Overview of current status of climate services in the Hindu Kush Himalaya (HKH) region

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Regional Stakeholder Consultation on Climate Services for the Third Pole Region
Jaipur, Rajasthan, India
9-11 March 2016

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- Capacities for provision of climate services
- Current status of provision of climate services to sectors and existing user interface mechanisms
- Gaps and challenges
- Future perspectives for improved climate services

Climate Services

Climate services provide climate information to the public or a specific user and such services involve high quality data from national and international database. It involves strong partnerships among providers, such as NMHSs, and stakeholders, including government agencies, private interests, and academia, for the purpose of interpreting and applying climate information for decision making, sustainable development, and improving climate information products, predictions, and outlooks.

Why needed?

Climate variability and change are posing significant challenges to societies worldwide. Timely communication of climate information helps prevent the economic setbacks and humanitarian disasters that can result from climate extremes and long term climate change. It also plays a crucial role in national development planning, for managing development opportunities and risks and for mitigation and adaptation. Efficient application of climate services requires that climate information become integrated into various sectors' policies.

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ICIMOD's Domain for work

HKH region covers 4.2 million sq. km

Preliminary plan

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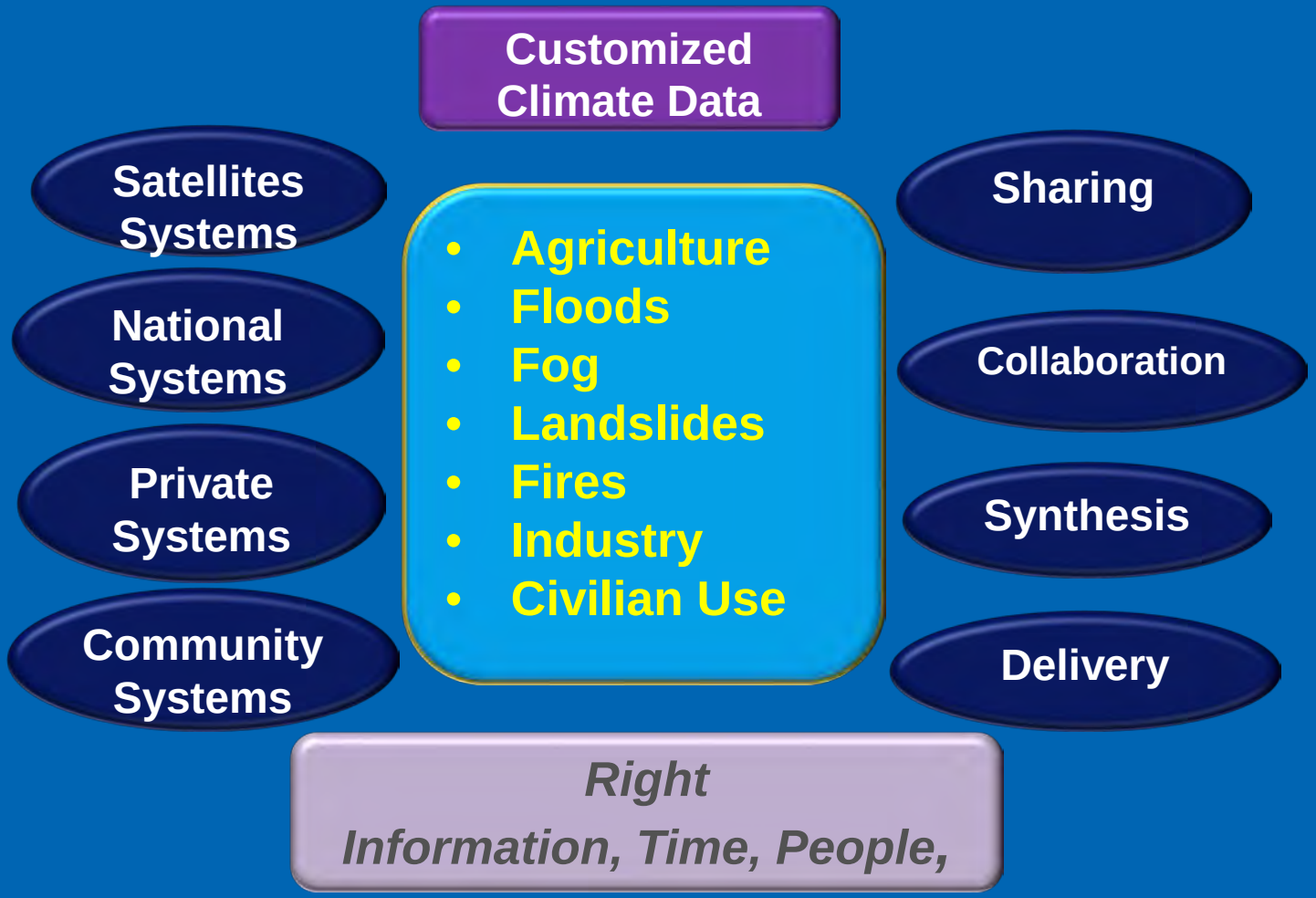
- Current ICIMOD Program needs, interfaces
- Broad scope of application across HKH
- Existing Frameworks (global, local)
- Current actors/activities(HKH)
- Potential service areas
- Scales and stakeholder
- Input data and parameters (Historical, current, projection)
- Generic windows/customization/value addition
- Delivery systems

Climate Services - Components



- *What is ICIMOD long term outlook/short term outlook?*
- *How do we integrate satellite Systems, climate and community science into service?*

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What is the component of Climate Services?

- Working Elements – Observations& Monitoring, Modeling and Prediction, Info Systems/Outlooks, User Interface platforms, Capacity building, Research and Policy, Institutionalization, Users
- Service Areas – Climate as information, Food security, disaster, water, health, tourism, Adaptation and resilience
- Global, regional systems, Frameworks – GFCS (WMO, World Bank, USAID,RMCs)

HKH Relevance

- Climate change and vulnerability perspective
- Food, Water security
- Disasters
- Climate service needs, scales, user landscape

Current Status / Existing Operating Systems

- Global data sets and Services
- RMC Systems
- Private Systems
- Research/Regional Organizations (ICIMOD EXAMPLES –HYCOS,HICAP,SERVIR, HIWARE, Cryosphere etc)

Glacier boundaries (inventory ICIMOD)

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Hydrological characteristics for each basin during the reference period (1998-2007)

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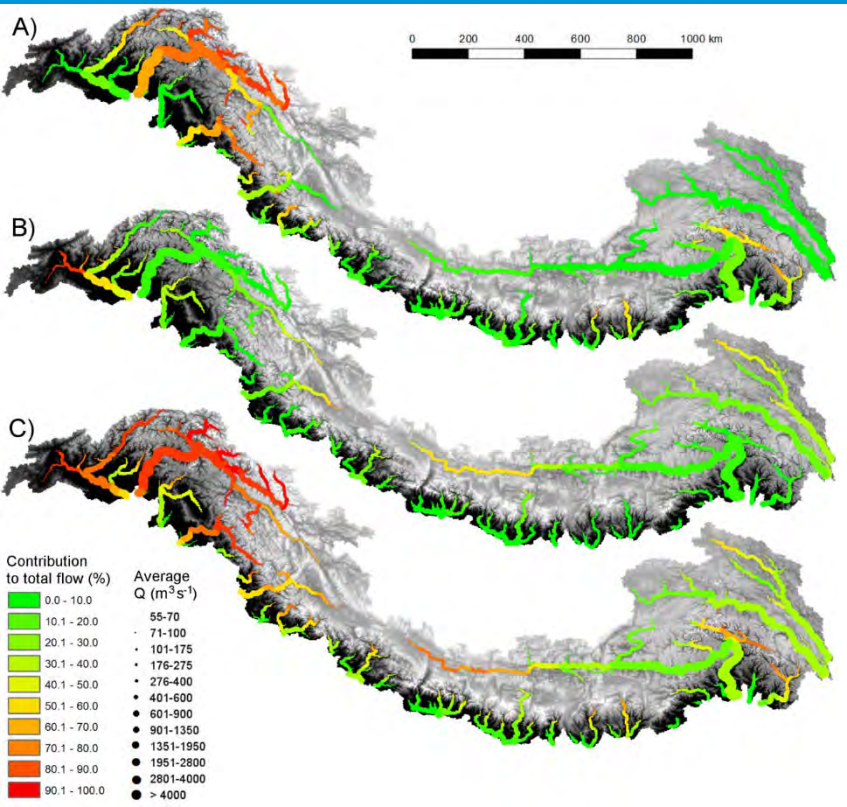
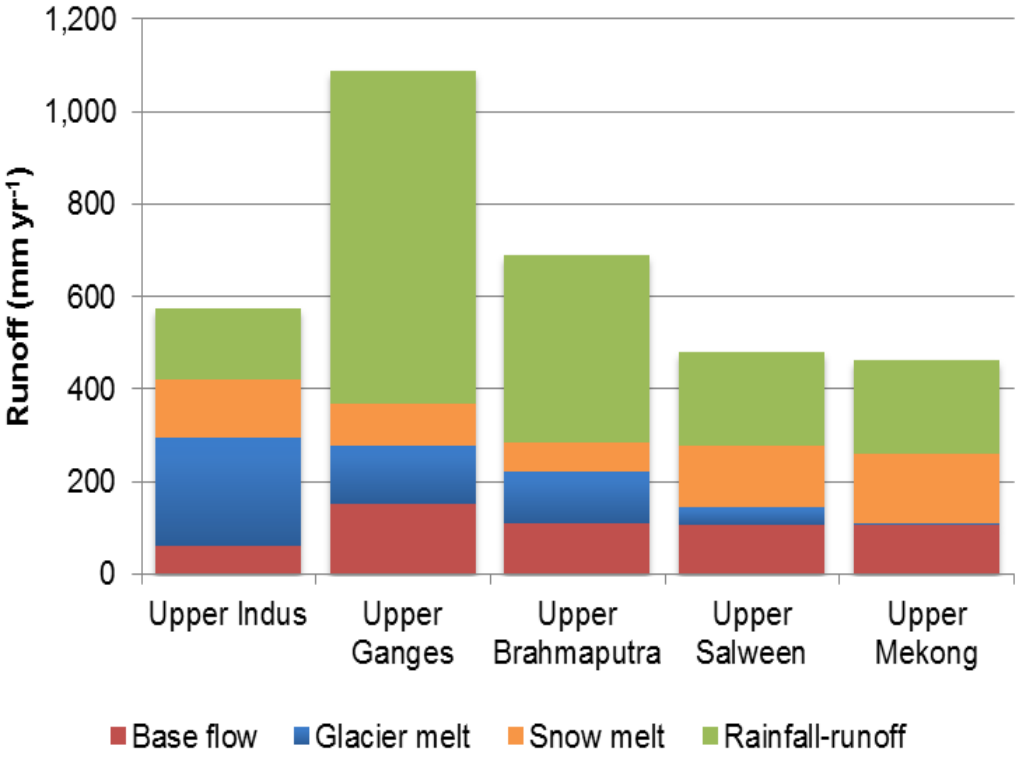
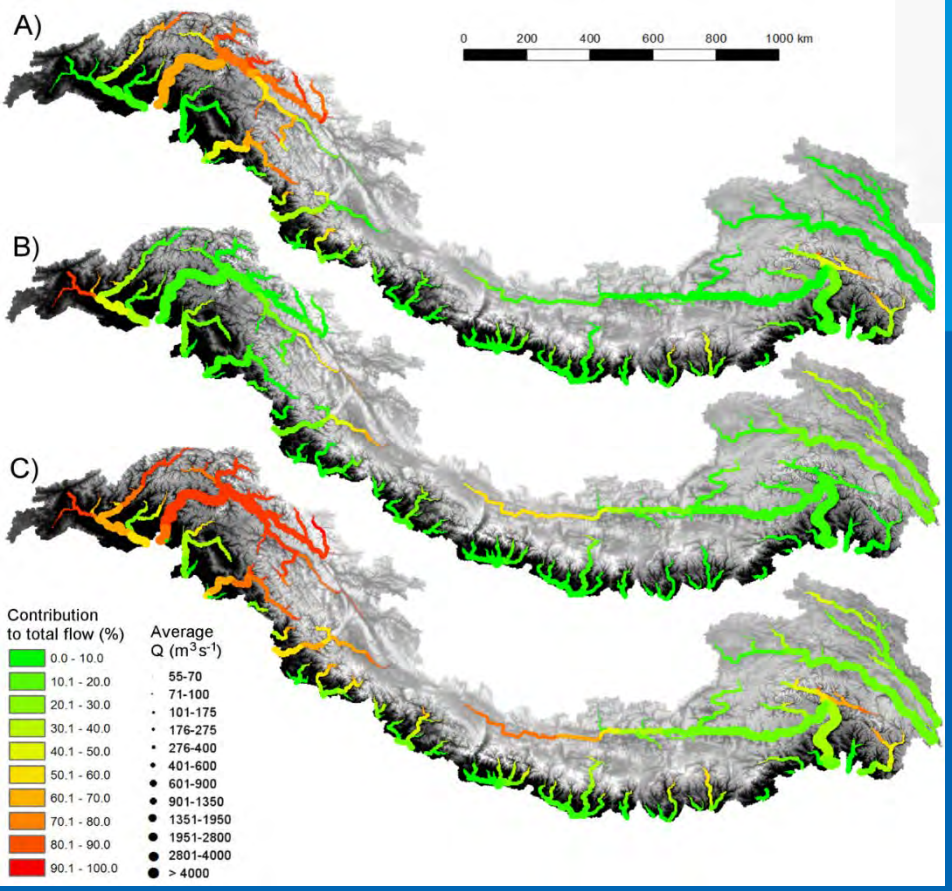
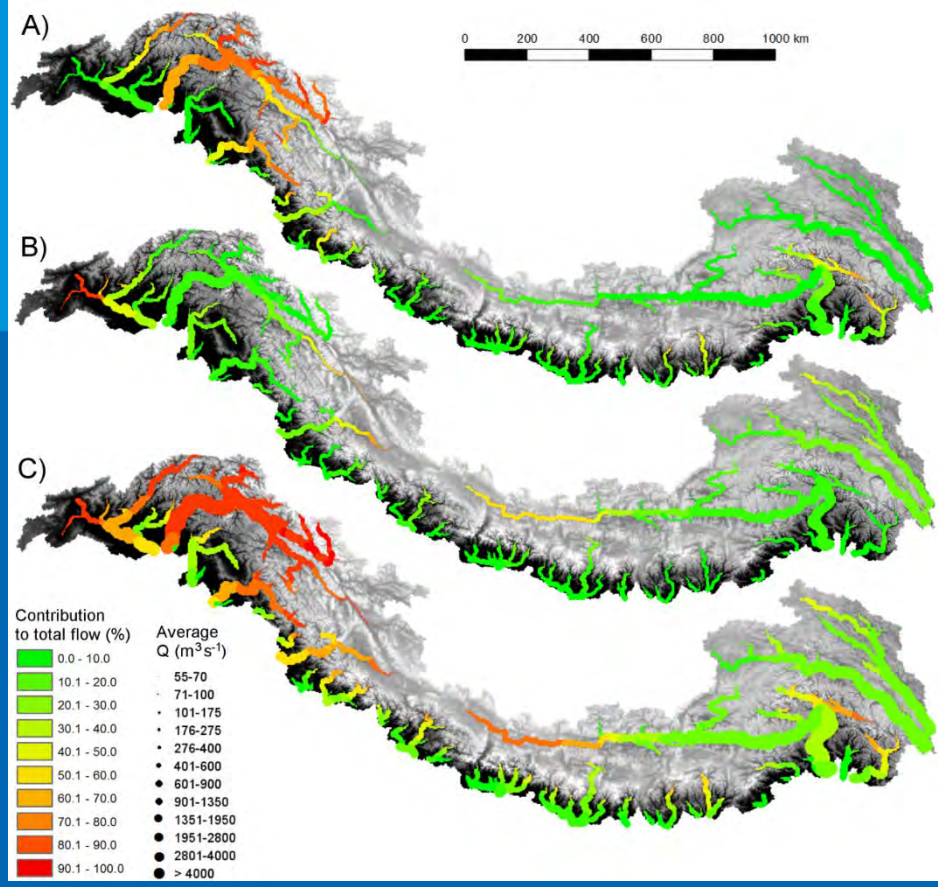




Basin	Annual precipitation (mm)	Glacierized area (%)	Annual runoff (mm)	Contribution to total runoff (%)			
				Glacier melt	Snow melt	Rainfall-runoff	Base flow
Upper Indus	346	4.9	574	40.6	21.8	26.8	10.8
Upper Ganges	900	5.4	1088	11.5	8.6	66.0	13.9
Upper Brahmaputra	573	3.1	691	15.9	9.0	58.9	16.2
Upper Salween	595	1.3	480	8.3	27.5	42.0	22.2
Upper Mekong	642	0.2	464	0.9	32.5	43.9	22.8



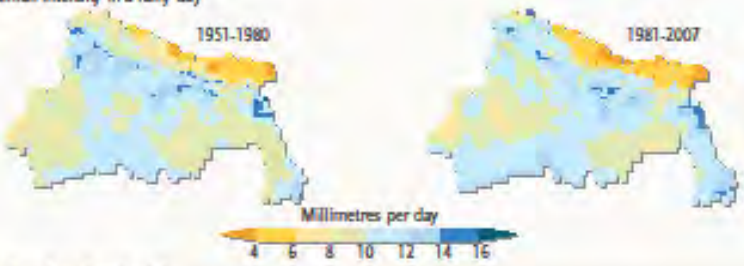
Average contribution of glacier melt (A), snow melt (B), glacier and snow melt combined (C) to total flow and average discharge during 2041-2050 in major streams in the model domain (all panels) Results are for HI-SPHY model forced with RCP 4.5 CCSM4-r5i1p1 GCM (cold, wet) case.



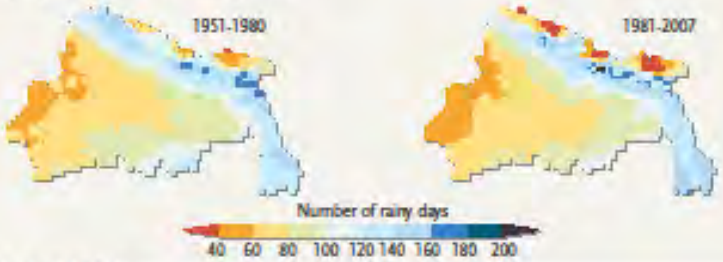
Average contribution of glacier melt (A), snow melt (B), glacier and snow melt combined (C) to total flow and average discharge during 2041-2050 in major streams in the model domain (all panels) Results are for HI-SPHY model forced with RCP 8.5 IPSL-CM5A-LR-r4i1p1 GCM (dry, warm case).

Ganga basin climate indicators - Rainfall

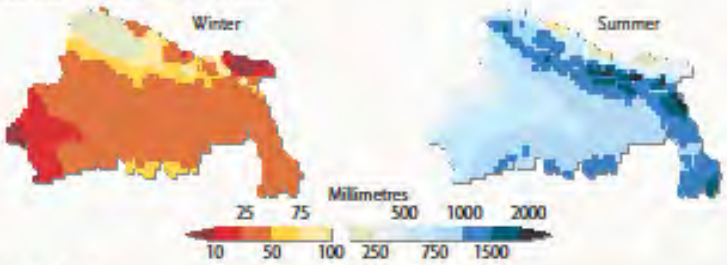
How much does it rain?
Rainfall intensity in a rainy day



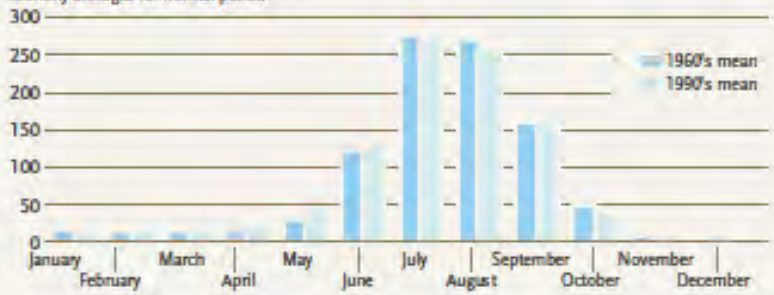
For how long does it rain?
Rainy days in a year for two normal periods



Where does it rain?
Spatial distribution of rainfall, 1981-2007



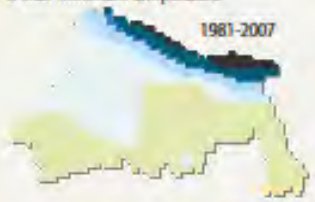
When does it rain?
Monthly averages for normal period



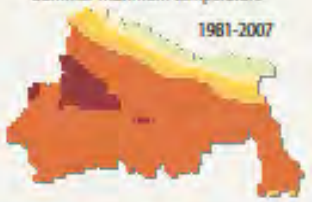
Ganga basin climate indicators - Temperature

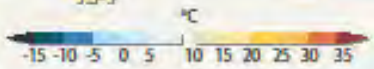
TEMPERATURE

Where's hot and where's cold
Winter minimum temperature

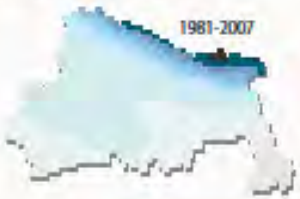


Summer maximum temperature





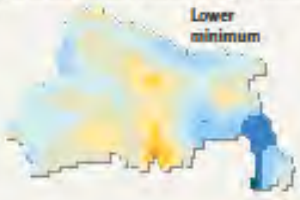
How hot and how cold
Lowest minimum temperature



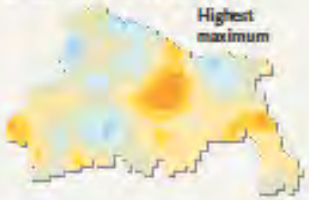
Highest maximum temperature

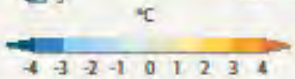
Temperature changes
Changes in temperature between the past normal (1951-1980) and recent normal period (1981-2007)

Lower minimum

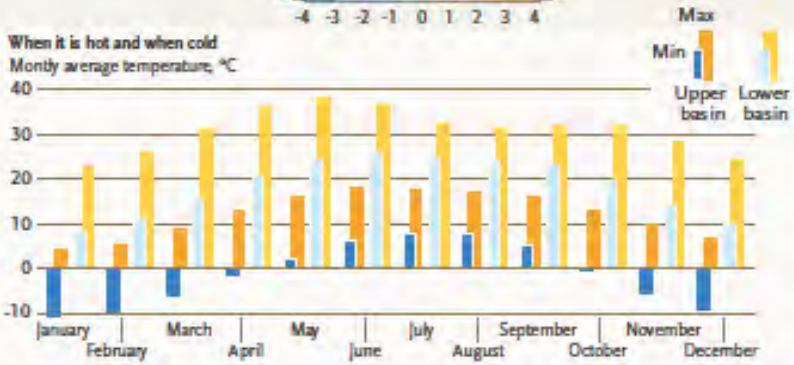


Highest maximum





When it is hot and when cold
Montly average temperature, °C



Climate Indices in Koshi Basin (Precipitation)

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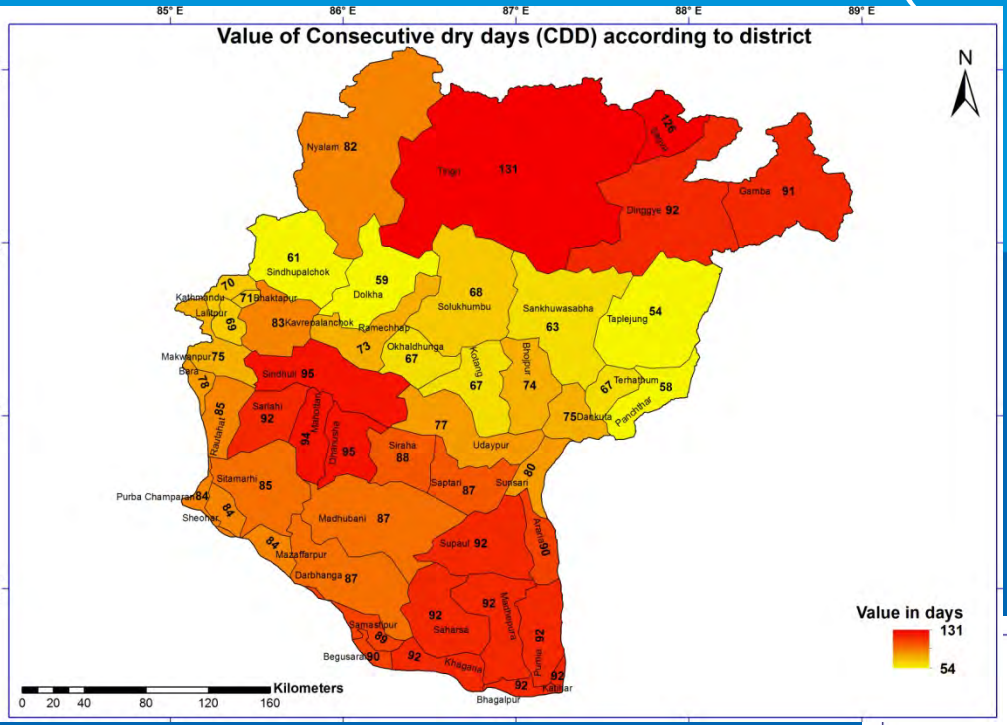

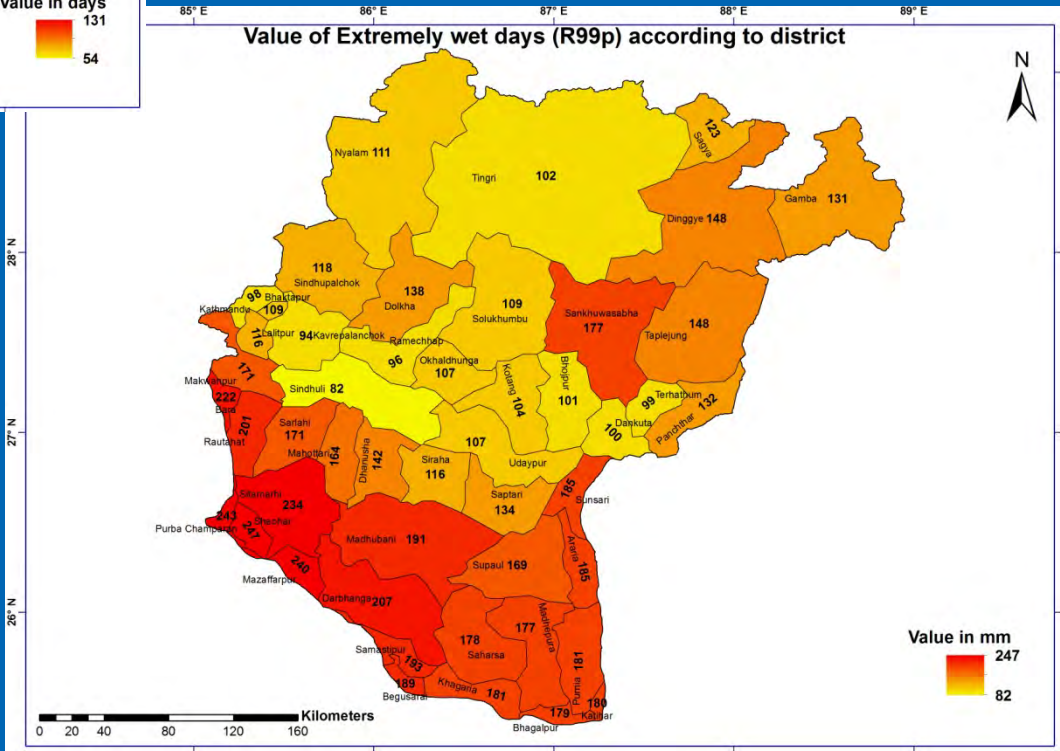

Climate change is believed to contribute to extreme weather events and possibility to increase the frequency and magnitude of natural hazards and associated disasters, exacting high economic and social costs.

Climate Indices in Koshi Basin (Temperature)

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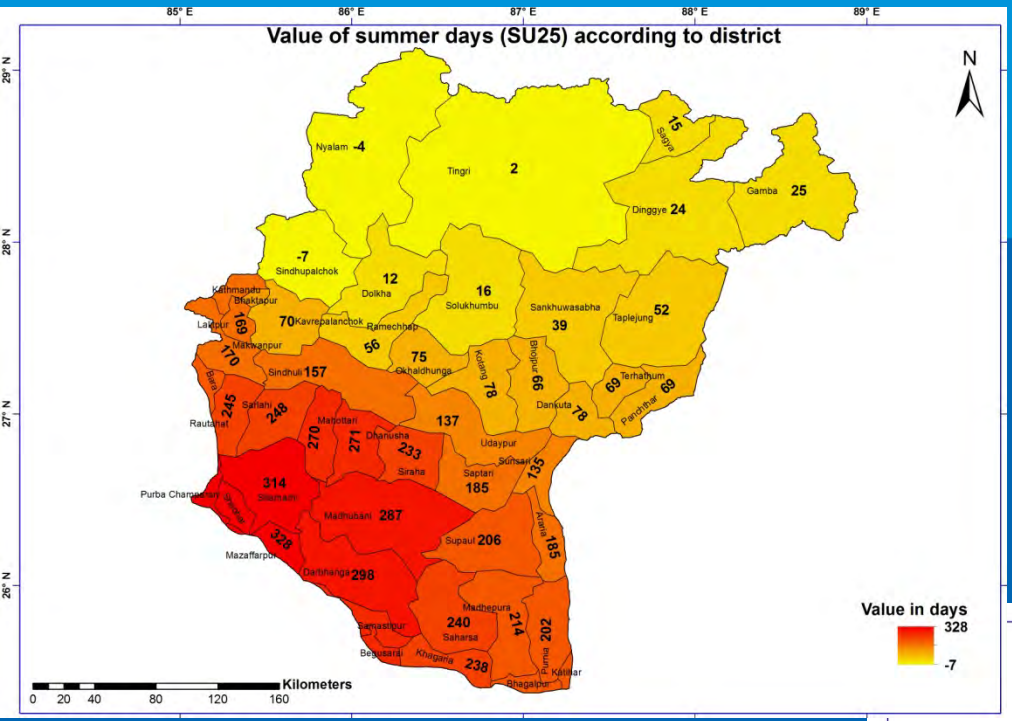

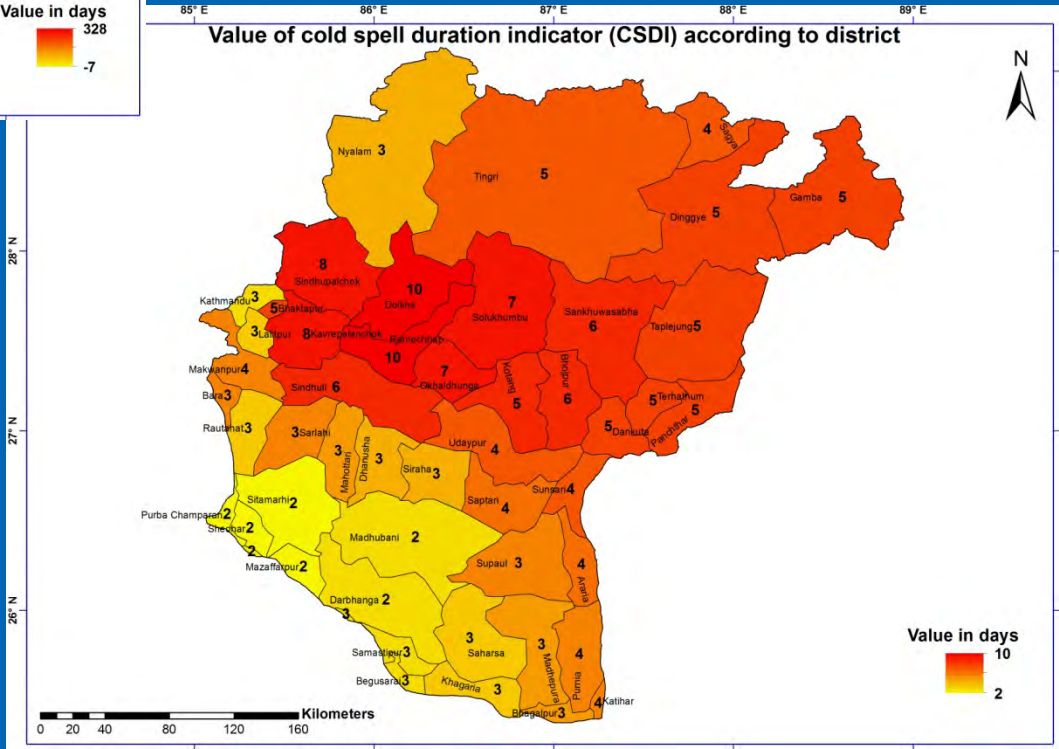

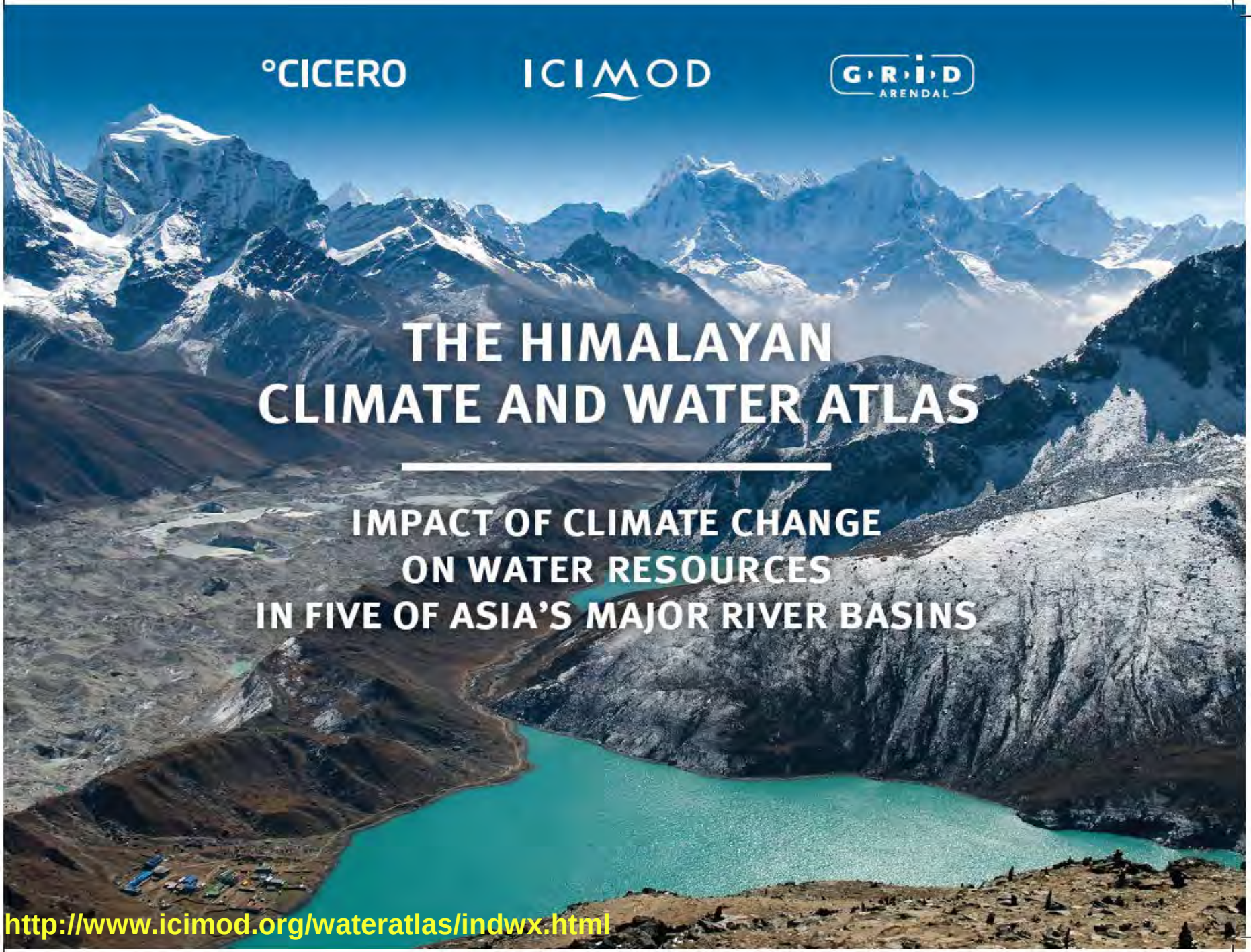
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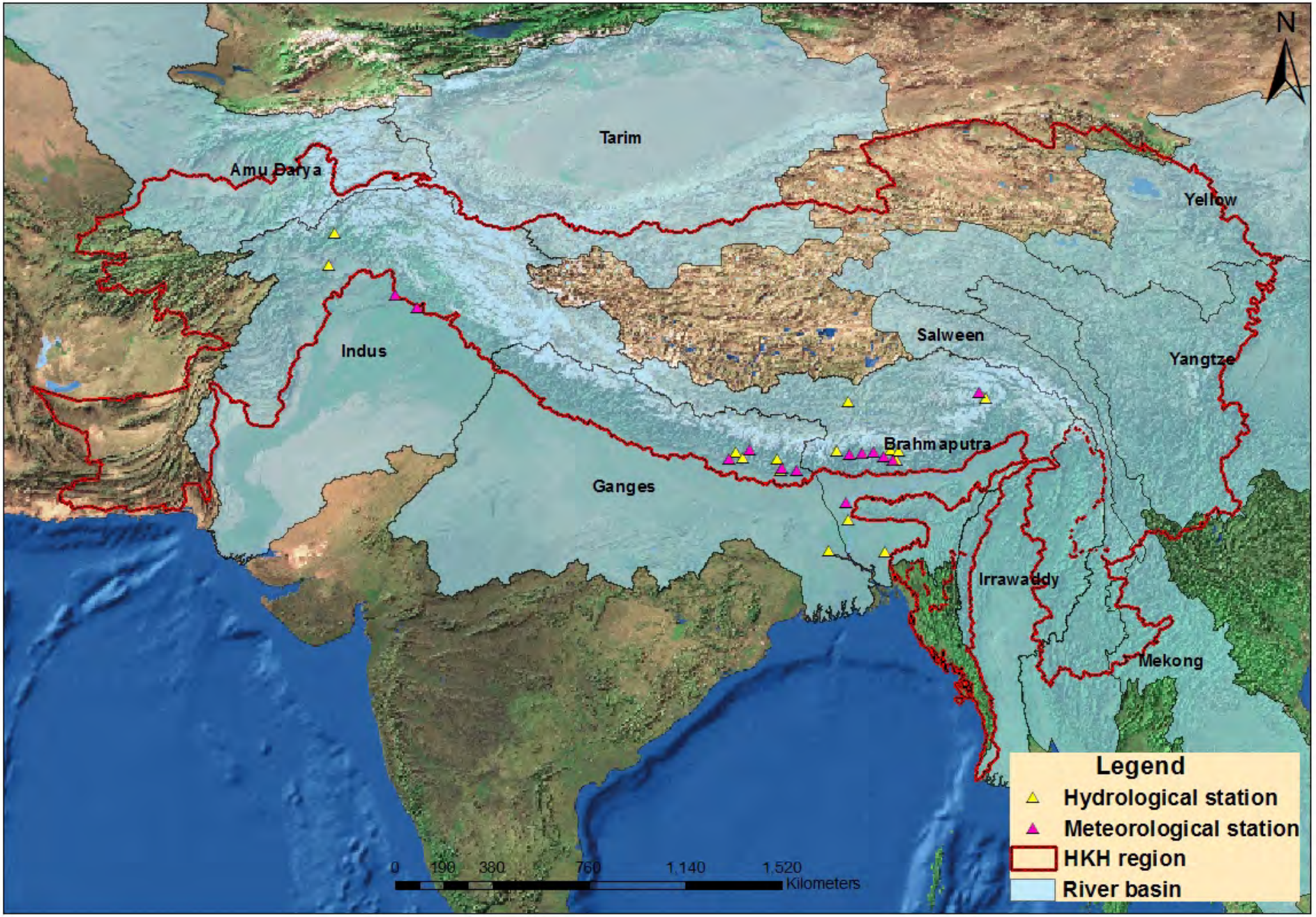
G·R·I·D
ARENDAL
THE HIMALAYAN
CLIMATE AND WATER ATLAS
IMPACT OF CLIMATE CHANGE
ON WATER RESOURCES
IN FIVE OF ASIA'S MAJOR RIVER BASINS
http://www.icimod.org/wateratlas/indwx.html


N
Tarim
Amu Darya
Yellow
Indus
Salween
Yangtze
Brahmaputra
Ganges
Irrawaddy
Mekong
Legend
Hydrological station
Meteorological station
HKH region
River basin
0 190 380 760 1,140 1,520
Kilometers

Capacity building on Community based flood early waning system (CBFEWS)

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Training methodology:

- Class room lectures
- Group work
- Instrument handling
- Field installation/testing

Training materials:

- Resource Manual
- Visual guide

Instrument installation

climate and water interactive portal (User Interface Platform)

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Climate and Water interactive tool (portal) enables technical and non-technical audiences alike to easily and intuitively access leading climate change and water availability information; visualize the impacts of climate change on major river basins over HKH region and also improve understanding of the partitioning of runoff contribution from different natural sources (snow, glacier, rainfall and base flow) anywhere on upper basin of HKH region.

The purpose of the Climate and Water interactive tool is disseminate recent climate and water products generated by ICIMOD with its partners and to communicate present conditions and future scenarios in water and climate based on current scientific understandings and also to enhance public understanding of possible future climate patterns at the spatial scale of catchments and watersheds.

climate and water interactive portal

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The interactive tool (portal) allows the user to choose a basin and assess how climate has changed over time and what future changes are projected to occur in a given area. It also shows how climate change impacts on cryosphere and water resources corresponding to base and different future climate scenarios at upper sub-basin and catchment in the five (Indus, Ganges, Brahmaputra, Mekong and Salween) basins.

Some key features

- view historic temperature and rainfall maps for the major basins of HKH region
- view state-of-the-art future projections of temperature and rainfall over in the major basins of HKH region
- view and download maps, graph, chart and data in a few easy steps
- view water availability and run off dependency from Ice/snow/rain corresponding to base and future climate scenarios at sub-basin and catchment in the three basins
- view the partition of runoff contribution from different natural sources (snow, glacier, rainfall and base flow) corresponding to base and different future climate scenarios at upper sub-basin and catchment in the five (Indus, Ganges, Brahmaputra, Mekong and Salween) basins

Some key features

- view the water balance at catchment level of three basins (Indus, Brahmaputra and Koshi) corresponding to base and different future climate scenarios.
- view projected changes in glacier area for the five basins between 2010 and 2050
- view and download water availability data according to base and different future climate scenarios, graph, chart and data in a few easy steps

Hydrology

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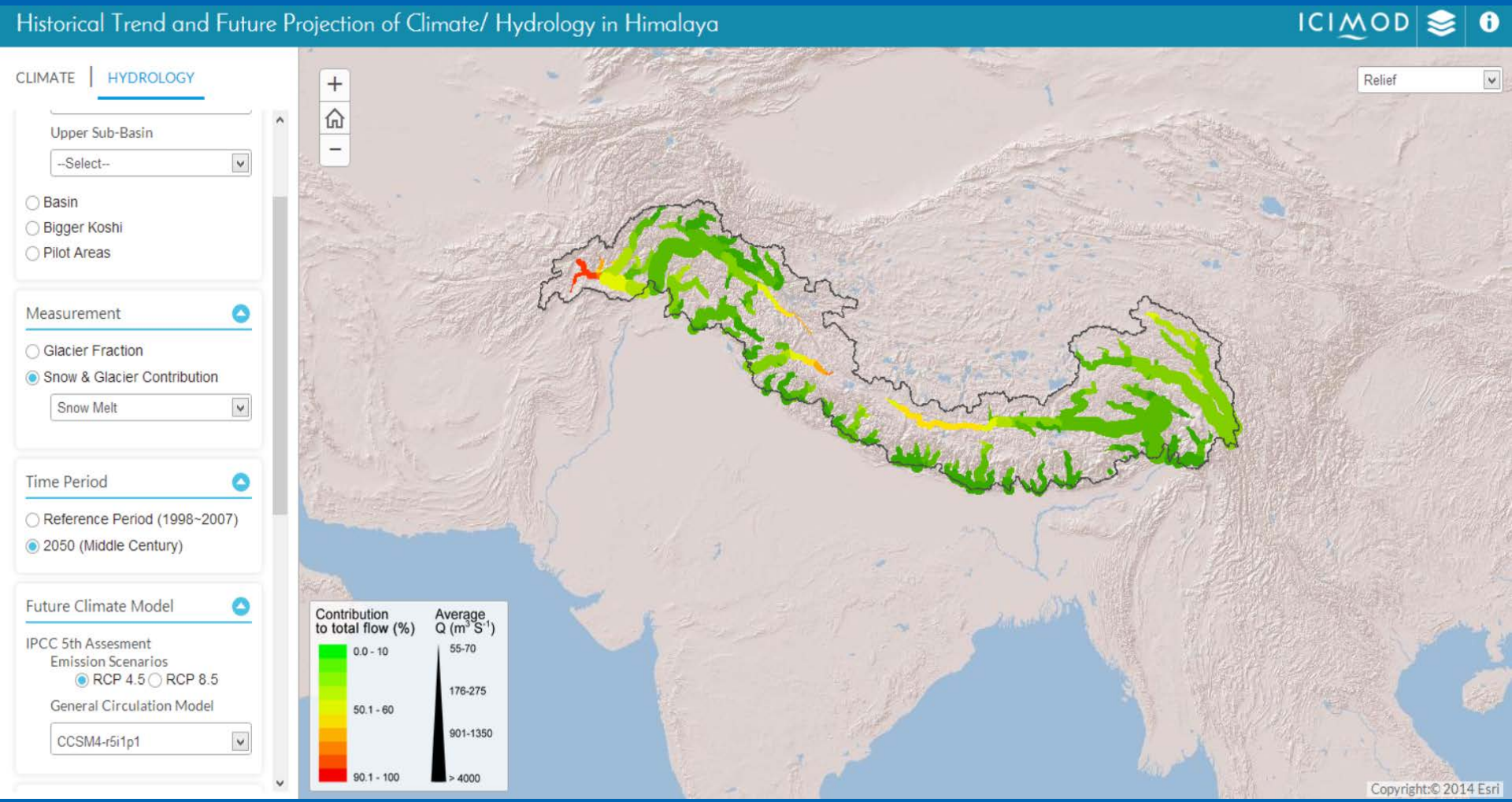

Climate

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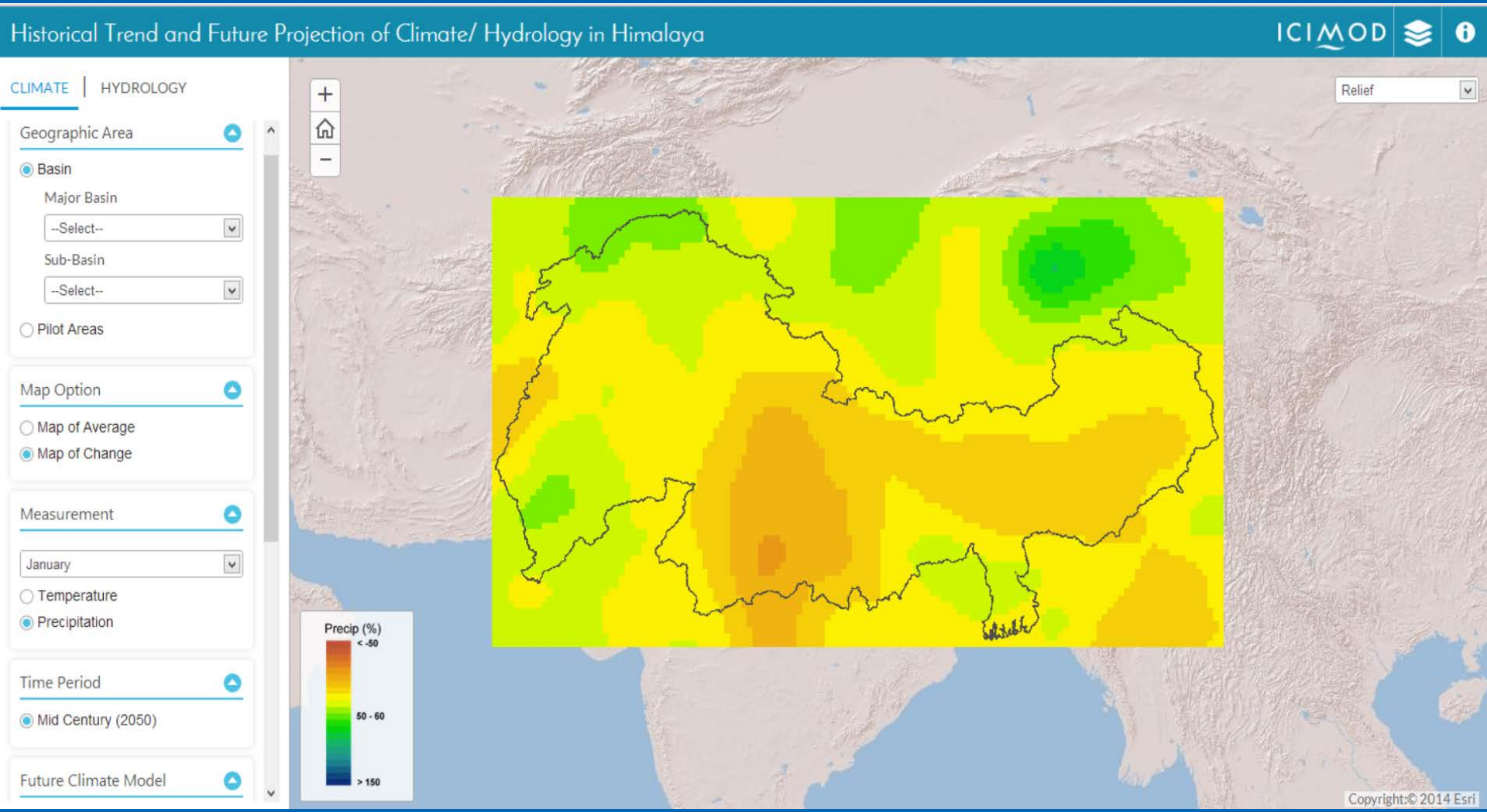

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apps.geoportal.icimod.org/climate

Historical Trend and Future Projection of Climate/ Hydrology in Himalaya

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Map Option: Map of Average | Map of Change

Measurement: Temperature | Precipitation

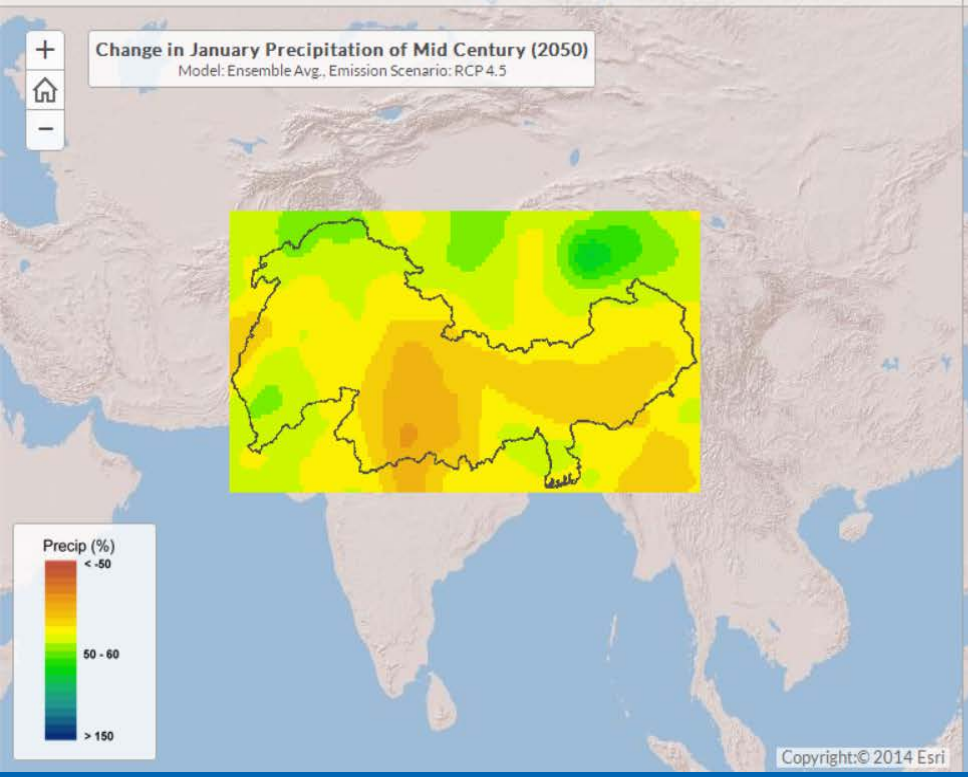
Time Period: Mid Century (2050)

Opacity: 100%

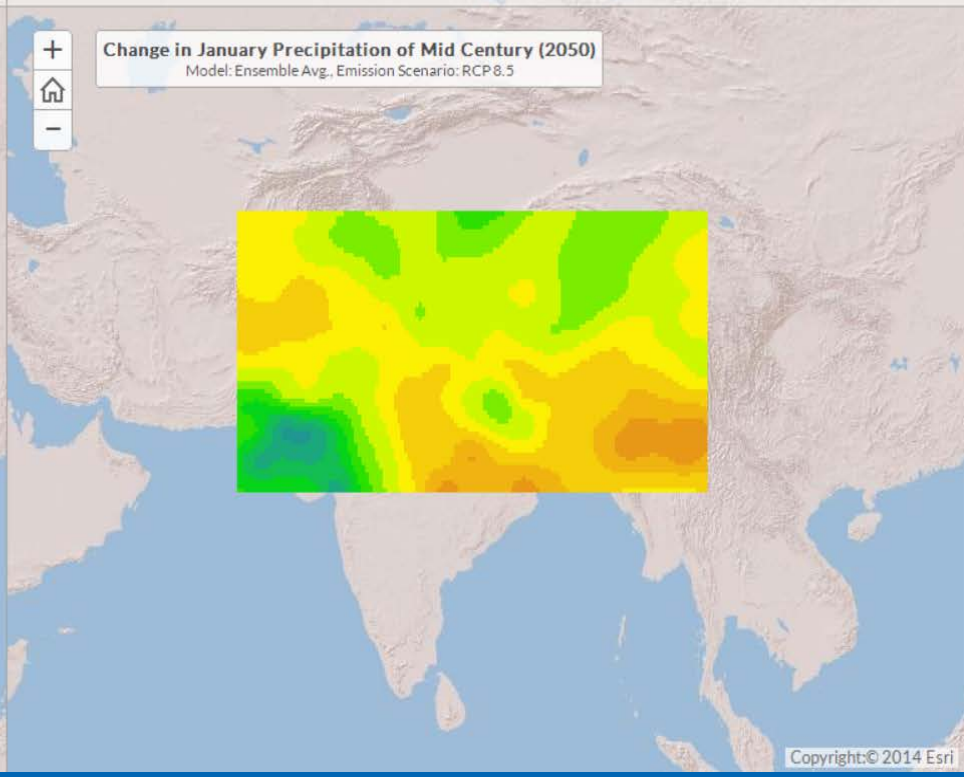
Relief

<< Back

Mea. Cycle: January Scenario: 4.5 Model: Ensemble Avg.



Mea. Cycle: January Scenario: 8.5 Model: Ensemble Avg.



Current water availability and projections

The SPHY hydrological model is set up for the upstream river basins of the Indus, Ganges, Brahmaputra, Salween and Mekong basins. The upstream models are forced by both precipitation and air temperature outputs of a regional climate model and a selection of global climate models:

- **The Bjerknes Centre for Climate Research is partner in the HICAP and outputs from their RCM simulations for RCP8.5 and RCP4.5 until 2050 are used to force the model.**

- **GCM AR5 data are downloaded from the CMIP5 model archive for the same RCPs. Four are selected per RCP that span the entire range of possible futures: dry and cold, dry and warm, wet and cold, wet and warm.**

NEX-GDDP

ACCESS1-0	CSIRO-MK3-6-0	MIROC-ESM
BCC-CSM1-1	GFDL-CM3	MIROC-ESM-CHEM
BNU-ESM	GFDL-ESM2G	MIROC5
CanESM2	GFDL-ESM2M	MPI-ESM-LR
CCSM4	INMCM4	MPI-ESM-MR
CESM1-BGC	IPSL-CM5A-LR	MRI-CGCM3
CNRM-CM5	IPSL-CM5A-MR	NorESM1-M

rcp45 = RCP4.5 climate scenario

rcp85 = RCP8.5 climate scenario

Geographic domain: 45N, 57W, 123E, 8S

Format: NetCDF

Resolution: 0.25 degree

Parameters: pr = precipitation, tasmin = temperature at surface minimum temperature (2 meters)

tasmax = temperature at surface maximum temperature (2 meters)

Historic data range = 1950-2005, Projection data range = 2006-2099 or 2100

Product name	CMORPH (NOAA CPC morphing technique) Source: ft p://ft p.cpc.ncep.noaa.gov/fews/CMORPH/	GSMaP (Global satellite mapping for precipitation) Source: http://sharaku.eorc.jaxa.jp/ GSMaP crest/html/about data.html	CPC-RFE2.0 (NOAA climate prediction centre rainfall estimates version 2.0) Source: ft p://ftp.cpc.ncep.noaa.gov/fews/S.Asia/data/	RFE2.0-Modified (The merged version of CPC-RFE2.0 products and local ground observed data improved at ICIMOD)	TRMM 3B42-V7 (Tropical rainfall measuring mission) Source: http://gcmd.nasa.gov/records/ GCMD GES DISC TRMM 3B42 daily V7.html
Spatial resolution	0.1deg	0.1deg	0.1deg	0.1deg	0.25deg.
Temporal resolution	30min	1 hour	24 hours	24 hours	30min
Domain	60N—60S (Global)	60N—60S (Global)	70–110E and 5–35N (Regional)	70–110E and 5–35N (Regional)	50N—50S (Global)
Product source	IR, SSM/I, AMSU-B, AMSR-E, TMI (No rain gauge)	MWR-GEO IR combined algorithm with NOAA AMSU-B products (No rain gauge)	GPI cloud-top IR, SSM/I, AMSU-A, GTS (Rain gauge)	GPI cloud-top IR, SSM/I, AMSU-A, GTS Merged local country wise rainfall data (Rain gauge)	IR,TMI,SSM/I,AMSR-E, AMSU-B, MHS, monthly 1 degree rain gauge grid data (Rain gauge)
Agency	Climate Prediction Centre (CPC), NOAA	Earth Observation Research Centre (EORC), Japan Aerospace Exploration Agency (JAXA)	Climate Prediction Centre (CPC), NOAA in association with USAID/FEWS-NET	Climate Prediction Centre (CPC), NOAA, and improved at ICIMOD	National Aeronautics and Space Administration (NASA)
Duration	2002- 2014	2003- 2014	2002- 2014	2002 - 2007	1997 - 2015

Gap Areas/Challenges

- Linkages between global/regional systems
- Research for value addition and local context
- Blending local and regional systems User Awareness
- Priority service areas
- Geographic heterogeneity
- Data Needs and Models
- Effective use of climate information
- Adoption of communication technology
- Understanding user scenario
- Capacity building
- Institutionalization
- Operational Sustainability

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ICIMOD Interface Areas/Future perspectives

- What is being done : MTAP-III Programmatic Areas – Relevance to Climate services(HIWARE,HICAP,SERVIR,HIMALICA,KAILASH, CRYOSPHERE etc)
- What are New emerging : MTAP – IV New portfolios: Energy, Disaster, Agriculture
- Potential role as service development, developing uptake systems, institutionalization, capacity building, observation and monitoring, research
- Role in the context of focus on Products-Services, Outcomes to Impacts

Thank you

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