International Water Management Institute

CGIAR

Water accounting for efficient water resources management

Building Resilience for Data-scarce Water Systems in Pakistan

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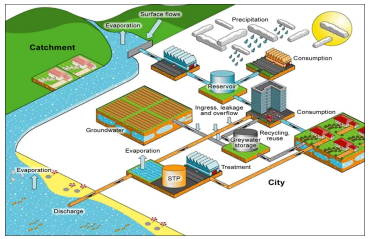
International Water Management Institute (IWMI)

Innovative water solutions for sustainable development

Food · Climate · Growth

Major water management challenges in Pakistan



Inflexible irrigation system

Climate variability

Uncapped GW abstraction

Competing inter-sectorial

Leading to growing WATER SCARCITY

hurts our…..

- Farms - Environment - Industries - Families

nsufficient storage capacity

Increasing crop intensities

Environmental flows

Inappropriate water allocation

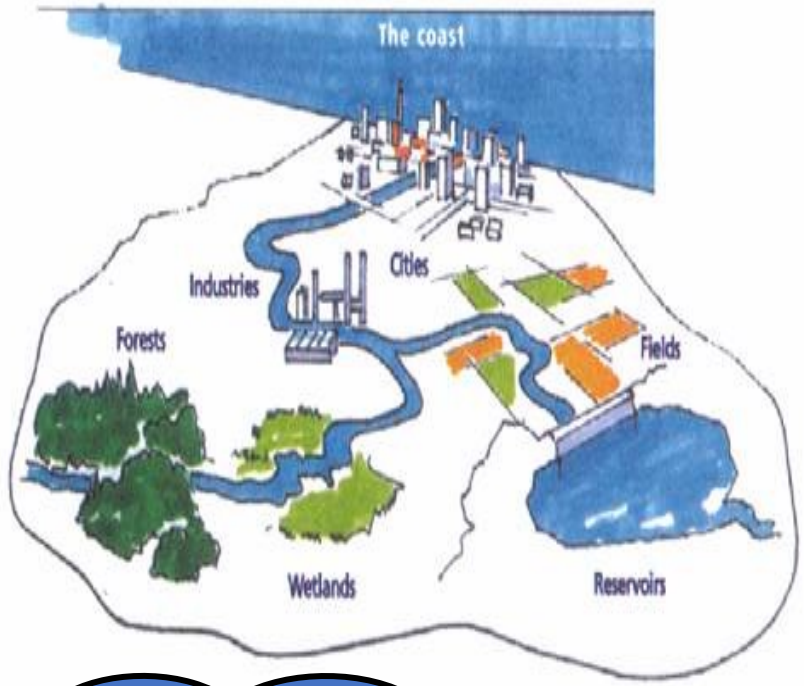
Pictures source: google.com

Why are the water management challenges not addressing?

Simple questions; answers unavailable

- *How much water is available and where?*
- *How much water i… …rs?*
  (Dor…
- *…*
- *W… …they using?*
- *What is futu… …our rivers and aquifers?*
- *How much water is being lost to evaporation and leakage?*

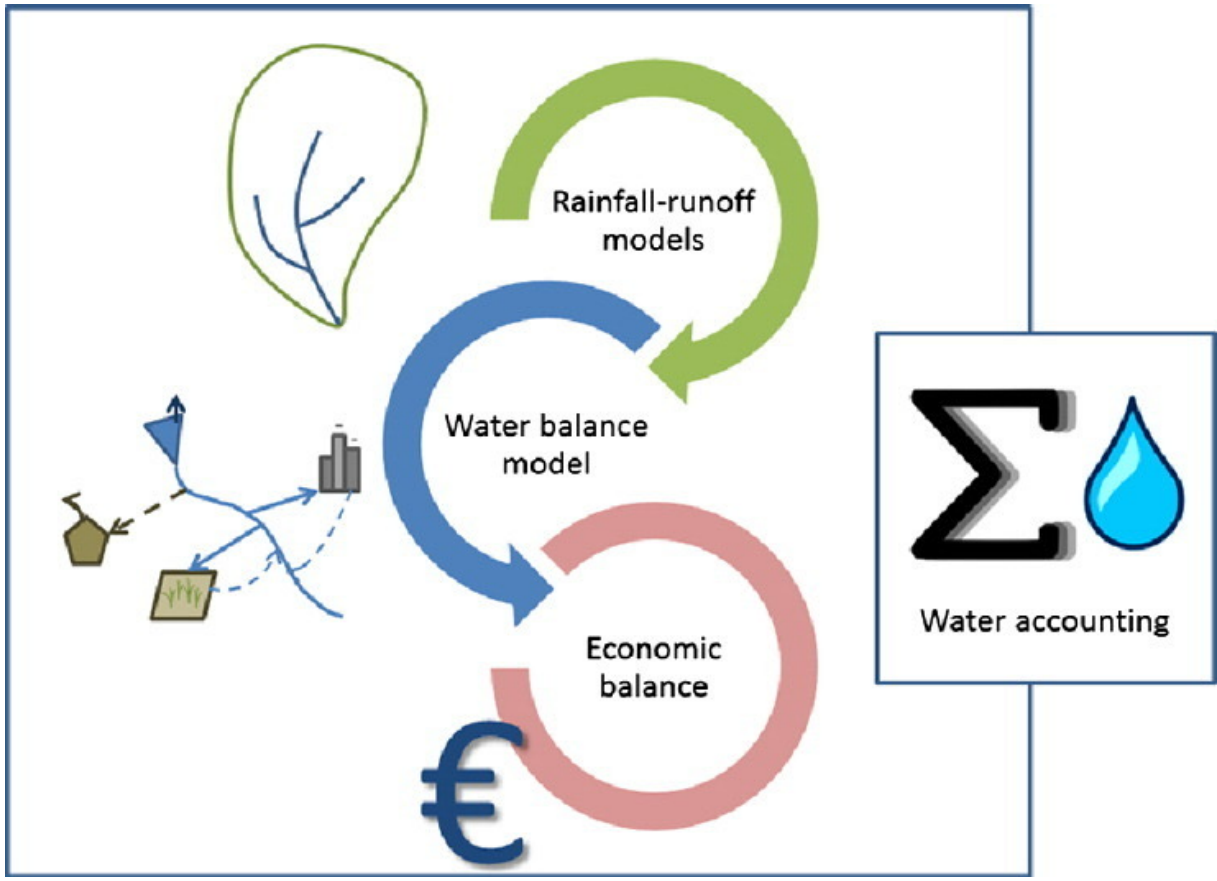
What can be measured, can be managed



Water Accounting can fill the gaps and provide answer on missing water information

What is water accounting (WA)?

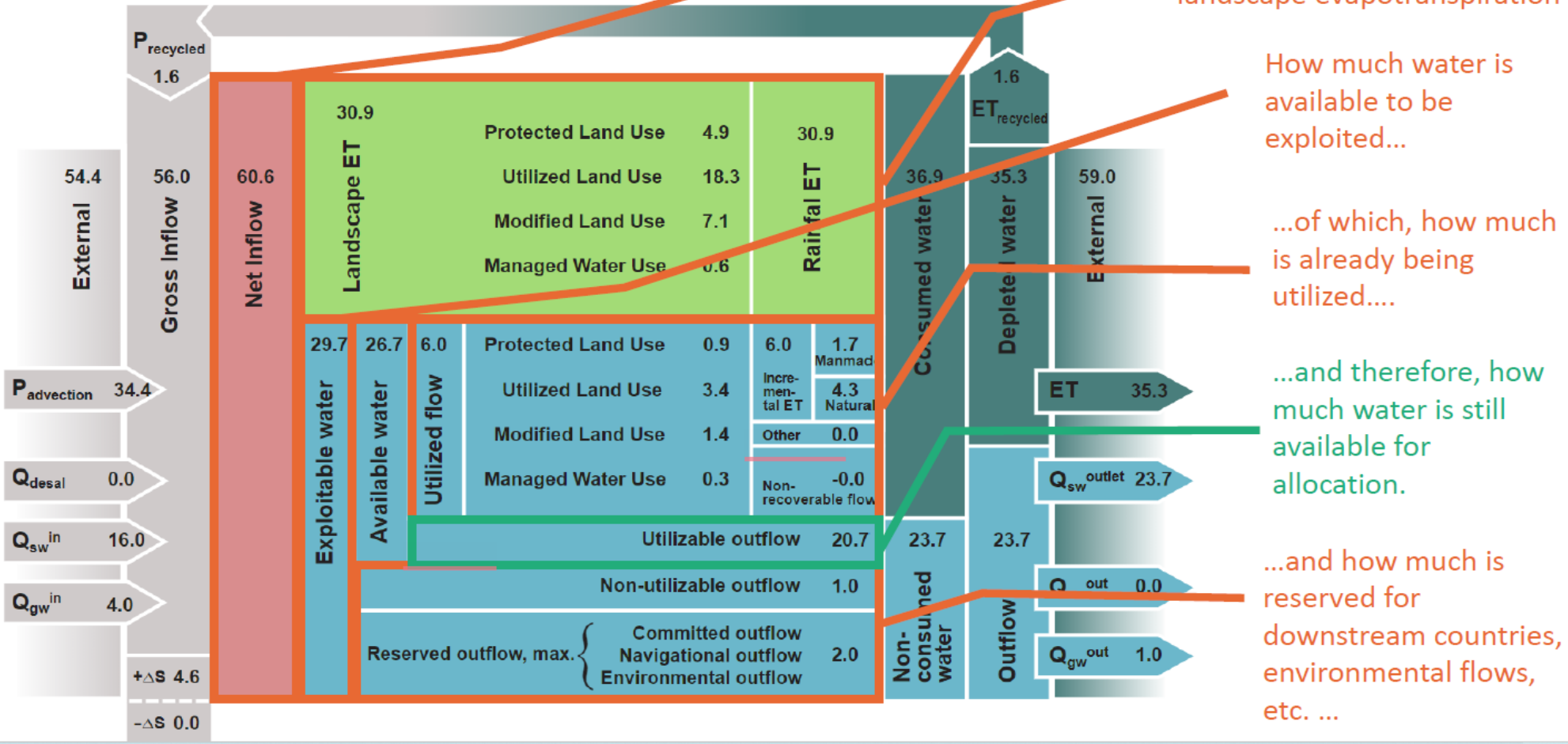
- Water accounting (WA) is a process of **systematic** measuring, quantifying, and communicating information about **water resources and their use**.
- WA provides an accurate picture of **water availability, use, distribution, accessibility and demand**, in specified domain which is essential for effective water management and water governance.



What is water accounting (WA)?

- **Policy makers:**
  - Accountability of water managers
- **Water managers:**
  - Quick overview of current status of all water issues
- **Water planners:**
  - Impact of changes (climate, land cover)
  - Effectiveness of adaptation
- **Donors:**
  - Impact assessment
- **Water users:**
  - Overall picture

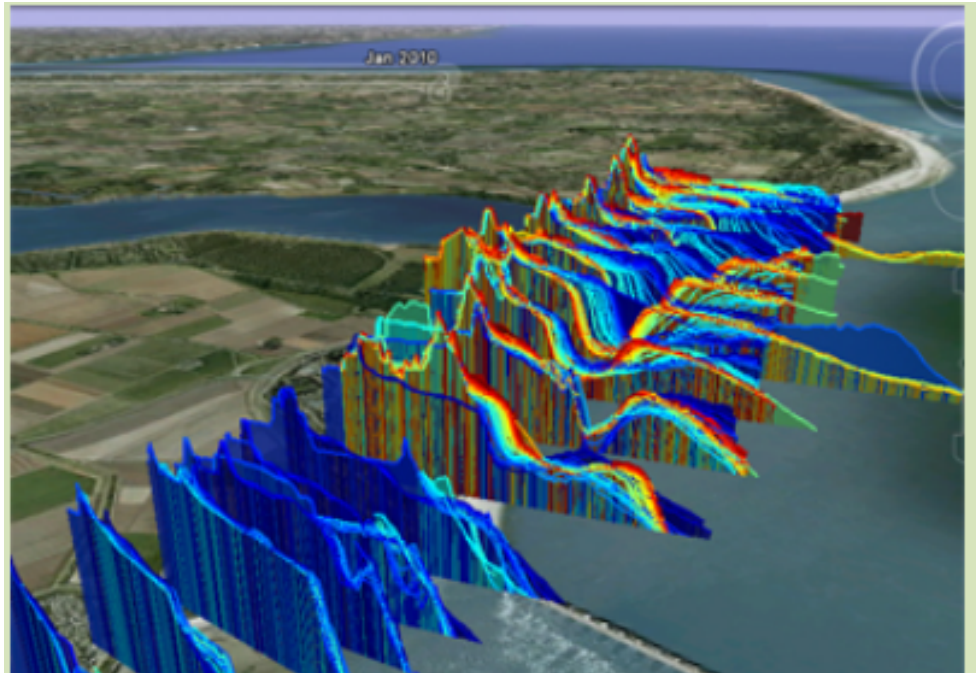
Water accounts provide information on…



Major issue in carrying out WA

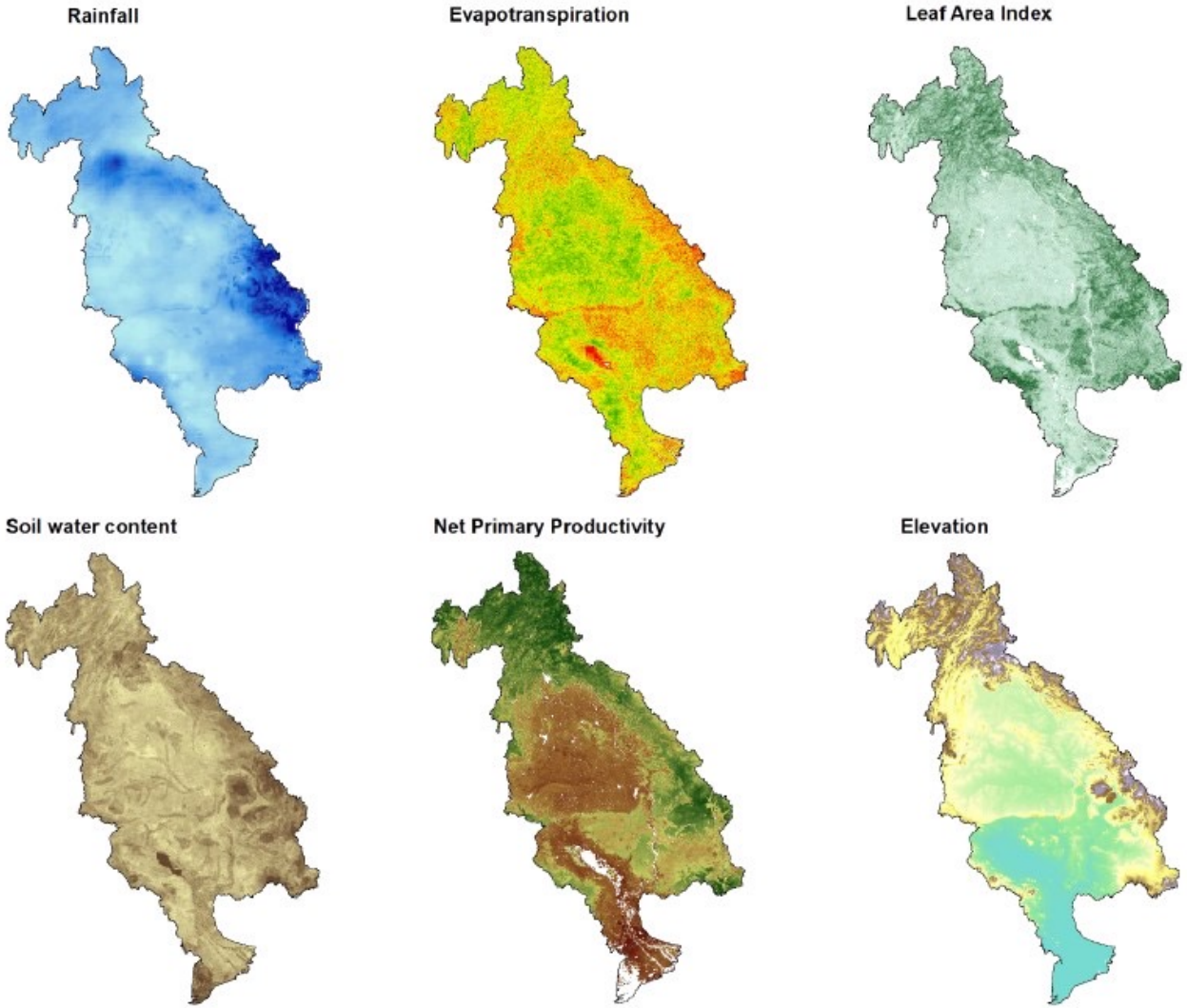
Data sources will never be complete and made fully accessible, especially when competition on water resources increases

Ideal data



Real data

Remote sensing dataset is key for WA

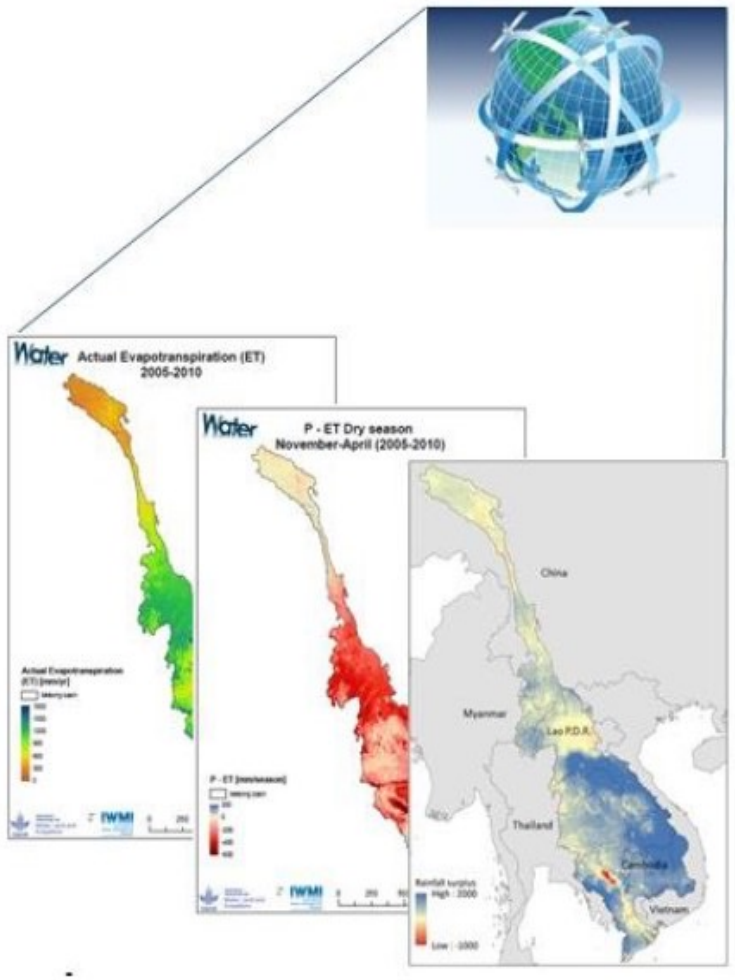


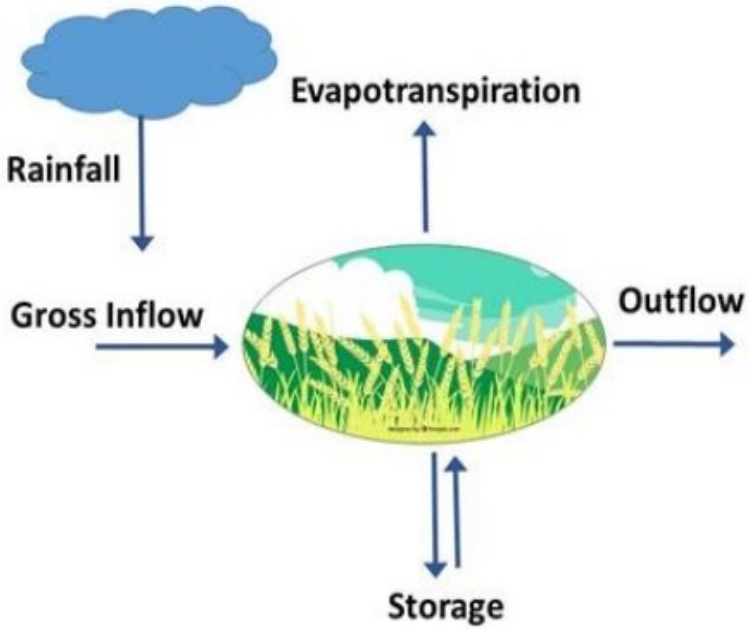
- Availability – in data scarce regions
- Accessibility - freely available on the web
- Coverage – global data
- Time saving – ready to use data available

Complemented by

- Hydrologic Models
- Station data
- Auxiliary data

The water accounting framework





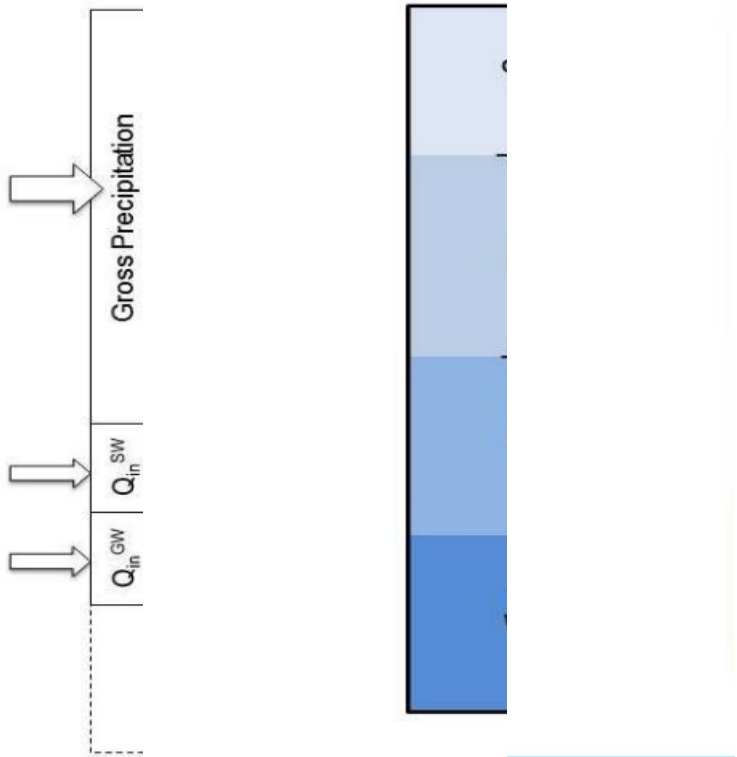
Remote sensing inputs

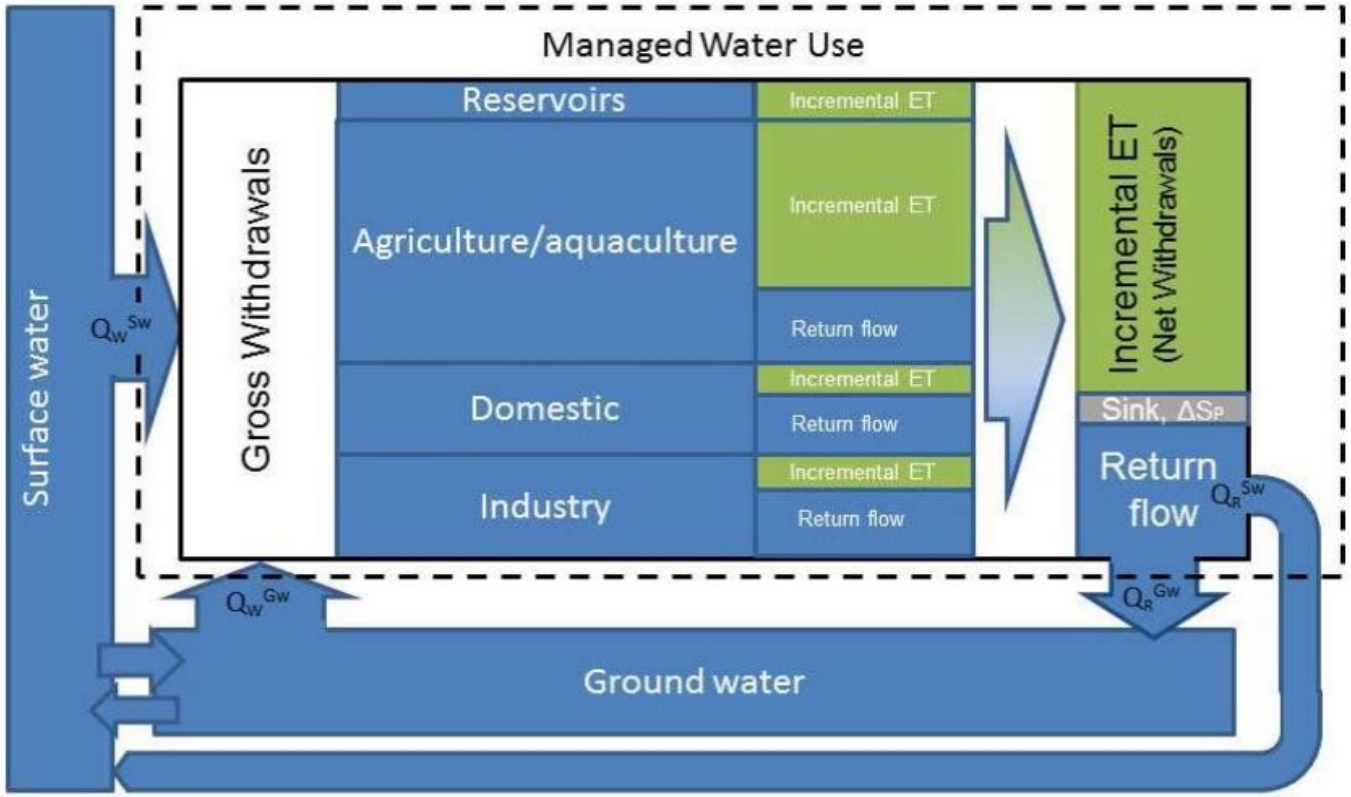
Water Balance Parameters

Indicators

Water accounting sheets

Resource Evapotrans Produc Withdrawals sheet





Indicators
Exploitable water fract
Storage change fractio
Available water fractio
Basin closure fraction
Reserved flow fraction

ndicators
T fraction
Beneficial fraction
Managed fraction
Agri. ET fraction
Irri. ET fraction

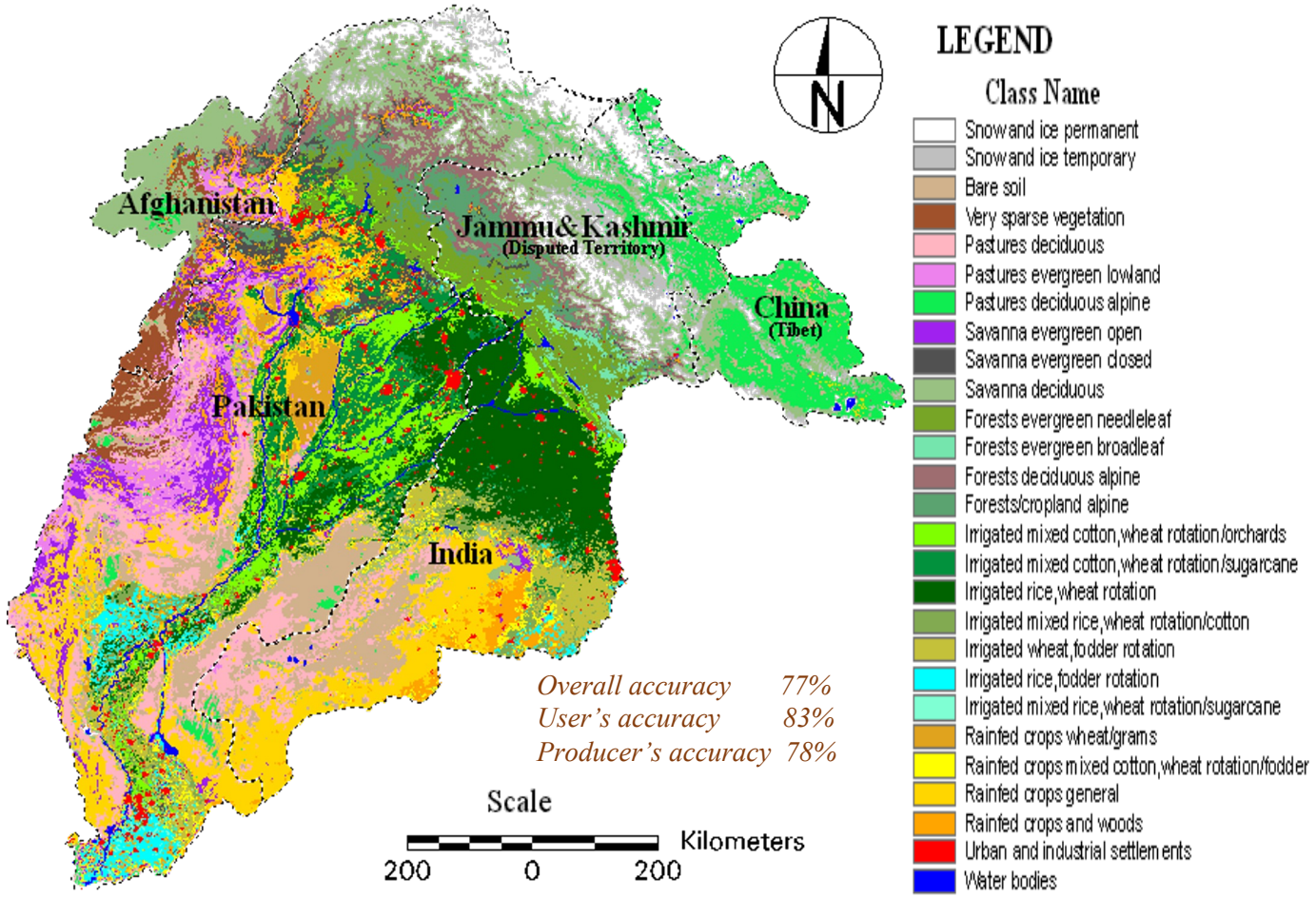
Indicators
Land producti
Land producti
Water produc
Water produc
Food Irri. Dep

Indicators	Definition
GW withdrawal fraction	Groundwater withdrawals divided by total withdrawals
Classical irrigation efficiency	Incremental ET of agriculture divided by withdrawals for agriculture
Recoverable fraction	Return flow divided by total withdrawals

Test Case: Transboundary Indus Basin

Input RS data

Land use



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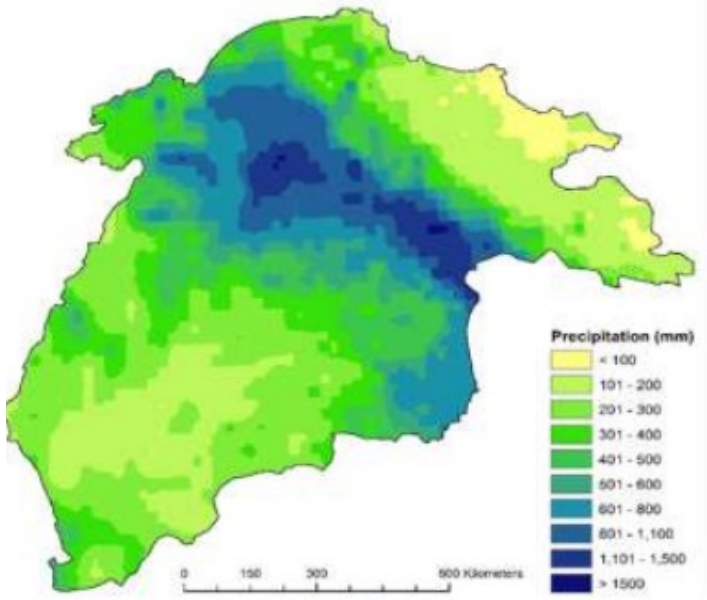
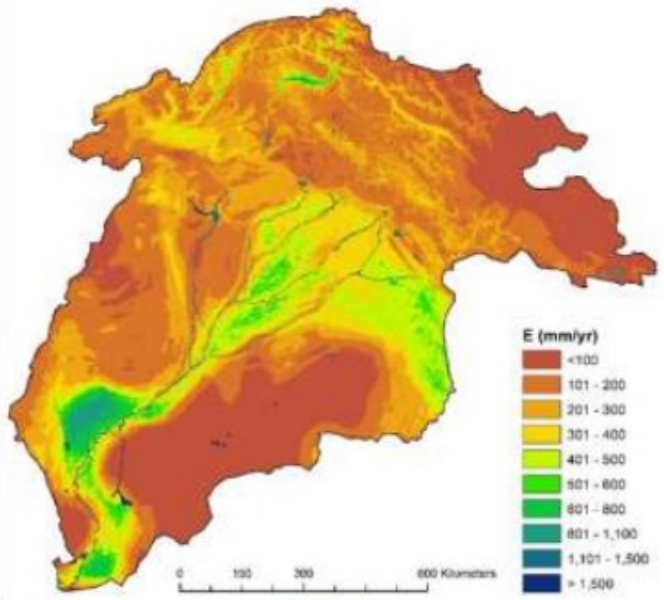
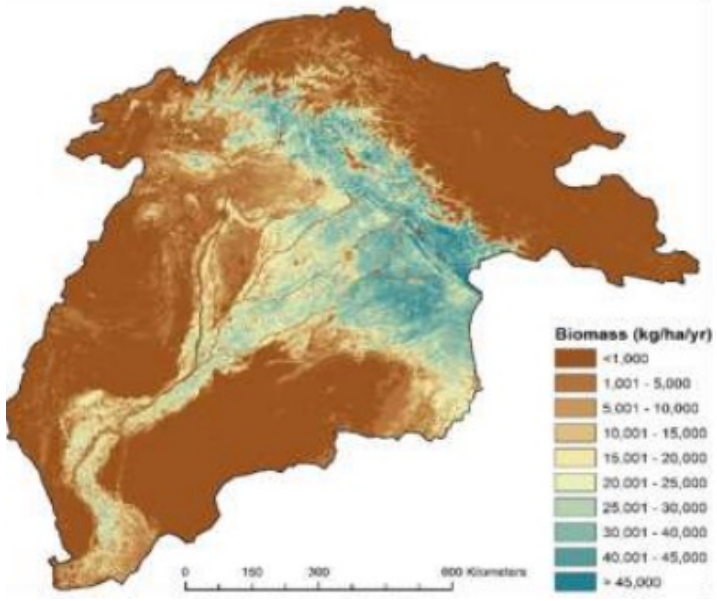
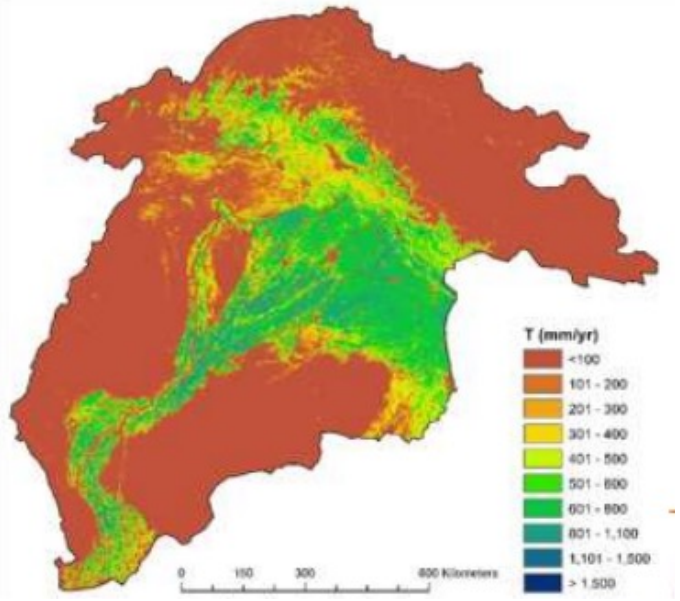


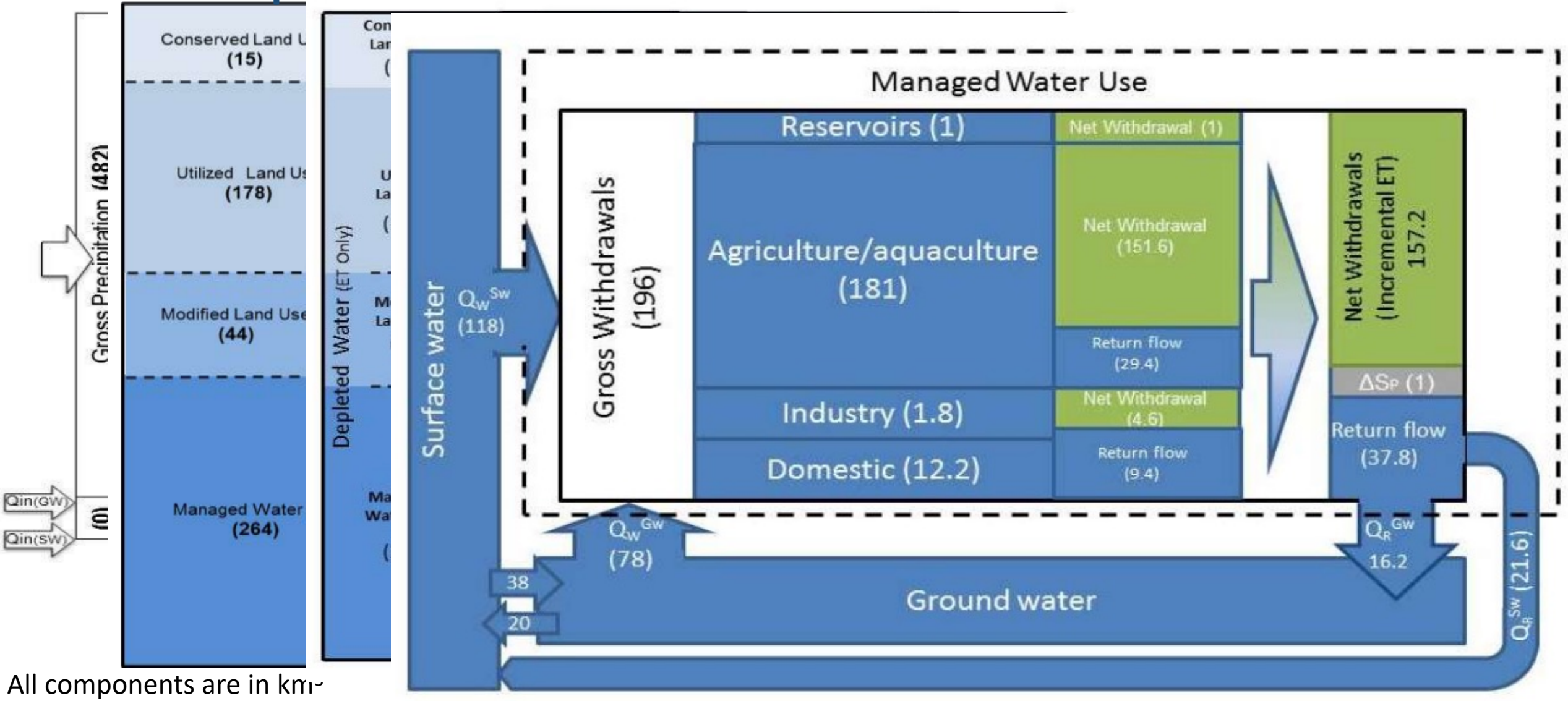






Water accounting for Indus Basin

Resource Base Sheet Evapotranspiration Withdrawals sheet



All components are in km³

Water accounting for Indus Basin

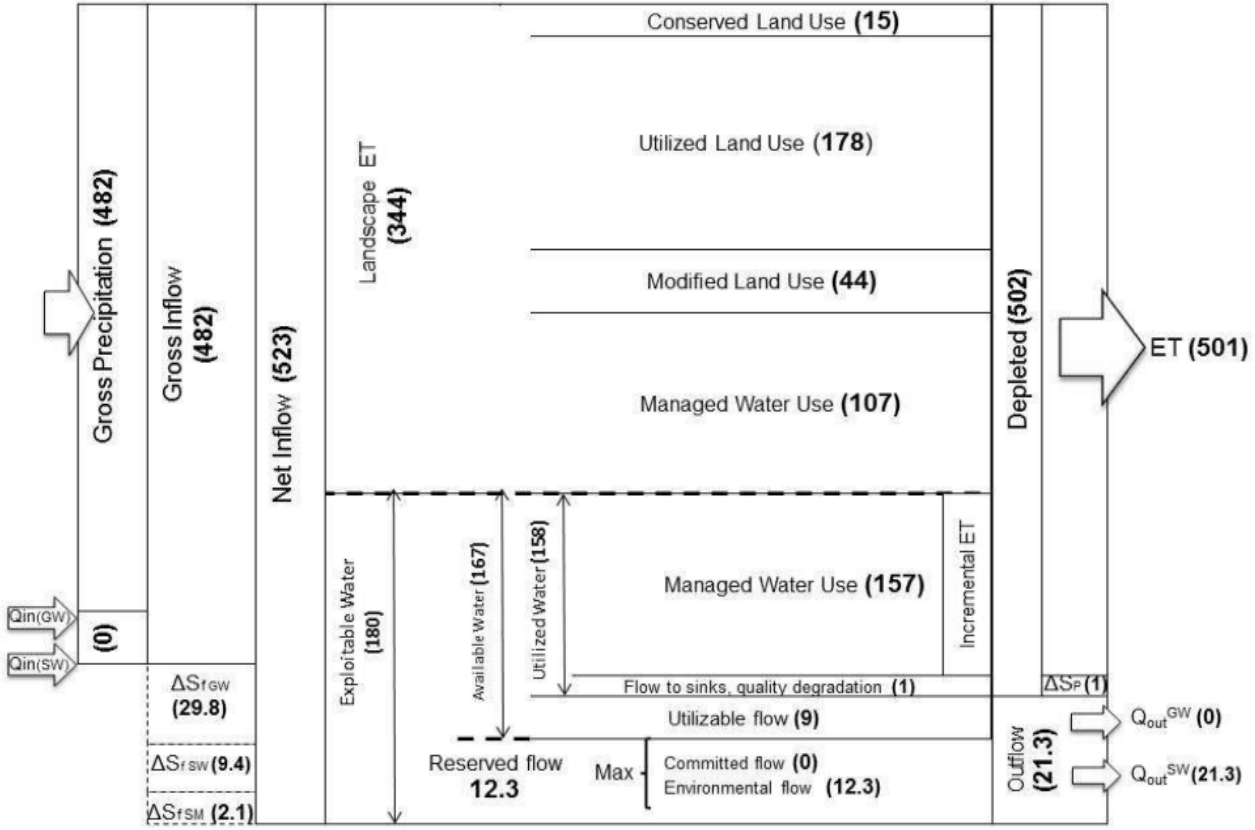
Indicators	Indus	Unit
Resource base sheet		
Exploitable water fraction	0.34	-
Storage change fraction	-0.23	-
Available water fraction	0.93	-
Basin closure fraction	0.95	-
Reserved flow fraction	0.58	-
Evapotranspiration sheet		
T fraction	0.46	-
Beneficial fraction	0.50	-
Managed fraction	0.61	-
Agri. ET fraction	0.59	-
Irri. ET fraction	0.85	-
Productivity sheet		
Land productivity $_{crops}$	5020	kg/ha/yr
Land productivity $_{pastures}$	177.4	kg/ha/yr
Water productivity $_{crops\ rainfed}$	0.35	kg/m3
Water productivity $_{crops\ irrigated}$	0.77	kg/m3
Food Irri. Dependency	0.90	-
Withdrawals sheet		
GW withdrawal fraction	0.40	-

Impact of example future scenarios' on WA+ indicators for the Indus Basin

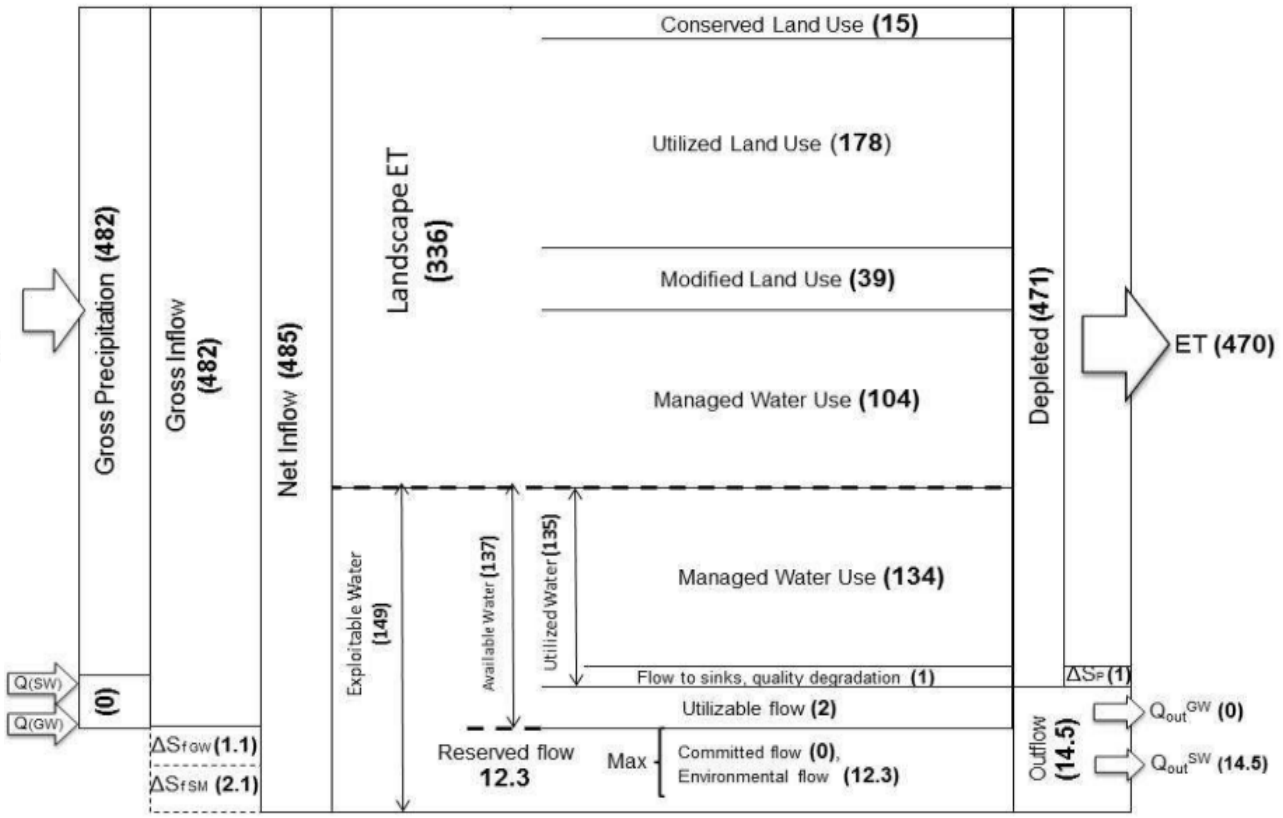
Scenario	Action	Real water saving	WA+ indicators	
		(km^3/yr)		
A Mixed actions	• Reduce E rainfed land by 5 % • Reduce E irrigated land by 15 % • Reduce irrigated area by 0 % • Biomass production increase 5 % • Harvest index increase 5% • Reduce utilizable flow by 50%	12.6	Storage change fr.: -0.17 Reserved flow fr.: 0.73 T fr.: 0.48 Beneficial fr.: 0.53	Land productivity $_{irri}$: 8,560 Land productivity $_{rainfed}$: 1,030 Water productivity $_{irri}$: 0.90 GW withdrawal fr.: 0.41
B Reduce E	• Reduce E rainfed land by 15 % • Reduce E irrigated land by 35 % • Reduce irrigated area by 0 % • Biomass production increase 5 % • Harvest index increase 10% • Reduce utilizable flow by 75%	37.8	Storage change fr.: -0.02 Reserved flow fr.: 0.85 T fr.: 0.50 Beneficial fr.: 0.55	Land productivity $_{irri}$: 9,300 Land productivity $_{rainfed}$: 1,130 Water productivity$_{irri}$:1.09 GW withdrawal fr.: 0.32
C Modify area	• Reduce E rainfed land by 5 % • Reduce E irrigated land by 15 % • Reduce irrigated area by 15 % • Biomass production increase 5 % • Harvest index increase 10% • Reduce non-utilizable flow by 75%	39.4	Storage change fr.: -0.01 Reserved flow fr.: 0.85 T fr.: 0.45 Beneficial fr.: 0.50	Land productivity $_{irri}$: 9,300 Land productivity $_{rainfed}$: 1,130 Water productivity y_{irri}: 0.93 GW withdrawal fr.: 0.30

Impact of example future scenario's on WA+ indicators for the Indus Basin

Resource base sheet- Actual



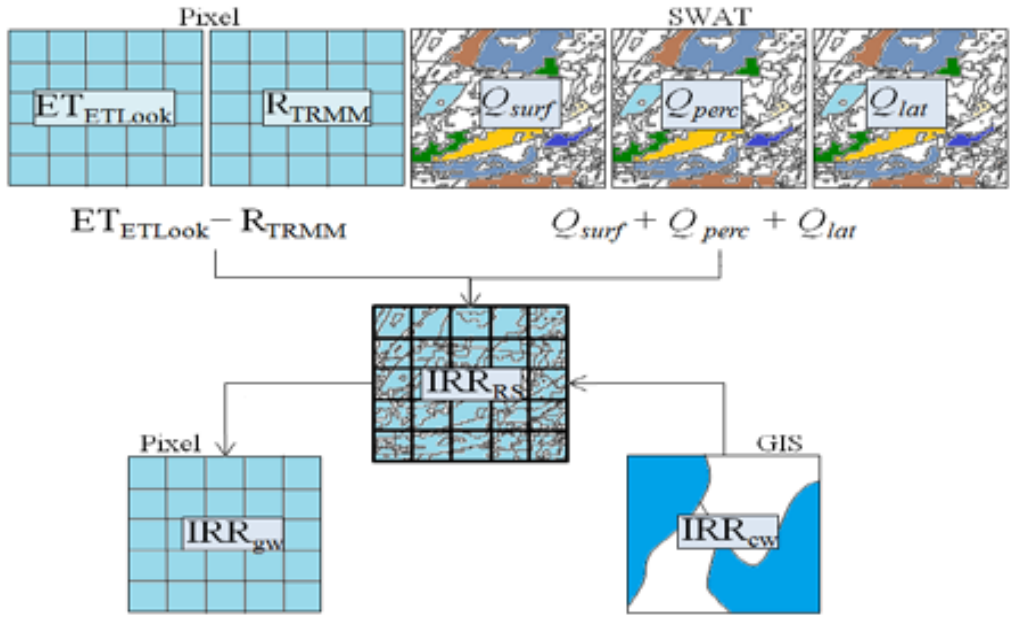
Resource base sheet- Projected

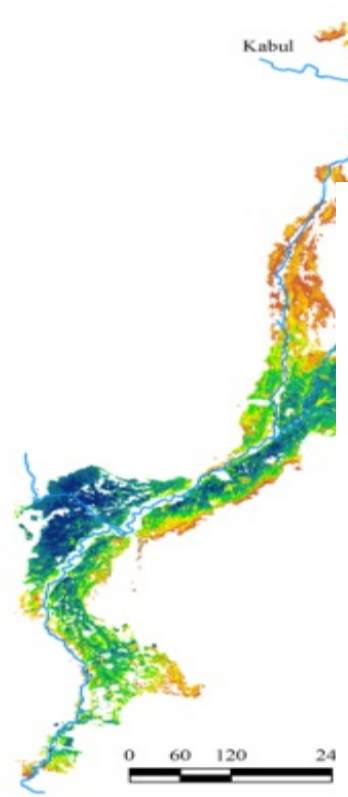


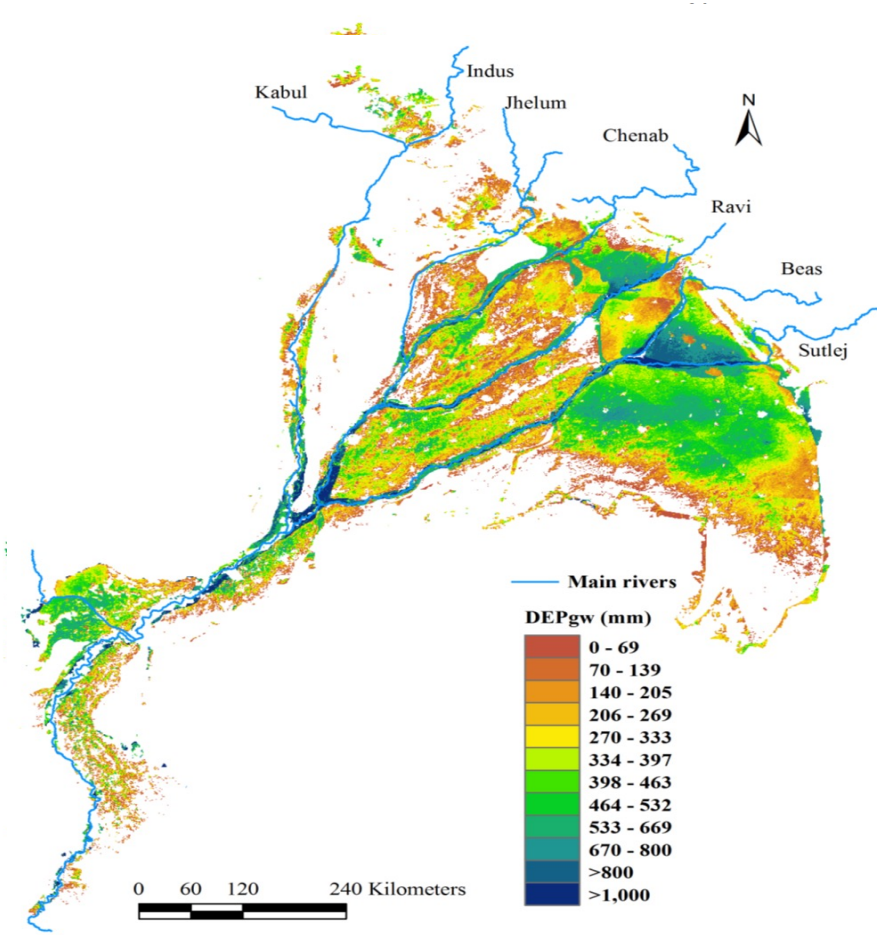
All components are in km^3

Spatial groundwater abstractions/depletion

Integration of RS,GIS and SWAT







$$IRR_{RS} = \Delta S_{us} + ET_{ETLook} + Q_{surf} + Q_{lat} + Q_{perc} - R_{TRMM}$$

$$\Delta S_{us} = K_{SWAT} + IRR_{SWAT} + C_r - ET_{SWAT} - Q_{perc} - Q_{surf} - Q_{lat}$$

IRR_{RS} = 181 km³ IRR_{cw} = 113 km³

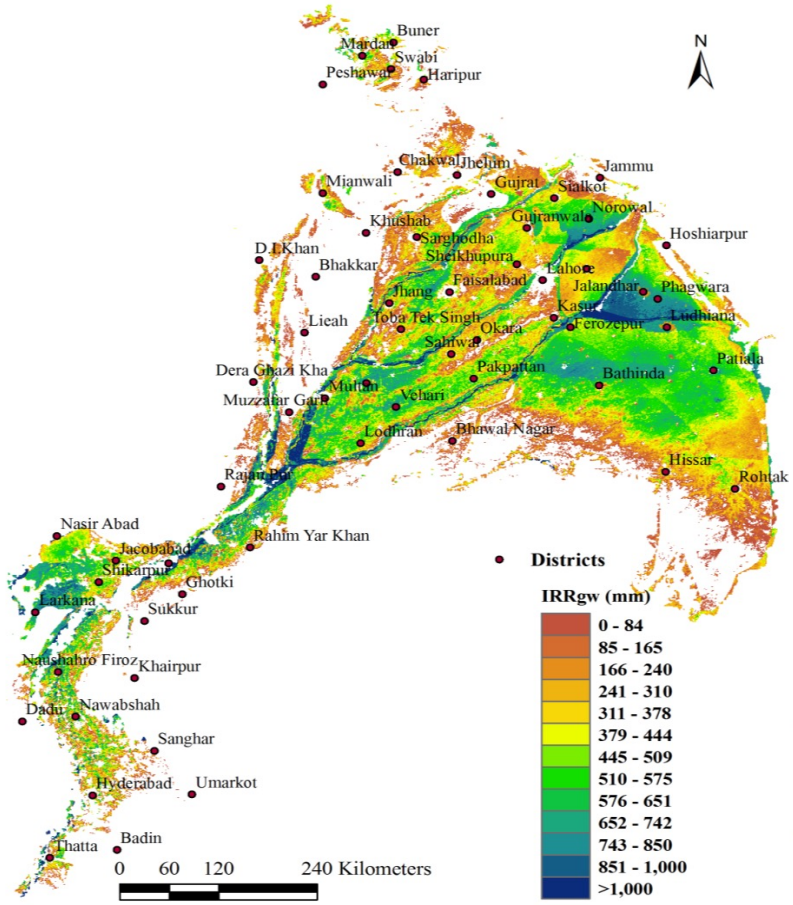
$$IRR_{gw} = IRR_{RS} - IRR_{cw}$$

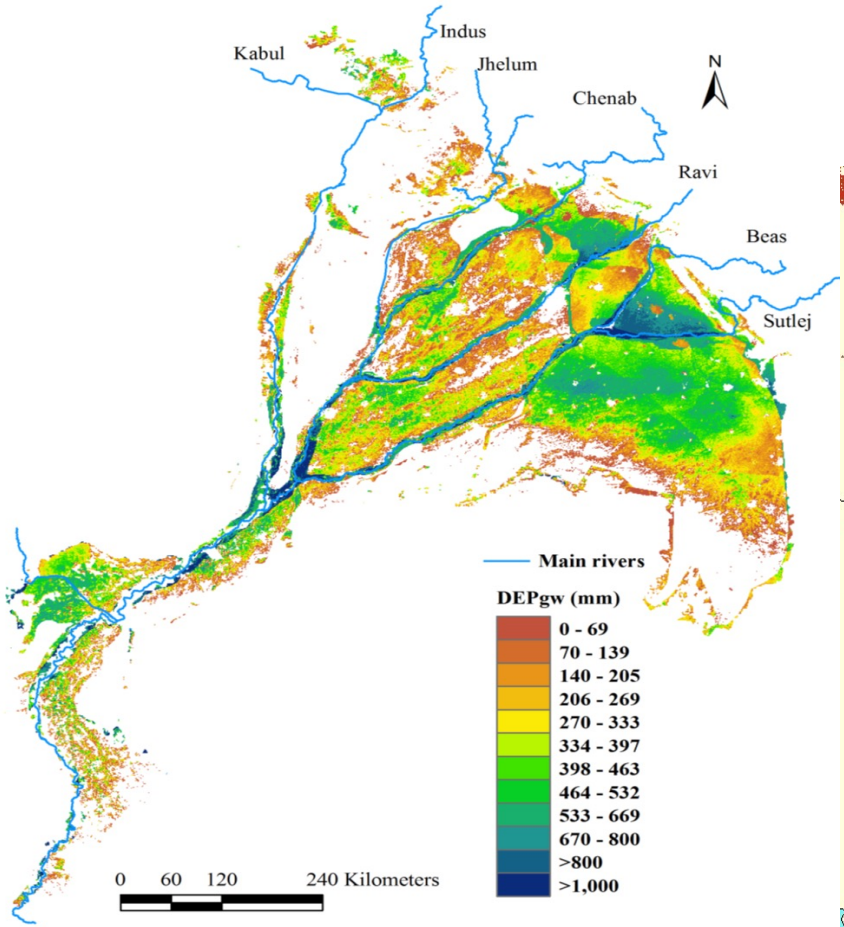
IRR_{gw} = 68 km³

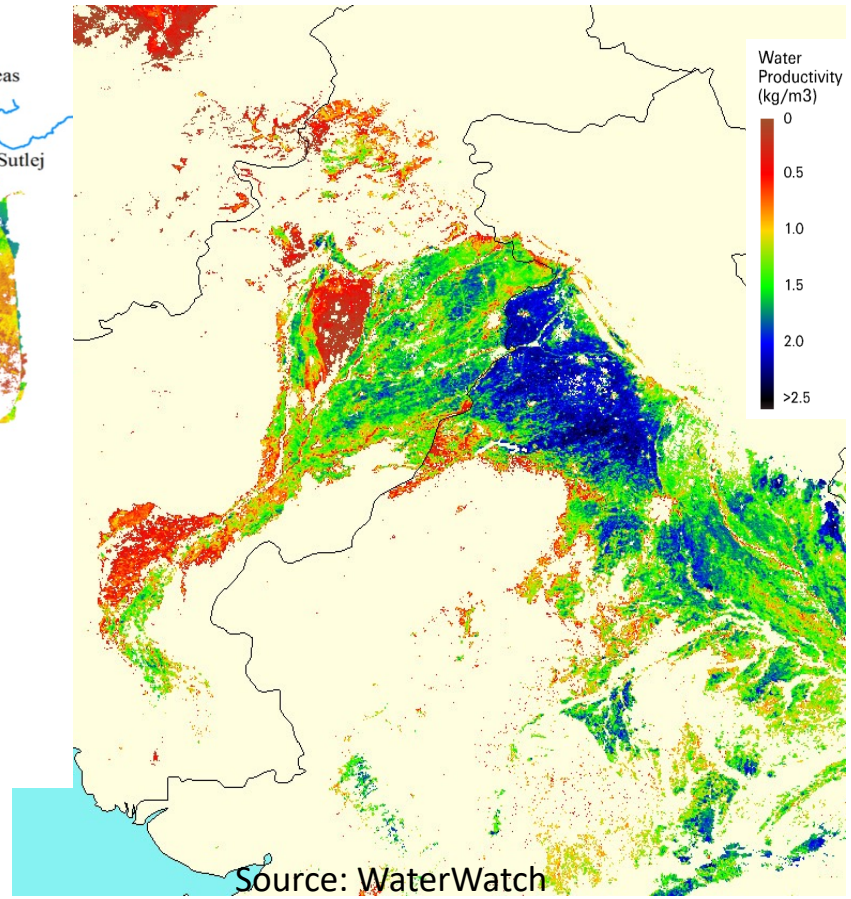
$$DEP_{gw} = IRR_{gw} + Q_{gw} - Q_{perc} - LOSS_{cw}$$

DEP_{gw} = 31 km³

Spatial water productivity



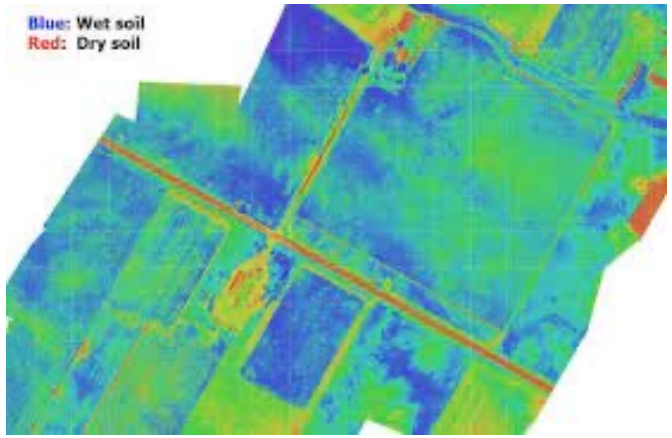




Cheema et al., 2015

Source: WaterWatch

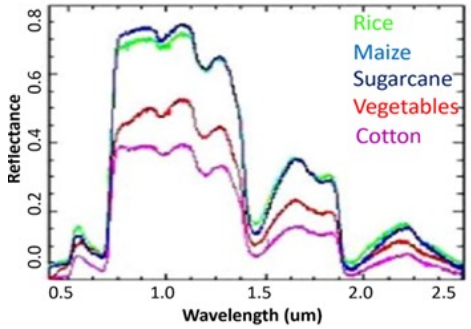
Validation: Digital tools are available



Water Accounting Instrumentation

Chameleon soil water kit

Leaf Area Index (LAI) meter

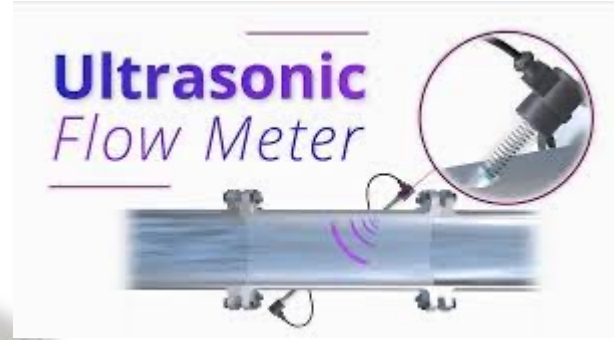


Groundwater (CTD) divers

EC Meter

Geotagging of Tube well

Wetting Front Detector



DGPS

Eddy covariance Flux Tower

Thank you for attention!