Building Resilience to Climate Change: Asian Experiences

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Outline

- Assessing local impacts of Climate Change
  - Transforming global projections to local scale
  - Downscaling approaches and uncertainties: case study
- Actions
  - Urbanization
  - Rice Terrace Systems
  - Rural irrigation systems

Climate Change Scenarios

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Downscaling

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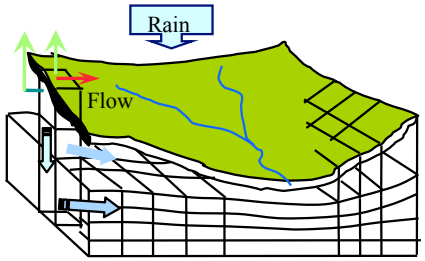
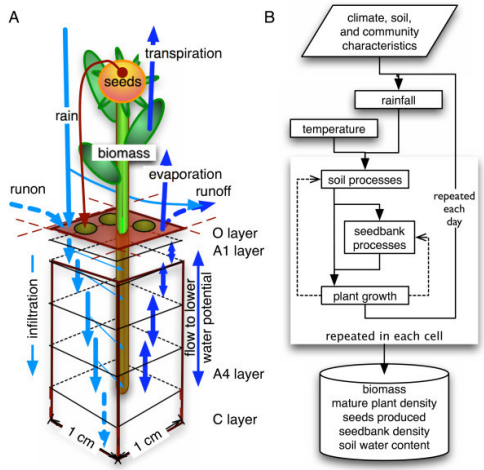
Impact Assessment (ex. flood, rice growth

↓

Measures to reduce negative Impacts

Adaptation Strategies

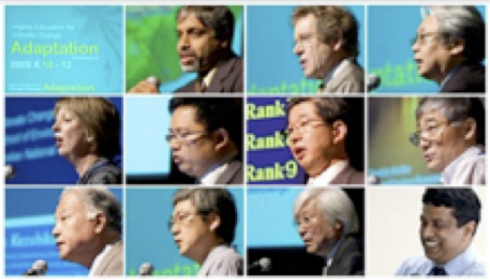


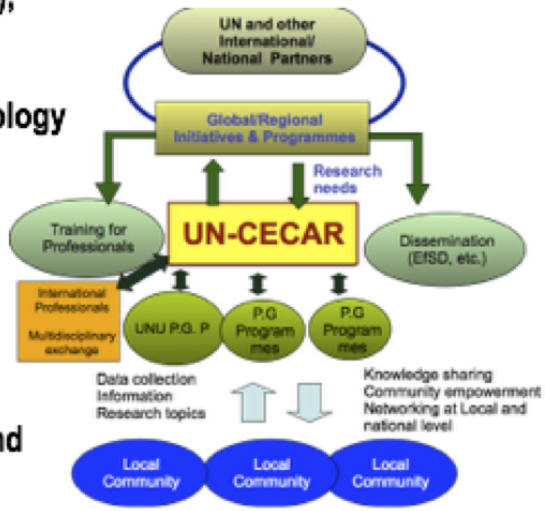


University Network for Climate and Ecosystems Adaptation Research: UN-CECAR

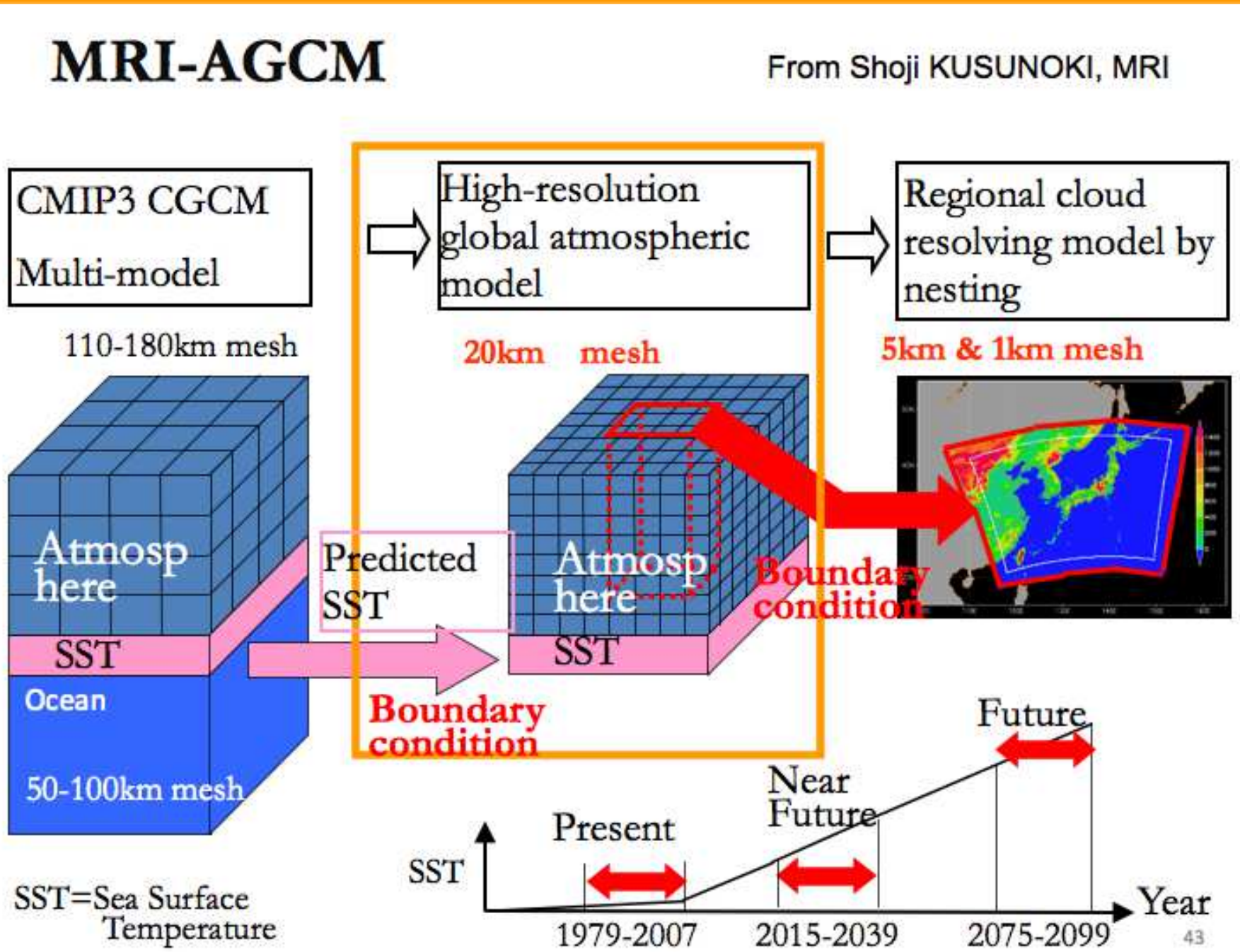
Established in 2009 to develop local capacities through Interdisciplinary approaches. The group jointly develop educational and research programmes.

- Australian National University
- Bangladesh University of Engineering and Technology
- Tsinghua University, China
- Chinese Academy of Forestry
- Indian Institute of Technology Delhi
- Indian Institute of Technology Kharagpur
- Gadjah Mada University (UGM), Indonesia
- Kyoto University, Japan
- The University of Tokyo, Japan
- Ibaraki University, Japan
- Ritsumeikan Asia Pacific University, Japan
- National University of Malaysia (UKM), Malaysia
- Tribhuvan University, Nepal
- University of Engineering and Technology Lahore (UET), Pakistan
- University of the Philippines,
- Yeungnam University, Korea
- Seoul National University, Korea
- Nanyang Technological University, Singapore
- University of Peradeniya, Sri Lanka
- Asian Institute of Technology, Thailand
- Chulalongkorn University, Thailand
- Viet Nam National University, Viet Nam

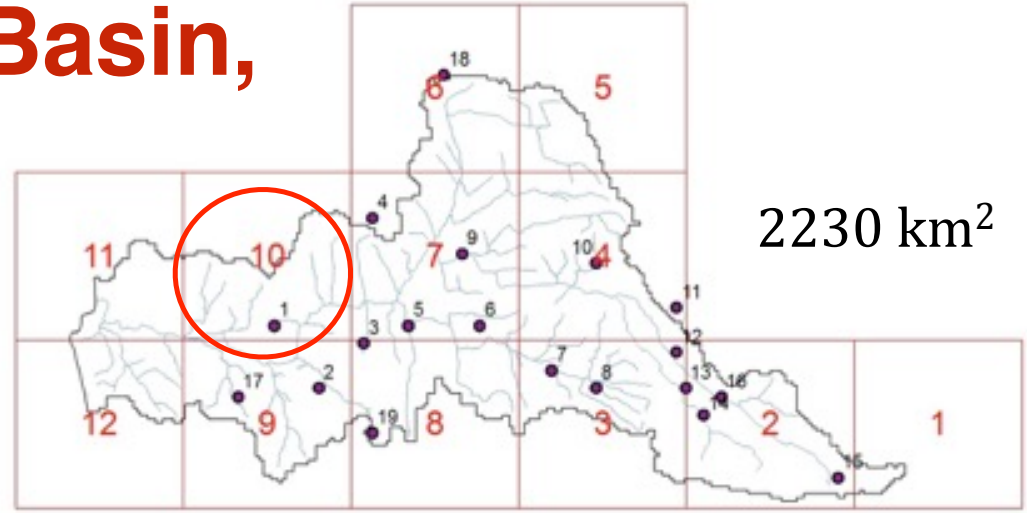




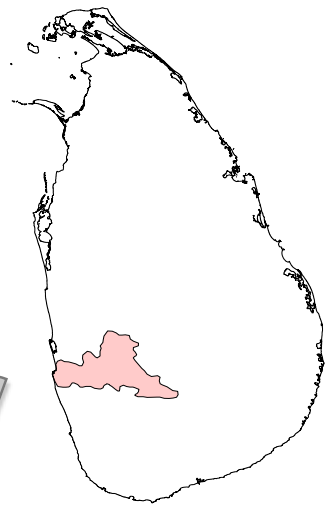
NU-IAS

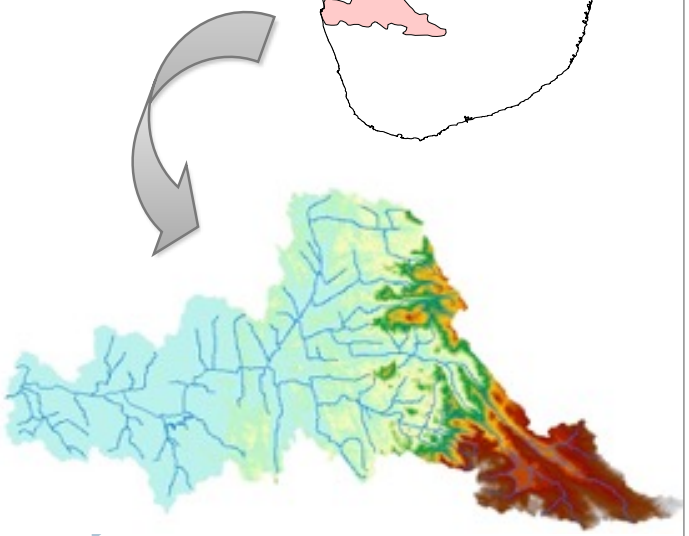

MRI-AGCM
From Shoji KUSUNOKI, MRI
CMIP3 CGCM
Multi-model
High-resolution global atmospheric model
Regional cloud resolving model by nesting
110-180km mesh
20km mesh
5km & 1km mesh
Atmosp here
SST
Ocean
50-100km mesh
Predicted SST
Boundary condition
Atmosp here
SST
Boundary condition
SST=Sea Surface Temperature
Future
Near Future
Present
SST
Year
1979-2007
2015-2039
2075-2099

Kelani River Basin, Sri Lanka



$2230\ km^2$

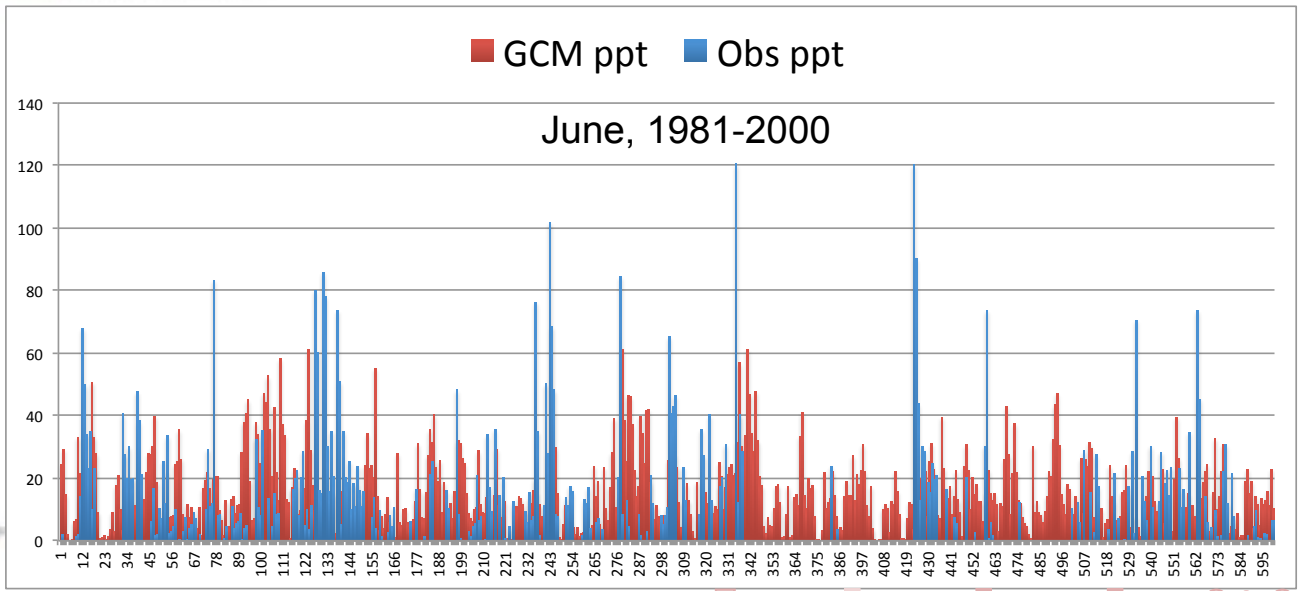




Legend

- rainfall_obs_stn
- Kelani_boundary
- Kelani_river
- gridbox_modified

	Observed	GCM
Max	120.6	61.3
Sum	5286.1	8753.2



Quantile-quantile method of bias correction

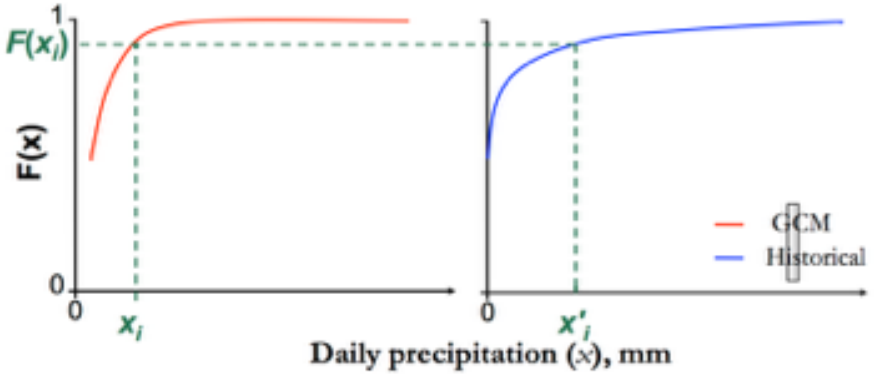
GCM precipitation data are found to have biases in:

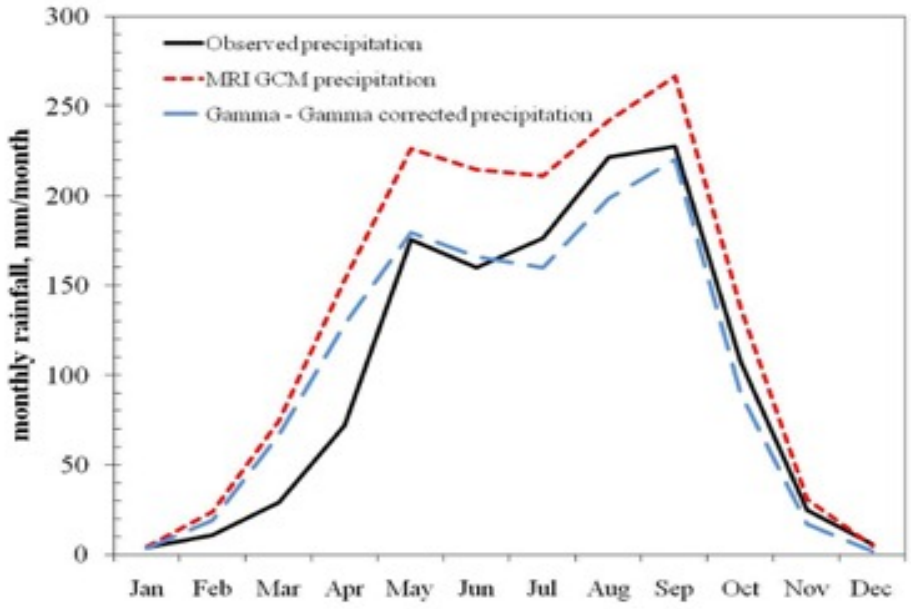
(i)Precipitation frequency (i.e., too many rainy days), and

(ii)Precipitation intensity (i.e., smaller precipitation values)

Correct bias by mapping probabilities of observation and projections.
Gama Distribution is used for the Quantile Mapping

$$x_i^{'} = F_{obs}^{-1}(F_{GCM}(x_i))$$

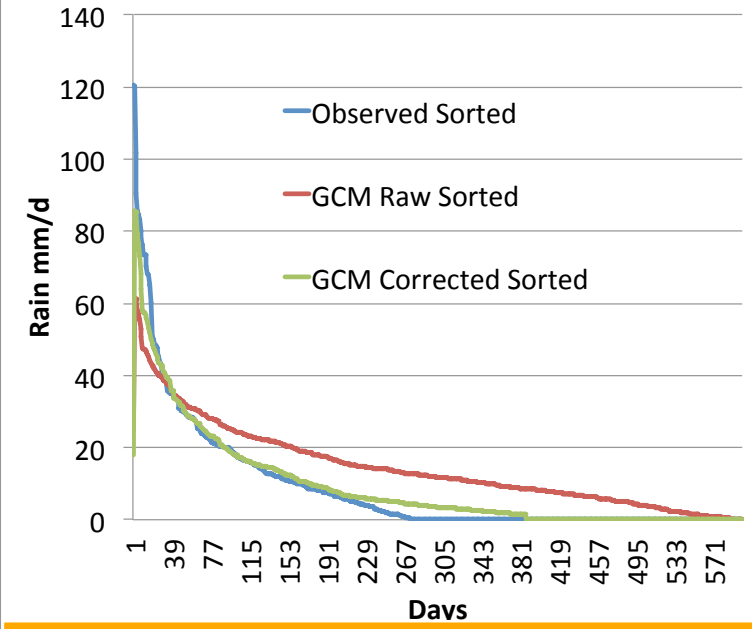




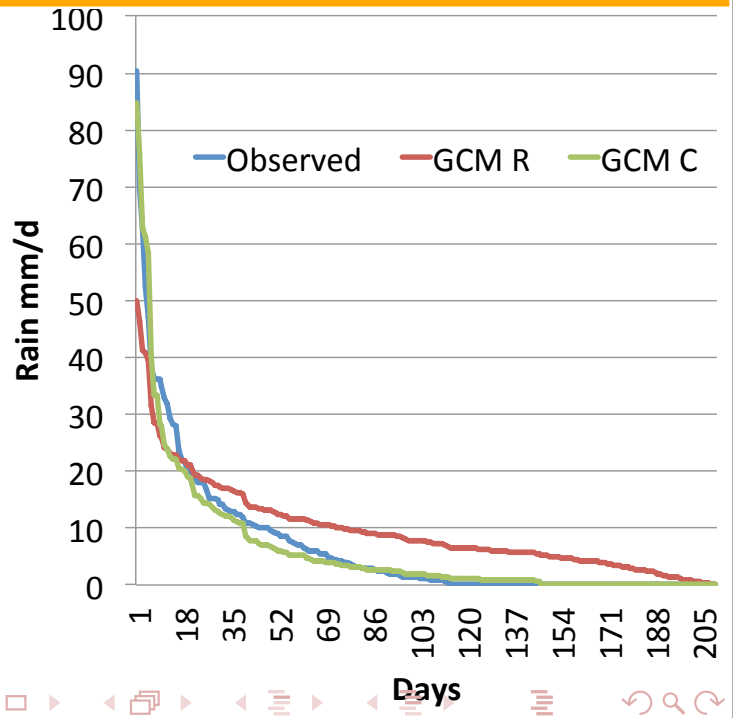
Validation

- To verify the applicability of the approach, 1981-2007 data set was split in to two periods covering 1981-2000 and 2001-2007.
- The approach shows good agreement with the statistical distribution of rain values.
- Totals: 5286(o), 8753(r), 5579 (c) for first period and 1396 (o), 2054 (r), 1292 (c) for the second period

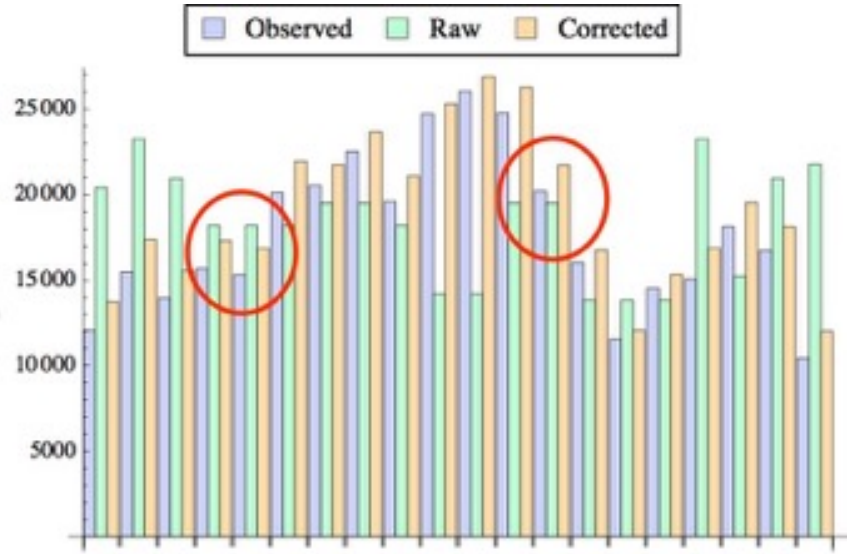
Model Calibration period 1981-2000

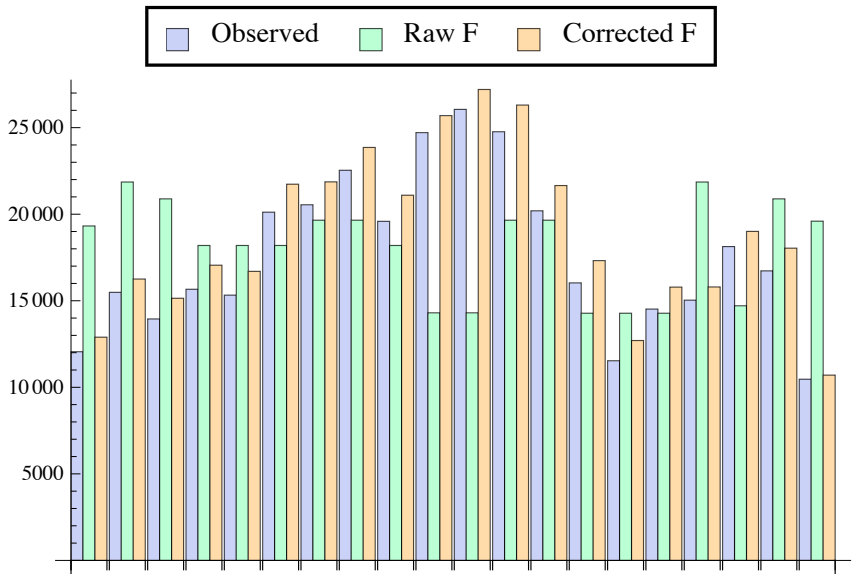


Future Prediction 2001-2007



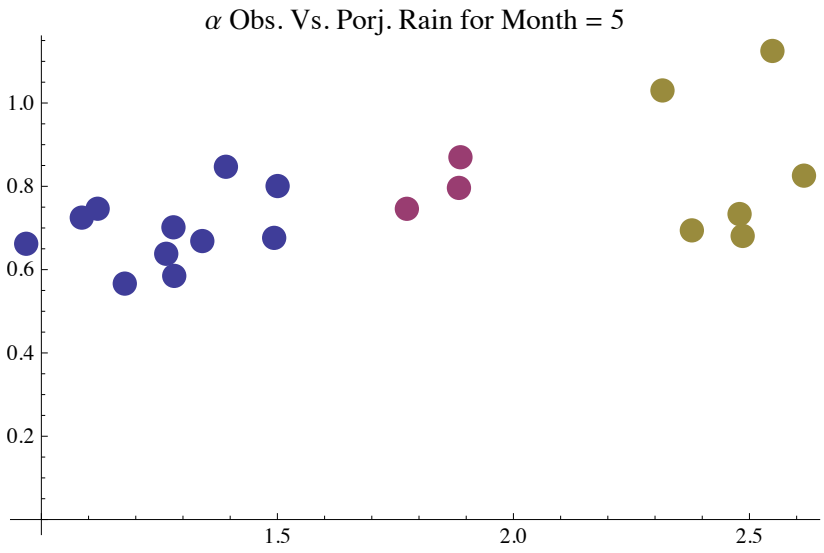
Spatial Variability



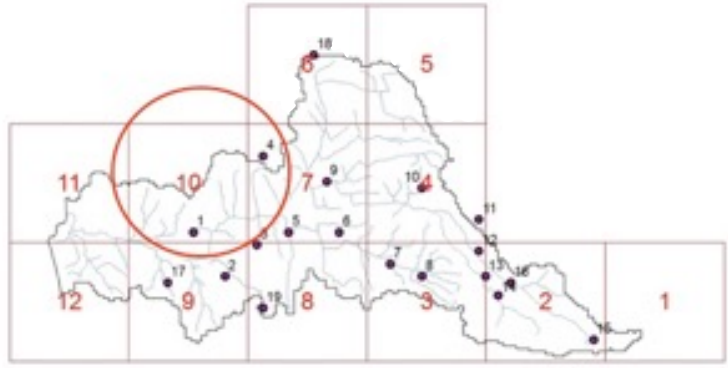


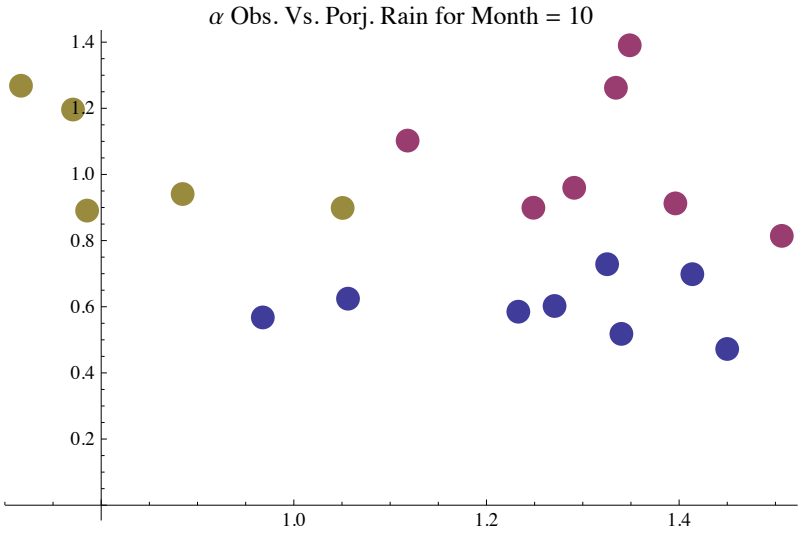
- The total rainfall of each station shows a reciprocal relation between the observed and the projected values.
- This may imply that regional characteristics could be different between the observed and predicted.

Regionality from the distribution parameters



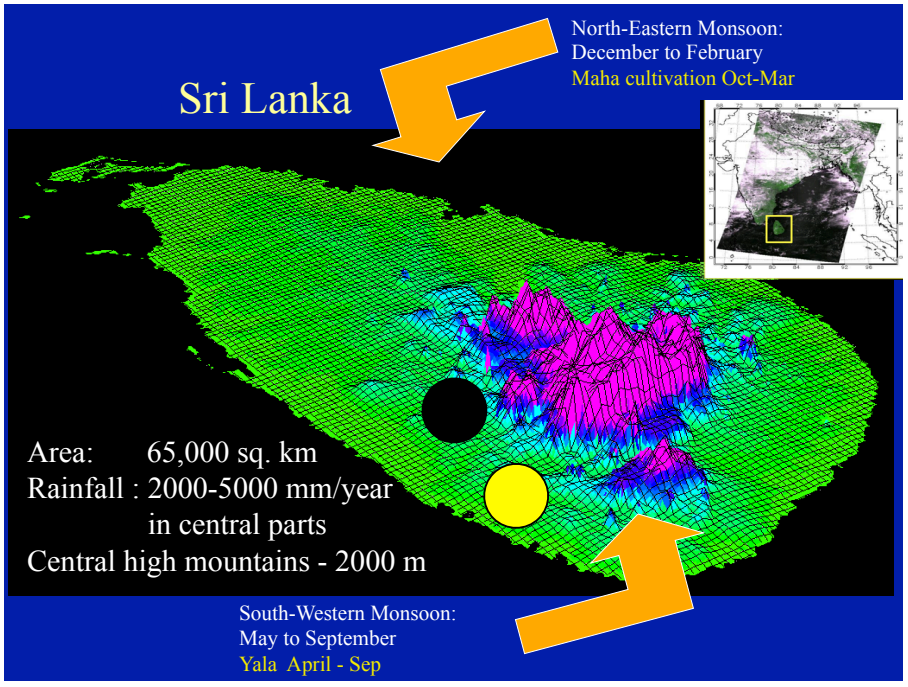
(1)





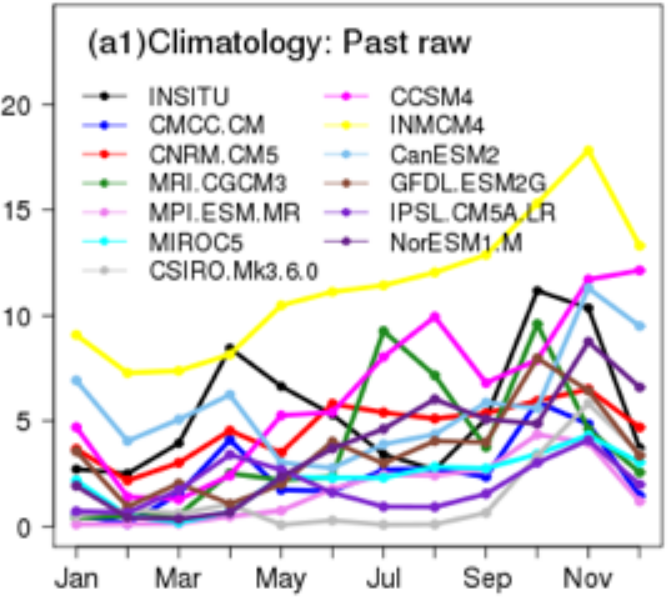
(2)

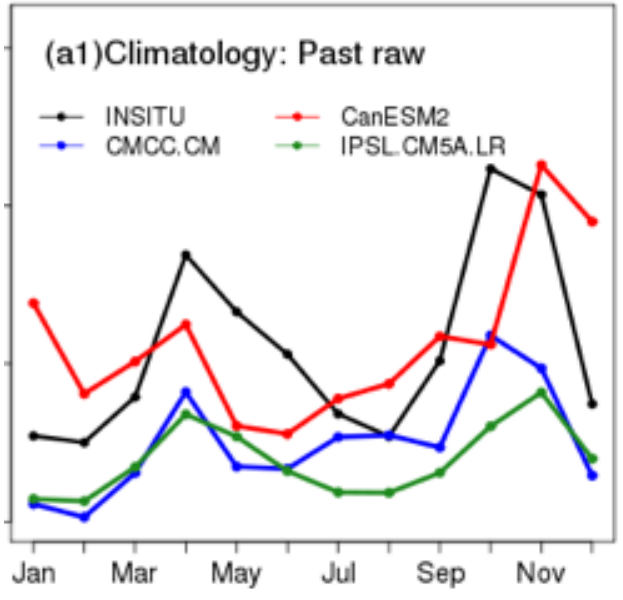
- Shape parameter (α) with y-axis for Observed and x-axis for Projected for May (1) and for Oct (2)
- It may not be necessary to correct for each grid considering the regional characteristics of distributions (1). Here 3 clusters may be adequate. However, the clusters change according to season. (2)

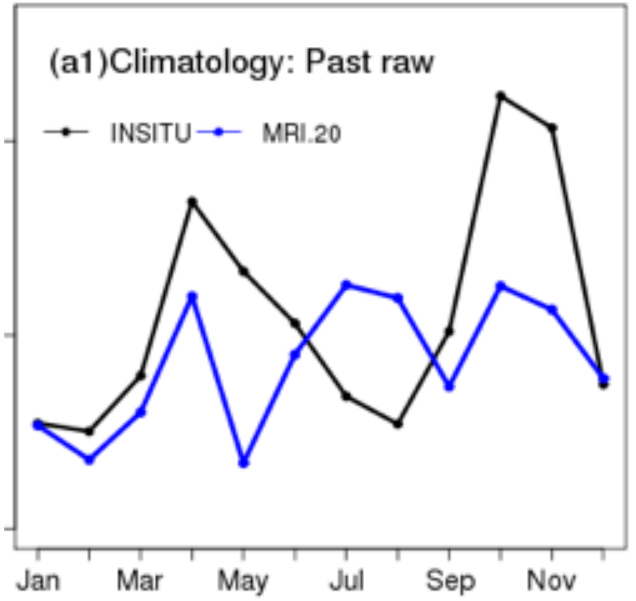


Kurunegala: Wet/Dry Interface

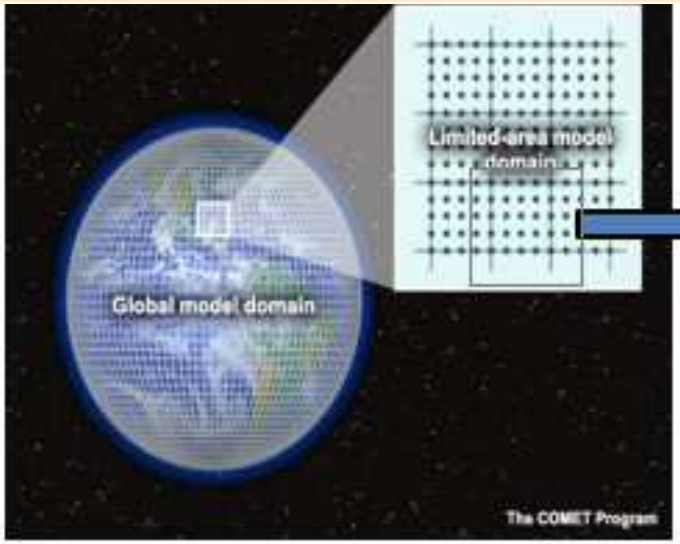
- CanESM2 - The Second Generation Canadian Earth System Model - 300 km horizontal resolution
- CMCC.CM - Euro-Mediterranean Center for Climate Change, Italy, 75km
- IPSL-CM5A-LR - The fifth generation coupled model developed at Institut Pierre-Simon Laplace, France - 350 km

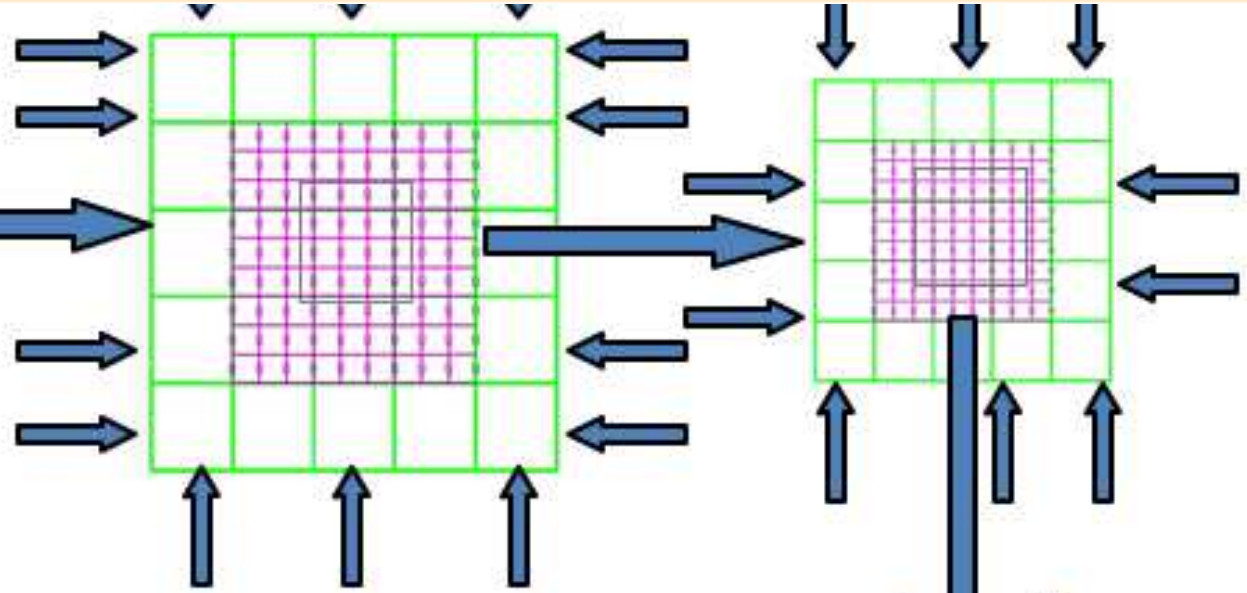


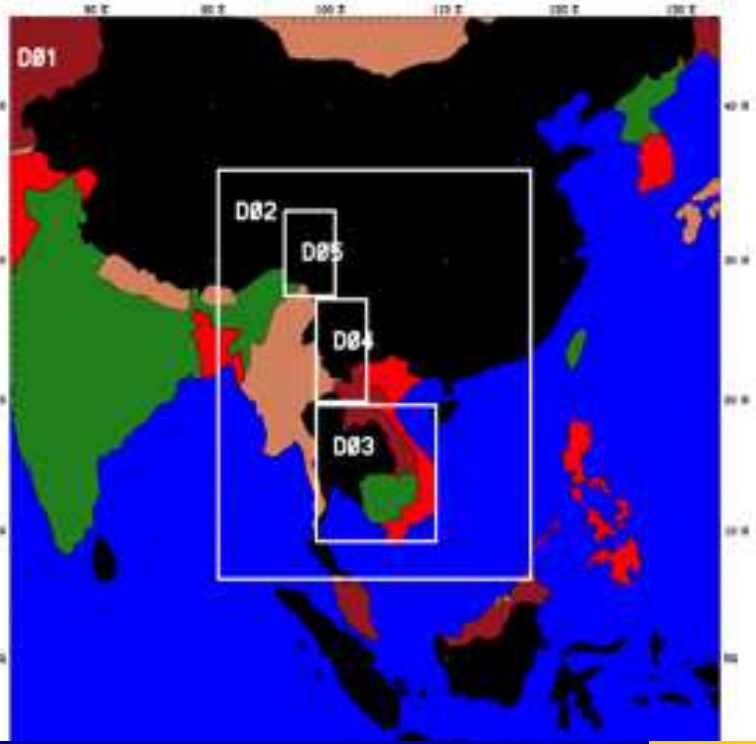




All GCMs SELECTED GCMs MRI 20km

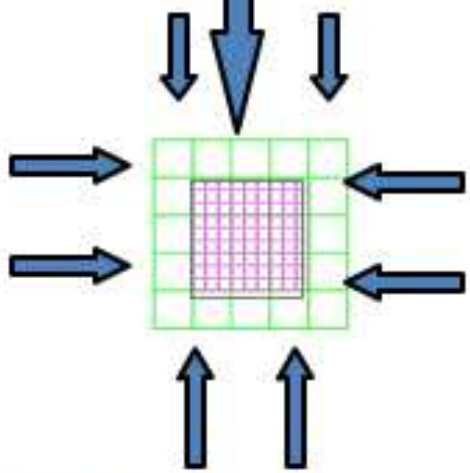




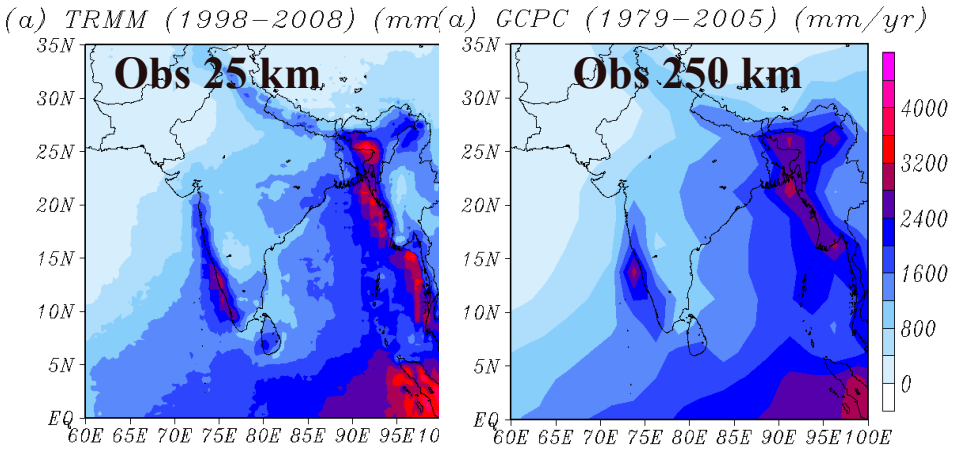


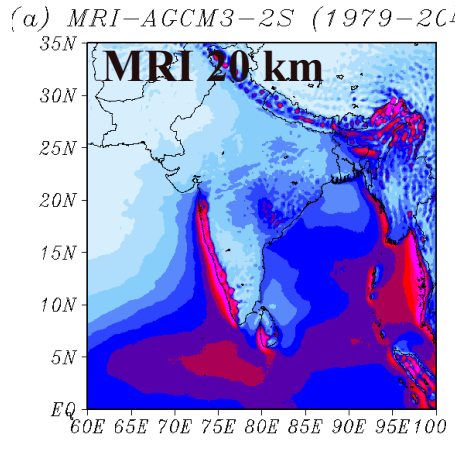
Downscaling with RCM

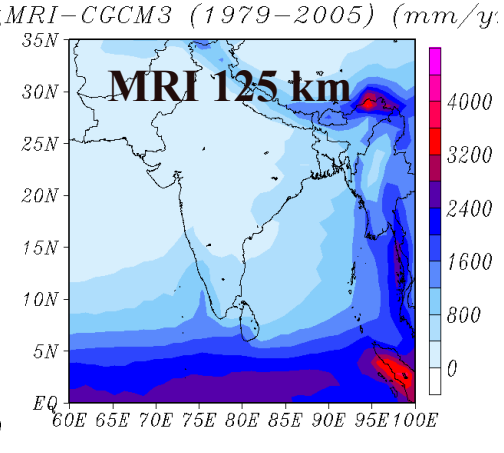
Weather Research and Forecasting (WRF) Model of NCAR, USA used for downscaling

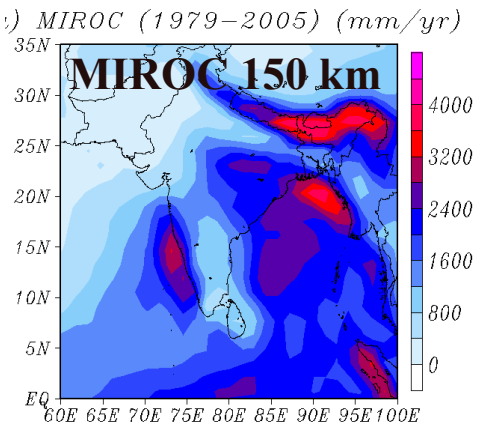


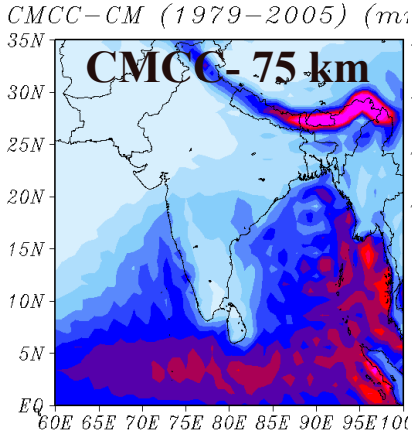
Global model projection performance

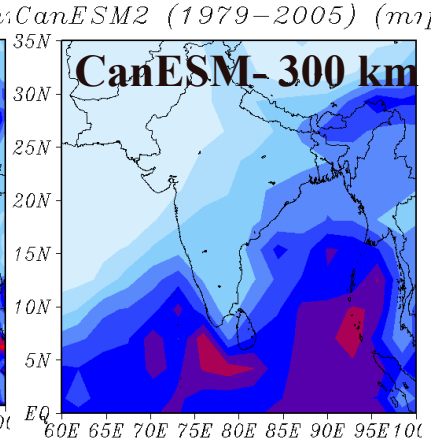


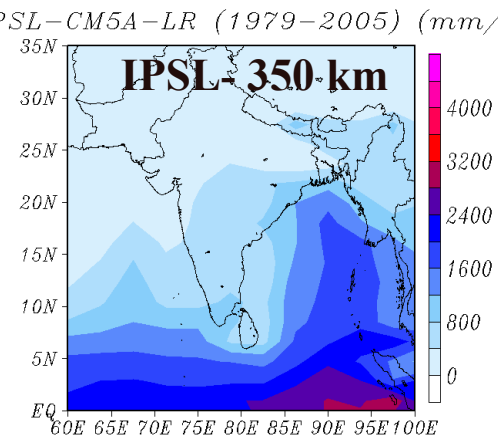












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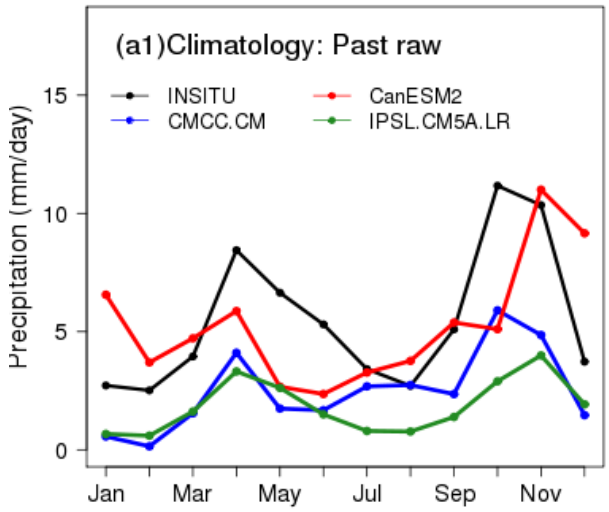
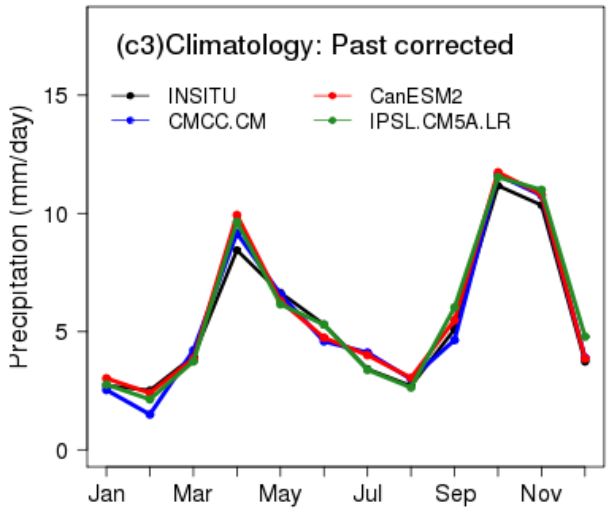
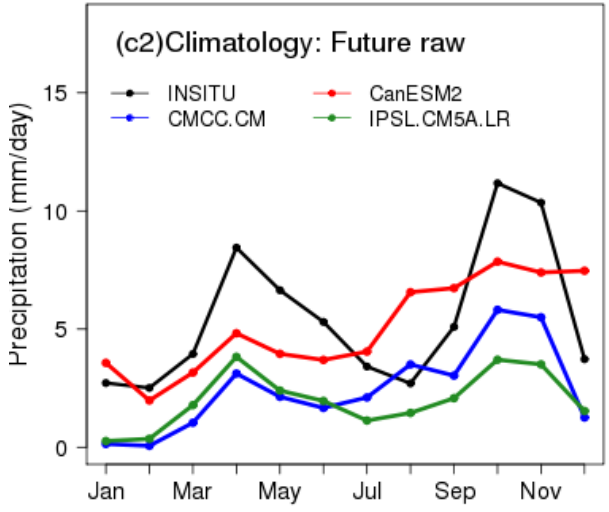
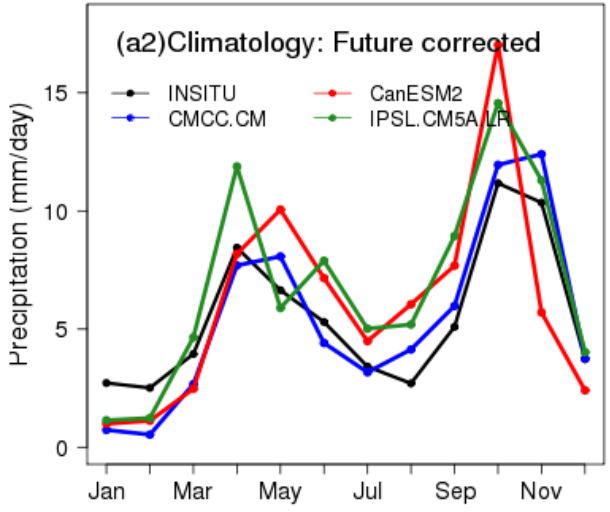
Bias Corrected



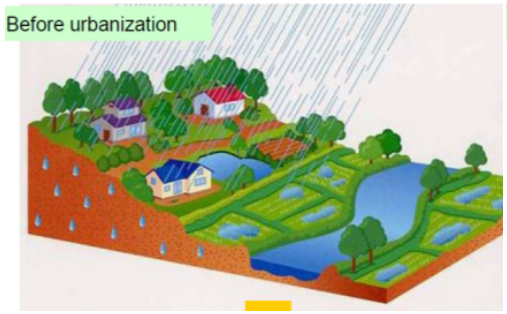


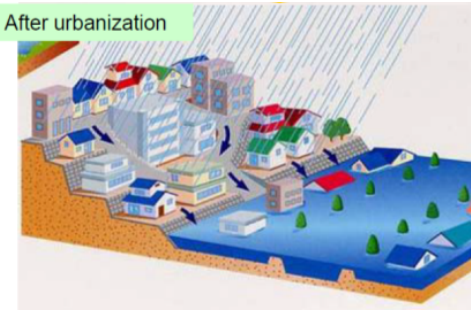


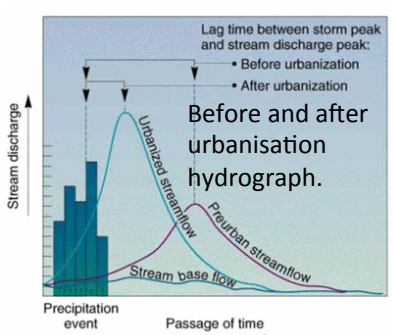


Case Study: Urbanisation and Climate Change

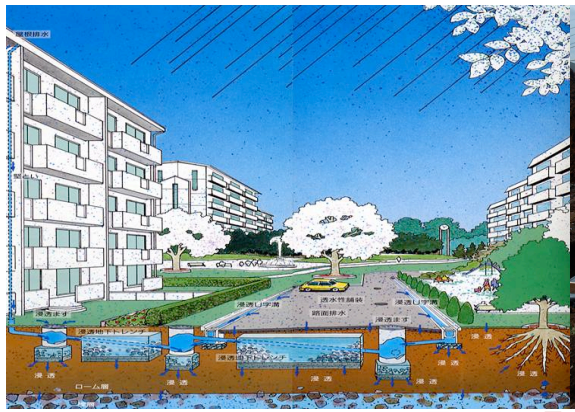
- Urbanisation: reduce natural storage and infiltration increasing runoff and decreasing ground water.
- Climate Change: increase rainfall intensities resulting in increased runoff. Longer dry periods → less ground water.
- Can make use of Experiences and Approaches
- Japan: Onsite management → Infiltration facilities and temporary detention. Creation of ARSIT (1991)
- Developed in late 80's early 90's but on-site measures are not practiced widely.







(Christopherson, R. W. (1997). Geosystems:An introduction to physical geography. Saddle River, NJ: Prentice Hall.)

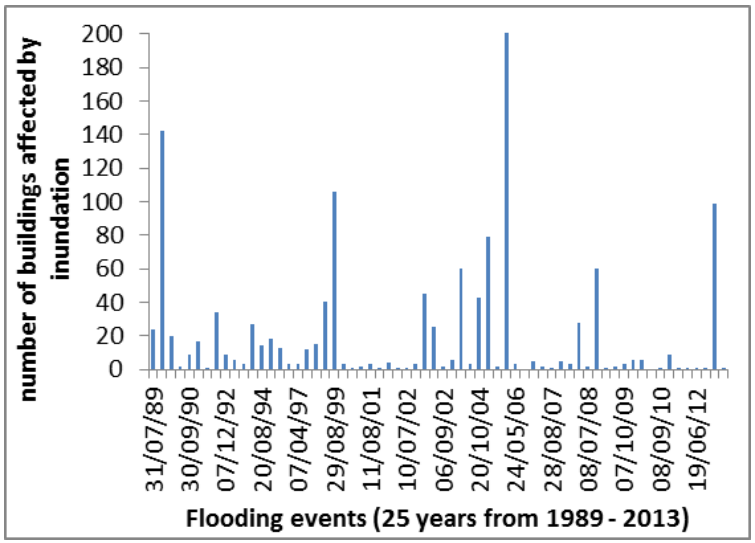


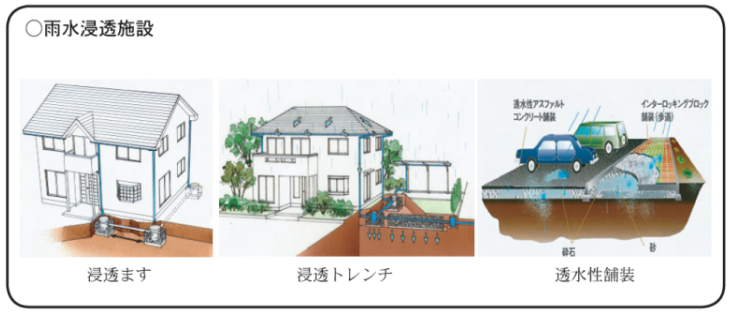
Yato watershed, Setagaya ward - Tokyo

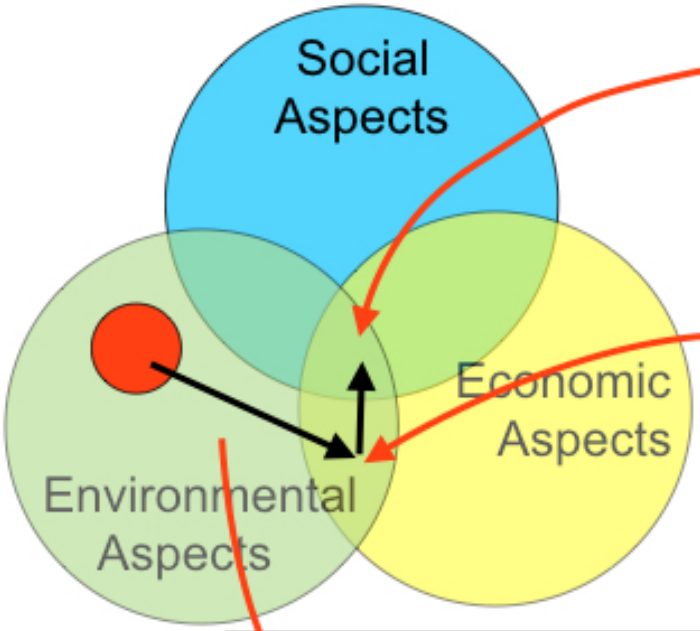
Extent $2.93 km^2$, tributary of Tama river. In Setagaya ward (largest population, 2nd largest in area, pop. dens. $14,400 pers/km^2$), Tokyo Metropolitan, Japan

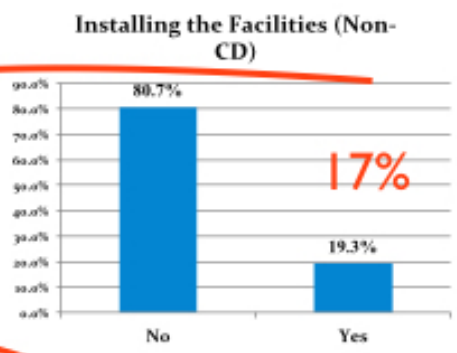
Problem: urban flood, inundation.

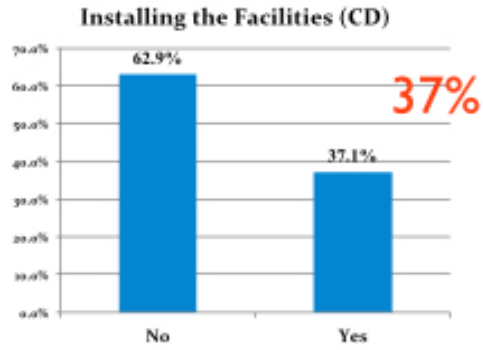
Solution: infiltration and storage





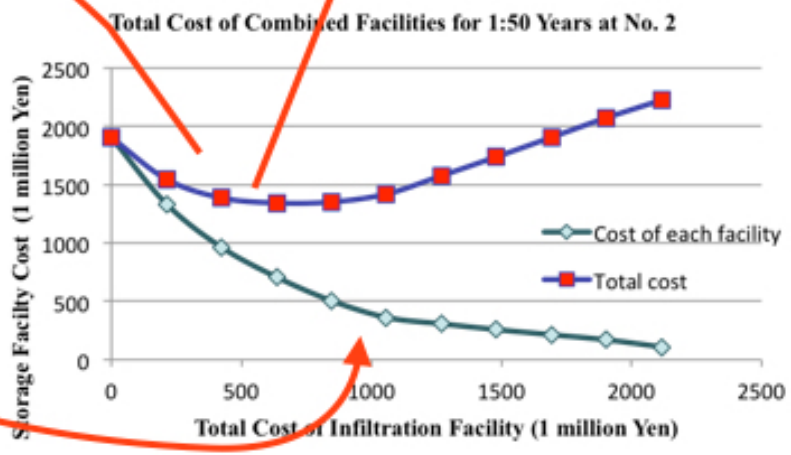


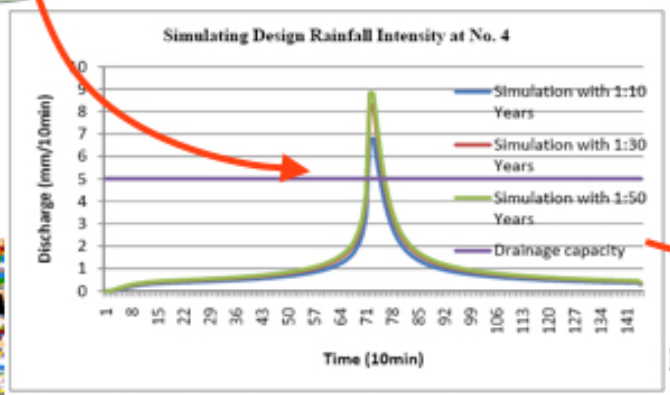


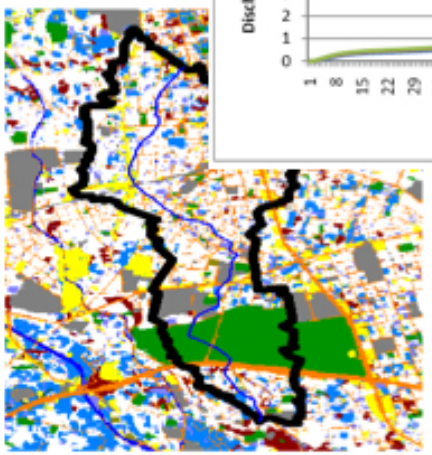


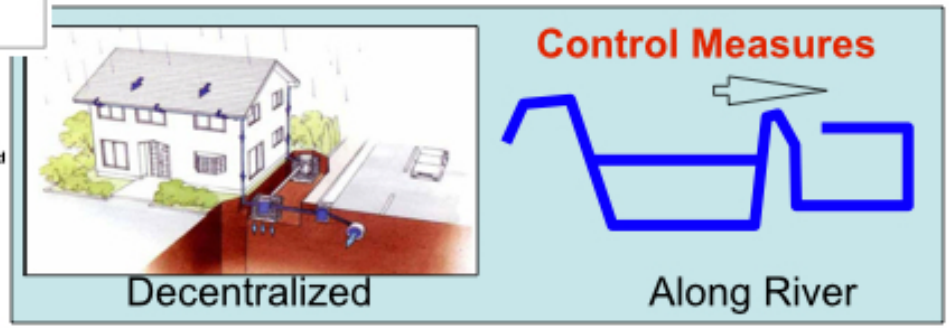
No Envi. Info

With Envi. Info





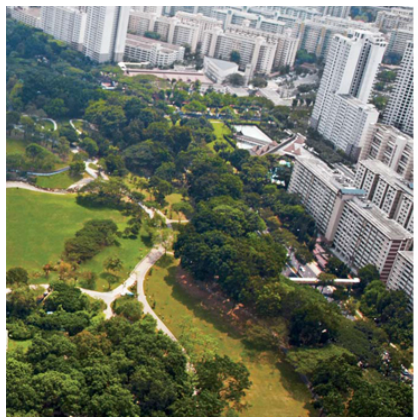




UNU-IAS

Singapore: ABC Waters (Active-Beautiful-Clean)

- ABC Water Program: capture and clean stormwater before it runs into reservoirs
- Ambition: Transforming into a City of Gardens and Water
- ABC Waters Program (2006): strategic initiative to improve the quality of water and life by harnessing the full potential of water bodies
- Aims to create beautiful and clean streams, rivers, and lakes for all to enjoy by integrating Environment (Green) Water (Blue) and Community (Orange)



The Park Royal Hotel & Bishan-Ang Mo Kio Park

Urban Greening - but where?

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Rainwater storage

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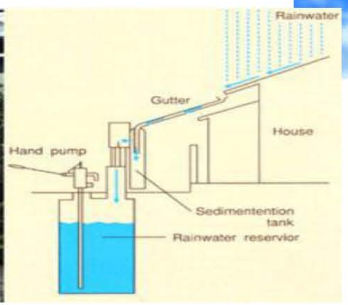
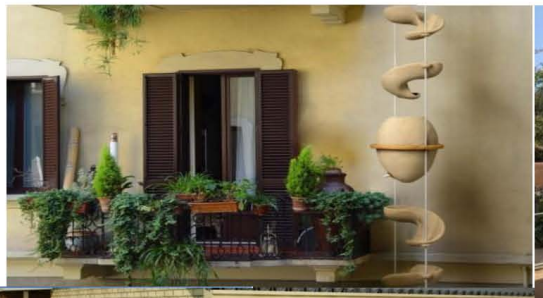
- Combine rainwater storage
- function with aesthetics
- Use during emergencies
- Flood reduction benefits
- Reduce stress





Rainwater harvesting for aesthetics

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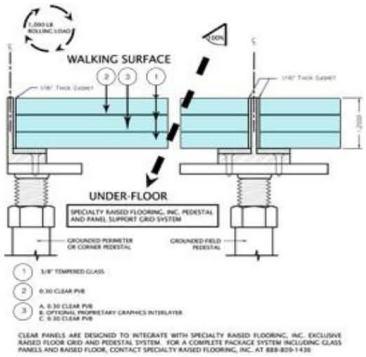
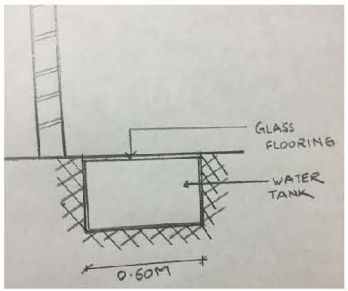
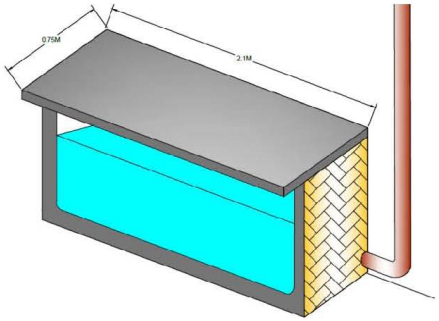
Proposing Glass flooring over Underground storage tanks.

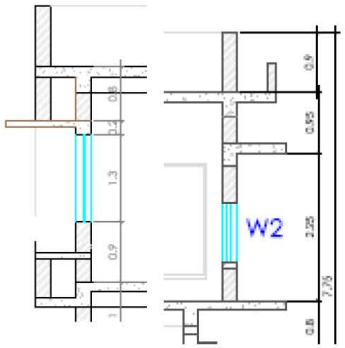




By proposing it a interactive space is create d which acts like a feature in outdoors without compromising the functionality of the space.

Integrating rain water harvest tanks with architecture

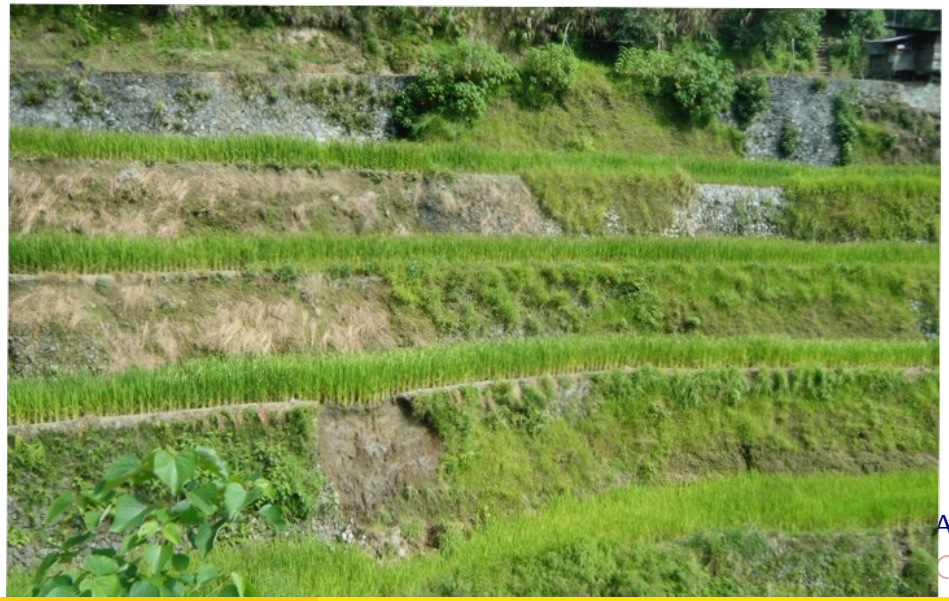


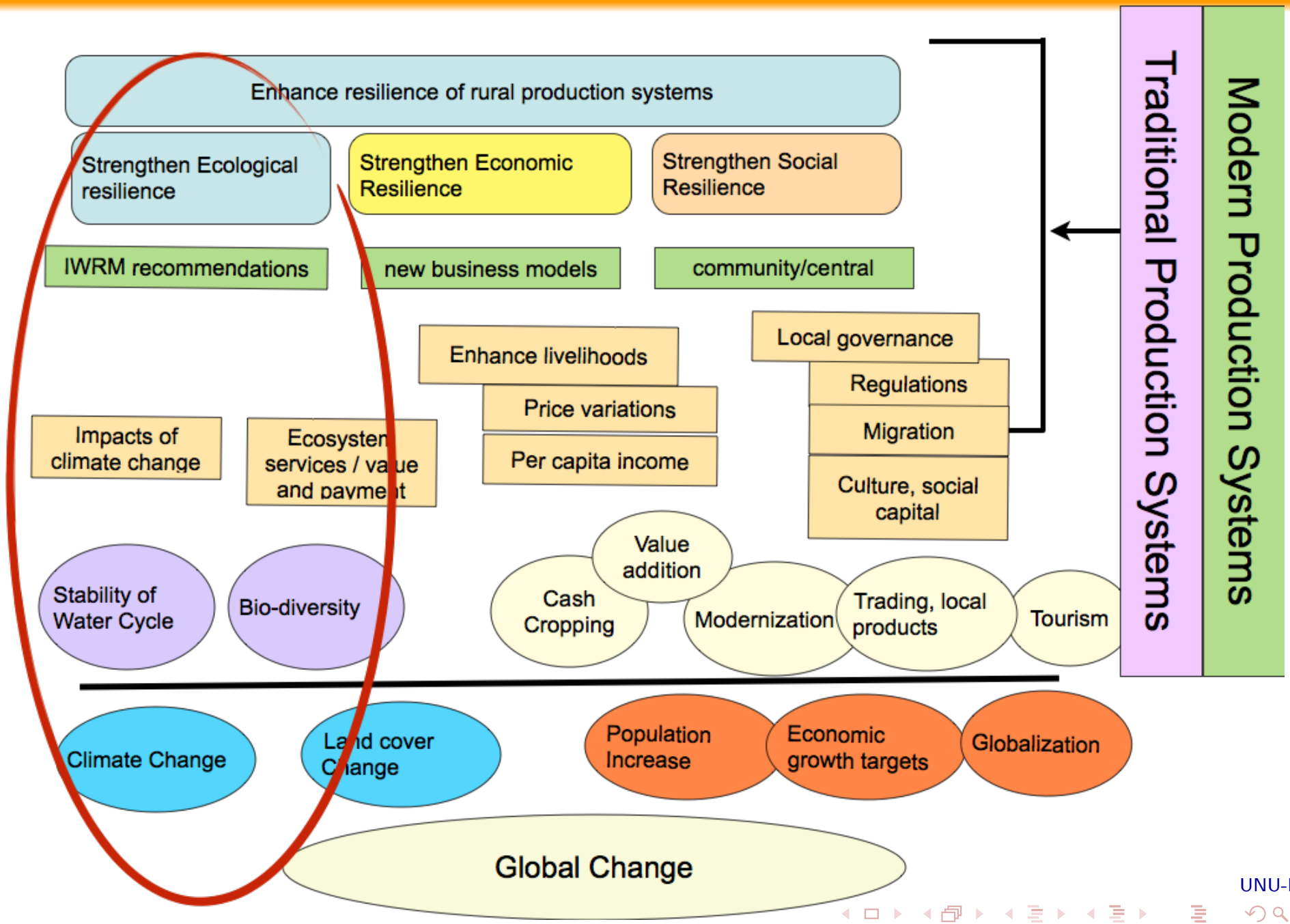


Flexibility in the shapes and sizes of water tanks can promote its optimum uses

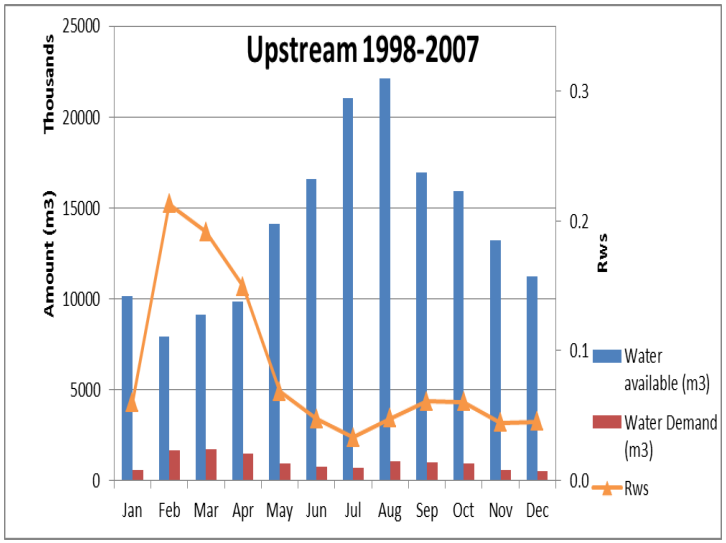
Hani terraces - Impacts of Climate Change? - Ifugao Terraces

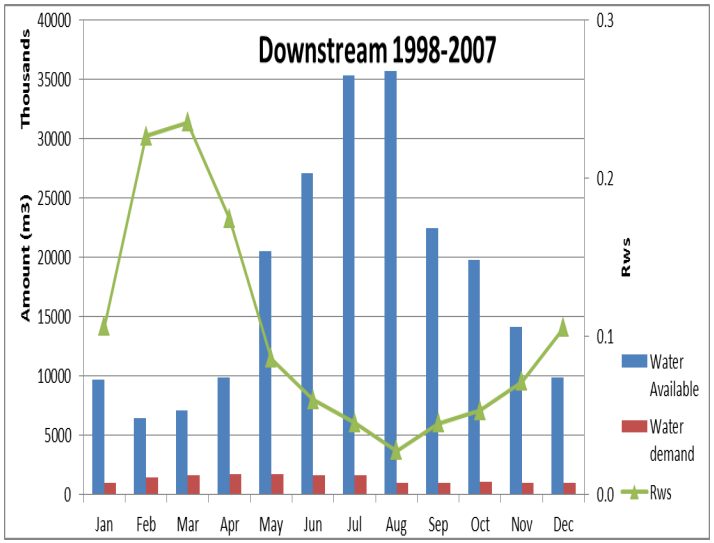
Hani terraces - Impacts of Climate Change? - Ifugao Terraces




Enhance resilience of rural production systems
Strengthen Ecological resilience
Strengthen Economic Resilience
Strengthen Social Resilience
IWRM recommendations
new business models
community/central
Enhance livelihoods
Price variations
Per capita income
Local governance
Regulations
Migration
Culture, social capital
Impacts of climate change
Ecosystem services / value and payment
Stability of Water Cycle
Bio-diversity
Value addition
Cash Cropping
Modernization
Trading, local products
Tourism
Traditional Production Systems
Modern Production Systems
Climate Change
Land cover Change
Population Increase
Economic growth targets
Globalization
Global Change

Water Security in Hani terraces: Results





Water Scarcity Index (use/availability) Rws $\leqslant$ 0.1 means no stress, Mild to moderate stress 0.2-0.3

- Water stress in Feb and March for both u/s and d/s. More stress for d/s
- Severe water shortage in Femio indicates lack of access
- Needs measures to ensure ground water availability

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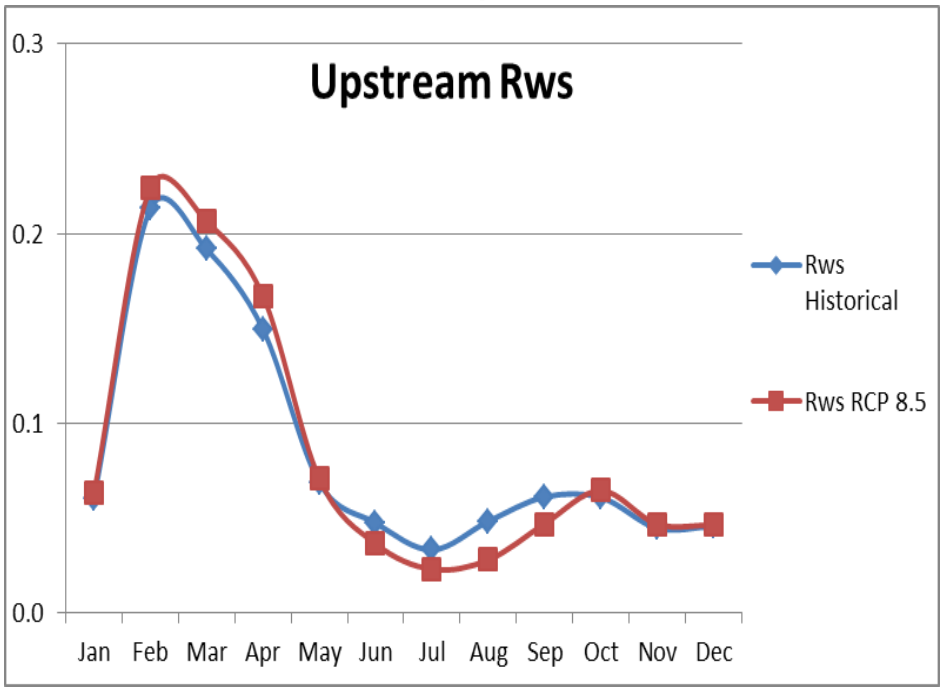
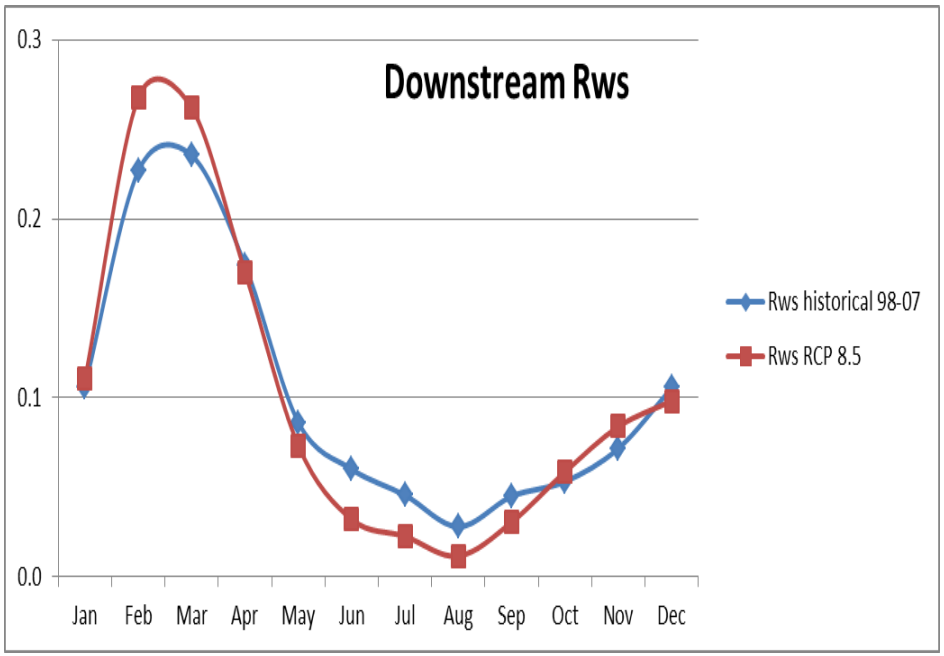
Climate Change Impacts: Hani Water Security

Bias corrected CORDEX (EC-Earth model) projections were used to analyse future water availability. Future demands computed for expected tourism demand, crop diversification and population change. Change of Present and Future Water Scarcity index shows increased stress in Feb and March, more pronounced for downstream than upstream.

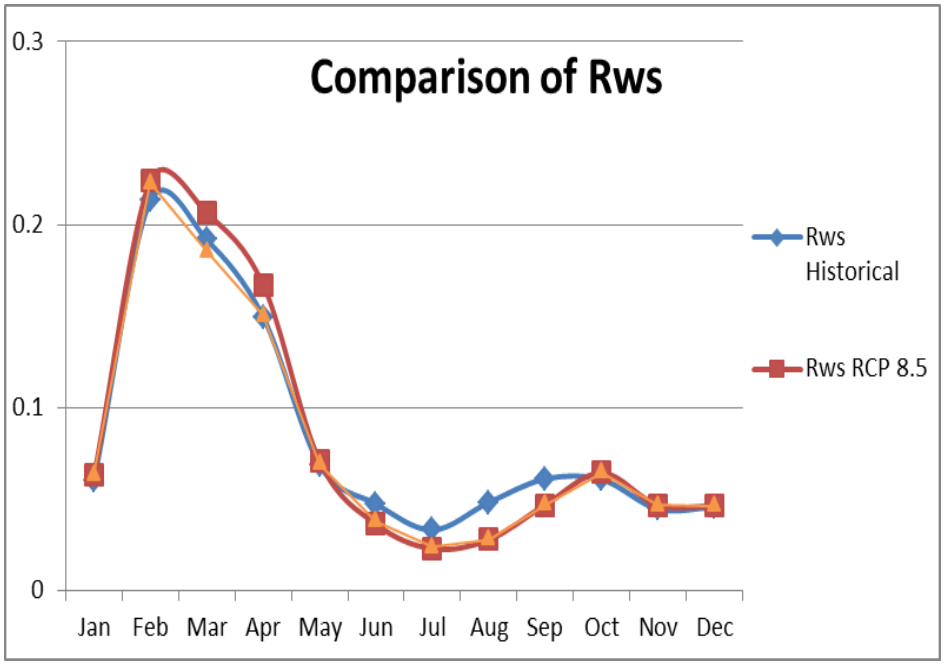




Addressing Water Security: Hani Terraces

Structural Measures

By doubling the upstream storage ponds, the increased water scarcity due to climate change can be addressed.



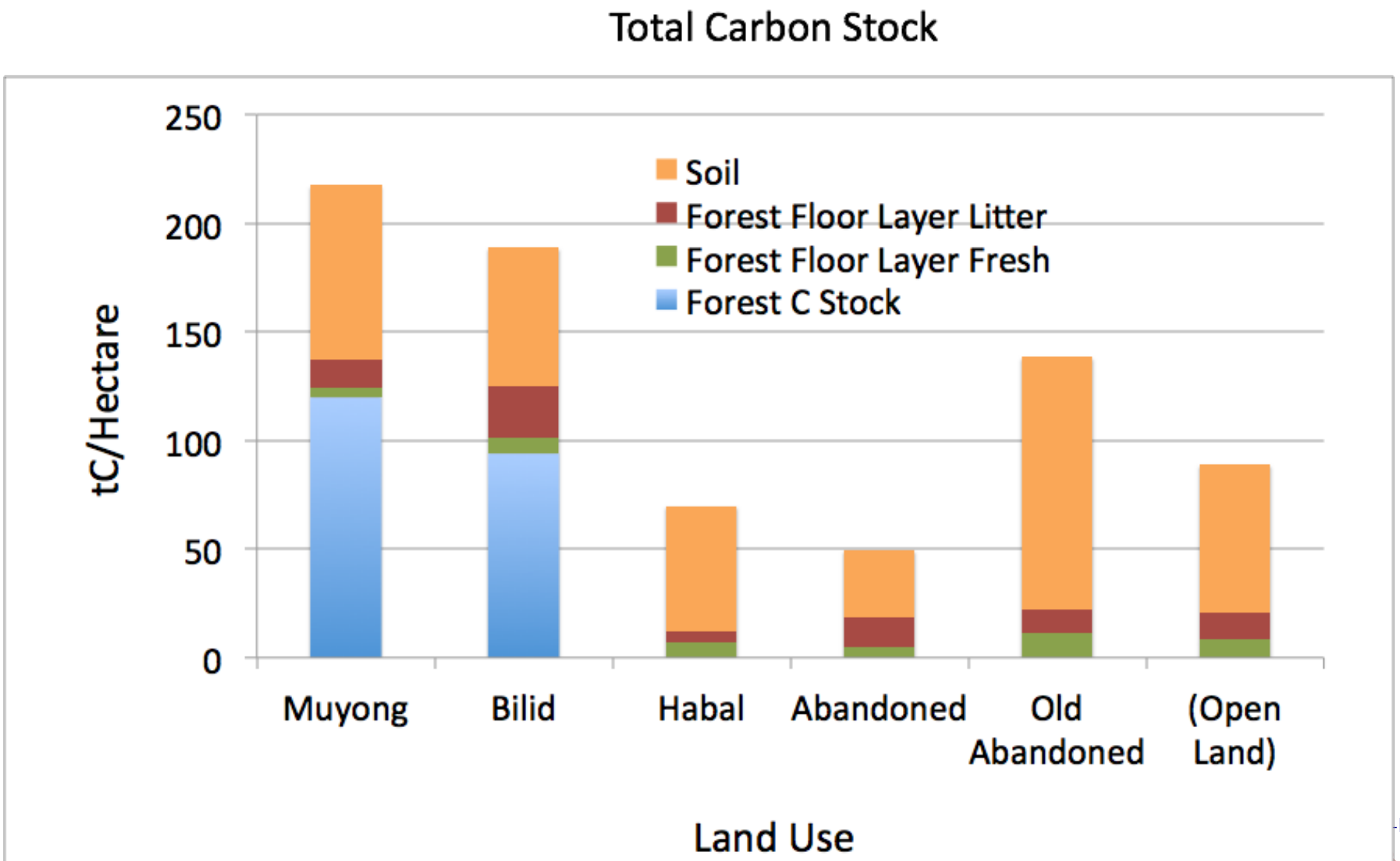
Non Structural Measures

- Understand dynamic links among surface water and groundwater resources and demand
- Institutions to manage water in villages with government and utility companies. Revival of water management systems with Water User Associations: Measures for conservation, recharge and management of groundwater

Enhancing Livelihoods - Opportunities for Ifugao

1. UN-REDD+ programme (Reducing Emissions from Deforestation and Forest Degradation) supports forest management for sequestration and preserving of carbon stocks.
2. In Nagacadan Barangay four different carbon pools of the local forests: the forest carbon stock, non-tree vegetation, forest floor litter layer, and soil carbon at 10 cm depth were estimated.
3. The results show that Muyong forests have the highest carbon stocks. Thus it may be possible to develop programmes for receive assistance for Muyong forest management under REDD+ schemes.

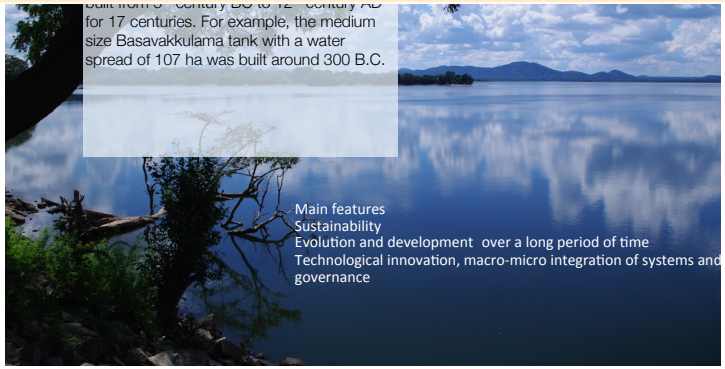
Climate Change Opportunities: REDD+



GC Driver Climate Change

Thematic focus Food, Water

Funding MOEJ



Partners Sri Lanka, (University of Peradeniya, Irrigation Department, CECB)

Synopsis

Ancient Systems **Modern Systems**

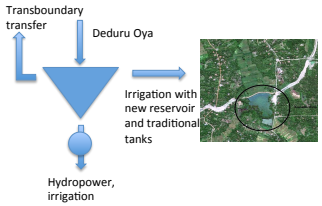
Micro-Macro Integration
Resilience from Distributed Systems
Multiple Benefits
Community Based Management, integral part of daily life

\+

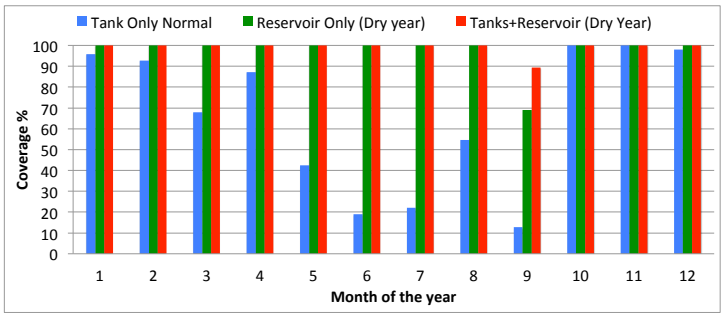
Rapid Development
High productivity, efficiency
Macro-scale solutions, Transboundary transfers
Removed from daily life

Sustainability & Resilience **Efficiency & high Productivity**

Mosaic Systems



- Mosaic System Test in Deduru Oya Basin in Sri Lanka
- The sixth largest River. Catchments area - 2620 km2 90%- Intermediate Zone,10%- Wet Zone.
- Construction started in 2007 and expected to complete in 2014.



- Analysis of the system shows;
  - Traditional systems cannot meet the irrigation demand of the total paddy areas (old and new)
  - New reservoir can manage all demands for normal years, but fails in dry year (Once in 5 years)
- New reservoir and traditional reservoirs can improve, but cannot meet the demands if water allocation is done independently.
- Detailed analysis of inflows to each reservoir was carried out and full system modeled in detail.

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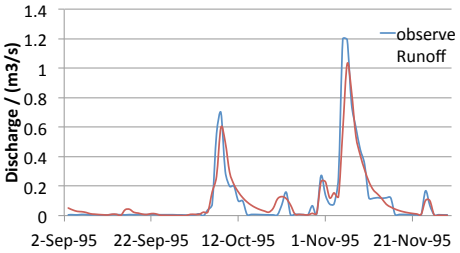

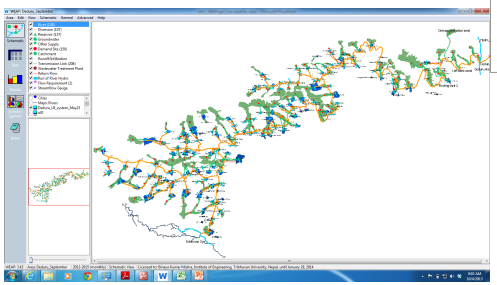

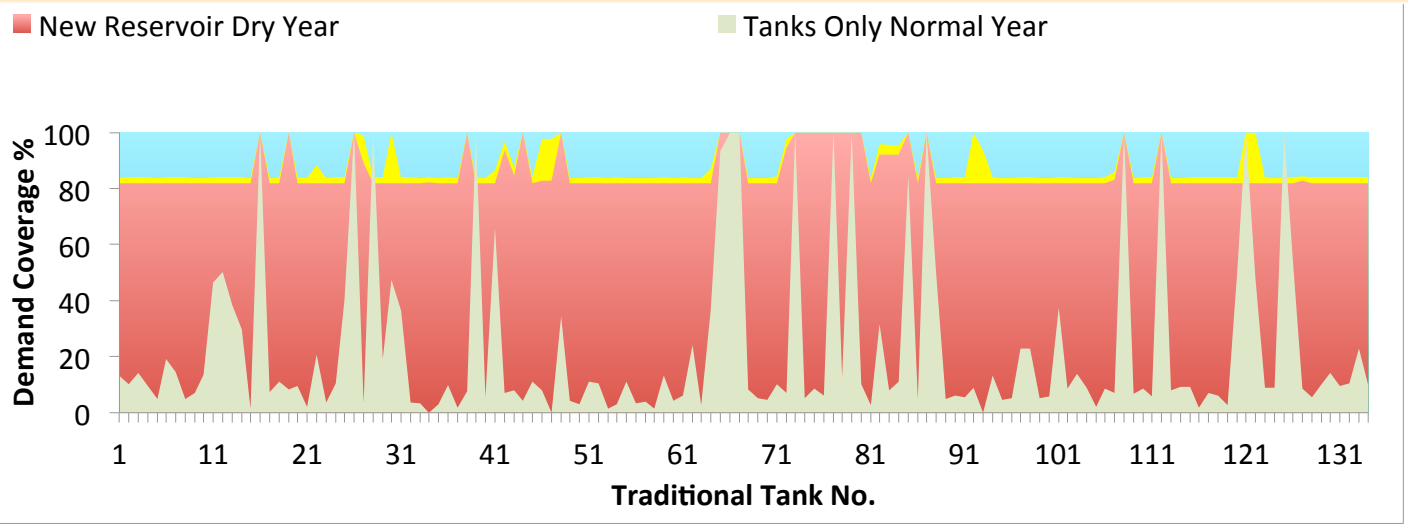

Joint management prioritizing to meet September dry year demand

- Joint management to prioritize dry year September year demands to be taken by traditional tanks can meet the total water needs.
- Joint management options were studied and methodology and guidelines prepared.
- MOU was signed with the Director General of the Irrigation Department signed for use of research outcomes.

Building Resilience for Sustainability

- Planned adaptation requires future impacts at local scale
- There is a large uncertainty in future development paths and uncertainty in climate projections at local scale.
- Planning specific measures as well as Investment under uncertain future is extremely difficult, especially for developing countries.
- Risk assessment helps in making decisions to minimise anticipated negative impacts and maximise benefits
- Building redundancy, diversity, resistance and recovery mechanisms considering multi-stakeholder involvement is a pragmatic approach to reduce adverse impacts of global change.

Thank You!