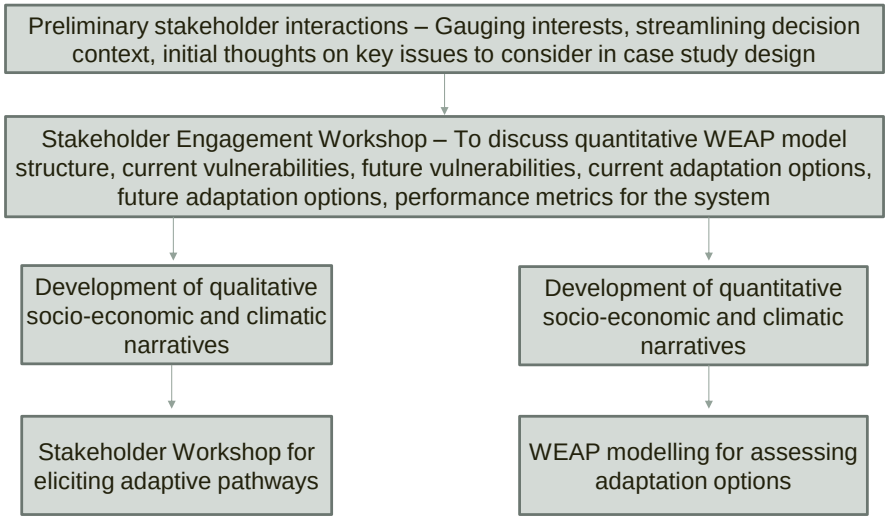
Comparing robust decision making approaches for long-term water resources in Southern India

AJAY BHAVE[1], DECLAN CONWAY[1], SURAJE DESSAI[2] AND DAVID STAINFORTH[1]

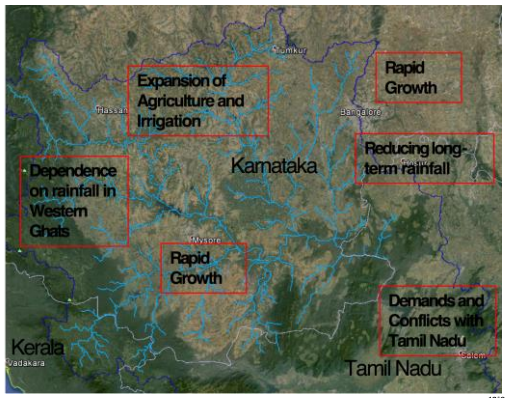
[1]Grantham Research Institute,
London School of Economics and Political Science

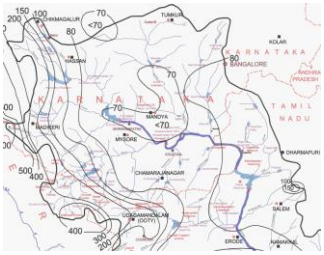
[2]University of Leeds

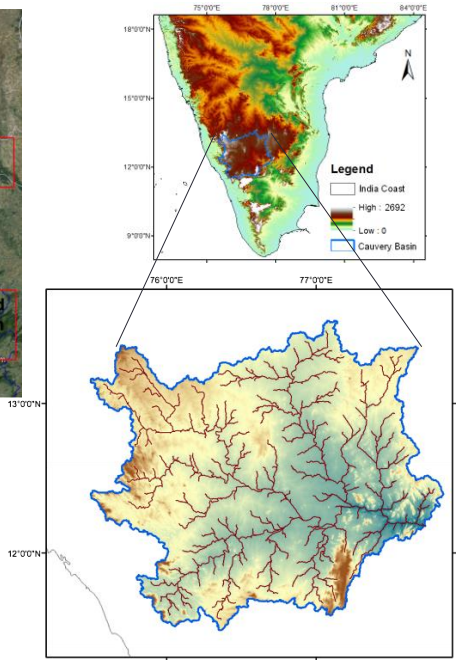
Parallel RDM approach



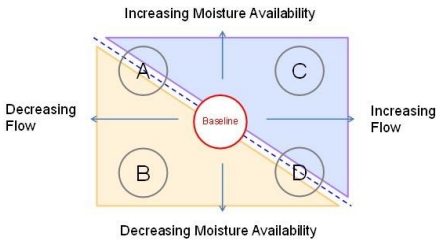
Decision Context







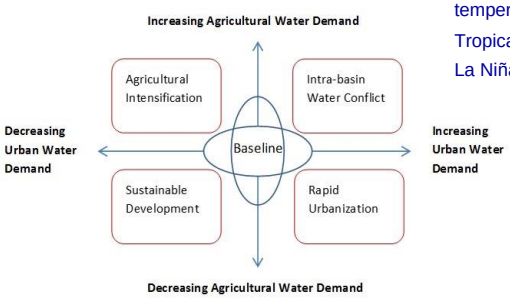
Narratives



Climate narratives A, B, C and D with respect to the two axes; moisture availability and strength of flow. Blue dashes divide the narratives into two based on expected precipitation.
Blue triangle - increasing precipitation.
Brown triangle - decreasing precipitation.

Narrative is informed by particular climate processes

For example Narrative C - Precipitation is expected to increase due to underlying plausible processes of global warming and intensification of the tropospheric temperature gradient, greater northward shift of the Inter Tropical Convergence Zone and greater influence of the La Niña teleconnection.

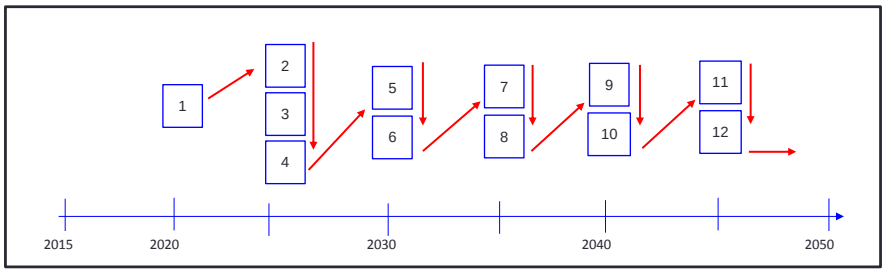


Socio-economic narratives based on the most important water users; agricultural and urban areas

Qualitative approach

Key Current Vulnerabilities	Key Future Vulnerabilities	Key Current Options	Key Future Options
• Rapid Bangalore • population increase in Agricultural expansion	• Climate change • Changing nature of extreme events • Dependence on Western Ghats rain	• Rainwater harvesting • Drip irrigation • Increasing efficiency	• Inter-basin water transfer • Waste water reuse • Expansion of water supply from Cauvery to Bangalore • Water pricing

Sequencing of adaptation options for the near to long term



Scenario combinations used for qualitative approach

	Increase in precipitation	Precipitation within Baseline variability	Decrease in precipitation
Agricultural Intensification	1	2	3
Intra-basin Water Conflict	4	5	6
Rapid Urbanization	7	8	9
Sustainable Development	10	11	12

Options

1
Urban Grey Water Recycling (25%)
- Detail – 25% of all urban areas (residential + commercial + industrial)
- Expected Effect – Average demand reduction per household by ~50%
- Estimated Cost – Per household ~ Rs. 1 lakh (piping, tanks and collection systems)

1

2
Urban Grey Water Recycling (50%)
- Detail – 50% of all urban areas (residential + commercial + industrial)
- Expected Effect – Average demand reduction per household by ~50%
- Estimated Cost – Per household ~ Rs. 1 lakh (piping, tanks and collection systems)

2

3
Urban Rain Water Harvesting (25%)
- Detail – In 25% of all urban areas (residential + commercial + industrial). Collected water is used to recharge wells locally for potable (post-treatment)/ non-potable purposes
- Expected Effect – Average demand reduction per household by ~50%
- Estimated Cost – Per household ~ Rs. 0.5 lakh (piping, tanks, collection and primary treatment systems)

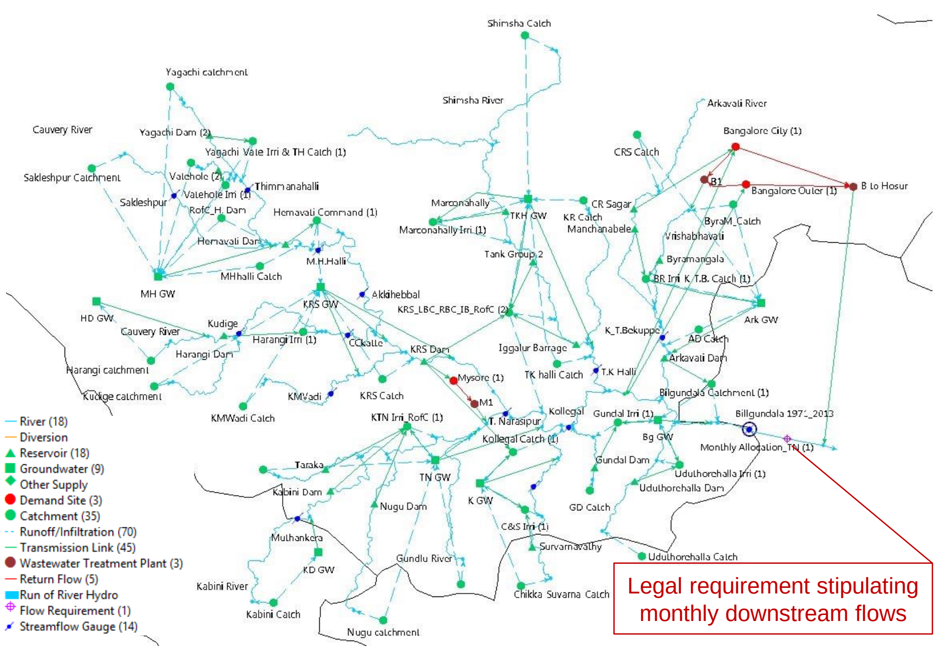
3

4
Urban Rain Water Harvesting (50%)
- Detail – In 50% of all urban areas (residential + commercial + industrial). Collected water is used to recharge wells locally for potable (post-treatment)/ non-potable purposes
- Expected Effect – Average demand reduction per household by ~50%
- Estimated Cost – Per household ~ Rs. 0.5 lakh (piping, tanks, collection and primary treatment systems)

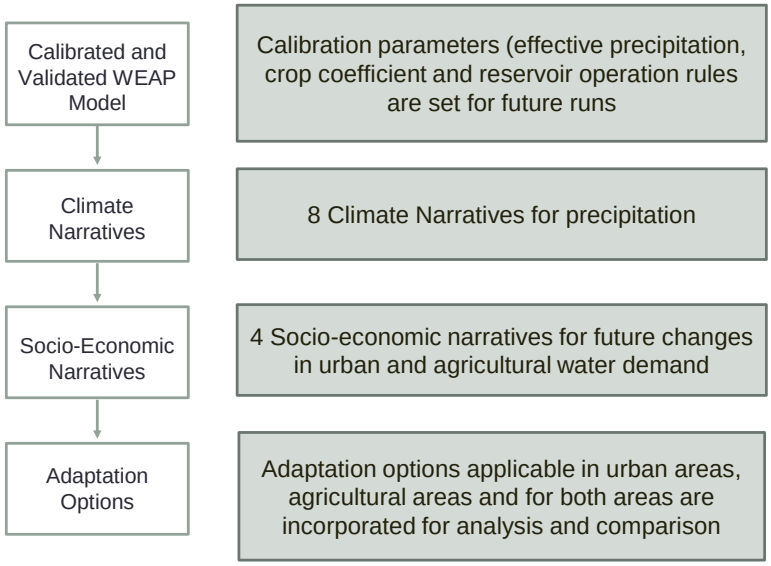
5
Agricultural – Drip Irrigation (5%)
- Detail – 5% of agricultural land
- Expected Effect – Water use efficiency is ~80-90% (well irrigation is ~30-40%). For Sugarcane the water usage compared to flood irrigation is ~35%
- Estimated Cost – Per household ~ Rs. 40,000 per acre

6
Agricultural – Drip Irrigation (10%)
- Detail – 10% of agricultural land
- Expected Effect – Water use efficiency is ~80-90% (well irrigation is ~30-40%). For Sugarcane the water usage compared to flood irrigation is ~35%
- Estimated Cost – Per household ~ Rs. 40,000 per acre

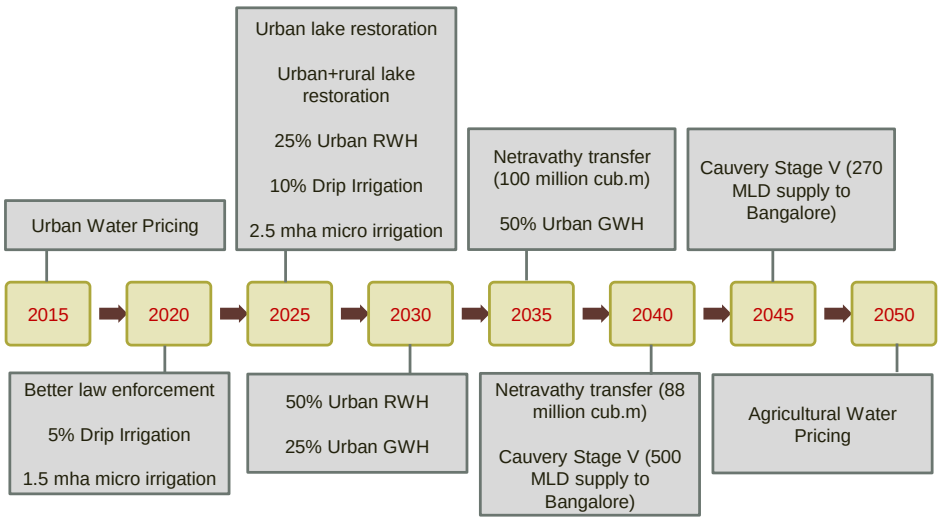
Quantitative Approach

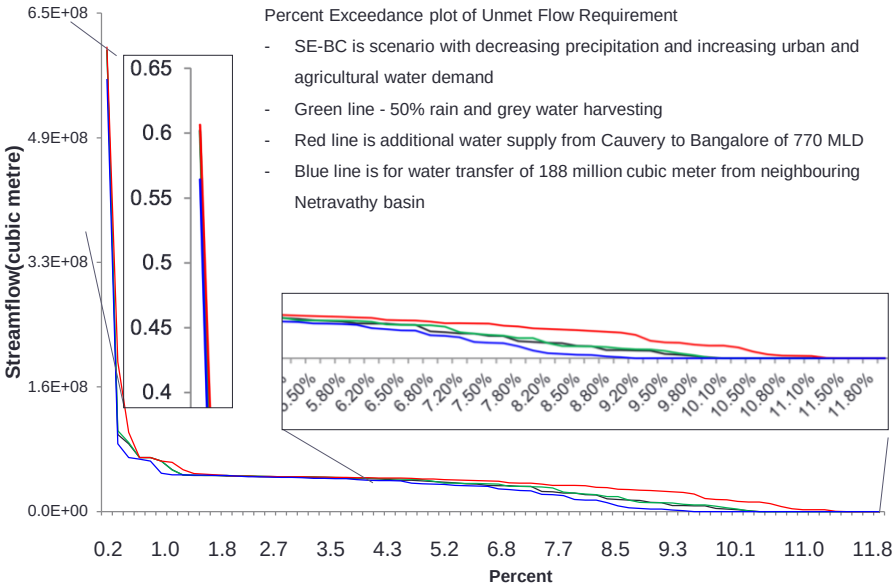

Shimsha Catch
Yagachi catchment
Shimsha River
Arkavati River
Cauvery River
Yagachi Dam (2)
Bangalore City (1)
Yagachi Vale Irri & TH Catch (1)
CRS Catch
Sakleshpur Catchment
Bangalore Outer (1)
B to Hosur
Thimmanahalli
Sakleshpur
Hemavali Command (1)
Marconahally
CR Sagar
TKH GW
KR Catch
Manchanabele
ByraM_Catch
Marconahally Irri (1)
Vrishabhavati
Hemavali Dam
Tank Group 2
M.H.Halli
Byramangala
MHhalli Catch
MH GW
Akkihebbal
KRS GW
HD GW
Kudige
Cauvery River
Harangi Irri (1)
K_T.Bekuppe
Ark GW
AD Catch
KRS Dam
Iggalur Barrage
Harangi Dam
Arkavati Dam
Harangi catchment
Mysore (1)
TK halli Catch
T.K Halli
Kudige catchment
KMVadi
KRS Catch
M1
Kollegal
Gundal Irri (1)
KMWadi Catch
KTN Irri_RofC (1)
T. Narasipur
Kollegal Catch (1)
Bg GW
Monthly Allocation_TN (1)
Gundal Dam
Taraka
TN GW
Udulhorehalla Irri (1)
Udulhorehalla Dam
Kabini Dam
Nugu Dam
K GW
GD Catch
C&S Irri (1)
Mulhankera
Suvarnavathy
Udulhorehalla Catch
KD GW
Gundlu River
Kabini River
Chikka Suvarna Catch
Kabini Catch
Nugu catchment
River (18)
Diversion
Reservoir (18)
Groundwater (9)
Other Supply
Demand Site (3)
Catchment (35)
Runoff/Infiltration (70)
Transmission Link (45)
Wastewater Treatment Plant (3)
Return Flow (5)
Run of River Hydro
Flow Requirement (1)
Streamflow Gauge (14)
Legal requirement stipulating monthly downstream flows

Scenario tree



Adaptation pathway suggested by Agriculture Stakeholders





Adaptation options alleviate water demand but do not substantially reducing unmet flow requirement into Tamil Nadu - Precipitation changes are important

In Summary

- Combined and comparative qualitative and quantitative approach to assess robustness of adaptation options
- Climate Narratives – A potentially useful alternative method for constructing future climate scenarios in a qualitative manner without forsaking knowledge and climate science
- Robustness of adaptation pathways suggested by different stakeholders using the WEAP model
- Assessing the relative utility of qualitative and quantitative approaches

Thank you

Results

- Calibration period – 1983-1998
- Validation period – 1999-2011
- Monthly Goodness of fit statistics
  R squared - 0.662
  NSE - 0.551