Climate Science & Technology in Asia: Current Status and Future Needs

Report on the Workshop held on
15-16 November 2018 in Kuala Lumpur, Malaysia

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Edited by:

Joy Jacqueline Pereira & Julian C.R. Hunt

With contribution from:

Edvin Aldrian, Linda Stevenson, Mazlan Othman,
Basanta Shrestha, Rajib Shaw &
Sarah Aziz

The Workshop on Status of Climate Science and Technology in Asia was convened under the aegis of the IPCC Working Group II Co-Chairs, Professor Hans-Otto Pörtner (Germany) and Dr. Debra Roberts (South Africa). It was organised by the Asian Network on Climate Science and Technology (ANCST), coordinated by Universiti Kebangsaan Malaysia's Southeast Asia Disaster Prevention Research Initiative (SEADPRI-UKM), Asia-Pacific Network for Global Change Research (APN), International Science Council Regional Office for Asia and the Pacific (ISC-ROAP) and International Centre for Integrated Mountain Development (ICIMOD).

Scientific Steering Committee: Hans-Otto Pörtner, Co-Chair of IPCC Working Group II; Debra Roberts, Co-Chair of IPCC Working Group II; Joy Jacqueline Pereira, Vice Chair of IPCC Working Group II; Edvin Aldrian, Vice Chair of IPCC Working Group I; Melinda Tignor, Head of IPCC Working Group II Technical Secretariat Unit; and Raphael Slade, Head of Science, IPCC Working Group III Technical Secretariat Unit.

Organising Committee: Joy Jacqueline Pereira, IPCC Working Group II; Julian C.R. Hunt, University of Cambridge; Edvin Aldrian, IPCC Working Group I; Linda Stevenson, Asia-Pacific Network for Global Change Research, APN; Mazlan Othman, International Science Council Regional Office for Asia and the Pacific, ISC-ROAP; Basanta Shrestha, International Centre for Integrated Mountain Development, ICIMOD; Rajib Shaw, Keio University; and Sarah Aziz, SEADPRI-Universiti Kebangsaan Malaysia.

The report was prepared by the Organising Committee with input from the Scientific Steering Committee and many participants. A draft version was shared for review with participants and we gratefully acknowledge the comments received.

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Report of the Workshop on Status of Climate Science and Technology in Asia

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The Workshop Report was an annex to the Progress Report on Communication and Outreach Activities, submitted to Governments by the Secretary of the IPCC at its Forty-Ninth Session in Kyoto, Japan, 8 – 13 March, 2019 [IPCC-XLIX/INF. 9 (12.IV.2019) Agenda Item: 6.9].

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FOREWORD

We congratulate the convenors of the Workshop on Status of Climate Science and Technology in Asia for hosting this important event on 15-16 November 2018 in Kuala Lumpur, Malaysia. We are especially pleased that key science institutions in Asia, with the cooperation of national partners, are collaborating to support the Intergovernmental Panel on Climate Change (IPCC) in its Sixth Assessment Report and enhancing contribution to the corpus of knowledge on climate science and technology in the region.

The cycle of the IPCC Sixth Assessment Report has already commenced with the preparation of three *Special Reports: Global Warming of 1.5°C, Ocean and Cryosphere in a Changing Climate, and Climate Change and Land*. This will be followed by formulation of the full Sixth Assessment Report (IPCC AR6), which includes three Working Group contributions on different aspects of climate change and a Synthesis Report that will be completed by 2022.

The IPCC Working Group II contribution to the AR6 will include, among other components, an assessment of regions. Chapter 10 on Asia will cover region-specific aspects on climate observations and projections, vulnerabilities and impacts on natural ecosystems and human systems as well as adaptation and mitigation activities and its interactions, in line with the goals of sustainable development. We are delighted to note that this workshop brings together scientists working on Asian issues to share current knowledge relevant to these issues. We are also pleased that great effort is being made to link authors working on the IPCC AR6 cycle to senior and early-career scientists in Asia, particularly from Central Asia, West Asia, Southeast Asia and the Hindu Kush Region (South Asia). This is particularly important to improve the engagement of scientists and strengthen the coverage of issues from these regions. We hope that the peer-reviewed publications from this workshop will contribute to provide a snapshot of the status of present knowledge on climate science and technology of these sub-regions of Asia.

We acknowledge the strong leadership of science institutions in the region, in particular the Asian Network on Climate Science and Technology (ANCST), coordinated by Universiti Kebangsaan Malaysia's Southeast Asia Disaster Prevention Research Initiative (SEADPRI-UKM), Asia-Pacific Network for Global Change Research (APN), International Science Council Regional Office for Asia and the Pacific (ICSU-ROAP) and International Centre for Integrated Mountain Development (ICIMOD) for convening this event. We also acknowledge national partners - Ministry of Energy, Science, Technology, Environment and Climate Change Malaysia, the National Focal Point to the IPCC, as well as the Academy of Sciences Malaysia, Universiti Kebangsaan Malaysia and Geological Society of Malaysia, for their strong support in hosting the workshop. We would like to see this event as a catalyst in creating an impetus and sustaining the momentum of scientific participation and contribution of Asian scientists to the IPCC AR6 cycle. We hope that key knowledge gaps as well as urgent research needs identified in the Workshop will be widely disseminated to advance science, technology and innovation in Asia.

Professor Hans-Otto Pörtner (Germany) & Dr. Debra Roberts (South Africa)
IPCC Working Group II Co-Chairs

EXECUTIVE SUMMARY

The Intergovernmental Panel on Climate Change (IPCC) supported the Workshop on Status of Climate Science and Technology in Asia, held on 15-16 November 2018 in Kuala Lumpur, Malaysia, which was organised by the Asian Network on Climate Science and Technology (ANCST), coordinated by Universiti Kebangsaan Malaysia's Southeast Asia Disaster Prevention Research Initiative (SEADPRI-UKM); Asia-Pacific Network for Global Change Research (APN); International Science Council Regional Office for Asia and the Pacific (ISC-ROAP); and International Centre for Integrated Mountain Development (ICIMOD). National partners included the National IPCC Focal Point, Ministry of Energy, Science, Technology, Environment and Climate Change Malaysia as well as the Academy of Sciences Malaysia, Universiti Kebangsaan Malaysia and the Geological Society of Malaysia.

The purpose of the workshop was to bring together scientists working on Asian issues from sub-regions with limited coverage in previous IPCC assessments, to share current knowledge and technology on climate change, disaster risk reduction and their interactions with sustainable development. The workshop also served as a platform for linking several key Asian authors from the three IPCC Working Group reports with each other, and connecting them to senior and early-career scientists, particularly from Central Asia, West Asia, Southeast Asia and the Hindu Kush Region (South Asia). Over 70 scientists from governments, universities and non-governmental organisations, primarily from developing countries and countries with economies in transition in Asia, attended the workshop About 30 papers covering 18 countries in the region were presented.

Scientists in Asia were urged to conduct research and publish their findings on climate change that are relevant and unique to the region. Several suggestions were made to increase the engagement of Asian scientists in the IPCC. These include developing ties with academia from these sub-regions, focusing on early-career researchers and women; as well as capacity building on conducting IPCC reviews and assessments, targeting early-career researchers. The importance of linking Asian scientists that work across the IPCC Working Groups, on the physical sciences, adaptation and mitigation was also noted. The Regional Atlas of the IPCC AR6 is a good starting point, while urban areas offer the best entry point to integrate these aspects. Maintaining such linkages in the region will be a major challenge.

The importance of improving climate science for urban areas, specifically for hazards modelling in the tropics was emphasised. Solutions to urban climate issues require sound understanding of the Earth's climate system and processes, and this is a challenge for the tropics in Asia. In this respect, capacity building and outreach programmes are critical for hazard modelling at the neighbourhood scale, to support effective policy and decision making in cities. The use of citizen science in generating local level information also needs to be further explored in the region. The potential for cities to lead in climate change mitigation to address the challenges of global warming was also strongly emphasised. It was also pointed out that communication of science to policy and decision-makers at the local level is a major challenge in the region, particularly for climate change adaptation.

Challenges for the sub-regions of Asia relate to knowledge gaps on impacts of slow-onset hazards and its attribution to climate change; need for robust downscaled climate models at the sub-regional levels; absence of observed and projected impacts of climate change, which are linked to planning and policy at all levels; and necessity for vulnerability assessment methodologies that incorporate climate change attribution, particularly for human settlements, among others. It has been highlighted that a pathway forward is to link science to regional policy processes and involve the private sector in bridging knowledge gaps. A critical element is the need for strategic collaboration between key science organisations in Asia to maintain linkages between scientists in the region.

The papers and discussion at the workshop provide a snapshot of the status of present knowledge on climate science and technology, particularly for the Asian sub-regions with limited coverage in previous assessment reports. About 20 full manuscripts have been obtained. These are being peer-reviewed for publication in an open access online journal. This report will be peer-reviewed, published and made available on the website of ANCST [http://www.ancst.org/] as well as other key science institutions and interested parties in the region. It is intended to serve as a basis for identifying urgent research needs for the region. The workshop is the first of a series of initiatives to strengthen Asian participation and contribution to the IPCC AR6 cycle. The key science institutions in Asia that have come together to organise the workshop will continue collaboration to expand the corpus of knowledge on climate science and technology in the region and support the IPCC during and beyond the current cycle.

INTRODUCTION

Context: The Intergovernmental Panel on Climate Change (IPCC) is currently in its Sixth Assessment Report (AR6) cycle and will be delivering several policy-relevant reports between 2018 and 2022. The IPCC AR6 cycle has commenced with the preparation of three Special Reports: *Global Warming of 1.5°C, Ocean and Cryosphere in a Changing Climate, and Climate Change and Land*. This will be followed by formulation of the full Sixth Assessment Report (IPCC AR6), which includes three working group contributions on different aspects of climate change and the Synthesis Report that will be completed by 2022, in time for the first global stocktake under the Paris Agreement the following year. The regional chapter on Asia (Chapter 10) of the IPCC Working Group II report will document an assessment of the region with respect to several elements. These include specific climate observations and projections, vulnerabilities and impacts on ecosystems (terrestrial, freshwater, marine), built environment, industry and infrastructure and human systems as well as present knowledge of adaptation and mitigation activities and its interactions among activities in line with development goals (http://www.ipcc.ch/).

Selected elements to be considered for Asia in the Sixth Assessment Report (modified from information in http://www.ipcc.ch/meetings/session46/AR6_WGII_outlines_P46.pdf)

- Information on selected regional and sub-regional climate characteristics and zones
- Detection and attribution of observed impacts in natural and human systems on diverse time scales
- Region specific information on exposure and vulnerability
- Current sectoral climate risks, including specific regional and sub-regional considerations related to land, coasts and regional oceans
- Cultural and psychological dimensions (values, attitudes, ethical aspects, identity, behaviours, and different types of knowledge systems)
- Observed impacts and projected risks including identifying key risks and residual risks as well as development pathways depending on rate and level of climate change, including extremes and sea level rise
- Diverse adaptation options including opportunities, enablers, limits, barriers, adaptive capacity, and finances
- Governance and economic aspects including legal, institutional, financing, price responses, and trade
- Cross sectoral, intra-regional, and inter-regional issues including consideration of temporal scale
- Interaction of risks and responses to climate change with sustainable development pathways

Partners: The Asian Network on Climate Science and Technology (ANCST), coordinated by Universiti Kebangsaan Malaysia's Southeast Asia Disaster Prevention Research Initiative (SEADPRI-UKM), in conjunction with international partners the Asia-Pacific Network for Global Change Research (APN), the International Science Council Regional Office for Asia and the Pacific (ISC-ROAP) and the International Centre for Integrated Mountain Development (ICIMOD) are collaborating with the IPCC to enhance support for the AR6 cycle in the region. National partners included the Ministry of Energy, Science, Technology, Environment and Climate Change Malaysia, the Academy of Sciences Malaysia, Universiti Kebangsaan Malaysia and the Geological Society of Malaysia. The primary aim is to improve participation and coverage of scientific information in Asia particularly for sub-regions such as Central Asia, West Asia, Southeast Asia and the Hindu Kush Region (South Asia). The Workshop on Status of Climate Science and Technology in Asia is the first of a series of initiatives to strengthen Asian participation and contribution to the IPCC AR6 cycle.

Workshop Execution: The purpose of the workshop was to bring together scientists working on Asian issues from those sub-regions with limited coverage in previous IPCC assessments, to share current knowledge and technology on climate change, disaster risk reduction and their interactions with sustainable development. Over 70 participants from governments, universities and non-governmental organisations attended the workshop (see Appendix 1 for the full list). About 30 papers covering 18 countries in the region were presented (see Appendix 2 for the programme). The workshop also served as a platform for linking Asian authors from the IPCC AR6 cycle with each other and connecting with senior and early career scientists, particularly from Central Asia, West Asia, Southeast Asia and the Hindu Kush Region (South Asia). After the workshop, a side meeting of Asian IPCC Authors from Working Group I, II and III was coordinated by Professor Rajib Shaw (Japan) and Dr. Cheong Tae-Sung (Korea), the Coordinating Lead Authors of Chapter 10 on Asia of the IPCC Working Group II AR6. Early-career scientists from the Asia also participated in this meeting. The key science institutions in Asia that have come together to organise the workshop will continue collaboration to expand the corpus of knowledge on climate science and technology in the region and support the IPCC AR6 cycle.

HIGHLIGHTS

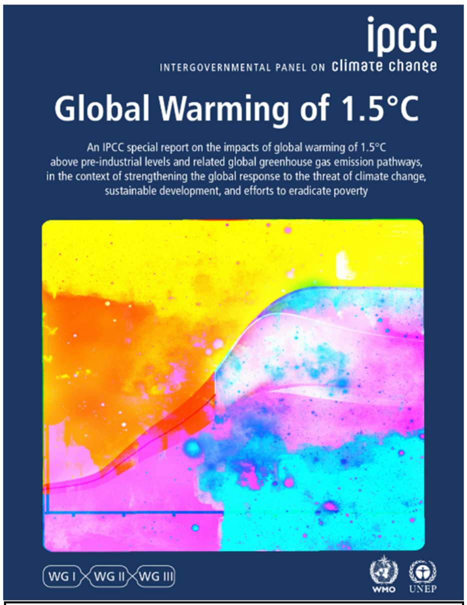
The Workshop participants included early-career researchers from Asia sponsored by the APN, ISC-ROAP and the Malaysia Window to Cambridge at UKM (MW2C@UKM) coordinated by ANCST.

Increasing Engagement of Scientists in the IPCC: The workshop commenced with an introduction of the IPCC, covering the history of its establishment and accomplishments over the past decades. Key findings of the IPCC Special Report on Global Warming of 1.5˚C were highlighted. Scientists in Asia were urged to be actively engaged in the IPCC AR6 cycle. Pathways for senior and early-career scientists to contribute to the IPCC AR6 work process was elaborated in detail. The outlines of Working Groups I, II and III were presented to provide context and highlight views of importance for the region. It was also mentioned that climate change in urban areas will be a major focus in the next cycle of the IPCC. A call was made for scientists in Asia to conduct research and publish their findings on climate change that are relevant and unique to the region. The need for peer-reviewed literature was stressed. Other aspects touched on include engaging academia in the region, in particular early-career researchers and women. There was also a call for capacity building on conducting reviews and assessments, specifically for early-career researchers.

Linking Scientists Across IPCC Working Groups: A general overview of the planning for the Regional Atlas of the IPCC AR6 was presented. The aim was to source for initial inputs on the types of sectoral information needs and metrics that are available in the region. Among the issues discussed include the ongoing regional climate downscaling experiments (CORDEX), limitations in observed data, coherence in information across timescales, and the need for the impactful community in the region to work with scientists involved in climate projection. The division of sub-regions in Asia as well as potential hotspots was also deliberated. It was reported that in the AR5, the 51 countries and territories in Asia was broadly divided into six sub-regions, i.e. Central Asia, East Asia, North Asia, South Asia, Southeast Asia and West Asia. The merits of retaining this division to enable linkages between the physical sciences, adaptation and mitigation were discussed. Urban areas offer the best entry point across these aspects. The need for climate information to be consistent across Working Groups I and II was stressed. The importance of this workshop as a platform for seeking Contributing Authors for the Atlas as well as the key role of the Coordinating Lead Authors of Asia (Chapter 10) in making the linkages across the Working Groups was also noted. The challenge is to maintain the linkages in the region after the workshop and beyond IPCC AR6.

Preparing for the Next IPCC cycle: The importance of climate science for urban areas, specifically for hazards modelling in the tropics was emphasised. Solutions to urban climate issues require sound understanding of the Earth's climate system and processes, which is a challenge in the tropics. The Weather Research and Forecasting (WRF) model is commonly used in the region to forecast rainfall patterns and urban heat island. The ADMS model is better for air pollution forecasting as it allows comparison with data from satellites. Capacity building and outreach programmes are critical for hazard modelling at the neighbourhood scale, to support effective policy and decision making in cities. In this respect, the use of citizen science in generating local level information need to be further explored in the region. The potential for cities to lead in climate change mitigation to address the challenges of global warming was also strongly emphasised. It was also pointed out that communication of science to policy and decision-makers at the local level is a major challenge in the region. This is a barrier to advancing climate change adaptation, which requires a bottom-up approach. Other aspects touched include getting development partners in the region to focus more on cities, and promoting peer-reviewed publications on urban climate change issues.

Scientific Challenges for Asia: Knowledge gaps are a key challenge for Asia. Such gaps relate to impacts of slow onset hazards and attribution to climate change; robust downscaled climate models at the sub-regional levels; observed and projected impacts of climate change that link to planning and policy at all levels; and vulnerability assessment methodologies that incorporate climate change attribution for human settlements, among others. It has been highlighted that a pathway forward is to link science to regional policy processes and involve the private sector in bridging knowledge gaps. A critical element is the need for strategic collaboration between key science organisations in Asia to maintain linkages between scientists in the region. A snapshot of the challenges for Asia is briefly described below:-



The Special Report on Global Warming of 1.5°Celcius is the first product of the IPCC Sixth Assessment cycle.

- Fast-onset hazards such as floods, landslides, flash floods, debris flows and slope failures are generally associated with monsoons in the region. More research is required to forecast monsoons, particularly at a scale that is relevant for decision-making, or integration into policy and planning. More research on slow-onset hazards is required in Asia and their findings have to be documented in peer reviewed publications. Impacts associated with increasing temperatures, glacial retreat, ocean acidification, sea-level rise and salinization are key policy areas that require more scientific input to strengthen climate policy. Challenges in the region with respect to slow-onset hazards include making the case for attribution to climate change, developing inter-disciplinary linkages, for example with human security, and systematically documenting the associated impacts for developing comparable indices.

- While both global and regional climate modelling have improved over the last two decades, many sub-regions in Asia, such as West, Southeast Asia and the Himalayas do not have robust downscaled products. Generally, temperature projections are dependable but precipitation models are not suitable, and therefore should be used judiciously for decision-making. This is in part due to the weak understanding of tropical phenomena such as monsoons, El Nino and La Nina, the use of a limited number of models in ensembles as well as paucity of observational data. In the case of Southeast Asia, more work is required for data collection, analyses, modelling and improving understanding of the influence of the archipelagic and insular land and seascapes unique to the region. The use of "best available science" and alternate approaches have to be explored in the region, to supplement this shortcoming.

- Peer-reviewed publications on adaptation is limited for many parts of Asia. Apart from East Asia, the use of models to project climate change impacts, for example CIMP5 Earth System Model, is not common in many sub-regions. In the sub-regions of West Asia, the challenge is greater. For example in Afghanistan, Iran and Iraq, there is no documentation on both observed and projected impacts of climate change. Where models are available, projected changes in spatial and temporal distribution of precipitation, and inter- and intra-annual variability is expected to have substantial, although regionally differentiated impact on mountain farming and pastoral system of Asian highlands. A major challenge in such areas is to integrate the findings of on-going and projected rapid climatic change into planning and policy at all levels.

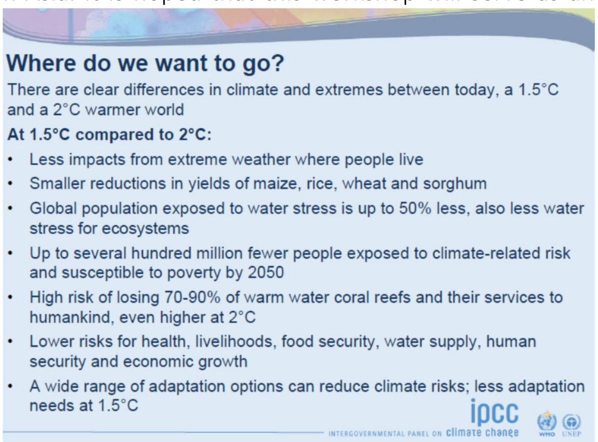
- There are many methods used to assess vulnerability in the region. The methods used depend on disciplinary traditions and objectives of the assessment. Scale and temporal aspects of vulnerability are important but the challenge is in integrating them into methodology. As a result, many aspects are not taken into account, and these include social differentiation, ecological shifts and institutional dynamics construct that perpetuate vulnerability. In India, it was found that there is a predominance of research in rural landscapes with a relatively lower coverage in urban and peri-urban settlements, which are key interfaces of transitions. As a majority of the world's poor are women, climate-change impact also reinforces gender inequality through gender-biased tasks that place women as bearers of responsibility in gathering resources, including water and foods. Notwithstanding this, direct attribution of this phenomena to climate change is a challenge.

- The importance of linking science to regional policy processes such as Sustainable Development Goals (SDGs) and Sendai Framework on Disaster Risk Reduction was emphasised. This is especially true for Asia where extreme events are perceived as the new norm. The situation requires redefinition of what is extreme climate events followed by appropriate mitigation and adaptation efforts to address the challenge. Science-based communication and the role of the private sector should be enhanced in bridging knowledge gaps and creating a new cluster industry on disaster risk reduction and climate-change adaptation.

- The Asia-Pacific Network for Global Change Research (APN) has been supporting research, science-based response strategies and acting as a vessel for science-policy intercommunication in the region. A synthesis of peer-reviewed documents of case studies conducted under the aegis of APN indicates that research is concentrated in South and Southeast Asia, primarily on disaster risk reduction and ecosystems. A major challenge is the limited replication potential of such case studies in the context of sustainable development. Future programmes will focus on the interlinkages and trade-offs of previous activities with regular assessments to avoid replication of the same studies. The success of this approach has been demonstrated by the APN's SEACLID/CORDEX-SEA for AR6, where knowledge gaps are being filled and scientific exchanges are facilitated to develop specific place-based capacities that address disaster risk and vulnerabilities. ANCST is a virtual network that facilitates collaboration and exchange of information between researchers engaged in the scientific and technological aspects of climate science, climate change, natural disasters, as well as associated impacts, adaptation and solution pathways specific to Asian conditions and phenomena. Under the aegis of ANCST, prominent Asian research champions self-organise, marshal and sustain members from multiple disciplines and age cohorts in the region on clearly defined topics related to climate science and technology. In conjunction with key science institutions in the region such as the APN, ISC-ROAP and ICIMOD, ANCST has the capacity to maintain linkages among scientists during the IPCC AR6 cycle and beyond.

CONCLUDING REMARKS

The Workshop on Status of Climate Science and Technology in Asia is the first of a series of initiatives to strengthen Asian participation and contribution to the IPCC AR6 cycle. Papers presented at the workshop provide a snapshot of the status of present knowledge on climate science and technology in Asia, particularly for those sub-regions with limited coverage in the previous IPCC assessments. The workshop has also enabled informal interaction between key authors involved in the IPCC AR6 cycle prior to the formal meetings that were scheduled to start in 2019, and facilitate their networking with scientists from Asia. It is hoped that this workshop will serve as an impetus to enhance the participation of senior and early-career scientists from inactive sub-regions of Asia in the IPCC AR6 cycle as Reviewers, and where appropriate, as Contributing Authors and Chapter Scientists. About 20 full manuscripts have been obtained from the workshop participants. These are being peer-reviewed for publication in an open access online journal. This report will be peer-reviewed, published and made available on the website of ANCST [http://www.ancst.org/] as well as other key science institutions and interested parties in the region; to serve as a basis for identifying urgent research needs for advancing science, technology and innovation to support the IPCC. The key collaborators of the workshop pledge to sustain the momentum of scientific participation and contribution of Asian scientists to the IPCC AR6 cycle through their respective communication mechanisms and initiatives.



Key findings of the IPCC Special Report on Global Warming of 1.5°C and its implications for Asia provided the backdrop for discussions at the Workshop.

APPENDIX 1: LIST OF PARTICIPANTS
WORKSHOP ON STATUS OF CLIMATE SCIENCE AND TECHNOLOGY IN ASIA
Sheraton Imperial Kuala Lumpur Hotel I 15-16 November 2018

1. A. Saleem Khan, Indian Institute of Technology, Madras, India
2. Achyut Tiwari, Tribhuvan University Kathmandu, Nepal
3. Adnan Arshad, China Agricultural University, China
4. Ahmad Fariz Mohammad, Institute for Env. and Development, Universiti Kebangsaan Malaysia
5. Aida Hayati Mohd Hassan, Global Environment Centre
6. Anna Lee, Geological Society of Malaysia
7. Asae Sayaka, Institut Darul Ridzuan, Perak
8. Asylbek Aidaraliev, National Academy of Science, Kyrgyzstan
9. Athirah Lim Abdullah, Department of Irrigation and Drainage Malaysia
10. Catherine Roween Chico Almaden, Xavier University-Ateneo de Cagayan, Philippines
11. Chandni Singh, Indian Institute for Human Settlements, Bangalore, India
12. Cheong Tae-Sung, National Disaster Management Institute, Republic of Korea
13. Chhinh Nyda, Royal University of Phnom Penh, Cambodia
14. Denise Margaret S. Matias, German Development Institute, Germany
15. Dipayan Dey, South Asian Forum for Environment (SAFE), India
16. Edvin Aldrian, Agency for Assessment and Application of Tech., Indonesia, Vice Chair, IPCC WG I
17. Effendi Tandoko, United Nations University, Japan
18. Emma Porio, Ateneo de Manila University, Philippines
19. Fasihah Mohd Yusof, SEADPRI-Universiti Kebangsaan Malaysia
20. Gemma Narisma, Manila Observatory, Ateneo de Manila University, Philippines
21. Jagriti Kher, University of Delhi, India
22. Jasmin Irisha Jim Ilham, Malaysian Youth Delegation
23. Jerico Consolacion, College of Agriculture and Forestry, Mindanao State University, Philippines
24. Joy Jacqueline Pereira, SEADPRI-Universiti Kebangsaan Malaysia, Vice Chair, IPCC WG II
25. Julian Hunt , University of Cambridge & University College London
26. Kamal Ahmed, University of Agriculture, Water and Marine Sciences, Pakistan
27. Khor Cheng Seong, Chemical Engineering Department, Universiti Teknologi Petronas
28. Koh Fui Pin, Independent Consultant, Malaysia
29. Kristoffer B. Berse, Nat. College of Public Administration & Governance, Univ. of the Philippines
30. Lee Ee Ling, Malaysian Nature Society
31. Lim Choun Sian, SEADPRI-Universiti Kebangsaan Malaysia
32. Lim Lee-Sim, School of Distance Education, Universiti Sains Malaysia
33. Lim Yun-Seng, Universiti Tunku Abdul Rahman, Malaysia
34. Linda Stevenson, Asia-Pacific Network for Global Change Research (APN)
35. Lorena Sabino, University of the Philippines Los Banos, Philippines
36. Mai Van Khiem, Vietnam Institute of Meteorology, Hydrology and Climate Change, Vietnam
37. Manju Mohan, Indian Institute of Technology, New Delhi, India
38. Mohammad Firdaus Ammar, Malaysian Meteorological Department
39. Mohammad Rahimi, Faculty of Desert Studies, Semnan University, Iran
40. Mohd Afzanizam Muda, Program Perubahan Iklim, Institut Penyelidikan Perhutanan Malaysia

41. Mohd Faizol Markom, SEADPRI-Universiti Kebangsaan Malaysia
42. Mohd Khairul Zain Ismail, SEADPRI-Universiti Kebangsaan Malaysia
43. Mohd Raihan Taha, Institute for Environment and Development, Universiti Kebangsaan Malaysia
44. Mohd Talib Latif, Fakulti Sains dan Teknologi, Universiti Kebangsaan Malaysia
45. Mostafa Jafari, Macro National Strategic Plan of Climate Change Research AREEO, Iran
46. Muhammad Farhan Ul Moazzam, Naresuan University, Thailand
47. Muhammad Firdaus Sulaiman, Faculty of Agriculture, Universiti Putra Malaysia
48. Nachatira Thuraichamy, Malaysian Youth Delegation
49. Nofri Yenita Dahlan, Universiti Teknologi MARA (UiTM)
50. Noralene Uy, Ateneo de Manila University, Philippines
51. Nurfashareena Muhammad, SEADPRI-Universiti Kebangsaan Malaysia
52. Nurul Syazwani Yahaya, SEADPRI-Universiti Kebangsaan Malaysia
53. Oxana S. Savoskul, The International Water Management Institute (IWMI), Sri Lanka
54. Pariva Dobriyal, Wildlife Institute of India
55. Rajib Shaw, Graduate School of Media and Governance, Keio University, Japan
56. Rawshan Ara Begum, Kumamoto University, Japan
57. Robert Zomer, Kunming Institute of Botany, Chinese Academy of Sciences
58. Sahar Hadi Pour, Center of Coastal & Ocean Engineering, Universiti of Teknologi Malaysia
59. Sangam Shrestha, Asian Institute of Technology (AIT), Thailand
60. Sarah Aziz, SEADPRI-Universiti Kebangsaan Malaysia
61. Sharina Abdul Halim, Institute for Env. and Development, Universiti Kebangsaan Malaysia
62. Shaukat Ali, Ministry of Climate Change, Pakistan
63. Sheeba Nettukandy Chenoli, Department of Geography, University of Malaya
64. Shiyamala Devi Sivakumar, Malaysian Nature Society
65. Siti Amira Sariyathul Rusly, SEADPRI-Universiti Kebangsaan Malaysia
66. Siti Hasniza Muhammad Arshad, SEADPRI-Universiti Kebangsaan Malaysia
67. Siti Khadijah Satari, SEADPRI-Universiti Kebangsaan Malaysia
68. Srivatsan V. Raghavan, National University of Singapore, Singapore
69. Syarifah Aini Dalimunthe, Research Center for Population, Indonesian Institute of Sciences
70. Umi Amira Jamaluddin, SEADPRI-Universiti Kebangsaan Malaysia
71. Ven Paolo Valenzuela, The University of Tokyo
72. Venus Leopardas, Mindanao State University at Naawan, Philippines
73. Yusmanisam Wan Yusof, Engineering Services Division, Ministry of Health Malaysia
74. Zelina Zaiton Ibrahim, Faculty of Environmental Studies, Universiti Putra Malaysia

APPENDIX 2: PROGRAMME
WORKSHOP ON STATUS OF CLIMATE SCIENCE AND TECHNOLOGY IN ASIA-FOR IPCC AR6
Sheraton Imperial Kuala Lumpur Hotel I 15-16 November 2018

Day 1: 15 November 2018 (Thursday)	
0900-0930	SESSION 1: OPENING & KEYNOTES
	Opening Remarks Associate Professor Dr. Sarah Aziz, Chair, SEADPRI-Universiti Kebangsaan Malaysia Dr. Linda Stevenson, Asia-Pacific Network for Global Change Research (APN)
0930-1030	*Moderators: Dr. Linda Stevenson, Asia-Pacific Network for Global Change Research (APN) & Associate Professor Dr. Sarah Aziz, Chair, SEADPRI-Universiti Kebangsaan Malaysia* Keynote Address 1: Climate Science and Technology for Cities Professor Lord Julian Hunt, University of Cambridge & University College London Keynote Address 2: IPCC Special Report on 1.5ºC Professor Joy Jacqueline Pereira, Vice Chair, IPCC WGp. II & Principal Fellow, SEADPRI-UKM
1030-1100	Morning Break & Poster Session
1100-1300	SESSION 2: IPCC SIXTH ASSESSMENT REPORT (AR6) OUTLINES *Moderators: Prof. Joy Jacqueline Pereira, Vice Chair, IPCC WGp. II & Universiti Kebangsaan Malaysia & Assoc. Prof. Dr. Gemma Narisma, Manila Observatory, Ateneo de Manila University, Philippines*
	Outline of Working Group I contribution to the IPCC AR6, Professor Edvin Aldrian, Vice Chair, IPCC WGp. I & Agency for Assessment and Application of Technology (BPPT), Indonesia Outline of Working Group II contribution to the IPCC AR6, Professor Rajib Shaw, Graduate School of Media and Governance, Keio University, Japan Outline of Working Group III contribution to the IPCC AR6, Professor Lim Yun-Seng, Universiti Tunku Abdul Rahman, Malaysia Working Group I - Chapter 12: Perspective on climate change information for Asia, Dr. Mohammad Rahimi, Faculty of Desert Studies, Semnan University, Iran Working Group III contribution to the IPCC AR5: A glance on climate change mitigation, *Professor Jafari Mostafa, Macro National Strategic Plan of Climate Change Research AREEO, Iran*
1300-1400	Lunch Break
1400-1700	SESSION 3: FAST AND SLOW-ONSET CLIMATIC HAZARDS *Moderators: Associate Professor Dr. Zelina Zaiton Ibrahim, Faculty of Environmental Studies, Universiti Putra Malaysia & Dr. Cheong Tae-Sung, National Disaster Management Institute, Republic of Korea*
	Impact of five decades of development process on heat island intensities over a sub-tropical region in India, Professor Manju Mohan, Indian Institute of Technology, New Delhi, India Spatio-statistical analysis of flood susceptibility using bivariate model in the floodplain of River Swat, District Charsadda, Pakistan, Muhammad Farhan Ul Moazzam, Naresuan University, Thailand Climate-related disasters and infrastructure development of Nepal, Dr. Achyut Tiwari, Tribhuvan University Kathmandu, Nepal Integrating adaptation, disaster risks and loss to address slow-onset processes in Quang Ngai Province, Dr. Mai Van Khiem, Vietnam Institute of Meteorology, Hydrology and Climate Change, Vietnam Meso-level analysis on rice farmers adaptive measures for slow-onset hazard: The case of saltwater intrusion, Dr. Catherine Roween Chico Almaden, Xavier University-Ateneo de Cagayan, Philippines Drought risk management in Cambodia by using ICT: A proposed model, Dr. Chhinh Nyda, Royal University of Phnom Penh, Cambodia Slow-onset events in Asia: A systematic review of regional trends and the role of science-policy partnerships, Dr. Denise Margaret S. Matias, German Development Institute, Germany
1700-1730	Refreshment & End of Day 1
1730-1930	ANCST Business Meeting [All are welcome]
1930-2130	Dinner [By invitation only]

Day 2: 16 November 2018 (Friday)	
0830-1000	SESSION 4: CLIMATE OBSERVATION AND PROJECTION *Moderators: Professor Edvin Aldrian, Vice Chair, IPCC WGp. I & BPPT, Indonesia & Assoc. Prof. Dr. Gemma Narisma, Manila Observatory, Ateneo de Manila University, Philippines*
	Future climate projections for Southeast Asia: What does high-resolution climate modelling tell us? Dr. Srivatsan V. Raghavan, Tropical Marine Science Institute, National University of Singapore Impact assessment and model simulation to urban extreme weather vulnerabilities to advance climate adaptation, Adnan Arshad, China Agricultural University, China Climate change projections in South and Southeast Asian river basins, Dr. Sangam Shrestha, Asian Institute of Technology (AIT), Thailand Quantitative assessment of precipitation changes under CMIP5 RCP scenarios over Northern Pakistan, Dr. Kamal Ahmed, Lasbela University of Agriculture, Water and Marine Sciences, Pakistan Greater Himalaya and Aral Sea Region: Modelling glacier response to climate change, Dr. Oxana S. Savoskul, The International Water Management Institute (IWMI), Sri Lanka
1000-1030	Morning Break & Poster Session
1030-1230	SESSION 5: CLIMATE IMPACTS AND ECOSYSTEMS *Moderators: Professor Jafari Mostafa, Macro National Strategic Plan of Climate Change Research AREEO, Iran & Dr. Chandni Singh, Indian Institute for Human Settlements, Bangalore, India*
	Effects of rising sea level and changing rainfall patterns on rice and oil palm yields in Peninsular Malaysia, Dr. Muhammad Firdaus Sulaiman, Faculty of Agriculture, Universiti Putra Malaysia Climate change impacts on bioclimatic zones and terrestrial ecosystems in Southeast Asia, Dr. Robert Zomer, Kunming Institute of Botany, Chinese Academy of Sciences Vulnerability and impacts on mangrove ecosystems: A review of South Asia's (Pichavaram) mangrove management for adaptation, Dr. A. Saleem Khan, Indian Institute of Technology, Madras, India Towards SDGs: forest, market and climate change nexus in Indian Western Himalaya, Dr. Pariva Dobriyal, Wildlife Institute of India Enhancing soil function by reusing crop residues for reducing emission from biomass burning, Dr. Dipayan Dey, South Asian Forum for Environment (SAFE), India Sustaining climate-impacted terrestrial, coastal, and aquatic ecosystems, Effendi Tondako, United Nations University, Institute for the Advanced Studies of Sustainability (UNU-IAS), Japan
1230-1400	Lunch Break
1400-1630	SESSION 6: VULNERABILITY, WELLBEING AND HEALTH *Moderators: Associate Professor Dr. Rawshan Ara Begum, Kumamoto University, Japan & Dr. Sharina Abdul Halim, Institute for Environment and Development, Universiti Kebangsaan Malaysia*
	How do we assess vulnerability to climate change in India? A systematic review of literature, Dr. Chandni Singh, Indian Institute for Human Settlements, Bangalore, India Climate risk and vulnerability assessment over Hindu Kush sub-regions (Bajaur, Mohmand and Khyber agencies) of Pakistan, Dr. Shaukat Ali, GCISC, Ministry of Climate Change, Pakistan Household vulnerability and adaptation to land and forest degradation in Kanan Watershed, Philippines, Dr. Lorena Sabino, University of the Philippines Los Banos, Philippines Vulnerability assessment in coastal areas of Misamis Occidental, southern Philippines, Dr. Venus Leopardas, Mindanao State University at Naawan, Philippines Vulnerability of poor women to climate-linked water stresses: Case study of slums in capital city of India, Dr. Jagriti Kher, University of Delhi, India Potential risk of tropical diseases occurring in mountain regions of Central Asia, Professor Asylbek Aidaraliev, International University of Kyrgyzstan
1630-1730	Closing Remarks, Refreshment & End of Workshop
1730	IPCC Asian Authors Meeting: Professor Rajib Shaw (Japan) & Dr. Cheong Tae-Sung (Korea)
1730	NUOF Project Meeting: Lord Julian Hunt (United Kingdom) & Prof. Joy Jacqueline Pereira (Malaysia)
1930	Dinner [By invitation only]

APPENDIX 3: ABSTRACTS

WORKSHOP ON STATUS OF CLIMATE SCIENCE AND TECHNOLOGY IN ASIA-FOR IPCC AR6

Sheraton Imperial Kuala Lumpur Hotel I 15-16 November 2018

LIST OF ABSTRACTS

1. Spatio-statistical analysis of flood susceptibility using bivariate model in the floodplains of River Swat, District Charsadda, Pakistan.
2. Climate-related disasters and infrastructure development of Nepal.
3. Integrating climate change adaptation, disaster risk reduction and loss and damage to address emerging challenges due to slow-onset processes in Quang Ngai Province.
4. A meso-level analysis on rice-farmers' adaptive measures for slow-onset hazards: The case of saltwater intrusion in the Philippines and Vietnam.
5. Drought risk management in Cambodia by using ICT: A proposed model.
6. Future climate projections for Southeast Asia: What does high resolution climate modelling tell us?
7. Slow-onset events in Asia: A systematic review of regional trends and the role of science-policy partnerships.
8. Impact assessment and model simulation to urban extreme weather vulnerabilities to advance climate adaptation.
9. Climate change projections in South and Southeast Asian river basins.
10. Quantitative assessment of precipitation changes under CMIP5 RCP scenarios over the Northern Sub-Himalayan region of Pakistan.
11. Greater Himalaya and Aral Sea region: Modelling glacier response to climate change.
12. Effects of rising sea level and changing rainfall patterns on rice and oil palm yields in Peninsular Malaysia.
13. Vulnerability and impacts on mangrove ecosystems to changing climate: A review of South Asia's mangrove management for adaptation.
14. Towards SDGs: Forest, market and climate change nexus in Indian Western Himalaya.
15. Enhancing soil function by reusing crop residues for reducing emission from biomass burning towards climate adaptive Agri-Waste Management.
16. Assessing the relevance of research and capacity development to sustainability goals: The Asia-Pacific Network for Global Change Research (APN) knowledge synthesis (2013-2018).
17. How do we assess vulnerability to climate change in India? A systematic review of literature.
18. Climate risk and vulnerability Assessment (CRVA) over Hindu Kush sub-regions (Bajaur, Mohmand and Khyber agencies) of Pakistan.
19. Household vulnerability and adaptation to land and forest degradation associated with climate change in Kanan Watershed, Philippines.
20. Vulnerability assessment in coastal areas of Misamis Occidental, Southern Philippines and its implications for development of climate-resilient communities.
21. Vulnerability of poor women to climate-linked water stresses: Case study of slums in capital city of India Theme: Poverty, livelihoods and sustainable development.
22. Potential risk of tropical diseases occurring in Mountain Regions of Central Asia.

Spatio-statistical analysis of flood susceptibility assessment using bivariate model in the floodplains of River Swat, District Charsadda, Pakistan

*1Muhammad Farhan Ul Moazzam, [2]Atta Ur Rahman, [3]Nasir Farid
*[*1]Department of natural resources and environment, Naresuan University, 65000, Thailand*
[2,3]Department of Geography, University of Peshawar, Pakistan
Corresponding author: farhan.moazzam@gmail.com

Abstract

Flood is one of the most predominant disasters around the globe and a frequently occurring phenomena in the northern part of Pakistan. In this study, the effects of various divisions of flood inventory and combination of conditioning factors were assessed for a final susceptibility map. In this paper, the flood inventory map was prepared for Charsadda by visual interpretation of Landsat 7 image together with field survey, and total of 161 flood locations were mapped. The flood inventory was subsequently divided into training and validation datasets, from a total of 129 (80%) and 112 (70%) locations for training the model, and 32 (20%) and 49 (30%) for validation of the model. Total ten conditioning factors were used (Elevation, Slope, Aspect, Curvature, Plan curvature, Profile curvature, Proximity to river, streams, roads, and Land use/land cover), for the development of a flood susceptibility map. All the conditioning factors were correlated with the flood inventory map using information value method. The final susceptibility maps were validated using prediction rate, and success rate curve. The results from validation showed that the prediction rate curve of all the models were 99.47%, 95.04%, and 94.06% respectively. The success rate curve obtained for three models with area under curve (AUC) were 95.03%, 86.91%, and 89.67%. Eventually, the susceptibility maps were classified into five susceptibility zones. The success rate and prediction rate curve indicated that the model A has more accuracy as compared with model B and model C; though, the results obtained from prediction and success rate curve indicated that all the models were reliable for flood susceptibility assessment. Thus, results obtained from this study are useful for researchers, managers, and decision makers to manage the flood prone areas in District Charsadda and to decrease flood damage.

Climate-related disasters and infrastructure development of Nepal

Archut Tiwari
Tribhuvan University Kathmandu, Nepal

Abstract

Nepal shows great variations in climate due to strong topographic gradients, with the altitudinal variations ranging from 60 meters to 8848 meters above mean sea level. The variable geoclimatic conditions, unplanned settlements, degradation of natural resources and increasing population make the country vulnerable to a variety of climate-related extreme events. Nepal is prone to a variety of recurring natural disasters such as floods, landslides, snow avalanches, Glacial Lake Outburst Floods (GLOF), hailstorms, thunderstorms, cold waves, heat waves, drought, epidemics and earthquakes. High-intensity rainfall events during the monsoon enhance water-induced natural disasters such as floods, landslides, flash floods, debris flows and slope failures, while prolonged droughts exacerbating agriculture are not uncommon in certain regions in Nepal. The vulnerability to climate-related extremes and natural hazards are often attributed to insufficient public awareness, lack or inadequacy in preparedness, lack of coordination among inter-government agencies, inadequate financial resources, low level technical know-how and skills in mitigation of natural disasters. The development of settlements in hazardous areas and marginal land are caused by the lack of proper land use planning. The relevancy of modern town planning, broader highways, larger hydropower stations and establishing big industries in Nepal are often less explored in terms of potential risks in the region. The decreasing number of rainy days and increasing intensity of rainfall are potentially hazardous in newly expanding cities due to insufficient drainage and lack of natural water recharge. The fragile geomorphology, highly diverse climatic zones, extreme climate events and insufficient preparedness to handle risks associated with large-scale infrastructure development are major issues to be considered in order to reduce climate-related disaster risks on infrastructure development in Nepal.

Integrating climate-change adaptation, disaster risk reduction, and loss and damage to address emerging challenges due to slow onset processes in Quang Ngai Province

Mai Van Khiem
Vietnam Institute of Meteorology, Hydrology and Climate Change (IMHEN)

Abstract
Located in the Central coastal region of Vietnam, Quang Ngai is a coastal province with diverse terrain. Quang Ngai is often affected by natural disasters such as storms, floods, droughts, causing a lot of damage and significantly affecting the lives and livelihoods of the communities in the province. In recent years, the climate in Quang Ngai province has changed fundamentally due to the impact of climate change such as increasing and uneven distribution of rainfall in the rainy season, decreasing and uneven distribution of rainfall in the dry season, the increase in temperature, leading to the increase of types of natural disasters due to slow-onset processes such as salinity intrusion and sea level rise that have a strong impact on production and lives. In order to contribute to Quang Ngai's response to climate change and sea level rise, the report assesses the vulnerability, exposure and resilience of slow onset processes and risks by calculating, identifying "risk mitigation" and "vulnerability" indicators, and then mapping the risk mitigation index and vulnerability map to natural disasters for the province. Also, the potential loss and damage caused by slow-onset processes is assessed for the provincial areas and sectors, from which policies for integrating and strategic planning for climate-change adaptation, disaster risk reduction are developed for the province.

A meso-level analysis on rice-farmers' adaptive measures for slow-onset hazard: The case of saltwater intrusion in the Philippines and Vietnam

CRC Almaden[1], T.T. Diep[2], AC Rola[3], RDT Baconguis[3],
JM Pulhin[3], JV Camacho, JR. [3], RC Ancog[3]
[1] *Economics Department, Xavier University-Ateneo de Cagayan, Philippines*
[2] *Tra Vinh University, Vietnam*
[3] *University of the Philippines Los Baños, Philippines*

Abstract
This study examined the factors influencing rural rice farmers' choice of adaptation measures for slow-onset hazard brought about by saltwater intrusion in selected rice farm communities in the Philippines and Vietnam. Specifically, this study determined the influence of social, economic and institutional factors as well as farmers' perception and level of awareness on climate-related events on the choice of adaptation measures to address saltwater intrusion. The study classified adaptation measures into specific categories and developed a multi-criteria assessment tool on adaptation measures. This led to the development of a measure-based adaptation index (MAI) which addressed a number of shortcomings of previous studies and captured the variation in adaptation measures implemented by the rice farmers in terms of the number of adaptation measures implemented by the rice farmers, feasibility of implementing the measures and the extent to which they are applied. Econometric approach was applied to determine the factors influencing rice farmers' choice of adaptation measures. The results indicated that adaptation takes place at different levels based on the propensity to adapt, the variety and diversity of adoption of various measures, and the feasibility of the various measures. The results also underscored that socio-economic and institutional factors significantly influence rice farmers' choice of adaptation measures to saltwater intrusion. The study is suggestive of important innovative interventions and policy implications crucial in the optimization of the current adaptation measures employed and the potential adoption of new measures.

Drought risk management in Cambodia by using ICT: A proposed model

Nyda Chhinh*, Nop Sothun & Thath Rido
Royal University of Phnom Penh, Phnom Penh, Cambodia
Corresponding author: chhinh.nyda@rupp.edu.kh

Abstract

The Impact of climate change (either from rapid and slow onset) has been increasingly experienced by many communities, especially in the developing countries, where their adaptive capacities (both structural and non-structural) remain inadequate. As facing those climate risks, local communities and relevant state agencies exercised different alternatives and strategies in preparing for and responding to the potential risks including the slow-onset processes. This article aims to scrutinize the existing responses which have been established and applied by rural farmers and relevant agencies in the Kampong Spue province in coping with slow-onset processes. Based on the SENDAI framework as proposed by UNISDR, this qualitative study relies primarily on both existing literature especially the reports from government and development agencies, and the primary information collected from Focused Group Discussions and in-depth interviews of key informants. The information obtained was analyzed by employing a thematic analysis approach. The study found that while the impacts of slow-onset process have been noticed, the way of analyzing and monitoring those impacts remain narrow as the consequence of the limited capacity of local government officials. It also reveals that collaboration between relevant departments in developing effective holistic provincial development plans remain inadequate resulting in a fragmentation of interventions for responding to Disaster Risk Reduction (DRR) as well as slow-onset process. It is recommended that drought monitoring mechanisms be established, and capacity strengthening of local government officials on how to monitor the impacts of slow onset-process is required in order for them to contribute in designing effective policy and action plans for provincial and local resilience. Simultaneously, the province's relevant departments should work closely together in order to effectively integrate DRR, Climate Change Adaptation and Loss & Damage into the provincial development plan. Without these, the attempt to promote resilience in these areas will not be possible; as it will be a waste of time and resources.

Future climate projections for Southeast Asia: What does high resolution climate modelling tell us?

Srivatsan V Raghavan
Tropical Marine Science Institute, National University of Singapore
18 Kent Ridge Road, Singapore 119227
Corresponding author: tmsvs@nus.edu.sg

Abstract

Southeast Asia is under studied when it comes to climate sciences. Unlike the scientific and technical expertise in countries such as the USA, UK, Australia and New Zealand, climate research studies in Southeast Asia remain challenging. The Asian Development Bank (ADB) has stressed the need for more adaptive measures and strategies to mitigate climate change impacts. Reports of the Intergovernmental Panel on Climate Change (IPCC) and the ADB have indicated that much more detailed research is needed for the Southeast Asian countries. This includes not just refinements in data collection, analyses and modelling, but also a new look at the archipelagic and insular land and seascapes unique to Southeast Asia. While both global and regional climate modelling have improved over the last two decades, lot of uncertainties exist in climate projections that these models deliver which the policy makers find difficult to consider for their adaptive strategies. Given uncertainties in global and regional climates, reliable climate change information is needed for policy makers and stakeholders. While both global and regional climate modelling has improved over the last two decades, lot of uncertainties exist in climate projections which the policy makers find difficult to consider for their adaptive strategies. This impasse is augmented due to the lack of sufficient observational records, especially extremes, as in the case of rainfall, which even the satellites fail to capture. Looking into the climate models at high-resolutions, a scale that is appropriate for Southeast Asia, is crucial. This talk describes high resolution climate projections derived using the Weather Research and Forecasting (WRF) model at a 20km spatial resolution over Southeast Asia. Some impact studies based on these projections are also illustrated. This study is a contribution to the climate science literature in Southeast Asia covering both climate modelling and impacts studies over the region.

Slow-onset events in Asia: A systematic review of regional trends and the role of science-policy partnerships

Dr. Denise Margaret S. Matias[1,2]
[1] *Non-Timber Forest Products Exchange Programme Asia (Philippines)*
[2] *German Development Institute / Deutsches Institut für Entwicklungspolitik (Germany)*
Corresponding author: Denise.Matias@die-gdi.de

Abstract

Climate change is often associated with extreme rapid-onset events such as intense typhoons (also known as hurricanes or cyclones) or heavy precipitation, but it also manifests in slow-onset events, such as sea level rise or ocean acidification, where rate of impact is gradual and appears less destructive than that of extreme events. Yet, the UNFCCC found that the negative impacts of slow-onset events are already affecting developing countries and there is an urgent need to manage the risks, despite the slow pace of the process. This proposed manuscript systematically reviews peer-reviewed publications on slow-onset events in Asia in order to understand how academic research is responding to this urgency. By looking at geographical, disciplinary, and thematic trends in research, the proposed manuscript will show research gaps and needs of the Asian region. In particular, the manuscript will review types of slow-onset impacts on humans and ecosystems, drivers of vulnerability, internal and external factors affecting slow-onset impacts, and scale of studies. In addition, the manuscript will also review recommendations on how to address slow-onset events and identify opportunities for cross-sectoral collaboration that have policy implications. This will enable the proposed manuscript to show that despite the difficulties in attribution, slow-onset events provide an opportunity to address both climate change and development challenges.

Impact assessment and model simulation of urban extreme weather vulnerabilities to advance climate adaptation

Adnan Arshad[1], Kamran Yousaf[2], Qi Hua[3], Li Ming[4], Weiwei Zhang[5], Abdul Mateen[6]& Mehmood-ul-Hasan[7]
[137]Potohar Organization for Development Advocacy, [12456] China Agricultural University.
Corresponding author: adnan.poda@gmail.com & ad@cau.edu.cn

Abstract

Cities emit significant and increasing quantities of greenhouse gases and rising temperatures, and the *Fifth Assessment Report of IPCC* cites projections that urban land cover will increase by 1.2 million sq. km between 2000 to 2030. Karachi, the largest city in Pakistan with a 16.22 million population and being the 7th largest metropolitan city worldwide, is highly vulnerable to extreme climatic events (IPCC/SR-2018). Severe heat waves (HW) with high temperatures of 49°C (120°F) and high humidity (60-70%) have struck Karachi and southern parts of Pakistan since 2015-17. It caused the deaths of about 2500-2800 people from dehydration and heat stroke/year. In April 2018, Nawabshah city recorded the highest temperature of 50.2 °C (122.3 F) which is the highest temperature to ever be recorded on Earth. Heat waves were a response to global climate change and extreme weather events aggravated by rapid urbanization, industrialization and motorization which have led to higher amounts of CO_2 level in the air creating high temperatures (micro climate heat effect). Another reason for these disasters is deforestation and degradation of Mangrove Forest (MF) by recent urbanization which reduced green spaces. This research finding illustrates the application of the SILVA and SWAT growth model for comparing relationships between urbanization and urban green space habitat strategic plan (HSP) to mitigate future HWs, improve air quality index (AQI) and simulate the possible opportunities to health and build disaster risk resilience. SILVA model simulations showed that 43.61% of the urban CO_2 stock can be deposited, which contributes 19% of the ecosystem. The model projected that forest areas around the city have the ability to absorb CO_2 emissions of up to 55.4 million tons. Model callibration and validation skill scores showed that forests have a huge potential to contribute to global efforts to reduce carbon footprints through climate smart practices of restoration, mitigate urbanization, reforestation and sustainable management of MF. SILVA estimated that forest populations have sink capacity to absorb maximum atmospheric CO_2 to combat global climate change impacts and efficiently contribute to improve the AQI and HW. Model callibration projected that urban heat island effect (UHI) can be counteracted. This research provides initial assessments and recommendations for the policy decision makers in the advancement of meteorological forecasting and establishment of climatology early warning system for observations and projections.

Climate change projections in South and Southeast Asian river basins

Sangam Shrestha*
Water Engineering and Management, Asian Institute of Technology, PO Box 4, Khlong Luang, Pathumthani, 12120, Thailand.
Corresponding author: sangamshrestha@gmail.com; sangam@ait.asia

Abstract

In Asia, past and present climate trends and variability have been characterized by an increasing temperature and strong variability in precipitation with both increasing and decreasing trends in different geographical locations and seasons. A detailed analysis and understanding of climate change impacts on water resources and water use sectors in Asian basins is becoming more important to develop adaptation strategies to offset the negative impacts and harness the positive impacts of climate change. However, most of the studies reported the climate change results at coarse spatial and temporal resolutions. Climate change projections at basin/local scale are needed to come up with basin-specific adaptation options and action plans to reduce the negative impacts of climate change. This study presents the climate change projections, mainly temperature and precipitation in 21 river basins of South and Southeast Asia under different emission scenarios from the Special Report on Emission Scenarios (SRES) and Representative Concentration Pathways (RCPs) suggested by Intergovernmental Panel on Climate Change (IPCC) in near, mid and far future. The average annual maximum and minimum temperatures are projected to increase in all the study basins in all future periods. The range of increase of average annual maximum temperature varies from 1.0 to 6.3°C under high-emission scenario and from 0.8 to 2.6°C under low-emission scenario in higher latitude basins whereas the increase varies from 1.2 to 3.6°C under high-emission scenario and from 0.9 to 2.7°C under low-emission scenario in lower latitude basins in far future. The average annual minimum temperature is also projected to be higher in higher latitude basins. The range of increase varies from 0.7 to 5.6°C under high emission scenario and from 0.4 to 3.6°C under low-emission scenario in higher latitude basins whereas the range of increase varies from 1.6 to 5.3°C under high-emission scenario and from 1.0 to 3.2°C under low-emission scenario in lower latitude basins in far future. Unlike temperature, precipitation shows different directions of change in the study basins. In higher latitude basins, Kabul River Basin of Afghanistan may witness the highest (82.6%) increase whereas Sikkim of India may witness decrease in precipitation by 15% in far future under high-emission scenario. In lower latitude basins, precipitation is projected to increase by 1.6% in Southern Vietnam to 40% in Bago River Basin of Myanmar in far future under high-emission scenario. Similarly, the precipitation in Bangkok is projected to decrease by 1.8%, and increase by 20.7% in Citarum River Basin of Indonesia in far future under low-emission scenario. The results of this study will be very useful in climate change impact and vulnerability assessment, and in formulating adaptation strategies to reduce negative impacts in various natural and managed ecosystems in study basins.

Quantitative assessment of precipitation changes under CMIP5 RCP scenarios over the Northern Sub-Himalayan region of Pakistan

Kamal Ahmed[1*], Shamsuddin Shahid[2], and Nadeem Nawaz[1]
[1] *Lasbela University of Agriculture Water and Marine Sciences Uthal, Balochistan, Pakistan*
[2]*School of Civil Engineering, Faculty of Engineering, Universiti Teknologi Malaysia (UTM), 81310 Johor Bahru*
Corresponding author:kamal_brc@hotmail.com

Abstract

Modeling the potential impacts of climate change on precipitation over the northern sub-Himalayan region is very important to ensure sustainable water supply for Pakistan. The objective of this study is to develop statistical downscaling models for the projection of precipitation using the outputs of Coupled Model Intercomparison Project Phase 5 (CMIP5) global circulation models (GCMs) under four representative concentration pathways (RCP) scenarios. The gauge-based gridded precipitation data of Global Precipitation Climatology Centre (GPCC) having a spatial resolution of 0.5° was used as the historical precipitation. The downscaling models were developed using non-local model output statistics (MOS) approach based on support vector machine (SVM). A Random Forest algorithm was used to develop a multi-model ensemble (MME) for the projection of precipitation. The model performances were assessed based on the Taylor diagram and other statistical measures including mean bias error (MBE), mean absolute error (MAE), root mean square error (RMSE), index of agreement (MD), Nash–Sutcliffe model efficiency (NSE) and coefficient of determination (R2). Results showed that the SVM downscaling model simulated the temporal and spatial distribution of historical precipitation with high skills. The ensemble of GCMs projected changes in rainfall in the range of -6.49% to 7.80%, -8.45% to 7.06%, -6.52% to 5.29%, and -8.56% to 9.14% for RCP2.6, RCP4.5, RCP6.0 and RCP8.5 scenarios, respectively. The spatial pattern of annual mean rainfall of MME revealed an expansion of high rainfall area, especially in 2070-2099 under all scenarios.

Greater Himalaya and Aral Sea region: Modelling glacier response to climate change

Oxana S. Savoskul
The International Water Management Institute (IWMI), Sri Lanka

Modeling glacier response to climate change is a long-standing research problem of special importance in High Asia, where glacier reduction may threaten the seasonal water availability of over hundred million people. The research problem of modeling climate change impact on glacier systems at large remains largely unsolved not only in that region, but elsewhere around the globe. Its importance is difficult to underestimate because in the absence of reliable methods for the assessment of future glacier states the large-scale hydrological modeling is hampered too. Here, a set of glacier system models is used to show that to melt down all glaciers in the large glacier systems of the Indus, Ganges, Brahmaputra and Amu Darya basins, an air temperature rise up to 10-15^{o}C is required. Under the 4-5^{o}C warming projected by IPCC for the end of 21st century, glacier systems in these basins will still exist but will be reduced in area by 77-89% compared with their baseline status in 1961-90. The Syr Darya and Mekong basins will become ice-free under this scenario since glaciers in these basins are more sensitive to climate change. The glacier systems in the Aral Sea region in their current state may serve as analogue models for the future state of the Greater Himalaya glacier systems.

Effects of rising sea level and changing rainfall patterns on rice and oil palm yields in Peninsular Malaysia

Muhammad Firdaus Sulaiman, Ph.D.
Department of Land Management Faculty of Agriculture, Universiti Putra Malaysia 43400 Serdang Selangor, Malaysia
Corresponding author: muhdfirdaus@upm.edu.my

Abstract:
Anthropogenic greenhouse gas emission has caused an increase in the mean global temperature which had led to the increase of sea level and alteration of rainfall distribution patterns around the world. The agricultural sector in Malaysia has also felt the repercussions of the ongoing phenomenon with rice and oil palm to being the primary crops affected. Rice, which is the staple food for Malaysians is mostly grown at coastal regions around Peninsular Malaysia, and is most susceptible to rising sea level. Sea water inundation, reported to have already occurred in the granary areas of northwestern Selangor, could potentially increase the soil salinity of the area, adversely affecting rice yields. Oil palm which is the main commodity crop of Malaysia has experienced declining yields, which was believed to be due to the changes of rainfall patterns over the recent years. This study presents data on the soil salinity status of the granary areas in northwestern Selangor through sampling of soil and analysis of electrical conductivity of the samples along a transect from the coast towards the inland. The severity of sea water inundation is presented by analyzing data provided by the Department of Irrigation and Drainage Malaysia and the Meteorological Department Malaysia. The two parameters were analyzed for correlations with rice yields of the area. Historical oil palm yields from the main oil palm producing areas around Peninsular Malaysia were analyzed for correlations with rainfall and temperature records during the same period. The outcome of this study provides an on- the-ground assessment on the effects of the rising sea level on rice production, and the changing rainfall patterns on oil palm production in Peninsular Malaysia.

Vulnerability and impacts on mangrove ecosystems to changing climate: A review of South Asia's mangrove management for adaptation

A. Saleem Khan*
Department of Humanities and Social Science
Indian Institute of Technology Madras, Sardar Patel Road, Chennai 600035, Tamil Nadu, India
Corresponding author: asaleemkhan.cc@gmail.com

Abstract:
Although geological records show climatic changes throughout history, the present rate of global warming threatens the survival of entire ecosystems at the regional level. Coastal ecosystems are more vulnerable to these changes, and among the most highly affected ecosystems are the mangroves, coral reefs and salt marshes. There are increasing speculations that mangrove ecosystem will become more fragile and sensitive to uncertain climate variability such as sea-level rise, high water events, storms, precipitation, temperature, atmospheric CO2 concentration, ocean circulation patterns, health, and functionally-linked neighboring ecosystems, as well as human responses to climate change. Furthermore, the socio-economic impacts of the effects of climate on mangrove ecosystems may include and exacerbate the increased risk of flooding, increased erosion of coast lines, saline intrusion, etc. Mangroves in the South Asian regions of the Ganges- Brahmaputra and Cauvery-Godavari Delta of Bangladesh and India, Indus Delta of Pakistan; and Puttalam Lagoon of Sri Lanka in South Asia witness high risks of a changing climate. Urgent action is necessary to prevent climate change-driven damage to mangrove coastal lines throughout the South Asia region as across the world. In this context, this article reviews the state of knowledge on the vulnerability and impacts of mangrove ecosystems to the changing climate in general and sea-level rise in particular, with reference to South Asia (Bangladesh, India, Pakistan, and Sri Lanka). This review also synthesizes various case studies on South Asia's mangrove management strategies for adaptation to changing climate. It is hoped that this review will torch more regional (South Asia) representative view of mangroves and would allow us to better understand the vulnerability and impacts of mangrove ecosystems to the changing climate and its adaptive management strategies at the regional level.

Towards SDGs: Forest, market and climate change nexus in Indian Western Himalaya

Pariva Dobriyal, Ruchi Badola & Syed Ainul Hussain
Wildlife Institute of India, Chandrabani, Dehradun- 248002, Uttarakhand, India
Corresponding author: parivadobriyal@gmail.com; pariva@wii.gov.in

Abstract

The wellbeing of mountain communities is determined by the availability and accessibility of ecosystem goods and services. We assessed the relationship between forest quality and wellbeing of local communities of Nanda Devi Biosphere Reserve (NDBBR), Indian Western Himalaya, India. The NDBR landscape is characterized by scenic beauty, remoteness, limited development and natural resource-dependent livelihoods. To assess the status of the wellbeing of local people, relevant Sustainable Development Goals of United Nations were used as indicators. Data on these indicators was collected in 22 villages selected based on secondary demographic information, distance and state of the forest resources i.e. degraded and less-degraded. Semi-structured questionnaire-based interviews were conducted in randomly selected households (n=764). To assess the quality and quantity of forest resources, transects (n=22) were laid in the forests frequented by the sampled households. It was found that the households located close to less-degraded forest scored high on wellbeing indicators than the households located away from forest as they have better and easy accessibility to forest resources and freshwater which provides alternatives for market and agricultural products. Households with access to less-degraded resources also have access to wild fruits, vegetables and medicinal plants adding to their food and health security. Our study found that the combination of climate change, declining forest resources and expansion of market-based economy is leading to a shift in traditional cropping patterns, and hence on nutritional status and forest use patterns of local people, making them vulnerable to diseases and hunger. Accessibility to an intact forest patch near a village contributes to the wellbeing of people and increases their resilience in the face of climate change and changes dictated by the market forces.

Enhancing soil function by reusing crop residues for reducing emission from biomass burning towards climate adaptive Agri-Waste Management

Dipayan Dey, Tsering Gyeltshen& Purisima P Juico
South Asian Forum for Environment, 176A Vivekananda Park, Ajaynagar, Kolkata 700099, West Bengal India
Email: office@safeinch.org

Abstract

Open burning of crop residues for removal or to yield biomass energy leads to emission, pollution, and adversely affects soil function & nutrients. Additionally, it contributes to climate change by releasing GHGs, forming tropospheric ozone, as well as emission of dioxins owing to the chlorine content and presence of pesticides in agricultural waste. Five hundred million tons of crop residues are diverted for energy needs every year in the Indian eco-region, accounting for 7% of total agricultural emissions. This paper explores reusing crop residues and horticultural agri-waste and using them as biochar or applying it raw in the field as mulch in varied geo-ecological conditions in Bhutan, India and Philippines showed potentials in augmenting soil organic carbon and carbon density, as well as improved soil organic matter and nitrogen content of the soil, enriching the soil microbial environment. Perusal of the results of application of raw agri-waste and biochar in randomized block experiments augmented soil organic carbon concentration in the top 20-cm soil layer that increased at an average rate of 0.035% each year, whereas mean bulk density of the top 20-cm soil layer decreased significantly with an average rate of 0.0032 g/cm/yr; the application of ash has no similar impact. The applications also increased organic matter, bulk density of soil and its porosity, thereby making it more conducive to support biological growth. Holistically, biochar increased soil moisture as well as the residence time of nitrate in the crop root zone, providing greater opportunity to absorb the nitrate. Another major benefit has been its ability to sequester carbon in the soil, thereby mitigating climate change. Raw bagasse used as mulch in the agricultural field, instead of burning as fuel, potentially reduced emission of ~ 42 %. The inferences help to determine adaptive agri-waste management practices in diverse cropping systems in climate milieu. The results validated that locally relevant conservation practices can be effectively adjoined with residue removal and re-application as an adaptive strategy for abating climate impacts.

Assessing the relevance of research and capacity development to sustainability goals: The Asia-Pacific Network for Global Change Research (APN) knowledge synthesis (2013-2018)

Tandoko, Effendi
United Nations University, Institute for the Advanced Studies of Sustainability (UNU-IAS), Japan

Abstract

Countering climate challenges will need genuine multi-layered approaches under the cooperation of various stakeholders. For years, the Asia-Pacific Network for Global Change Research has been channeling that by providing grass-roots solutions while acting as a vessel for science-policy intercommunication. Thus, the objective of this synthesis is to review the extent of relevance that APN projects have so far achieved upon the targets of Sustainable Development Goals and the Paris Agreement, as well as its possible contribution to the upcoming IPCC AR6. Data is garnered from peer-reviewed documents of various case studies conducted under the aegis of APN, which have gone through two scanning phases to identify their scope and level of significance. A modified solution scanning with Likert-scale is used to categorize the outcomes' relevance with the predetermined indicators and targets of the international climate and sustainability regimes. Findings suggest 108 distinct topical and cross-cutting activities that are highly concentrated in South and Southeast Asia with many of them asserting the importance of community-based adaptation and mitigation actions to address issues related to ecosystem and biodiversity, extreme weather events, water-food-energy nexus, sustainable waste management, and climate education. Beyond that, the synthesis has undoubtedly proven APN's function to fill existing knowledge gaps by facilitating scientific exchanges through SEACLID/CORDEX-SEA for AR6 among others, attributing the observed impacts of socio-ecological changes, and developing specific place-based capacities against disaster risk and vulnerabilities. However, despite the opportunities APN possess to extend its program coverage, its strength is, paradoxically, also its weakness as specific case-study models are hardly likely to be replicated elsewhere in the context of sustainable development. Ergo, future programs should recognize the interlinkages and trade-offs of past activities with regular assessment to avoid being redundant down the line.

How do we assess vulnerability to climate change in India? A systematic review of literature

Chandni Singh, Tanvi Deshpande, Ritwika Basu
Indian Institute for Human Settlements, Bangalore, India

Abstract

In countries like India, where multiple risks interact with socio-economic differences to create and sustain vulnerability, assessing the vulnerability of people, places, and systems to climate change is a critical tool to prioritise adaptation. In India, several vulnerability assessment tools have been designed spanning multiple disciplines, by multiple actors, and at multiple scales. However, their conceptual, methodological, and disciplinary underpinnings, and resulting implications on who is identified as vulnerable, have not been interrogated. Addressing this gap, we systematically review peer-reviewed publications (n = 78) and grey literature (n = 42) to characterise how vulnerability to climate change is assessed in India. We frame our enquiry against four questions: (1) How is vulnerability conceptualised (vulnerability of whom/what, vulnerability to what), (2) who assesses vulnerability, (3) how is vulnerability assessed (methodology, scale), and (4) what are the implications of methodology on outcomes of the assessment. Our findings emphasise that methods to assess vulnerability to climate change are embedded in the disciplinary traditions, methodological approaches, and often-unstated motivations of those designing the assessment. Further, while most assessments acknowledge the importance of scalar and temporal aspects of vulnerability, we find few examples of it being integrated in methodology. Such methodological myopia potentially overlooks how social differentiation, ecological shifts, and institutional dynamics construct and perpetuate vulnerability. Finally, we synthesise the strengths and weaknesses of current vulnerability assessment methods in India and identify a predominance of research in rural landscapes with a relatively lower coverage in urban and peri-urban settlements, which are key interfaces of transitions.

Climate risk and vulnerability Assessment (CRVA) over Hindu Kush sub-regions (Bajaur, Mohmand and Khyber agencies) of Pakistan.

Shaukat Ali
Global Change Impact Studies Centre, Ministry of Climate Change, Pakistan

Abstract

Future projections of climate change and climatic extremes in a data-scarce region of Hindu Kush (Bajaur, Mohmand and Khyber agency) is a challenge due to its varied topography and hydro-climatic conditions. The data of 05 GCMs and 03 RCMs for RCP4.5 and RCP8.5 (19762100) is downscaled with Spatial Disaggregation Quantile Delta Mapping and Best Easy Systemic methods respectively, using 1 km reference datasets. Future extremes were projected by using indices developed by Expert Team on Climate Change Detection and Indices. GCM projections of RCP4.5 show warm and wet conditions in regions of Bajaur and Mohmand agency while the regions in Khyber agency show warm and dry conditions. RCP8.5 shows warm and wet conditions in all the regions of the study area and it shows double increase in temperature compared with RCP4.5 till the end of century. While the behaviour is different for precipitation where RCP4.5 shows decrease in precipitation in 2071-2100 whereas RCP8.5 shows greater increase in precipitation in 2071-2100 as compared with 2006-2041 and 2041-2070 respectively. RCM projections of RCP4.5 show warm and wet conditions in all the regions of the study area. However, in the mid-century, the Khyber agency will experience drier conditions which will become wetter towards the end of century. Precipitation in RCP8.5 shows overall wetter conditions in all regions. These variations in temperature and precipitation in the region can have serious implications in terms of rapid snow melt and increased river flow which make the area vulnerable to flash floods. In terms of climate extremes, SU, WSDI, TX90p and TN90p show an increasing trend while the number of cool nights and days has decreased annually over all the regions. CDD and CWD are decreasing. Overall the model results are satisfactory with little uncertainties for baseline periods while it increases slightly for the future periods.

Household vulnerability and adaptation to land and forest degradation associated with climate change in Kanan Watershed, Philippines

Juan M. Pulhin, Lorena L. Sabino, Josephine E. Garcia Catherine C. de Luna, Liezl B. Grefalda & Canesio D. Predo
University of the Philippines Los Banos, Philippines

Abstract

In the Philippines, land and forest degradation in watershed areas is primarily caused by a number of interacting human, institutional, governance and climatic factors. These include among others, uncontrolled access to forest lands which increases upland migration, and inappropriate land uses such as cultivation of steep sloping lands, shifting cultivation or kaingin system due to lack of livelihood opportunities. Deforestation and irresponsible mining operations further intensify the degradation due to weak governance and the lack of accountability system. Moreover, the persistence of land and forest degradation is heavily aggravated by climate change-related extreme events which result in soil erosion, siltation of water courses and loss of biodiversity affecting forestry, agriculture, settlement, and coastal areas, thereby continuing the vicious cycle of poverty and environmental deterioration. As such, this study assessed the household vulnerability and adaptation to land and forest degradation associated with climate change in Kanan Watershed, Municipality of General Nakar, Quezon Province, Philippines. Data were gathered through household surveys involving 189 respondents, complemented with focus group discussions (FGDs), and field observations from 2014 until 2018. Household vulnerability to land and forest degradation was assessed based on biophysical and socio-economic factors using equal and unequal weighting methods. Results using both methods showed that households' vulnerability to land and forest degradation associated with climate change fall into low to moderate vulnerabilities with the majority being moderately vulnerable. Typhoons and heavy rainfall which cause floods/flash floods and landslides are the common climate risk events experienced by the communities in the study area. Considering that future climate change impacts including land and forest degradation are likely to worsen under the business as usual scenario, transformational adaptation is key to minimize the disaster risks and reduce climate change vulnerability, including its associated loss and damages. This goes beyond the current and planned adaptation strategies identified by the households and local stakeholders to include the transformation of socio-economic, political, and governance structures and processes that perpetuate and reproduce households' and communities' vulnerability.

Vulnerability assessment in coastal areas of Misamis Occidental, Southern Philippines and its implications for development of climate-resilient communities

Venus Leopardas, Wilfredo Uy[1], Lovely Parungao, Jerico Consolacion, Garry Marapao and Hessed Cabanilla
Mindanao State University at Naawan, Institute of Fisheries Research and Development, 9023 Naawan, Misamis Oriental, PHILIPPINES
[1] Corresponding author: wilfredo.uy@gmail.com

Vulnerability assessment can recommend strategies on how communities adapt to climate-driven hazards. The study conducted vulnerability assessments towards climate-driven hazards (i.e., sea level rise, storm surge and tropical cyclone, watershed runoff) on selected coastal areas of the municipalities of Tudela and Plaridel, and city of Oroquieta in Misamis Occidental, southern Philippines following some standard protocols. Results showed that most of the coastal areas with few to no natural buffers (i.e., mangroves, seagrasses, and corals) had relatively high vulnerabilities to hazards, more specifically to cyclones and surges, compared with coastal areas with presence of natural buffers. More often these areas consisted of human settlements situated in close proximity to the coasts, or with the presence of solid-based structures in the foreshore, or a combination of these situations. Coastal integrity vulnerability assessment also revealed relatively higher vulnerabilities on coastal areas to sea level rise and wave impacts with low-lying coastal slopes, settlements close to the shore, absence to little extent of beach vegetation and coastal habitats, and the like. Remote coastal areas also happened to have few to minimal disaster-risk equipment / interventions. This study highlights the importance of soft engineering for natural coastal protection and the urgent need to revisit and enhance coastal land-use plan and risk-reduction strategies so that coastal communities can be fully supported in adapting to the the changing environment.

Vulnerability of poor women to climate-linked water stresses: Case study of slums in capital city of India
Theme: Poverty, livelihoods and sustainable development

Jagriti Kher[a] & Savita Aggarwal[b]
[a] Assistant Professor, [b]Associate Professor, Department of Development Communication and Extension, Institute of Home Economics, (University of Delhi, India)

Abstract
Provision of safe water for the household is one of the Practical Gender Needs of women, which in turn is crucial to enable them to meet their Strategic Gender Needs such as skill development and income generation. In developing countries including India, a considerable section of rural and poor urban families lack access to safe water and sanitation, adversely affecting women and children who have to headload water. Trends of urbanization show that by 2030, almost 2 billion people will come to live in slums and related settlements with inadequate access to water and sanitation. Climatic changes coupled with non-climatic drivers affecting the quantity of water availability as well as its quality will further confound the scenario. The present study has been conducted to assess the vulnerability of poor slum women of Delhi, India to climate-linked water stresses using quantitative and qualitative approaches. An index 'Climate Vulnerability Index for water at the household level' (CVI-WH) was used to quantify the vulnerability of slum women; several Participatory Learning and Action (PLA) tools were used for the qualitative study. The results have shown that slum women were highly vulnerable to climate-mediated water stresses with a CVI-WH score of 0.63 as compared with the whole of Delhi placed at 0.36. This was due to poor access to water resources, limited human development, a dismal state of environment and climatic stresses. Thus, if the quality of life of the slum women has to be improved, it is very important to invest in water-related infrastructure and equip the poor women with skills and knowledge to enhance their adaptive capacity to face climatic variability and extremes. This can enable them to lead climate resilient lives.

Potential risk of tropical diseases occurring in the Mountain Regions of Central Asia

Asylbek Aidaraliev
Academician of National Academy of Science, Prof. Dr. Med. Sc.,
Member of the World Bank Strategic Climate Investment Funds TF Committee,
Chairman of Board of Trustees at Academic Consortium "International University of Kyrgyzstan"
Corresponding author: board-iuk@mail.ru

Abstract

Asian terrestrial land occupies a space from the Pacific Ocean to the Black Sea, where the Central-Asian mountain region is located with over a billion population of mountain inhabitants. During the last decades, the number of natural disasters in Central Asia have greatly increased due to intensive global increase in temperatures. These changes have a direct impact on human health and on health systems as a whole. The welfare of mountain communities, in comparison with flat territories, demands essentially big biological and physical power expenses. According to the World Bank's report *Adaptation of Europe and Central Asia to Climate Change*, the impacts of temperature increase can bring profound consequences on public health. Climate warming promotes the development of many infectious and parasitic diseases. Climate change can cause an increase in the incidence of diseases of the cardiovascular system, infectious diseases transmitted through air and water, intestinal infections, including malaria, as well as diseases carried by ticks. Examples of the more direct and obvious threats to the health of mountain population are infectious diseases spread through contaminated water, and vector-borne diseases such as tick-borne encephalitis, dengue fever, malaria and etc. We believe that it is necessary to include the sub-project *Development of Prevention Measures on Tropical Diseases in Mountainous Regions of Central Asia* into the World Bank's Program *Adaptation of Europe and Central Asia to Climate Change*. This paper will discuss factors leading to possible tropical diseases occurring in the Central Asian mountain regions and preventive measures.

APPENDIX 4: PRESENTATION MATERIAL
WORKSHOP ON STATUS OF CLIMATE SCIENCE AND TECHNOLOGY IN ASIA-FOR IPCC AR6
Sheraton Imperial Kuala Lumpur Hotel I 15-16 November 2018

LIST OF SLIDE PRESENTATION

Workshop on Status of Climate Science and Technology in Asia
15-16, November 2018, Kuala Lumpur, Malaysia

Climate Science and Technology for Cities

J.C.R. Hunt[1,2,3], Michael Davey[4], Kai Wang[2], Joy Pereira[5]

[1] *Cambridge Environmental Research Consultants*
[2] *University College London*
[3] *Trinity College, University of Cambridge*
[4] *DAMTP, University of Cambridge*
[5] *SEADPRI, Universiti Kebangsaan Malaysia*

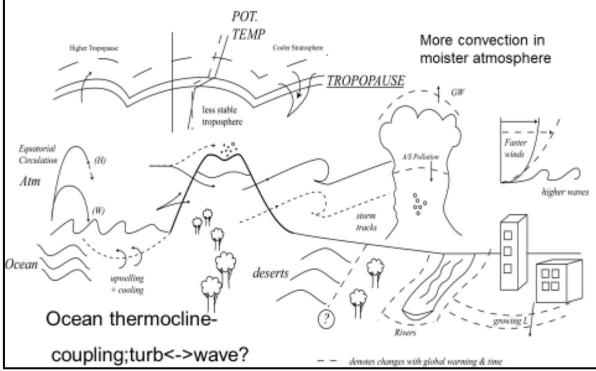
CERC UNIVERSITY OF CAMBRIDGE UCL seadpri

Summary

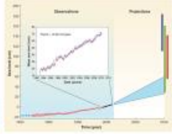
- This presentation aims to show features of interactions, modelling, data, significant applications, and considerations of urban policies.

New solutions needed

Schematic Diagram of Climate Change Processes



Sea Level Rise



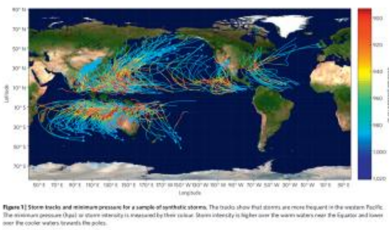
- dense populations
- low elevations
- appreciable rates of subsidence
- inadequate adaptive capacity.

Areas that are vulnerable to coastal flooding caused by future relative or climate-induced sea-level rise.

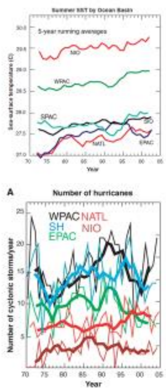
There are engineering solutions in other critical areas

Nicholls & Cazenave, *Science*, 2010

Tropical cyclones – trends in time and space - toward equator?



Mendelsohn, et al. Nature climate change 2012



Webster, et al. Science, 2005

Regional weather forecasting

Weather forecasts days ahead need global data, but high resolution (≤1km) global numerical forecast models are too expensive

Strategy: use information from a lower resolution (≥10km) forecast to drive high resolution regional forecasts

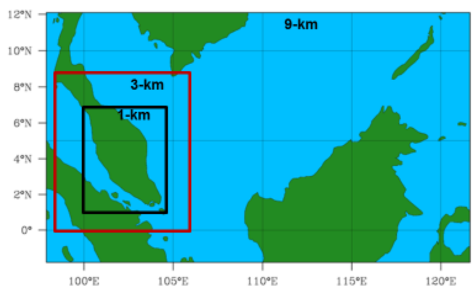
E.g. MetMalaysia use 3 nested models, with boundary conditions from a global forecast for the outer domain

The inner domain can in turn be used to drive **urban models** such as for KL

MOSTI METMalaysia

WRF MODEL DOMAINS

nested within global model



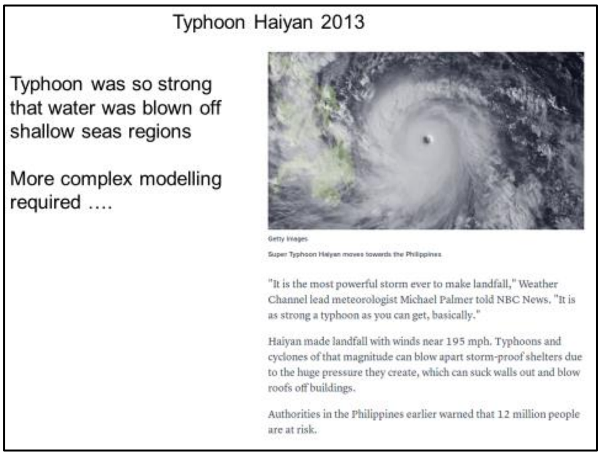
provides input to high resolution urban models

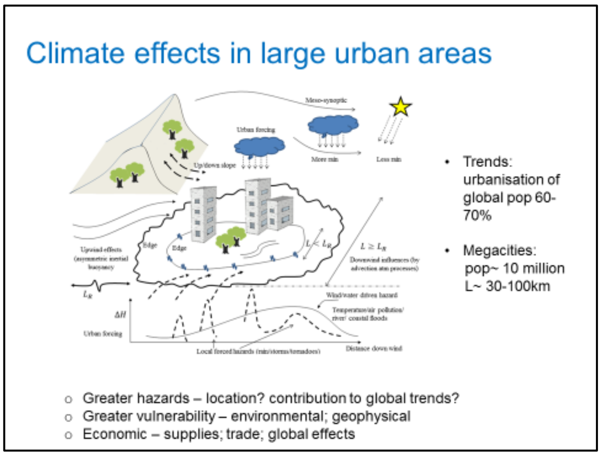
Mesoscale weather forecasting

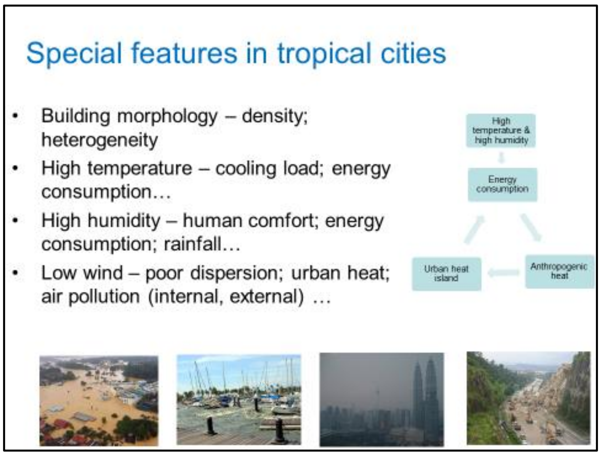
There are **weather processes** specific to the tropics – clouds, deep convection, tropical cyclones influenced by ocean-atmosphere interaction (turning to tropical storms nearer the equator), …..

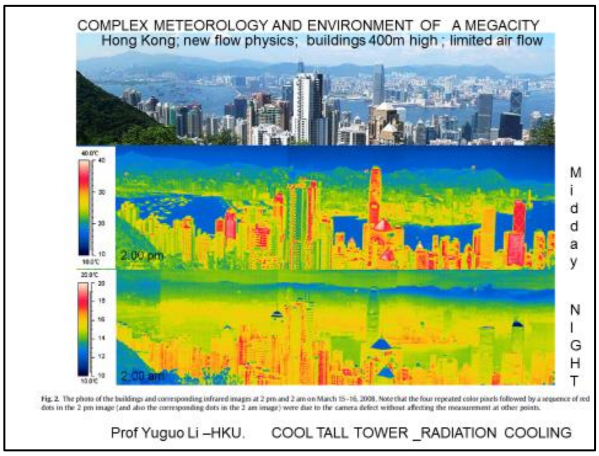
To what extent should general circulation models be adapted for **tropics – regional/urban forecasting** ??

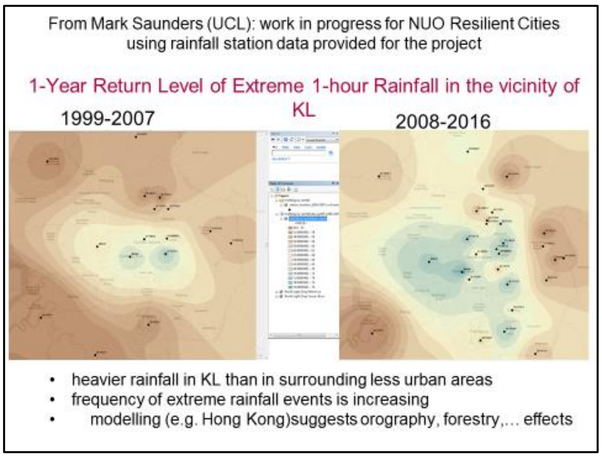

Typhoon Haiyan 2013
'most powerful storm ever to make landfall'
Alexander Smith and Becky Bratu
NBC NEWS
NEWS ALERT
SUPER TYPHOON HITS PHILIPPINES
CNBC
The most powerful storm ever to make landfall battered the Philippines with winds approaching 200 mph early Friday.
Millions of people fled in search of safety ahead of category-five super typhoon Haiyan, which caused mudslides, flash flooding and a storm surge with waves of up to 30 feet.

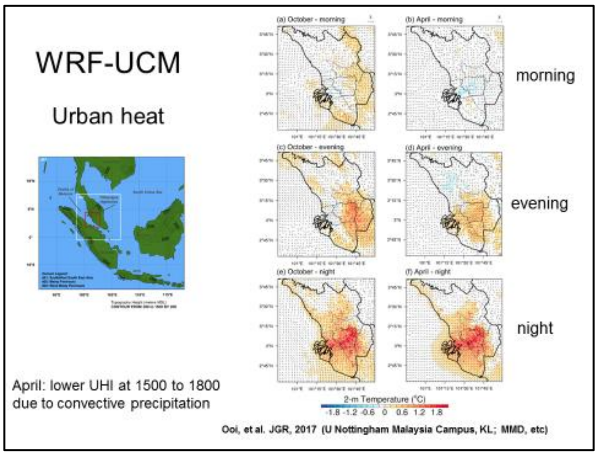

Typhoon Haiyan 2013
Typhoon was so strong that water was blown off shallow seas regions
More complex modelling required ….
Getty Images
Super Typhoon Haiyan moves towards the Philippines
"It is the most powerful storm ever to make landfall," Weather Channel lead meteorologist Michael Palmer told NBC News. "It is as strong a typhoon as you can get, basically."
Haiyan made landfall with winds near 195 mph. Typhoons and cyclones of that magnitude can blow apart storm-proof shelters due to the huge pressure they create, which can suck walls out and blow roofs off buildings.
Authorities in the Philippines earlier warned that 12 million people are at risk.

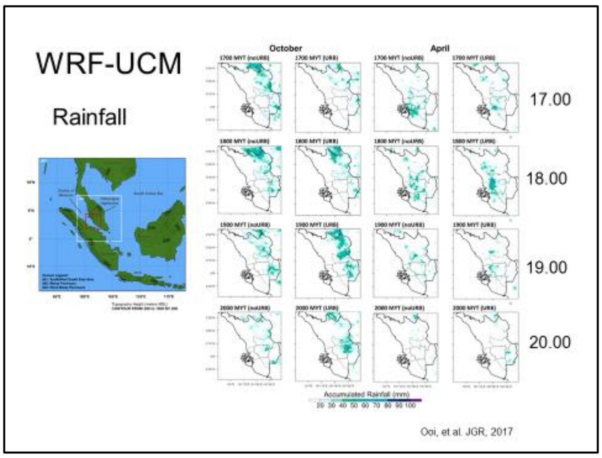

Climate effects in large urban areas
Trends: urbanisation of global pop 60-70%
Megacities: pop~ 10 million L~ 30-100km
Greater hazards – location? contribution to global trends?
Greater vulnerability – environmental; geophysical
Economic – supplies; trade; global effects

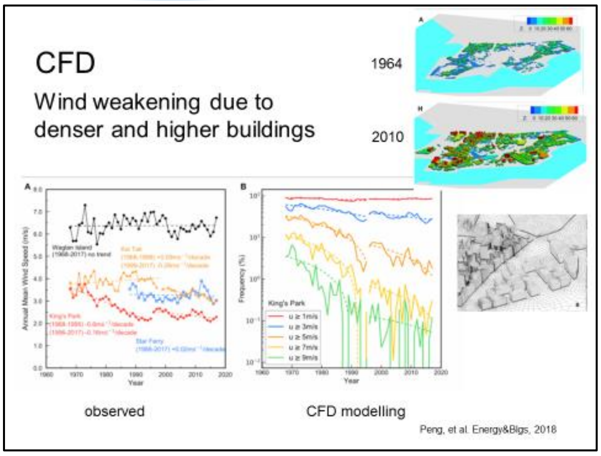

Special features in tropical cities
Building morphology – density; heterogeneity
High temperature – cooling load; energy consumption…
High humidity – human comfort; energy consumption; rainfall…
Low wind – poor dispersion; urban heat; air pollution (internal, external) …
High temperature & high humidity
Energy consumption
Urban heat island
Anthropogenic heat


COMPLEX METEOROLOGY AND ENVIRONMENT OF A MEGACITY
Hong Kong; new flow physics; buildings 400m high ; limited air flow
2:00 pm
2:00 am
Midday
NIGHT
Prof Yuguo Li –HKU. COOL TALL TOWER _RADIATION COOLING

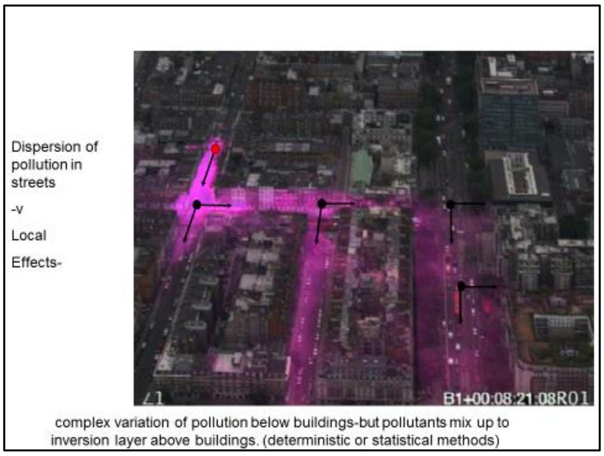

From Mark Saunders (UCL): work in progress for NUO Resilient Cities using rainfall station data provided for the project
1-Year Return Level of Extreme 1-hour Rainfall in the vicinity of KL
1999-2007
2008-2016
heavier rainfall in KL than in surrounding less urban areas
frequency of extreme rainfall events is increasing
modelling (e.g. Hong Kong)suggests orography, forestry,… effects


WRF-UCM
Urban heat
(a) October - morning
(b) April - morning
(c) October - evening
(d) April - evening
(e) October - night
(f) April - night
morning
evening
night
2-m Temperature (°C)
April: lower UHI at 1500 to 1800 due to convective precipitation
Ooi, et al. JGR, 2017 (U Nottingham Malaysia Campus, KL; MMD, etc)

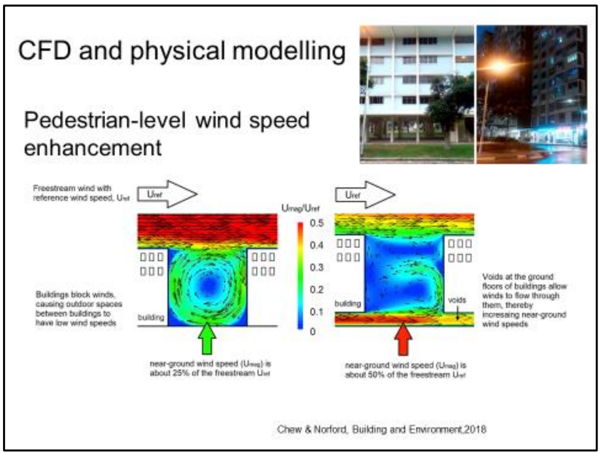

WRF-UCM
Rainfall
October
April
17.00
18.00
19.00
20.00
Accumulated Rainfall (mm)
Ooi, et al. JGR, 2017



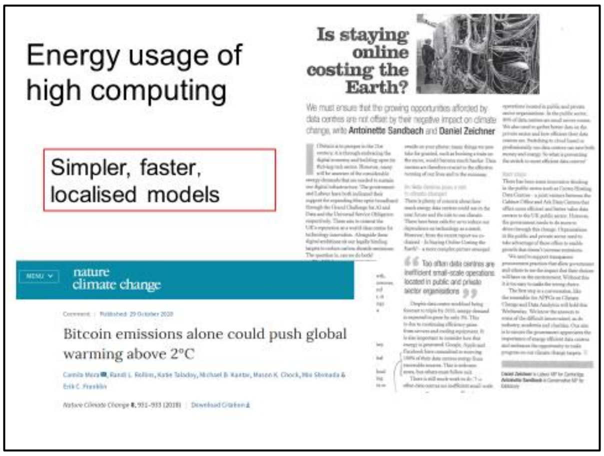
CFD
Wind weakening due to denser and higher buildings
1964
2010
observed
CFD modelling
Peng, et al. Energy&Blgs, 2018



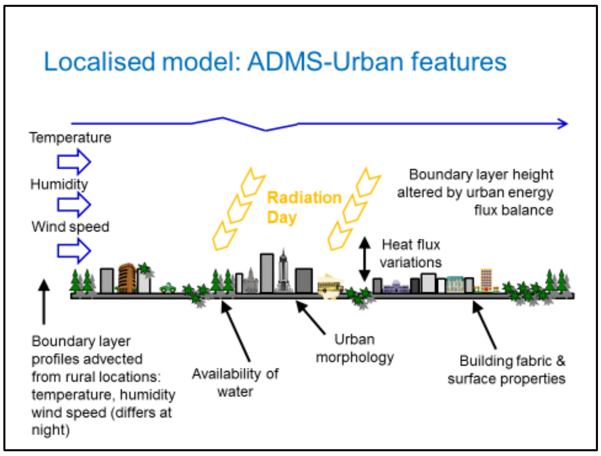
Dispersion of pollution in streets
-v
Local
Effects-
complex variation of pollution below buildings-but pollutants mix up to inversion layer above buildings. (deterministic or statistical methods)



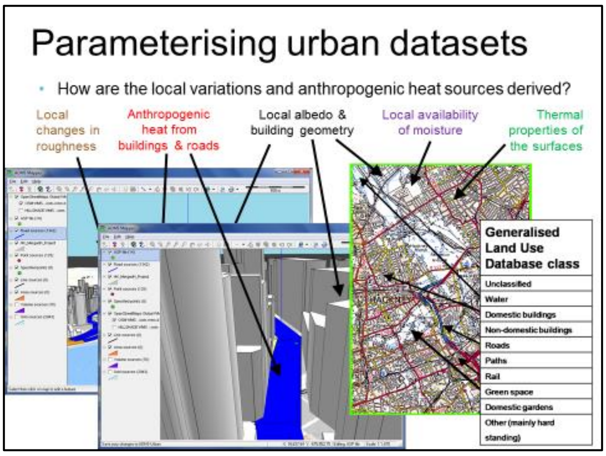
CFD and physical modelling
Pedestrian-level wind speed enhancement
Buildings block winds, causing outdoor spaces between buildings to have low wind speeds
Voids at the ground floors of buildings allow winds to flow through them, thereby increasing near-ground wind speeds
Chew & Norford, Building and Environment,2018



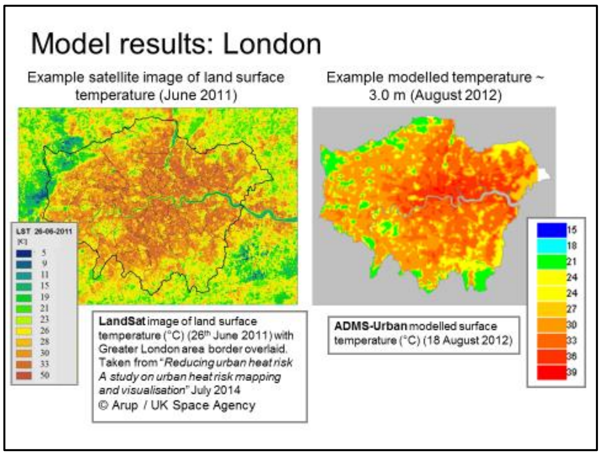
Energy usage of high computing
Simpler, faster, localised models
Is staying online costing the Earth?
nature climate change
Bitcoin emissions alone could push global warming above 2°C



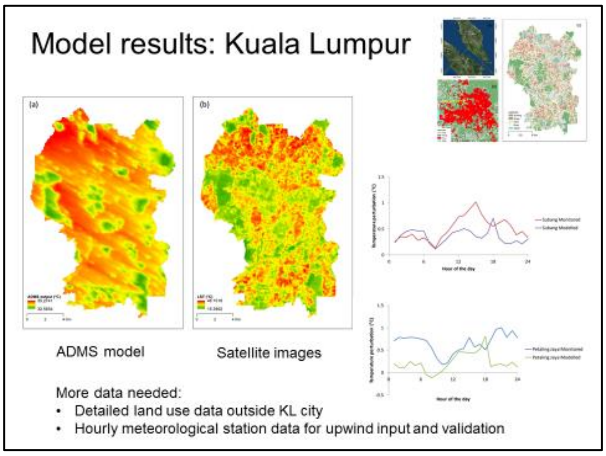
Localised model: ADMS-Urban features
Temperature
Humidity
Wind speed
Radiation Day
Boundary layer height altered by urban energy flux balance
Heat flux variations
Boundary layer profiles advected from rural locations: temperature, humidity wind speed (differs at night)
Availability of water
Urban morphology
Building fabric & surface properties



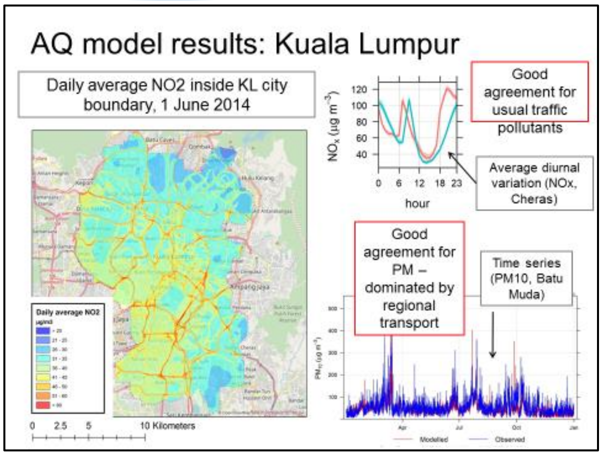
Parameterising urban datasets
How are the local variations and anthropogenic heat sources derived?
Local changes in roughness
Anthropogenic heat from buildings & roads
Local albedo & building geometry
Local availability of moisture
Thermal properties of the surfaces
Generalised Land Use Database class
Unclassified
Water
Domestic buildings
Non-domestic buildings
Roads
Paths
Rail
Green space
Domestic gardens
Other (mainly hard standing)

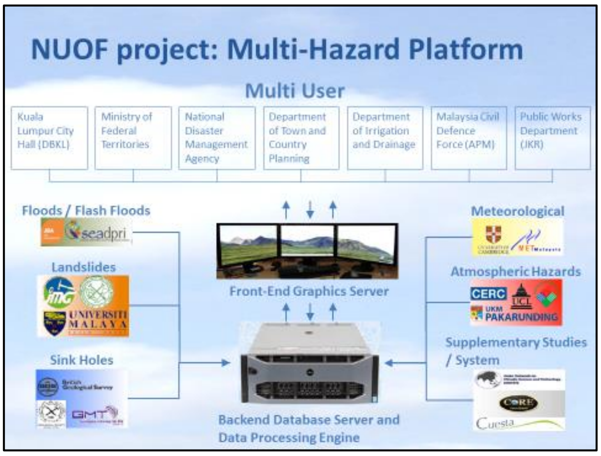


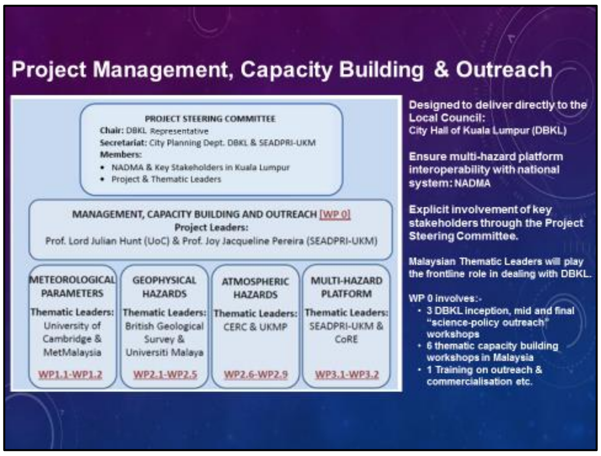
Model results: London
Example satellite image of land surface temperature (June 2011)
Example modelled temperature ~ 3.0 m (August 2012)
LandSat image of land surface temperature (°C) (26th June 2011) with Greater London area border overlaid. Taken from "Reducing urban heat risk A study on urban heat risk mapping and visualisation" July 2014 © Arup / UK Space Agency
ADMS-Urban modelled surface temperature (°C) (18 August 2012)



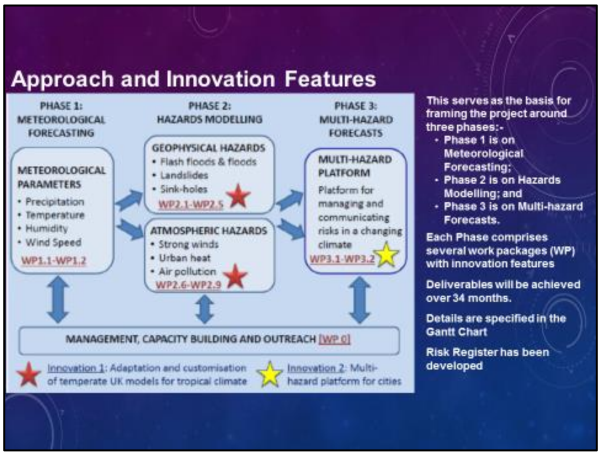
Model results: Kuala Lumpur
ADMS model
Satellite images
More data needed:
Detailed land use data outside KL city
Hourly meteorological station data for upwind input and validation

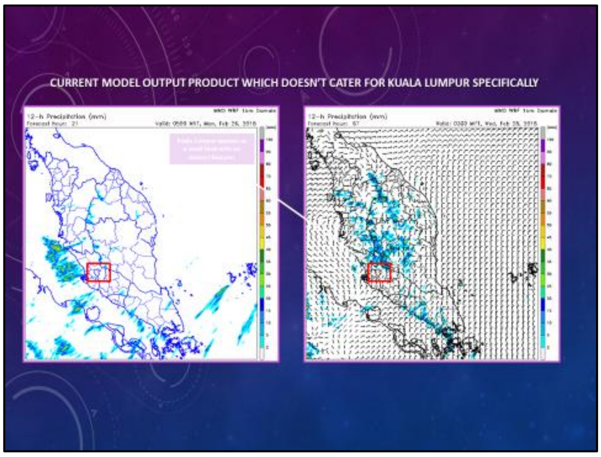

AQ model results: Kuala Lumpur
Daily average NO2 inside KL city boundary, 1 June 2014
Good agreement for usual traffic pollutants
Average diurnal variation (NOx, Cheras)
hour
Good agreement for PM – dominated by regional transport
Time series (PM10, Batu Muda)
Daily average NO2
0 2.5 5 10 Kilometers

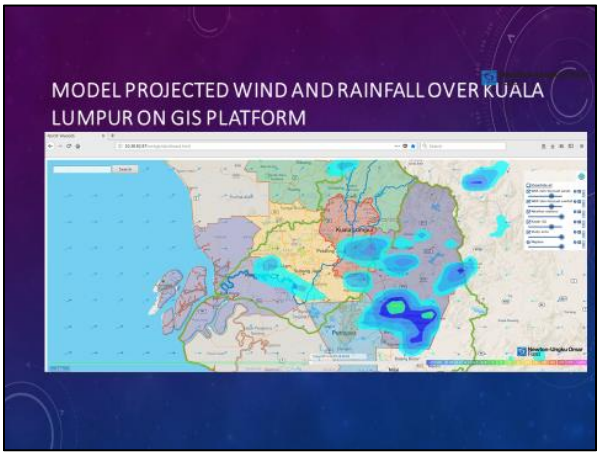

NUOF project: Multi-Hazard Platform
Multi User
Kuala Lumpur City Hall (DBKL)
Ministry of Federal Territories
National Disaster Management Agency
Department of Town and Country Planning
Department of Irrigation and Drainage
Malaysia Civil Defence Force (APM)
Public Works Department (JKR)
Floods / Flash Floods
Landslides
Sink Holes
Front-End Graphics Server
Backend Database Server and Data Processing Engine
Meteorological
Atmospheric Hazards
Supplementary Studies / System

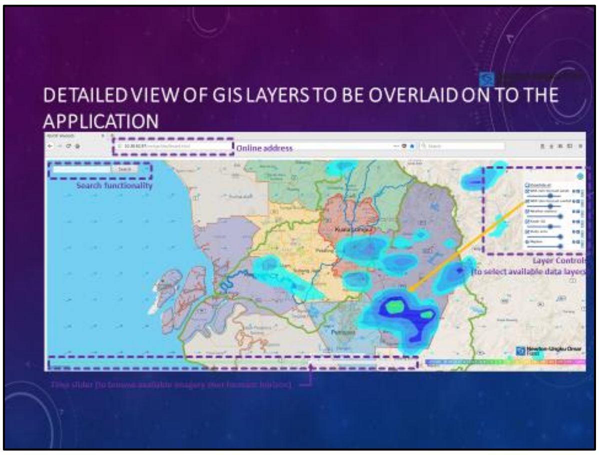

Project Management, Capacity Building & Outreach
PROJECT STEERING COMMITTEE
Chair: DBKL Representative
Secretariat: City Planning Dept. DBKL & SEADPRI-UKM
Members:
NADMA & Key Stakeholders in Kuala Lumpur
Project & Thematic Leaders
MANAGEMENT, CAPACITY BUILDING AND OUTREACH [WP 0]
Project Leaders:
Prof. Lord Julian Hunt (UoC) & Prof. Joy Jacqueline Pereira (SEADPRI-UKM)
METEOROLOGICAL PARAMETERS
Thematic Leaders: University of Cambridge & MetMalaysia
WP1.1-WP1.2
GEOPHYSICAL HAZARDS
Thematic Leaders: British Geological Survey & Universiti Malaya
WP2.1-WP2.5
ATMOSPHERIC HAZARDS
Thematic Leaders: CERC & UKMP
WP2.6-WP2.9
MULTI-HAZARD PLATFORM
Thematic Leaders: SEADPRI-UKM & CoRE
WP3.1-WP3.2
Designed to deliver directly to the Local Council: City Hall of Kuala Lumpur (DBKL)
Ensure multi-hazard platform interoperability with national system: NADMA
Explicit involvement of key stakeholders through the Project Steering Committee.
Malaysian Thematic Leaders will play the frontline role in dealing with DBKL.
WP 0 involves:-
3 DBKL inception, mid and final "science-policy outreach" workshops
6 thematic capacity building workshops in Malaysia
1 Training on outreach & commercialisation etc.

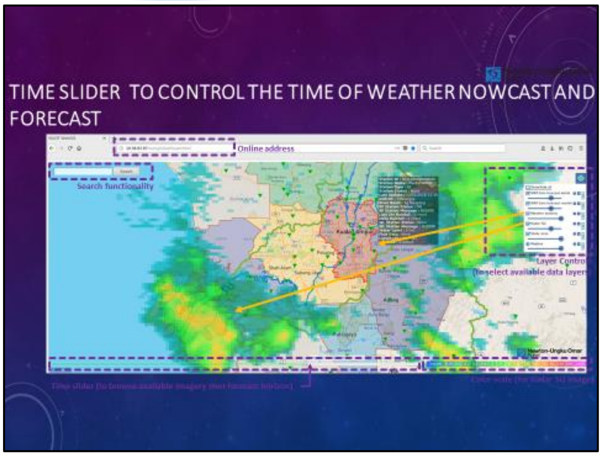

Boundary of Science for Meteorological & Atmospheric Information, Kelang River Basin
Boundary of Science for Geophysical Information, Kelang River Basin
Boundary of Pilot Study, Kuala Lumpur


Approach and Innovation Features
PHASE 1: METEOROLOGICAL FORECASTING
PHASE 2: HAZARDS MODELLING
PHASE 3: MULTI-HAZARD FORECASTS
METEOROLOGICAL PARAMETERS
Precipitation
Temperature
Humidity
Wind Speed
WP1.1-WP1.2
GEOPHYSICAL HAZARDS
Flash floods & floods
Landslides
Sink-holes
WP2.1-WP2.5
ATMOSPHERIC HAZARDS
Strong winds
Urban heat
Air pollution
WP2.6-WP2.9
MULTI-HAZARD PLATFORM
Platform for managing and communicating risks in a changing climate
WP3.1-WP3.2
MANAGEMENT, CAPACITY BUILDING AND OUTREACH [WP 0]
Innovation 1: Adaptation and customisation of temperate UK models for tropical climate
Innovation 2: Multi-hazard platform for cities
This serves as the basis for framing the project around three phases:-
Phase 1 is on Meteorological Forecasting;
Phase 2 is on Hazards Modelling; and
Phase 3 is on Multi-hazard Forecasts.
Each Phase comprises several work packages (WP) with innovation features
Deliverables will be achieved over 34 months.
Details are specified in the Gantt Chart
Risk Register has been developed

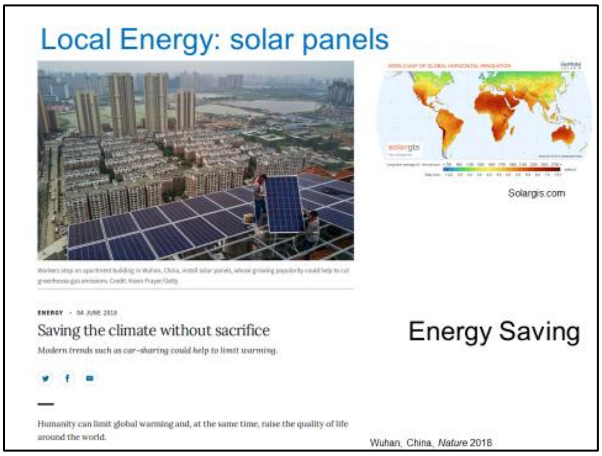

CURRENT MODEL OUTPUT PRODUCT WHICH DOESN'T CATER FOR KUALA LUMPUR SPECIFICALLY

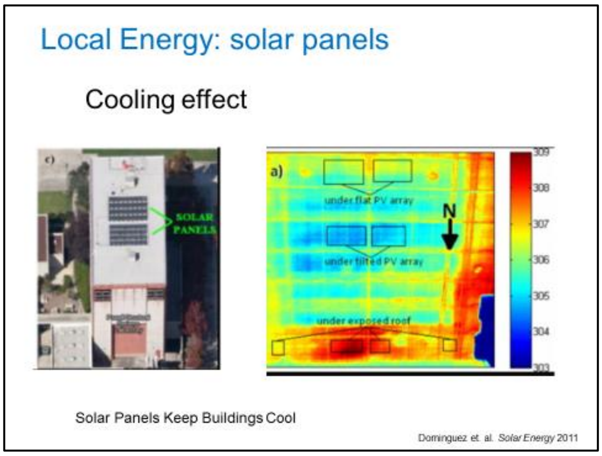

MODEL PROJECTED WIND AND RAINFALL OVER KUALA LUMPUR ON GIS PLATFORM

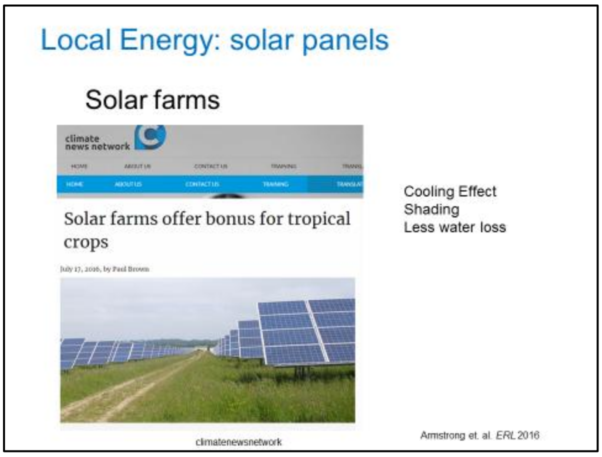

DETAILED VIEW OF GIS LAYERS TO BE OVERLAID ON TO THE APPLICATION
Online address
Search functionality
Layer Control to select available data layers


TIME SLIDER TO CONTROL THE TIME OF WEATHER NOWCAST AND FORECAST
Online address
Search functionality
Layer Control (to select available data layers)

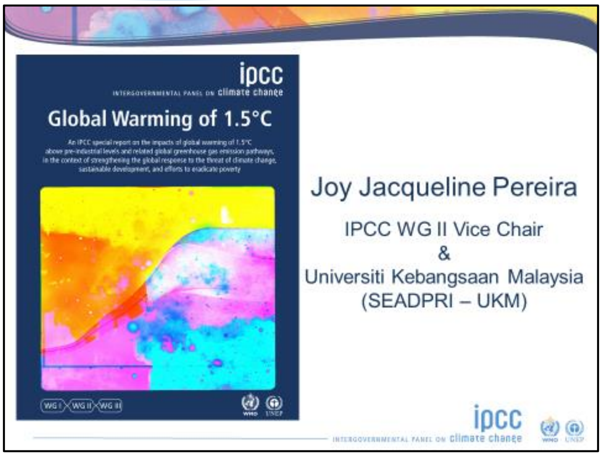

• Input:
– hazard models provide physical risk information for next few days
• Output:
– Decision 'theatre'-> tailored products for decision makers
METROPOLITAN SAFE CITY
0. 40
0. 47
0. 21
0. 00
0. 80
0. 23
CORE
seadpri

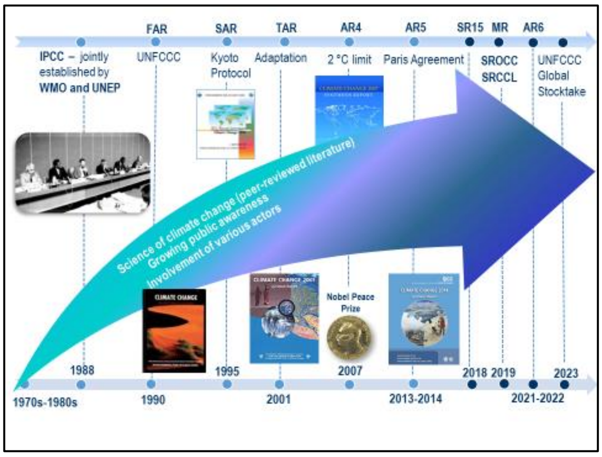

Local Energy: solar panels
Solargis.com
Saving the climate without sacrifice
Modern trends such as car-sharing could help to limit warming.
Humanity can limit global warming and, at the same time, raise the quality of life around the world.
Energy Saving
Wuhan, China, Nature 2018

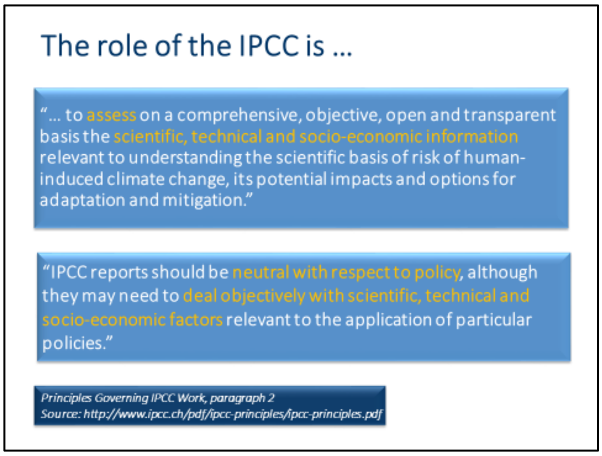

Local Energy: solar panels
Cooling effect
SOLAR PANELS
under flat PV array
under tilted PV array
under exposed roof
N
309
308
307
306
305
304
303
Solar Panels Keep Buildings Cool
Dominguez et. al. Solar Energy 2011

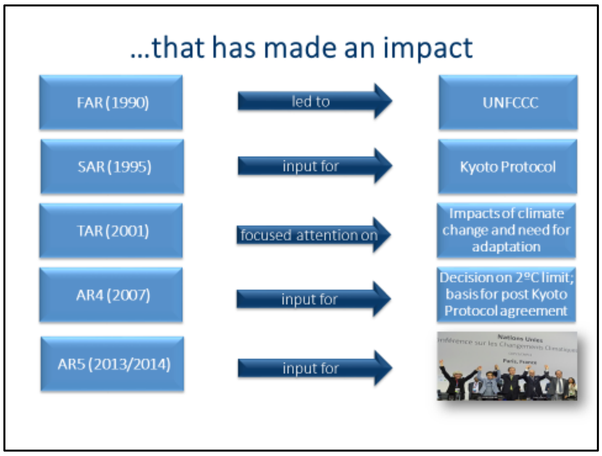

Local Energy: solar panels
Solar farms
climate news network
Solar farms offer bonus for tropical crops
July 17, 2016, by Paul Brown
Cooling Effect
Shading
Less water loss
climatenewsnetwork
Armstrong et. al. ERL 2016

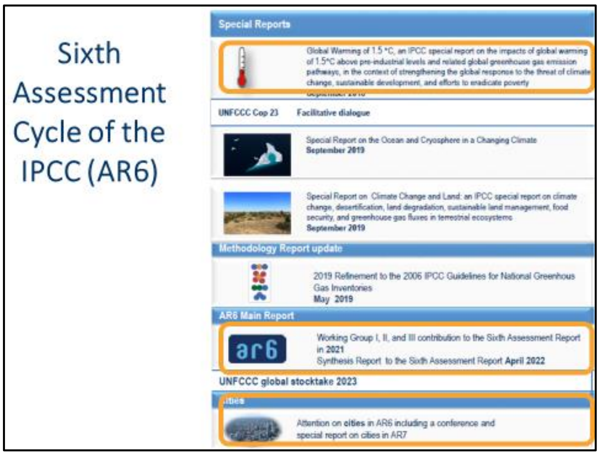

Innovate UK
MiGHT
Newton-Ungku Omar Fund
SCIENCE to ACTION
Thank you for your attention
and I look forward to our discussion!
Professor Julian Hunt
julian.hunt@ucl.ac.uk
UNIVERSITY OF CAMBRIDGE
British Geological Survey
seadpri
UNIVERSITY OF MALAYA
UCL
CERC
UKM PAKARUNDING
CORE
GMT
Cuesta

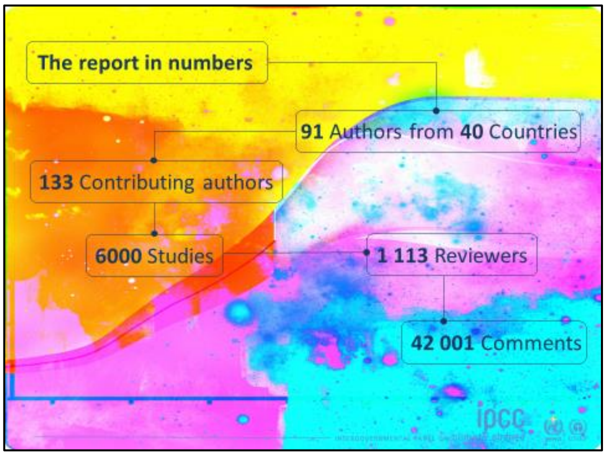

ipcc
INTERGOVERNMENTAL PANEL ON climate change
Global Warming of 1.5°C
Joy Jacqueline Pereira
IPCC WG II Vice Chair
&
Universiti Kebangsaan Malaysia
(SEADPRI – UKM)
ipcc
INTERGOVERNMENTAL PANEL ON climate change


FAR
SAR
TAR
AR4
AR5
SR15
MR
AR6
IPCC – jointly established by WMO and UNEP
UNFCCC
Kyoto Protocol
Adaptation
2 °C limit
Paris Agreement
SROCC
SRCCL
UNFCCC Global Stocktake
Science of climate change (peer-reviewed literature)
Growing public awareness
Involvement of various actors
Nobel Peace Prize
1988
1995
2007
2018 2019
2023
1970s-1980s
1990
2001
2013-2014
2021-2022


The role of the IPCC is …
"… to assess on a comprehensive, objective, open and transparent basis the scientific, technical and socio-economic information relevant to understanding the scientific basis of risk of human-induced climate change, its potential impacts and options for adaptation and mitigation."
"IPCC reports should be neutral with respect to policy, although they may need to deal objectively with scientific, technical and socio-economic factors relevant to the application of particular policies."
Principles Governing IPCC Work, paragraph 2
Source: http://www.ipcc.ch/pdf/ipcc-principles/ipcc-principles.pdf


…that has made an impact
FAR (1990)
led to
UNFCCC
SAR (1995)
input for
Kyoto Protocol
TAR (2001)
focused attention on
Impacts of climate change and need for adaptation
AR4 (2007)
input for
Decision on 2°C limit; basis for post Kyoto Protocol agreement
AR5 (2013/2014)
input for


Sixth Assessment Cycle of the IPCC (AR6)
Special Reports
Global Warming of 1.5 °C, an IPCC special report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty
UNFCCC Cop 23
Facilitative dialogue
Special Report on the Ocean and Cryosphere in a Changing Climate
September 2019
Special Report on Climate Change and Land: an IPCC special report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems
September 2019
Methodology Report update
2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories
May 2019
AR6 Main Report
ar6
Working Group I, II, and III contribution to the Sixth Assessment Report in 2021
Synthesis Report to the Sixth Assessment Report April 2022
UNFCCC global stocktake 2023
Attention on cities in AR6 including a conference and special report on cities in AR7


The report in numbers
91 Authors from 40 Countries
133 Contributing authors
6000 Studies
1 113 Reviewers
42 001 Comments
ipcc


Where are we now?
Since pre-industrial times, human activities have caused approximately 1°C of global warming.
Already seeing consequences for people, nature and livelihoods
At current rate, would reach 1.5°C between 2030 and 2052
Past emissions alone do not commit the world to 1.5°C
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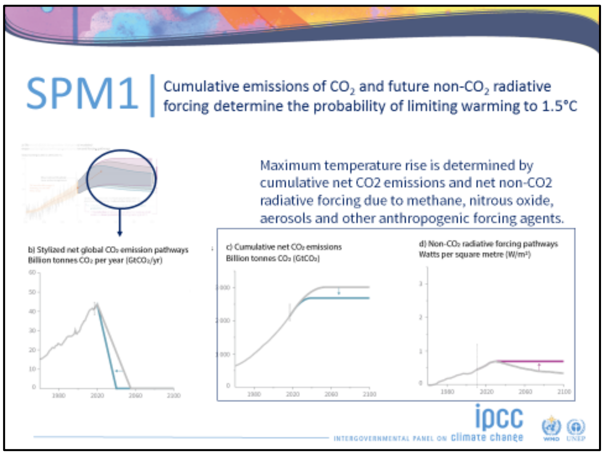
INTERGOVERNMENTAL PANEL ON climate change


SPM1
Cumulative emissions of CO2 and future non-CO2 radiative forcing determine the probability of limiting warming to 1.5°C
Maximum temperature rise is determined by cumulative net CO2 emissions and net non-CO2 radiative forcing due to methane, nitrous oxide, aerosols and other anthropogenic forcing agents.
b) Stylized net global CO2 emission pathways
Billion tonnes CO2 per year (GtCO2/yr)
c) Cumulative net CO2 emissions
Billion tonnes CO2 (GtCO2)
d) Non-CO2 radiative forcing pathways
Watts per square metre (W/m2)
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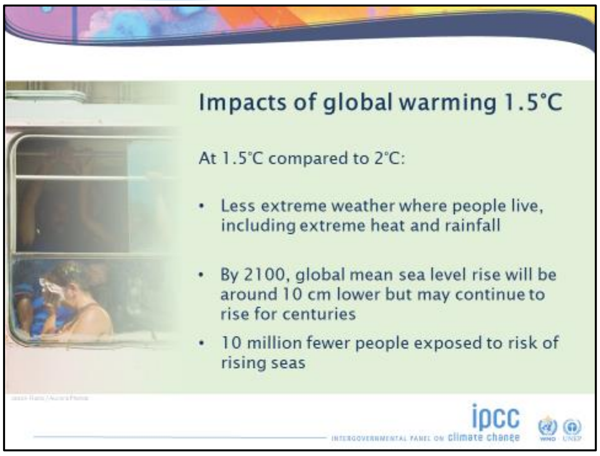
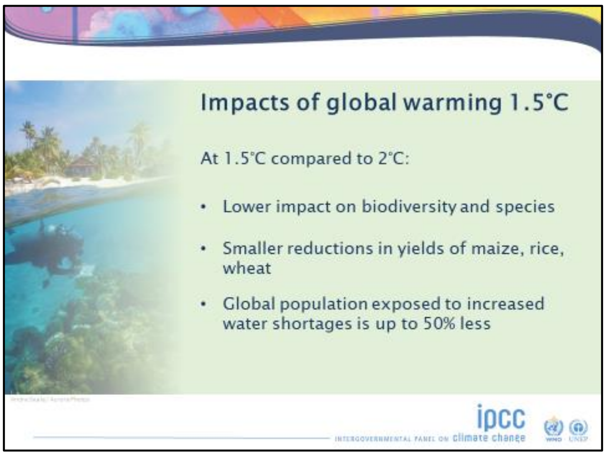
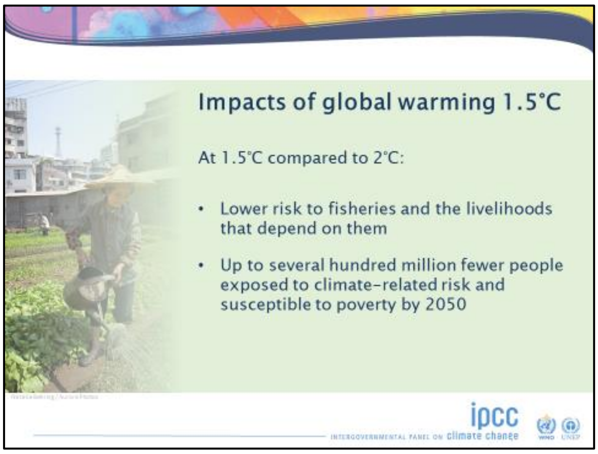
INTERGOVERNMENTAL PANEL ON climate change


Impacts of global warming 1.5°C
At 1.5°C compared to 2°C:
• Less extreme weather where people live, including extreme heat and rainfall
• By 2100, global mean sea level rise will be around 10 cm lower but may continue to rise for centuries
• 10 million fewer people exposed to risk of rising seas
ipcc
INTERGOVERNMENTAL PANEL ON climate change


Impacts of global warming 1.5°C
At 1.5°C compared to 2°C:
• Lower impact on biodiversity and species
• Smaller reductions in yields of maize, rice, wheat
• Global population exposed to increased water shortages is up to 50% less
ipcc
INTERGOVERNMENTAL PANEL ON climate change


Impacts of global warming 1.5°C
At 1.5°C compared to 2°C:
• Lower risk to fisheries and the livelihoods that depend on them
• Up to several hundred million fewer people exposed to climate-related risk and susceptible to poverty by 2050
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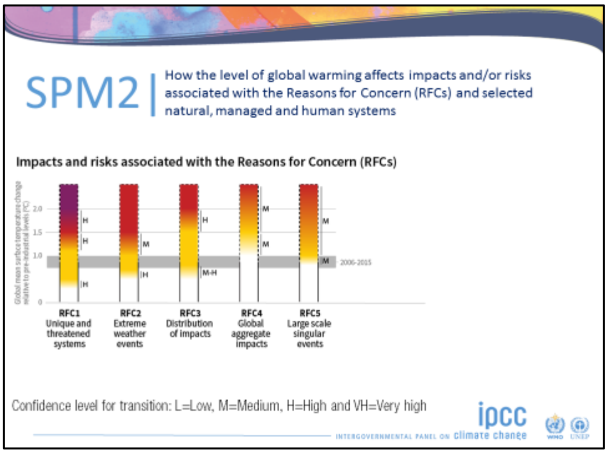
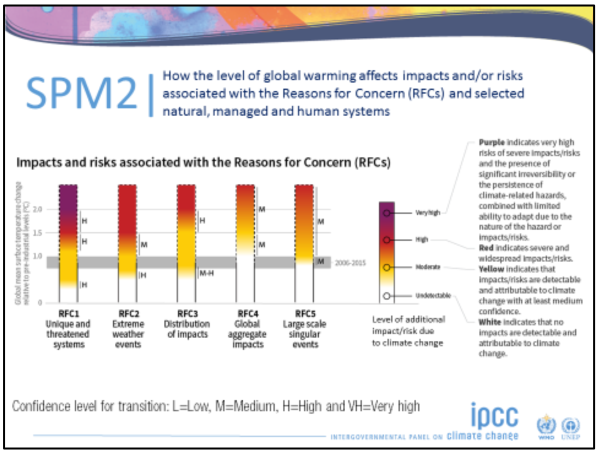
INTERGOVERNMENTAL PANEL ON climate change


SPM2
How the level of global warming affects impacts and/or risks associated with the Reasons for Concern (RFCs) and selected natural, managed and human systems
Impacts and risks associated with the Reasons for Concern (RFCs)
2006-2015
RFC1 Unique and threatened systems
RFC2 Extreme weather events
RFC3 Distribution of impacts
RFC4 Global aggregate impacts
RFC5 Large scale singular events
Confidence level for transition: L=Low, M=Medium, H=High and VH=Very high
ipcc
INTERGOVERNMENTAL PANEL ON climate change


SPM2
How the level of global warming affects impacts and/or risks associated with the Reasons for Concern (RFCs) and selected natural, managed and human systems
Impacts and risks associated with the Reasons for Concern (RFCs)
2006-2015
RFC1 Unique and threatened systems
RFC2 Extreme weather events
RFC3 Distribution of impacts
RFC4 Global aggregate impacts
RFC5 Large scale singular events
Very high
High
Moderate
Undetectable
Level of additional impact/risk due to climate change
Purple indicates very high risks of severe impacts/risks and the presence of significant irreversibility or the persistence of climate-related hazards, combined with limited ability to adapt due to the nature of the hazard or impacts/risks.
Red indicates severe and widespread impacts/risks.
Yellow indicates that impacts/risks are detectable and attributable to climate change with at least medium confidence.
White indicates that no impacts are detectable and attributable to climate change.
Confidence level for transition: L=Low, M=Medium, H=High and VH=Very high
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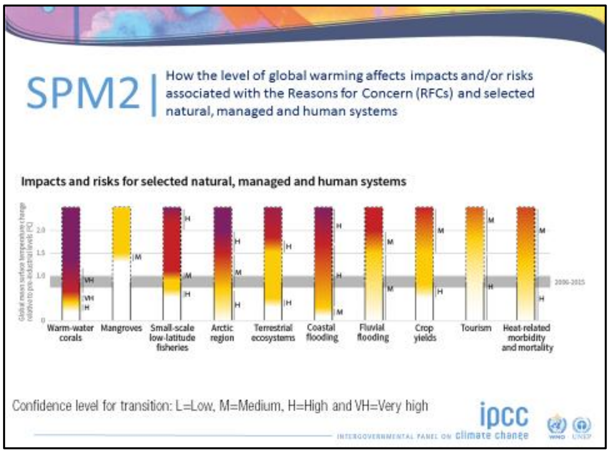
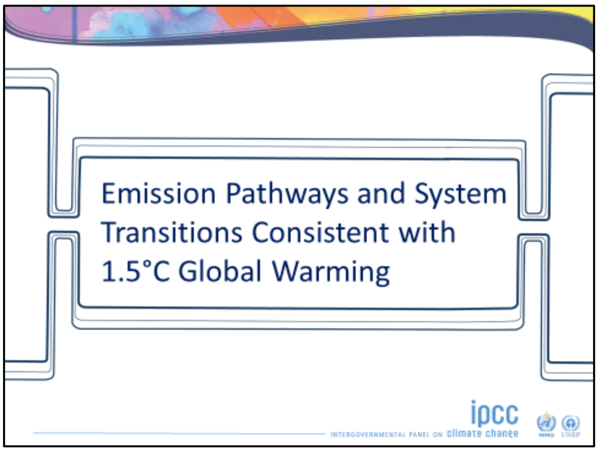
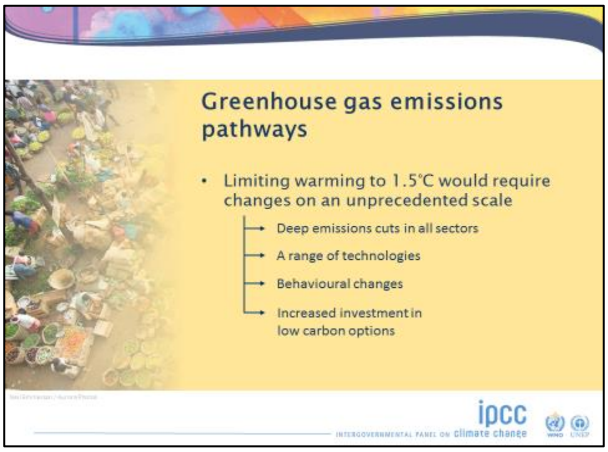
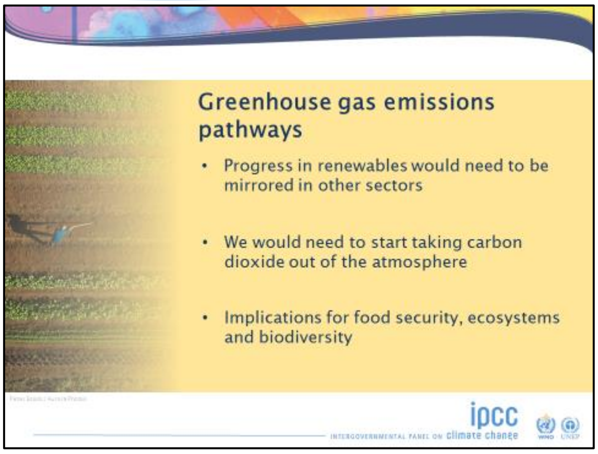
INTERGOVERNMENTAL PANEL ON climate change


SPM2
How the level of global warming affects impacts and/or risks associated with the Reasons for Concern (RFCs) and selected natural, managed and human systems
Impacts and risks for selected natural, managed and human systems
2006-2015
Warm-water corals
Mangroves
Small-scale low-latitude fisheries
Arctic region
Terrestrial ecosystems
Coastal flooding
Fluvial flooding
Crop yields
Tourism
Heat-related morbidity and mortality
Confidence level for transition: L=Low, M=Medium, H=High and VH=Very high
ipcc
INTERGOVERNMENTAL PANEL ON climate change


Emission Pathways and System Transitions Consistent with 1.5°C Global Warming
ipcc
INTERGOVERNMENTAL PANEL ON climate change


Greenhouse gas emissions pathways
• Limiting warming to 1.5°C would require changes on an unprecedented scale
Deep emissions cuts in all sectors
A range of technologies
Behavioural changes
Increased investment in low carbon options
ipcc
INTERGOVERNMENTAL PANEL ON climate change


Greenhouse gas emissions pathways
Progress in renewables would need to be mirrored in other sectors
We would need to start taking carbon dioxide out of the atmosphere
Implications for food security, ecosystems and biodiversity
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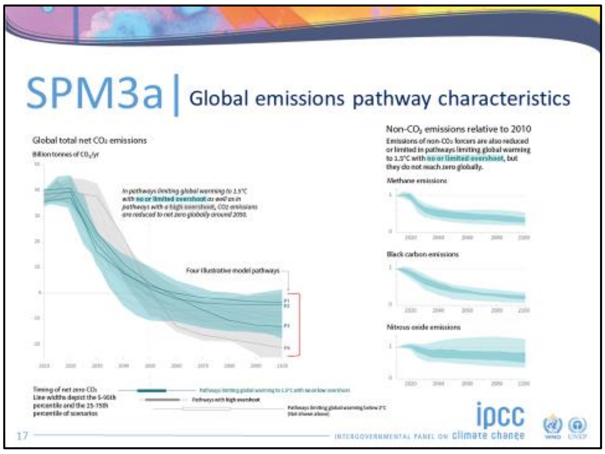
INTERGOVERNMENTAL PANEL ON climate change


SPM3a | Global emissions pathway characteristics
Global total net CO₂ emissions
Non-CO₂ emissions relative to 2010
Methane emissions
Black carbon emissions
Nitrous oxide emissions
Four illustrative model pathways
17
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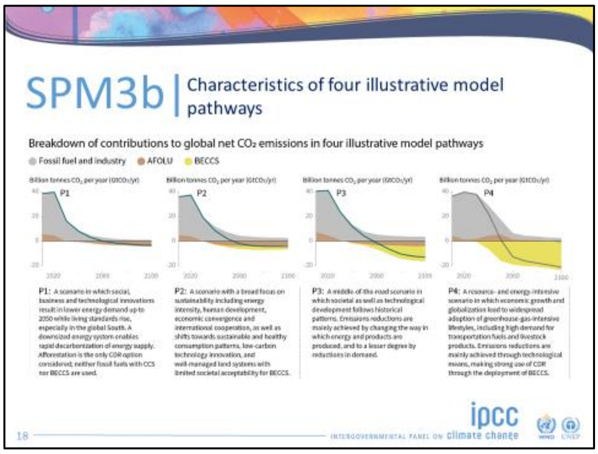
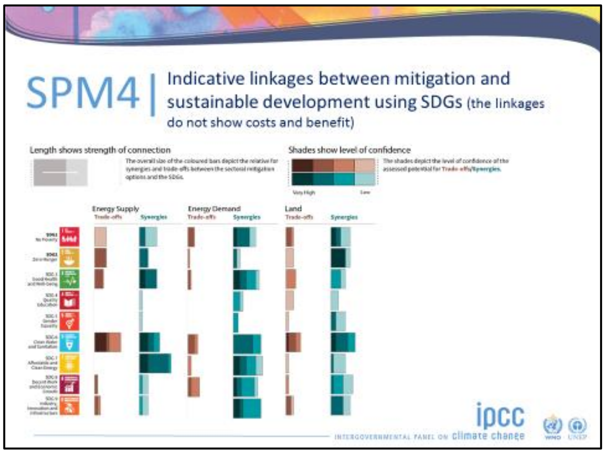
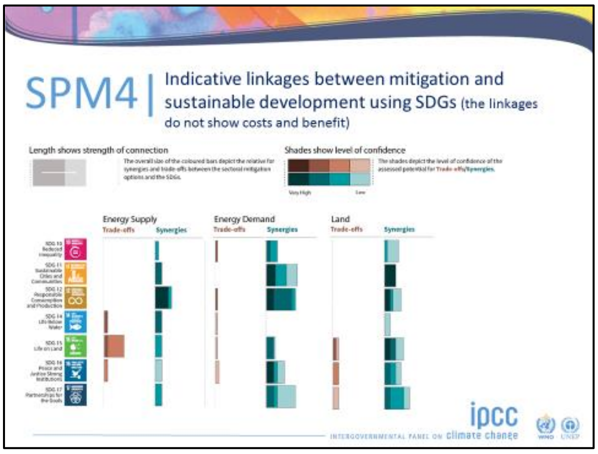
INTERGOVERNMENTAL PANEL ON climate change


SPM3b | Characteristics of four illustrative model pathways
Breakdown of contributions to global net CO₂ emissions in four illustrative model pathways
Fossil fuel and industry
AFOLU
BECCS
P1
P2
P3
P4
18
ipcc
INTERGOVERNMENTAL PANEL ON climate change


SPM4 | Indicative linkages between mitigation and sustainable development using SDGs (the linkages do not show costs and benefit)
Length shows strength of connection
Shades show level of confidence
Energy Supply
Energy Demand
Land
ipcc
INTERGOVERNMENTAL PANEL ON climate change


SPM4 | Indicative linkages between mitigation and sustainable development using SDGs (the linkages do not show costs and benefit)
Length shows strength of connection
Shades show level of confidence
Energy Supply
Energy Demand
Land
Trade-offs
Synergies
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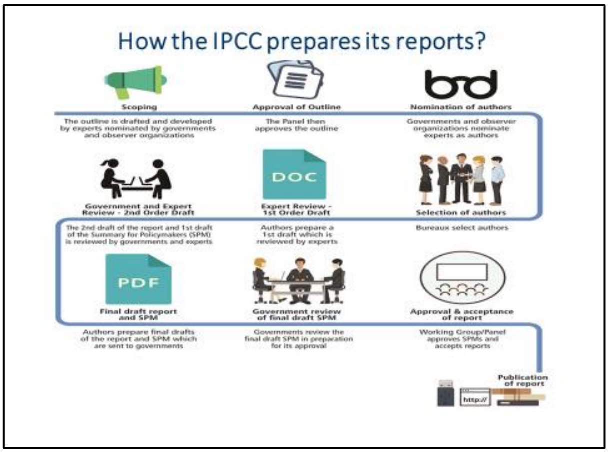
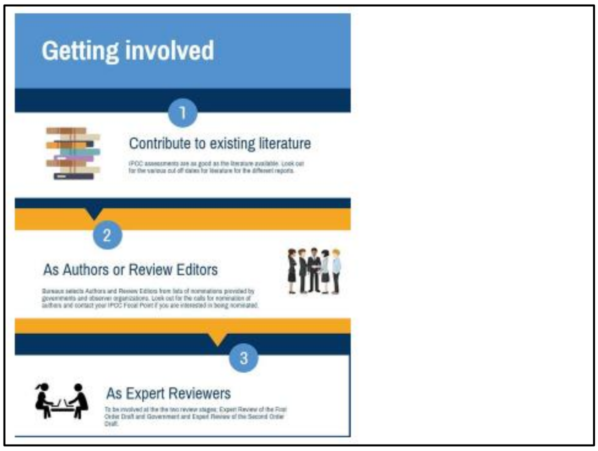
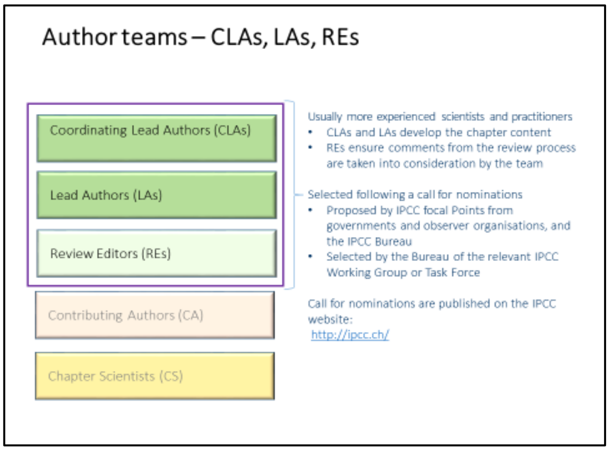
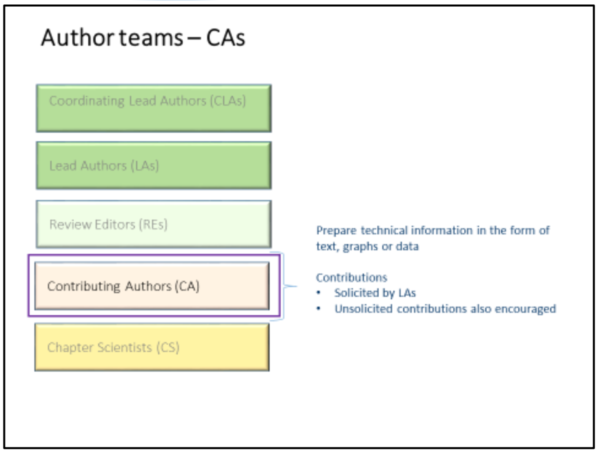
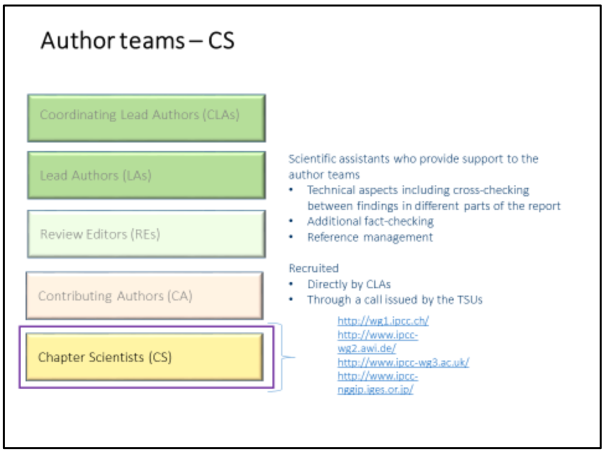
INTERGOVERNMENTAL PANEL ON climate change


How the IPCC prepares its reports?
Scoping
Approval of Outline
Nomination of authors
The outline is drafted and developed by experts nominated by governments and observer organizations
The Panel then approves the outline
Governments and observer organizations nominate experts as authors
Government and Expert Review - 2nd Order Draft
Expert Review - 1st Order Draft
Selection of authors
The 2nd draft of the report and 1st draft of the Summary for Policymakers (SPM) is reviewed by governments and experts
Authors prepare a 1st draft which is reviewed by experts
Bureaux select authors
Final draft report and SPM
Government review of final draft SPM
Approval & acceptance of report
Authors prepare final drafts of the report and SPM which are sent to governments
Governments review the final draft SPM in preparation for its approval
Working Group/Panel approves SPMs and accepts reports
Publication of report


Getting involved
1
Contribute to existing literature
2
As Authors or Review Editors
3
As Expert Reviewers


Author teams – CLAs, LAs, REs
Coordinating Lead Authors (CLAs)
Lead Authors (LAs)
Review Editors (REs)
Contributing Authors (CA)
Chapter Scientists (CS)
Usually more experienced scientists and practitioners
CLAs and LAs develop the chapter content
REs ensure comments from the review process are taken into consideration by the team
Selected following a call for nominations
Proposed by IPCC focal Points from governments and observer organisations, and the IPCC Bureau
Selected by the Bureau of the relevant IPCC Working Group or Task Force
Call for nominations are published on the IPCC website:
http://ipcc.ch/

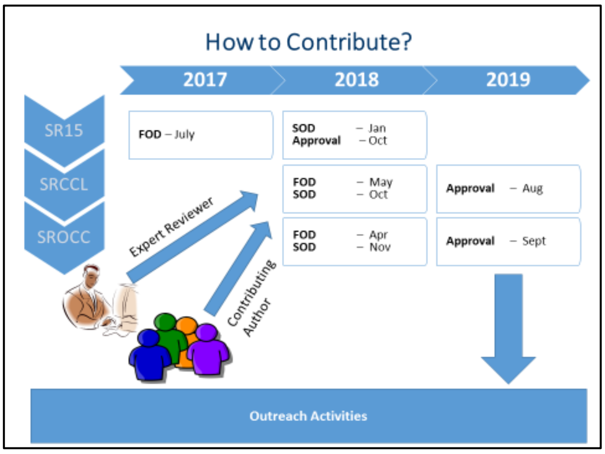


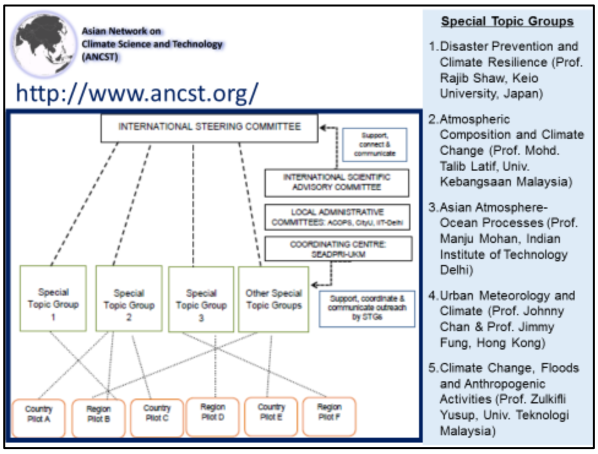


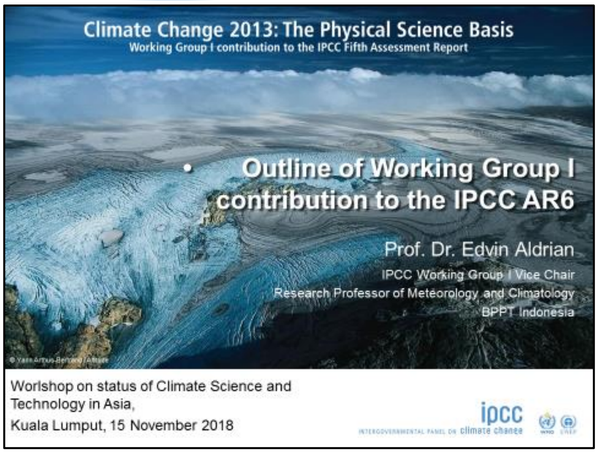
Products and Important Milestones

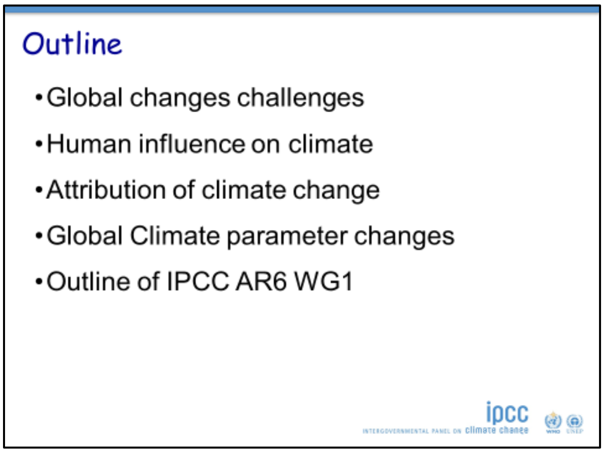
	SR15	SRCCL	SROCC	TFI MR	AR6
Call for nominations					Oct 17
First Order Draft	Jul 17	May 18	Apr 18	Dec 17	
Second Order Draft	Jan 18	Oct 18	Nov 18	Jul 18	
Final Government Review	May 18	Apr 19	Jun 19	Jan 19	
Approval Plenary	Oct 18	Aug 19	Sept 19	May 19	

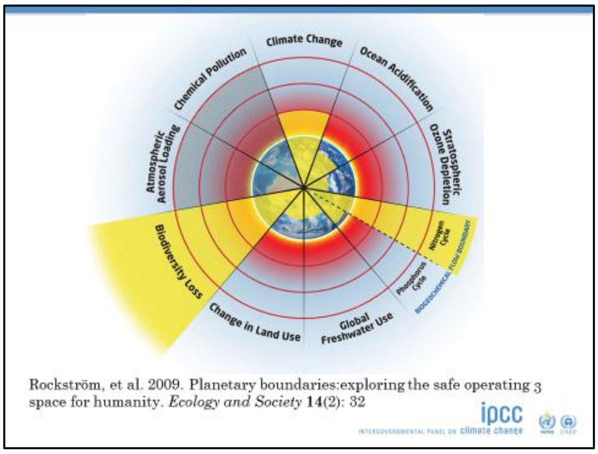
Other Activities	
Cities and Climate Change Science Conference	Mar 18
Expert meeting on SLCF	May 18
Expert meeting on Regional Aspects	May 18

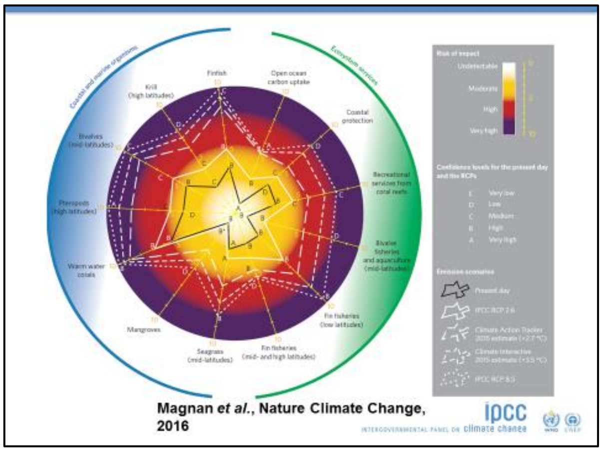


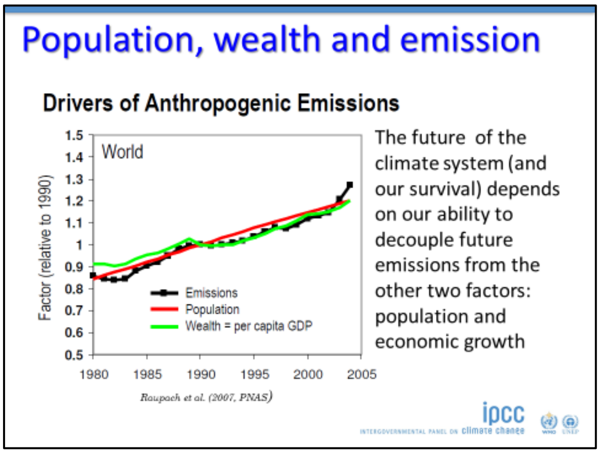


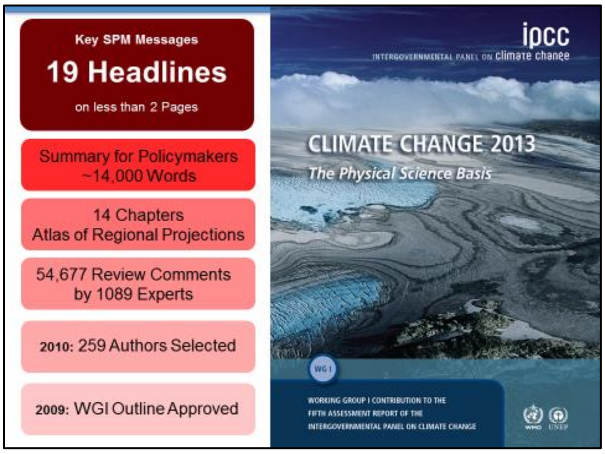

Climate Change 2013: The Physical Science Basis
Working Group I contribution to the IPCC Fifth Assessment Report
• Outline of Working Group I contribution to the IPCC AR6
Prof. Dr. Edvin Aldrian
IPCC Working Group I Vice Chair
Research Professor of Meteorology and Climatology
BPPT Indonesia
Worlshop on status of Climate Science and Technology in Asia,
Kuala Lumput, 15 November 2018
ipcc


Outline
•Global changes challenges
•Human influence on climate
•Attribution of climate change
•Global Climate parameter changes
•Outline of IPCC AR6 WG1
ipcc


Climate Change
Ocean Acidification
Stratospheric Ozone Depletion
Nitrogen Cycle
Phosphorus Cycle
Global Freshwater Use
Change in Land Use
Biodiversity Loss
Atmospheric Aerosol Loading
Chemical Pollution
Rockström, et al. 2009. Planetary boundaries:exploring the safe operating space for humanity. Ecology and Society 14(2): 32
3
ipcc


Magnan et al., Nature Climate Change, 2016
ipcc


Population, wealth and emission
Drivers of Anthropogenic Emissions
World
Factor (relative to 1990)
Emissions
Population
Wealth = per capita GDP
1980 1985 1990 1995 2000 2005
Raupach et al. (2007, PNAS)
The future of the climate system (and our survival) depends on our ability to decouple future emissions from the other two factors: population and economic growth
ipcc


Key SPM Messages
19 Headlines
on less than 2 Pages
Summary for Policymakers ~14,000 Words
14 Chapters
Atlas of Regional Projections
54,677 Review Comments by 1089 Experts
2010: 259 Authors Selected
2009: WGI Outline Approved
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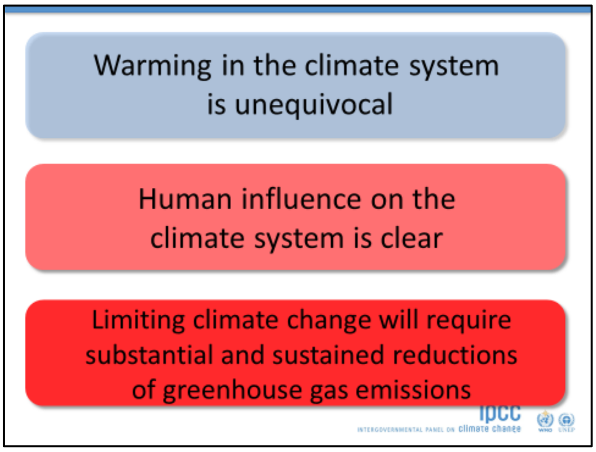
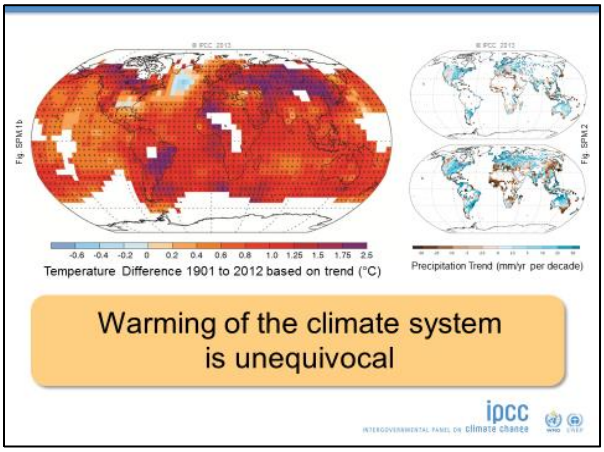
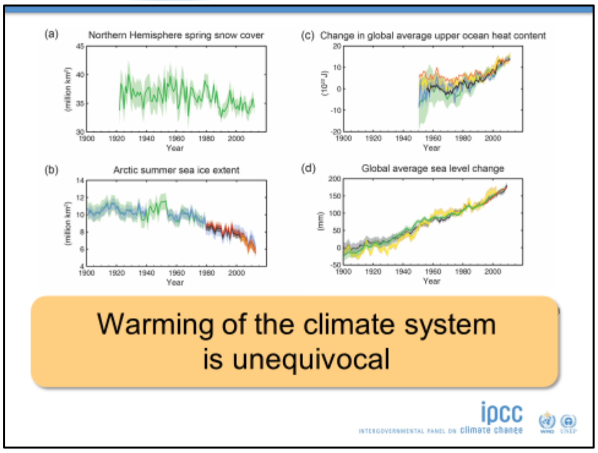
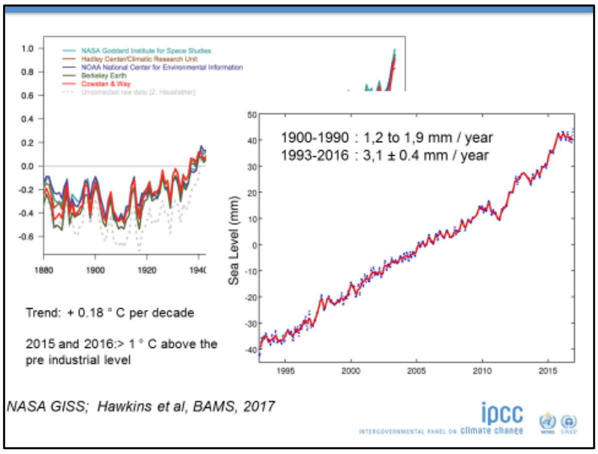
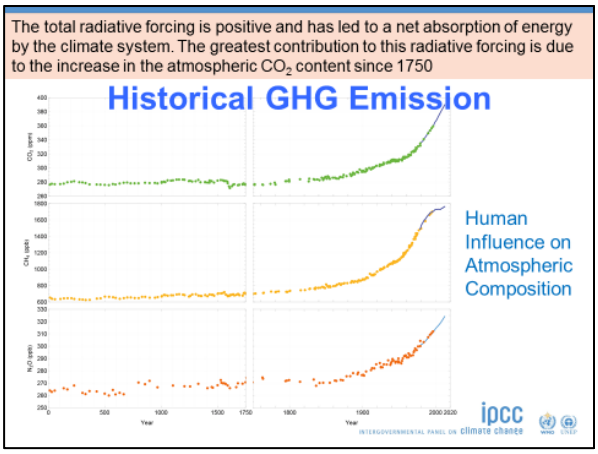
INTERGOVERNMENTAL PANEL ON climate change
CLIMATE CHANGE 2013
The Physical Science Basis
WG I
WORKING GROUP I CONTRIBUTION TO THE FIFTH ASSESSMENT REPORT OF THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE

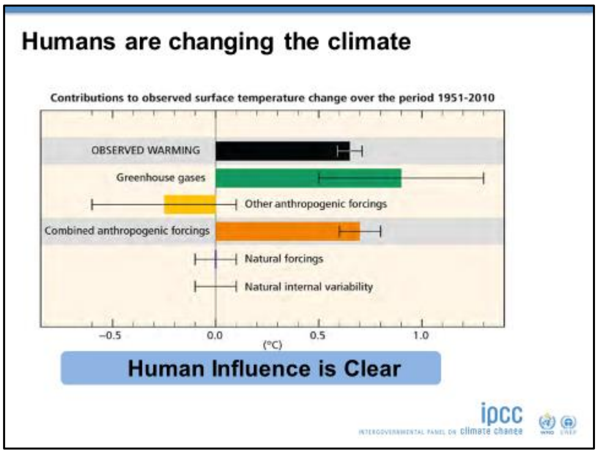

Warming in the climate system is unequivocal
Human influence on the climate system is clear
Limiting climate change will require substantial and sustained reductions of greenhouse gas emissions
ipcc

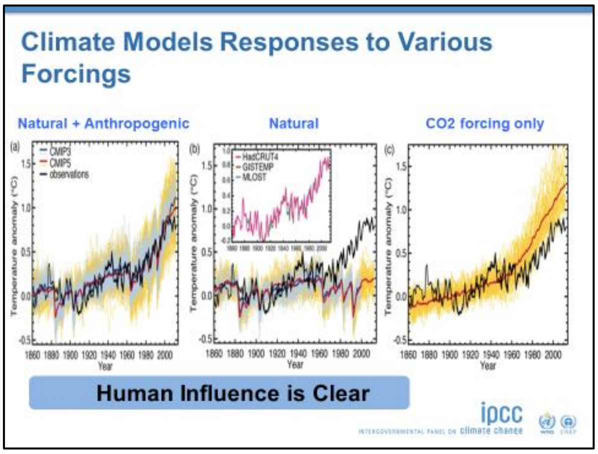

Temperature Difference 1901 to 2012 based on trend (°C)
Precipitation Trend (mm/yr per decade)
Warming of the climate system is unequivocal
ipcc

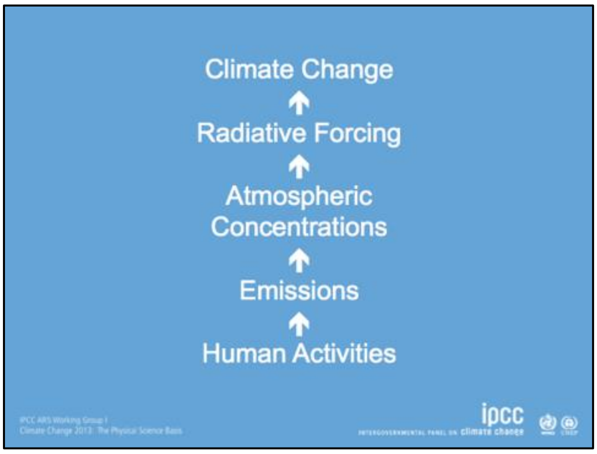

(a) Northern Hemisphere spring snow cover
(c) Change in global average upper ocean heat content
(b) Arctic summer sea ice extent
(d) Global average sea level change
Warming of the climate system is unequivocal
ipcc

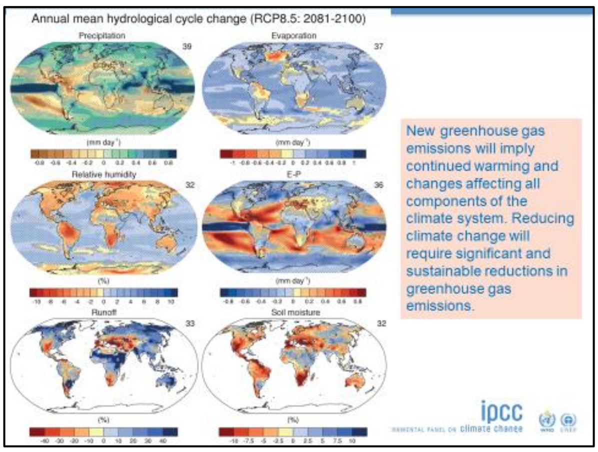

1900-1990 : 1,2 to 1,9 mm / year
1993-2016 : 3,1 ± 0.4 mm / year
Sea Level (mm)
Trend: + 0.18 ° C per decade
2015 and 2016:> 1 ° C above the pre industrial level
NASA GISS; Hawkins et al, BAMS, 2017
ipcc

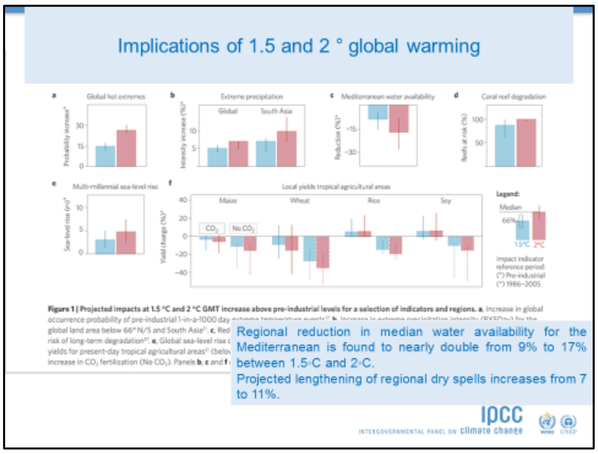

The total radiative forcing is positive and has led to a net absorption of energy by the climate system. The greatest contribution to this radiative forcing is due to the increase in the atmospheric CO_2 content since 1750
Historical GHG Emission
Human Influence on Atmospheric Composition
ipcc


Humans are changing the climate
Contributions to observed surface temperature change over the period 1951-2010
OBSERVED WARMING
Greenhouse gases
Other anthropogenic forcings
Combined anthropogenic forcings
Natural forcings
Natural internal variability
(°C)
Human Influence is Clear
ipcc


Climate Models Responses to Various Forcings
Natural + Anthropogenic
Natural
CO2 forcing only
Temperature anomaly (°C)
Year
Human Influence is Clear
ipcc


Climate Change
Radiative Forcing
Atmospheric Concentrations
Emissions
Human Activities
ipcc


Annual mean hydrological cycle change (RCP8.5: 2081-2100)
Precipitation
Evaporation
Relative humidity
E-P
Runoff
Soil moisture
New greenhouse gas emissions will imply continued warming and changes affecting all components of the climate system. Reducing climate change will require significant and sustainable reductions in greenhouse gas emissions.
ipcc


Implications of 1.5 and 2 ° global warming
Regional reduction in median water availability for the Mediterranean is found to nearly double from 9% to 17% between 1.5°C and 2°C.
Projected lengthening of regional dry spells increases from 7 to 11%.
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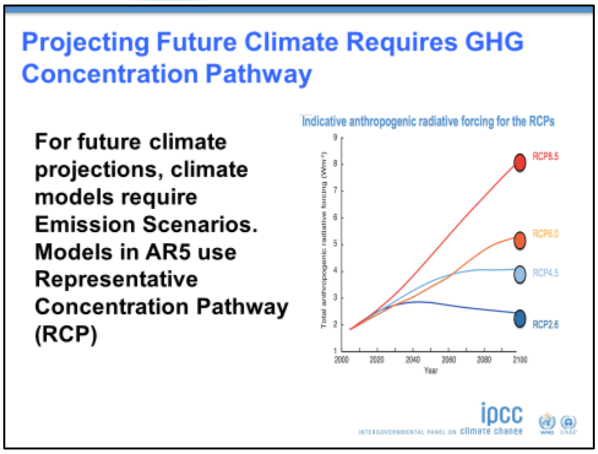
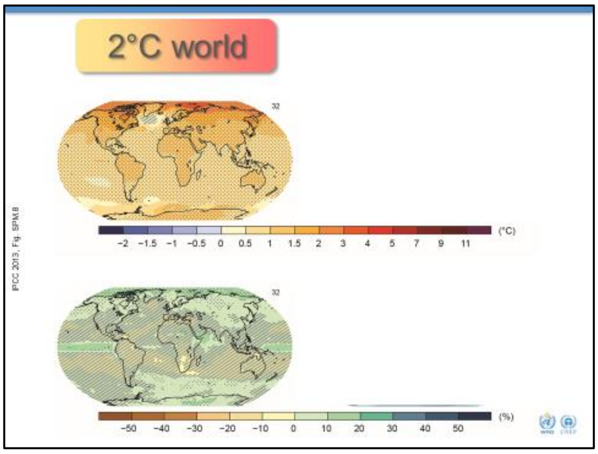
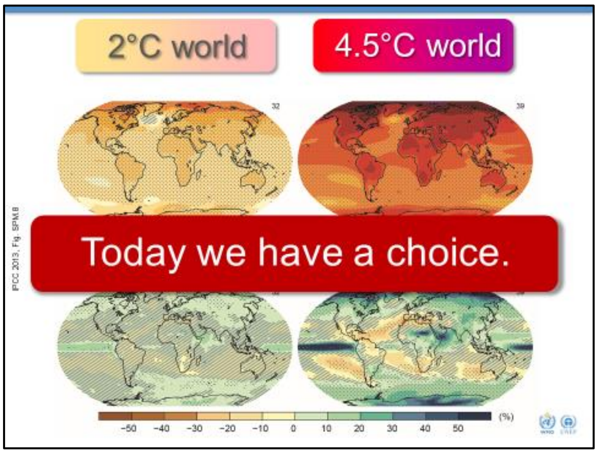
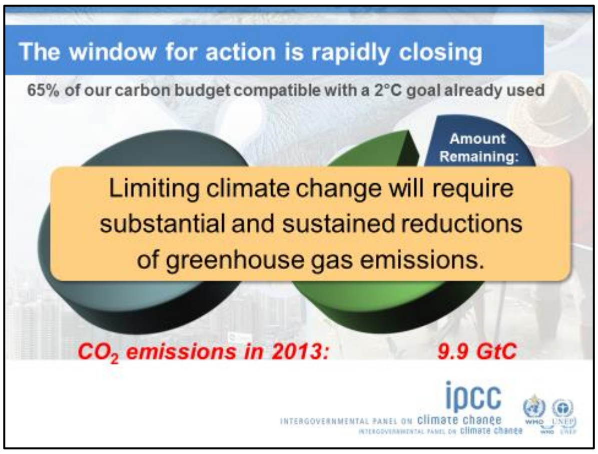
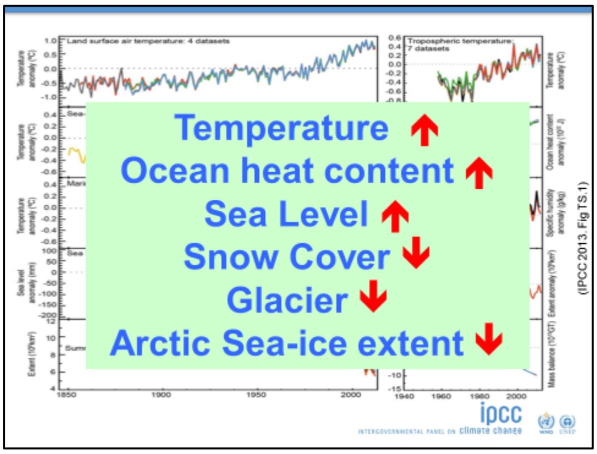
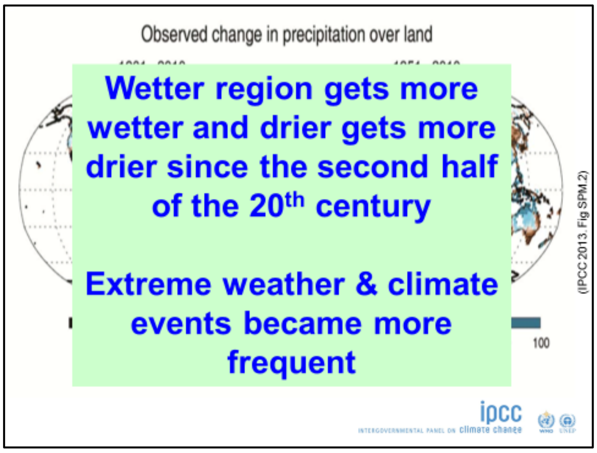

Projecting Future Climate Requires GHG Concentration Pathway
For future climate projections, climate models require Emission Scenarios. Models in AR5 use Representative Concentration Pathway (RCP)
Indicative anthropogenic radiative forcing for the RCPs
RCP8.5
RCP6.0
RCP4.5
RCP2.6
Year
ipcc

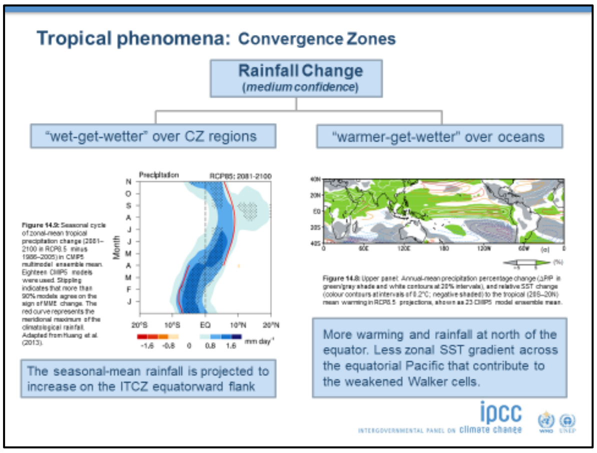

2°C world
IPCC 2013, Fig. SPM.8
(°C)
(%)

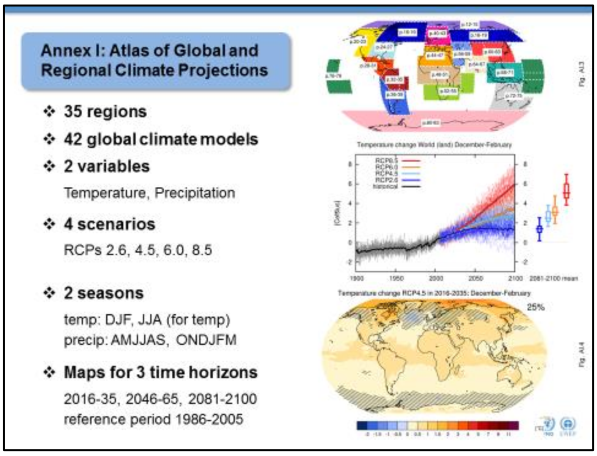

2°C world
4.5°C world
Today we have a choice.
IPCC 2013, Fig. SPM.8
(%)


The window for action is rapidly closing
65% of our carbon budget compatible with a 2°C goal already used
Amount Remaining:
Limiting climate change will require substantial and sustained reductions of greenhouse gas emissions.
CO2 emissions in 2013: 9.9 GtC
ipcc
INTERGOVERNMENTAL PANEL ON climate change


Land surface air temperature: 4 datasets
Tropospheric temperature: 7 datasets
Temperature ↑
Ocean heat content ↑
Sea Level ↑
Snow Cover ↓
Glacier ↓
Arctic Sea-ice extent ↓
(IPCC 2013, Fig TS.1)
ipcc


Observed change in precipitation over land
Wetter region gets more wetter and drier gets more drier since the second half of the 20th century
Extreme weather & climate events became more frequent
(IPCC 2013, Fig SPM 2)
ipcc


Tropical phenomena: Convergence Zones
Rainfall Change (medium confidence)
"wet-get-wetter" over CZ regions
"warmer-get-wetter" over oceans
The seasonal-mean rainfall is projected to increase on the ITCZ equatorward flank
More warming and rainfall at north of the equator. Less zonal SST gradient across the equatorial Pacific that contribute to the weakened Walker cells.
ipcc


Annex I: Atlas of Global and Regional Climate Projections
35 regions
42 global climate models
2 variables
Temperature, Precipitation
4 scenarios
RCPs 2.6, 4.5, 6.0, 8.5
2 seasons
temp: DJF, JJA (for temp)
precip: AMJJAS, ONDJFM
Maps for 3 time horizons
2016-35, 2046-65, 2081-2100
reference period 1986-2005

Current IPCC agenda

- Special report on 1.5°C (**09/2018**)
- Special report on ocean and cryosphere (**2019**)
- Special report on desertification, land degradation, sustainable land management, food security (**2019**)
- TFI methodological report on greenhouse gas emission inventories (**2019**)
- Main assessment report of WGI (**end of 2020 – beginning of 2021**)
  Calling for Chapter Scientists
- *IPCC Special Workshop on Cities* **early 2018**

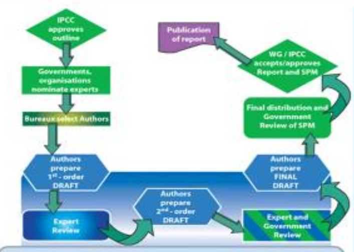
Opportunity of involvement in IPCC process

- As lead author
- Coordinator lead author
- contributor and
- review editor
- Public review
- Citation product of scientific literatures (only international peer reviewed articles)
- Attending IPCC workshop and Outreach as expert

Key AR5 WG1 gaps:

- **Land climate and regional changes**
- **Linking CO_2 emissions pathways with regional changes quantitatively**
- **Land hot spots (interface between physical processes, impacts and mitigation):**
  - **Agricultural areas**
  - **Cities, mountains, forest regions**

IPCC Assessment Process



IPCC assessment is based on available peer-reviewed publications

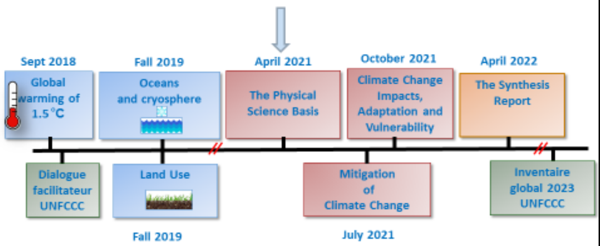
Key « Rules » for IPCC Work

- COMPREHENSIVE – all the latest relevant scientific, technical and socio-economic literature published worldwide is assessed
- BALANCED – differing views are reflected in the reports
- OPEN – selection of authors from all countries and relevant discipline, wide review process by experts and governments
- TRANSPARENT – strict clear procedures

IPCC AR5 Working Group I
Climate Change 2013: The Physical Science Basis

ar6 WGI Outline

Summary for Policy Makers
Technical Summary
Chapter 1: Framing, context, methods
Chapter 2: Changing state of the climate system
Chapter 3: Human influence on the climate system
Chapter 4: Future global climate: scenario based projections and near-term information
Chapter 5: Global carbon and other biogeochemical cycles and feedbacks
Chapter 6: Short-lived climate forcers
Chapter 7: The Earth's energy budget, climate feedbacks, and climate sensitivity
Chapter 8: Water cycle changes
Chapter 9: Ocean, cryosphere, and sea level change
Chapter 10: Linking global to regional climate change
Chapter 11: Weather and climate extreme events in a changing climate
Chapter 12: Climate change information for regional impact and for risk assessment
Annexes incl. options for a Regional Atlas and Technical Annexes
Glossary, Index



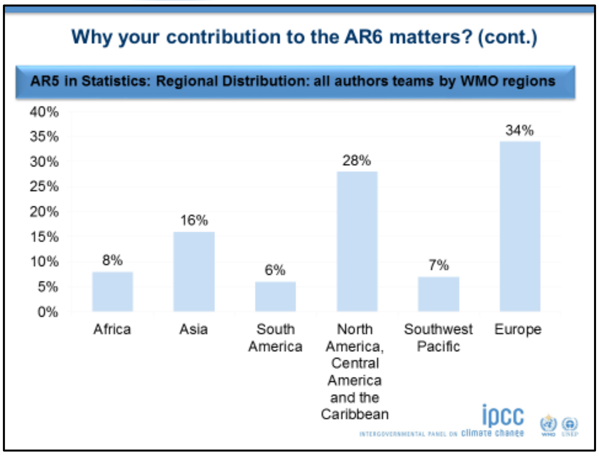
AR6 WGI schedule

- 15 September – 27 October 2017 Call for author nominations
- 29 January – 4 February 2018 Decision on Selection of authors
- 25 June – 1 July 2018 First Lead Author Meeting
- 7 – 13 January 2019 Second Lead Author Meeting
- 29 April – 23 June 2019 Expert Review of the First Order Draft
- 26 August – 1 September 2019 Third Lead Author Meeting
- 2 March – 26 April 2020 Expert and Government Review of the Second Order Draft
- 1 – 7 June 2020 Fourth Lead Author Meeting
- 7 December 2020 – 31 January 2021 Final Government Distribution of the Final Draft and Final Government Review of the Summary for Policy Makers
- 12 – 18 April 2021 Submission to the WGI Session for approval of the Summary for Policymakers and acceptance of the underlying Report

Why your contribution to the AR6 matters?

AR5 in Statistics:

Total number of Coordinating Lead Authors, Authors and Reviewers: **+ 830**
Total number of countries represented on writing teams: up to **85**


Why your contribution to the AR6 matters? (cont.)
AR5 in Statistics: Regional Distribution: all authors teams by WMO regions
40%
35%
30%
25%
20%
15%
10%
5%
0%
8%
16%
6%
28%
7%
34%
Africa
Asia
South America
North America, Central America and the Caribbean
Southwest Pacific
Europe
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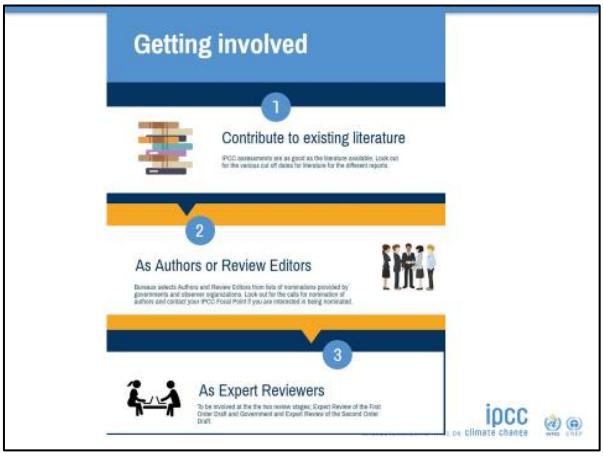
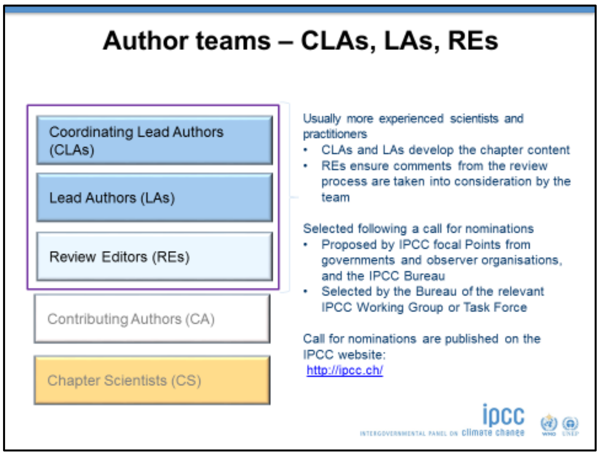
INTERGOVERNMENTAL PANEL ON climate change


Getting involved
1
Contribute to existing literature
2
As Authors or Review Editors
3
As Expert Reviewers
ipcc
climate change


Author teams – CLAs, LAs, REs
Coordinating Lead Authors (CLAs)
Lead Authors (LAs)
Review Editors (REs)
Contributing Authors (CA)
Chapter Scientists (CS)
Usually more experienced scientists and practitioners
• CLAs and LAs develop the chapter content
• REs ensure comments from the review process are taken into consideration by the team
Selected following a call for nominations
• Proposed by IPCC focal Points from governments and observer organisations, and the IPCC Bureau
• Selected by the Bureau of the relevant IPCC Working Group or Task Force
Call for nominations are published on the IPCC website:
http://ipcc.ch/
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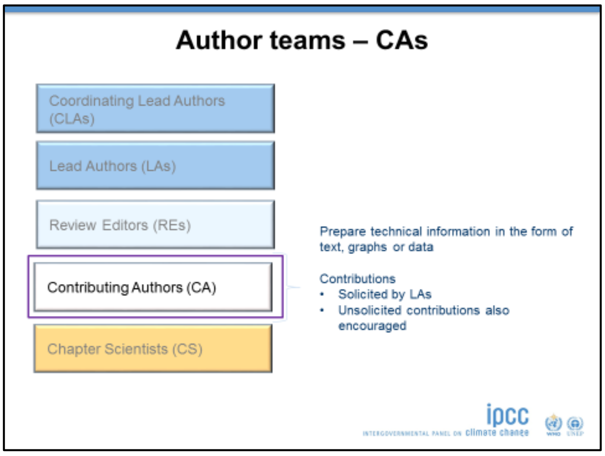
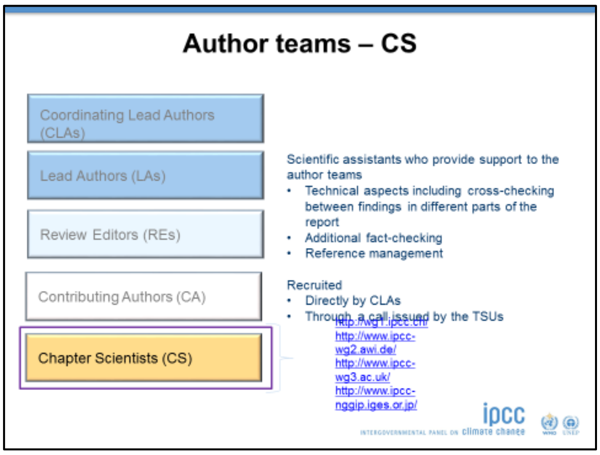
INTERGOVERNMENTAL PANEL ON climate change


Author teams – CAs
Coordinating Lead Authors (CLAs)
Lead Authors (LAs)
Review Editors (REs)
Contributing Authors (CA)
Chapter Scientists (CS)
Prepare technical information in the form of text, graphs or data
Contributions
• Solicited by LAs
• Unsolicited contributions also encouraged
ipcc
INTERGOVERNMENTAL PANEL ON climate change


Author teams – CS
Coordinating Lead Authors (CLAs)
Lead Authors (LAs)
Review Editors (REs)
Contributing Authors (CA)
Chapter Scientists (CS)
Scientific assistants who provide support to the author teams
• Technical aspects including cross-checking between findings in different parts of the report
• Additional fact-checking
• Reference management
Recruited
• Directly by CLAs
• Through a call issued by the TSUs
http://wg1.ipcc.ch/
http://www.ipcc-wg2.awi.de/
http://www.ipcc-wg3.ac.uk/
http://www.ipcc-nggip.iges.or.jp/
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INTERGOVERNMENTAL PANEL ON climate change


THANK YOU FOR YOUR ATTENTION!
For more information:
Website: http://ipcc.ch/
IPCC Secretariat: ipcc-sec@wmo.int
IPCC Press Office: ipcc-media@wmo.int
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@IPCC_CH
IPCC_Climate_Change
https://www.linkedin.com/company/ipcc
http://www.slideshare.net/ipcc-media/presentations
https://www.flickr.com/photos/ipccphoto/sets/
https://www.youtube.com/c/ipccgeneva
https://vimeo.com/ipcc
ipcc
INTERGOVERNMENTAL PANEL ON climate change
WMO UNEP

IPCC AR6 : Outline of WG II

Some thoughts on Asia Regional Chapter

Rajib Shaw
Professor, Keio University, Japan
Chair, Science Technology Advisory Group (STAG) UN ISDR
Science Committee Member, Integrated Research on Disaster Risk (IRDR)
Co-Chair, Asia Science Technology Academia Advisory Group (ASTAAG) of UN ISDR
Coordinating Lead Author (CLA), Asia Chapter, IPCC 6th Assessment Report
Co-Founder, RIKA (Resilience Innovational Knowledge Academy) Pvt. Ltd.

Web: www.rajibshaw.org

Statistics: WG II

Impacts, Adaptation and Vulnerability

- 3 sections
- 18 chapters [Total of 970 + pages]
- 5 Annexes

- 2 Co-Chairs
- 2 Vice Chairs
- 263 CLA, LA, RE

Chapter 1: Point of departure and key concepts [30 pages]

- Changing policy context (including UNFCCC, Paris Agreement and Global Stocktake, SDGs, etc.); AR5 and SR findings and critical messages, goals of this report
- The significance of sectoral and regional climate risks to natural and human systems and their interactions in the context of culture, values, ethics, identity, behaviour, historical experience, and knowledge systems (e.g., indigenous and local)
- The climate risk framework used in this report encompassing hazard, exposure, and vulnerabilities, including their spatial distribution, cascading impacts, disaster risk reduction, and risk uncertainties
- The significance of adaptation, in addressing climate change risks, including diverse adaptation responses, technologies including nature and ecosystem-based adaptation, outcomes, common principles, resilience, and issues of scale
- Detection and attribution of climate impacts and methods to evaluate adaptation responses

Chapter 1: Point of departure and key concepts [30 pages] Contd.

- Understanding dynamic climate risks from scenarios that reflect multiple interacting drivers
- Scientific, technical and socioeconomic aspects of current and future residual impacts of climate change, including residual damage, irreversible loss, and economic and non-economic losses caused by slow onset and extreme events
- Limits to adaptation, and enabling conditions for effective adaptation including governance, institutions, and economic aspects
- Climate change responses and their interactions with sustainable development, including adaptation with mitigation co-benefits and trade-offs
- Opportunities for enhancing climate resilient development pathways

Section 1: Risks, adaptation and sustainability for systems impacted by climate change

(7 chapters, 410 pages)

- **Chapter 2:** Terrestrial and freshwater ecosystems and their services [60 pages]
- **Chapter 3:** Ocean and coastal ecosystems and their services [60 pages]
- **Chapter 4:** Water [60 pages]
- **Chapter 5:** Food, fibre, and other ecosystem products [60 pages]
- **Chapter 6:** Cities, settlements and key infrastructure [60 pages]
- **Chapter 7:** Health, wellbeing and the changing structure of communities [50 pages]
- **Chapter 8:** Poverty, livelihoods and sustainable development [60 pages]

Section 2: Regions

(7 chapters + Cross chapter papers
370 (290 + 80) pages)

- **Chapter 9:** Africa [50 pages]
- **Chapter 10:** Asia [50 pages]
- **Chapter 11:** Australasia [30 pages]
- **Chapter 12:** Central and South America [50 pages]
- **Chapter 13:** Europe [40 pages]
- **Chapter 14:** North America [40 pages]
- **Chapter 15:** Small Islands [30 pages]

Section 2: Regions (Contd.)

CROSS-CHAPTER PAPERS (with material for TS/SPM as appropriate) : 80 pages

- Biodiversity hotspots (land, coasts and oceans) [10 pages]
- Cities and settlements by the sea [10 pages]
- Deserts, semi-arid areas, and desertification [10 pages]
- Mediterranean region [10 pages]
- Mountains [15 pages]
- Polar regions [15 pages]
- Tropical forests [10 pages]

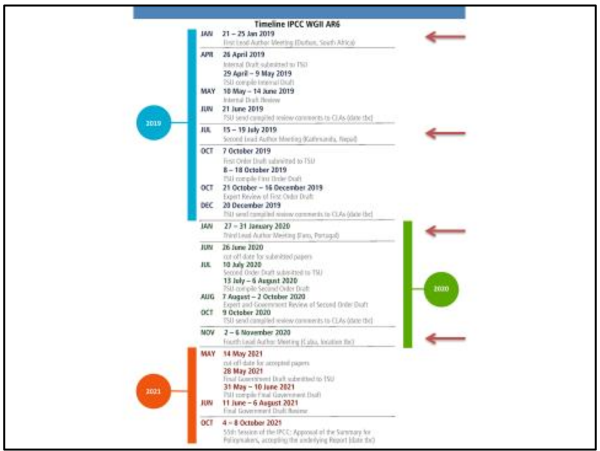
Section 3: Sustainable development pathways: integrating adaptation and mitigation

(3 chapters,120 pages)

- **Chapter 16:** Key risks across sectors and regions [40 pages]
- **Chapter 17:** Decision-making options for managing risk [40 pages]
- **Chapter 18:** Climate resilient development pathways* [40 pages]

Annexes

- **ANNEX I:** Regional Atlas
- **ANNEX II:** Glossary
- **ANNEX III:** List of Acronyms
- **ANNEX IV:** List of Contributors
- **ANNEX V:** List of Reviewers
- **INDEX**



Chapter 10: Asia [50 pages]

Chapter 10: Asia

	Last Name	First Name	Role	Gender	Country	Citizenship	Current Affiliation
1	CHEONG	Tae Sung	CLA	M	Republic of Korea	Republic of Korea	Ministry of Interior and Safety, National Disaster Management Institute
2	LUO	Yong	CLA	M	China	China	Department of Earth System Science, Tsinghua University
3	SHAW	Rajib	CLA	M	Japan	Japan	KEIO UNIVERSITY, Graduate School of Media and Governance
4	ABDUL HALIM	Sharina	LA	F	Malaysia	Malaysia	Institute for Environment and Development, University Kebangsaan Malaysia
5	CHATURVEDI	Sanjay	LA	M	India	India	South Asian University
6	HASHIZUME	Masahiro	LA	M	Japan	Japan	Institute of Tropical Medicine, Nagasaki University
7	INSAROV	Gregory E.	LA	M	Russia	Russia	Institute of Geography of the Russian Academy of Sciences
8	ISHIKAWA	Yoichi	LA	M	Japan	Japan	Japan Agency for Marine-Earth Science and Technology
9	JAFARI	Mostafa	LA	M	Iran	Iran	Executive Director of Macro National Strategic Plan of Climate Change Research AREEO/ and Head of TPS for LFCCs
10	KITOH	Akio	LA	M	Japan	Japan	Japan Meteorological Business Support Center
11	PULHIN	Juan	LA	M	Philippines	Philippines	NATIONAL PANEL OF TECHNICAL EXPERTS- CLIMATE CHANGE COMMISSION
12	SINGH	Chandni	LA	F	India	India	Indian Institute for Human Settlements
13	VASANT	Kripa	LA	F	India	India	INDIAN COUNCIL OF AGRICULTURAL RESEARCH
14	ZHANG	Zhibin	LA	M	China	China	Institute of Zoology, Chinese Academy of Sciences
15	MYEONG	Soojeong	RE	F	Republic of Korea	Republic of Korea	Korea Environment Institute
16	PEREIRA	Joy Jacqueline	RE	F	Malaysia	Malaysia	Institute for Environment and Development

Common elements across all regional chapters

- Information on selected regional and sub-regional climate characteristics and zones
- Summary Table and/or figures with WGI and WGII information, combined with risk assessment (e.g., SREX SPM.1)
- Detection and attribution of observed impacts in natural and human systems on diverse time scales
- Region specific information on exposure and vulnerability
- Current sectoral climate risks, including specific regional and sub-regional considerations related to land, coasts and regional oceans Cultural and psychological dimensions (values, attitudes, ethical aspects, identity, behaviours, and different types of knowledge systems)
- Observed impacts and projected risks including identifying key risks and residual risks as well as development pathways depending on rate and level of climate change, including extremes and sea level rise
- Diverse adaptation options including opportunities, enablers, limits, barriers, adaptive capacity, and finances
- Governance and economic aspects including legal, institutional, financing, price responses, and trade
- Cross sectoral, intra-regional, and inter-regional issues including consideration of temporal scale
- Interaction of risks and responses to climate change with sustainable development pathways
- Implications of availability and heterogeneity of data, including the use of 'grey literature'
- Lessons from case studies

AR5 Regional Chapter on Asia (44 pages)

- Executive summary (2)
- Introduction
- Major conclusion from AR4 (1)
- Observed and projected climate change (2)
- Observed and projected impacts, vulnerability and adaptation (16)
  - Freshwater; Terrestrial and inland water; Coastal and low lying; Food production and food security; Human settlements, industry and infra; Human health, security, livelihoods and poverty; Valuation of impacts and adaptation
- Adaptation and managing risk (2)
- Adaptation and mitigation interactions (1)
- Intra and inter regional issues (1)
  - Trans boundary pollution; Trade and economy; Migration and population displacement.
- Research and data gaps (1)
- Case studies (2)
- References (13)

Chapter 24, Asia: AR5

Coverage - 51 countries/regions

Source: IPCC, 2013

ipcc
INTERGOVERNMENTAL PANEL ON climate change

Chapter 10: Some personal thoughts

- Link to regional process of SDG, Sendai Framework: science technology and policy interface
- Recent major reports on 1.5 Deg, Land and Ocean and its implications to the region

- Extreme events and new normal
- Climate Fragility Risk (compounded risk)
- Slow onset disasters
- Urban rural linkages
- Food Energy Water (FEW) – Health Nexus
- Adaptation Law / Disaster Management Law
- Adaptation Communication
- Private sector and adaptation industry (?)
- Innovation and new and emerging technology

Chapter Outline of WK III Contribution to IPCC AR6

Prof Dr Lim Yun Seng
Universiti Tunku Abdul Rahman
Lead Author in Chapter 16:
Innovation, Technology Development and Transfer

Outline of AR6 by WK III

- Chapter 1: Introduction and Framing:
  - Key findings, Recent developments, Sustainable developments, Technology and other development (multiple entry points to climate mitigation). Solution orientation and accelerating progress.
  - Policy (Multiple goal setting)
  - Regional breakdown, sector, services and systems
  - Methods and framings including models, analysis,
- Chapter 2: Emissions trends and drivers
  - Past and present trends of territorial emissions and sinks on an annual and cumulative basis. Past and present trends of consumption-based emissions on an annual and cumulative basis.
  - Socio-economic and demographic drivers and their trends.
  - Overview of sectoral emission drivers and their trends. Climate and non-climate policies and measures at different scales and their impacts on emissions. Technological choices and changes. Emissions associated with existing and planned long-lived infrastructure. Behavioural choices and lifestyles of individuals and societal levels.
- Chapter 3: Mitigation pathways compatible with long-term goals
  - Methods of assessment, Socio-cultural-techno-economic assumptions and projections, modelled emission pathways compatible with the Paris Agreement, Role of changing climate on emissions, System transition and transformations with mitigation pathways, Economics of mitigation and development pathways.
  - Technological and behavioural aspects of mitigation pathways.

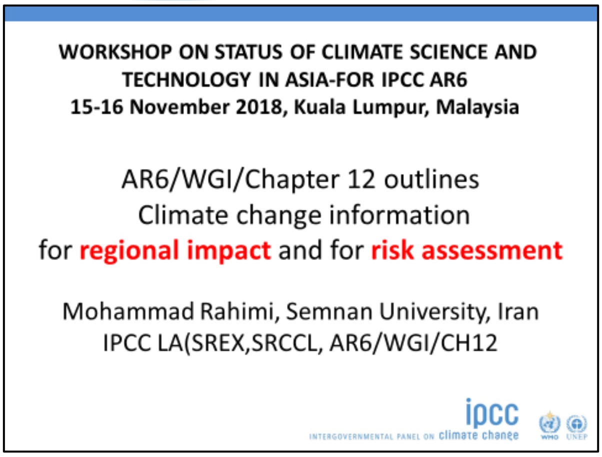
- Chapter 4: Mitigation and development pathways in the near to mid term
  - Accelerating mitigation, Projections of socio-economic and demographic drivers, aggregate effects of climate actions, mitigation efforts, national, regional and global modelling of mitigation pathways, implications of mitigations, enabling conditions for mitigation, uncertainties and risks.
  - Links to sustainable development, and adaptations. Benefits of mitigation
- Chapter 5: Demand, services and social aspects of mitigation
  - Mitigation, sustainable development, patterns of development, sustainable consumption and production, linking services with demands, culture, social norms and practices for lower resources, sharing economy.
  - Implications of information and communication technologies, Circular economy, Social acceptability of supply and demand.
- Chapter 6: Energy Systems
  - Energy services, Energy resources, Global and regional trends, Policies and measures, Global and regional new trends of electricity.
  - Smart energy systems, energy efficiency technologies, mitigation options, interconnection, storage and infrastructure.

- Chapter 7: Agriculture, Forestry and Other Land Uses
  - Mitigation Measures, Mitigation Potentials, Emerging Technologies, Constraints and Opportunities.
  - Provision of food, feed and others for energy, Assessment of social and policy responses.
  - Mitigation approaches and Anthropogenic emissions and removals
- Chapter 8: Urban systems and other settlements
  - Demographic Perspectives, Consumption, lifestyles of rural and urban, urbanisation wedge in future emissions, city emissions, urban emissions, low-carbon city scenarios, options and costs, Urban Technologies, Innovative Strategies.
- Chapter 9: Buildings
  - Access to sector specific services, Services, Components, Mitigation options, Systematic Interactions, Scenarios and links with targets.

- Chapter 10: Transport
  - Access to mobility services, Components and system boundaries, Aviation and Shipping
  - Mitigation options, Mobility trends and drivers, Systematic interactions
- Chapter 11: Industry
  - Industrial development, Maximising materials and industrial production.
  - Evolving Demands for Industrial Products,
  - Mitigation Technologies and Efficient System Options
  - Implications of Ambitious Climate Targets.
- Chapter 12: Cross sectoral perspectives
  - Comparison of sector cots and potentials
  - Aspects of GHG Removal Techniques
  - Impacts, Risks and Opportunities from Large-Scale Land-Based Mitigation.
  - Emissions Intensity of Food Systems.
  - Policies related to Food Systems and Food Security.

- Chapter 13: National and Sub-National Policies and Institutions
  - Cross-country insights, Trends in national climate legislation, Building agreement, Governance systems, Assessment of policy instrument,
  - Integrated analysis of sectoral policies, Institutions for climate governance,
  - Subnational climate action, partnership for climate governance.
- Chapter 14: International Cooperation
  - International cooperation and institutions, International sectoral agreements, Implementing mitigation pathways, Enabling institutions and International Partnership.
  - Transparency and accountability frameworks.
  - Lessons of implementation from relevant international environment agreements
- Chapter 15: Investment and Finance
  - Definition of climate finance.
  - Scenarios of and needs for investment and financial flows related to mitigation pathways.
  - Scenarios and needs for investments and financial flows.
  - Investment patterns and financing for climate resilient development.
  - Enabling conditions for changing finance and investment patterns.

- Chapter 16: Innovation, Technology Development and Transfer
  - Roles of innovation, technology development, diffusion and transfer in contributing to sustainable developments. Aims of the Paris Agreements.
  - Innovation and Technology as Systematic Issues.
  - Assessment of international institutions partnerships and cooperative approaches relevant to technology and R&D.
  - Capacity for transformative change
  - Assessment of experiences with accelerating technological change through innovation.
  - Specific challenges in emerging economies and least developed countries.
  - Acceptability and social inclusion in decision making
  - Characterisation and implications of new disruptive technologies.
  - Links to adaptation and sustainable development.
- Chapter 17: Accelerating the transition in the context of sustainable development
  - Learning from integrative perspectives on sustainable development.
  - Pathways for joint responses to climate changes.
  - Climate change mitigation responses and mitigation-adaptations interlinkages.
  - Regional perspectives on climate change mitigations.
  - Other emerging issues


WORKSHOP ON STATUS OF CLIMATE SCIENCE AND TECHNOLOGY IN ASIA-FOR IPCC AR6
15-16 November 2018, Kuala Lumpur, Malaysia
AR6/WGI/Chapter 12 outlines
Climate change information
for regional impact and for risk assessment
Mohammad Rahimi, Semnan University, Iran
IPCC LA(SREX,SRCCL, AR6/WGI/CH12
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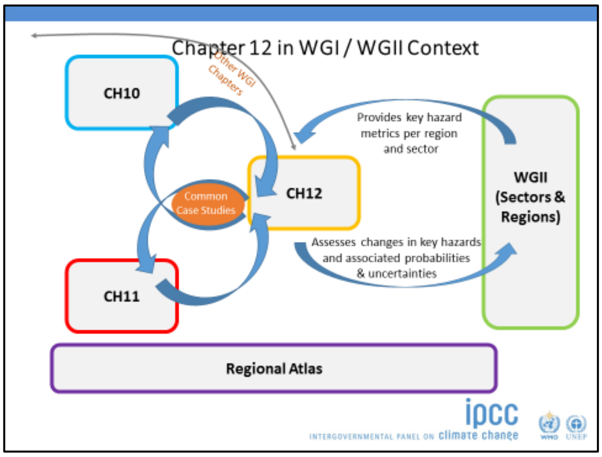
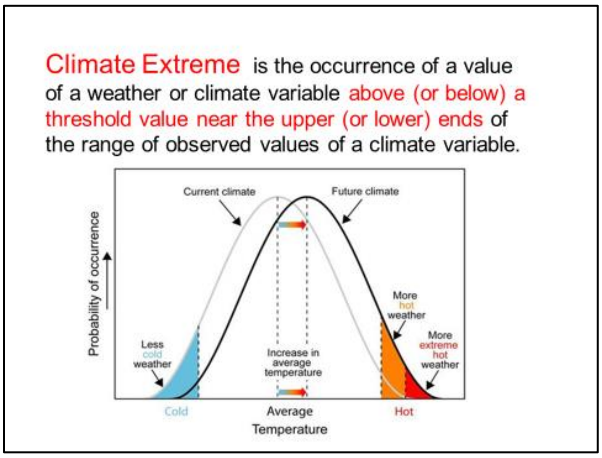
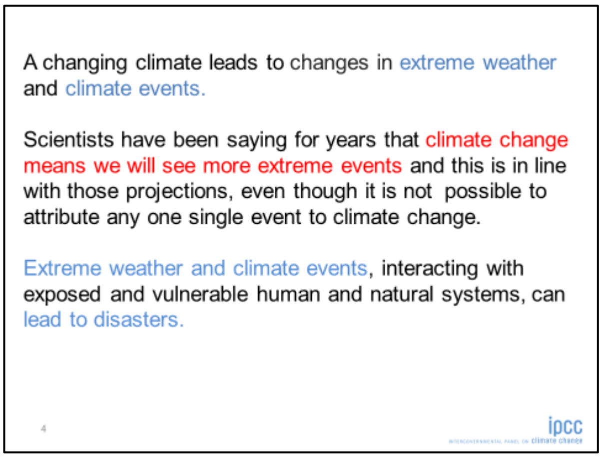
INTERGOVERNMENTAL PANEL ON climate change


Chapter 12 in WGI / WGII Context
Other WGI Chapters
CH10
Provides key hazard metrics per region and sector
CH12
Common Case Studies
WGII (Sectors & Regions)
Assesses changes in key hazards and associated probabilities & uncertainties
CH11
Regional Atlas
ipcc
INTERGOVERNMENTAL PANEL ON climate change


Climate Extreme is the occurrence of a value of a weather or climate variable above (or below) a threshold value near the upper (or lower) ends of the range of observed values of a climate variable.
Current climate
Future climate
Probability of occurrence
More hot weather
Less cold weather
Increase in average temperature
More extreme hot weather
Cold
Average Temperature
Hot


A changing climate leads to changes in extreme weather and climate events.
Scientists have been saying for years that climate change means we will see more extreme events and this is in line with those projections, even though it is not possible to attribute any one single event to climate change.
Extreme weather and climate events, interacting with exposed and vulnerable human and natural systems, can lead to disasters.
4
ipcc


A changing climate leads to changes in the frequency, intensity, spatial extent, duration, and timing of weather and climate extremes, and can result in unprecedented extremes.
5
ipcc

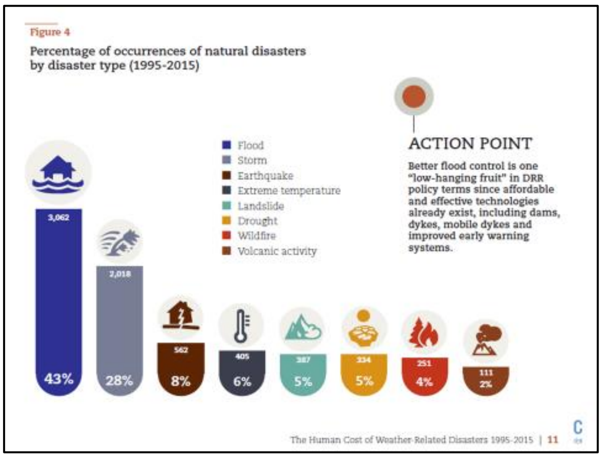
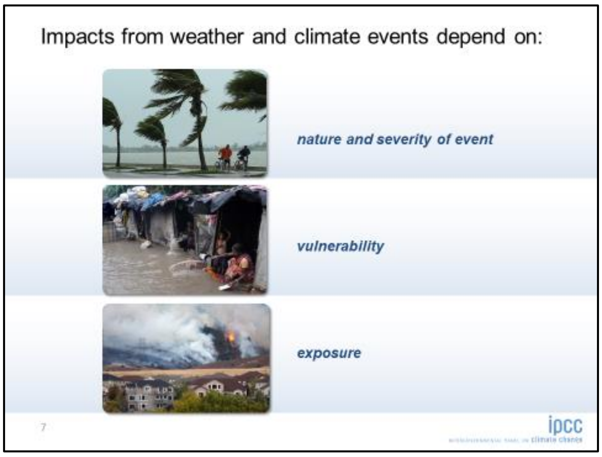
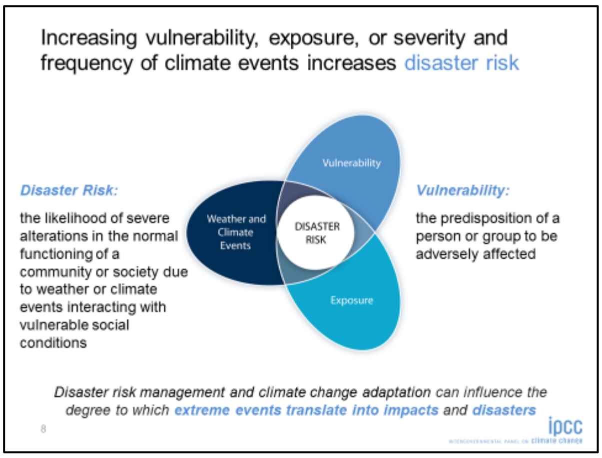


Figure 4
Percentage of occurrences of natural disasters by disaster type (1995-2015)
Flood
Storm
Earthquake
Extreme temperature
Landslide
Drought
Wildfire
Volcanic activity
ACTION POINT
Better flood control is one "low-hanging fruit" in DRR policy terms since affordable and effective technologies already exist, including dams, dykes, mobile dykes and improved early warning systems.
3,062
43%
2,018
28%
562
8%
405
6%
387
5%
334
5%
251
4%
111
2%
The Human Cost of Weather-Related Disasters 1995-2015 | 11


Impacts from weather and climate events depend on:
nature and severity of event
vulnerability
exposure
7
ipcc


Increasing vulnerability, exposure, or severity and frequency of climate events increases disaster risk
Disaster Risk:
the likelihood of severe alterations in the normal functioning of a community or society due to weather or climate events interacting with vulnerable social conditions
Vulnerability
Weather and Climate Events
DISASTER RISK
Exposure
Vulnerability:
the predisposition of a person or group to be adversely affected
Disaster risk management and climate change adaptation can influence the degree to which extreme events translate into impacts and disasters
8
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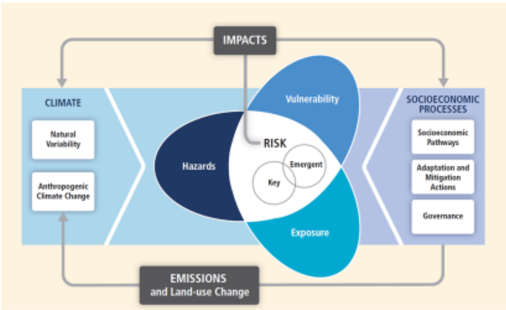
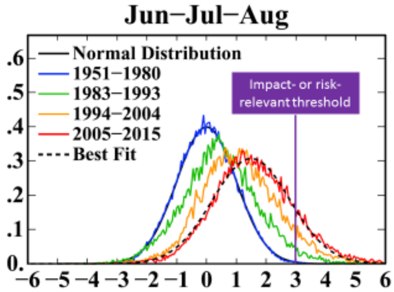
New Chapter in IPCC – Driven by WG2 Needs



Schematic from Oppenheimer et al. (2014) – AR5-WG2 Chapter 19

Chapter 12 Provides Hazards Perspective



Local seasonal mean temperature anomalies compared to 1951-1980 distribution [from Hansen and Sato (2016) – ERL]

Chapter 12 Scoping

- Framing: physical climate system and hazards
- Information (quantitative and qualitative) on changing hazards: present day, near term and long term
- Region-specific methodologies
- Region-specific integration of information, including confidence
- Relationship between changing hazards, global mean temperature change, scenarios and emissions

Climate metrics for hazardous impact assessment

- **Region/subregion based**
- **Sector based**
- **Hazard based**

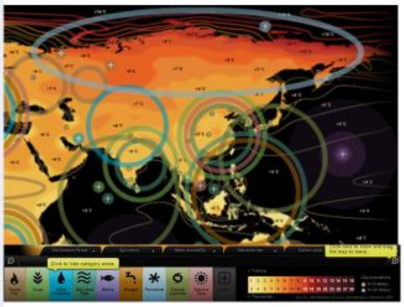
Chapter 12 Chapter Outline

Regional information on changing hazards
Africa
Asia
Australasia
Central and South America
Europe
North America
Small Islands
Oceans
Specific zones of impacts and risk

- **Link to WG2 regional chapters driven by climate metrics**
- **Audience is national policymakers concerned about their countries**

Asia sub-regions

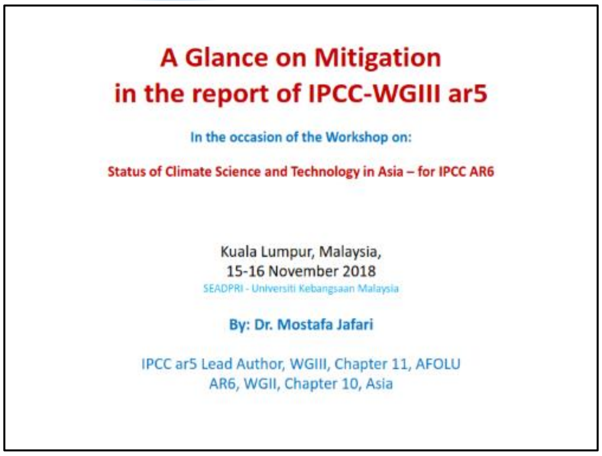
West and Southwest Asia
East Asia
South Asia
Southeast Asia
Central Asia
North Asia



Need CA for Asia section

- **conduct literature review and provide a synthesis**
- **textual contributions to draft chapter**
- **data analysis**
- **preparation of key figures for chapter as requested**
- **Anything else that we would provide/ask of the contributing author**
- **Specific contributing author's name, affiliation and email address (if you have one identified)**
  - **Please note their specific expertise**
  - **Provide a short argument about why this person is best suited**

Thank you


A Glance on Mitigation
in the report of IPCC-WGIII ar5
In the occasion of the Workshop on:
Status of Climate Science and Technology in Asia – for IPCC AR6
Kuala Lumpur, Malaysia,
15-16 November 2018
SEADPRI - Universiti Kebangsaan Malaysia
By: Dr. Mostafa Jafari
IPCC ar5 Lead Author, WGIII, Chapter 11, AFOLU
AR6, WGII, Chapter 10, Asia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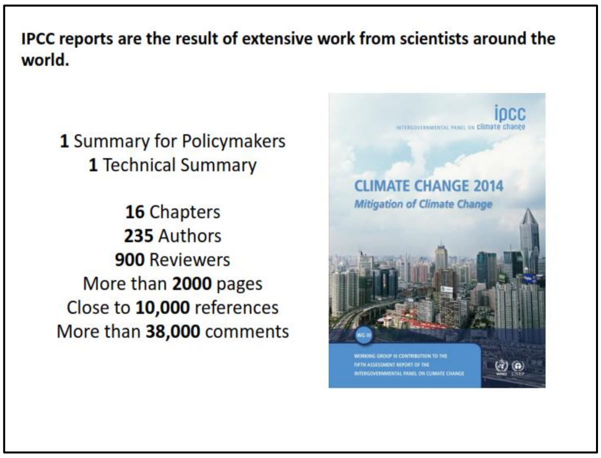
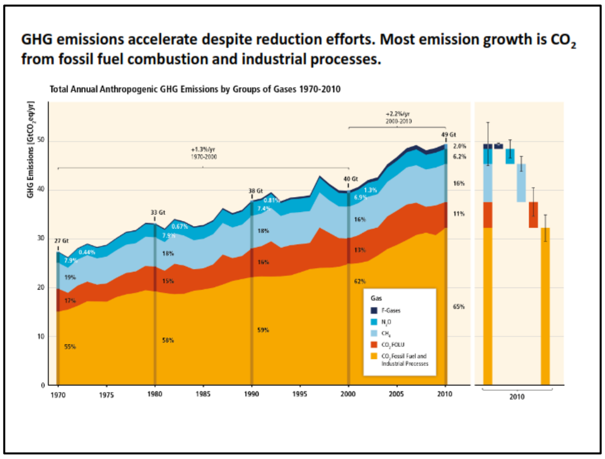
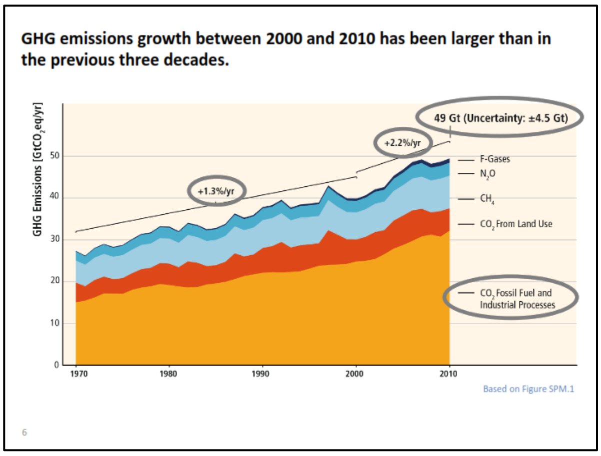
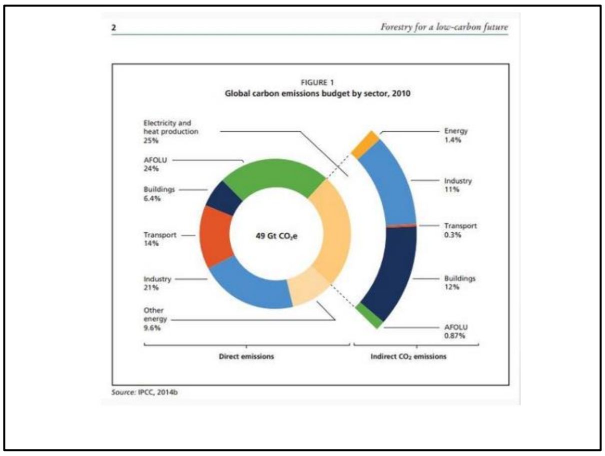
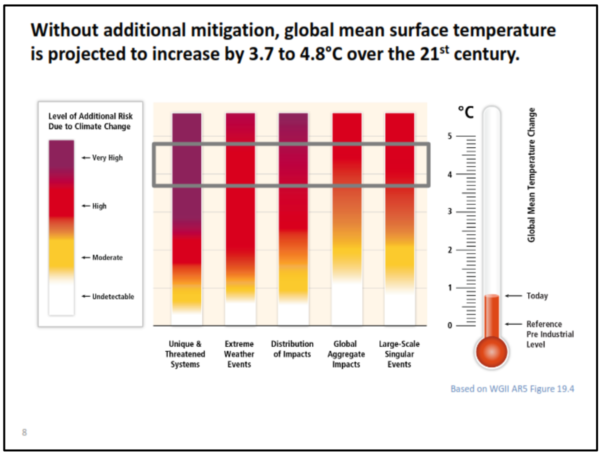
INTERGOVERNMENTAL PANEL ON climate change
Workshop on:
Status of Climate Science and Technology
in Asia – for IPCC AR6
Kuala Lumpur, Malaysia,
15-16 November 2018
CLIMATE CHANGE 2014
Mitigation of Climate Change
By: Dr. Mostafa Jafari
Working Group III contribution to the IPCC Fifth Assessment Report
IPCC ar5 Lead Author, WGIII, Chapter 11, AFOLU
AR6, WGII, Chapter 10, Asia

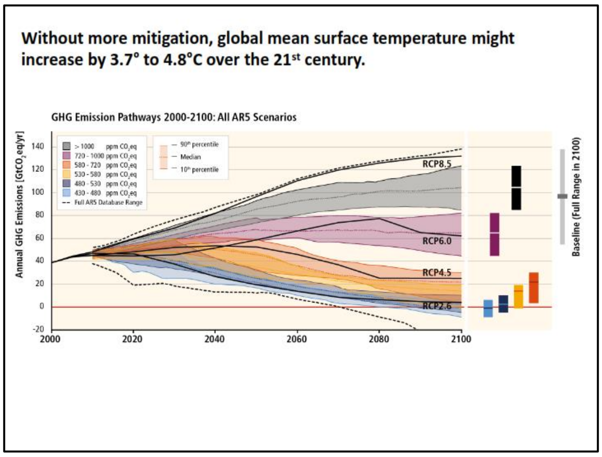

IPCC reports are the result of extensive work from scientists around the world.
1 Summary for Policymakers
1 Technical Summary
16 Chapters
235 Authors
900 Reviewers
More than 2000 pages
Close to 10,000 references
More than 38,000 comments
CLIMATE CHANGE 2014
Mitigation of Climate Change


GHG emissions accelerate despite reduction efforts. Most emission growth is CO2 from fossil fuel combustion and industrial processes.
Total Annual Anthropogenic GHG Emissions by Groups of Gases 1970-2010
GHG Emissions [GtCO2eq/yr]
F-Gases
N2O
CH4
CO2 FOLU
CO2 Fossil Fuel and Industrial Processes

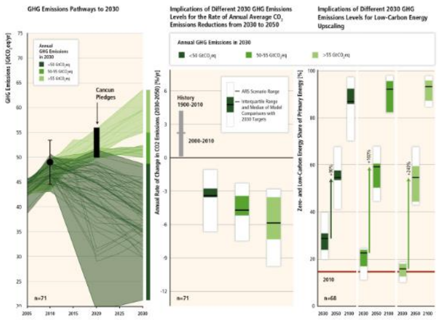

GHG emissions growth between 2000 and 2010 has been larger than in the previous three decades.
GHG Emissions [GtCO2eq/yr]
49 Gt (Uncertainty: ±4.5 Gt)
+2.2%/yr
+1.3%/yr
F-Gases
N2O
CH4
CO2 From Land Use
CO2 Fossil Fuel and Industrial Processes
Based on Figure SPM.1
6


2
Forestry for a low-carbon future
FIGURE 1
Global carbon emissions budget by sector, 2010
Electricity and heat production 25%
AFOLU 24%
Buildings 6.4%
Transport 14%
Industry 21%
Other energy 9.6%
49 Gt CO2e
Energy 1.4%
Industry 11%
Transport 0.3%
Buildings 12%
AFOLU 0.87%
Direct emissions
Indirect CO2 emissions
Source: IPCC, 2014b


Without additional mitigation, global mean surface temperature is projected to increase by 3.7 to 4.8°C over the 21st century.
Level of Additional Risk Due to Climate Change
Very High
High
Moderate
Undetectable
Unique & Threatened Systems
Extreme Weather Events
Distribution of Impacts
Global Aggregate Impacts
Large-Scale Singular Events
°C
Global Mean Temperature Change
Today
Reference Pre Industrial Level
Based on WGII AR5 Figure 19.4
8


Without more mitigation, global mean surface temperature might increase by 3.7° to 4.8°C over the 21st century.
GHG Emission Pathways 2000-2100: All AR5 Scenarios
Annual GHG Emissions [GtCO2eq/yr]
RCP8.5
RCP6.0
RCP4.5
RCP2.6
Baseline (Full Range in 2100)

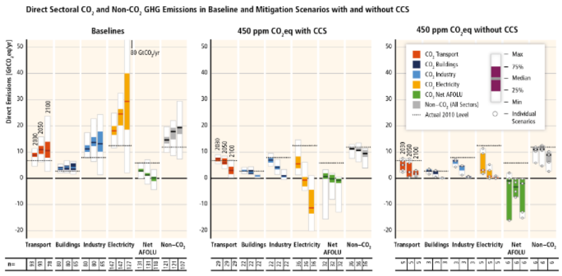
Delaying mitigation is estimated to increase the difficulty and narrow the options for limiting warming to 2°C.



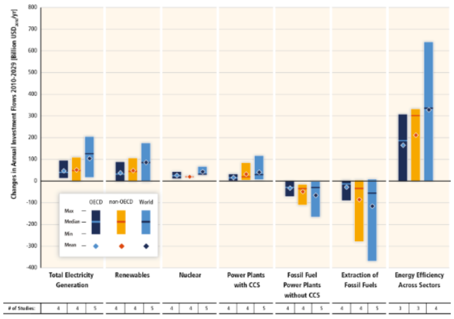
Estimates for mitigation costs vary widely.

- Reaching 450ppm CO_2eq entails consumption losses of 1.7% (1%-4%) by 2030, 3.4% (2% to 6%) by 2050 and 4.8% (3%-11%) by 2100 relative to baseline (which grows between 300% to 900% over the course of the century).
- This is equivalent to a reduction in consumption growth over the 21st century by about 0.06 (0.04-0.14) percentage points a year (relative to annualized consumption growth that is between 1.6% and 3% per year).
- Cost estimates exlude benefits of mitigation (reduced impacts from climate change). They also exclude other benefits (e.g. improvements for local air quality).
- Cost estimates are based on a series of assumptions.

Mitigation requires changes throughout the economy. Efforts in one sector determine mitigation efforts in others.
With or without CCS (Carbon Dioxide Capture and Storage)



Substantial reductions in emissions would require large changes in investment patterns.



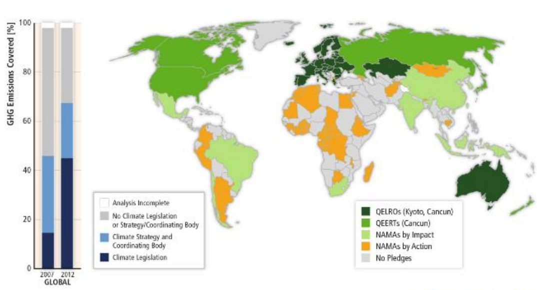
Since AR4, there has been an increased focus on policies designed to integrate multiple objectives, increase co-benefits and reduce adverse side-effects.

- Sector-specific policies have been more widely used than economy-wide policies.
- Regulatory approaches and information measures are widely used, and are often environmentally effective.
- Since AR4, cap and trade systems for GHGs have been established in a number of countries and regions.
- In some countries, tax-based policies specifically aimed at reducing GHG emissions–alongside technology and other policies–have helped to weaken the link between GHG emissions and GDP
- The reduction of subsidies for GHG-related activities in various sectors can achieve emission reductions, depending on the social and economic context.

Effective mitigation will not be achieved if individual agents advance their own interests independently.

- Existing and proposed international climate change cooperation arrangements vary in their focus and degree of centralization and coordination.
- Issues of equity, justice, and fairness arise with respect to mitigation and adaptation.
- Climate policy may be informed by a consideration of a diverse array of risks and uncertainties, some of which are difficult to measure, notably events that are of low probability but which would have a significant impact if they occur.

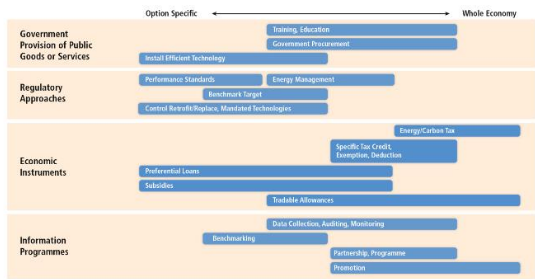
There has been a considerable increase in national and sub-national mitigation policies since AR4.
Quantified Emission Limitation and Reduction Objectives (QELROs); Quantified Economy-wide Emission Reduction Target (QEERT) Nationally Appropriate Mitigation Action (NAMA)



Based on Figures 15.1 and 13.3

18

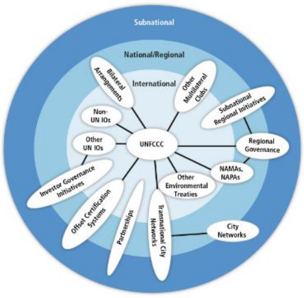
Sector-specific policies have been more widely used than economy-wide policies.



Based on Figure 10.15

19

Climate change mitigation requires international cooperation across scales.



Based on Figure 13.1

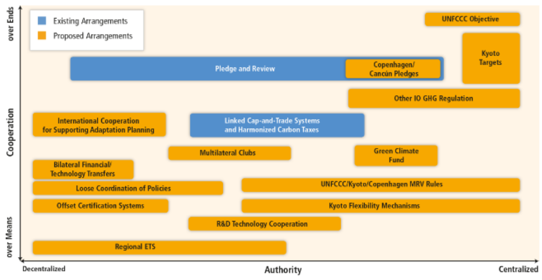
20

International cooperation can focus on the ends or means and vary in the degree of centralization.

Based on Figure 13.2

21

Effective mitigation will not be achieved if individual agents advance their own interests independently.



Based on Figure 13.2

22

IPCC reports are relevant

Sustainable Development and Mitigation

There is growing emphasis in the literature on the two-way relationship between **climate change mitigation** and **sustainable development**. The relationship may not always be mutually beneficial.

In most instances, mitigation can have ancillary benefits or co-benefits that contribute to other sustainable development goals (climate first).

Development that is sustainable in many other respects can create conditions in which mitigation can be effectively pursued (development first) (high agreement, much evidence).

Ref.: Climate Change 2007: Working Group III: Mitigation of Climate Change
AR4 WGIII Chapter 12 Sustainable Development and mitigation

International cooperation and Mitigation

International cooperation is necessary to significantly **mitigate climate change impacts** (robust evidence, high agreement).

This is principally due to the fact that greenhouse gases (GHGs) mix globally in the atmosphere, making anthropogenic climate change a common global problem. International cooperation has the potential to address several challenges: multiple actors that are diverse in their perceptions of the costs and benefits of collective action, emissions sources that are unevenly distributed, heterogeneous climate impacts that are uncertain and distant in space and time, and mitigation costs that vary. [Section 13.2.1.1, 13.15]

Ref.: AR5 WGIII Chapter 13 International Cooperation: Agreements and Instruments

General Conclusions on SD and Mitigation

Some general conclusions emerging from the case studies of how changes in development pathways at the sectoral level have or could lower emissions are reviewed in this chapter (high agreement, medium evidence):

- Greenhouse gas (GHG) emissions are influenced by but not rigidly **linked to economic growth**: policy choices make a difference. Sectors where effective production is far below the maximum feasible with the same amount of inputs - sectors far from their production frontier - have opportunities to adopt 'win-win-win' policies. These policies free up resources and bolster growth, meet other sustainable development goals, and also reduce GHG emissions relative to baseline.
- Sectors where production is close to optimal given available inputs – sectors that are closer to the **production frontier** - also have opportunities to reduce emissions by meeting other sustainable development goals. However, the closer to the production frontier, the more trade-offs are likely to appear.
- To truly have an effect, what matters is that not only a 'good' choice is made at a certain point, but also that the **initial policy is sustained for a long period** - sometimes several decades.
- It is often not one policy decision, but an **array of decisions that are necessary to influence emissions**. This raises the issue of coordination between policies in several sectors, and at various scales.

Ref.: Climate Change 2007: Working Group III: Mitigation of Climate Change
AR4 WGIII Chapter 12 Sustainable Development and mitigation

Workshop on Status of Climate Science and Technology in Asia, Kuala Lumpur 15-16 November 2018

Impact of Land-use Land-cover Change during Five Decades on UHI Intensities and Thermal Comfort over a Sub-tropical Region in India

Manju Mohan
Professor and Head,
Centre for Atmospheric Sciences
Indian Institute of Technology, Delhi India
Email: mmanju@cas.iitd.ac.in, mmohan66@gmail.com

15 November, 2018

IPCC WGII AR5:Chapter 8. Urban Areas

- Urbanization alters local environments via a series of physical phenomena that can result in local environmental stresses. Much of key and emerging global climate risks are concentrated in urban areas.
- In the past, long-term trends in surface air temperature in urban centers have been found to be associated with the intensity of urbanization.
- More than half the world's population in 2008 was living in urban centers and the proportion continues to grow (UN DESA Population Division, 2012)
- Three-quarters of the world's urban population and most of its largest cities are now in low- and middle income nations implying stronger adaptation measures
- The spatial, temporal, and sustainability-related qualities of urbanization are important for understanding the shifting complex interactions between climate change and urban growth.

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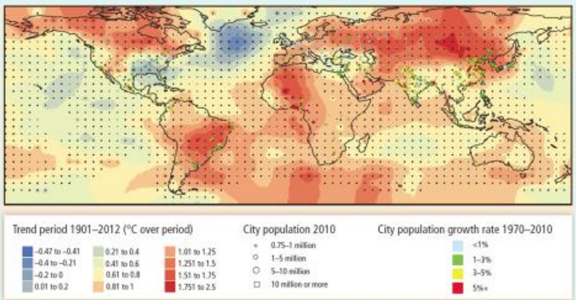

Large urban agglomerations with observed climate change Trend period 1901–2012

Source: IPCC AR5

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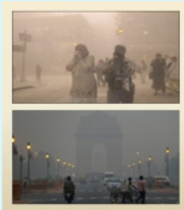
Urbanization, Air Quality and Health

- Urbanization reduces the wind speed in its vicinity which reduces both heat and pollutant flushing capacity of the region resulting in stagnation and exacerbating pollution levels.
- Along with various heat related illness.
- Urbanization leads to higher temperature and increase in thermal stress leading to health complications and reduction in work efficiency.
- Key inference: Climate Change is proved to be very closely related to urbanisation affecting significant population and key to CC impacts reduction lies with mitigation and adaptation at city level.



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IPCC WGII AR5:Chapter 8. Urban Areas

- Anthropogenic heat fluxes across large cities can average within a range of approximately 10 to 150 W m–2 but over small areas of the city can be three to four times these values or even more (Flanner, 2009; Allen et al., 2011).
- Projections suggest that by 2050, London's nocturnal UHI in August could rise another 0.5°C, representing a 40% increase in the number of nights with intense UHI episodes(Wilby, 2007).
- Climate change in NewYork City is expected to increase extended heat waves, thus exacerbating existing UHI conditions (Rosenzweig et al., 2009). Increased nighttime minimum temperatures are associated with increased cooling demand and health-related stresses. Similarly for Tokyo and other cities, effects are more severe. Likewise for India.

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IPCC has recognized* connections between urbanization and the development of UHI in several cities of the world including Delhi . Further, it states that for cities in India, the implications of future climate for connections between urbanization and the development of UHI have been defined (Mohan et al., 2011a,b, 2012)

The report includes above studies in Delhi which have explored this relationship

- *Dynamics of Urbanization and LULC (Mohan et al, 2011)*: shows there has been significant change in LULC which is expected to have led to changes in temperatures (ISRO, RESPOND Project; 2007-2010).
- *Urban Heat Island and Temperature Trends* (Mohan et al, 2011) wherein some signatures of heat island effect were obtained to relate urbanisation with change in temperature trends (ISRO, RESPOND Project; 2007-2010).
- *UHI based on ambient and satellite derived temperatures* (Mohan et al, 2012) in which systematic field campaign was carried out to estimate existing UHI effect (Indo-Japanese Cooperative Project on Heat Island Effect 2008-2015).

***IPCC WGII AR5 Chapter 8, 2014**

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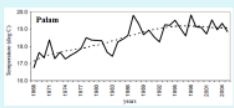
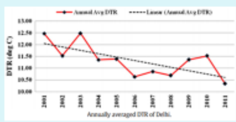
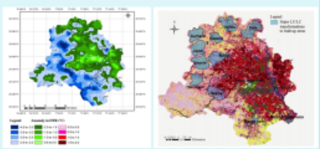
Urban Heat Island and Temperature Trends

- A consistent increasing trend was seen in the annual mean minimum temperatures indicating an overall warming trend over the NCR especially after 1990.
- Satellite based annually averaged DTR of entire Delhi shows a significant decreasing trend.
- Areas of Rapid urbanization exhibited a highly decreasing trend in DTR.
- Increasing warming trends reflect the contribution of changing land-use patterns and additional anthropogenic heat that may enhance the urban heat island intensities in the city







DTR anomaly across Delhi for year 2011 with reference to year 2001 Major Land Use / Land Cover changes in Delhi during 1997-2008

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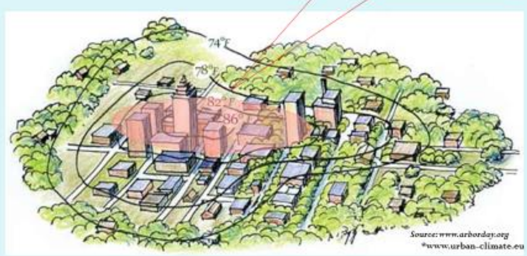
Mohan and Kandya, 2015, Science of the Total Environment

Urban Heat Island

An urban heat island (UHI) is defined as any urban area which has a tendency to be warmer than a surrounding rural/lesser developed area.



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Urban Heat Island Effect over Delhi: Field Experiments

Objective:

- to understand the present scenario of heat-island phenomena in Delhi through surface meteorological observations in Delhi

In-situ Observations through Field Campaigns

- UHI-I : 25 May 2008 – 28 May 2008, and,
- UHI-II : 6-10 March 2010

- 30 sites (27 surface stations, 3 weather stations)

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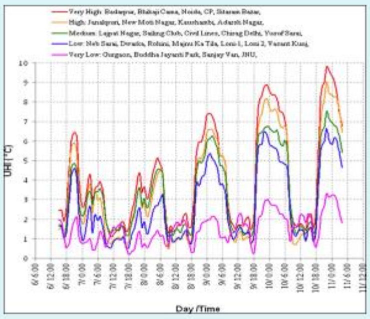
Diurnal Variation of grouped UHI



Ref: Theor Appl Climatol (2013) 112:647–658

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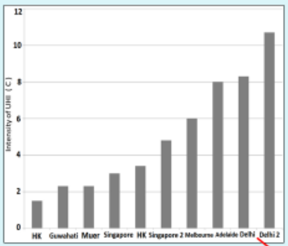
UHI Comparison with other cities



City	UHI	Source	Remarks
New York	Max: 5.4°C Mean: ~3°C	Gaffin 2008	UHI in summer 2002
Paris	Max: 6°C Mean: 2.6°C	Sarkar and Ridder 2011	12 Day experiment in June 2006
London	8°C - 9°C	GLA 2006	MaxUHI in summer 2003 heat wave episode
Beijing	7.9°C	Wang and Hu 2006	Max UHI in July 2002
Tokyo	Max: 8.1°C Mean: 5.3°C	Saitoh *et al.* 1996	Nocturnal UHI in March 1992

Mohan et al, 2012, 2013

Reported intensity of the urban heat island in various cities across the world

*Fig from **Santamouris, 2015, Sci Total Env**

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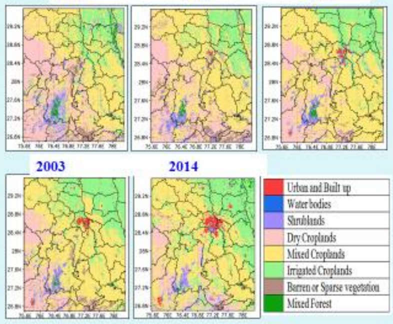
Land use distribution of NCR India for various decades

Total NCR area: 86,991 km²

- Almost 17 fold increase in the urban and built up areas (126 km² of urban built up in 1972 to 2180 km² in 2014). This is 38 fold in Central NCR region.
- Conversion of dry croplands to irrigated and mixed croplands.
- Substantial decrease (40%) in water bodies is noticed.

Reference: Sati and Mohan, 2017; Theore. Appl. Climato.



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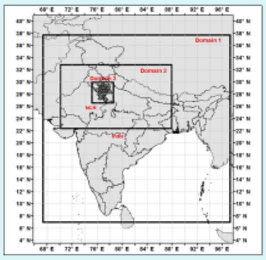
Domain and Methodology



Model : Weather Research and Forecasting Model (WRF)

Simulation Period : 01 May 2012 – 15 May 2012

Cases of LULC		
	D1972	LULC of the year 1972
	D1981	LULC of the year 1981
	D1993	LULC of the year 1993
	D2003	LULC of the year 2003
	D2014	LULC of the year 2014

Physics Options	
Microphysics	Lin
Cumulus	Kain Fritsch
Shortwave radiation	Goddard
Longwave radiation	RRTM
PBL scheme	YSU
Land surface model	Noah
Surface Physics	MM5

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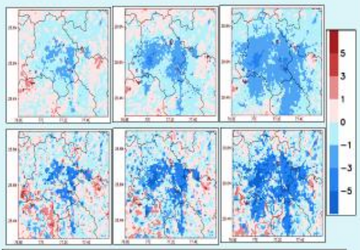
Effect on Diurnal Temperature range

- The difference in DTR of LST shows that it has decreased in the expanding urban area from 1972-2014.
- The differences in DTR of surface temperature show a noticeable decrease (2- 3 K) in these regions.
- The urban area show maximum decrease in the LST values (≈5 K).



Difference in DTR values of AT (upper panel) and LST (lower panel) between the corresponding decades and values in 1972

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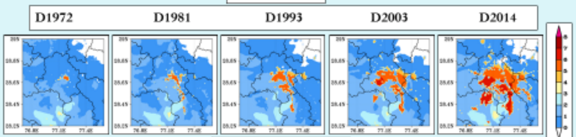
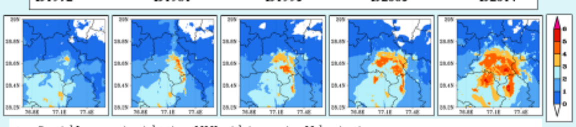
3 day averaged NightTime (1:30 am) UHI for various Decadal LULC over NCT

Surface UHI



Canopy Layer UHI



- Spatial Increase in night time UHI with increasing Urbanization
- 1-2 degree strengthening of night time UHI

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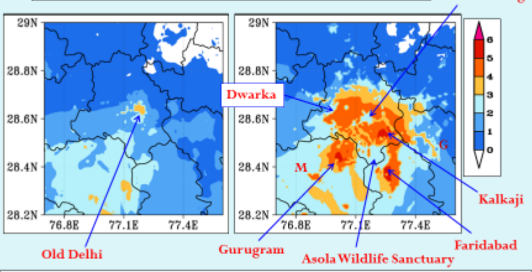
What changed between 1972-2014!! -Some Prominent canopy Layer UHI hotspots



- The Prominent Hotspots are the densely urbanized area such as Gurugram, Kalkaji, Old Delhi, Faridabad.
- The localities which have urbanized recently such as Manesar(M) and Greater Noida (G) also show development of UHI

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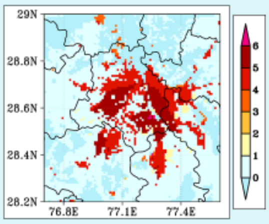
What changed between 1972-2014!!
-Difference in nocturnal Surface UHI intensity



Increase (K)	Area (sq Km)
6+	9
5-6	667
4-5	794
3-4	68
1-3	80

- The maximum increase in UHI intensity corresponds to the underlying urbanization which has been maximum in the current (2014 LULC) decade.
- Maximum increase in SLHI is 4-5 K followed closely by 5-6 K.
- This increase is majorly in the expanded urban region in the NCR.
- 1-3 K increase is visible in the locations adjacent to/covered by the urban built up area.

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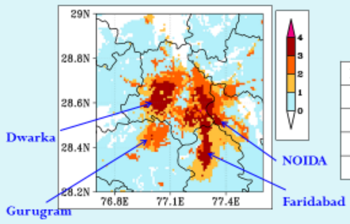
What changed between 1972-2014!!
-Difference in nocturnal Canopy layer UHI intensity



Increase (K)	Area (sq Km)
4+	3
3-4	573
2-3	787
1-2	816

- 3-4 K increase is visible in the densely built up region prominently in satellite cities viz., Faridabad, NOIDA, Gurugram and Dwarka.
- Most of the area (816 sq km) experience an increase of 1-2 K in night time UHI followed closely by 2-3 K rise (787 sq km).
- This increase is majorly in the expanded urban region in the NCR.

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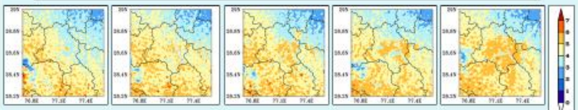
3 day averaged Day Time (1:30 pm) UHI for various Decadal LULC over NCR

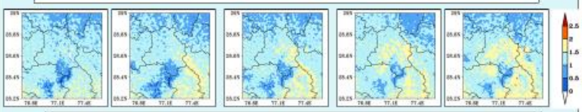
Surface UHI

D1972 D1981 D1993 D2003 D2014



Canopy Layer UHI

D1972 D1981 D1993 D2003 D2014



Prominent development of daytime UHI visible in latter decadal LULC of 2003 and 2014

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Urban Areas and Thermal Comfort

- The urban heat island effect has a direct relation with thermal comfort. It has the potential to prevent the city from cooling down, maintaining night-time temperatures at a level that affects human health and comfort (Tan et al. 2009; Lo et al. 2003; Tomlinson et al. 2011; Mavrogianni et al. 2011).
- Thermal stress is most relevant to people who spend a substantial time outdoors during a day such as pedestrians, cyclists, vendors, shopkeepers near roadside and most people from the lower strata of society who live in makeshift houses (Mohan et al. 2014).

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Ramifications of UHI induced Thermal Discomfort

- Urban heat island induced thermal discomfort affects people both with and without access to cooling amenities.
- Higher temperatures have a serious impact on the electricity consumption due to building sector increasing considerably the peak leading to an additional electricity penalty of about 21 (±10.4) W per degree of temperature increase and per person (Santamouris et al.,2015). Further, heat released due to operation of electrical cooling devices further exacerbates the heat island effect in the city.
- This increase greatly outweighs the otherwise small beneficial decrease in heating demand in winter especially for sub-tropical/tropical cities.
- Hence, analysis of UHI vis-a-vis thermal comfort is essential with regards to both economic as well as environmental concerns.
- An increase of up to 2.5°C in heat index has been found at dense built up areas in comparison to non-urban areas due to urban heat island effect. (Bhati and Mohan, 2018, Geoscience Letters)

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Thermal Indices

- There are many indices devised for assessing thermal comfort such as
  - Heat Index (Rothfusz,1990)
  - physiological equivalent temperature (PET) (Hoppe 1999),
  - Universal Thermal Climate Index (UTCI) (Blazejczyk et al. 2012),
  - Wet Bulb Globe Temperature (Yaglou and Minard 1957).
  - Robba Index(RI) (Robba 2011)
- Numerical weather prediction models like WRF and UCM help in assessing thermal comfort by means of providing a continuous distribution of spatial and temporal data.

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Thermal Comfort with Robaa Index

Robaa proposed formula accounting for the combined effect of the three weather elements (dry air temperature, humidity and wind speed) on human discomfort. His formula, RI, is expressed as follows;

$$RI = 1.53\ T_d - 0.32\ T_w - 1.38V + 44.65$$

Where,
T_d = dry temperature (°C) of surface air
T_w = wet bulb temperature in °C
V = wind speed (m/s)

The range of applicability of this formula is wide and adequate for subtropical climatic region (Egypt's climate). The criterions of RI are given in **Table 1.**

Table 1. Criterions of, RI, at different discomforts.

RI values	Human feeling
RI < 60	All people feel quite uncomfortable cooling.
60 ≤ RI < 65	50% of people feel partial uncomfortable cooling.
65 ≤ RI < 75	All people feel quite comfortable.
75 ≤ RI < 80	50% of people feel partially uncomfortable heat.
80 ≤ RI < 85	All people feel uncomfortable heat.
85 ≤ RI	All people feel extreme serious uncomfortable heat.

Reference: Robaa SM (2011*Atmospheric and Climate Sciences*, **1**,

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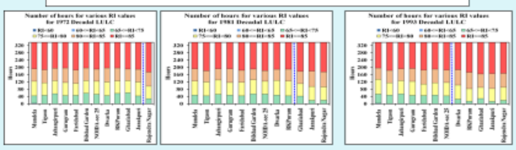
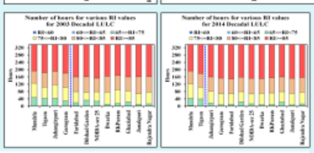
Number of Hours for various RI values at the stations across Delhi-NCR for various decadal LULC





Blue line separates rural-cropland(left) and urban (right) stations. **When the station converts to Urban ,decrease in green comfortable hours with each decade is observed.**

RI values	Human feeling
RI < 60	All people feel quite uncomfortable cooling.
60 ≤ RI < 65	50% of people feel partial uncomfortable cooling.
65 ≤ RI < 75	All people feel quite comfortable.
75 ≤ RI < 80	50% of people feel partially uncomfortable heat.
80 ≤ RI < 85	All people feel uncomfortable heat.
85 ≤ RI	All people feel extreme serious uncomfortable heat

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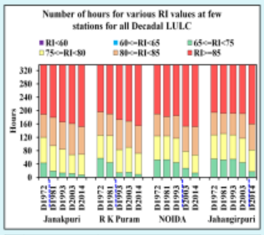
Number of Hours for various RI values at few stations across Delhi-NCR for all decadal LULC



	RI values	Human feeling
(green)	65 ≤ RI < 75	All people feel quite comfortable.
(yellow)	75 ≤ RI < 80	50% of people feel partially uncomfortable heat.
(orange)	80 ≤ RI < 85	All people feel uncomfortable heat.
(red)	85 ≤ RI	All people feel extreme serious uncomfortable heat

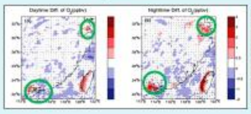
Table : No of hours (in %) for various RI values for different decadal LULC

		D1972	D1981	D1993	D2003	D2014
Janak puri	65<=RI<75	13	6	4	3	2
	75<=RI<80	23	23	21	17	18
	80<=RI<85	20	25	24	28	25
	RI>=85	44	47	51	52	55
RK Puram	65<=RI<75	17	13	4	4	3
	75<=RI<80	20	24	20	22	19
	80<=RI<85	21	19	27	23	25
	RI>=85	42	44	49	50	54
NOIDA	65<=RI<75	15	16	13	8	4
	75<=RI<80	21	21	22	15	16
	80<=RI<85	20	17	20	22	25
	RI>=85	44	46	45	55	55
Jahangir puri	65<=RI<75	16	15	16	13	5
	75<=RI<80	21	23	22	22	19
	80<=RI<85	20	18	19	22	23
	RI>=85	42	43	43	43	53

Blue line separates rural-cropland(left) and urban (right) stations in various decadal LULC. When the station converts to Urban it can be seen:

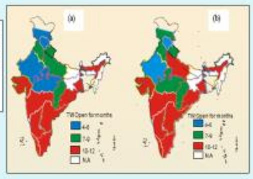
- Decrease in comfortable hours with each decade.
- Increase in uncomfortable hours.

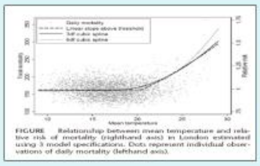
Impact of Urbanization on Air Quality and Health



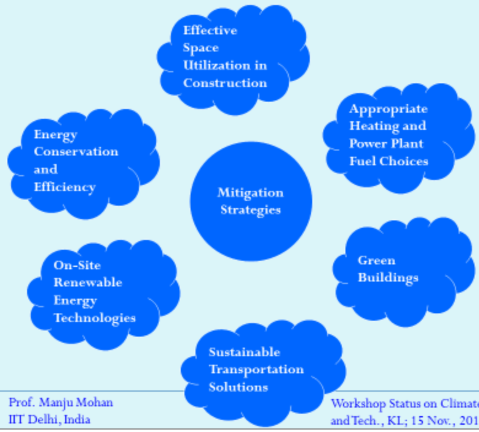
Urbanization increases surface ozone concentrations by about 4.7%–8.5% for the nighttime and by about 2.9%–4.2% for the daytime.
Wang et al (2009). Advances In Atmospheric Sciences

Increasing temperature has projected growth in transmission window of malaria on an average by two months in many regions of India.
Patwardhan and Harit, 2007





Studies have shown exponential increase in mortality risk with increasing mean temperatures
Hajat et al., (2006). Epidemiology



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Recommendation

- Significant investment in sustainable cities development is needed as part of Climate Change Action Plan
- The emissions are accounted in terms of carbon emissions from cities and industries. However, LULC has significant impact
- The majority of Urbanisation in past few decades (as illustrated with NCR India example) is going to take place in middle and low income countries and thereby affecting most vulnerable population; it is therefore required to focus greater attention on adaptation strategies due to urbanisation and implement mitigation with best available technology with greater investments.

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IIT Delhi, India
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with Contributions from

Mr. Ankur P. Sati

Dr. Shweta Bhati

Prof. Manju Mohan
IIT Delhi, India
Workshop Status on Climate Sci and Tech., KL; 15 Nov., 2018

Urbanization Across the World

Prof. Manju Mohan
IIT Delhi, India
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References

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- Sati, A. P., Mohan, M. **2017**, The impact of Urbanization during half a century on surface meteorology based on WRF model simulations over National Capital Region, India. Theoretical and Applied Climatology, DOI 10.1007/s00704-017-2275-6.
- Shweta Bhati and Manju Mohan, "WRF model evaluation for the urban heat island assessment under varying land use/land cover and reference site conditions", Theoretical and Applied Climatology, 2016, Volume 1-16. 10.1007/s00704-015-1589-5
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- Manju Mohan, Yukihiro Kikegawa, B.R. Gurjar, Shweta Bhati, Anurag Kandya and Koichi Ogawa: Urban Heat Island Assessment for a Tropical Urban Airshed in India, Atmospheric and Climate Sciences, 2012, Volume 2, pages 127-138. doi:10.4236/acs.2012.22014 .
- Mohan M, Kandya A, Battiprolu A (2011) Urban heat island effect over National Capital Region of India: a study using the temperature trends. J Environ Prot 2:465–472

Prof. Manju Mohan
IIT Delhi, India
31
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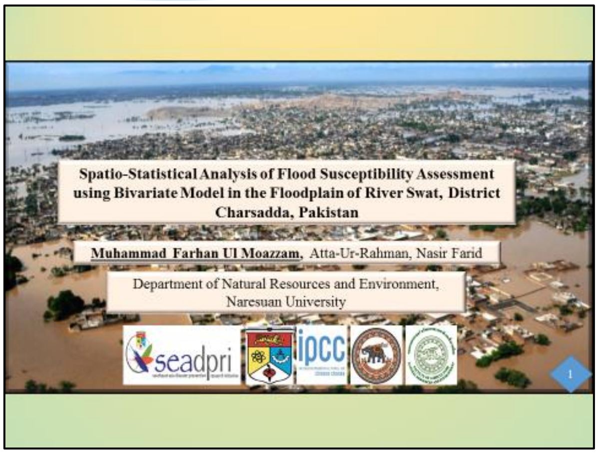
Spatio-Statistical Analysis of Flood Susceptibility Assessment using Bivariate Model in the Floodplain of River Swat, District Charsadda, Pakistan
Muhammad Farhan Ul Moazzam, Atta-Ur-Rahman, Nasir Farid
Department of Natural Resources and Environment, Naresuan University
seadpri
ipcc
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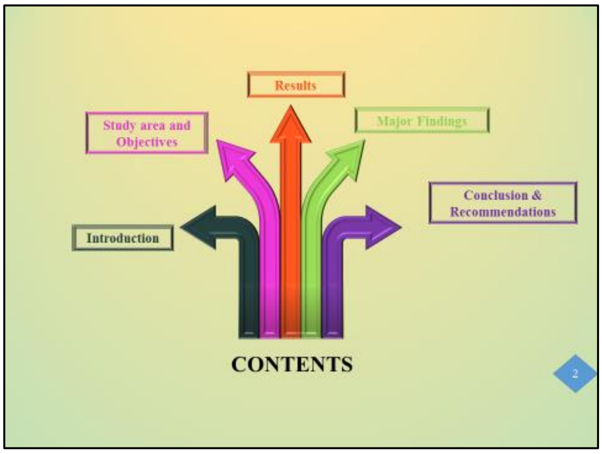
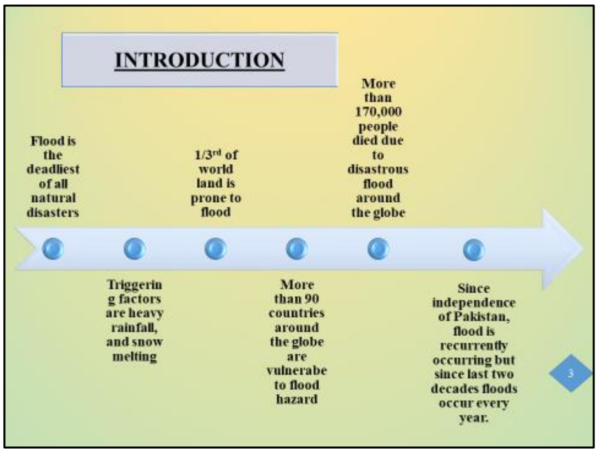
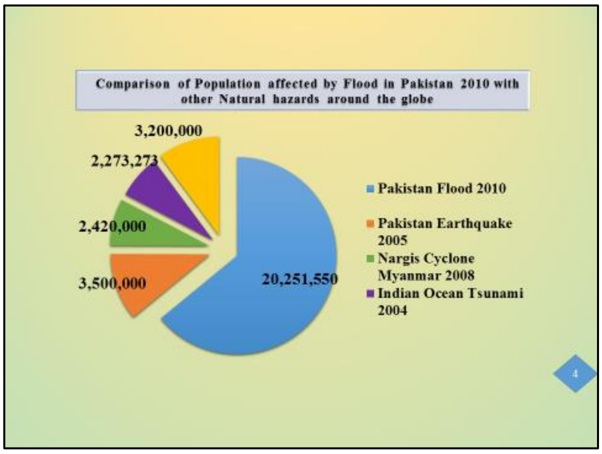
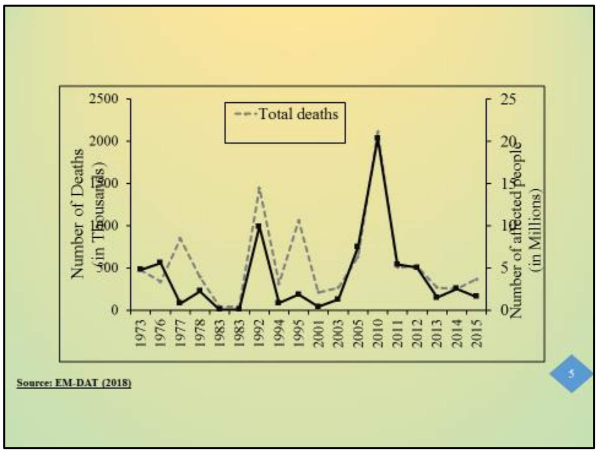
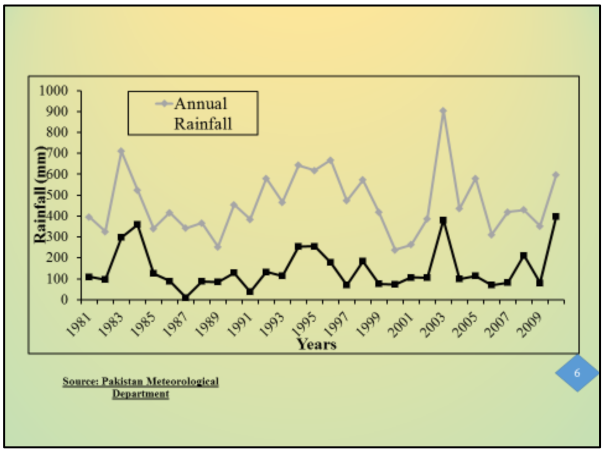
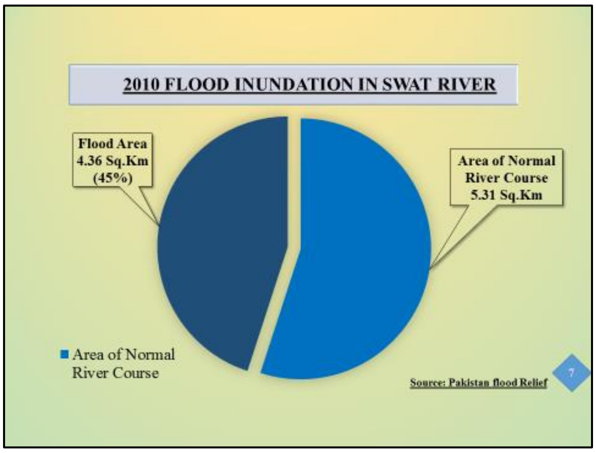

Results
Study area and Objectives
Major Findings
Conclusion & Recommendations
Introduction
CONTENTS
2

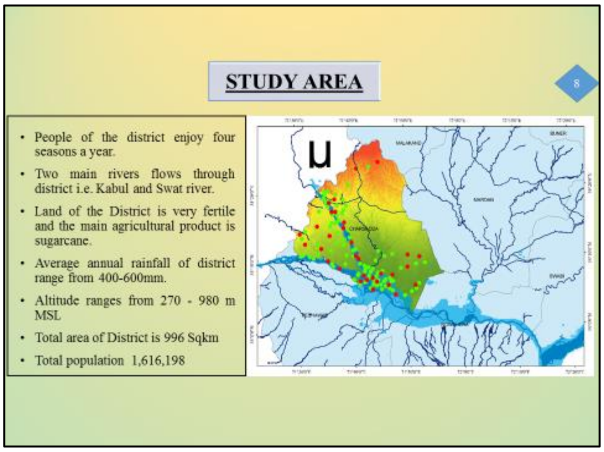

INTRODUCTION
Flood is the deadliest of all natural disasters
1/3rd of world land is prone to flood
More than 170,000 people died due to disastrous flood around the globe
Triggering factors are heavy rainfall, and snow melting
More than 90 countries around the globe are vulnerabe to flood hazard
Since independence of Pakistan, flood is recurrently occurring but since last two decades floods occur every year.
3

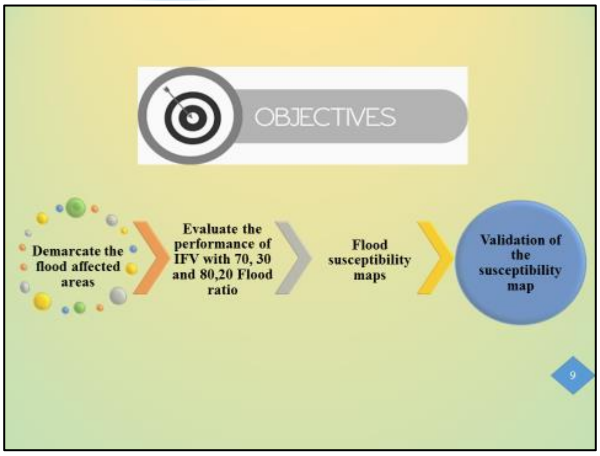

Comparison of Population affected by Flood in Pakistan 2010 with other Natural hazards around the globe
3,200,000
2,273,273
2,420,000
3,500,000
20,251,550
Pakistan Flood 2010
Pakistan Earthquake 2005
Nargis Cyclone Myanmar 2008
Indian Ocean Tsunami 2004
4


Total deaths
Number of Deaths (in Thousands)
Number of affected People (in Millions)
Source: EM-DAT (2018)
5

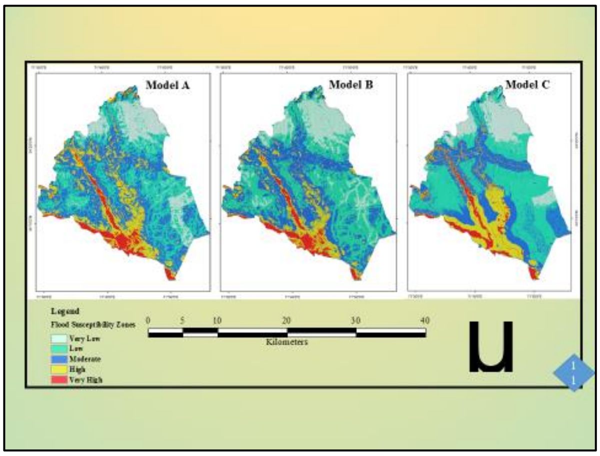

Annual Rainfall
Rainfall (mm)
Years
Source: Pakistan Meteorological Department
6

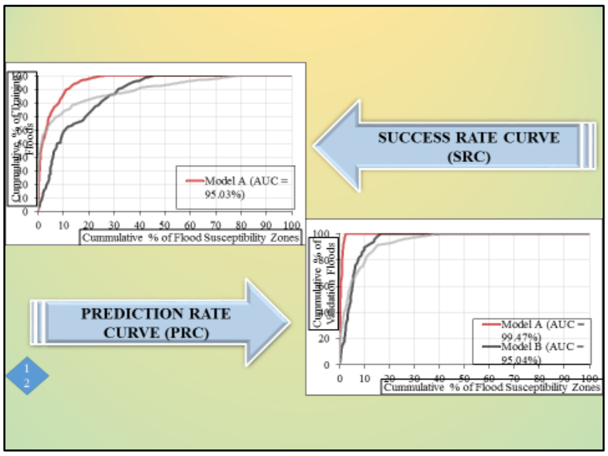

2010 FLOOD INUNDATION IN SWAT RIVER
Flood Area 4.36 Sq.Km (45%)
Area of Normal River Course 5.31 Sq.Km
Area of Normal River Course
Source: Pakistan flood Relief
7

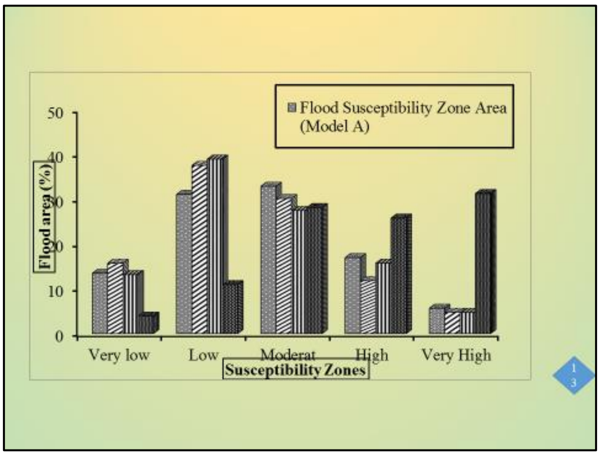

STUDY AREA
People of the district enjoy four seasons a year.
Two main rivers flows through district i.e. Kabul and Swat river.
Land of the District is very fertile and the main agricultural product is sugarcane.
Average annual rainfall of district range from 400-600mm.
Altitude ranges from 270 - 980 m MSL
Total area of District is 996 Sqkm
Total population 1,616,198
8

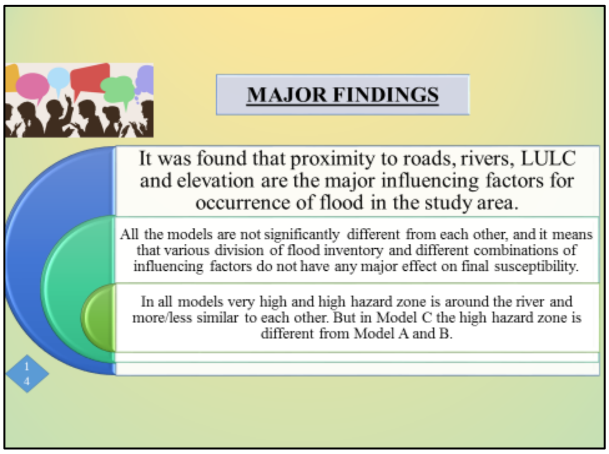

OBJECTIVES
Demarcate the flood affected areas
Evaluate the performance of IFV with 70, 30 and 80,20 Flood ratio
Flood susceptibility maps
Validation of the susceptibility map
9

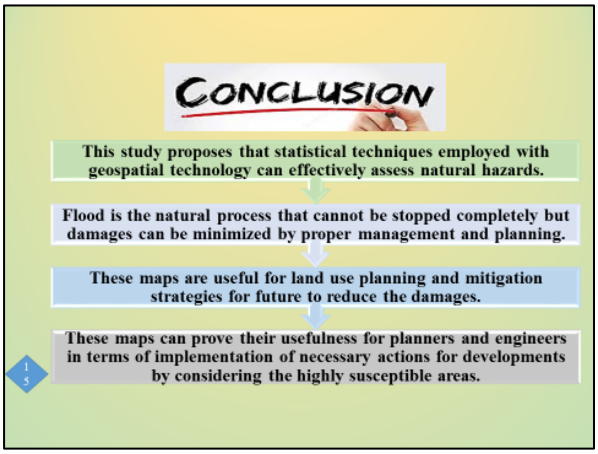

RESULTS

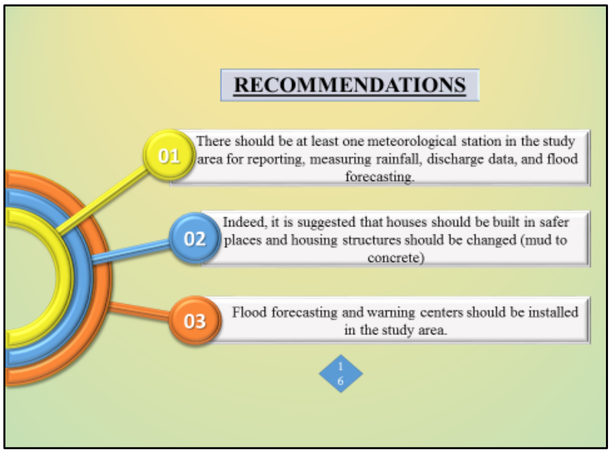

Model A
Model B
Model C
Legend
Flood Susceptibility Zones
Very Low
Low
Moderate
High
Very High
0 5 10 20 30 40
Kilometers

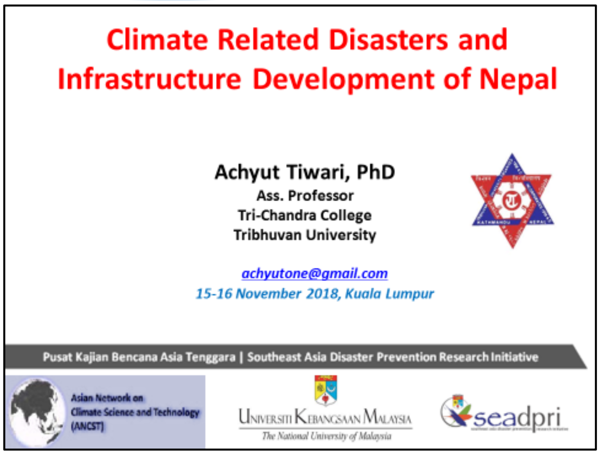

SUCCESS RATE CURVE (SRC)
Model A (AUC = 95.03%)
Cummulative % of Flood Susceptibility Zones
PREDICTION RATE CURVE (PRC)
Model A (AUC = 99.47%)
Model B (AUC = 95.04%)
Cummulative % of Flood Susceptibility Zones

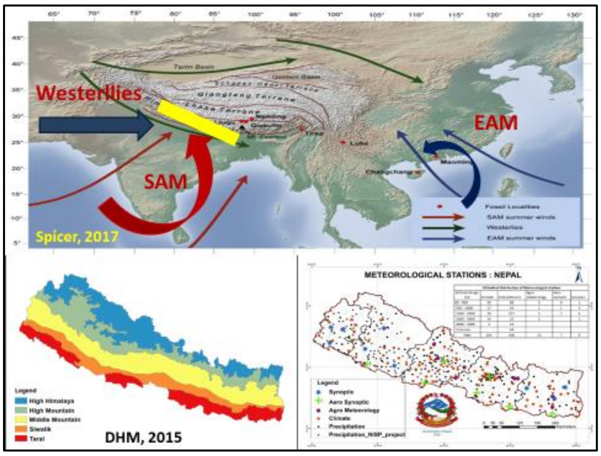

Flood Susceptibility Zone Area (Model A)
Flood area (%)
50
40
10
0
Very low
Low
Moderat
High
Very High
Susceptibility Zones

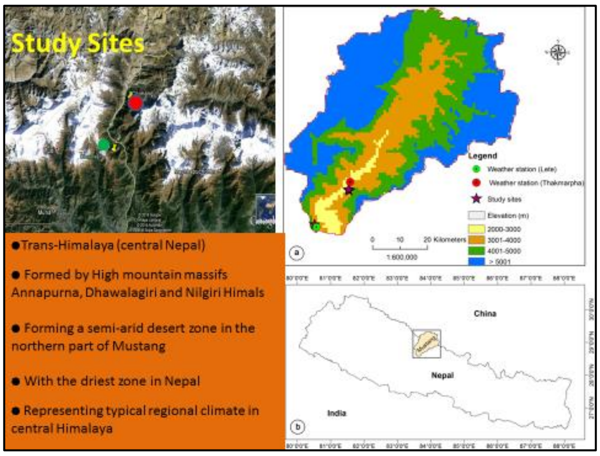

MAJOR FINDINGS
It was found that proximity to roads, rivers, LULC and elevation are the major influencing factors for occurrence of flood in the study area.
All the models are not significantly different from each other, and it means that various division of flood inventory and different combinations of influencing factors do not have any major effect on final susceptibility.
In all models very high and high hazard zone is around the river and more/less similar to each other. But in Model C the high hazard zone is different from Model A and B.

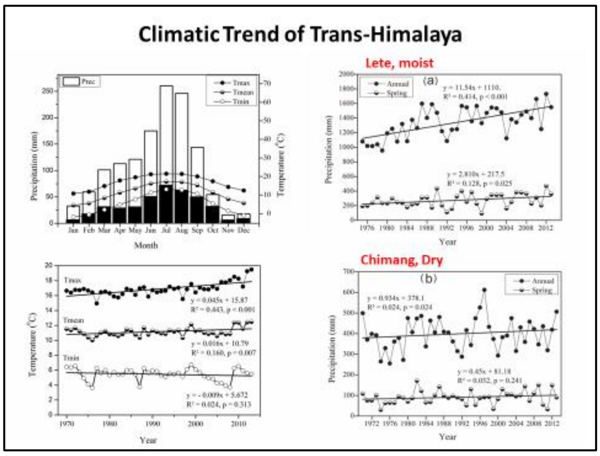

CONCLUSION
This study proposes that statistical techniques employed with geospatial technology can effectively assess natural hazards.
Flood is the natural process that cannot be stopped completely but damages can be minimized by proper management and planning.
These maps are useful for land use planning and mitigation strategies for future to reduce the damages.
These maps can prove their usefulness for planners and engineers in terms of implementation of necessary actions for developments by considering the highly susceptible areas.

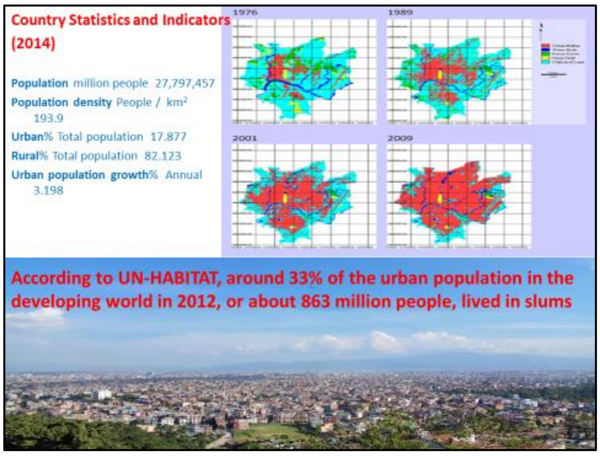

RECOMMENDATIONS
01
There should be at least one meteorological station in the study area for reporting, measuring rainfall, discharge data, and flood forecasting.
02
Indeed, it is suggested that houses should be built in safer places and housing structures should be changed (mud to concrete)
03
Flood forecasting and warning centers should be installed in the study area.

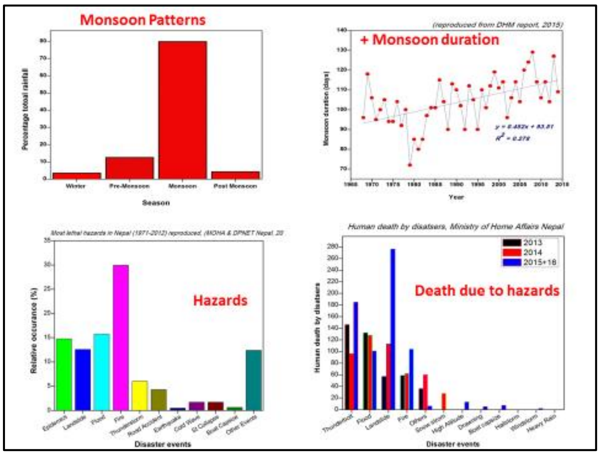

Climate Related Disasters and Infrastructure Development of Nepal
Achyut Tiwari, PhD
Ass. Professor
Tri-Chandra College
Tribhuvan University
achyutone@gmail.com
15-16 November 2018, Kuala Lumpur
Pusat Kajian Bencana Asia Tenggara | Southeast Asia Disaster Prevention Research Initiative
Asian Network on Climate Science and Technology (ANCST)
Universiti Kebangsaan Malaysia
The National University of Malaysia
seadpri


Westerlies
EAM
SAM
Spicer, 2017
METEOROLOGICAL STATIONS : NEPAL
DHM, 2015


Study Sites
Trans-Himalaya (central Nepal)
Formed by High mountain massifs Annapurna, Dhawalagiri and Nilgiri Himals
Forming a semi-arid desert zone in the northern part of Mustang
With the driest zone in Nepal
Representing typical regional climate in central Himalaya
China
Nepal
India


Climatic Trend of Trans-Himalaya
Lete, moist
Chimang, Dry


Country Statistics and Indicators (2014)
Population million people 27,797,457
Population density People / km² 193.9
Urban% Total population 17.877
Rural% Total population 82.123
Urban population growth% Annual 3.198
1976
1989
2001
2009
According to UN-HABITAT, around 33% of the urban population in the developing world in 2012, or about 863 million people, lived in slums


Monsoon Patterns
+ Monsoon duration
Hazards
Death due to hazards


Urban flood in Kathmandu


Disasters in Nepal
Nepal: 30th most vulnerable country for flood and landslide
Earthquake 2015
(Entire Himalayan region is tectonically active)


Landslides triggered by prolonged rainfall at Anglung-8, Gulmi (June 2014)
Nine members of a family including five children died after their house was swept away by landslide


Let us act to save humanity, save the Earth

Integrating CC adaptation, disaster risk reduction and loss to address emerging challenges due to slow onset processes in Quang Ngai Province, Vietnam

IMHEN VIỆN KHOA HỌC KHÍ TƯỢNG THỦY VĂN VÀ BIẾN ĐỔI KHÍ HẬU

Mai Van Khiem

Vietnam Institute of Meteorology, Hydrology and Climate change (IMHEN)

CLIMATE CHANGE IN VIET NAM

Climate change impact

- 1 of Top 5 countries/nations most vulnerable to climate changes. Sea level rises 1m, **5% land loss**, **11% population affected**, 7% agricultural activities impacted, **10% GDP reduced**.
- Most vulnerable regions: **Red River Delta and Mekong River Delta**
- Most vulnerable sectors: **Agriculture, Water Resources**, Transport, Trade, Education…
- Most vulnerable group: **the poor**, women, children, and ethnic minorities…
- Climate changes in Vietnam: **increase** in strength and frequency of **extreme weather, disasters, sea level rise, land erosions and slides.**

Climate change and disaster in Quang Ngai province

- No. of hot days increased
- **Extreme rainfall** increase many areas
- No. of strong and very strong typhoon increase
- Extreme drought, heatwave occures more frequently
- Sea water level increase. Salinity intrusion is likely to increase in the future under the climate change

III. The potential loss and damage assessed for the typical sectors

CC and DR have high impact on all sectors in Quang Ngai:
Water resources

- Losses and damages are most apparent in water resources through **flooding**
- December 1999 caused the biggest flooded area of 59366ha, above-2m-deep inundated area of 43,407 hectares, above-3-m (34656 ha), above-4-m (26030ha), above-5-m (17217ha)

Agriculture

- Total agricultural area flooded in 1999 was 29132 ha, of which 26292 ha of paddy land were flooded, the area of cultivated for food crops was 2840 ha.
- Natural disasters and climate change negatively affect crop yields. For spring rice, in deltas and mountainous areas, under the impact of climate change, the grain productivity of the delta will decrease about 1-11% and in the mountains it would see a 1-9% decrease

III. Risks caused by natural disasters and climate change in Quang Ngai

The risks caused by natural disasters and climate change in Quang Ngai

Map of Risk reduction in Quang Ngai Province

- Low: Tay Tra, Son Tay, Minh Long, Mo Duc, Duc Pho, Nghia Hanh, Tu Nghia, TP. Quang Ngai, Son Tinh, Ly Son (71.43%)
- Medium: Son Ha, Tra Dong, Binh Son (21.43%).
- High : Ba To (7.14%).

IV. Strategic plans for disaster risk reduction and CC adaptation

1. Mapping various climate risks
2. Mapping exposure, vulnerabilities and adaptation measures
3. Improving forecasting capacities and early warning systems
4. Poverty reduction programmes
5. Strengthen social protection and social care networks to reach vulnerable groups
6. Integrate disaster risk reduction and climate change adaptation in urban & land use planning
7. Develop integrated plans for water resource management in river basins and key areas
8. Improve practices for water saving, water demand management, and rainwater and groundwater harvesting and storage systems.
9. Upgrade irrigation and drinking water systems, also drainage.
10. Develop policies and management mechanisms associated with multi-purpose reservoirs, especially hydroelectric works.

CHALLENGES

1. Lack of Finance
2. Lack of Information sharing due to absence of database for DRR and CCA in the whole nation
3. Lack of experience staff at provincial level
4. Lack of awareness of community on CCA
5. Lack of experience on integration DRM into CCA or integration both into socio-economy plans
6. Lack of equipment for climate forecast, projections
7. Need to improve early warning system
8. Disaster risk reduction measures are still focused on agriculture and flood and storm control. The role to deal with climate change is assigned to MoNRE while DRR and CCA is an interrelated issue that needs a coherent approach

Is disaster risk taken into account in policies and plans in Viet Nam?

Key documents:
1. Natural Disaster Preparedness and Prevention (2013).
2. The National Target Program to Respond to Climate Change (2007) [NTP-RCC]
3. The National Strategy on Climate Change (2011)
4. Law on Natural Disaster Prevention and Control (2013)
5. Decision 46/2014/QDD-TTg to regulate the forecast, warning and information transmission of disasters
6. Decision 44/2014/QDD-TTg to regulate the level of disaster risk
7. Community Based Disaster Risk Management Programme (2009).
8. National Strategy for Natural Disaster Prevention, Response and Mitigation toward 2020 (2007).
9. Master Plan on Search and Rescue till 2015, vision to 2020 (Decision No. 46/2006/QĐ-TTg) approved by Prime Minister.
10. Environment Protection Law (2013)
11. ......

In recent years, a lot of important legal documents, strategies, and plans addressing DRR and climate change adaptation (CCA) have been issued

Is disaster risk taken into account in policies and plans in Viet Nam?

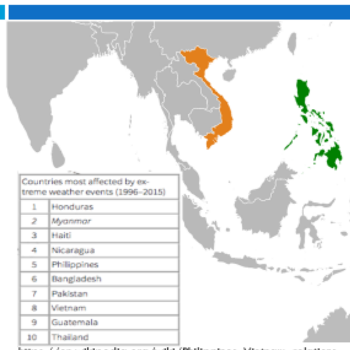
- In Vietnam, the Ministry of Planning and Investment has issued Circular 05/2016/TT-BKH which guides to mainstream the content of prevention of natural disasters into the sector and social-economic development plans
- All 63 provinces have developed action plans to implement the National DRM Strategy as well as Provincial Committees for Climate Change. Most ministries and sectors represented in the CCFSC have developed action plans for the mainstreaming of DRR in their sectors. DRM action plans are already being implemented in many the provinces and sectors (e.g. dyke construction, relocation, embankments, training, awareness-raising, risk mapping, etc.).
- Gender mainstreaming into DRR has been a key element of this approach to promote women's roles before, during and after the disasters occur. In 2013, the CCFSC also accepted the Vietnam Women's Union as an official member through the Decision 216/QD-PCLBTW

MESO-LEVEL ANALYSIS ON RICE-FARMERS' ADAPTIVE MEASURES FOR SLOW ONSET HAZARD: THE CASE OF SALTWATER INTRUSION IN THE PHILIPPINES AND VIETNAM

CATHERINE ROWEEN C. ALMADEN, PhD [1]
T.T. DIEP[2], AC ROLA[3], RDT BACONGUIS[3], JM PULHIN[3], JV CAMACHO, JR.[3], RC ANCOG[3]

[1] Xavier University-Ateneo de Cagayan, Philippines
[2] Tra Vinh University , Vietnam
[3] University of the Philippines Los Baños, Philippines

Climate Risk Index for Southeast Asia 2017



Many coastal areas in the Philippines and Vietnam face significant threats from increasing coastal flooding, that lead to saltwater intrusion.

This study focused on salt-water intrusion in rice farming households in Northern Mindanao, Philippines and in two districts in Ben Tre and Tra Vihn, Vietnam.

https://en.wikipedia.org/wiki/Philippines–Vietnam_relations

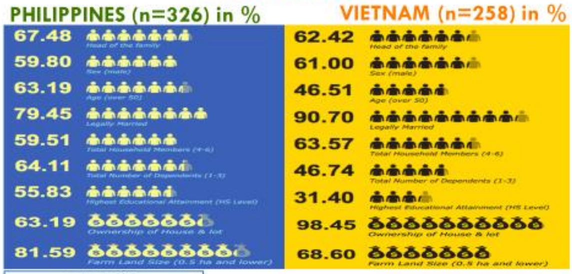
Research Objectives

- This research aimed to
  1. Examine the existing knowledge and perceptions rice-farming households have on varying conditions of salt-water intrusion;
  2. Assess the perceived feasibility of the adaptation measures to address saltwater intrusion
  3. Formulate an index of adaptation measures to address salt-water intrusion
  4. Determine the adaptive capacity indicators influencing the measure-based adaptation of the rice farming households

Methodology

- Data Analysis
  - Descriptive statistical methods
    - Survey: 326 farmers (Philippines); 258 farmers (Vietnam)
  - Iterative assignment of weights for adaptation measures applying Multi-criteria Analysis (MCA)
  - Development of Indices:Perception Index; Awareness Index; Measure-based Adaptation Index (MAI)
  - Multiple linear regression techniques
  - Principal Component Analysis

SOCIOECONOMIC CHARACTERISTICS OF THE RICE FARMERS AND THEIR HOUSEHOLDS



World Bank 2015 **International Poverty Line (IPL)** at $1.90 a day.

- 251 or 77% of the farmers in the Philippines are below the IPL
- 68 farmers or 26.36% in Vietnam are below the IPL

Major Adaptation Measures for Saltwater Intrusion in the Philippines and Vietnam

ADAPTION MEASURES	Philippines	Vietnam
Technology-based Adaptation Measure		
using saline-resistant variety	2.45	6.20
changing timing of chemical use (fertilizer, pesticides, herbicide)	31.60	3.10
using crop rotation	20.86	1.94
changing timing of irrigation	21.47	8.91
Farm-based Crop Management		
replacing damaged plants	65.03	3.49
growing multiple crops	23.62	2.33
Ecosystem-based Adaptation Measures		
desalination	58.90	35.27
filtering water	17.79	5.06
planting trees/ mangroves	4.59	1.16
Fish culture in rice farm	0.61	4.65
Off-farm Diversification		
aquaculture	1.23	2.33
non-farming activities	50.11	10.85
livestock production	51.56	59.3
Other Measures		
buying insurance (crop insurance)	10.12	0
moving to other place	0.73	0

Determinants of Adaptation Measures

Table 6a Regression Estimates (Dependent Variable: MAI): Philippines

INDEPENDENT VARIABLES	STANDARDIZED REGRESSION COEFFICIENTS	STD. ERROR	t	SIG.
Economic Capacity	.089**	.008	2.007	.046
Knowledge and Trainings on Saltwater Intrusion	.615**	.008	13.726	.000
Rice Farming Experience	-.065	.008	-1.486	.138
Perception on Climate Related Events	.025	.008	.578	.564
Human Capital	.019	.008	.433	.665

Note: R = .646
Adjusted R^2 = .41
F Stat: 15.552
** indicates significance at 99%

Table 6b Regression Estimates (Dependent Variable: MAI): Vietnam

INDEPENDENT VARIABLES	STANDARDIZED REGRESSION COEFFICIENTS	STD. ERROR	t	SIG.
Household Resources	.067	.010	1.191	.235
Knowledge on CRE	.229**	.010	4.092	.000
Income Propensity	-.417**	.010	-7.502	.000
Rice Farming Capacity	.071	.010	1.261	.208
Household Dependents	-.002	.010	-.036	.971
Educational Aptitude	-.051	.010	-.906	.366

Note: R = .482
Adjusted R^2 = .214
F Stat: 12.644
** indicates significance at 99%

Rice Farm, Misamis Occidental, Philippines

Drought risk management in Cambodia by using ICT: a proposed model

By Chhinh Nyda, Nop Sothun, and Thath Rido

Background

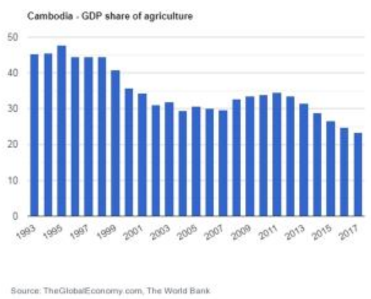
❶ Economic growth but depending heavily on agriculture

❷ Climate related risk is higher

❸ Agriculture practices are not modern

❹ Lack of physical infrastructure (such as irrigation for supplementary irrigation)

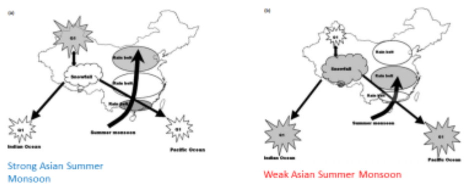
❺ Institutional supports are yet to improve



❶

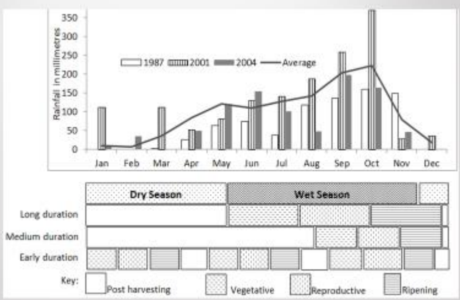
Hydro-meteorological early warning

❷



Climate

❷



❸

Labor shortage

- People between age 18-45, migrate to work (Cities and abroad)
- Mixture of success and failure of migration ❸
- Lack of labor in rural communities

Agricultural practices

❸

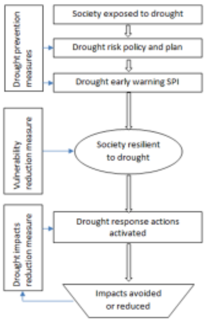
Transplanting > labor intensive

Direct seedling > low yield and prone to damage and loss

❸

❹

12 percent of rice cultivation is supplementary irrigated



❺

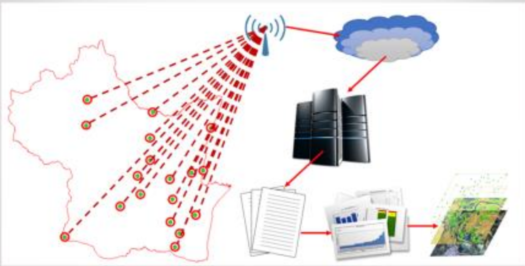
Mechanism to reduce slow-onset impact yet to be established

CBA: Analytical framework

Cost and Benefit of changing crop (USD): to be studied

	Drought	Normal
Rice	500	800
Alternative crop (Taro)	1000	600

- We believe that early warning about drought and provide options for alternative crop for farmers will optimize the benefits during drought and normal year.
- Drought forecasting should come with suggested crops and technology for a certain locality for farmer communities and markets.

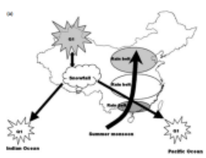


Data	Data processing	API	Users
Rainfall	SPI/Formula	Algorithm	Display
Time series data and automatic weather station	Mathematical models	Programming...	Web push, mobile notification

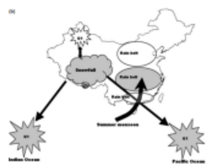
Trigger	Comments
ENSO	ENSO is telling about regional drought. When ANOM is greater than 0.5, it signified possible drought onset in Cambodia. From this indicator, drought in Kampong Speu committee should be alerted and be ready for drought early warning.
SPI	When SPI negative from 1 (or depending on calibration on the ground), it is showing the meteorological drought. It can also reflect the water availability on the ground too if the time scale is set for a particular usage.
NDVI	NDVI is mainly agricultural drought which is based on the greenery of the agricultural field. The usage of NDVI value in a particular region/area must be contextualized depending on the crop varieties and stages of growth.

Hydro-meteorological early warning

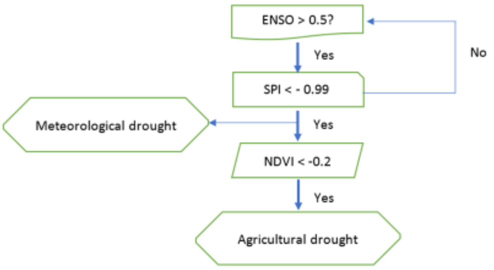
❷

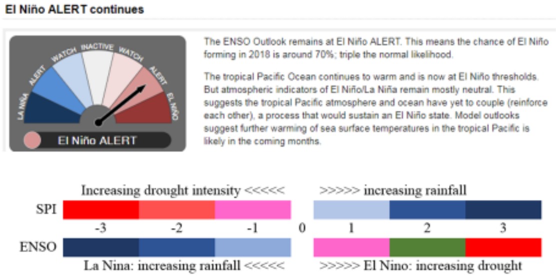


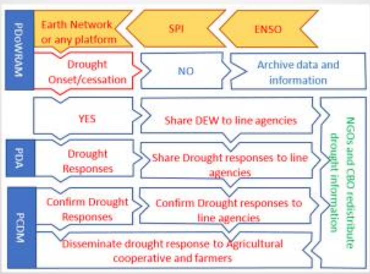
Strong Asian Summer Monsoon



Weak Asian Summer Monsoon







Strengthening climate information and early warning systems in Cambodia

U N D P

US$4.9 million for 4 Years

Objectives of the projects

- Assimilate and forecast weather, hydrological, climate and environmental information
- Provide Climate and weather information and utilize them for national, sectoral and sub-national planning as well as for transboundary communication in the region
- Operate and maintain EWS and climate information infrastructure, both software and hardware in order to monitor weather


d·i·e
Deutsches Institut für Entwicklungspolitik
German Development Institute
INSTITUTE FOR CLIMATE AND SUSTAINABLE CITIES
Slow onset events in Asia: regional trends and role of science-policy partnerships
Denise Margaret Matias
German Development Institute / Deutsches Institut für Entwicklungspolitik (DIE)


Identifying gaps through a systematic review
Suva expert dialogue
„Slow onset events should be tackled by the other Rio Conventions (CBD and UNCCD) (...)" - Representative of the BMZ during SB48 (May 2018)
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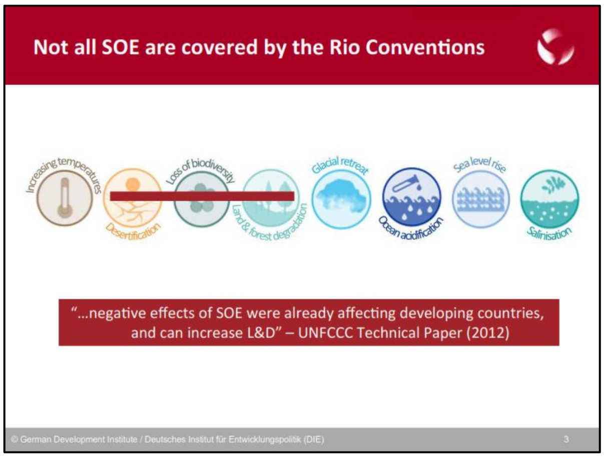
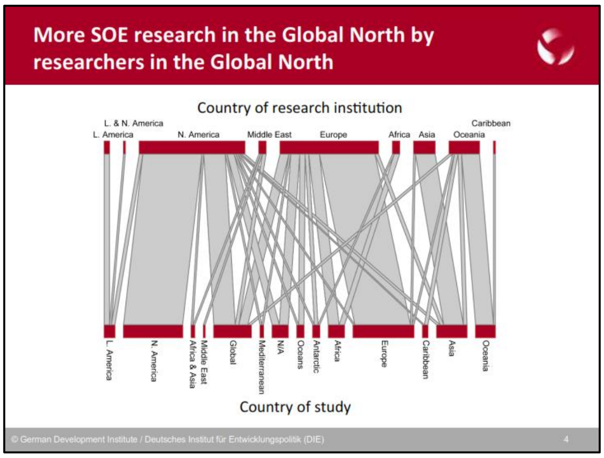
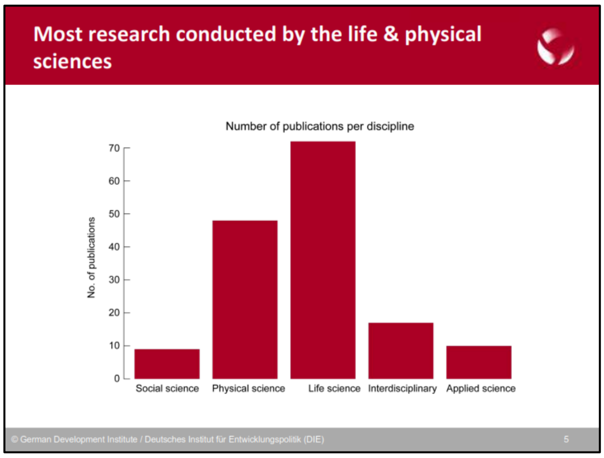
2


Not all SOE are covered by the Rio Conventions
Increasing temperatures
Desertification
Loss of biodiversity
Land & forest degradation
Glacial retreat
Ocean acidification
Sea level rise
Salinisation
"...negative effects of SOE were already affecting developing countries, and can increase L&D" – UNFCCC Technical Paper (2012)
© German Development Institute / Deutsches Institut für Entwicklungspolitik (DIE)
3


More SOE research in the Global North by researchers in the Global North
Country of research institution
L. & N. America
L. America
N. America
Middle East
Europe
Africa
Asia
Caribbean
Oceania
L. America
N. America
Africa & Asia
Middle East
Global
Mediterranean
N/A
Oceans
Antarctic
Africa
Europe
Caribbean
Asia
Oceania
Country of study
© German Development Institute / Deutsches Institut für Entwicklungspolitik (DIE)
4


Most research conducted by the life & physical sciences
Number of publications per discipline
No. of publications
0
10
20
30
40
50
60
70
Social science
Physical science
Life science
Interdisciplinary
Applied science
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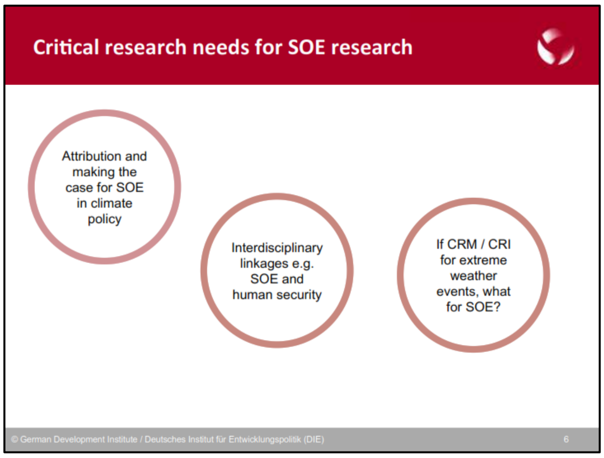
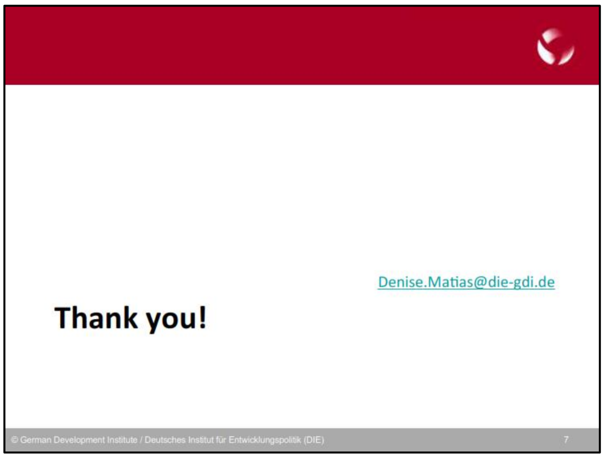
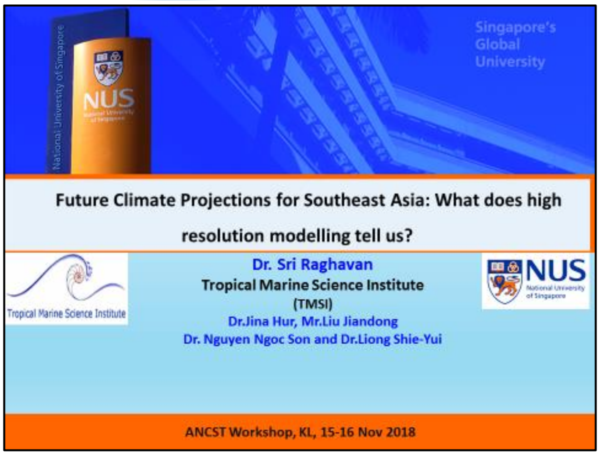
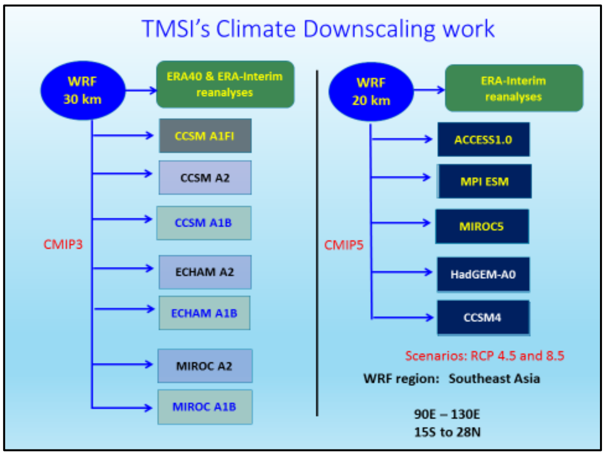
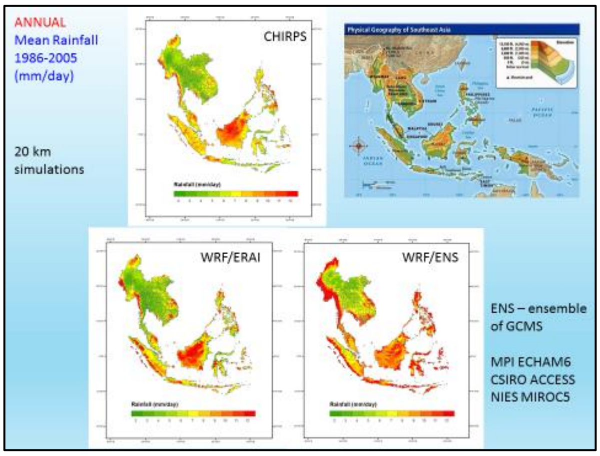
5

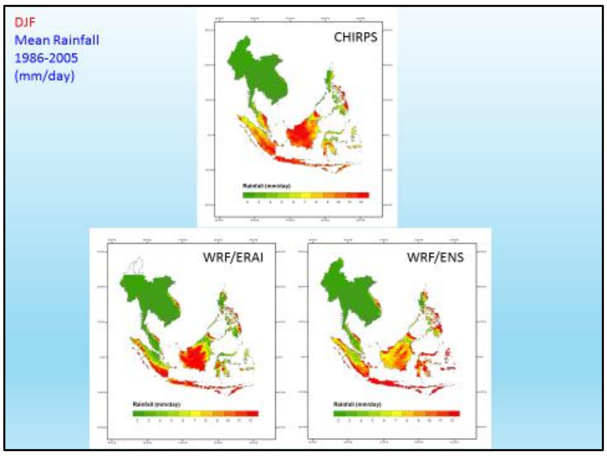

Critical research needs for SOE research
Attribution and making the case for SOE in climate policy
Interdisciplinary linkages e.g. SOE and human security
If CRM / CRI for extreme weather events, what for SOE?
© German Development Institute / Deutsches Institut für Entwicklungspolitik (DIE)
6

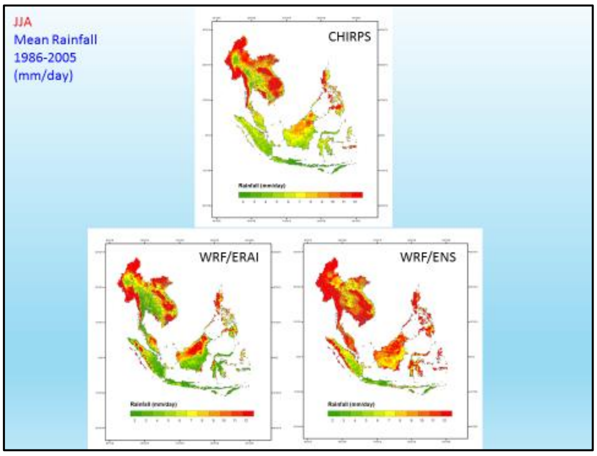

Denise.Matias@die-gdi.de
Thank you!
© German Development Institute / Deutsches Institut für Entwicklungspolitik (DIE)
7

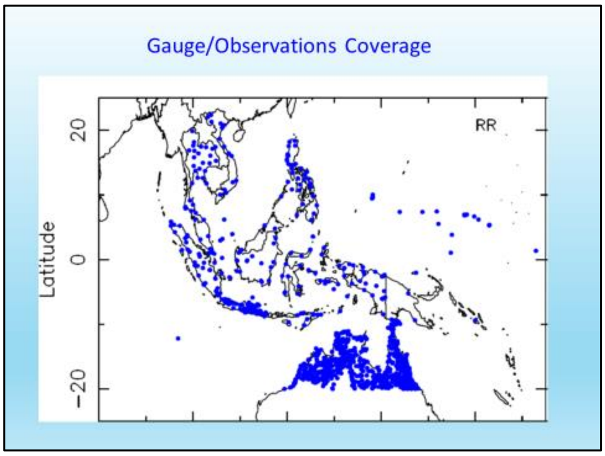

Singapore's
Global
University
NUS
Future Climate Projections for Southeast Asia: What does high resolution modelling tell us?
Dr. Sri Raghavan
Tropical Marine Science Institute
(TMSI)
Dr.Jina Hur, Mr.Liu Jiandong
Dr. Nguyen Ngoc Son and Dr.Liong Shie-Yui
Tropical Marine Science Institute
NUS
National University of Singapore
ANCST Workshop, KL, 15-16 Nov 2018

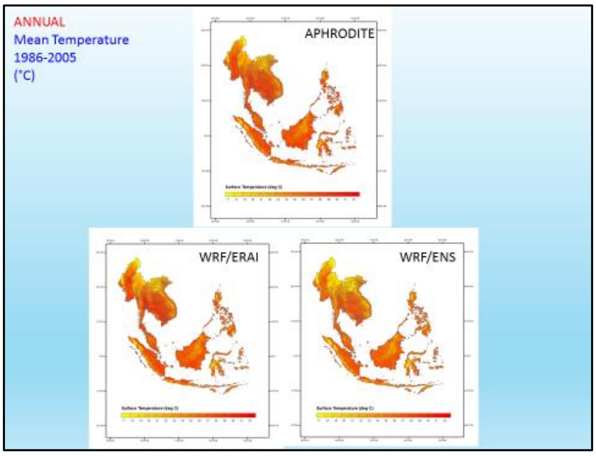

TMSI's Climate Downscaling work
WRF
30 km
ERA40 & ERA-Interim reanalyses
CMIP3
CCSM A1FI
CCSM A2
CCSM A1B
ECHAM A2
ECHAM A1B
MIROC A2
MIROC A1B
WRF
20 km
ERA-Interim reanalyses
CMIP5
ACCESS1.0
MPI ESM
MIROC5
HadGEM-AO
CCSM4
Scenarios: RCP 4.5 and 8.5
WRF region: Southeast Asia
90E – 130E
15S to 28N

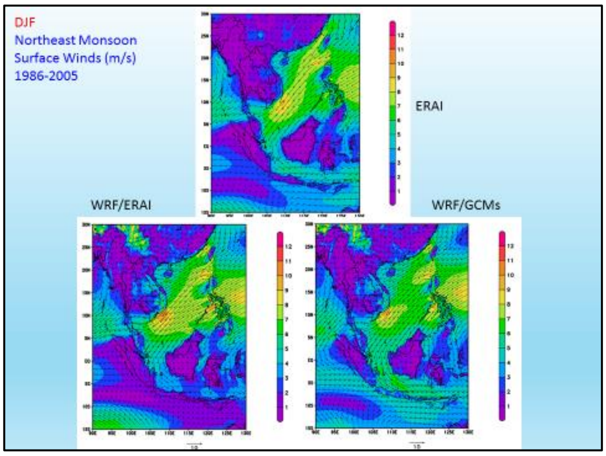

ANNUAL
Mean Rainfall
1986-2005
(mm/day)
20 km
simulations
CHIRPS
Physical Geography of Southeast Asia
WRF/ERAI
WRF/ENS
ENS – ensemble
of GCMS
MPI ECHAM6
CSIRO ACCESS
NIES MIROC5

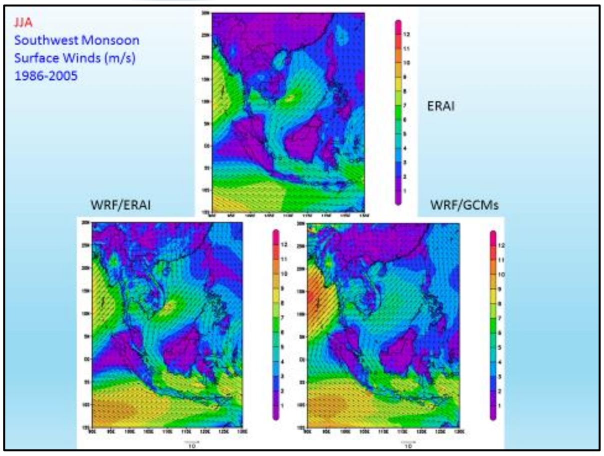

DJF
Mean Rainfall
1986-2005
(mm/day)
CHIRPS
WRF/ERAI
WRF/ENS

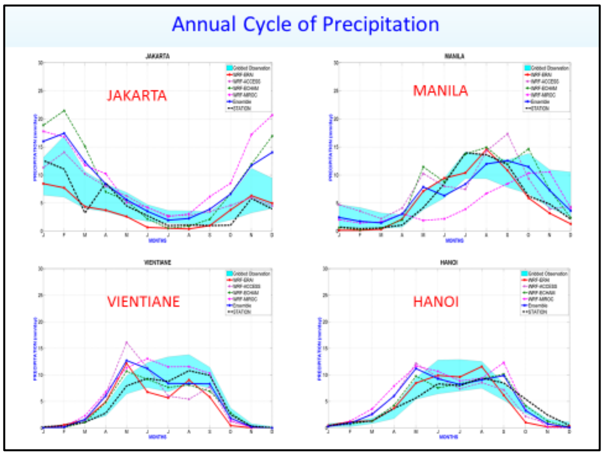

JJA
Mean Rainfall
1986-2005
(mm/day)
CHIRPS
WRF/ERAI
WRF/ENS

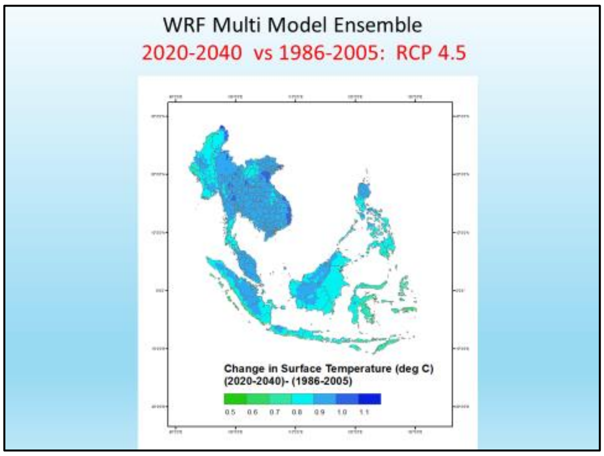

Gauge/Observations Coverage
RR
Latitude
20
0
−20

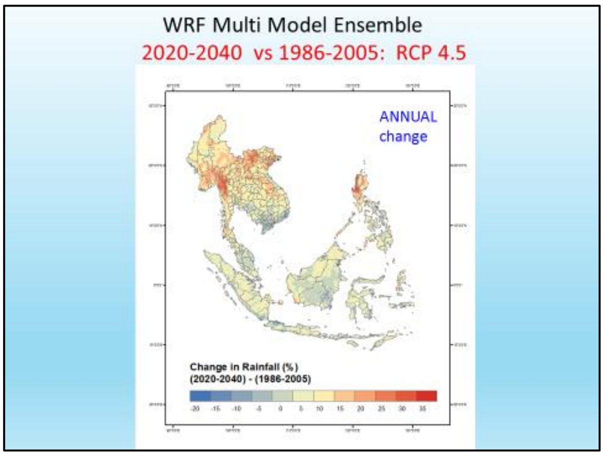

ANNUAL
Mean Temperature
1986-2005
(°C)
APHRODITE
WRF/ERAI
WRF/ENS

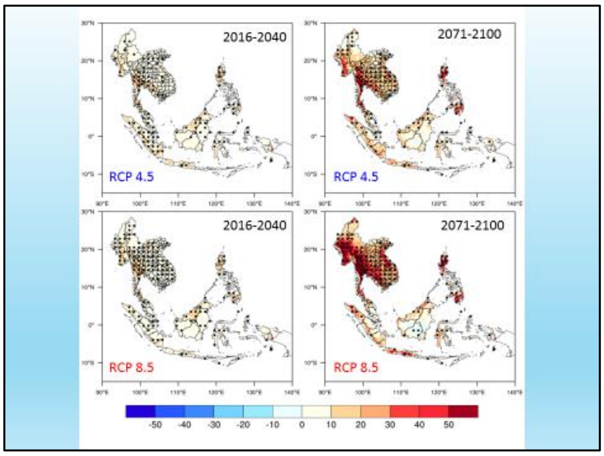

DJF
Northeast Monsoon
Surface Winds (m/s)
1986-2005
ERAI
WRF/ERAI
WRF/GCMs





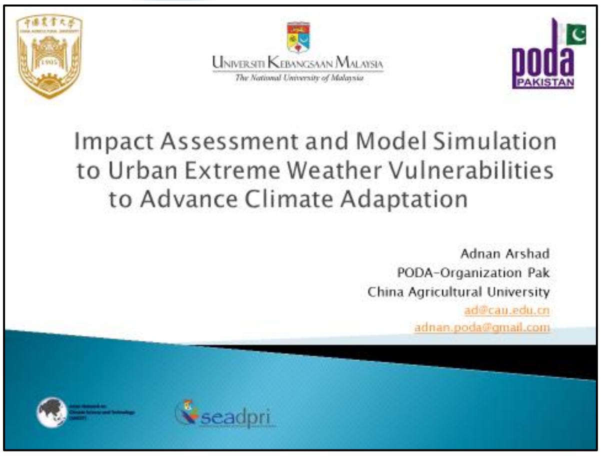




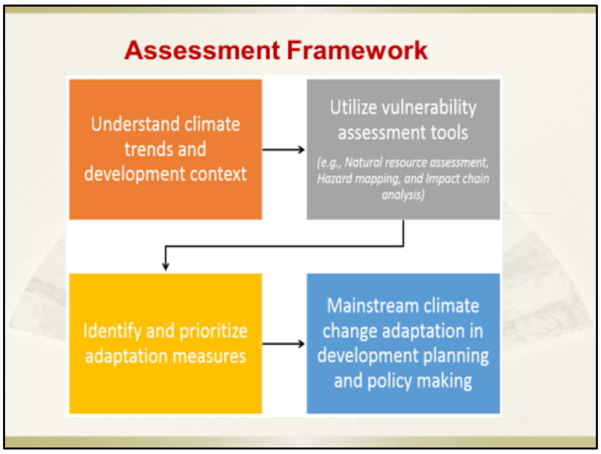


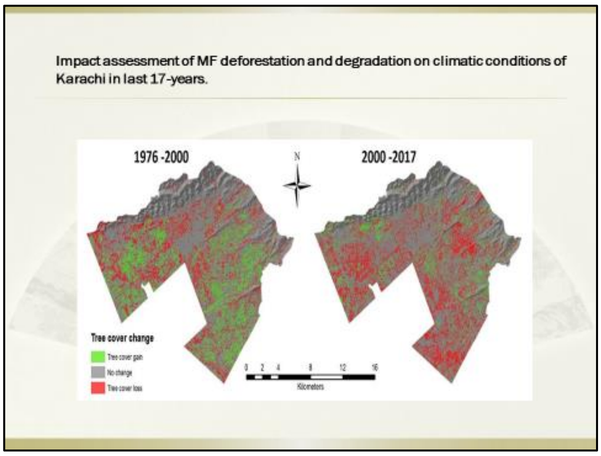
Summary

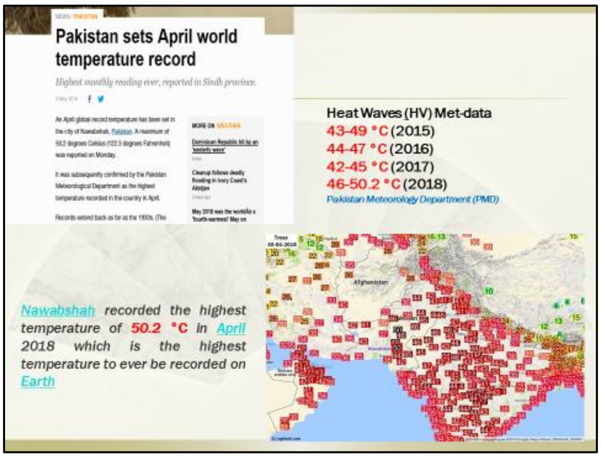
- **WRF model is able to reproduce the regional climate reasonably well.**
- **Multi-Model ensemble show some uncertainties, yet capture the mean state of the climate of the region**
- **That SEAsia will be affected largely by temperature increases is certain.**
- **Rainfall trends are mixed and still uncertain. Seasonal (monsoonal changes) are nevertheless significant**
- **Further downscaling is in progress @ 10 km and 5 km. With additional fine tuning and physics improvements, downscaling of selected GCMs will be performed.**

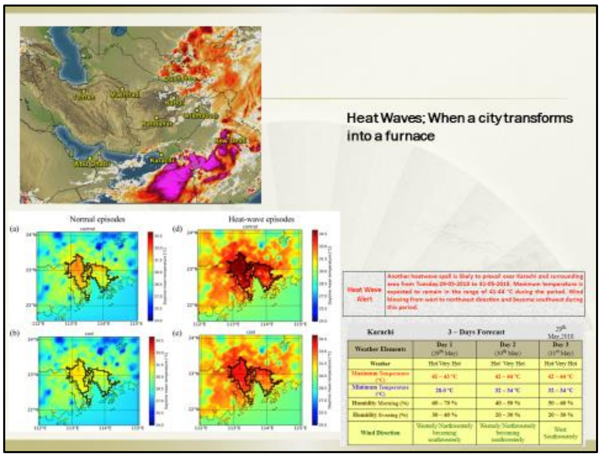

Universiti Kebangsaan Malaysia
The National University of Malaysia
poda
PAKISTAN
Impact Assessment and Model Simulation to Urban Extreme Weather Vulnerabilities to Advance Climate Adaptation
Adnan Arshad
PODA-Organization Pak
China Agricultural University
ad@cau.edu.cn
adnan.poda@gmail.com
seadpri

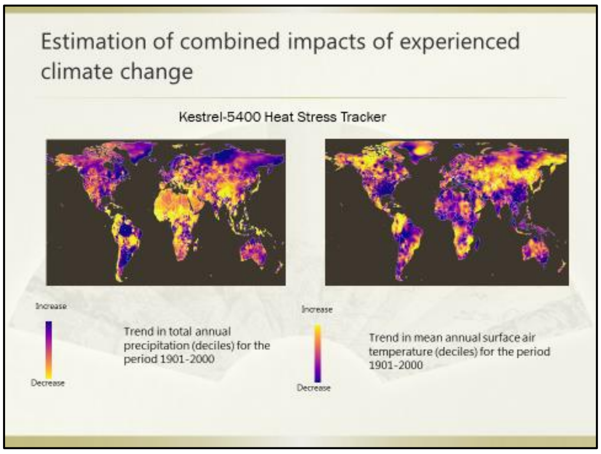

KARACHI: Unplanned urbanization destroying environment:
• Karachi is the largest city in Pakistan
• 16.22 million population
• 7th largest metropolitan city in the world
• 50 % of population lives in informal settlements
• Mangrove Forests spread 350-km long, 129,000 hectares
• 129-km long the city coast.
• Mangroves being destroyed in the name of development; urbanization

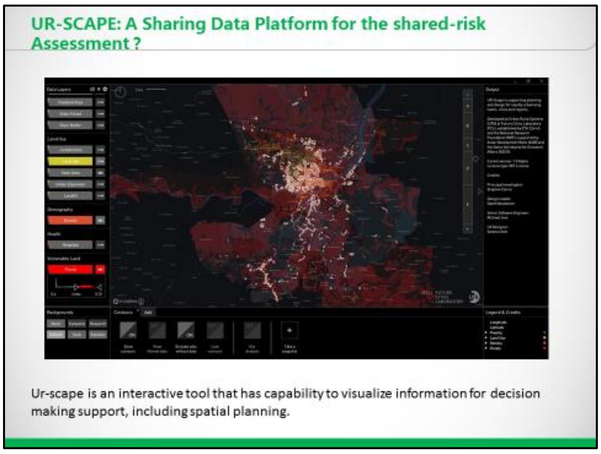

Assessment Framework
Understand climate trends and development context
Utilize vulnerability assessment tools
(e.g., Natural resource assessment, Hazard mapping, and Impact chain analysis)
Identify and prioritize adaptation measures
Mainstream climate change adaptation in development planning and policy making

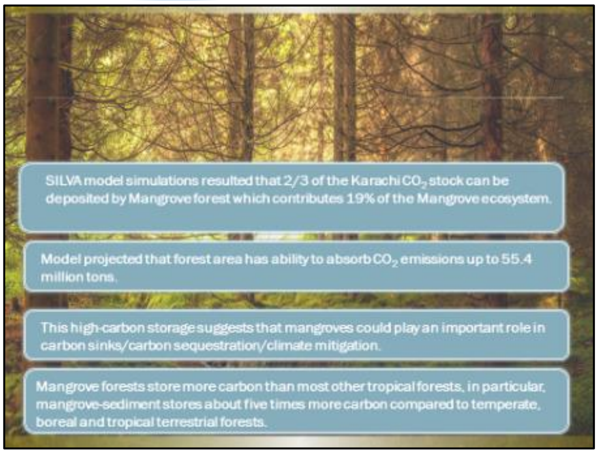

Impact assessment of MF deforestation and degradation on climatic conditions of Karachi in last 17-years.
1976 -2000
2000 -2017
N
Tree cover change
Tree cover gain
No change
Tree cover loss
Kilometers

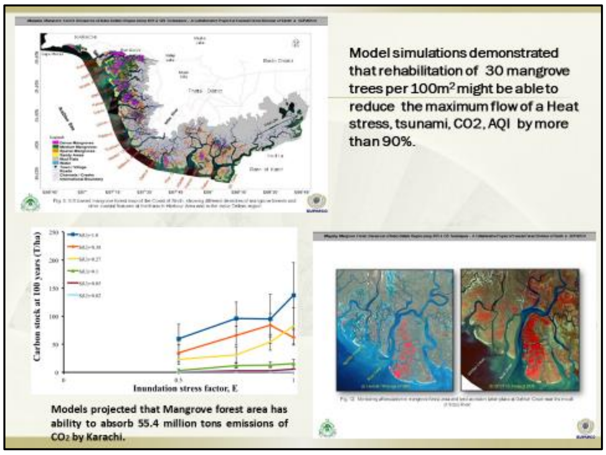

Pakistan sets April world temperature record
Highest monthly reading ever, reported in Sindh province.
Heat Waves (HV) Met-data
43-49 °C (2015)
44-47 °C (2016)
42-45 °C (2017)
46-50.2 °C (2018)
Pakistan Meteorology Department (PMD)
Nawabshah recorded the highest temperature of 50.2 °C in April 2018 which is the highest temperature to ever be recorded on Earth


Heat Waves; When a city transforms into a furnace
Normal episodes
Heat-wave episodes
Karachi
3 - Days Forecast

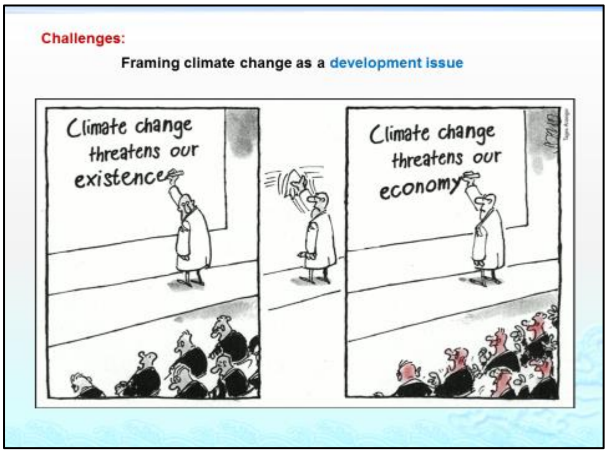

Estimation of combined impacts of experienced climate change
Kestrel-5400 Heat Stress Tracker
Increase
Decrease
Trend in total annual precipitation (deciles) for the period 1901-2000
Increase
Decrease
Trend in mean annual surface air temperature (deciles) for the period 1901-2000

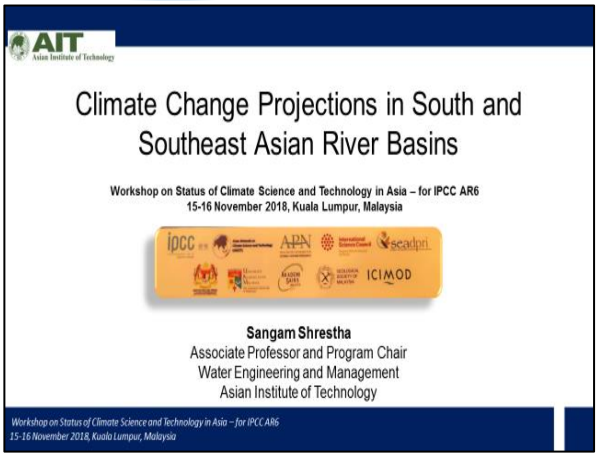

UR-SCAPE: A Sharing Data Platform for the shared-risk Assessment ?
Ur-scape is an interactive tool that has capability to visualize information for decision making support, including spatial planning.

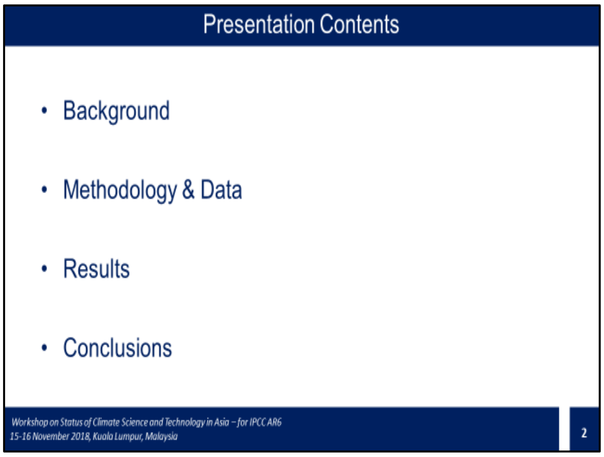


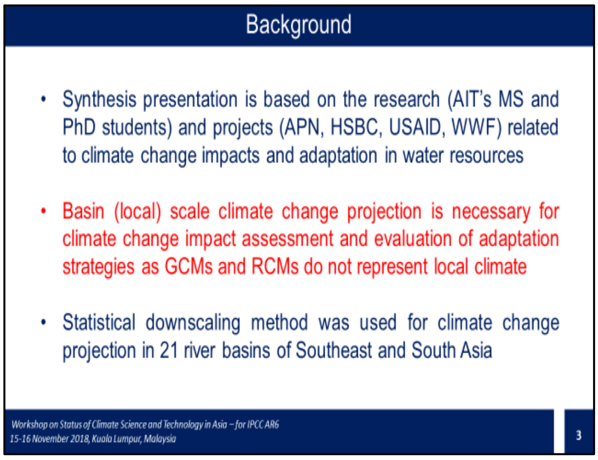


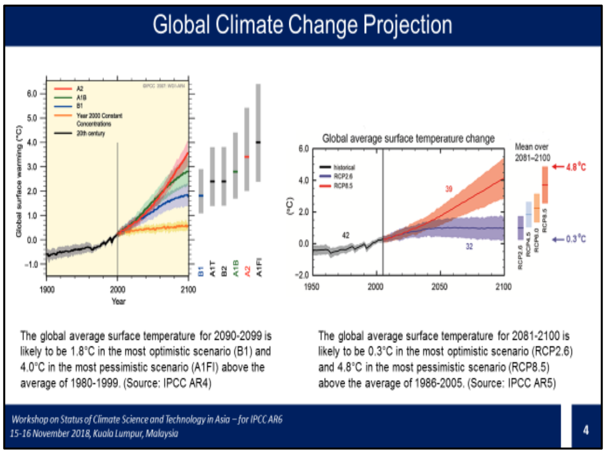
- Rehabilitation and reforestation of Mangroves forest need to be done on emergency basis with application of advance meteorological forecasting system.
- Advancement of meteorological forecasting of Monsoon cycle and establishment of Early Warning System to Climate Disasters.
- Capacity building of individuals and communities to respond to the heat stress during heat-waves by raising heat-health awareness campaigns in the both countries.
- Green spaces may be increased by tree planting in the city on emergency basis.
- Adapting white or reflective materials to build houses, roofs, pavements, and roads of the city.
- Cool Centres.

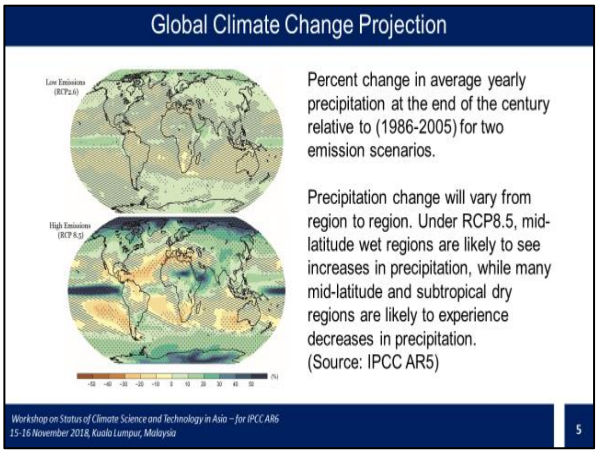



AIT
Asian Institute of Technology
Climate Change Projections in South and Southeast Asian River Basins
Workshop on Status of Climate Science and Technology in Asia – for IPCC AR6
15-16 November 2018, Kuala Lumpur, Malaysia
Sangam Shrestha
Associate Professor and Program Chair
Water Engineering and Management
Asian Institute of Technology
Workshop on Status of Climate Science and Technology in Asia – for IPCC AR6
15-16 November 2018, Kuala Lumpur, Malaysia


Presentation Contents
• Background
• Methodology & Data
• Results
• Conclusions
Workshop on Status of Climate Science and Technology in Asia – for IPCC AR6
15-16 November 2018, Kuala Lumpur, Malaysia
2


Background
• Synthesis presentation is based on the research (AIT's MS and PhD students) and projects (APN, HSBC, USAID, WWF) related to climate change impacts and adaptation in water resources
• Basin (local) scale climate change projection is necessary for climate change impact assessment and evaluation of adaptation strategies as GCMs and RCMs do not represent local climate
• Statistical downscaling method was used for climate change projection in 21 river basins of Southeast and South Asia
Workshop on Status of Climate Science and Technology in Asia – for IPCC AR6
15-16 November 2018, Kuala Lumpur, Malaysia
3


Global Climate Change Projection
Global average surface temperature change
The global average surface temperature for 2090-2099 is likely to be 1.8°C in the most optimistic scenario (B1) and 4.0°C in the most pessimistic scenario (A1FI) above the average of 1980-1999. (Source: IPCC AR4)
The global average surface temperature for 2081-2100 is likely to be 0.3°C in the most optimistic scenario (RCP2.6) and 4.8°C in the most pessimistic scenario (RCP8.5) above the average of 1986-2005. (Source: IPCC AR5)
Workshop on Status of Climate Science and Technology in Asia – for IPCC AR6
15-16 November 2018, Kuala Lumpur, Malaysia
4


Global Climate Change Projection
Percent change in average yearly precipitation at the end of the century relative to (1986-2005) for two emission scenarios.
Precipitation change will vary from region to region. Under RCP8.5, mid-latitude wet regions are likely to see increases in precipitation, while many mid-latitude and subtropical dry regions are likely to experience decreases in precipitation.
(Source: IPCC AR5)
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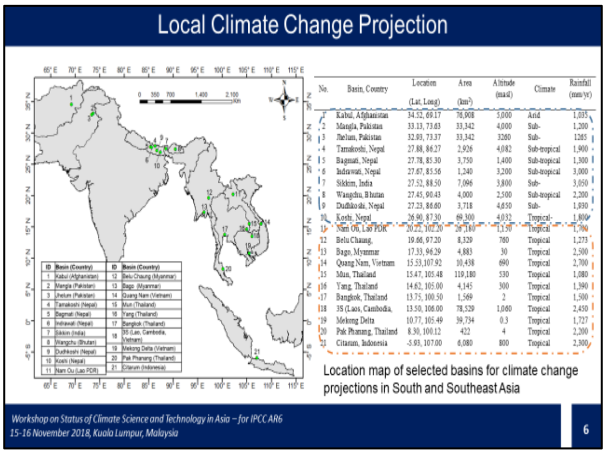
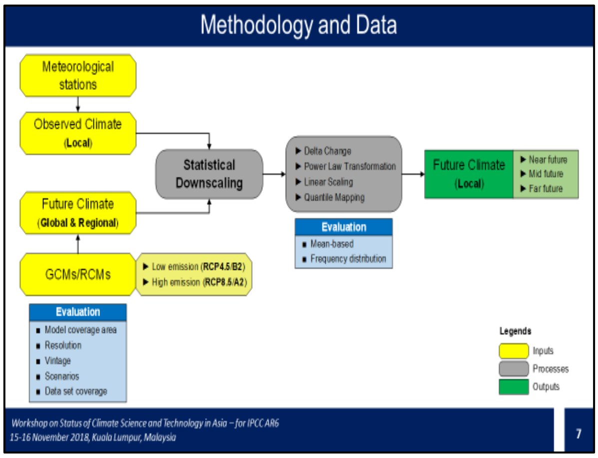
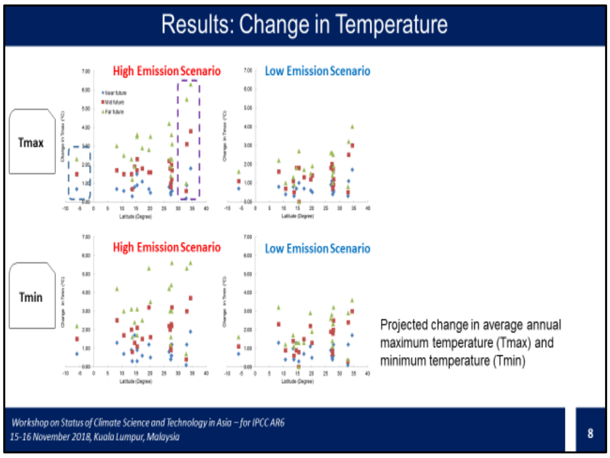
15-16 November 2018, Kuala Lumpur, Malaysia
5


Local Climate Change Projection
Location map of selected basins for climate change projections in South and Southeast Asia
Workshop on Status of Climate Science and Technology in Asia – for IPCC AR6
15-16 November 2018, Kuala Lumpur, Malaysia
6


Methodology and Data
Meteorological stations
Observed Climate (Local)
Future Climate (Global & Regional)
GCMs/RCMs
Low emission (RCP4.5/B2)
High emission (RCP8.5/A2)
Evaluation
Model coverage area
Resolution
Vintage
Scenarios
Data set coverage
Statistical Downscaling
Delta Change
Power Law Transformation
Linear Scaling
Quantile Mapping
Evaluation
Mean-based
Frequency distribution
Future Climate (Local)
Near future
Mid future
Far future
Legends
Inputs
Processes
Outputs
Workshop on Status of Climate Science and Technology in Asia – for IPCC AR6
15-16 November 2018, Kuala Lumpur, Malaysia
7

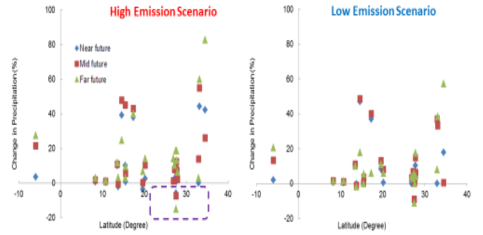

Results: Change in Temperature
Tmax
Tmin
High Emission Scenario
Low Emission Scenario
High Emission Scenario
Low Emission Scenario
Projected change in average annual maximum temperature (Tmax) and minimum temperature (Tmin)
Workshop on Status of Climate Science and Technology in Asia – for IPCC AR6
15-16 November 2018, Kuala Lumpur, Malaysia
8

Results: Change in Temperature

Projected change in average annual maximum temperature (Tmax) and minimum temperature (Tmin) in far future period

	Emission scenarios	Tmax	Highest increase in Tmax	Tmin	Highest increase in Tmin
Higher latitude	Low emission scenario	0.8 to 2.6°C	Kabul River Basin (Afghanistan)	0.4 to 3.6°C	Kabul River Basin (Afghanistan)
	High emission scenario	1.0 to 6.3°C		0.7 to 5.6°C	
Lower latitude	Low emission scenario	0.9 to 2.7°C	Quang Nam River Basin (Vietnam)	1.0 to 3.2°C	Belu Chaung River Basin (Myanmar)
	High emission scenario	1.2 to 3.6°C		1.6 to 5.3°C	

Results: Change in Precipitation



Projected changes (%) in average annual precipitation, as compared to the baseline period under high and low emission scenarios in near, mid, and far future periods

Results: Change in Precipitation

Projected change in average annual precipitation (%) in far future period

	Emission scenarios	Highest increase	Highest decrease
Higher latitude	Low emission scenario	+57.3%, Kabul Basin (Afghanistan)	-11%, Sikkim Basin (India)
	High emission scenario	+82.6%, Kabul Basin (Afghanistan)	-15%, Sikkim Basin (India)
Lower latitude	Low emission scenario	+20,7%, Citarum Basin (Indonesia)	-1.8%, Bangkok (Thailand)
	High emission scenario	+40%, Bago Basin (Myanmar)	-0.4%, Bangkok (Thailand)

Conclusions

- Average annual maximum and minimum temperatures are projected to increase in all three future time periods, with lower increase in the near future and higher increase in the far future periods.
- The magnitude of increase of average annual minimum temperature is higher than average annual maximum temperature in a majority of the basins.
- Unlike temperature, precipitation shows different directions of change in the basins.
- Uncertainty exists in climate change projections due to selection of climate models, downscaling/bias correction methods.

Acknowledgements

AIT Asian Institute of Technology

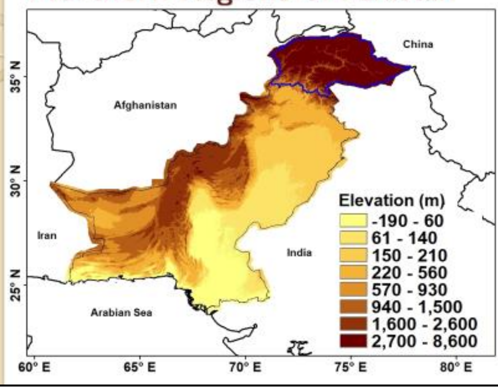
Quantitative Assessment of Precipitation Changes under CMIP5 RCP Scenarios over the Northern Sub-Himalayan Region of Pakistan

Prepared by

Dr. Kamal Ahmed

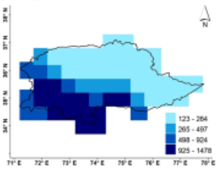
Faculty of Water Resource Management
Lasbela University of Agriculture, Water and Marine Sciences, Uthal, Balochistan, Pakistan

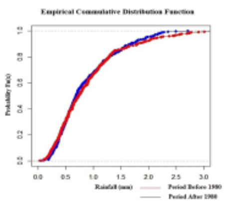
Northern Regions of Pakistan



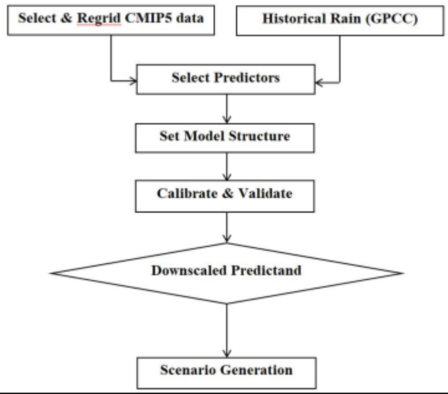
Background

- Himalaya regions are one of the most sensitive hotspots to climate change in the World.
- The upper Indus River basin, a part of Himalaya and Karakoram regions is the major source of water of Pakistan.
- The river basin provides about 138 Million acre feet of water annually only in Pakistan.
- The rainfall and snowfall characteristics in the basin have implicit effect on the glaciology and hydrology.
- Changes in precipitation pattern due to climate change may severely affect the water cycle.

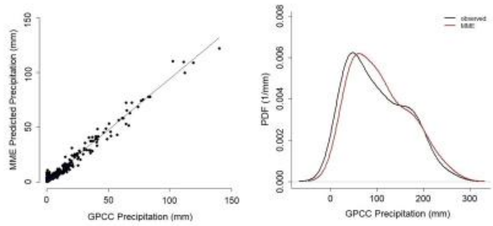




Methodology

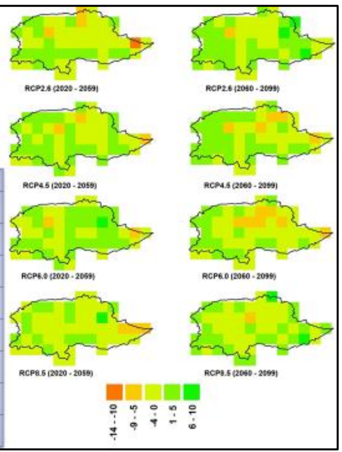


Performance of Multi-model Ensemble



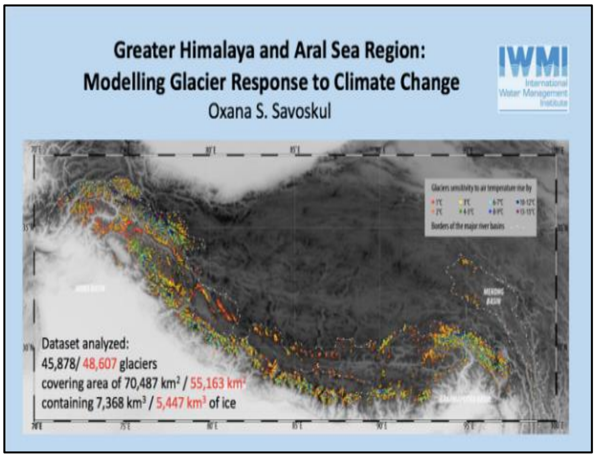
Changing Patterns of Precipitation

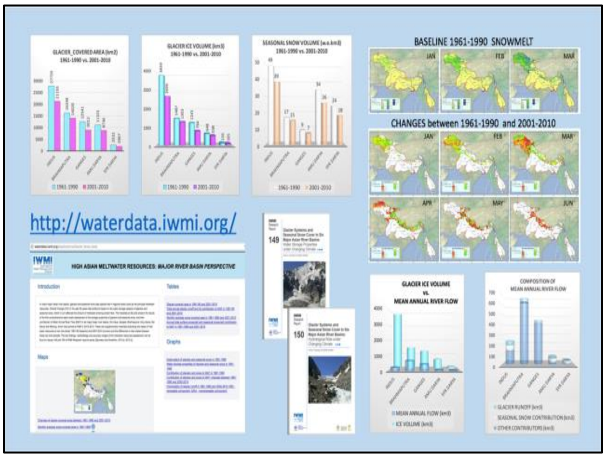
RCP	Period	Min	Mean	Max
RCP2.6	2020-2059	-12.68	-1.12	2.31
	2060-2099	-6.10	0.47	6.31
RCP4.5	2020-2059	-6.59	-0.54	3.31
	2060-2099	-9.61	-0.78	3.45
RCP6.0	2020-2059	-6.44	0.05	**9.15**
	2060-2099	-8.70	-1.55	3.22
RCP8.5	2020-2059	-9.40	-1.55	5.45
	2060-2099	-7.83	-0.06	5.47

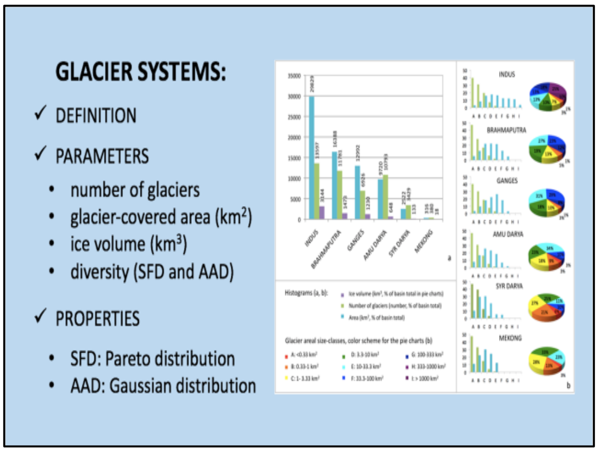


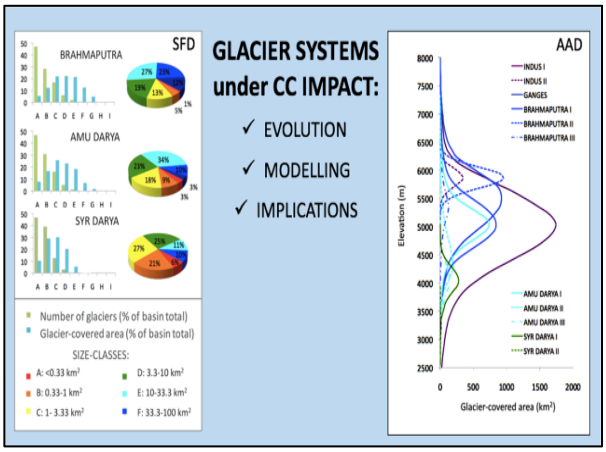
Conclusions

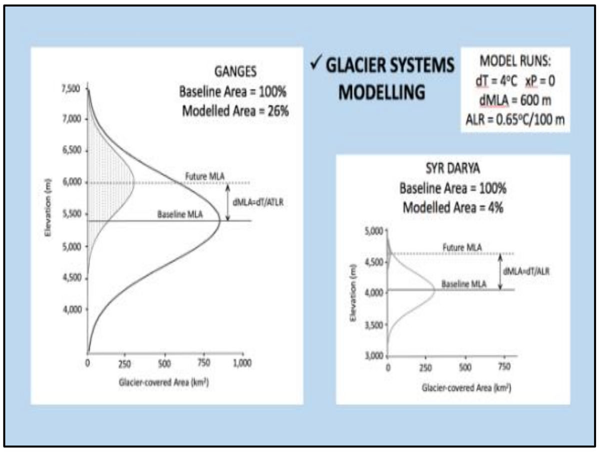
- Downscaling models are highly capable in downscaling precipitation of northern regions.
- The spatial pattern of precipitation showed more decrease in precipitation over a larger area.
- The annual precipitation would change in the range of -12% to 10% in all scenarios.
- The precipitation is expected to decrease during 2060-2099 for all the scenarios.

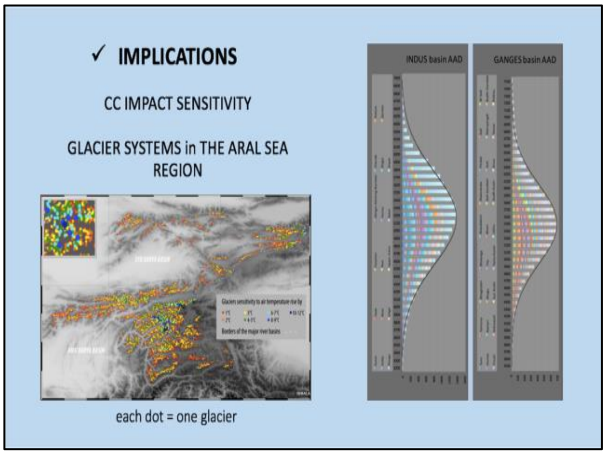

Greater Himalaya and Aral Sea Region:
Modelling Glacier Response to Climate Change
Oxana S. Savoskul
IWMI
International Water Management Institute
Dataset analyzed:
45,878/ 48,607 glaciers
covering area of 70,487 km² / 55,163 km²
containing 7,368 km³ / 5,447 km³ of ice


BASELINE 1961-1990 SNOWMELT
CHANGES between 1961-1990 and 2001-2010
http://waterdata.iwmi.org/
HIGH ASIAN MELTWATER RESOURCES: MAJOR RIVER BASIN PERSPECTIVE
149
150


GLACIER SYSTEMS:
✓ DEFINITION
✓ PARAMETERS
• number of glaciers
• glacier-covered area (km²)
• ice volume (km³)
• diversity (SFD and AAD)
✓ PROPERTIES
• SFD: Pareto distribution
• AAD: Gaussian distribution
INDUS
BRAHMAPUTRA
GANGES
AMU DARYA
SYR DARYA
MEKONG


SFD
BRAHMAPUTRA
AMU DARYA
SYR DARYA
GLACIER SYSTEMS under CC IMPACT:
✓ EVOLUTION
✓ MODELLING
✓ IMPLICATIONS
Number of glaciers (% of basin total)
Glacier-covered area (% of basin total)
SIZE-CLASSES:
A: <0.33 km²
B: 0.33-1 km²
C: 1-3.33 km²
D: 3.3-10 km²
E: 10-33.3 km²
F: 33.3-100 km²
AAD
Elevation (m)
Glacier-covered area (km²)
INDUS I
INDUS II
GANGES
BRAHMAPUTRA I
BRAHMAPUTRA II
BRAHMAPUTRA III
AMU DARYA I
AMU DARYA II
AMU DARYA III
SYR DARYA I
SYR DARYA II


GANGES
Baseline Area = 100%
Modelled Area = 26%
Future MLA
Baseline MLA
dMLA=dT/ATLR
Elevation (m)
Glacier-covered Area (km²)
✓ GLACIER SYSTEMS MODELLING
MODEL RUNS:
dT = 4°C xP = 0
dMLA = 600 m
ALR = 0.65°C/100 m
SYR DARYA
Baseline Area = 100%
Modelled Area = 4%
Future MLA
Baseline MLA
dMLA=dT/ALR
Elevation (m)
Glacier-covered Area (km²)


✓ IMPLICATIONS
CC IMPACT SENSITIVITY
GLACIER SYSTEMS in THE ARAL SEA REGION
each dot = one glacier
INDUS basin AAD
GANGES basin AAD

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Effects of rising sea level and changing rainfall patterns on rice and oil palm yields in Peninsular Malaysia

Muhammad Firdaus Sulaiman, Ph.D.
Dept. of Land Management, Faculty of Agriculture,
Universiti Putra Malaysia

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Problem Statement - Rice

- Rice is the staple food for Malaysians
- Rice grown in flooded paddy system – highly dependent on irrigation
- Rising of sea level due to climate change have led to inundation of saline sea water into rivers that are used for irrigating paddy fields.
- Rice is sensitive to salinity – increase in salinity of irrigation water source reduces yield

Problem Statement – Oil Palm

- Oil palm is the main industrial crop for Malaysia
- Increase in temperature → decrease yield of oil palm – amplification of current disease, emergence of new disease, physiological stress to oil palm
- Irrigation for oil palm in Malaysia is rain-fed – change in precipitation patterns will alter productivity
- Too much rain – flooding, poor soil condition, water borne disease.
- Reduced rainfall – drought, water stress, reduced yield.

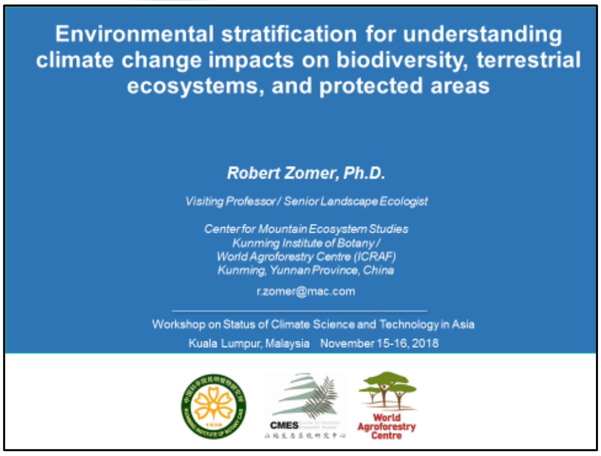
Methodology

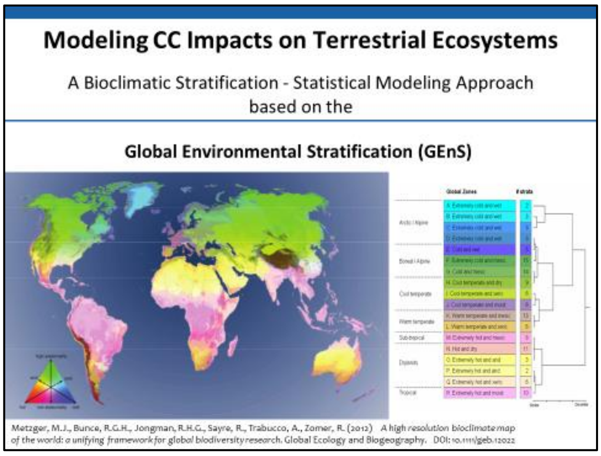
- Sampling soil and water from river and irrigation canals for rice. Determine salinity i.e. electrical conductivity, Na^+ and other soil cations – analyze for correlation with yield and compare with non-saline irrigation water source
- Analyze for correlation between average Peninsular Malaysia oil palm FFB yield and changes in temperature and rainfall over past 50 years

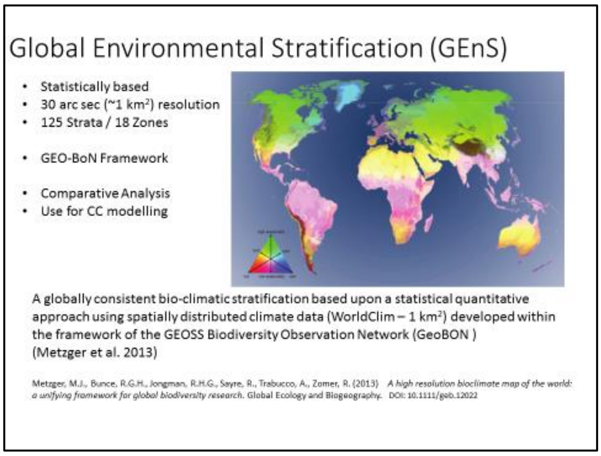
Result

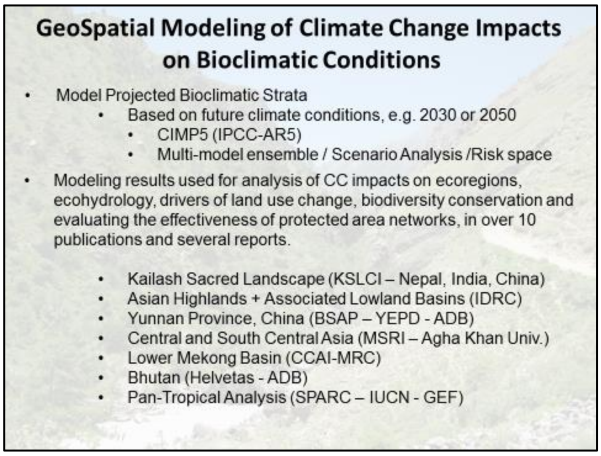
- Still waiting for approval from Dept. of Agriculture Selangor and Malaysian Palm Oil Board for release of yield data
- Oil palm experienced reduced yield during the La Nina
- Rice yield has been declining for river-sourced irrigated fields as compared to rain collected ponds

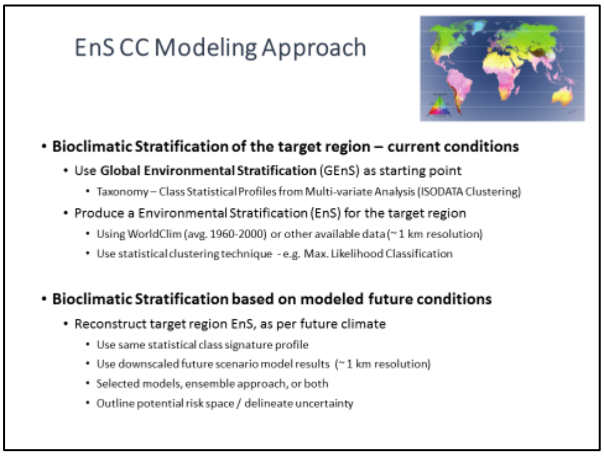
Thank you

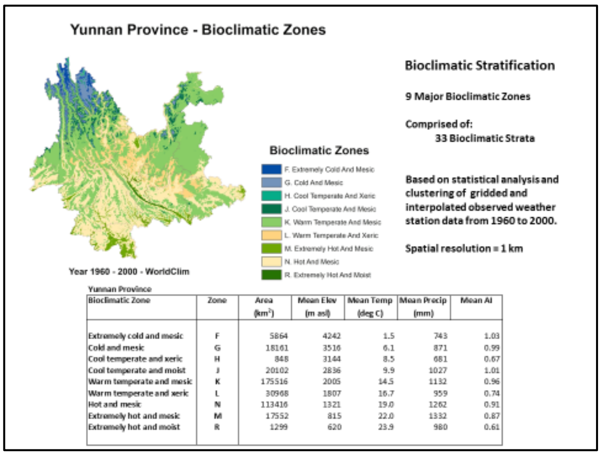




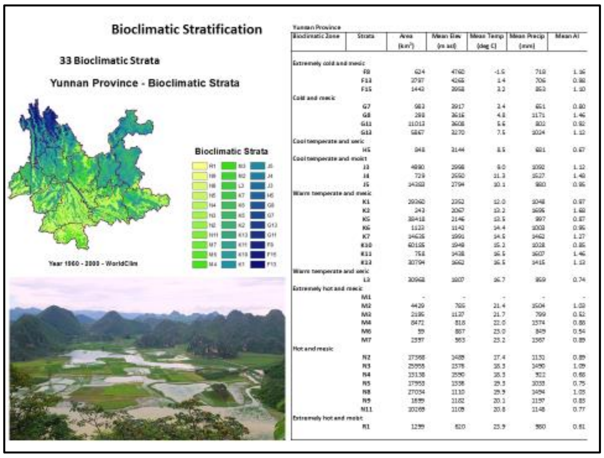




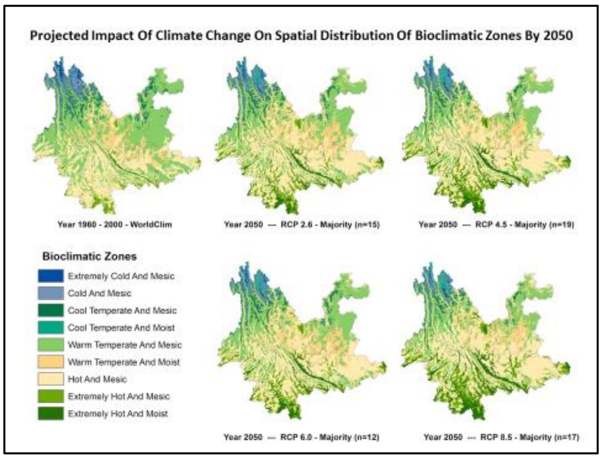


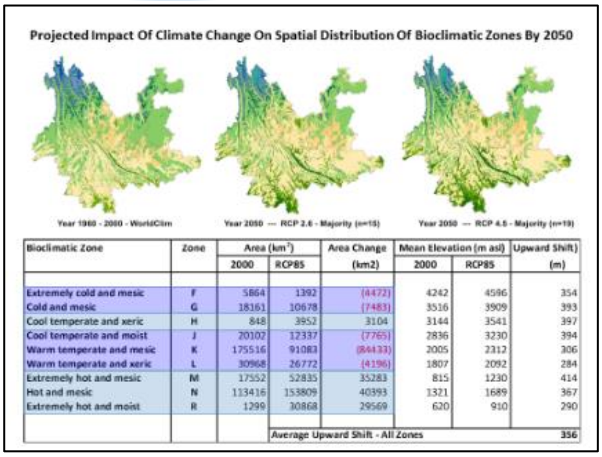


Bioclimatic Zone	Zone	Area (km²)	Mean Elev (m asl)	Mean Temp (deg C)	Mean Precip (mm)	Mean AI
Extremely cold and mesic	F	5864	4242	1.5	743	1.03
Cold and mesic	G	18161	3516	6.1	871	0.99
Cool temperate and xeric	H	848	3144	8.5	681	0.67
Cool temperate and moist	J	20102	2836	9.9	1027	1.01
Warm temperate and mesic	K	175516	2005	14.5	1132	0.96
Warm temperate and xeric	L	30968	1807	16.7	959	0.74
Hot and mesic	N	113416	1321	19.0	1262	0.91
Extremely hot and mesic	M	17552	815	22.0	1332	0.87
Extremely hot and moist	R	1299	620	23.9	980	0.61

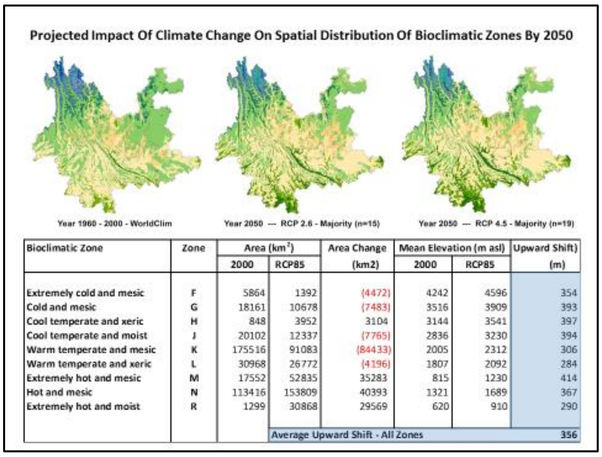


Biodimatic Zone	Strata	Area (km²)	Mean Elev (m asl)	Mean Temp (deg C)	Mean Precip (mm)	Mean AI
Extremely cold and mesic						
	F8	624	4760	-1.6	718	1.16
	F13	2797	4266	1.4	706	0.88
	F15	1443	3958	3.2	853	1.10
Cold and mesic						
	G7	583	3917	3.4	651	0.80
	G8	288	3616	4.8	1171	1.46
	G11	11013	3608	5.6	802	0.92
	G13	5867	3270	7.5	1024	1.12
Cool temperate and xeric						
	H5	848	3144	8.5	681	0.67
Cool temperate and moist						
	J3	4990	2998	9.0	1092	1.12
	J4	729	2590	11.3	1527	1.48
	J5	14363	2794	10.1	880	0.96
Warm temperate and mesic						
	K1	29260	2352	12.0	1048	0.97
	K2	243	2067	13.2	1696	1.68
	K5	38418	2146	13.5	997	0.87
	K6	1123	2142	14.4	1003	0.96
	K7	14626	1991	14.5	1462	1.27
	K10	60196	1949	15.2	1028	0.86
	K11	758	1438	16.5	1607	1.46
	K13	30794	1662	16.5	1415	1.13
Warm temperate and xeric						
	L3	30968	1807	16.7	959	0.74
Extremely hot and mesic						
	M1	-	-	-	-	-
	M2	4429	765	21.4	1504	1.03
	M3	2186	1127	21.7	799	0.62
	M4	8472	818	22.0	1374	0.88
	M6	59	887	23.0	849	0.54
	M7	2397	563	23.2	1367	0.89
Hot and mesic						
	N2	17368	1488	17.4	1131	0.89
	N3	25958	1378	18.3	1490	1.09
	N4	15138	1590	18.3	922	0.68
	N5	17953	1338	19.3	1033	0.75
	N8	27034	1110	19.9	1494	1.05
	N9	1899	1182	20.1	1197	0.83
	N11	10269	1109	20.8	1148	0.77
Extremely hot and moist						
	R1	1299	620	23.9	980	0.61





Bioclimatic Zone	Zone	Area (km²) 2000	Area (km²) RCP85	Area Change (km2)	Mean Elevation (m asl) 2000	Mean Elevation (m asl) RCP85	Upward Shift) (m)
Extremely cold and mesic	F	5864	1392	(4472)	4242	4596	354
Cold and mesic	G	18161	10678	(7483)	3516	3909	393
Cool temperate and xeric	H	848	3952	3104	3144	3541	397
Cool temperate and moist	J	20102	12337	(7765)	2836	3230	394
Warm temperate and mesic	K	175516	91083	(84433)	2005	2312	306
Warm temperate and xeric	L	30968	26772	(4196)	1807	2092	284
Extremely hot and mesic	M	17552	52835	35283	815	1230	414
Hot and mesic	N	113416	153809	40393	1321	1689	367
Extremely hot and moist	R	1299	30868	29569	620	910	290
			Average Upward Shift - All Zones				356



Bioclimatic Zone	Zone	Area (km²) 2000	Area (km²) RCP85	Area Change (km2)	Mean Elevation (m asl) 2000	Mean Elevation (m asl) RCP85	Upward Shift) (m)
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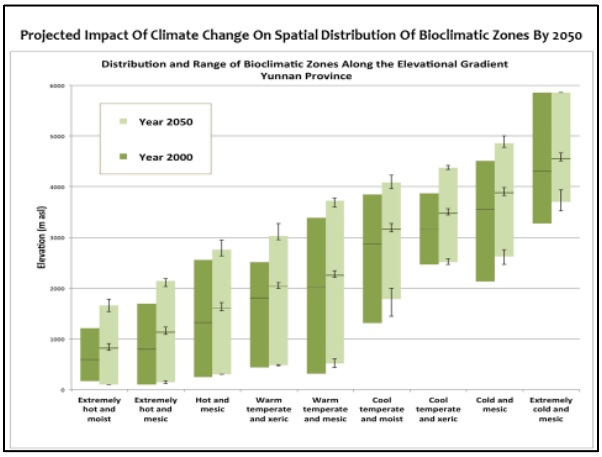
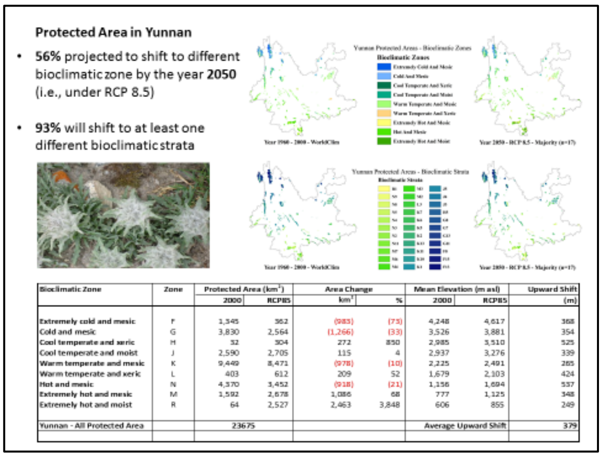
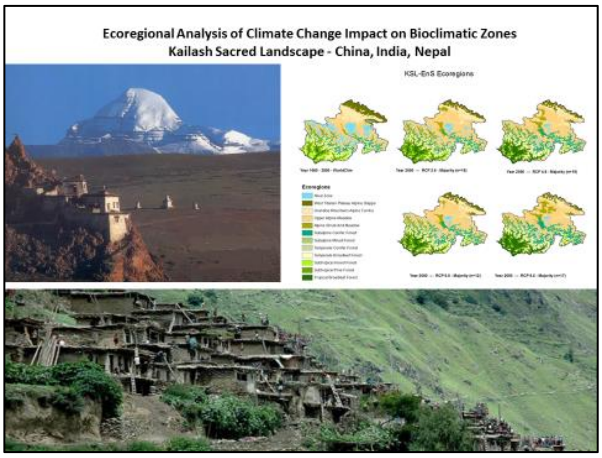
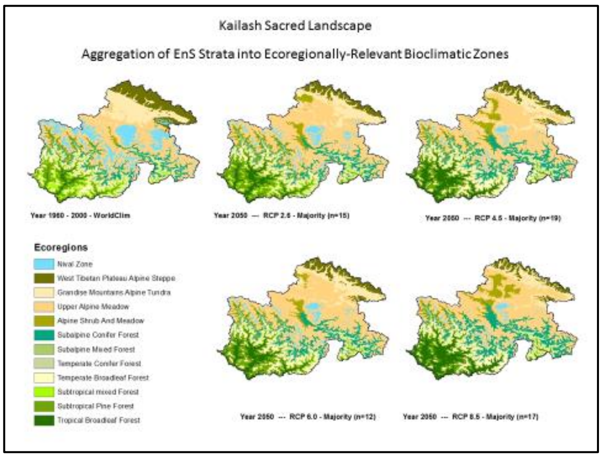
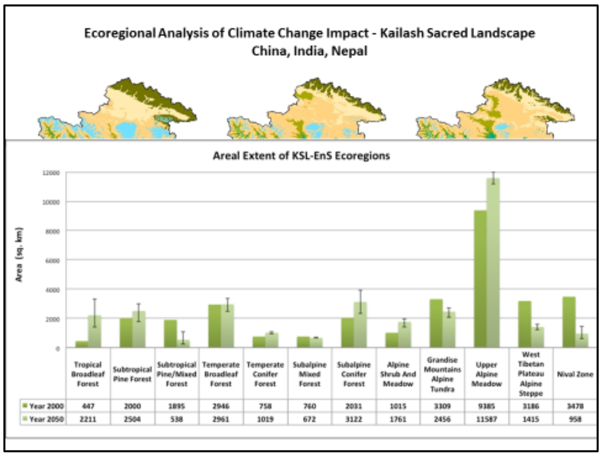




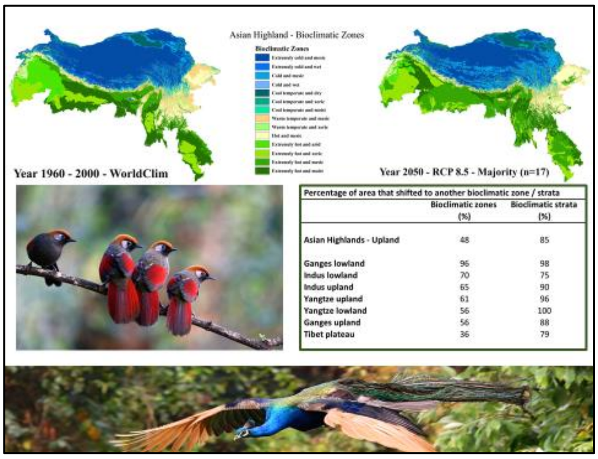
Bioclimatic Zone	Zone	Protected Area (km²) 2000	Protected Area (km²) RCP85	Area Change km²	Area Change %	Mean Elevation (m asl) 2000	Mean Elevation (m asl) RCP85	Upward Shift (m)
Extremely cold and mesic	F	1,345	362	(983)	(73)	4,248	4,617	368
Cold and mesic	G	3,830	2,564	(1,266)	(33)	3,526	3,881	354
Cool temperate and xeric	H	32	304	272	850	2,985	3,510	525
Cool temperate and moist	J	2,590	2,705	115	4	2,937	3,276	339
Warm temperate and mesic	K	9,449	8,471	(978)	(10)	2,225	2,491	265
Warm temperate and xeric	L	403	612	209	52	1,679	2,103	424
Hot and mesic	N	4,370	3,452	(918)	(21)	1,156	1,694	537
Extremely hot and mesic	M	1,592	2,678	1,086	68	777	1,125	348
Extremely hot and moist	R	64	2,527	2,463	3,848	606	855	249
Yunnan - All Protected Area		23675				Average Upward Shift		379



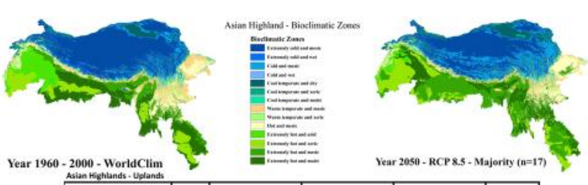




	Tropical Broadleaf Forest	Subtropical Pine Forest	Subtropical Pine/Mixed Forest	Temperate Broadleaf Forest	Temperate Conifer Forest	Subalpine Mixed Forest	Subalpine Conifer Forest	Alpine Shrub And Meadow	Grandise Mountains Alpine Tundra	Upper Alpine Meadow	West Tibetan Plateau Alpine Steppe	Nival Zone
Year 2000	447	2000	1895	2946	758	760	2031	1015	3309	9385	3186	3478
Year 2050	2211	2504	538	2961	1019	672	3122	1761	2456	11587	1415	958

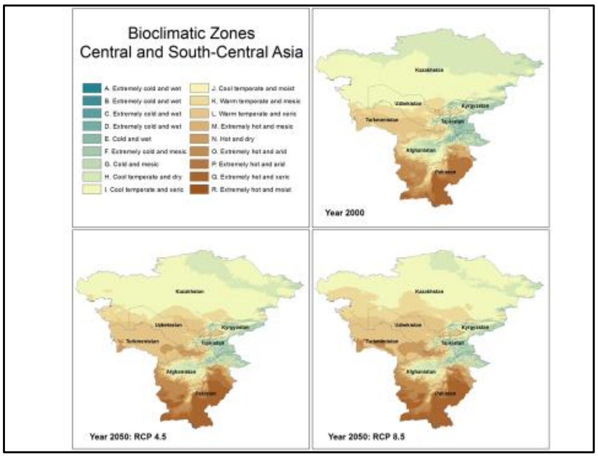


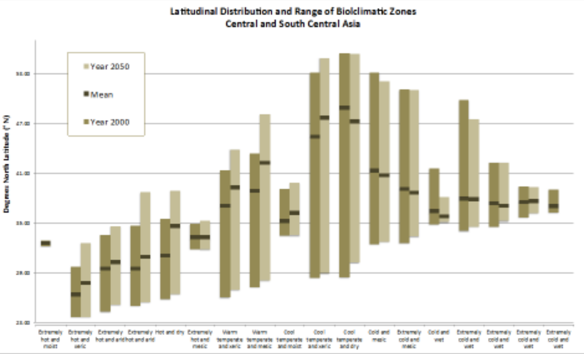
Percentage of area that shifted to another bioclimatic zone / strata	Bioclimatic zones (%)	Bioclimatic strata (%)
Asian Highlands - Upland	48	85
Ganges lowland	96	98
Indus lowland	70	75
Indus upland	65	90
Yangtze upland	61	96
Yangtze lowland	56	100
Ganges upland	56	88
Tibet plateau	36	79



Asian Highlands - Uplands

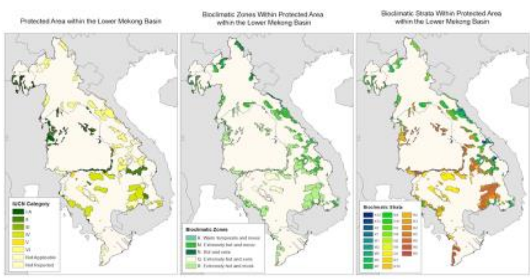
Bioclimatic Zone	Zone	Area (km2)		Area Change		Mean Elevation (m asl)		Upward Shift
		2000	RCP85	Km2	%	2000	RCP85	(m)
Extremely cold and wet	C	17,237	664	(16,573)	(96)	5,231	6,284	1,053
Extremely cold and wet	D	29,955	6,779	(23,176)	(77)	5,287	5,657	370
Cold and wet	E	15,768	2,047	(13,721)	(87)	5,441	6,259	818
Extremely cold and mesic	F	2,081,728	1,478,611	(603,117)	(29)	4,737	4,938	201
Cold and mesic	G	482,477	851,367	368,890	76	3,625	4,236	611
Cool temperate and dry	H	220,573	373,028	152,455	69	2,897	3,259	362
Cool temperate and xeric	I	30,488	50,049	19,561	64	2,314	2,657	342
Cool temperate and moist	J	109,445	86,595	(22,850)	(21)	2,613	3,146	533
Warm temperate and mesic	K	443,738	327,936	(115,802)	(26)	1,677	2,247	570
Warm temperate and xeric	L	62,227	51,431	(10,796)	(17)	1,585	2,019	434
Extremely hot and mesic	M	345,516	390,331	44,815	13	719	970	251
Hot and dry	N	315,404	286,270	(29,134)	(9)	1,087	1,279	191
Extremely hot and arid	O	44,585	47,809	3,224	7	736	1,208	471
Extremely hot and arid	P	13,219	30,190	16,971	128	416	697	281
Extremely hot and xeric	Q	3,892	81,315	77,423	1,989	407	483	76
Extremely hot and moist	R	112,392	264,222	151,830	135	491	687	196
Percent of area shifting to another zone: 48% ; to another stratum: 85%						Average Upward Shift		423





Protected Area within the Lower Mekong Basin:

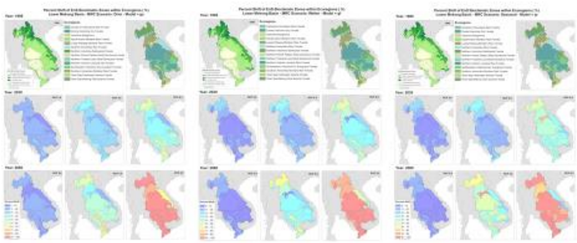
EnS Bioclimatic Zones and Strata within the individual Protected Areas



(Source: IUCN and UNEP-WCMC, 2015),

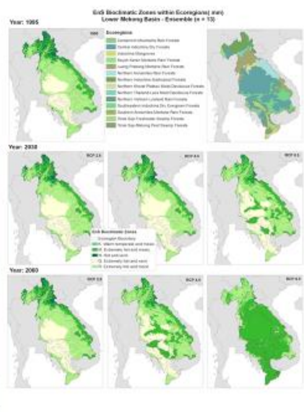
Comparison of Percent Shift of Bioclimatic Zones within Ecoregions

Scenarios: Drier, Wetter, Increased Seasonality



Internal ecoregion change dynamics, both in the near-term (2030) and mid-term (2060) timeframes, reveals rapidly changing landscapes and indicates the rapid onset of a period of prolonged biological and ecological perturbation, driven by changing bioclimatic conditions and spatial displacement of bioclimatic zones, at medium and high impact levels, under all scenarios.

Percent of each of the 14 ecoregions within the Lower Mekong Basin occupied by each of the bioclimatic zones, under baseline (1995) conditions, and as projected for the years 2030 and 2060, across three emission scenarios (RCP 2.6; 4.5; 8.5).



Distribution of Bioclimatic Strata: Protected Area within the LMB

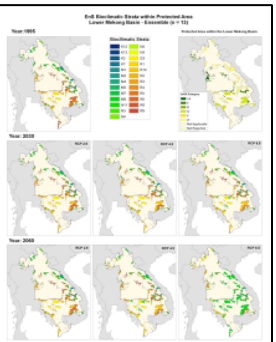
A shift to a nearby EnS Bioclimatic Strata represents a novel set of bioclimatic conditions that will be experienced by the biota and biodiversity within that protected area indicative of biotic perturbance and spatial displacement of biotic conditions within the landscape driven by changing climatic conditions.

Percent of area shifting to a different bioclimatic stratum (drier scenario as example):

By 2030, from 33% to over 75%, of all protected area

By 2060, from 25% to over 97%

Signals profound change in ecosystems, habitats, and species ranges.



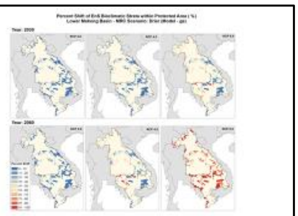
Percent of Area Shifting to a Different Bioclimatic Zone or Strata (model - ga)

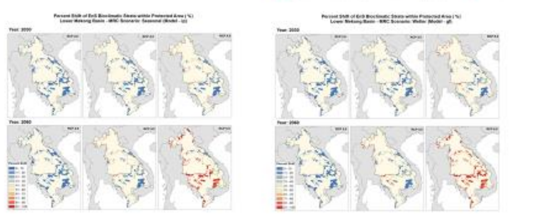
	2030			2060		
	RCP 2.6	RCP 4.5	RCP 8.5	RCP 2.6	RCP 4.5	RCP 8.5
Bioclimatic Zones						
LMB - all	14.1	22.7	41.3	10.9	44.3	82.6
LMB - Protected Area	9.4	16.9	39	7.3	25.1	87.1
Bioclimatic Strata						
LMB - all	28.4	43.9	65.7	22.2	68.4	97.6
LMB - Protected Area	30.1	53.2	75.3	25.5	77	97.2

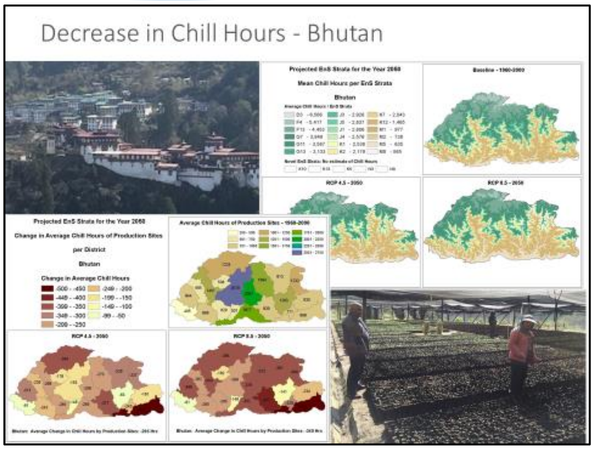
Percent Shift of Bioclimatic Strata within Protected Areas within the LMB

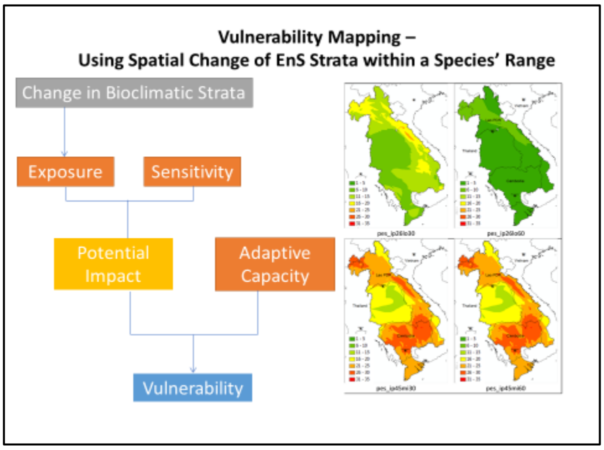
MRC Scenarios

Results indicate an urgent need to to consider projected profound climate change impacts on individual protected areas, the overall protected area network, and for on-going and planned conservation efforts throughout the Lower Mekong Basin.









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Zomer, R. J., Xu, J., Trabucco, Wang, M., Zhuoqing L. 2015. Projected Impact of Climate Change on the Effectiveness of the Existing Protected Area Network for Biodiversity Conservation within Yunnan Province, China. Biological Conservation. 184(C), 335–345. doi:10.1016/j.biocon.2015.01.031

Zomer, R; Wang, M.; and Xu, J., 2015. Projected climate change and impact on bioclimatic conditions in Central and South-Central Asia. ICRAF Working Paper 187. World Agroforestry Centre East and Central Asia, Kunming, China. pp 50. Doi: http://dx.doi.org/10.5716/WP14144.PDF

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Zomer, R. J., Trabucco, A., Wang, M., Rong, L., Chen, H., Metzger, M., Smajgl, A. Beckshafer, P., Xu, J. 2014. Environmental Stratification to Model Climate Change Impacts on Biodiversity and Rubber Production in Xishuangbanna, Yunnan, China, Biological Conservation. 170: 264-273. DOI: 10.1016/j.biocon.2013.11.028.

Zomer, R.J., Trabucco, A., Metzger, M., Oli, K.P., 2013. Environmental Stratification of Kailash Sacred Landscape and Projected Climate Change Impacts on Ecosystems and Productivity: ICIMOD Working Paper 2013/1. International Centre for Integrated Mountain Development (ICIMOD), Kathmandu, Nepal.

Metzger, M., Jongman, R., Sayre, R., Trabucco, A., Zomer, R.J. 2013. A high resolution bioclimate map of the world: a unifying framework for global biodiversity research. Global Ecology and Biogeography 22: 630-638.

Metzger, M.J., Brus, D.J., Bunce, R., Carey, P.D., Goncalves, J., Honrado, J.P., Jongman, R., Trabucco, A., Zomer, R., 2013. Environmental stratifications as the basis for national, European and global ecological monitoring. Ecological Indicators 33: 26-35..

Trabucco, A., and Zomer, R.J. 2010. Global Soil Water Balance Geospatial Database. CGIAR Consortium for Spatial Information. Published online, available from the CGIAR-CSI GeoPortal at: http://www.cgiar-csi.org

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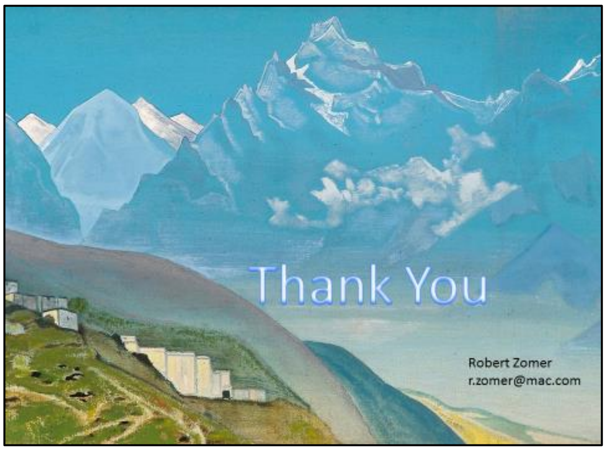
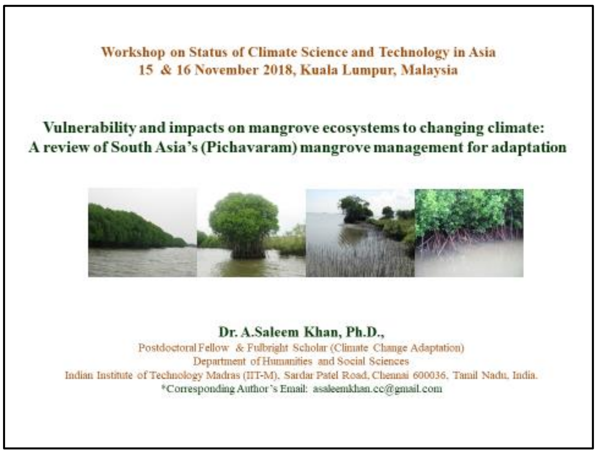
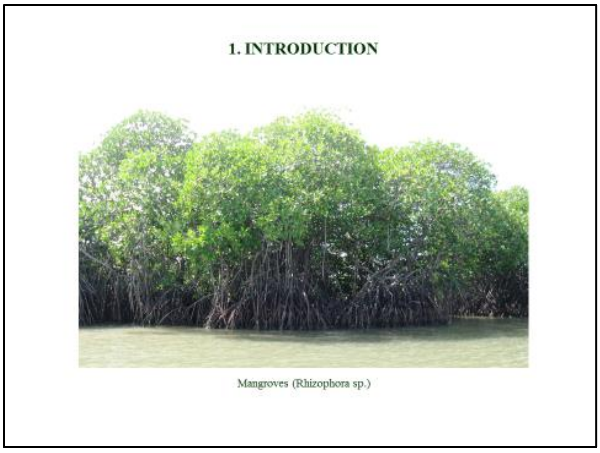
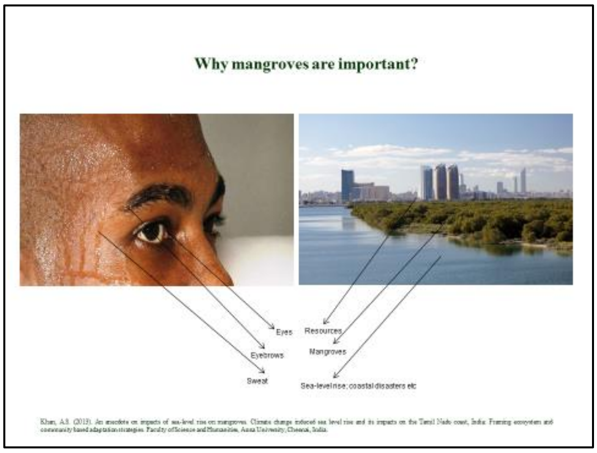
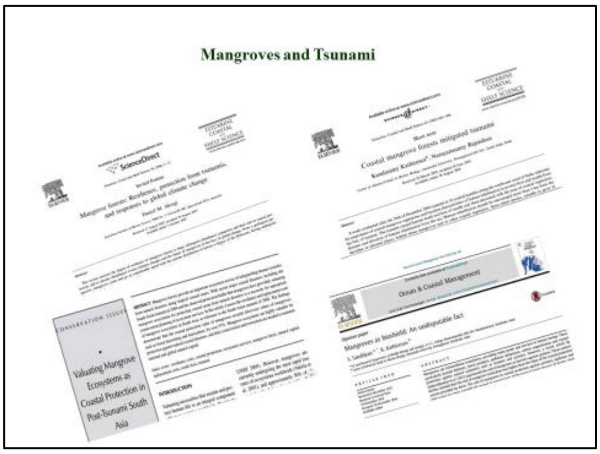
Trabucco, A.; Zomer, R. J.; Bossio, D. A.; van Straaten, O.; Verchot, L.V. 2008. Climate Change Mitigation through Afforestation / Reforestation: A global analysis of hydrologic impacts with four case studies. Agric. Ecosystems and Environment. 126: 81-97.

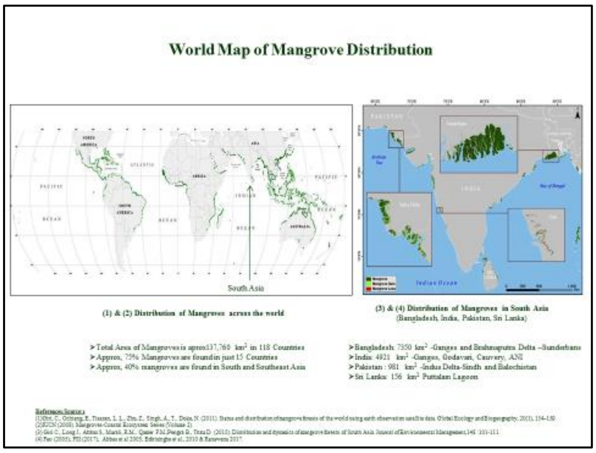


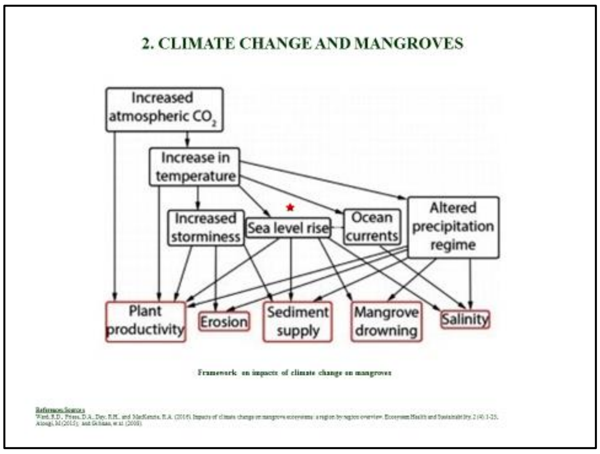

Workshop on Status of Climate Science and Technology in Asia
15 & 16 November 2018, Kuala Lumpur, Malaysia
Vulnerability and impacts on mangrove ecosystems to changing climate:
A review of South Asia's (Pichavaram) mangrove management for adaptation
Dr. A.Saleem Khan, Ph.D.,
Postdoctoral Fellow & Fulbright Scholar (Climate Change Adaptation)
Department of Humanities and Social Sciences
Indian Institute of Technology Madras (IIT-M), Sardar Patel Road, Chennai 600036, Tamil Nadu, India.
*Corresponding Author's Email: asaleemkhan.cc@gmail.com

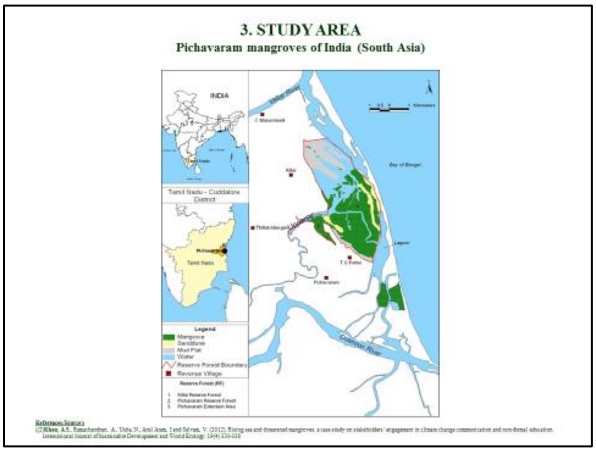

1. INTRODUCTION
Mangroves (Rhizophora sp.)

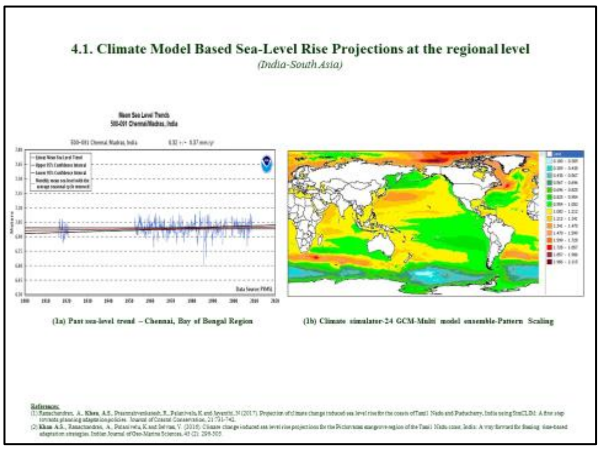

Why mangroves are important?
Eyes
Eyebrows
Sweat
Resources
Mangroves
Sea-level rise; coastal disasters etc

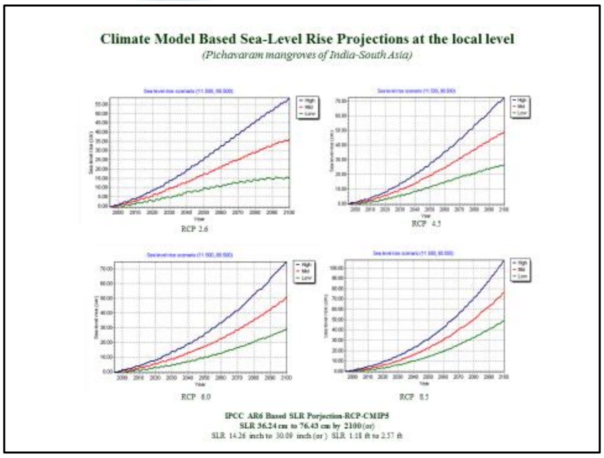

Mangroves and Tsunami
Valuating Mangrove Ecosystems as Coastal Protection in Post-Tsunami South Asia

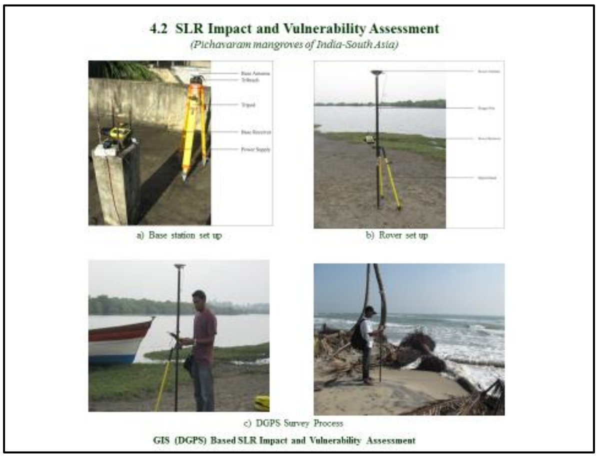

World Map of Mangrove Distribution
South Asia
(1) & (2) Distribution of Mangroves across the world
(3) & (4) Distribution of Mangroves in South Asia
(Bangladesh, India, Pakistan, Sri Lanka)
➤Total Area of Mangroves is aprox137,760 km² in 118 Countries
➤Approx, 75% Mangroves are found in just 15 Countries
➤Approx, 40% mangroves are found in South and Southeast Asia
➤Bangladesh: 7350 km² -Ganges and Brahmaputra Delta –Sunderbans
➤India: 4921 km² -Ganges, Godavari, Cauvery, ANI
➤Pakistan : 981 km² -Indus Delta-Sindh and Balochistan
➤Sri Lanka: 156 km² Puttalam Lagoon
Reference Sources

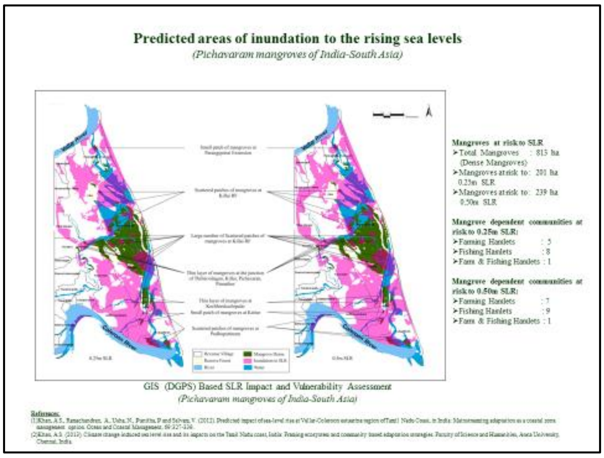

2. CLIMATE CHANGE AND MANGROVES
Increased atmospheric CO2
Increase in temperature
Increased storminess
Sea level rise
Ocean currents
Altered precipitation regime
Plant productivity
Erosion
Sediment supply
Mangrove drowning
Salinity
Framework on impacts of climate change on mangroves
Reference Sources

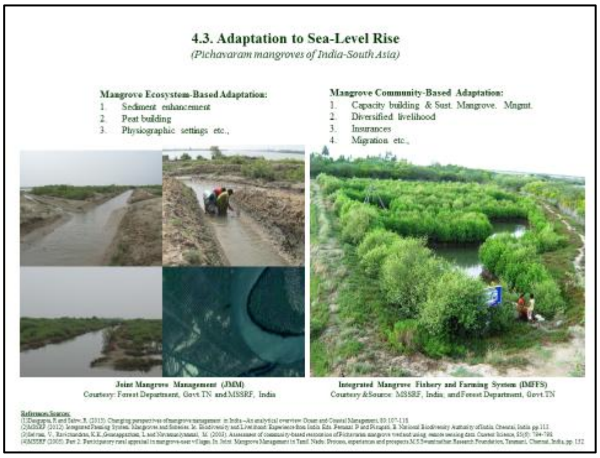

3. STUDY AREA
Pichavaram mangroves of India (South Asia)
INDIA
Tamil Nadu - Cuddalore District
Bay of Bengal
Legend
Mangrove
Sandstone
Mud Flat
Water
Reserve Forest Boundary
Revenue Village
Reference Sources


4.1. Climate Model Based Sea-Level Rise Projections at the regional level
(India-South Asia)
Mean Sea Level Trends
(1a) Past sea-level trend – Chennai, Bay of Bengal Region
(1b) Climate simulator-24 GCM-Multi model ensemble-Pattern Scaling
References



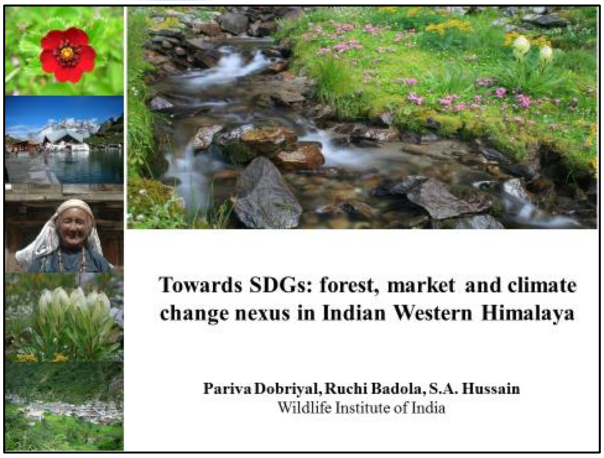




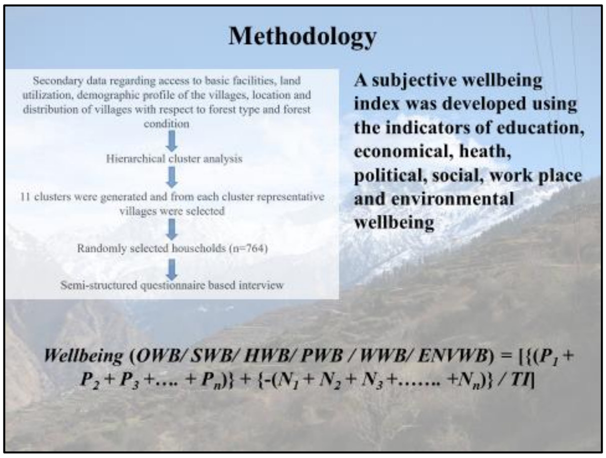


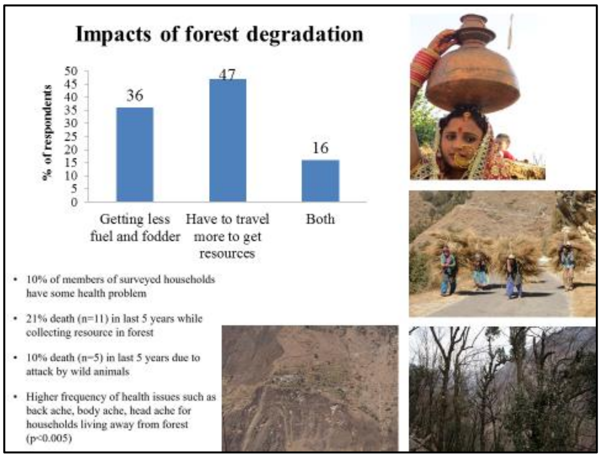
5. CONCLUSION

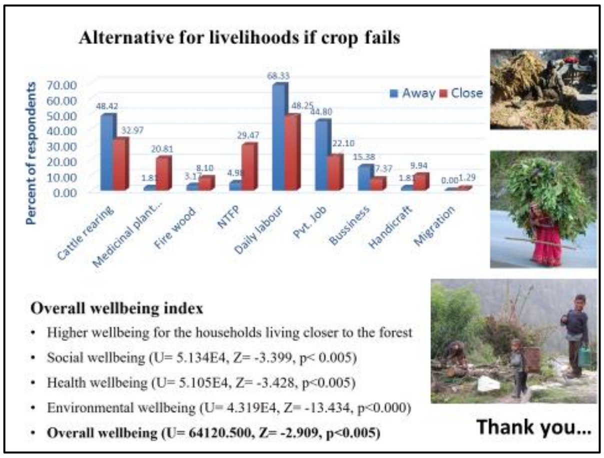
1. An effective application of climate science and technology from the global to the local level - sea level rise projections
2. A systematic approach to address the impact and vulnerability assessment – sea-level rise impacts on mangroves
3. Planning placed based / tailor made adaptation strategies - ecosystem and community based adaptation strategies.

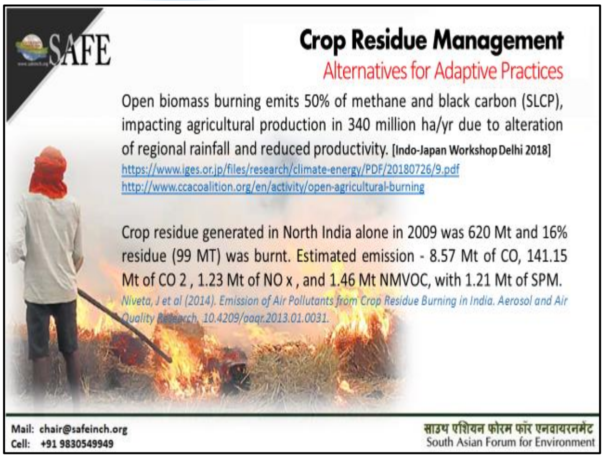

Towards SDGs: forest, market and climate change nexus in Indian Western Himalaya
Pariva Dobriyal, Ruchi Badola, S.A. Hussain
Wildlife Institute of India

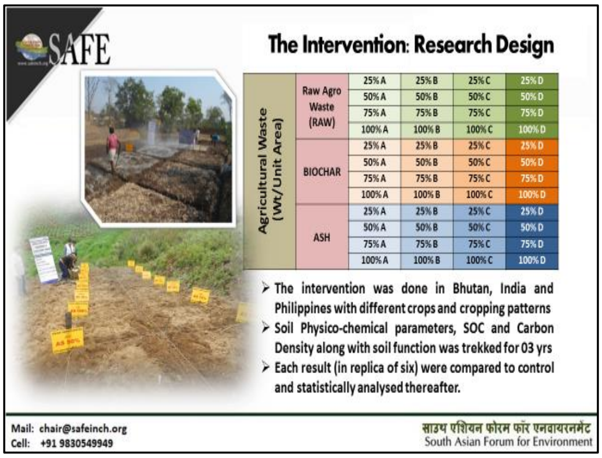

To assess the linkages between health of forest resources and status of human wellbeing


Methodology
Secondary data regarding access to basic facilities, land utilization, demographic profile of the villages, location and distribution of villages with respect to forest type and forest condition
Hierarchical cluster analysis
11 clusters were generated and from each cluster representative villages were selected
Randomly selected households (n=764)
Semi-structured questionnaire based interview
A subjective wellbeing index was developed using the indicators of education, economical, heath, political, social, work place and environmental wellbeing
Wellbeing (OWB/ SWB/ HWB/ PWB / WWB/ ENVWB) = [{(P1 + P2 + P3 +…. + Pn)} + {-(N1 + N2 + N3 +……. +Nn)} / TI]

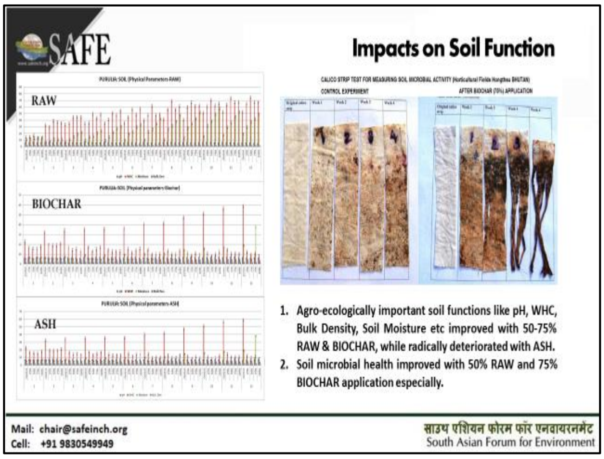

Impacts of forest degradation
% of respondents
50
45
40
35
30
25
20
15
10
5
0
36
47
16
Getting less fuel and fodder
Have to travel more to get resources
Both
10% of members of surveyed households have some health problem
21% death (n=11) in last 5 years while collecting resource in forest
10% death (n=5) in last 5 years due to attack by wild animals
Higher frequency of health issues such as back ache, body ache, head ache for households living away from forest (p<0.005)

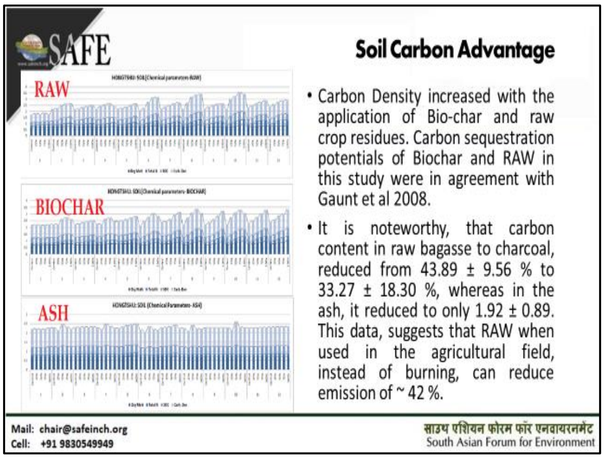

Alternative for livelihoods if crop fails
Percent of respondents
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
Away
Close
48.42
32.97
1.81
20.81
3.1
8.10
4.98
29.47
68.33
48.25
44.80
22.10
15.38
7.37
1.81
9.94
0.00
1.29
Cattle rearing
Medicinal plant...
Fire wood
NTFP
Daily labour
Pvt. Job
Bussiness
Handicraft
Migration
Overall wellbeing index
Higher wellbeing for the households living closer to the forest
Social wellbeing (U= 5.134E4, Z= -3.399, p< 0.005)
Health wellbeing (U= 5.105E4, Z= -3.428, p<0.005)
Environmental wellbeing (U= 4.319E4, Z= -13.434, p<0.000)
Overall wellbeing (U= 64120.500, Z= -2.909, p<0.005)
Thank you...

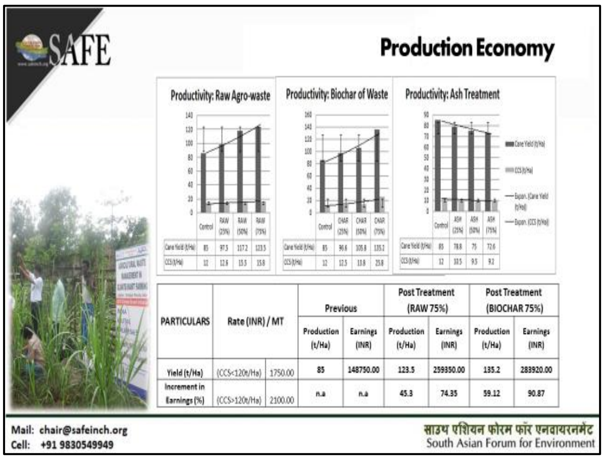




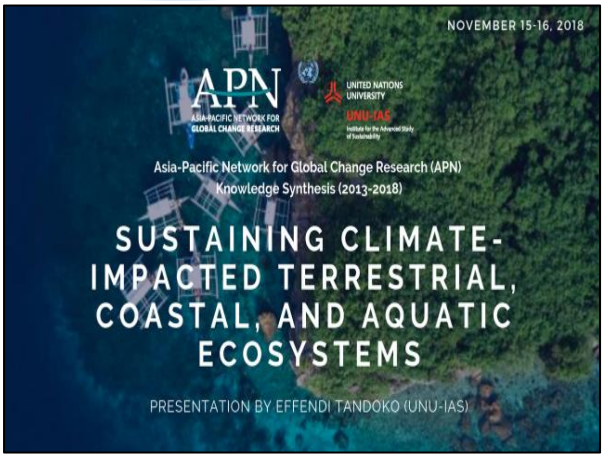
Raw Agro Waste (RAW)	25% A	25% B	25% C	25% D
	50% A	50% B	50% C	50% D
	75% A	75% B	75% C	75% D
	100% A	100% B	100% C	100% D
BIOCHAR	25% A	25% B	25% C	25% D
	50% A	50% B	50% C	50% D
	75% A	75% B	75% C	75% D
	100% A	100% B	100% C	100% D
ASH	25% A	25% B	25% C	25% D
	50% A	50% B	50% C	50% D
	75% A	75% B	75% C	75% D
	100% A	100% B	100% C	100% D

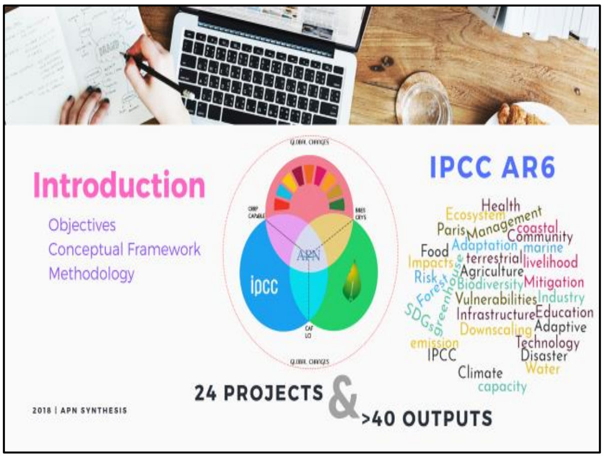


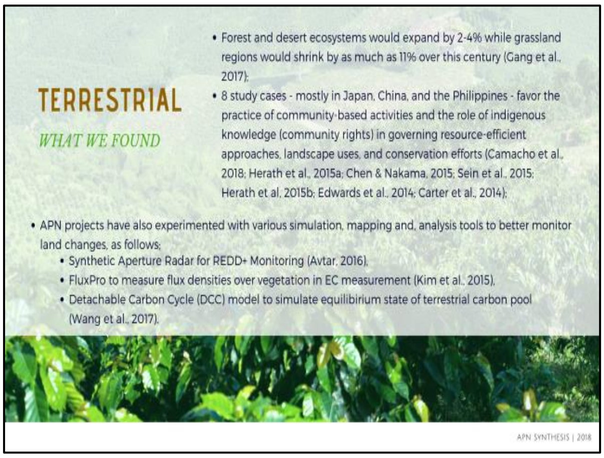


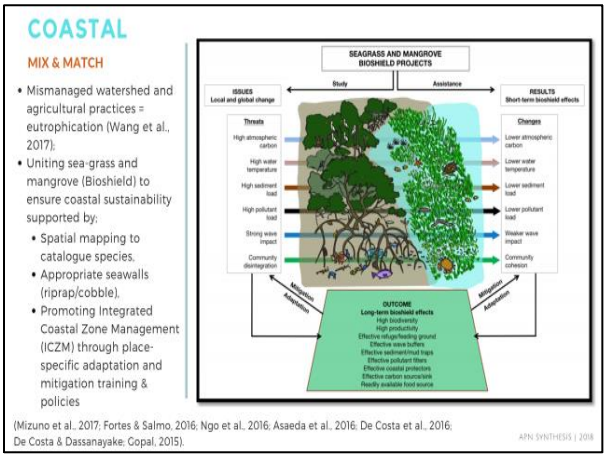


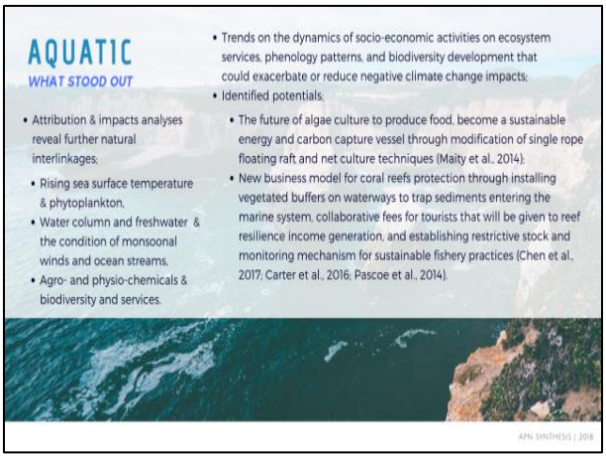
PARTICULARS	Rate (INR) / MT		Previous Production (t/Ha)	Previous Earnings (INR)	Post Treatment (RAW 75%) Production (t/Ha)	Post Treatment (RAW 75%) Earnings (INR)	Post Treatment (BIOCHAR 75%) Production (t/Ha)	Post Treatment (BIOCHAR 75%) Earnings (INR)
Yield (t/Ha)	(CCS<120t/Ha)	1750.00	85	148750.00	123.5	259350.00	135.2	283920.00
Increment in Earnings (%)	(CCS>120t/Ha)	2100.00	n.a	n.a	45.3	74.35	59.12	90.87

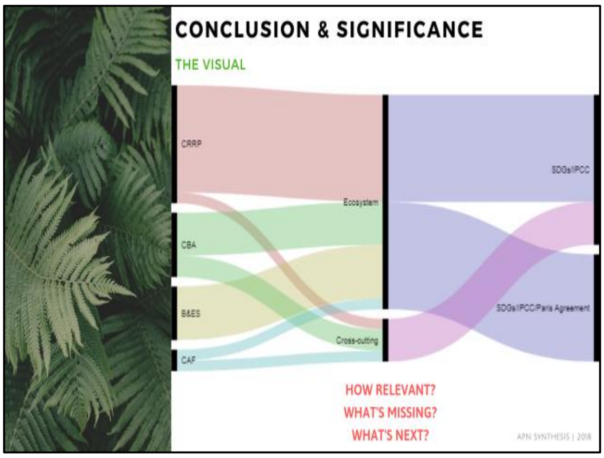

NOVEMBER 15-16, 2018
APN
ASIA-PACIFIC NETWORK FOR GLOBAL CHANGE RESEARCH
UNITED NATIONS UNIVERSITY
UNU-IAS
Asia-Pacific Network for Global Change Research (APN)
Knowledge Synthesis (2013-2018)
SUSTAINING CLIMATE-IMPACTED TERRESTRIAL, COASTAL, AND AQUATIC ECOSYSTEMS
PRESENTATION BY EFFENDI TANDOKO (UNU-IAS)


Introduction
Objectives
Conceptual Framework
Methodology
IPCC AR6
ipcc
APN
Health
Ecosystem
Paris
Management
coastal
Community
Food
Adaptation
marine
Impacts
terrestrial
livelihood
Agriculture
Risk
Biodiversity
Mitigation
Vulnerabilities
Industry
Infrastructure
Education
Downscaling
Adaptive
emission
Technology
IPCC
Disaster
Climate
Water
capacity
2018 | APN SYNTHESIS
24 PROJECTS & >40 OUTPUTS


TERRESTRIAL
WHAT WE FOUND
• Forest and desert ecosystems would expand by 2-4% while grassland regions would shrink by as much as 11% over this century (Gang et al., 2017);
• 8 study cases - mostly in Japan, China, and the Philippines - favor the practice of community-based activities and the role of indigenous knowledge (community rights) in governing resource-efficient approaches, landscape uses, and conservation efforts (Camacho et al., 2018; Herath et al., 2015a; Chen & Nakama, 2015; Sein et al., 2015; Herath et al., 2015b; Edwards et al., 2014; Carter et al., 2014);
• APN projects have also experimented with various simulation, mapping and, analysis tools to better monitor land changes, as follows:
• Synthetic Aperture Radar for REDD+ Monitoring (Avtar, 2016),
• FluxPro to measure flux densities over vegetation in EC measurement (Kim et al., 2015),
• Detachable Carbon Cycle (DCC) model to simulate equilibrium state of terrestrial carbon pool (Wang et al., 2017).
APN SYNTHESIS | 2018


COASTAL
MIX & MATCH
• Mismanaged watershed and agricultural practices = eutrophication (Wang et al., 2017);
• Uniting sea-grass and mangrove (Bioshield) to ensure coastal sustainability supported by:
• Spatial mapping to catalogue species,
• Appropriate seawalls (riprap/cobble),
• Promoting Integrated Coastal Zone Management (ICZM) through place-specific adaptation and mitigation training & policies
SEAGRASS AND MANGROVE BIOSHIELD PROJECTS
ISSUES
Local and global change
RESULTS
Short-term bioshield effects
OUTCOME
Long-term bioshield effects
(Mizuno et al., 2017; Fortes & Salmo, 2016; Ngo et al., 2016; Asaeda et al., 2016; De Costa et al., 2016; De Costa & Dassanayake; Copal, 2015).
APN SYNTHESIS | 2018


AQUATIC
WHAT STOOD OUT
• Trends on the dynamics of socio-economic activities on ecosystem services, phenology patterns, and biodiversity development that could exacerbate or reduce negative climate change impacts;
• Identified potentials:
• The future of algae culture to produce food, become a sustainable energy and carbon capture vessel through modification of single rope floating raft and net culture techniques (Maity et al., 2014);
• New business model for coral reefs protection through installing vegetated buffers on waterways to trap sediments entering the marine system, collaborative fees for tourists that will be given to reef resilience income generation, and establishing restrictive stock and monitoring mechanism for sustainable fishery practices (Chen et al., 2017; Carter et al., 2016; Pascoe et al., 2014).
• Attribution & impacts analyses reveal further natural interlinkages:
• Rising sea surface temperature & phytoplankton,
• Water column and freshwater & the condition of monsoonal winds and ocean streams,
• Agro- and physio-chemicals & biodiversity and services.
APN SYNTHESIS | 2018


CONCLUSION & SIGNIFICANCE
THE VISUAL
CRRP
CBA
B&ES
CAF
Ecosystem
Cross-cutting
SDGs/IPCC
SDGs/IPCC/Paris Agreement
HOW RELEVANT?
WHAT'S MISSING?
WHAT'S NEXT?
APN SYNTHESIS | 2018


THANK YOU!
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ASIA-PACIFIC NETWORK FOR GLOBAL CHANGE RESEARCH
UNITED NATIONS UNIVERSITY
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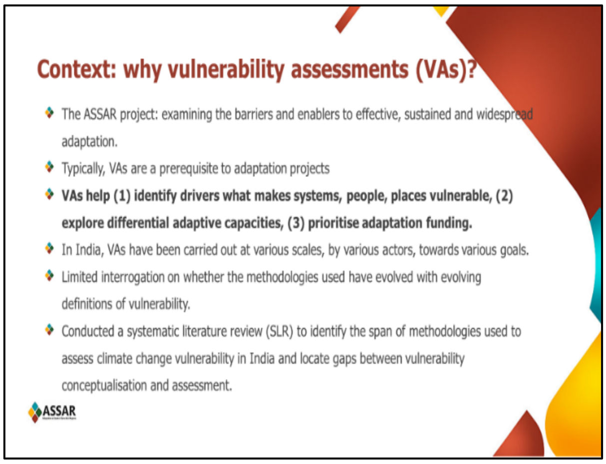
CONTACT ME
Email
tandoko@student.unu.edu
Phone / Whatsapp
+8180-7798-1913 / +62838-9403-7725
Twitter
@daeyura


How do we assess vulnerability to climate change in India? A systematic review of literature
Chandni Singh
iihs
INDIAN INSTITUTE FOR HUMAN SETTLEMENTS
ASSAR
Adaptation at Scale in Semi-Arid Regions


Context: why vulnerability assessments (VAs)?
The ASSAR project: examining the barriers and enablers to effective, sustained and widespread adaptation.
Typically, VAs are a prerequisite to adaptation projects
VAs help (1) identify drivers what makes systems, people, places vulnerable, (2) explore differential adaptive capacities, (3) prioritise adaptation funding.
In India, VAs have been carried out at various scales, by various actors, towards various goals.
Limited interrogation on whether the methodologies used have evolved with evolving definitions of vulnerability.
Conducted a systematic literature review (SLR) to identify the span of methodologies used to assess climate change vulnerability in India and locate gaps between vulnerability conceptualisation and assessment.
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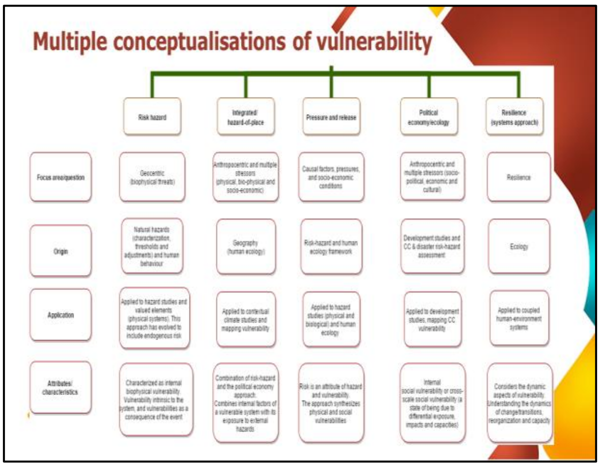
Multiple conceptualisations of vulnerability
Risk hazard
Integrated/ hazard-of-place
Pressure and release
Political economy/ecology
Resilience (systems approach)
Focus area/question
Geocentric (biophysical threats)
Anthropocentric and multiple stressors (physical, bio-physical and socio-economic)
Causal factors, pressures, and socio-economic conditions
Anthropocentric and multiple stressors (socio-political, economic and cultural)
Resilience
Origin
Natural hazards (characterization, thresholds and adjustments) and human behaviour
Geography (human ecology)
Risk-hazard and human ecology framework
Development studies and CC & disaster risk-hazard assessment
Ecology
Application
Applied to hazard studies and valued elements (physical systems). This approach has evolved to include endogenous risk
Applied to contextual climate studies and mapping vulnerability
Applied to hazard studies (physical and biological) and human ecology
Applied to development studies, mapping CC vulnerability
Applied to coupled human-environment systems
Attributes/ characteristics
Characterized as internal biophysical vulnerability. Vulnerability intrinsic to the system, and vulnerabilities as a consequence of the event
Combination of risk-hazard and the political economy approach. Combines internal factors of a vulnerable system with its exposure to external hazards
Risk is an attribute of hazard and vulnerability. The approach synthesizes physical and social vulnerabilities
Internal social vulnerability or cross-scale social vulnerability (a state of being due to differential exposure, impacts and capacities)
Considers the dynamic aspects of vulnerability. Understanding the dynamics of change/transitions, reorganization and capacity


Research questions
In VAs conducted in India,
How is vulnerability conceptually framed?
Who is assessing vulnerability?
How is vulnerability assessed and what scale?
What are the outcomes of these assessments?
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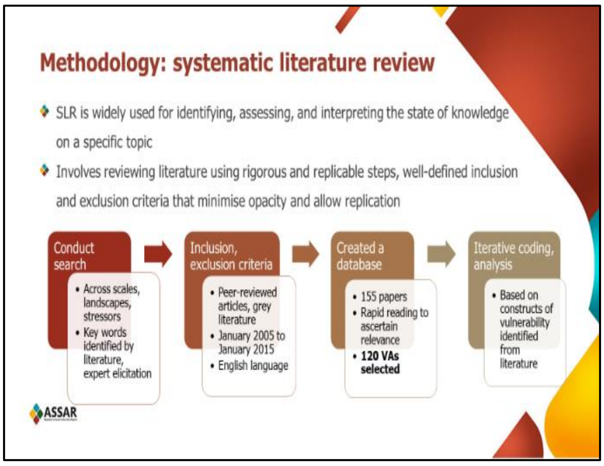
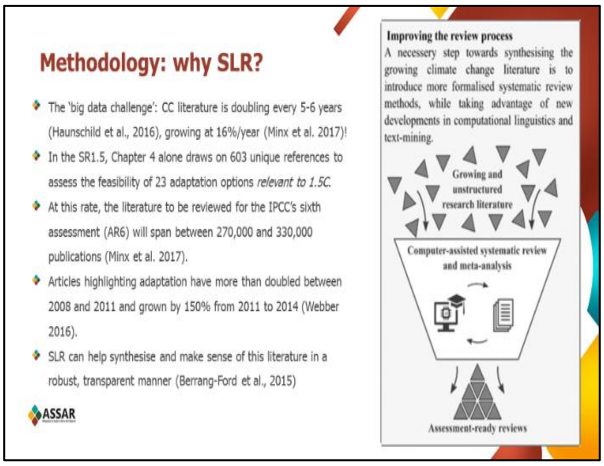
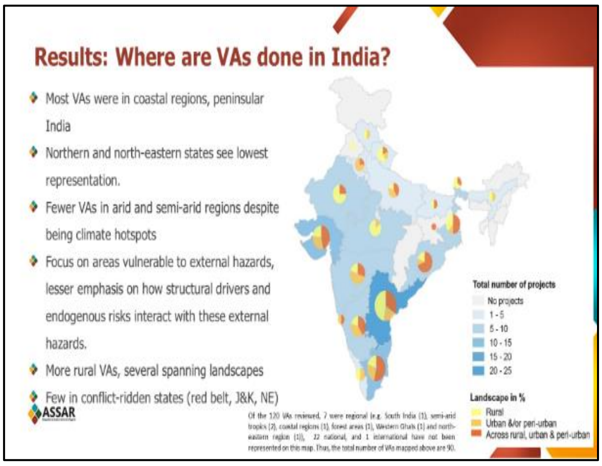
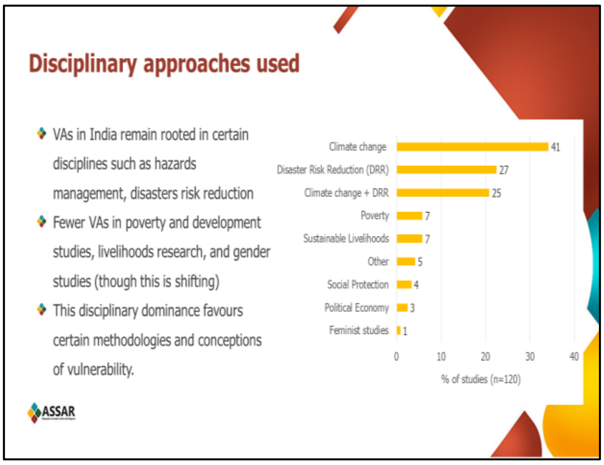
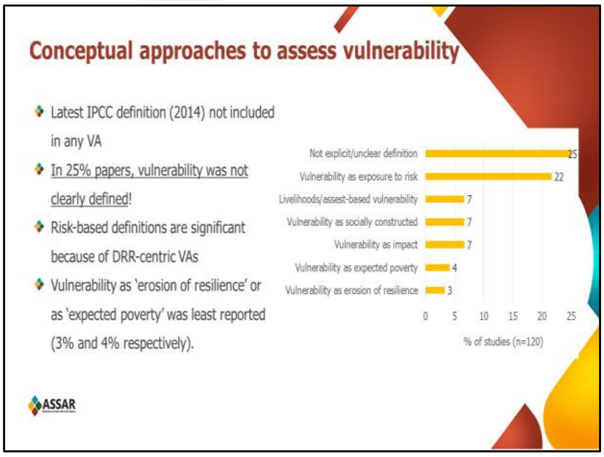
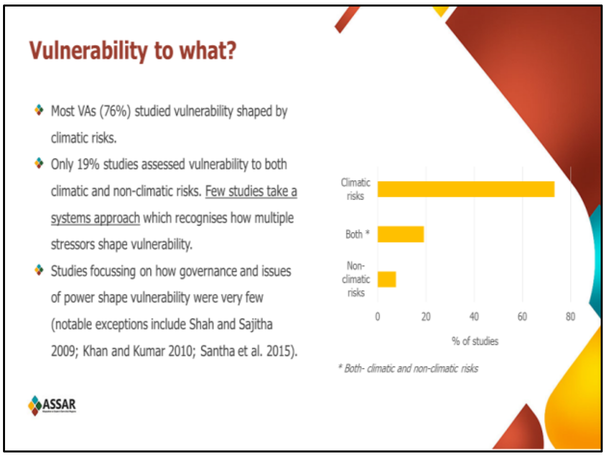

Methodology: systematic literature review
SLR is widely used for identifying, assessing, and interpreting the state of knowledge on a specific topic
Involves reviewing literature using rigorous and replicable steps, well-defined inclusion and exclusion criteria that minimise opacity and allow replication
Conduct search
Across scales, landscapes, stressors
Key words identified by literature, expert elicitation
Inclusion, exclusion criteria
Peer-reviewed articles, grey literature
January 2005 to January 2015
English language
Created a database
155 papers
Rapid reading to ascertain relevance
120 VAs selected
Iterative coding, analysis
Based on constructs of vulnerability identified from literature
ASSAR

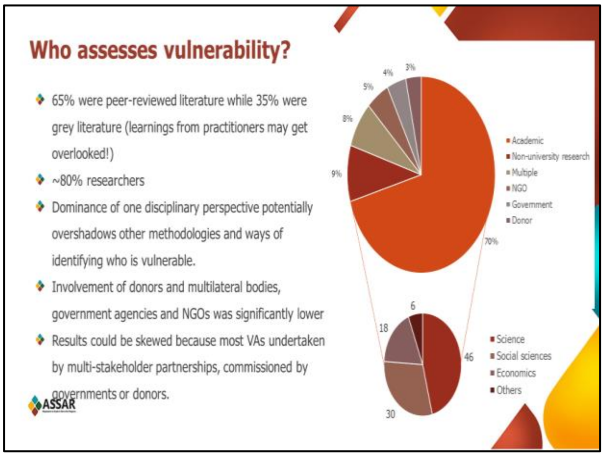

Methodology: why SLR?
The 'big data challenge': CC literature is doubling every 5-6 years (Haunschild et al., 2016), growing at 16%/year (Minx et al. 2017)!
In the SR1.5, Chapter 4 alone draws on 603 unique references to assess the feasibility of 23 adaptation options relevant to 1.5C.
At this rate, the literature to be reviewed for the IPCC's sixth assessment (AR6) will span between 270,000 and 330,000 publications (Minx et al. 2017).
Articles highlighting adaptation have more than doubled between 2008 and 2011 and grown by 150% from 2011 to 2014 (Webber 2016).
SLR can help synthesise and make sense of this literature in a robust, transparent manner (Berrang-Ford et al., 2015)
Improving the review process
A necessary step towards synthesising the growing climate change literature is to introduce more formalised systematic review methods, while taking advantage of new developments in computational linguistics and text-mining.
Growing and unstructured research literature
Computer-assisted systematic review and meta-analysis
Assessment-ready reviews
ASSAR

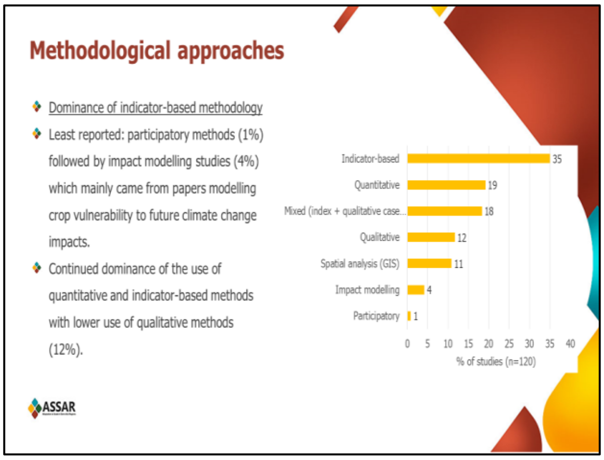

Results: Where are VAs done in India?
Most VAs were in coastal regions, peninsular India
Northern and north-eastern states see lowest representation.
Fewer VAs in arid and semi-arid regions despite being climate hotspots
Focus on areas vulnerable to external hazards, lesser emphasis on how structural drivers and endogenous risks interact with these external hazards.
More rural VAs, several spanning landscapes
Few in conflict-ridden states (red belt, J&K, NE)
Total number of projects
No projects
1 - 5
5 - 10
10 - 15
15 - 20
20 - 25
Landscape in %
Rural
Urban &/or peri-urban
Across rural, urban & peri-urban
Of the 120 VAs reviewed, 7 were regional (e.g. South India (1), semi-arid tropics (2), coastal regions (1), forest areas (1), Western Ghats (1) and north-eastern region (1)), 22 national, and 1 international have not been represented on this map. Thus, the total number of VAs mapped above are 90.
ASSAR

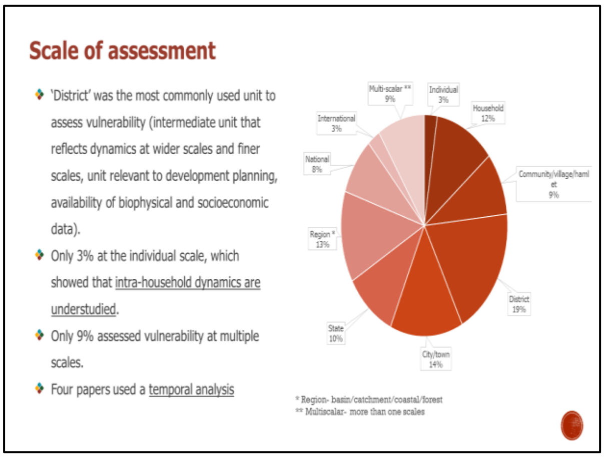

Disciplinary approaches used
VAs in India remain rooted in certain disciplines such as hazards management, disasters risk reduction
Fewer VAs in poverty and development studies, livelihoods research, and gender studies (though this is shifting)
This disciplinary dominance favours certain methodologies and conceptions of vulnerability.
Climate change 41
Disaster Risk Reduction (DRR) 27
Climate change + DRR 25
Poverty 7
Sustainable Livelihoods 7
Other 5
Social Protection 4
Political Economy 3
Feminist studies 1
0
10
20
30
40
% of studies (n=120)
ASSAR

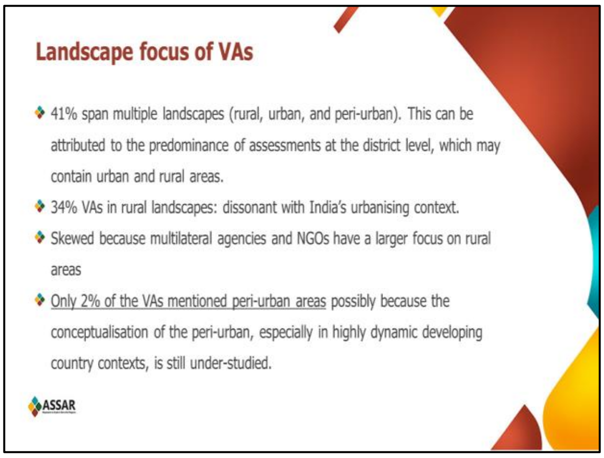

Conceptual approaches to assess vulnerability
Latest IPCC definition (2014) not included in any VA
In 25% papers, vulnerability was not clearly defined!
Risk-based definitions are significant because of DRR-centric VAs
Vulnerability as 'erosion of resilience' or as 'expected poverty' was least reported (3% and 4% respectively).
Not explicit/unclear definition 25
Vulnerability as exposure to risk 22
Livelihoods/assest-based vulnerability 7
Vulnerability as socially constructed 7
Vulnerability as impact 7
Vulnerability as expected poverty 4
Vulnerability as erosion of resilience 3
0 5 10 15 20 25
% of studies (n=120)
ASSAR

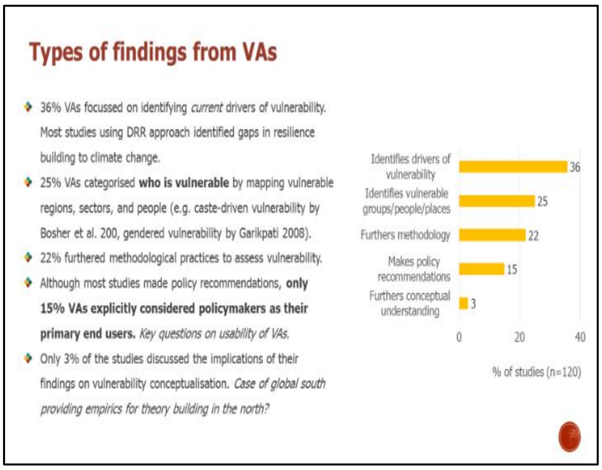

Vulnerability to what?
Most VAs (76%) studied vulnerability shaped by climatic risks.
Only 19% studies assessed vulnerability to both climatic and non-climatic risks. Few studies take a systems approach which recognises how multiple stressors shape vulnerability.
Studies focussing on how governance and issues of power shape vulnerability were very few (notable exceptions include Shah and Sajitha 2009; Khan and Kumar 2010; Santha et al. 2015).
Climatic risks
Both *
Non-climatic risks
0 20 40 60 80
% of studies
* Both- climatic and non-climatic risks
ASSAR

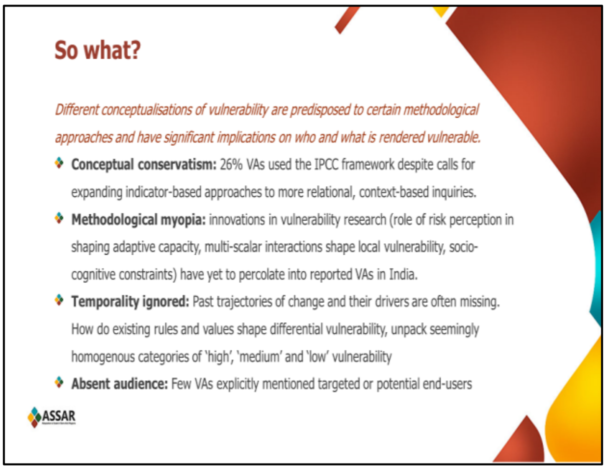

Who assesses vulnerability?
65% were peer-reviewed literature while 35% were grey literature (learnings from practitioners may get overlooked!)
~80% researchers
Dominance of one disciplinary perspective potentially overshadows other methodologies and ways of identifying who is vulnerable.
Involvement of donors and multilateral bodies, government agencies and NGOs was significantly lower
Results could be skewed because most VAs undertaken by multi-stakeholder partnerships, commissioned by governments or donors.
4% 3% 5% 8% 9% 70%
Academic
Non-university research
Multiple
NGO
Government
Donor
6 18 46 30
Science
Social sciences
Economics
Others
ASSAR


Methodological approaches
Dominance of indicator-based methodology
Least reported: participatory methods (1%) followed by impact modelling studies (4%) which mainly came from papers modelling crop vulnerability to future climate change impacts.
Continued dominance of the use of quantitative and indicator-based methods with lower use of qualitative methods (12%).
Indicator-based 35
Quantitative 19
Mixed (index + qualitative case... 18
Qualitative 12
Spatial analysis (GIS) 11
Impact modelling 4
Participatory 1
0 5 10 15 20 25 30 35 40
% of studies (n=120)
ASSAR


Scale of assessment
'District' was the most commonly used unit to assess vulnerability (intermediate unit that reflects dynamics at wider scales and finer scales, unit relevant to development planning, availability of biophysical and socioeconomic data).
Only 3% at the individual scale, which showed that intra-household dynamics are understudied.
Only 9% assessed vulnerability at multiple scales.
Four papers used a temporal analysis
Multi-scalar ** 9%
Individual 3%
Household 12%
Community/village/hamlet 9%
District 19%
City/town 14%
State 10%
Region * 13%
National 8%
International 3%
* Region- basin/catchment/coastal/forest
** Multiscalar- more than one scales


Landscape focus of VAs
41% span multiple landscapes (rural, urban, and peri-urban). This can be attributed to the predominance of assessments at the district level, which may contain urban and rural areas.
34% VAs in rural landscapes: dissonant with India's urbanising context.
Skewed because multilateral agencies and NGOs have a larger focus on rural areas
Only 2% of the VAs mentioned peri-urban areas possibly because the conceptualisation of the peri-urban, especially in highly dynamic developing country contexts, is still under-studied.
ASSAR


Types of findings from VAs
36% VAs focussed on identifying current drivers of vulnerability. Most studies using DRR approach identified gaps in resilience building to climate change.
25% VAs categorised who is vulnerable by mapping vulnerable regions, sectors, and people (e.g. caste-driven vulnerability by Bosher et al. 200, gendered vulnerability by Garikpati 2008).
22% furthered methodological practices to assess vulnerability.
Although most studies made policy recommendations, only 15% VAs explicitly considered policymakers as their primary end users. Key questions on usability of VAs.
Only 3% of the studies discussed the implications of their findings on vulnerability conceptualisation. Case of global south providing empirics for theory building in the north?
Identifies drivers of vulnerability 36
Identifies vulnerable groups/people/places 25
Furthers methodology 22
Makes policy recommendations 15
Furthers conceptual understanding 3
0 20 40
% of studies (n=120)


So what?
Different conceptualisations of vulnerability are predisposed to certain methodological approaches and have significant implications on who and what is rendered vulnerable.
Conceptual conservatism: 26% VAs used the IPCC framework despite calls for expanding indicator-based approaches to more relational, context-based inquiries.
Methodological myopia: innovations in vulnerability research (role of risk perception in shaping adaptive capacity, multi-scalar interactions shape local vulnerability, socio-cognitive constraints) have yet to percolate into reported VAs in India.
Temporality ignored: Past trajectories of change and their drivers are often missing. How do existing rules and values shape differential vulnerability, unpack seemingly homogenous categories of 'high', 'medium' and 'low' vulnerability
Absent audience: Few VAs explicitly mentioned targeted or potential end-users
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Ideas for future research
How are existing and future vulnerabilities perpetuated and (re)created in places of transition such as at peri-urban interfaces?
How do relatively passive drivers (climate variability, natural resource degradation) interface with highly political and contested factors (changing caste dynamics, rising inequality, or political will and fund allocation)?
How does vulnerability change over time – temporality
SLR for urban adaptation
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Website: www.chandnisingh.blogspot.com
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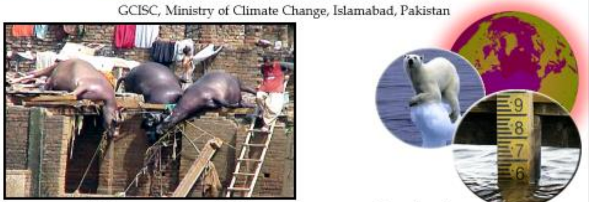
Future climatic changes, extreme event and related uncertainties over Hindu Kush sub-regions of Pakistan

Shaukat Ali

GCISC, Ministry of Climate Change, Islamabad, Pakistan



Workshop on Status of Climate Science and Technology in Asia

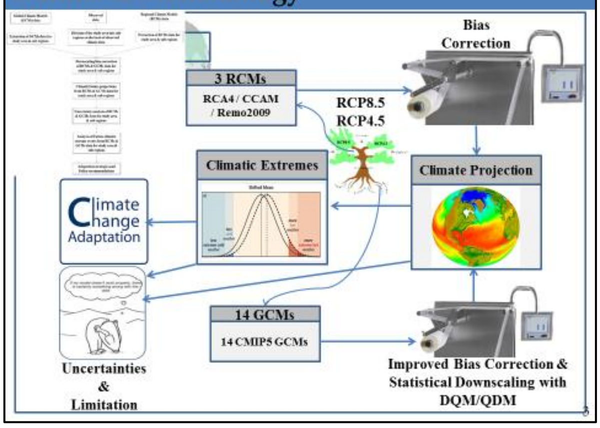
15-16 November 2018, Kuala Lumpur, Malaysia

My ongoing Projects

1. Consultant: Asia Development Bank (ADB) project titled "Climate Risk and Vulnerability Assessment (CRVA) in Bajaur, Khyber, and Mohmand Agencies of Pakistan 2018".
2. PI: APN project "Towards robust projections of climate extremes and adaptation plans over South Asia: CRRP2017-SP589-ALI. 2018-2021"
3. Consultant (Climate Change Expert): The health impacts of heatwaves and future climate changes in temperature on the movement of disease vector" with National Institute of Health(NIH), Islamabad
4. Co-PI: "Impact of debris cover thickness and temperature variations on glacier melting (in relation to Karakoram Anomaly) in the Upper Indus Basin" with Chinese Academy of Sciences and International Centre for Integrated Mountain Development (ICIMOD).

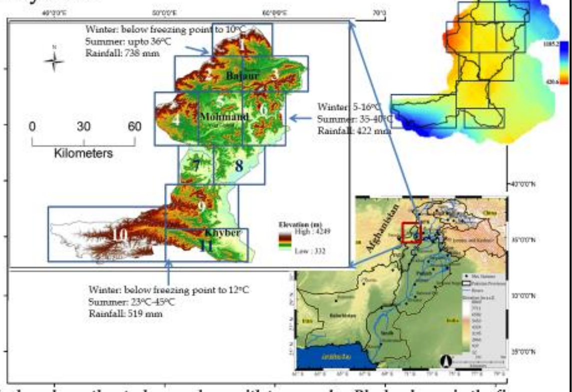
2

Outline & Methodology



3

Study Area



The box shows the study area along with topography. Blocks shown in the figure are sub-regions based on estimated high resolution precipitation gridded data 4

Global Climate Models

#	Model	Resolution	Organization
1	CanESM2	2.7906 x 2.8125	Canadian Centre for Climate Modelling and Analysis
2	CCSM4	1.250 x 0.942	National Center for Atmospheric Research
3	CESM1-CAM5	1.250 x 0.942	National Center for Atmospheric Research
4	CMCC-CMS	1.875 x 1.865	Centro Euro-Mediterraneo per I Cambiamenti Climatici
5	CNRM-CM5	1.406 x 1.401	Centre National de Recherches Meteorologiques
6	EC-EARTH	1.1215 x 1.125	Irish Centre for High-End Computing (ICHEC), European Consortium
7	FGOALS-s2	2.813 x 1.659	LASG, Institute of Atmospheric Physics, Chinese Academy of Sciences
8	GFDL-ESM2G	2.500 x 2.023	Geophysical Fluid Dynamics Laboratory
9	GFDL-ESM2M	2.500 x 2.023	Geophysical Fluid Dynamics Laboratory
10	INM-CM4	2.000 x 1.500	Institute for Numerical Mathematics
11	MIROC-ESM-CHEM	2.7906 x 2.8125	National Institute for Environmental Studies, The University of Tokyo
12	MPI-ESM-LR	1.875 x 1.865	Max Planck Institute for Meteorology (MPI-M)
13	MPI-ESM-MR	1.875 x 1.865	Max Planck Institute for Meteorology (MPI-M)
14	NorESM1-M	2.500 x 1.895	Norwegian Climate Centre

5

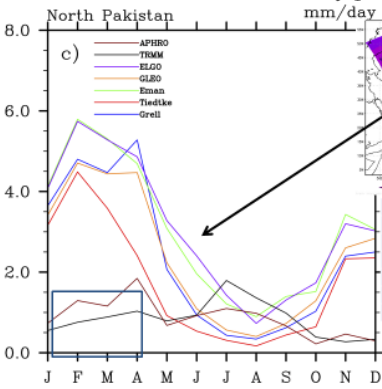
Regional Climate Models

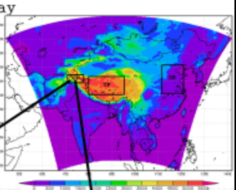
Model	RCM Description	Driving GCM
RCA4 (ICHEC)	Rossby Centre regional atmospheric model version 4 (RCA4; Samuelsson et al., 2011)	Irish Centre for High-End Computing (ICHEC), European Consortium ESM (EC-EARTH; Hazeleger et al. 2012)
CCAM	Commonwealth Scientific and Industrial Research Organisation (CSIRO), Conformal-Cubic Atmospheric Model (CCAM; McGregor and Dix, 2001)	MPI-ESM-LR
REMO2009 (MPI)	MPI Regional model 2009 (REMO2009)	MPI-ESM-LR (Giorgetta et al 2013)

6

Validation of RCM Run on 20km

Seasonal variation of the monthly precipitation





Precipitation (RMSEs)				
CPSs	MAM	JJA	SON	DJF
Tiedtke	*1.85*	*1.17*	*0.85*	3.35
Grell	3.44	1.09	1.03	3.72
Emanuel	3.74	0.99	1.72	4.41
GLEO	3.19	1.02	1.20	3.72
ELGO	3.85	0.92	1.68	4.36

>Rapid variation in the topography

>The actual height of Himalayas is more than prescribed height in RegCM model (Sinha et al. 2013).

> Problem with observe data.

7

Climate Change (Temperature)RCP8.5

Duration	Seasonal mean of Max-temperature				Seasonal mean of Min-temperature				
	DJF	MAM	JJA	SON	DJF	MAM	JJA	SON	Average
Observation	8.52	20.68	30.22	21.13	-1.38	9.49	18.15	7.95	**14.99**
1976-2005	2.53	15.15	22.25	12.26	-9.12	2.03	8.63	1.06	**7.54**
2006-2035	3.42	16.27	23.36	13.00	-5.59	5.93	12.45	4.12	9.66
2041-2070	5.53	18.31	25.48	15.04	-3.49	7.78	14.27	5.96	11.66
2071-2100	8.35	21.51	28.71	17.27	-2.42	7.96	14.07	6.20	13.40

(°C)

	Future increase in Max-temperature with 1976-2005				Future increase in Min-temperature with 1976-2005				
2006-2035	0.89	1.12	1.12	0.74	3.53	3.90	3.82	3.05	2.27
2041-2070	2.99	3.16	3.23	2.78	5.64	5.74	5.64	4.90	4.26
2071-2100	5.82	6.36	6.46	5.01	6.70	5.93	5.44	5.14	5.86

RCP4.5 and RCP8.5 comparison

	RCP4.5	RCP8.5
2006-2035	0.54	2.27
2041-2070	1.55	4.26
2071-2100	2.08	5.86

More increase

Less increase

8

Climate Change (Precipitation)RCP8.5

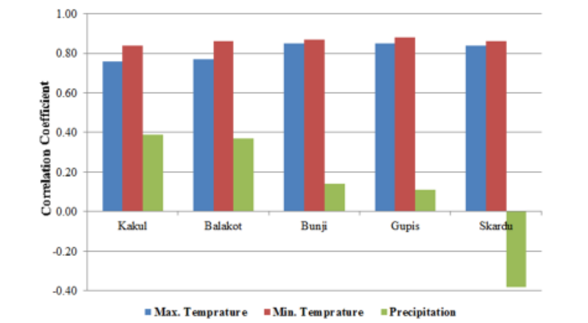
Duration	Seasonal values of precipitation in RCP8.5					Seasonal values of precipitation in RCP4.5				
	DJF	MAM	JJA	SON	Avg.	DJF	MAM	JJA	SON	Avg.
Observation	1.42	2.14	3.15	1.08	1.95	1.42	2.14	3.15	1.08	1.95
1976-2005	2.95	2.08	4.07	4.09	3.30	2.84	2.11	4.24	3.98	3.29
2006-2035	3.18	2.32	4.43	4.75	3.67	2.69	2.29	4.88	4.86	3.68
2041-2070	2.92	2.38	4.72	5.09	3.78	3.17	2.23	4.65	5.04	3.77
2071-2100	3.06	2.77	4.60	5.45	3.97	2.93	2.30	4.61	5.18	3.75

mm/day

	Future percentage increase of precipitation with 1976-2005 in RCP8.5					Future percentage increase of precipitation with 1976-2005 in RCP4.5				
2006-2035	7.59	11.60	8.92	16.08	**11.05 %**	-5.15	8.38	14.96	21.99	**10.05 %**
2041-2070	-1.24	14.16	16.09	24.47	**13.37 %**	11.51	5.74	9.47	26.65	**13.34 %**
2071-2100	3.49	32.95	13.02	33.23	**20.67 %**	3.25	8.77	8.52	30.13	**12.67 %**

9

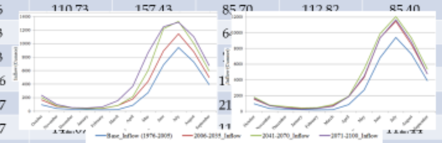
Correlation Coefficient between observed Max. TMP, Min. TMP, Precipitation with Inflow (1991-2000)



10

Hydrological Changes (Mean of monthly % Inflows)

	RCP8.5 (% increase inflow)			RCP4.5 (% increase inflow)		
Month	**2006-2035**	**2041-2070**	**2071-2100**	**2006-2035**	**2041-2070**	**2071-2100**
October	73.93	111.15	144.28	59.20	85.23	73.32
November	85.36	110.73	157.43	85.70	112.82	85.40
December	75.23	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
January	93.03	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
February	122.26	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
March	253.97	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
April	104.77	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
May	60.14	119.48	215.62	58.55	95.73	63.06
June	30.33	78.27	82.66	37.25	44.37	36.41
July	21.78	41.14	39.99	21.85	28.31	24.20
August	20.59	37.74	50.96	16.57	28.13	21.39
September	27.88	52.26	73.01	21.74	37.63	22.00
Average	**34.65**	**63.73**	**87.01**	**33.68**	**46.81**	**35.38**



CCAM

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Limitations

- In UIB basin, the river flow is contributed mostly from snow and glaciers melt. More robust modeling approach and observed data (currently depending on lapse rate) is required to handle the glacier, debris cover and snow melting and accumulation.
- Bias correction and calibration approaches implicitly assume that it will retain in future scenarios, and this added an additional uncertainty to the future projection of climate models, despite the fact that the bias correction was performed with recent observed data.
- Two climate models (CCAM and RegCM) and one hydrological model is used. It needs to improve with finer resolution and multi-model (climate and hydrological) ensemble results to explore the uncertainties in more details.

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Simple Bias Correction

The following two techniques for bias correction.

1. Best Easy Systematic (BES; Wonnacott and Wonnacott 1972) is used for Temperature:
   a) BES = [Q1+2*Q2+Q3]/4
   b) Bias Corrected data = [RCM Simulated data – BES]
   Where Q1, Q2 and Q3 are first, second and third quartile of the bias series

2. Mean Monthly Correction Factor (MMCF) method:
   a) BC = k × model_data
   Where k = Ratio of observed monthly and simulated monthly average Precipitation.
   model_data = Baseline simulated uncorrected data
   BC = Baseline simulated bias corrected data.

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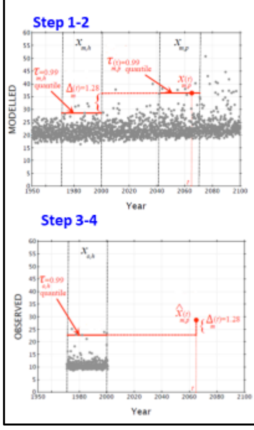
Improved bias correction Quantile Delta Mapping (QDM)



Step in QDM

1. Considered a date in future period say 01-01-2060 and find the value of precipitation on above date e.g T_{future} (01-01-2060) = 36.5 and calculate the quantile of this value Q(36.5)=0.99
2. Now find the value in historical period of same quantile e.g $T_{historical}$ (0.99) = 28.5.
3. Take the diff of T_{future} - $T_{historical}$ (in case of temperature) and ratio Pr future/Pr historical (in care of precipitation) . e.g $Diff_{f,h}$ = 36.5-28.5 = 8
4. Find the value in observed time series against the same quantile in future period e.g $T_{observe}$ (0.99) = 22.6.
5. Bias corrected data of future for Temperature T_{future} (Bias Corrected) = 22.6 +8 = 30.6 (for precipitation the ratio will multiple 22.6 * ratio)

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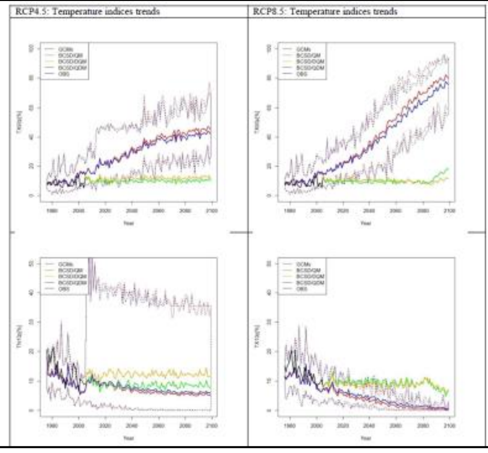

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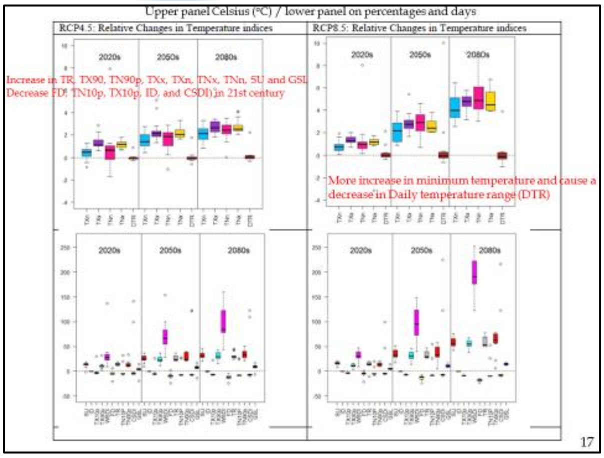

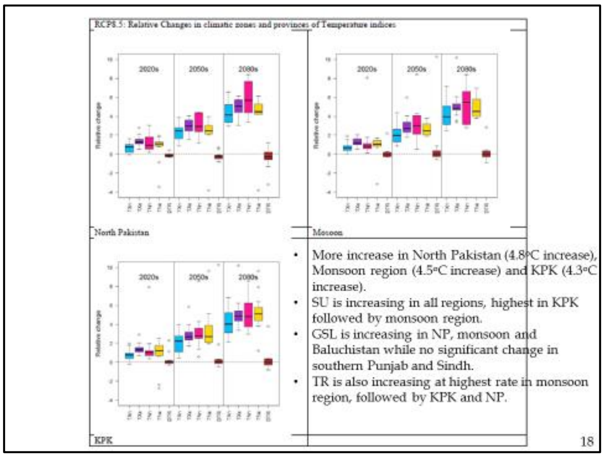

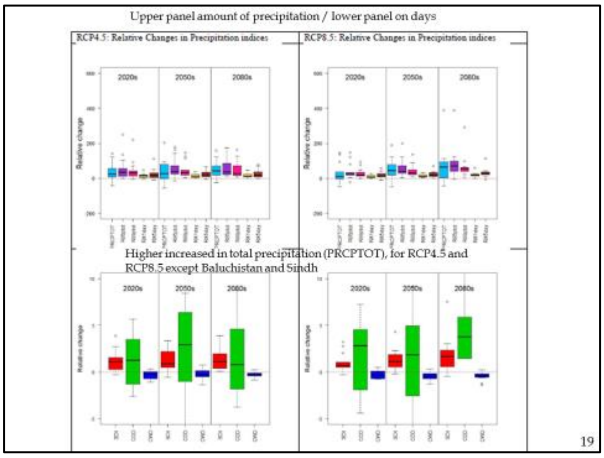

Maximum temperature increase

	RCP4.5 (Maximum Temperature)					RCP8.5 (Maximum Temperature)				
Bajaur	**DJF**	**MAM**	**JJA**	**SON**	**Avg**	**DJF**	**MAM**	**JJA**	**SON**	**Avg**
2006-2040	0.84	1.12	0.98	1.01	0.99	1.12	1.59	1.07	1.09	1.22
2041-2070	1.81	2.09	1.89	1.94	1.93	2.82	3.23	2.74	2.96	2.94
2071-2100	2.36	2.54	2.06	2.25	2.30	5.11	5.27	4.72	4.72	4.96
Mohmand										
2006-2040	0.82	1.10	0.97	1.00	0.97	1.10	1.52	1.06	1.06	1.19
2041-2070	1.76	2.00	1.87	1.90	1.88	2.72	3.10	2.68	2.88	2.85
2071-2100	2.30	2.47	2.01	2.19	2.24	4.96	5.13	4.63	4.80	4.88
Khyber										
2006-2040	0.81	1.08	0.98	1.02	0.97	1.09	1.46	1.06	1.07	1.17
2041-2070	1.74	1.95	1.88	1.89	1.87	2.69	3.02	2.65	2.85	2.80
2071-2100	2.27	2.40	2.00	2.20	2.22	4.88	5.05	4.55	4.73	4.80
Total Area										
2006-2040	0.82	1.10	0.98	1.01	0.98	1.10	1.52	1.07	1.07	1.19
2041-2070	1.77	2.02	1.88	1.91	1.89	2.74	3.12	2.69	2.90	2.86
2071-2100	2.31	2.47	2.02	2.21	2.25	4.98	5.15	4.63	4.75	4.88

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Minimum temperature increase

	RCP4.5 (Minimum Temperature)					RCP8.5 (Minimum Temperature)				
Bajaur	**DJF**	**MAM**	**JJA**	**SON**	**Avg**	**DJF**	**MAM**	**JJA**	**SON**	**Avg**
2006-2040	2.52	1.50	0.19	0.99	1.30	2.85	1.93	0.22	1.04	1.51
2041-2070	3.77	2.56	0.75	1.67	2.18	4.64	3.28	1.57	2.46	2.99
2071-2100	4.95	2.75	0.86	1.67	2.56	6.52	4.92	3.25	3.25	4.49
Mohmand										
2006-2040	2.28	1.42	0.04	0.85	1.15	2.58	1.78	0.06	0.91	1.33
2041-2070	3.43	2.40	0.66	1.50	2.00	4.23	3.11	1.44	2.29	2.77
2071-2100	4.51	2.59	0.76	1.49	2.34	6.02	4.78	3.14	3.95	4.48
Khyber										
2006-2040	2.04	1.26	-0.21	0.73	0.95	2.34	1.61	-0.16	0.79	1.15
2041-2070	3.12	2.22	0.38	1.29	1.75	3.87	2.93	1.16	2.09	2.51
2071-2100	4.11	2.38	0.46	1.30	2.06	5.62	4.62	2.88	3.81	4.23
Total Area										
2006-2040	2.28	1.39	0.01	0.86	1.13	2.59	1.77	0.04	0.91	1.33
2041-2070	3.44	2.39	0.60	1.48	1.98	4.25	3.10	1.39	2.28	2.76
2071-2100	4.52	2.57	0.69	1.49	2.32	6.05	4.78	3.09	3.67	4.40

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Precipitation increase

	RCP4.5 (Precipitation %)					RCP8.5 (Precipitation %)				
Bajaur	**DJF**	**MAM**	**JJA**	**SON**	**Avg**	**DJF**	**MAM**	**JJA**	**SON**	**Avg**
2006-2040	11.01	6.11	6.55	9.73	8.35	14.96	7.58	9.45	11.73	10.93
2041-2070	20.04	11.52	11.74	22.49	16.45	9.78	10.92	14.87	13.95	12.38
2071-2100	16.59	6.59	12.06	9.97	11.30	26.90	8.62	19.46	19.46	18.61
Mohmand										
2006-2040	10.63	7.46	9.21	13.27	10.14	15.34	8.44	9.15	12.80	11.43
2041-2070	22.46	10.63	11.71	22.86	16.92	11.16	12.18	16.33	15.21	13.72
2071-2100	12.66	6.65	13.27	10.67	10.81	23.43	8.48	24.14	35.22	22.82
Khyber										
2006-2040	9.80	7.77	12.29	17.26	11.78	15.69	9.28	12.72	13.61	12.82
2041-2070	25.25	11.00	15.32	24.08	18.91	12.88	12.00	20.23	19.02	16.03
2071-2100	11.37	6.77	14.12	13.28	11.38	22.36	10.71	29.28	37.36	24.93
Total Area										
2006-2040	10.48	7.11	9.35	13.42	10.09	15.33	8.43	10.44	12.72	11.73
2041-2070	22.58	11.05	12.92	23.14	17.43	11.27	11.70	17.15	16.06	14.05
2071-2100	13.54	6.67	13.15	11.31	11.17	24.23	9.27	24.29	30.68	22.12

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Minimum/Maximum temperature increase

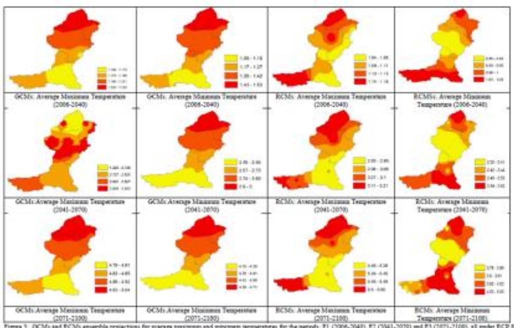

Figure 3: GCMs and RCMs ensemble projections for average maximum and minimum temperatures for the periods, F1 (2006-2040), F2 (2041-2070) and F3 (2071-2100), all under RCP 8.5.

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Trends of extreme climate events

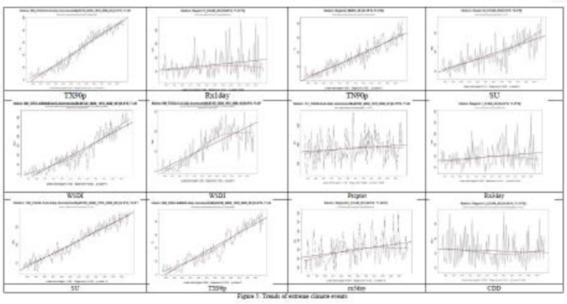

Figure 5: Trends of extreme climate events

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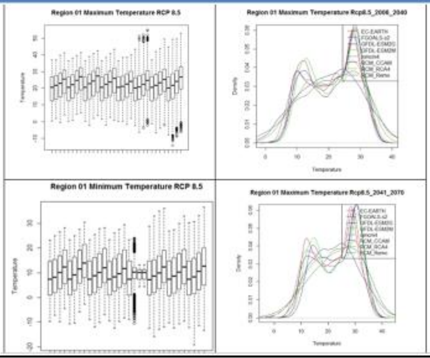
Uncertainties



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Average value & standard deviation

	RCP4.5			RCP8.5		
PERIOD	Max Temp	Min Temp	Precipitation	Max Temp	Min Temp	Precipitation
1976-2005	19.35 ± 1.00	7.74± 0.37	2.53 ± 1.09	19.76 ± 0.01	7.59± 0.01	2.08± 0.01
2006-2040	20.40 ± 0.90	9.08 ± 0.67	2.58± 1.10	20.99 ± 0.47	9.11 ± 0.50	2.10 ± 0.22
2041-2070	21.46 ± 0.73	10.08± 0.85	2.70 ± 1.15	22.72 ± 0.82	10.59 ± 0.99	2.19± 0.19
2071-2099	21.88 ± 0.59	10.35 ± 1.01	2.63 ± 1.26	24.79 ± 0.90	12.28± 1.80	2.25 ± 0.47

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Adaptations & limitations

1. It is essential to establish some early warning system for flash floods and install hydro-climatic stations for better understanding of the climatology and weather condition of the region.
2. To improve water storage and to reduce the risk of the flash floods, construction of small dams is suggested on the northern streams and also in the southern part. This is vital as due to extreme temperature the snow is also expected to melt rapidly in future.
3. Precipitation estimates provided by reanalysis, station observations, remote sensing have large discrepancies.

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Acknowledgment

Asia-Pacific Network for Global Change Research (**APN**)
Asian Network on Climate Science and Technology (ANCST)
Asian Development Bank

Household Vulnerability and Adaptation to Land and Forest Degradation Associated with Climate Change in Kanan Watershed, Philippines

Juan M. Pulhin, Lorena L. Sabino, Josephine E. Garcia
Catherine C. de Luna, Liezl B. Grefalda and Canesio D. Predo

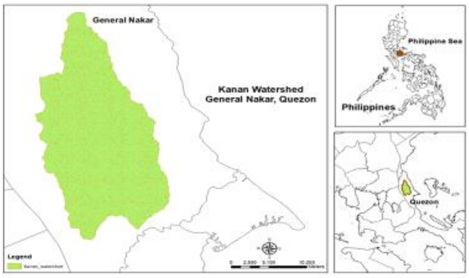
College of Forestry and Natural Resources
University of the Philippines Los Banos

Introduction

- In the Philippines, land and forest degradation in watershed areas is primarily caused by a number of interacting human, institutional, governance and climatic factors.
- Climate change vulnerability has to be understood from a broader, socio-economic and political context, not simply from a climate science perspective.

Source: Environmental Science for Social Change (199) cited in FLUP, 2010

Study Location



Kanan Watershed, Municipality of General Nakar
Province of Quezon, Philippines

Research Design and Methods

- ***Household survey*** involving 189 respondents with the aid of stratified random sampling with proportional allocation
- It was complemented with Focus group discussion, field observations and with secondary data

- **Vulnerability** was assessed based on developed indicators from biophysical and socio-economic parameters using equal and unequal weighting methods.

Key Findings

- Typhoons and heavy rainfall which cause floods/flash floods and landslide are the common climate risk events experienced by the communities in the study area.
- Households vulnerability fall into low to moderate vulnerabilities with the majority, being moderately vulnerable.

Level and percentage of households' livelihood vulnerability using equal and unequal weighting

Barangay/no. of samples	Level* and Percentage equal weighting			Level* and Percentage unequal weighting		
	Low	Medium	High	Low	Medium	High
Mahabang Lalim (n= 56)	62.5	37.5	0	91.07	8.93	0
Pagsangahan (n=133)	11.28	87.97	0.75	18.80	81.20	0
Total (N = 189)	26.46	73.02	0.53	**40.21**	**59.79**	**0**

*Legend: (0.00-0.33 – Low); (0.34-0.66 – Moderate); (0.67-1.00 – High)

Key Findings

Current adaptations :

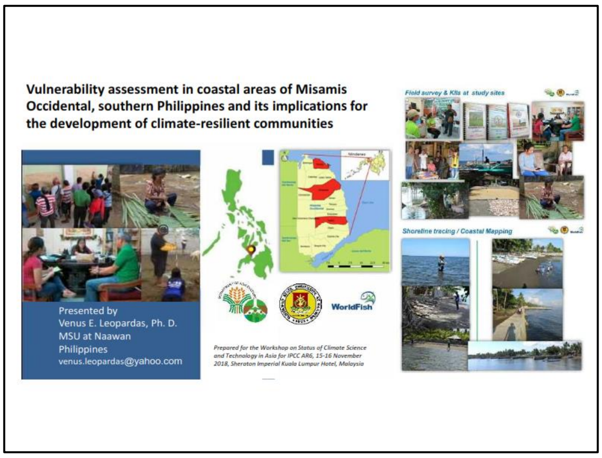
- nursery and agroforestry establishment
- establishment of evacuation center
- adopting soil and water conservation
- formation of Barangay (village) law enforcement team

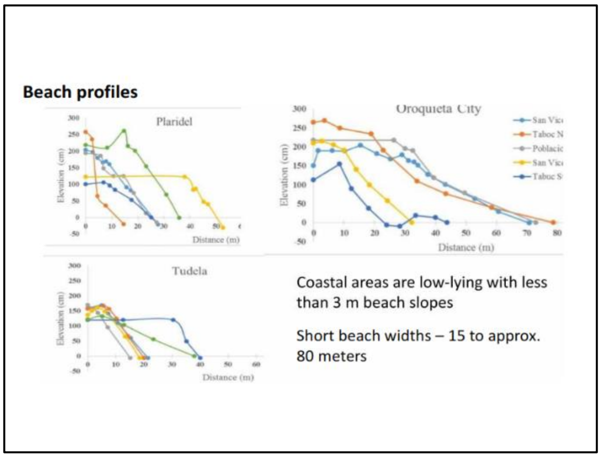
Potential adaptations:

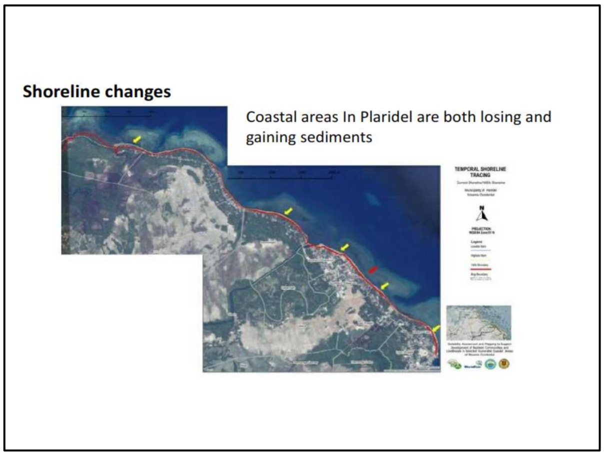
- riprap along river banks
- enhancement of ecotourism

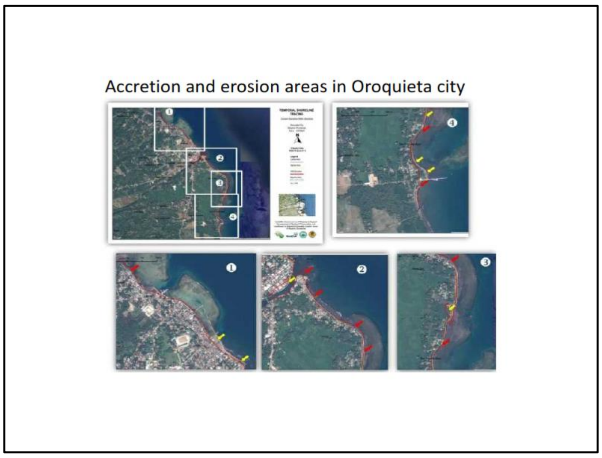
Conclusion

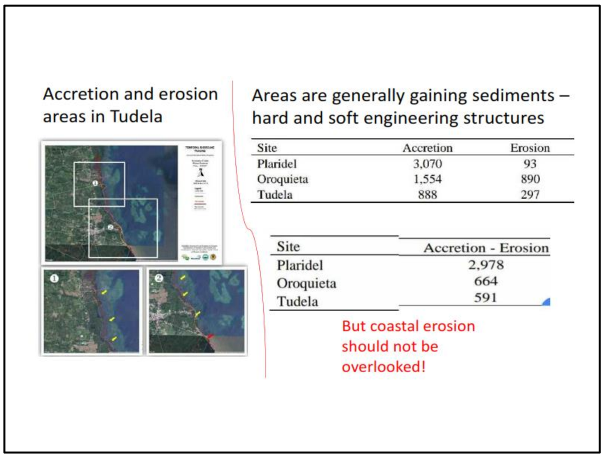
- "Band aid" forms of adaptations commonly identified by farmers will not effectively address present and future vulnerability considering the multifaceted factors that drives vulnerability.
- Transformational adaptation is key to minimize the disaster risks and reduce climate change vulnerability including its associated loss and damages.
- There is a need for transformation of the socio-economic, political, governance structures and processes that perpetuate and reproduce households' and communities' vulnerability.

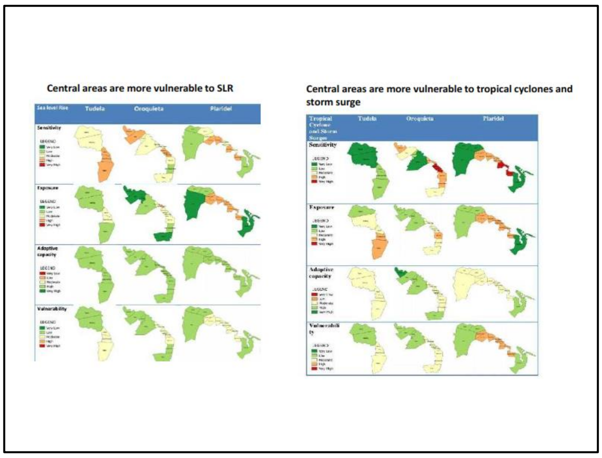

Vulnerability assessment in coastal areas of Misamis Occidental, southern Philippines and its implications for the development of climate-resilient communities
Field survey & KIIs at study sites
Shoreline tracing / Coastal Mapping
Presented by
Venus E. Leopardas, Ph. D.
MSU at Naawan
Philippines
venus.leopardas@yahoo.com
WorldFish
Prepared for the Workshop on Status of Climate Science and Technology in Asia for IPCC AR6, 15-16 November 2018, Sheraton Imperial Kuala Lumpur Hotel, Malaysia

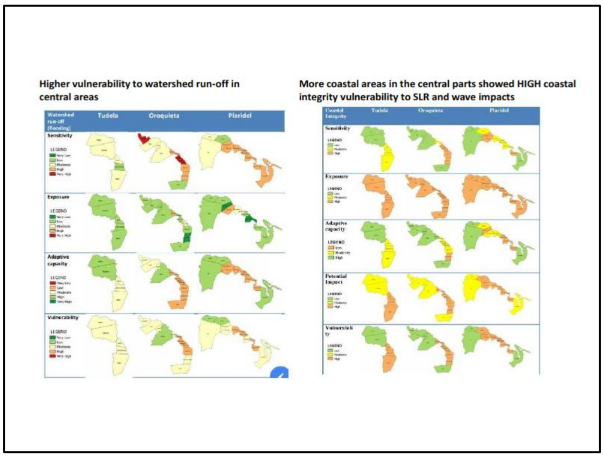

Beach profiles
Plaridel
Oroquieta City
Tudela
Elevation (cm)
Distance (m)
Coastal areas are low-lying with less than 3 m beach slopes
Short beach widths – 15 to approx. 80 meters


Shoreline changes
Coastal areas In Plaridel are both losing and gaining sediments
TEMPORAL SHORELINE TRACING


Accretion and erosion areas in Oroquieta city


Accretion and erosion areas in Tudela
Areas are generally gaining sediments – hard and soft engineering structures
Site Accretion Erosion
Plaridel 3,070 93
Oroquieta 1,554 890
Tudela 888 297
Site Accretion - Erosion
Plaridel 2,978
Oroquieta 664
Tudela 591
But coastal erosion should not be overlooked!


Central areas are more vulnerable to SLR
Central areas are more vulnerable to tropical cyclones and storm surge
Tudela
Oroquieta
Plaridel


Higher vulnerability to watershed run-off in central areas
More coastal areas in the central parts showed HIGH coastal integrity vulnerability to SLR and wave impacts
Tudela
Oroquieta
Plaridel


CIVAT Field exercises: shoreline tracing and profiling with LGU participants

Vulnerability of poor women to climate linked water stresses: Case study of slums in capital city of India

Dr. Jagriti Kher and Dr. Savita Aggarwal

INSTITUTE OF HOME ECONOMICS

UNIVERSITY OF DELHI, INDIA

WORKSHOP ON STATUS OF CLIMATE SCIENCE AND TECHNOLOGY IN ASIA-FOR IPCC AR6
15-16 November 2018

Water and Women

- Water sustains life - crucial for domestic, industrial and agricultural purposes
- Almost two-third population lacking access to clean water survive on less than $2 a day.
- Access to water: One of the components of Multi dimensional Poverty Index (MPI)
- SDGs- Goal number 5 deals with achieving gender equality whereas goal number 6 focuses on ensuring access to safe water and sanitation facilities for all
- Time spent studies conducted over a period of 30 years: Women spend considerable amount of time to meet Practical gender Needs (PGNs) including water collection and neglect their Strategic Gender Needs (SGNs) of education and skill development.
- Globally women spent 200 million hours each day collecting water (WHO/UNICEF, JMP, 2010)
- Girls share the temporal and physical burden of water collection.

Vulnerability of urban poor to climate change

- Global mean surface temperature for the decade (2006-2015) was 0.87°C higher than the average over the 1850-1900 period (IPCC, 2018)
- India: Annual mean temperature showed warming of 0.56°C over the period (1901-2007) and it is predicted to rise by 3.5°C to 4.3°C by the end of the century (MoEF, 2012)
- Per capita availability of water is likely to decline in future (MOWR, 2012)
- Urbanization rate in India is 1.1 percent as compared to the global average of 0.9 percent (UNDESA, 2014)
- By 2030 rapidly rising slum population will make India look like a giant slum (McKinsey Global Report, 2010)
- Lack of adequate housing, poor access to basic services, low or no education and limited income makes slum highly vulnerable, women will be most vulnerable

Present study

- HDI/MPI assess overall development but do not capture water related poverty problems
- Need for a holistic water management index/tool integrating physical availability of water, capacity of households/ communities to access and utilize water
- Water Poverty Index, (WPI) Climate Vulnerability Index (CVI): holistic water management tools developed in 2002 and 2005
- These indices were modified to CVI-WH for India (Climate vulnerability Index for water at the household level) to reflect the vulnerability of families to water availability and its management at the household level
- Statistically defined sample of 300 families was used for the study. The data was collected in slums across five regions of National Capital Territory of Delhi (NCT)
- The number of households selected from each region was proportionate to the percentage of slum clusters present in that region.

Components and sub-components of CVI-WH

Components	Sub-components
Resources	• Average annual rainfall, Number of rainy days • Per capita annual replenish able ground water, length of rivers. Percent area irrigated by canals & tanks
Access	• Percent population with access to safe water supply and safe location of water source
Capacity	• Literacy rate, Matric/Secondary but below graduate • Life expectancy at birth and Per capita annual income
Environment	• Percent population with access to safe toilet and bathroom facilities. Percentage of wastes treated in the city. Percent population living in slums
Use	• Per capita annual ground water used by domestic , industrial sectors and agriculture sector • Percent of net irrigated area to net sown area (NIA/NSA)
Geospatial/ Climate	• Percent area affected by droughts and floods

Computation of CVI-WH

- Normalization method
- The sub-components: Negative and positive
- Index value $(X_{in}) = (X_{s/n} - X_i(\min)) / (X_i(\max) - X_i(\min))$ {For positive indicators}
- Index Value $(X_{in}) = (X_i(\max) - X_{e/n}) / (X_i(\max) - X_i(\min))$ {For negative indicators}
- Index value of a component computed by averaging the sub-components

$$\text{CVI-WH} = \frac{\{(1-I_R) + (1-I_A) + (1-I_C) + (1-I_E) + (1-I_U) + (1-I_G)\}}{6}$$

The index values of CVI-WH ranged from zero (least vulnerable) to one (most vulnerable)

Quantitative, Qualitative data collection




Poor urban women & girls struggle to collect water




Major Findings

- Majority of the women (78%) were illiterate, 19% studied up to primary level and less than 2% had any form of higher education.
- The water source for 73% of the families was tap water supplied by the local water authority at community point.
- Water collection was the prime responsibility of the women (almost 90%) especially younger women. Girls also helped in water collection
- More than 90% of the women were spending up to 4 hrs per day in water collection
- Majority (66%) of the women were making more than 6 trips daily to collect water
- Timings of water supply were very erratic and fluctuated causing hardship to women
- People reported multiple problems during water collection: high tap to user ratio, long queues, low water pressure, time expenditure, eve teasing, fights & conflicts.
- During water stress periods, women coped up by spending less time on household work, taking help of children, cutting down time on income generating activities and cutting down leisure time.
- Most families lived in a dismal state of environment as only 4% had safe toilet facilities, majority of the respondents were using community toilets and were also practicing open defecation.

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Variation in Climate Vulnerability Index for Water at the Household Level (CVI-WH) across different regions of Delhi

Location of slums in Delhi	Inadequate access	Limited capacity	Poor environment	Inadequate use	CVI-WH
North Delhi	0.27	0.71	1.00	0.58	0.62
South Delhi	0.38	0.70	1.00	0.61	0.65
Central Delhi	0.26	0.70	1.00	0.60	0.62
East Delhi	0.22	0.71	1.00	0.61	0.62
West Delhi	0.50	0.71	1.00	0.61	0.67
Delhi Slums (average)	0.33	0.71	1.00	0.6	0.63
Delhi	0.04	0.24	0.22	0.48	0.36

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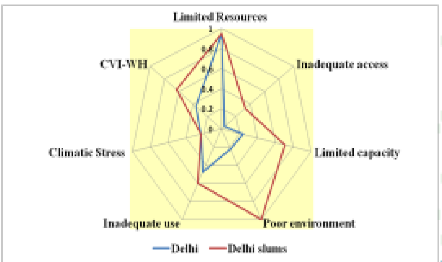
Comparison of CVI-WH in Slum areas in Delhi with rest of Delhi



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Conclusion

➢CVI-WH is important tool for monitoring water availability at different spatial scales: Prioritizing the needs for interventions in the water sector.

➢Poor slum women and children highly vulnerable to climate and water linked stresses because of their prime role in water accession and management.

➢Situation is not likely to improve: High levels of urbanization, climatic changes, population growth, and no significant changes in gender distribution of household responsibilities.

➢Huge gender based inequalities exist in India reflected by low ranks in gender related development indicator- GII (125 rank out of 188 countries) and GGI (87 rank out of 144) **(UNDP, 2016 & WEF, 2017)**

➢To meet goals of gender equity and equality in society it is important to pay special attention to the provision of PGNs of women.

➢It is extremely important to enhance the adaptive capacity of women to face challenges posed by climatic & non-climatic drivers and equip them to lead climate resilient lives.

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THANK YOU

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Academic Consortium
"International University of Kyrgyzstan"

Potential Risk of Tropical diseases Occurring in Mountain regions of Central Asia

Asylbek Aidaraliev
Academician of National Academy of Science, Prof. Dr. Med. Sc.,
Chairman of Board of Trustees of the Academic Consortium
"International University of Kyrgyzstan"
E-mail: board-iuk@mail.ru

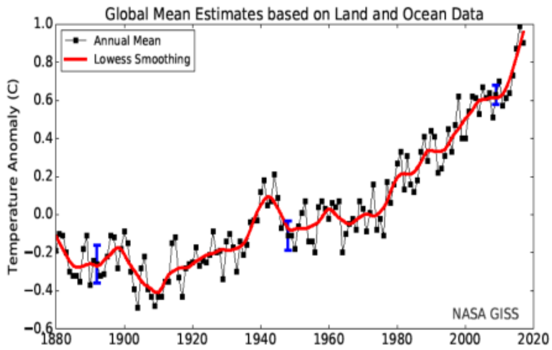

Figure 1. Forecast of climate change shows continuous increase of annual mean temperature anomalies until 2020 (NASA GISS observations).

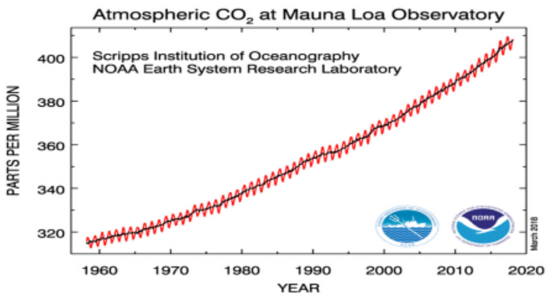

Figure 2. Forecast of glaciation coincides with the forecast of carbon dioxide content in the atmosphere based on the researchers of the SCRIPPS Institute of Oceanography (USA). Increase of CO2 in atmosphere observed since 1960-s with continuation up to 2020

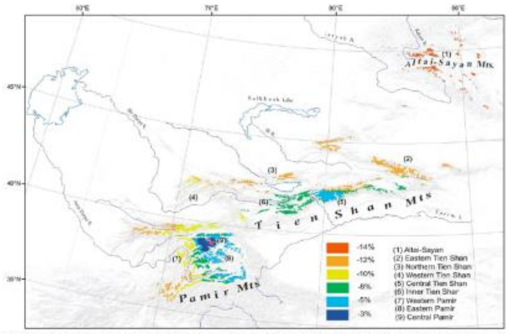

Figure 3. Forecast of glacial areas in Pamir, Tien-Shan and Altai-Sayan Mountains: about 14% reduction expected in Altay-Sayan mountains, 8% – in Central Asian Tien Shan and -3% - in the Central Pamir.

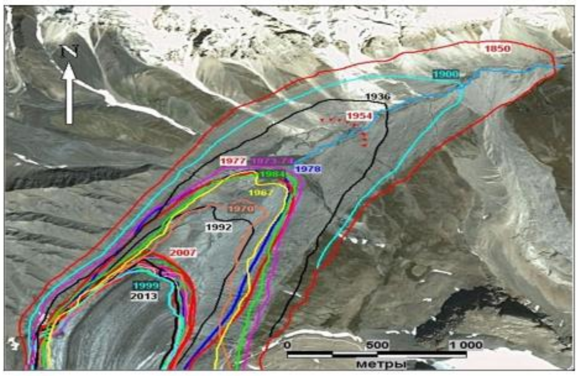

Figure 4. Change in the Abramov glacier in different years from 1850 to 2013, which show its melting and decrease of 13.8%.

Disease	Number of probable and confirmed, people	Number of suspected cases, people
Malaria	Kyrgyzstan - 4	Kyrgyzstan – 33,983
	Tajikistan - 165	Tajikistan – 165,266
	Turkmenistan – 0	Turkmenistan – 94,237
	Uzbekistan - 4	Uzbekistan – 916,839

Table 1. Distribution of Malaria (tropical disease) in Central Asia (after Hotez et al., 2011)

Conclusions

- Mountain are highly sensitive to global warming.
- Malaria may appear to be high among the poorest people living in high and middle mountain areas of Central Asia, therefore there is an urgent need to take preventive measures.
- The Academic Consortium "International University of Kyrgyzstan" will be able through the studies and researches to implement the idea of adaptation to climate change, establishing training on adaptation to climate change.
- We believe it is necessary to include the project "Development of preventive measures against occurrence of tropical diseases in mountain regions of Central Asia" into the program of the World Bank «Adaptation of Europe and Central Asia to Climate Change» and/or IPCC sub-chapters.

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