Incorporating realistic land-surface complexity in water availability forecasts for the Latin America and Caribbean region

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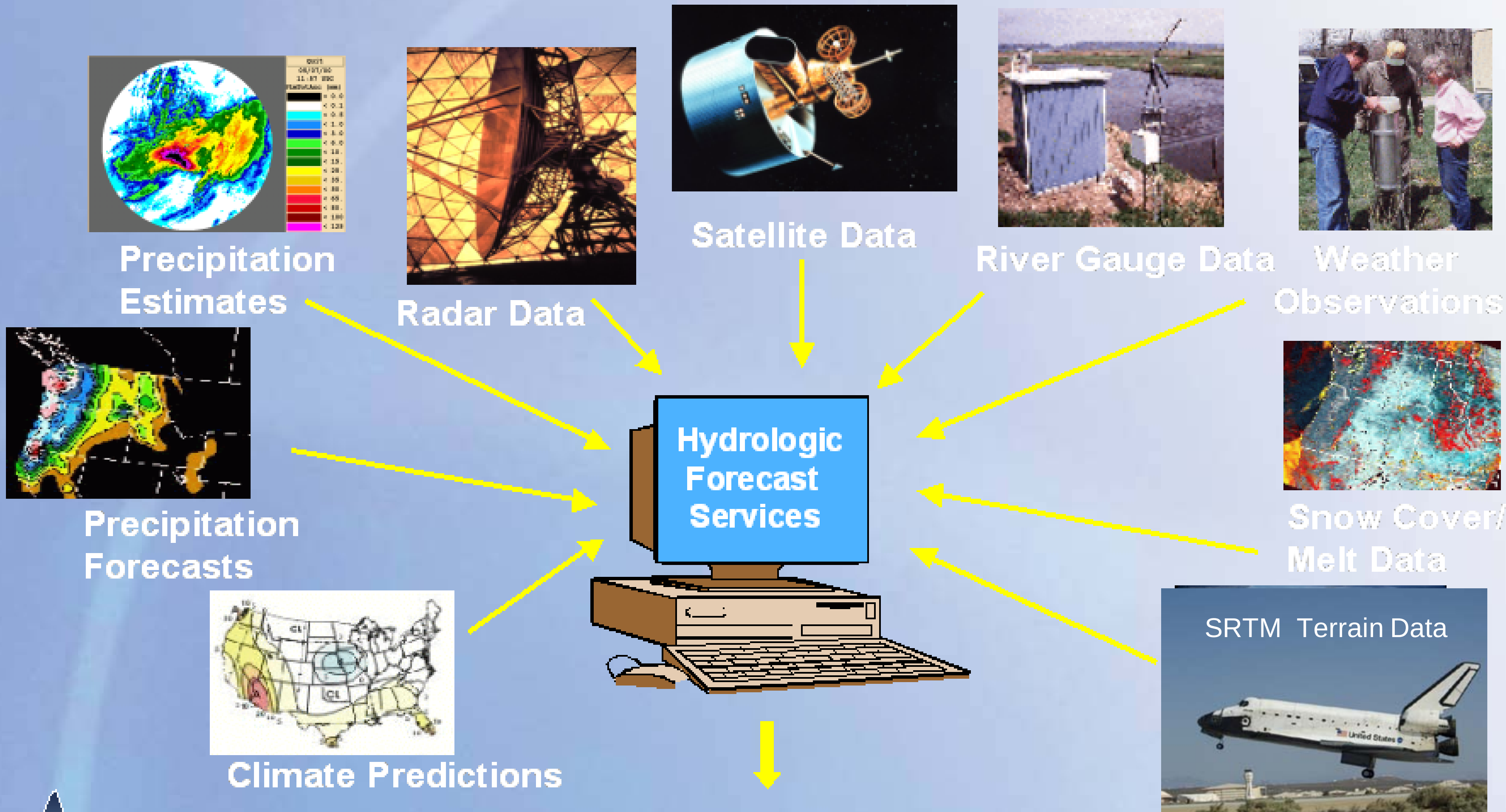
Data



Valuable Information to Satisfy Diverse Customer Needs

Water Predictions for Life Decisions

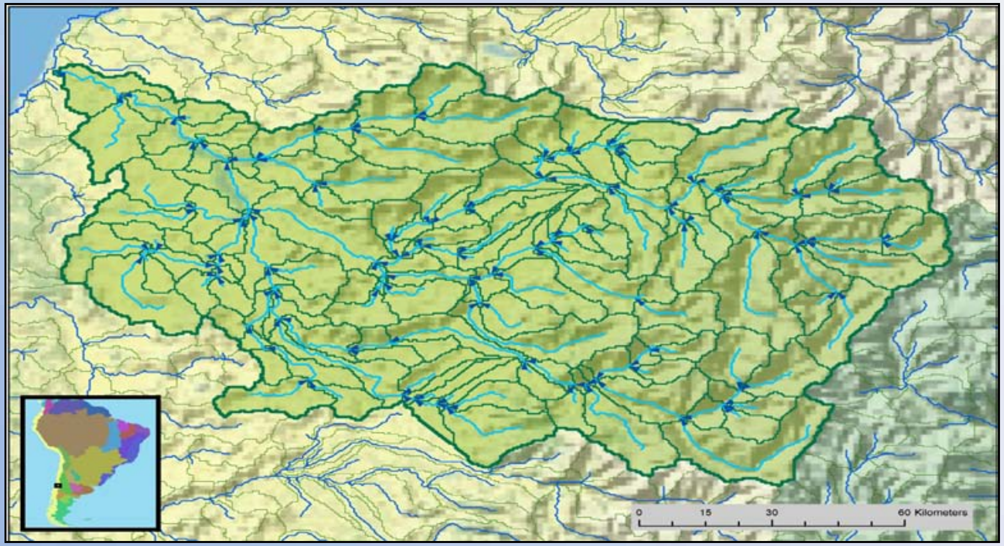
Overview

Hydro-BID -A public tool

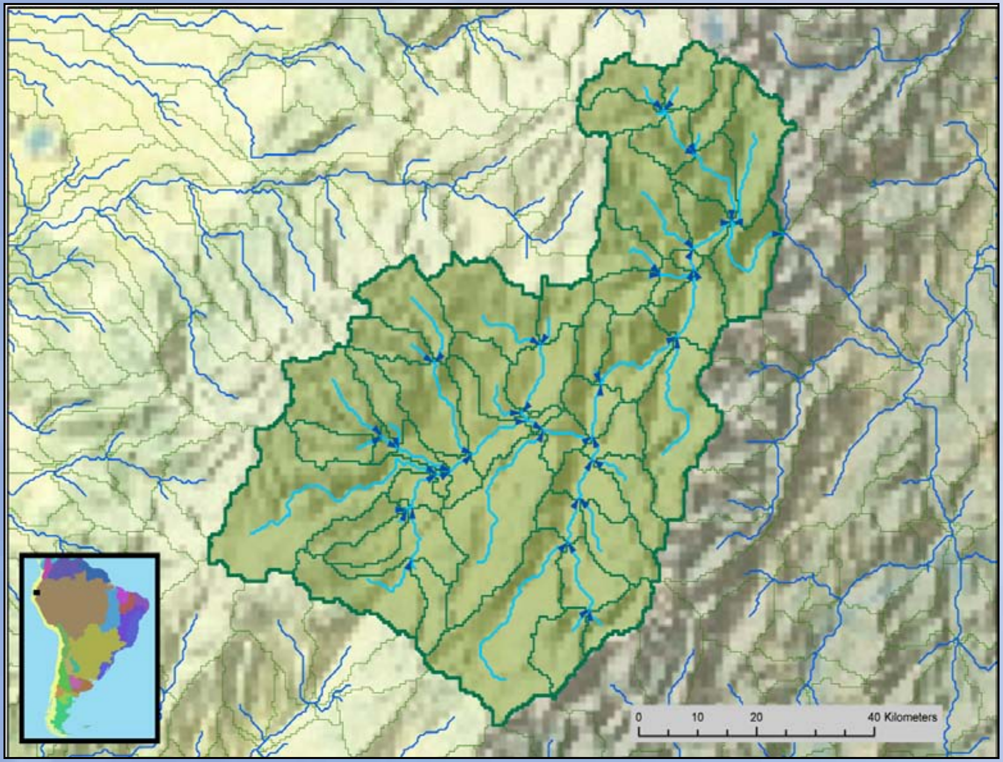
Create a system for integrated, quantitative simulation of hydrology and climate change in Latin America and the Caribbean, for assessing the potential impacts of climate change on water flows and infrastructure and supporting the design of adaptive projects and strategies.

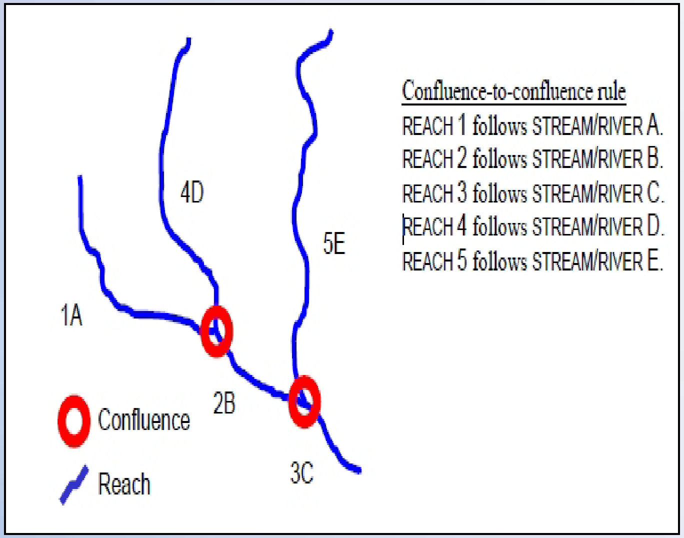
Analytical Hydrogrphy Datset from DEM

- RTI has developed an AHD for the entire LAC region
- Derived from SRTM terrain data, as modified by USGS
  - 15 –arc seconds pixels
- Data processed to create drainage catchments (polygons) and linear stream segments (flow lines) with connectivity



DEM to Watershed





The AHD for Latin America / Caribbean

Central America:

33,000 catchments and stream segments
Average catchment area 84 km^2
Average stream segment length 10 km

Caribbean:

3,300 catchments and stream segments
Average catchment area 72 km^2
Average stream segment length 11 km

South America:

193,000 catchments and stream segments
Average catchment area 92 Km^2
Average stream segment length is approx.11 km

Navigation:

- Catchment connectivity
- Allows lag-time computation for routing

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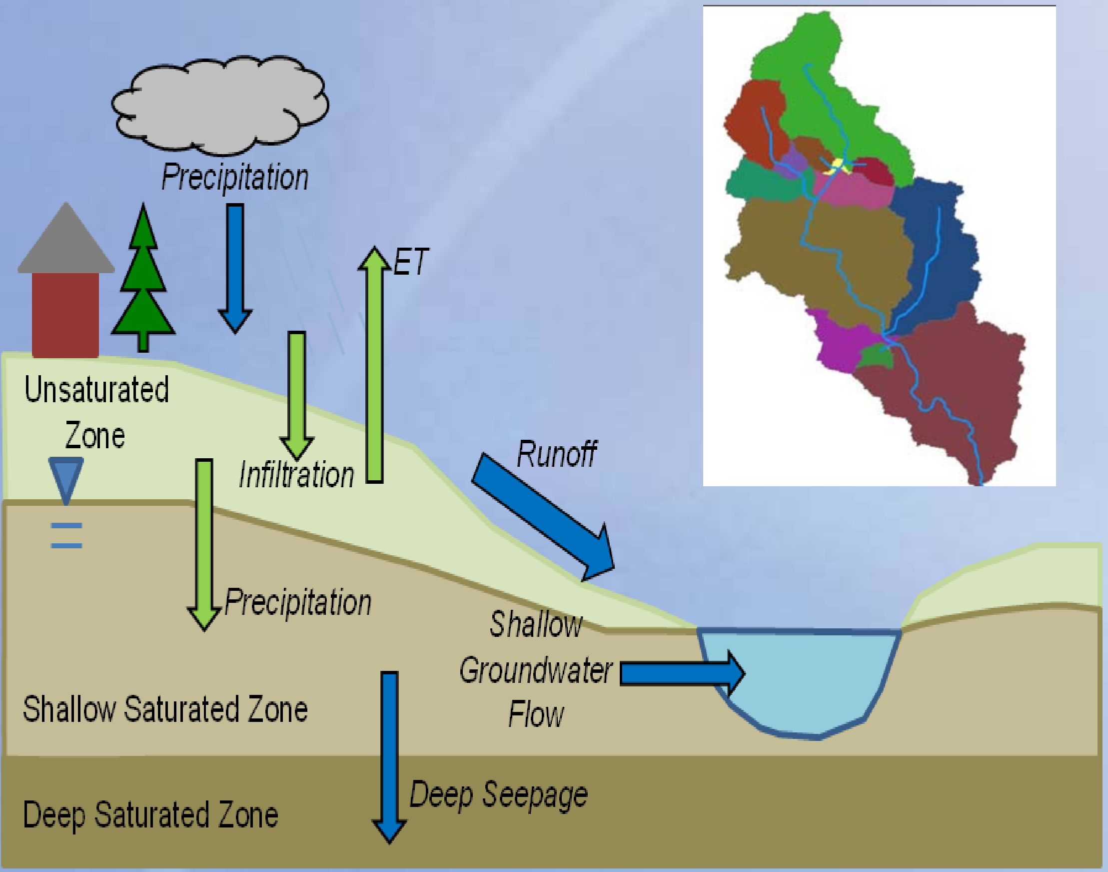
Generalized Watershed Loading Function (GWLF)



Runoff

$$Q_t = \frac{\left(R_t + M_t - 0.2Dt\right)^2}{R_t + M_t + 0.8D_t}$$

Potential Evaporation

$$PE_t = \frac{0.021 H_t e_t}{T_t + 273}$$

Base Flow

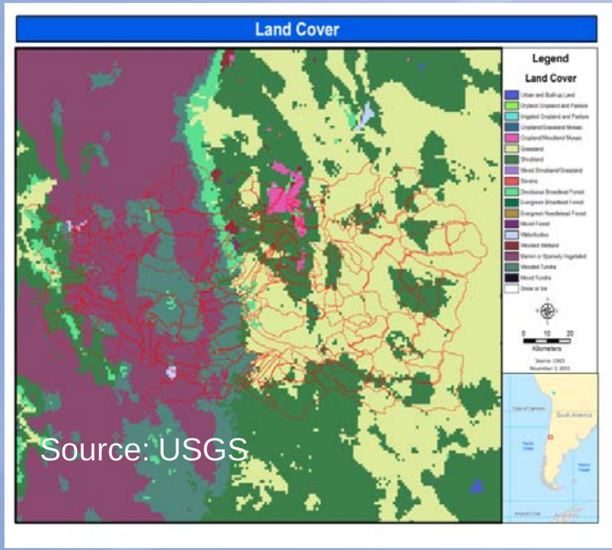
$$G_t = rS_t$$

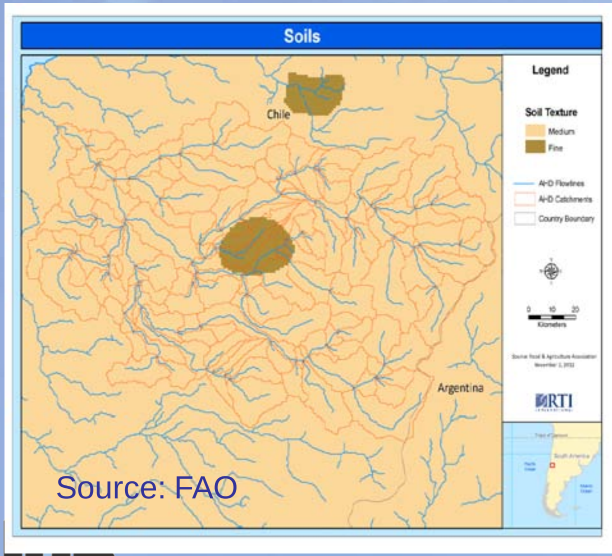
Water Balance

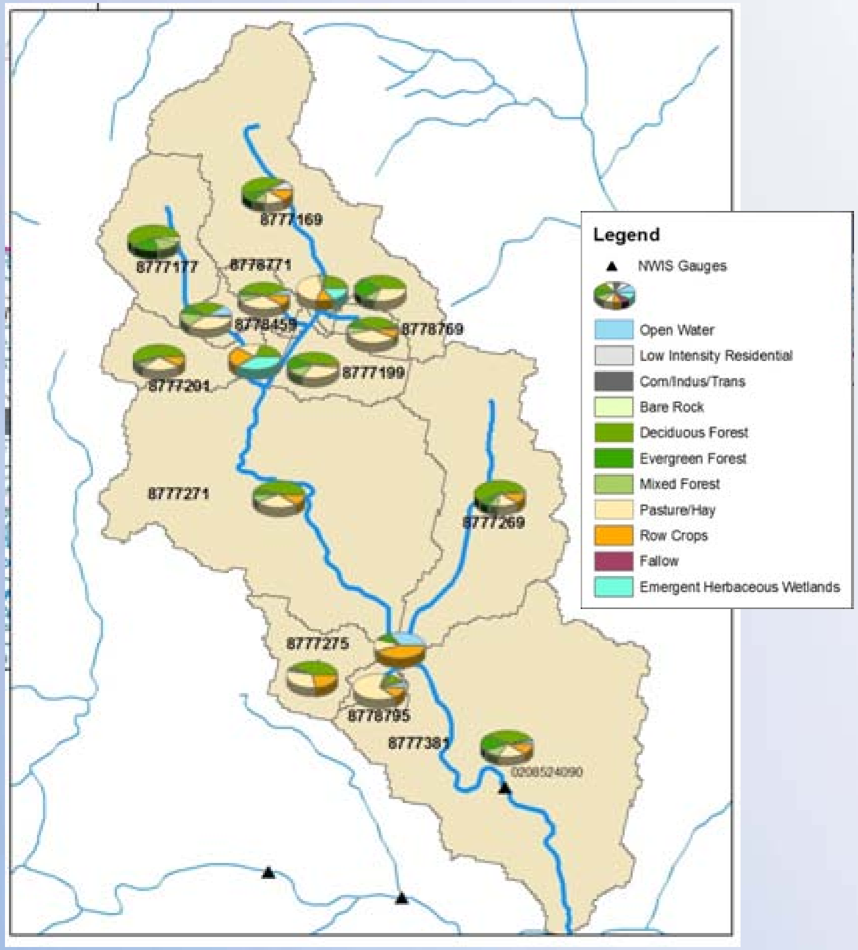
$$U_{t+1} = U_t + R_t + M_t - Q_t - E_t - P_t$$

$$S_{t+1} = S_t + P_t - G_t - D_t$$

Land Use and Soil

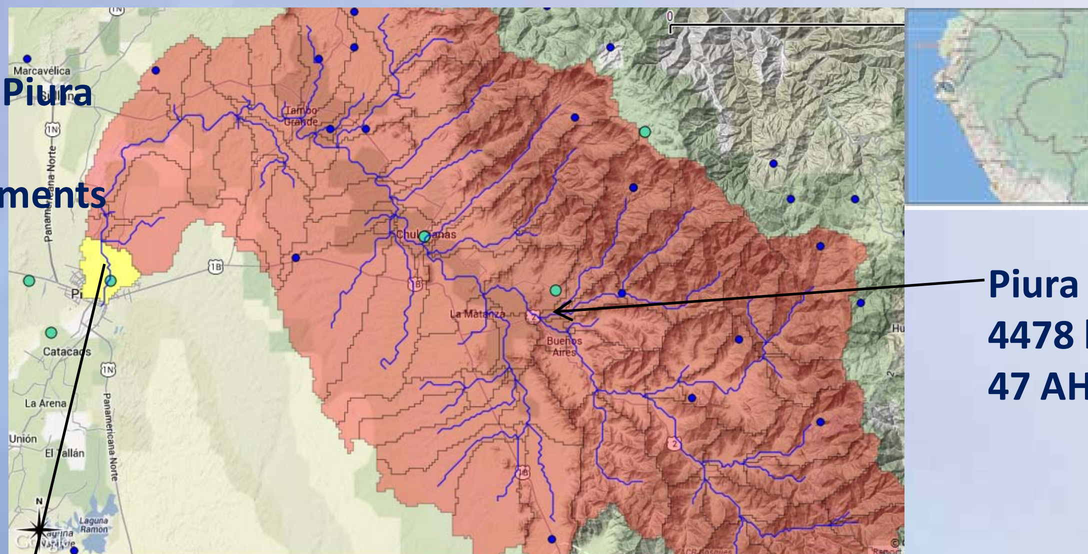






Example of Parameterizations, Piura Basin

Piura River at Piura
7538 km^2
84 AHD Catchments

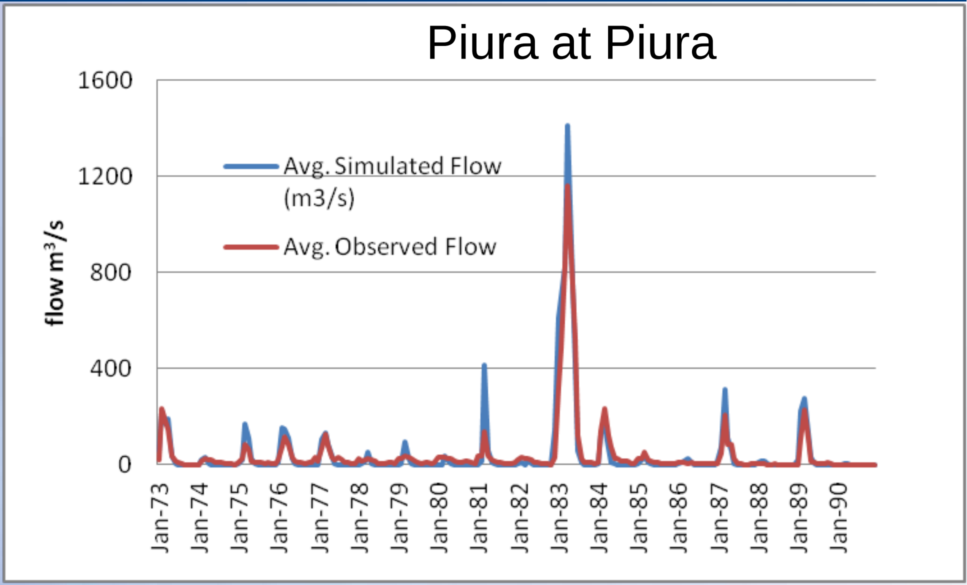


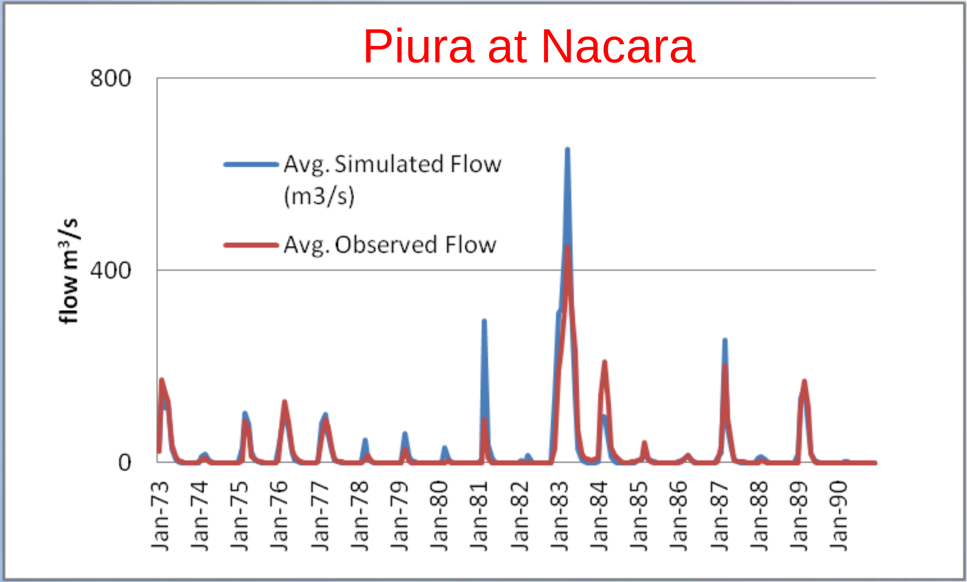
Piura River at Nacara
4478 km^2
47 AHD Catchments

COMID	Land Cover Type	Area (km2)	Percent	HydrGrp	Curve Number
305596100	Urban and Built Up	13.16	12.76	B	88
	Cropland	29.99	29.08	B	64
	Grassland	48.20	46.74	A	49
	Decidous Forest	6.78	6.57	B	60
	Wood Tundra	5.00	4.85	B	57
Total Area		103.13			

Model Performance

	Piura Calibration	Nacara Verification
Daily		
Correlation	0.87	0.84
Overall Error (%)	4.40	7.50
Nash-Sutcliffe	0.65	0.33
Monthly		
Correlation	0.96	0.92
Overall Error (%)	4.40	7.50
Nash-Sutcliffe	0.89	0.75





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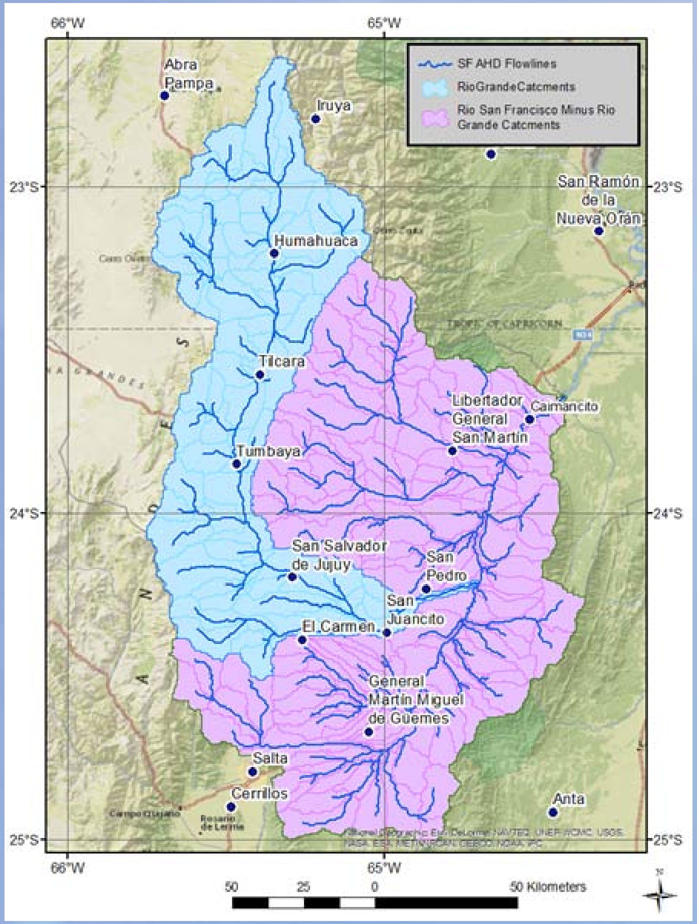
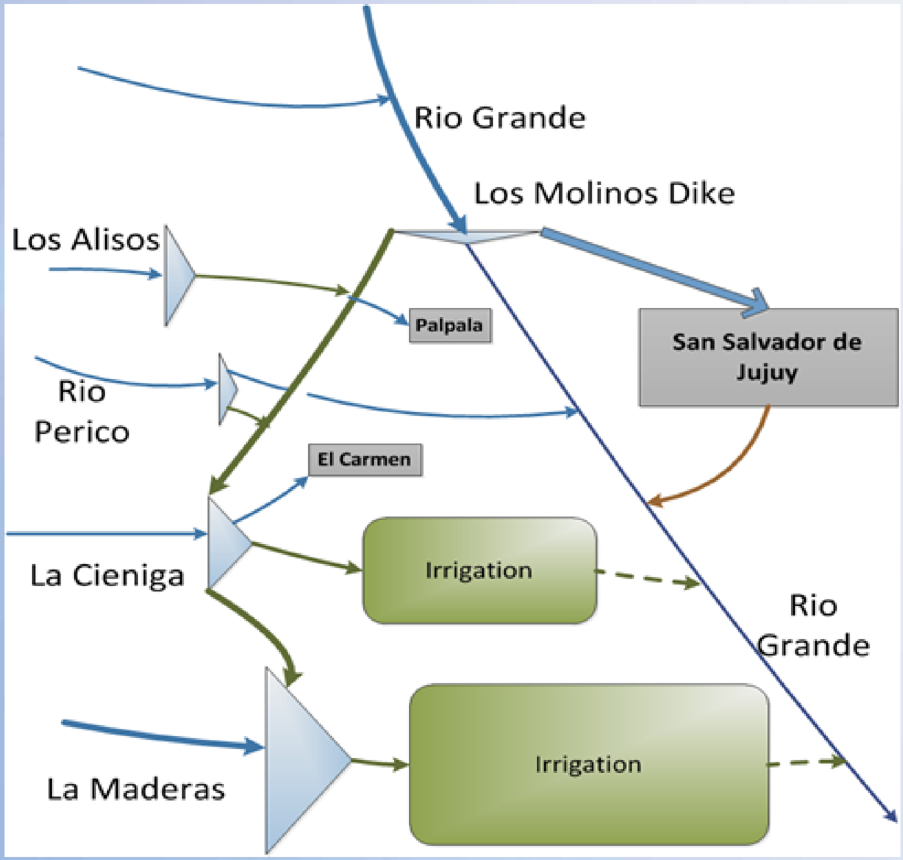
Rio Grande Example

Jujuy Province, Northwestern Argentina





Future Climate Modeling

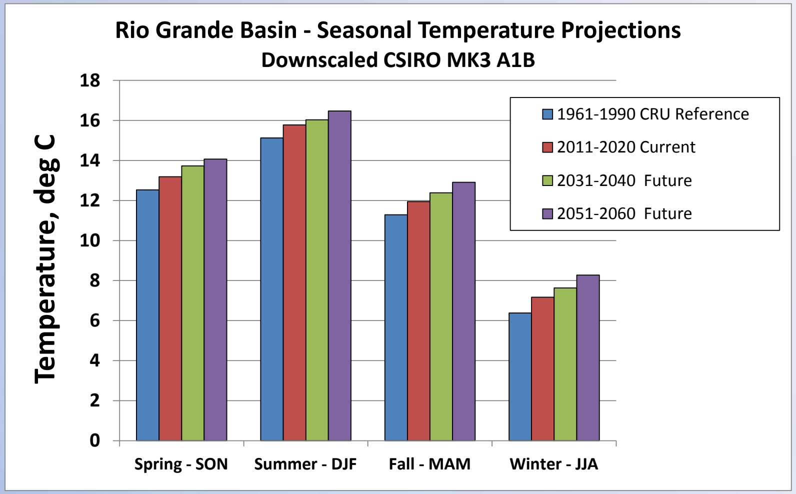
Two Approaches to Climate Projections

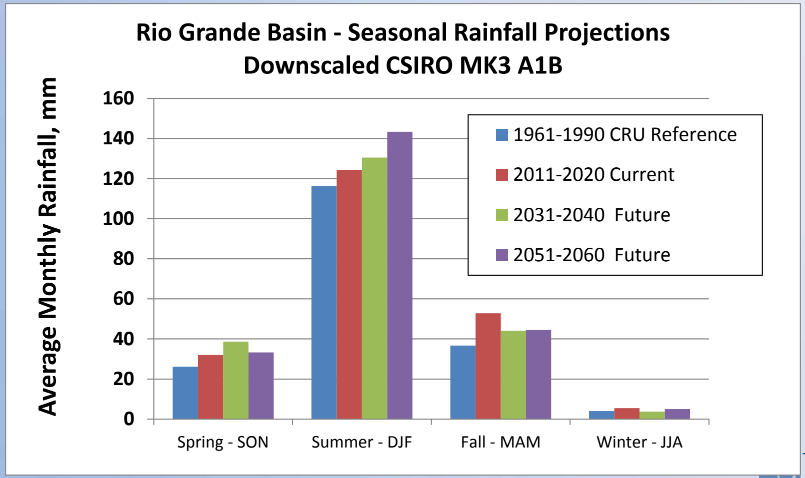
Downscaled data (50 km grid) from ClimateWizard.org A1B moderate emissions scenario and two downscaled GCMs:

- UKMO Hadley CM3 – Used frequently in Argentina
- CSIRO Mk3 – “Dry” Scenario used by World Bank

CIMA Ensemble model, based on 6 locally calibrated GCMs

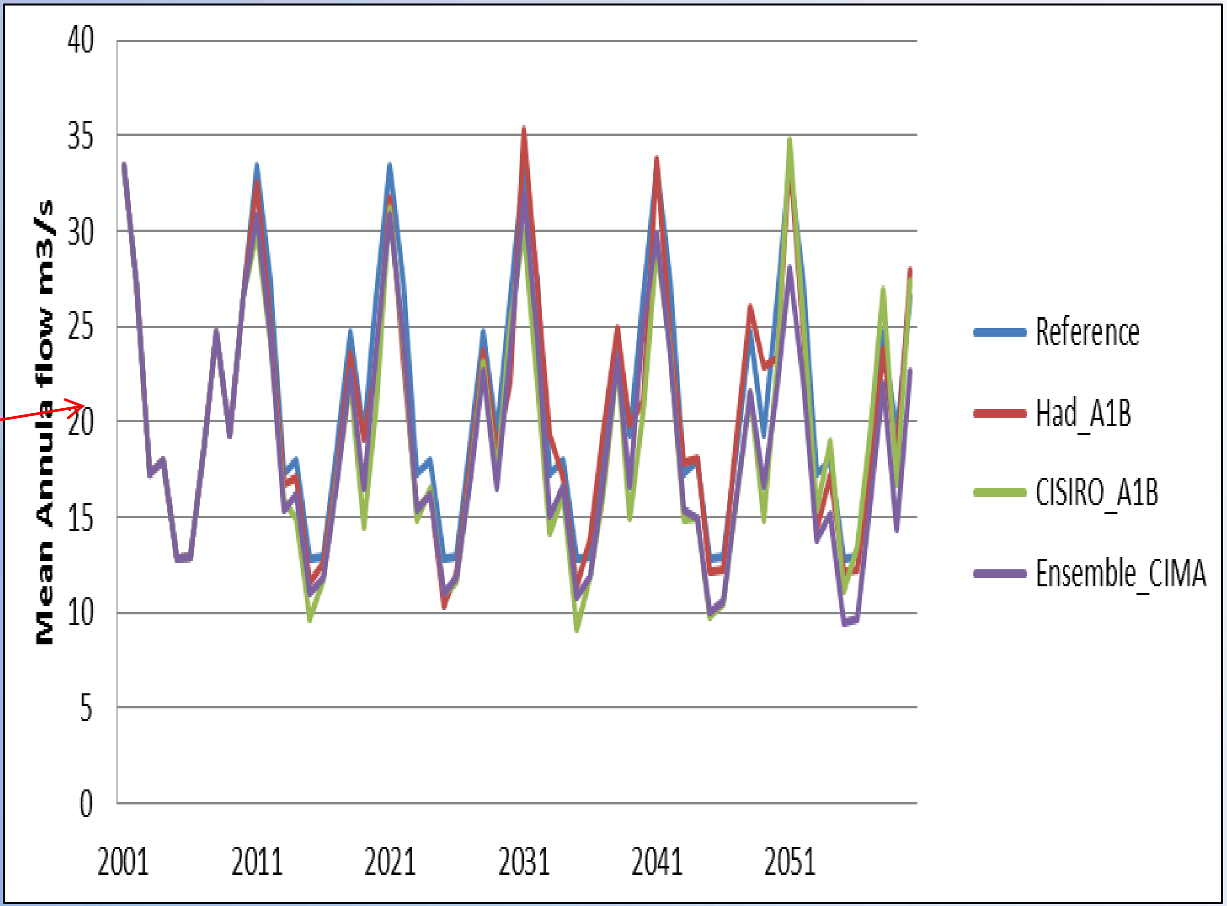
Seasonal Projections





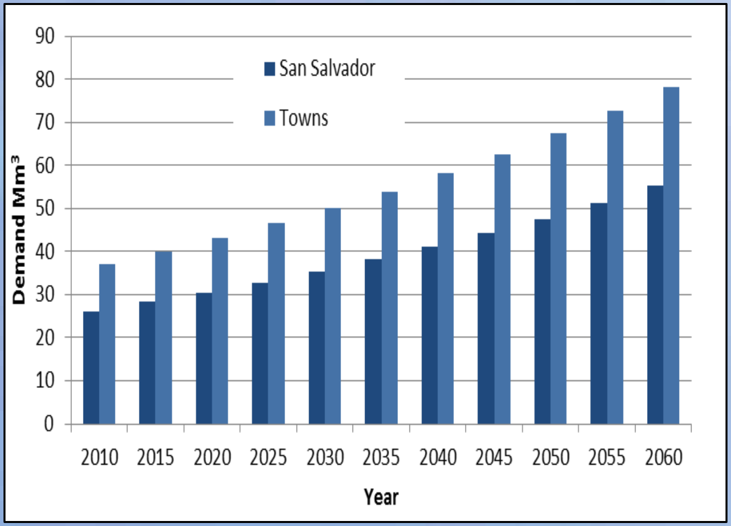
Simulation of flow time series

- Climate Scenarios
  Reference
  Hadely
  CSIRO
  CIMA -ensemble
- Annual flow using reference climate and three climate projections for Rio Grande at Los Molinos

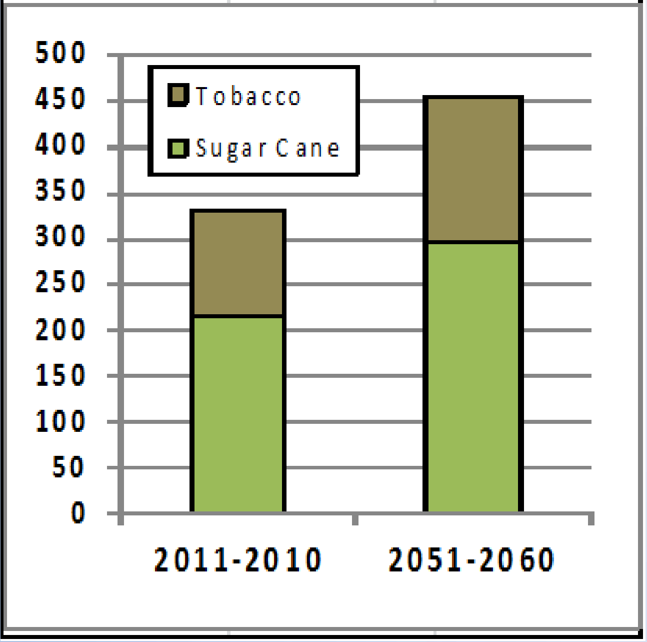


Water Demand – Current and Future

Irrigation demand is much larger than urban water demand, at current efficiencies.

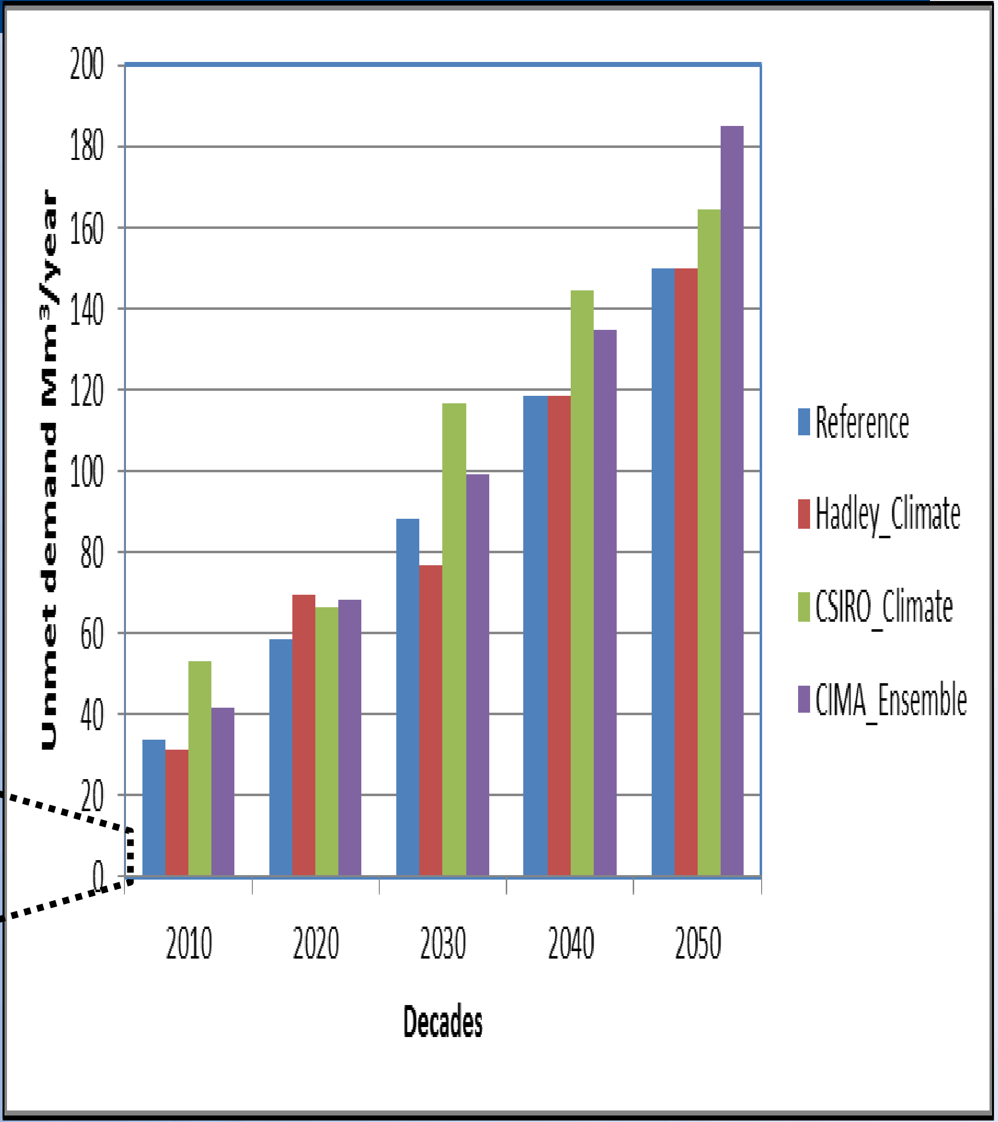


Annual Water Requirement, Mm3/year	**2010** Current Efficiency	**2060** Current Efficiency
Sugar Cane	215	296
Tobacco	117	158
Total	332	454

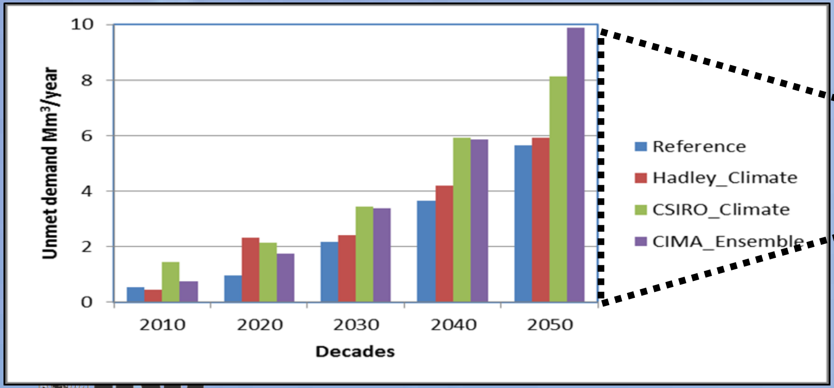


Unmet Water Demand – No Adaptation

Unmet Agricultural Demand



Unmet Urban Demand



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Adaptations

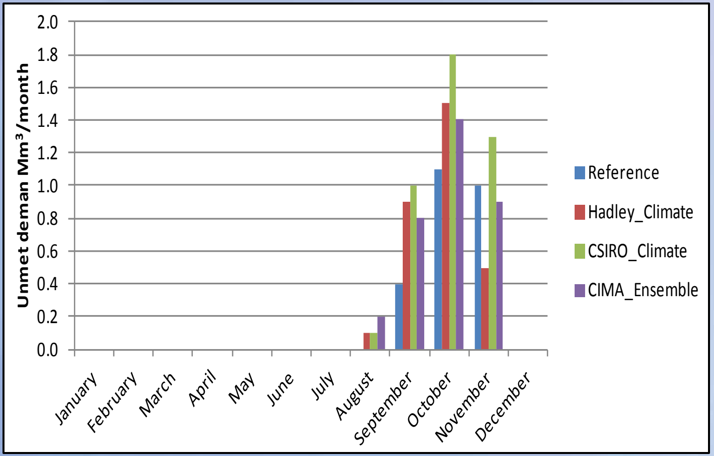
- ***Option 0 – Current Efficiency***
  - no efficiency improvements,
  - leakage in urban water supply systems remains at 30%
  - irrigation efficiency remains at 37%.
- ***Option 1 – Improved Urban Water Efficiency***
  - the distribution system leakage rate, for San Salvador de Jujuy and surrounding towns reduced from 30% to 10%.
- ***Option 2 – Improved Irrigation Efficiency***
  - the overall irrigation efficiency rise from 37% to 55%
  - no improvement in conveyance efficiency
  - an increase in application efficiency shift from basic furrow to surface drip irrigation.
- ***Option 3 – Improved Urban and Irrigation Efficiency***
  - Option1 and Option 2 combined

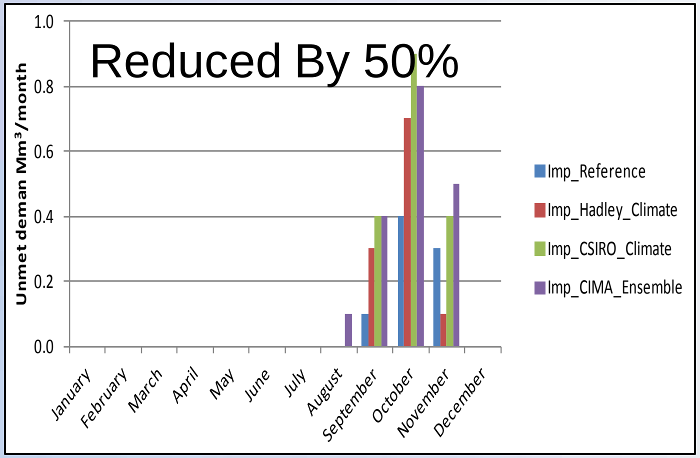
Option 1- Improved Urban Water Efficiency -San Salvador

Option 0

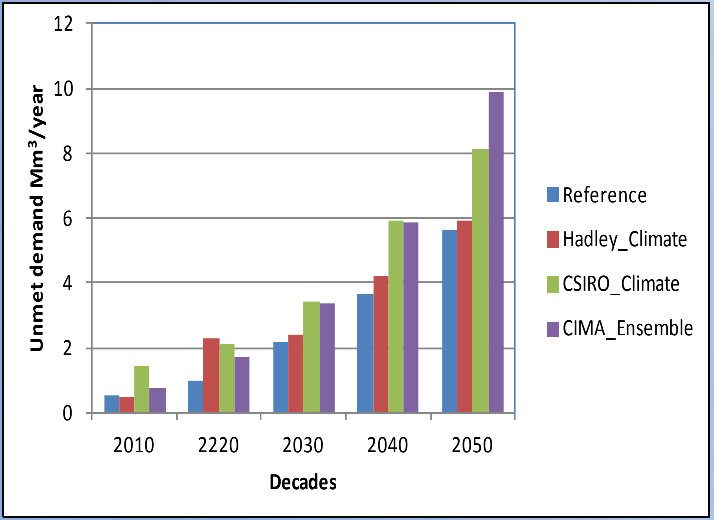
Option 1

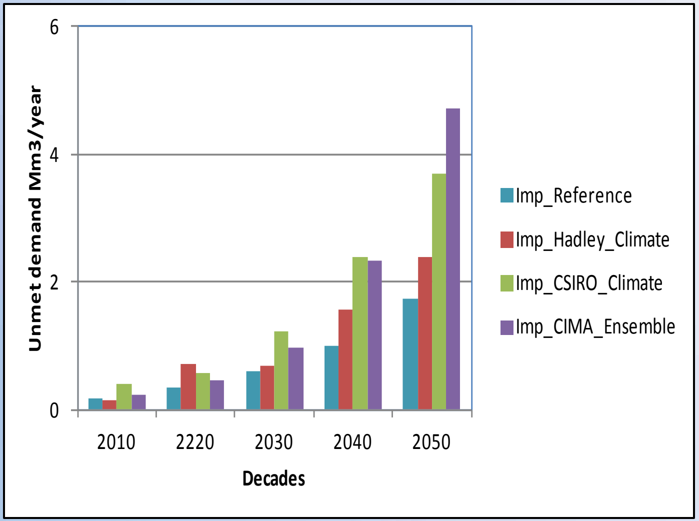
Dry season unmet demand





Annual unmet demand





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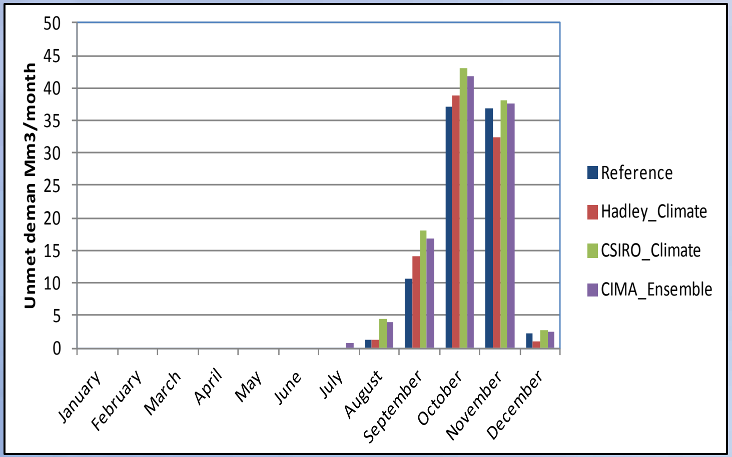
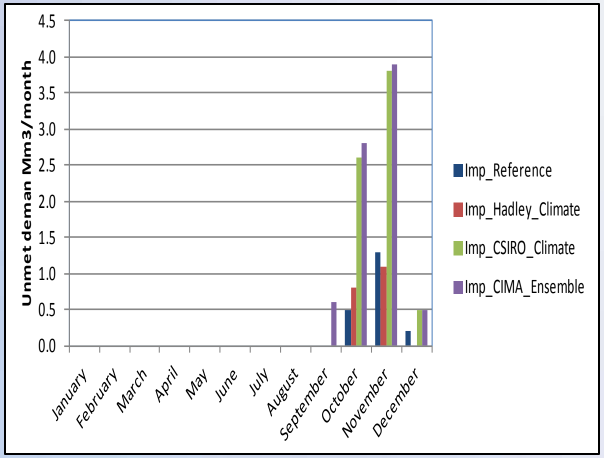
Option 2: Improved Irrigation Efficiency - Irrigation

Option 0

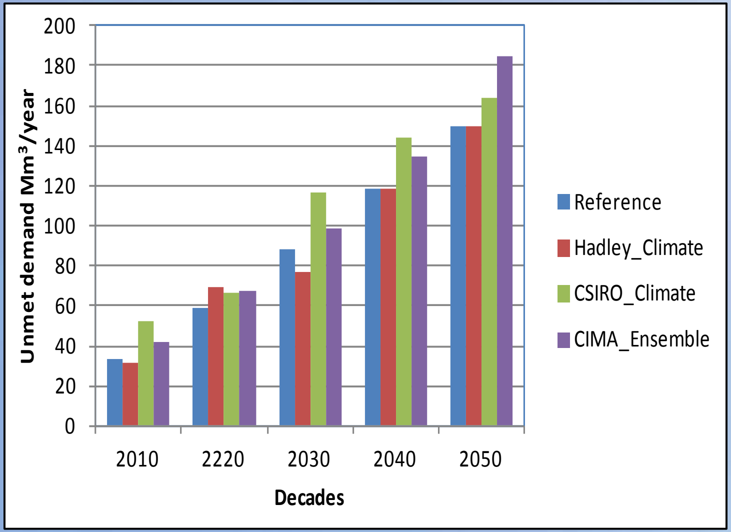
Option 2

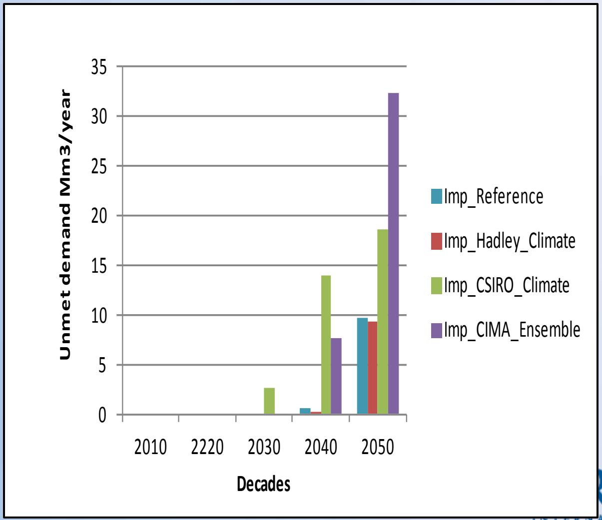
Dry season unmet demand





Annual unmet demand



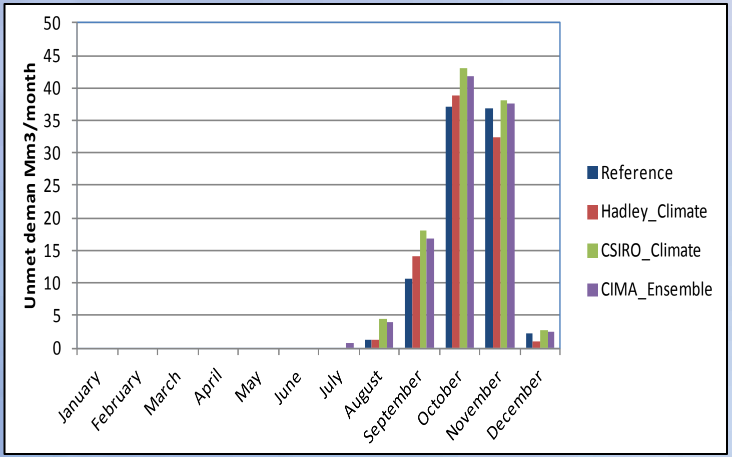


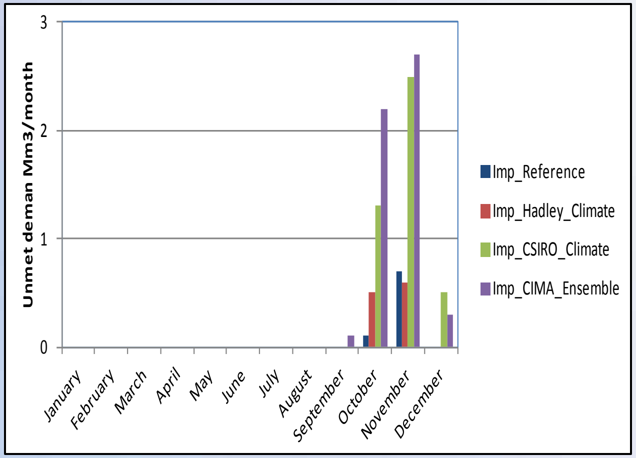
Option 3: Option 1 and Option 2 Combined - Irrigation

Option 0

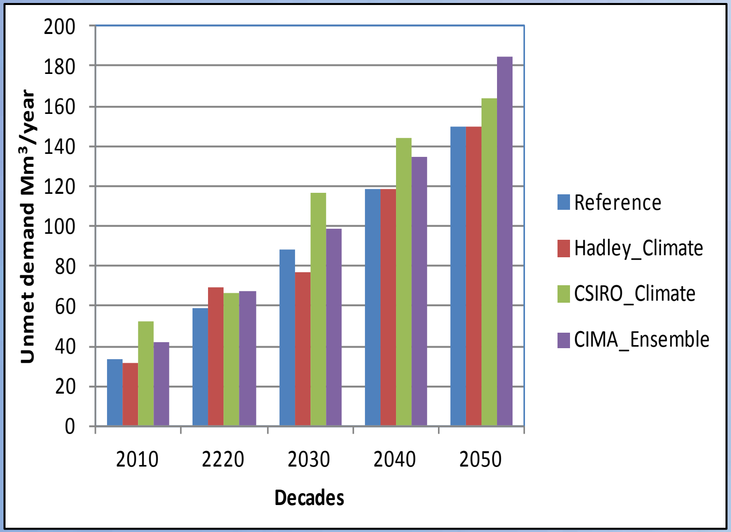
Option 3

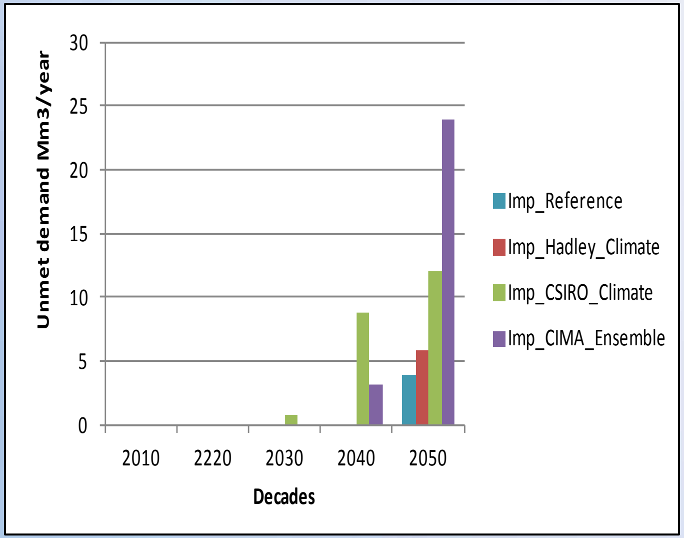
Dry season unmet demand





Annual unmet demand





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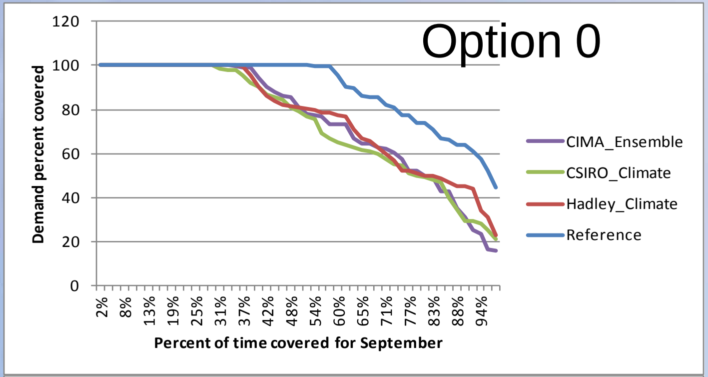
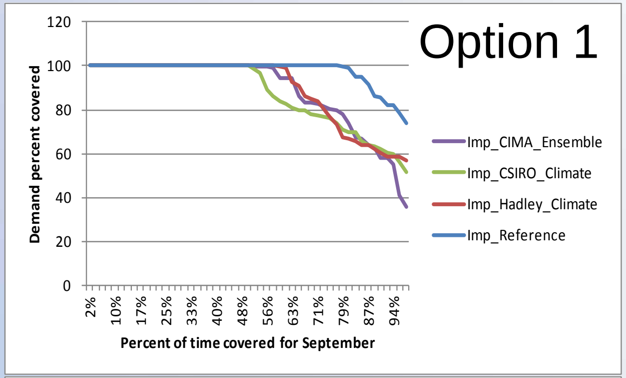
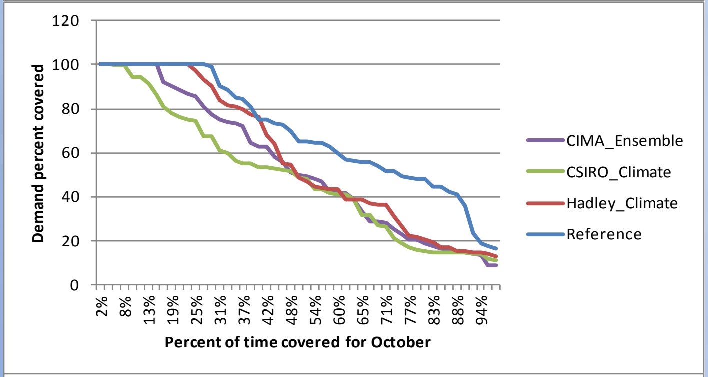
Option 1- Improved Urban Water Efficiency -San Salvador

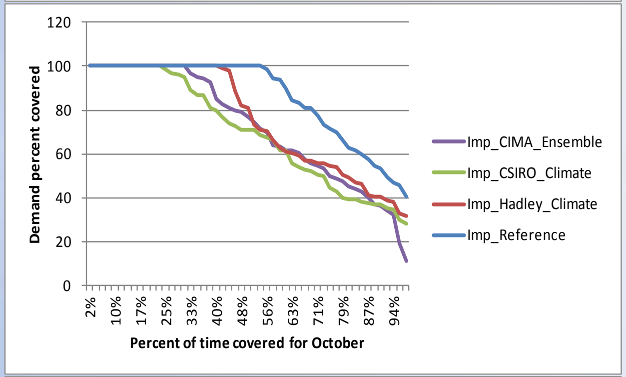
Coverage in September



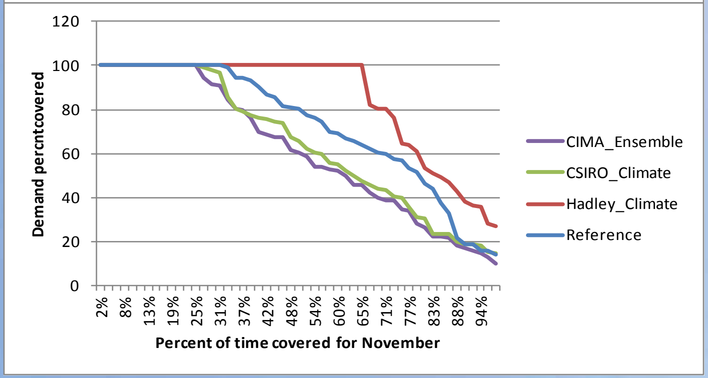


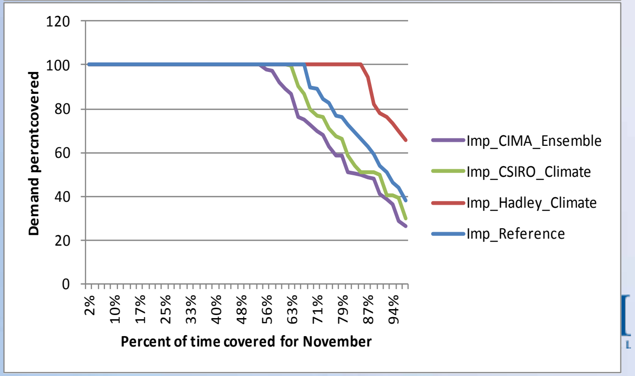
Coverage in October





Coverage in November





Summary

- Hydro-BID 's AHD is a unique, flexible and powerful dataset to build predictive river flows model in user-defined areas from the catchment to basin scale.
- The system allows data layering and an ability to use "off-the-shelf" international datasets

- The Hydro-BID model was applied successfully in case studies, by using a mix of international and local datasets to delineate watersheds as well as parameterize the hydrological model.
- There is tremendous potential in using the model assessing water availability at different level from small watersheds to large trans-boundary basins