 1992
- Signature: 12 June 1992
- Ratification: 2 May 1994
- Entry into force in Nepal: 31 July 1994
- First INC Report prepared in July 2004 and shared with Parties

**Kyoto Protocol**
- Text adopted on 11 December 1997
- Deposition of instrument of Accession: 16 Sept. 2005
- Entry into force (global) 16 February 2005; and Nepal: 14 December 2005

**CDM**
- MoEST functions as DNA for CDM activities on 22 December 2005
- DNA - SC, TAC and SD criteria in place
The Problem

- Low GHG emission (0.025% of global share) – high impacts in the mountains
- Temperature increase @ 0.15-0.6°C/decade in the Nepal Himalaya
- Rainfall – increasing in very wet days and decreasing in consecutive dry days
- ‘Too much water’ and ‘too little water’ – late monsoon and droughts
- Increase in number of warm days and nights
- Impacts of climate change visible - increase in size and/or formation of glacial lakes, glaciers retreating, impacts on agriculture, forests, health, downstream impacts etc.
- Effect from other’s activities - adaptation

Past Efforts: 1994-2005

Studies and Workshop
- Inventory of GHGs for energy sector based on 1990 data under US Country Studies Program in October 1994
- Implementation Strategy on environment related conventions formulated in 1999
- Potential linkages between UNCCD, CBD and UNFCC identified in 2000
- Workshop on UNFCCC and Institutional Design of the Cooperative Implementation Mechanism of KP – organized in collaboration with UNEP/ROAP and ADB on 23-24 August 2000

Past Efforts: 1994-2005

- PREGA – Promotion of Renewable Energy, Energy Efficiency and GHG Abatement with objectives to:
  a. Promote investments in REGA technologies;
  b. Address policy and institutional barriers to dissemination of REGA technologies; and
  c. Build capacity for developing REGA investment projects.
- PINs and PDDs developed for some potential CDM projects
- Glacial Lakes Outburst Floods – threats and risk mitigation study
- Water induced disaster management initiatives

Policy Measures
- Carbon trade for resource management and poverty reduction
- Implementation of sustainable development agenda
- Promotion of the use of environment-friendly technologies, cleaner production, energy efficiency, clean energy and environment management system, adoption of polluter pays principles and pollution fees
- Promotion of clean and alternative energy in rural areas
- Implementation of MEAs including UNFCCC
- Submission of First Initial National Communication Report, 2004
**Initiatives: 2006 Onwards**

**Awareness raising**
- August 1, 2006 - workshop on capacity building on CDM (MoEST+WB+Winrock)
- December 13-14, 2006 workshop on building capacity to respond to climate change (MoEST+IUCN)
- December 15, 2006 - Consultation on climate change (CARE Nepal)
- December 23, 2006 - national dialogue initiative on the environment including on the implementation of UNFCCC (Indigenous group)
- Signature campaigns on climate change and about 6,000 signatures documented (WWF)
- 17 January 2007 – workshop on identifying priorities and opportunities for actions on climate change adaptation in Nepal (DHM+WB)
- Radio program on climate change - ongoing

**Initiatives: 2006 Onwards ...**

- Proposal for NAPA, December 2006
- Drafting of climate change policy in process, Jan. 2007
- CDM/DNA Presentation, 23 April 2007 (MoEST+BSP)
- Implementation of NCSA Project – March 2007, Thematic group meetings ongoing, stocktaking exercise in final stage
- Formation of 23-member CCN under the chairmanship of the Secretary, MoEST with representation from government, inter-governmental, NGOs, academia and private sector, March 2007
- Workshop on Impacts of Climate Change in Nepal (MoEST+Practical Action), June 2 and 20, 2007
- Workshop on International Negotiations on Climate Change, 20-22 November 2007 (MoEST+WWF)
- Planned for stocktaking workshop for 2nd Communication Report, early 2008

**Functions of CCN**

- Identify working areas on climate change amongst the government, NGOs, private and donor organizations;
- Conduct policy/field level research and studies and implement activities based on the capacity and expertise;
- Promote CDM related activities, and launch public awareness and capacity building programs;
- Develop position papers for the Parties meeting and enhance negotiation capacity; and
- Develop Climate Change Clearing House for easy information sharing.

**Composition of the Climate Change Network**

- Secretary, Ministry of Environment, Science and Technology: Chairman
- Representative, Ministry of Forests and Soil Conservation: Member
- Representative, Ministry of Industry, Commerce and Supplies: Member
- Representative, Ministry of Water Resources: Member
- Representative, Ministry of Agriculture and Cooperatives: Member
- Director-General, Department of Hydrology and Meteorology: Member
- Executive Director, Alternative Energy Promotion Centre: Member
- Representative, ICIMOD: Member
- Representative, National Trust for Nature Conservation (NTNC): Member
- Representative, World Wildlife Fund (WWF) - Nepal Programme: Member
- Representative, The World Conservation Union (IUCN) - Nepal: Member
- Representative, Practical Action: Member
- Representative, Winrock Nepal: Member
- Representative, CARE Nepal: Member
- Representative, Centre for Energy Study, Institute of Engineering: Member
- Representative, FNCCI: Member
- President, Independent Power Producer Association of Nepal (IPPAN): Member
- Representative, UNDP Nepal: Member
- Representative, JICA Nepal: Member
- Representative, World Bank, Nepal: Member
- Representative, Asian Development Bank, Nepal: Member
- Executive Director, Biogas Sector Partnership Nepal: Member
- Joint-Secretary, MoEST - Environment Division: Member-Secretary
**CDM Projects**

- Two biogas projects registered with World Bank Community Development Carbon Fund in 2005 - @ US$ 7/ton of carbon
- No objection letter for PIN of vertical shaft brick kiln issued, February 2006
- PDD approved for 15 MW micro-hydro promotion project - @ US$ 10.25/ton of carbon
- Biogas project – stakeholders' consultation completed, March 2007

**Government of Nepal**
MoEST
Designated National Authority (DNA) for CDM Projects

**Steering Committee**
- Secretary, MoEST Chairman
- Representative, MOF Member
- Representative, MFSC Member
- Representative, MOICS Member
- Representative, MOLTM Member
- Representative, MLD Member
- Representative, MOWR Member
- Representative, MOFSC Member
- Representative, MOICS Member
- Representative, MOFSC Member
- Representative, MOFSC Member
- Representative, MOFSC Member
- Representative, MOFSC Member
- Representative, MOFSC Member
- Joint-Secretary, MoEST-ED

**Technical Advisory Committee**
- Joint-Secretary/Chief, MoEST-ED
- Representative, concerned ministry
- Experts (three)
- Under-Secretary/Chief, EA Section

**CDM Institutional Structure**

**Functions of DNA**

1. Develop and implement strategies and guidelines on CDM;
2. Launch CDM promotional activities;
3. Provide CDM information to interested project developers, investors, related organisations, consultants and the public;
4. Receive, assess and ensure technical review of CDM projects;
5. Make CDM projects public and conduct consultations;
6. Issue letter of *no objection or endorsement letter* on Project Idea Note (PIN) of the CDM projects;
7. Approve Project Design Document (PDD); and
8. Manage and coordinate CDM activities.

**Approval Procedure for CDM Projects**

- Project Developer
- DNA Secretariat
- CDM Executive Board
- PIN
- SD Criteria
- No
- Yes
- Approval
- Endorsement Letter
- PDD
- SD Criteria
- No
- Yes
- Registration of CDM Project
- Approval Letter
**Sustainable Development Criteria**

**Environment**
- Environmental sustainability by practicing natural resource conservation
- Local community health and safety
- GHG emissions reductions

**Economic**
- Poverty reductions and local community welfare

**Social**
- Local community participation in the project
- Local community social integrity

**Technology**
- Technology transfer

The proposal should comply with existing policies, strategies and laws. Proof of consultations, comments and complaints of local communities to be submitted by the proponent.

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**Bali COP13/CMP3**

Nepal’s Interest Areas

**UNFCCC**
- Fourth Assessment Report of IPCC – impacts on the Himalayas
- National Communications from non-Annex countries
- Capacity building
- Implementation of Article 4, para (8) and (9) [Para 8 – related to specific needs and concerns of developing countries; Para 9 – related to needs of LDC – funding and technology transfer]
- Implementation of Buenos Aires programme of work on adaptation and response measures
- Matters relating to LDCs
- Reducing emissions from deforestation in developing countries

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**Bali Climate Change Conference COP13/MOP3**

- Inclusion of replacement or displacement of non-renewable biomass under CDM project (biogas, improved cooking stoves could be developed as CDM projects) – achievement after one year of continuous efforts
- Interventions on, *inter alia*, transparency of GEF, technology transfer, impacts of snow melting, capacity building and/or education and public awareness, matter related to LDCs, issues related to CDM etc.
- Focus on high-level segment - capacity building, inclusion small and innovative actions as CDM projects that provide social and environmental benefits, fast-track mechanism for technical and financial support, window for carbon credit from community managed forests to encourage and compensate poor people, and long-term commitments on GHGs reduction targets.
- Nepal nominated – SBSTA Rapporteur, LEG Member

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**Convention Negotiation Process in General**

Adoption of Agenda Items in Plenary Session

Subsidiary Bodies

Adhoc Working Group

Dialogue Session

Implementation (SBI)

Scientific and Technological Advice (SBSTA)

Contact Groups (Issues based groups)

Informal meetings

Friends of the Chair

- Meetings of the G77 and China
- Meetings of the Regional Groups
- Meetings of LDC
- Coordinator selected on each or selected agenda item

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*Thanks*
Group Work

Group A Water Resources and Climate Change
Group B Agriculture Sector and Climate Change
Group C: Vector Borne Diseases and Climate Change

Group Guidelines

1. Assessment of health impact of climate change (Develop list of concerns and issues and suggest actions)
2. How do we know about the impact of climate change on health? (Methods and tools)
3. How should we move forward, with special reference to the role of health sector? (Institutional collaboration, networking, coordination, capacity building etc.)
Assessment of Health impact of climate change (Develop list of concerns & issues & suggest actions)

Sources of Water
- Rain
- River
- Streams
- Lakes
- Springs
- Glaciers
- Wells etc.

Effects of Climate change on Water resources

I) Short term effect
- Delayed or early monsoon
- Heavy precipitation (Cloud burst) brings natural disasters like flood, landslides etc.
- Lack of rainfall and longer hotter days brings drought and decreases availability of required amount of potable water.

II) Long term effect
- Depletion in level of ground water and decreases availability of potable water
- Heavy precipitation (Cloud burst) brings flood, landslides etc. destroying natural habitation of water resources
Effects of climate change on water resources and its impact on health

A) Direct Impact
- Epidemic of Diseases (water, food and vector borne disease)
- Loss of life and disabilities (Natural Disaster)
- Injuries and Trauma
- Increases no. of water borne diseases (eg. diarrhoea, cholera, skin diseases etc)

B) Indirect Impact
- Increases burden of disease (DALYs)
- Increases migration (Environmental refugees)
- Famine (Enhance vicious poverty and malnutrition cycle)
- Increases economic burden
- Increases no. of water borne diseases

Suggestions for Action
- Sensitize people about what is happening and what may happen.
- Formation of emergency preparedness team (eg. RRT to mitigate the harm)
- Ensure quantity as well as quality of water supplied
- Promote Researches and link the scientific evidences

Methods and Tools to know the impact on Health
- Routine surveillance system to relate water supply, food, health and climate change
- Descriptive studies to link up primary and secondary data to see the trends and for forecasting
- Use of international models in local context
Institutional collaboration and coordination

Suggested ministries, departments and organizations are:
- Dept of Hydrology and Meteorology (DHM)
- Ministry of Health (MOH)
- Ministry of forest and land conservation
- Dept of Water Induced Disaster Prevention (DWIDP)
- Department of Water Supply and Sanitation (DWSS)
- Water and Energy Commission (WEC)
- Ministry of Envt. Science and Technology (MOEST)
- Epidemiology and Disease Control Division (EDCD)
- Nepal Health Research Council (NHRC)
- NGOs and INGOs
- EDPs

Networking for action

Strong networking should be established under the leadership of MOH

MOEST  MOH

PH institutions

DHM

DWSS

Research institutes

Medical colleges

Capacity Building

- To develop and strengthen the capacity of existing research institutions
  - Infrastructures, logistics, Hi-tech lab etc
- Produce technical manpower to access the situation and quality of water
- Strengthen Early Warning and Response System (EWARS)

Thank you!
Climate change, agriculture and human health

Group B

A. Climate change is likely to affect on food security adversely (both qualitative and quantitative)

<table>
<thead>
<tr>
<th>Climate change</th>
<th>Primary impacts</th>
<th>Impacts on production and productivity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intensive and excessive rain</td>
<td>Increase in flood events - destroying crops, lands and irrigation facilities</td>
<td>Decrease agriculture production</td>
</tr>
<tr>
<td></td>
<td>Increase landslides - destroying crops and land</td>
<td></td>
</tr>
<tr>
<td>Long dry spells</td>
<td>Increase in crop pests and disease</td>
<td>Decrease agriculture production</td>
</tr>
<tr>
<td></td>
<td>Increase in invasive plants / weeds - more labor demand</td>
<td></td>
</tr>
<tr>
<td>Increase in temperature</td>
<td>Decrease in physiological performance of animal and poultry</td>
<td>Decrease in livestock production and productivity</td>
</tr>
<tr>
<td></td>
<td>Increase in invasive plants in the pasture / grassland - decrease pasture land area, production and quality</td>
<td></td>
</tr>
</tbody>
</table>

1. Direct impacts of climate change on agriculture thereby affecting the human health

<table>
<thead>
<tr>
<th>Climate change</th>
<th>Primary impacts</th>
<th>Impact on human health</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increase in temperature and air CO$_2$ concentration</td>
<td>Likely increase in agriculture production</td>
<td>Exhaust soil fertility - decrease in long run productivity</td>
</tr>
<tr>
<td></td>
<td>likely adverse impacts on nutritional value of the crops</td>
<td></td>
</tr>
</tbody>
</table>

2. Indirect impacts of climate change on human health through agriculture

<table>
<thead>
<tr>
<th>Climate change</th>
<th>Primary impacts</th>
<th>Impact on human health</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increase in temperature</td>
<td>Increase in zoonotic diseases (e.g. Japanese encephalitis)</td>
<td>More risk to human health</td>
</tr>
<tr>
<td></td>
<td>Increase in pesticides because of increase in pests and diseases</td>
<td>Direct impacts on human health</td>
</tr>
<tr>
<td>Intensive rain - erratic rain - flood, drought, landslides</td>
<td>Decrease in agro-based incomes</td>
<td>Decrease in income to purchase health services</td>
</tr>
</tbody>
</table>

B. Methods and tools to understand the impacts

- Monitoring the malnutrition evidences of the population in respect to climate change
- Monitoring incidences of zoonotic diseases across altitudes
- Monitoring crop and livestock production trends in relation to climate change
- Monitoring of pesticides generated and related diseases
- Monitoring food quality trend over years

Through capacity development
C. Actions required for climate change and human health

I. Establishment of Environmental Health Research Institute (EHRI)

The EHRI will have the following responsibilities:

- In overall coordination with MoEST, regularly coordinate with concern government and non-government organization (Some government organizations are - Ministry of Water Resources, Ministry of Agriculture and Cooperatives, Ministry of Environment, Science and Technology, Ministry of Health etc.)
- Research on Climate Change and Human Health, Climate Change and Human Health Vulnerability, Mitigation and Adaptation Measures etc.
- Dissemination, extension and training on Climate Change and Human Health
- Advice and Influence the policy in climate change, agriculture and human health
- Involvement of communities and stakeholders in research, training and extension on climate change and human health

II. Special emphasis on health sector policy and include strongly in National Climate Change Policy

III. Public awareness strongly implemented on climate change and human health

IV. Poverty alleviation program strongly linked with climate change, agriculture and human health

V. Early Warning System on Extreme Climate Events to Agriculture

Climate Change and Vector Borne Disease

Group C

Chairperson: Dr. Nilamber Jha

Group Members:
- Dr. Sharad Raj Onta
- Alok Sharma
- Han Heijnen
- Sanam Kumar Aksha
- Ram B Yadav
- Namita Ghimire
- Jay Bahadur Karki
- Mohan Singh T
- Manoj Badu
- Kesari Laxmi Bajracharya
- Kapil Mani Acharya
- Sikchya Upadhyay
- Archana Shrestha
- Milima Singh
- Nisha Rana
- Saju Maiya Shrestha
- Ram Chandra Pathak
- Arvindra Srivastav
Guidelines for group work

- Assessment of health impact of climate change (Develop list of concerns and issues and suggest actions)
- How do we know about the impact of climate change on health (Methods and tools)
- How should we move forward, with special reference to the role of health sector? (Institutional Collaboration, networking, coordination, capacity building etc)

Vector Borne Disease

- Malaria
- Kala-azar
- Japanese Encephalitis
- Filariasis
- Dengue – Emerging disease

List of concerns and issues

- Knowledge gap on
  - Vector Borne Diseases
    - Present knowledge based on reported cases (Passive case finding, possibilities of hidden cases) with limitations to generalize in the population
    - Magnitude and Severity of disease
    - Disease Pattern (Person, Place, TIME : seasonal, cyclic, epidemics…. distribution)
    - Risk factors

List of concerns and issues contd..

- Knowledge gap on
  - Vectors of the disease (Mosquito, Sand fly)
    - Existence (place, time distribution)
    - Growth, Survival and Multiplication (in relation to climate change)
    - Behavior change (shifting habitat, skills to penetrate bednets…)
    - Infectivity of the vector
    - Resistance to pesticides

- Causative agents of the disease (Plasmodium, Leishmania donovani, Microfilaria, JE virus, Dengue virus etc)
  - Survival and multiplication (with relation to climate change)
  - Resistance to drugs
List of concerns and issues contd..

• Human behavior and practice (Sleeping habits, use of nets, sanitation practices, deforestation….)
• Human settlement/ Urbanization (Housing, drainage….)
• Inactive existing bodies (Vector Borne Disease Control Center ….)
• Lack of expertise (Medical Entomologist, Medical anthropologist….)

Methods/ Tools: How to know impact of climate change in human health ??

• Existing data available from
  – Hospital records
  – Surveys
    • Not national representative (because done in small pockets)
  – Surveillance
    • Passive Case Detection

But …..inadequate …...
(likelihood of hidden cases in community)

Methods/ Tools: How to know impact of climate change in human health contd…

• We need
  – Better Surveillance system (Active Case Detection strategy, Support present system and identify risk)
  – Integrated Data Management System (Health, Agriculture, Environment, Climate, Energy etc)
  – Anthropological/Sociological Studies (Study human behaviour and practice related with vector born disease and climate change)
  – Periodic Data collection and reporting from non endemic areas (Key informant information in non endemic areas, Photographs)
  – Partnership with local organization (Universities, Non Government Organizations)

How should we move forward ??

• Human Resource Development/ Capacity Building
  – Medical Entomologists
  – Medical Anthropologist
  – Vector Borne Disease Control Assistant in each district
• Research (Vectors, Risk factors, environment, Agent, Host ….)
  – Basic
  – Applied
• Strengthen/reactivate existing system
  – Vector Borne Disease Control Center
How should we move forward contd...

- Strengthen Surveillance system (Initiate Active Surveillance, information on risk factors)
- Establish an integrated Data base and develop scenarios for possible mitigation (Health, Agriculture, Environment, Energy, Veterinary, Meteorology, Engineering, Hydrology etc)
- Dissemination of Information (At national, regional and local level)
- Integrated Pest Management/ Integrated Pest and Vector Management (IPM/IPVM)

How should we move forward contd...

- Human Settlement improvement responding to the climate change (Planned urbanization, architectural modification to avoid GHG emission ……)
- Intersectoral networking at
  - Local level (DHO, Agricultural extension services, NGOs especially dealing with livelihoods, Local Governments ……)
  - Regional level (RHD, Regional Academic Institutions like BPKIHS, Agriculture, Hydrology………)
  - National level (Ministry of Health and Population, DoHS, NHRC, Ministry of Environment, Science and Technology, Ministry of Agriculture and Cooperatives, Ministry of Local Government (Dolidar) ……)

How should we move forward contd...

- Follow up mechanism for this workshop
  - Set indicators (Activation of Vector Borne Disease Control Center, No of VBDCA trained)
  - Periodic meeting and monitoring (Minutes of meeting, Formulation of research activities, Dissemination of knowledge)
  - Further planning (Public Relation, Advocacy, Recommendations)
Closing Session

Dr. Sharad Raj Onta, Member Secretary of Nepal Health Research Council delivered his remarks expressing his happiness to for the active participation of the participants from different sectors. He said that though it was the first National Workshop for the three days the discussion was beyond the expectation which benefited a lot to the organization. He reminded the participants once again how different paper presenters had focused on the effect of the climate change in the human health in different sectors. He further added that it was really unknown valuable tasks conducted by different sectors regarding the effect of the climate change. Therefore the workshop has provided a lot of information which affects the human health from different sectors. He also said that though there was less number of participants from the health sector, he hoped that the sharing would really be benefited them too. He assured that it is not a one time event; follow up program would be conducted linking environment and health. He reminded the participants that "intervention" should be in the mind regarding the climate change. Similarly he also stressed that adoption to the climate change should also be kept in mind rather than cure.

In the end he thanked World Health Organization who stimulated and supported NHRC to conduct the National Workshop, technical committee members and the valuable paper presenters for their great contribution. Once again he thanked the chairperson, Dr. Mahesh Kumar Maskey, chairman of Nepal Health Research Council, WHO Environmental Health Advisor, Mr. Han Heijnen, all the participants from different sectors and NHRC's staffs to make the workshop success and worthy. He also assured that NHRC will further move forward in the climate change issue in future.

Mr. Han Heijnen, Environmental Health Advisor from WHO shared that the workshop was really exciting and interesting. He said that due to the active participation of the participants the interactions and the suggestions was the reward to the workshop. He also reminded the participants that lots of works have to be done to find out the fact regarding the climate change. He further added that since we have to give advice to the community level we ourselves have to strengthen our capacity. He ended his remarks saying "let's continue the discussion and interaction in future too."

Ms. Nirmala Sharma, representative from Care Nepal delivered remark from the participants' side. She thanked NHRC for providing the opportunity to participate in the workshop. She said that the topic regarding the climate change was frequently heard but the workshop really gave the image of the effect of the climate change. She assured that the participants from different field would utilize the knowledge gained in the different sectors. Lastly she suggested NHRC to take a lead role since NHRC had started the unique program which has achieve a great success observing the huge number of participants gathered in the workshop.

Ms.Saju Maiya Shrestha, representative from the media thanked the organizer for providing the opportunity to participate in the workshop. She said that the workshop has provided knowledge regarding the effect of climate change in the different sector as well as in the health. She pointed out that the workshop has built up the confidentiality regarding the effect of the climate change in different sectors. She said that the knowledge gained from the workshop would help to create awareness in the backward areas of our country. In the end she wished effective program in future.
Dr. Mahesh Kumar Maskey, Chairman of Nepal Health Research Council said that the workshop will not remain as workshop. Since NHRC has taken initiative from the health sector NHRC will try to move forward but the governmental level should think more seriously on the recommendation came from the workshop. He further suggested the participants to utilize the knowledge to link with health and the climate change and to conduct research which is unknown. He also pointed out challenges to Nepal due to global warming. In the end he requested WHO reflect the program and support to move forward in the field of climate change as it is a burning issue and has given priority in the world health day 2008.
SECTION 5

HIGHLIGHTS OF ISSUES IN THE WORKSHOP AND RECOMMENDATIONS

Highlights of the Issues in the Workshop

- The matter of the paper presentation and the picture need to match.
- Is the case due to the climate change?
- Is the disease due to the climate change?
- Why water quantity had been reduce in the domestic use?
- Actual data need/ facts have to be finding out.
- Is it because of the climate change the vector borne disease occurring?
- Why climate changes happen after a long time?
- Why there is high rate of diarrhea patients?
- How to generate fund to conduct the research?
- What type of model could be used to predict climate change and health impact?
- Climate change has become a burning issue but still the government level is not taking it seriously, why?
- What impact dose the climate change play in the tourism sector in Nepal?
- Is it water scarcity and malnutrition due to the climate change only?
- We need to explore and cause and effect relationship regarding impact of climate change on human health.

Recommendations

- Disease have comer out more than before but have to find out whether it is due to climate change or due to management or behavior.
- Research study and intervention have to focus on local level.
- We need to involve all the sectors to see the effect of the climate change.
- Holistic research/ ground level research needed to conduct in the community level to see the impact of climate change.
- Since there is real effect of climate change in different sectors effective program has to be implemented.
- Too much and too little water impacts humans being so have to think about it.
- Cross-sectional comprehensive research study as well as prospective study should be done to see the impact of the climate change
- There should be concrete policy on climate change.
- Scattered study regarding the climate change should be collected.
- Awareness regarding climate change and disaster prevention should be taken in consideration, otherwise it gets too late.
- Interaction and discussion with different section needed.
Annex- I
List of Participants