

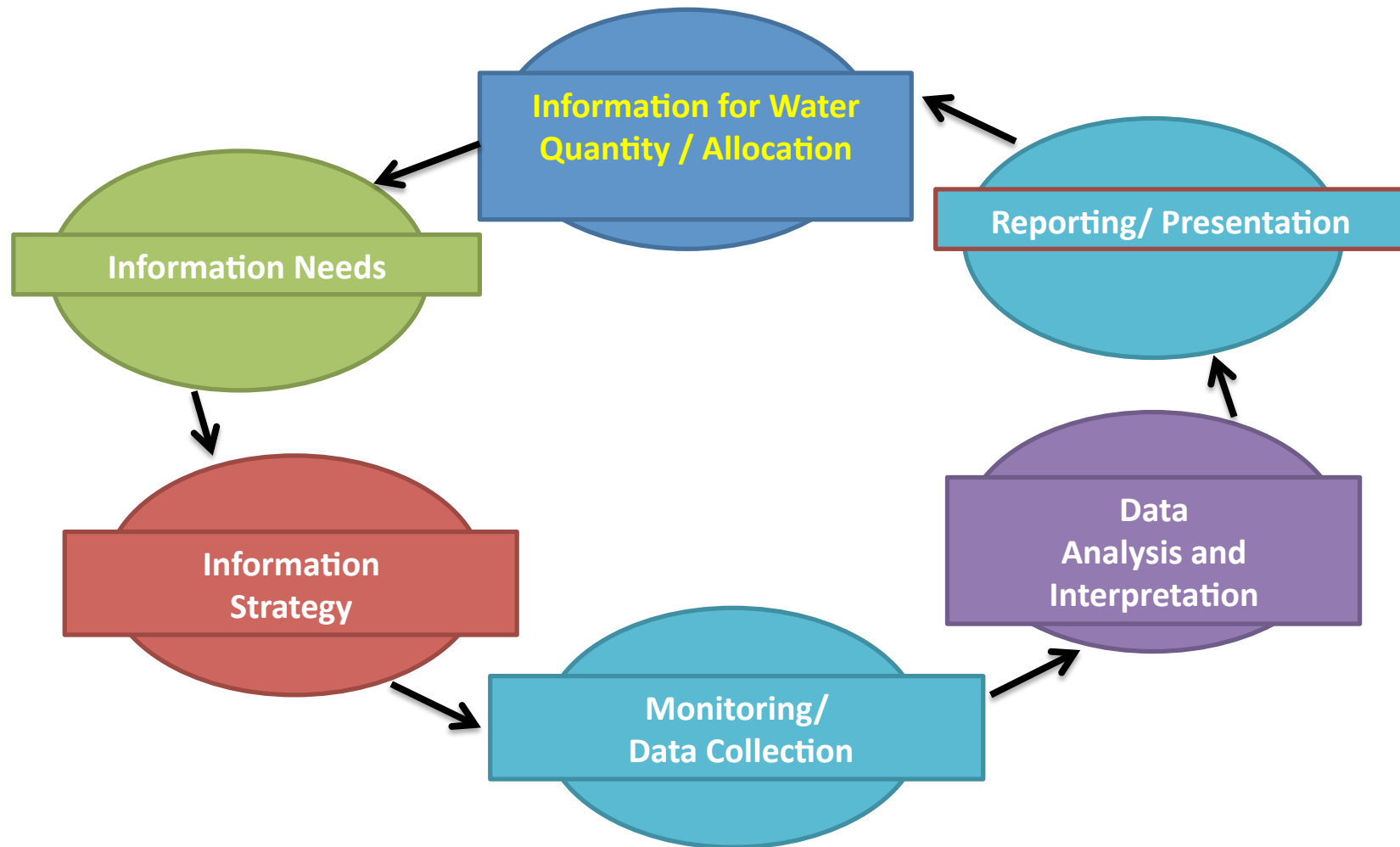


# ***Data Management – Making it Matter and Helping it Flow***

- Part 1: Introduction - IWRM and how data management connects
- **Part 2: Information in Water Quantity and Water Allocation**
- Part 3: Information in Water Quality Management
- Part 4: Other aspects of IWRM and information management needs
- Part 5: Discussion

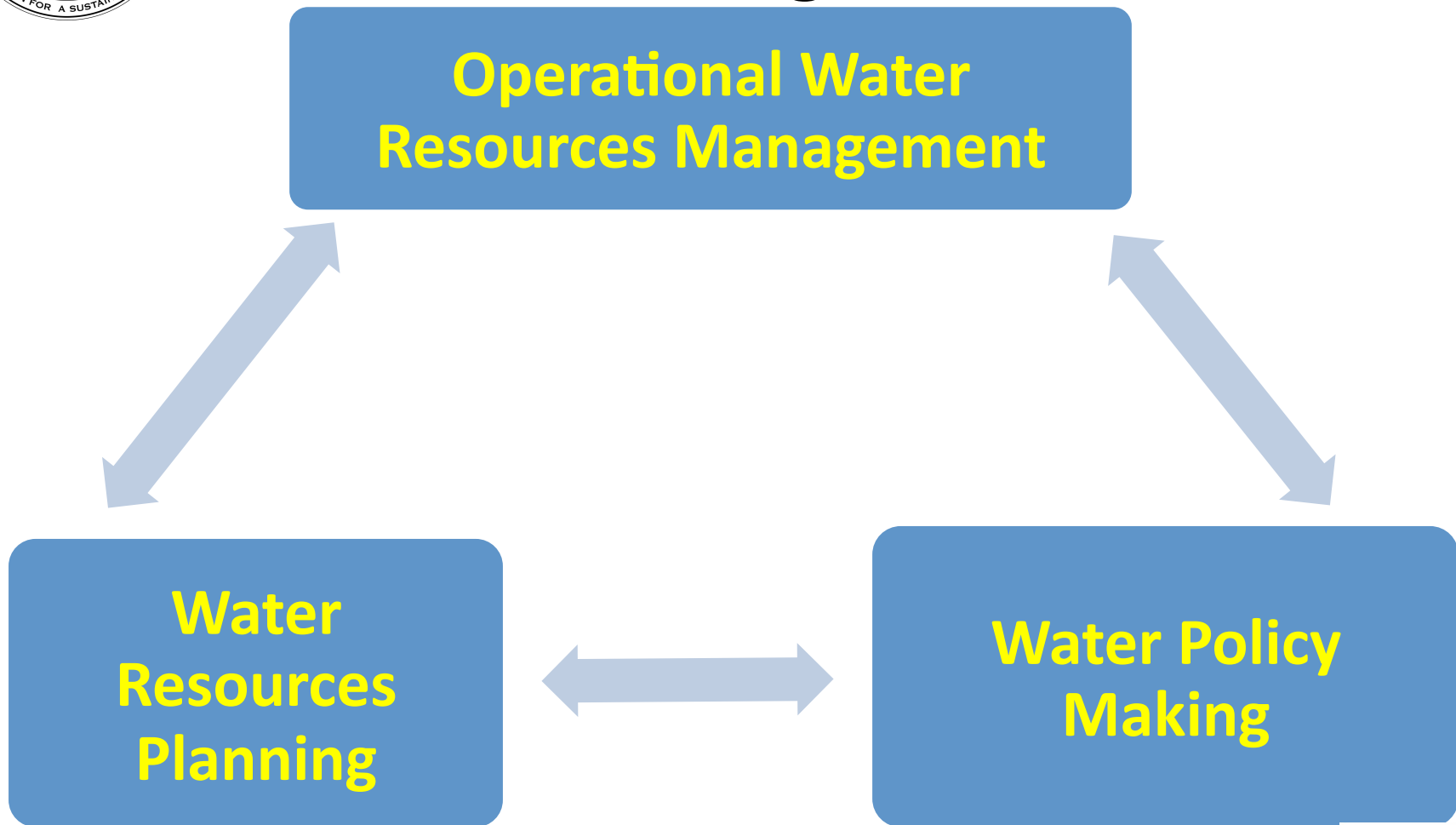


# Information Cycle



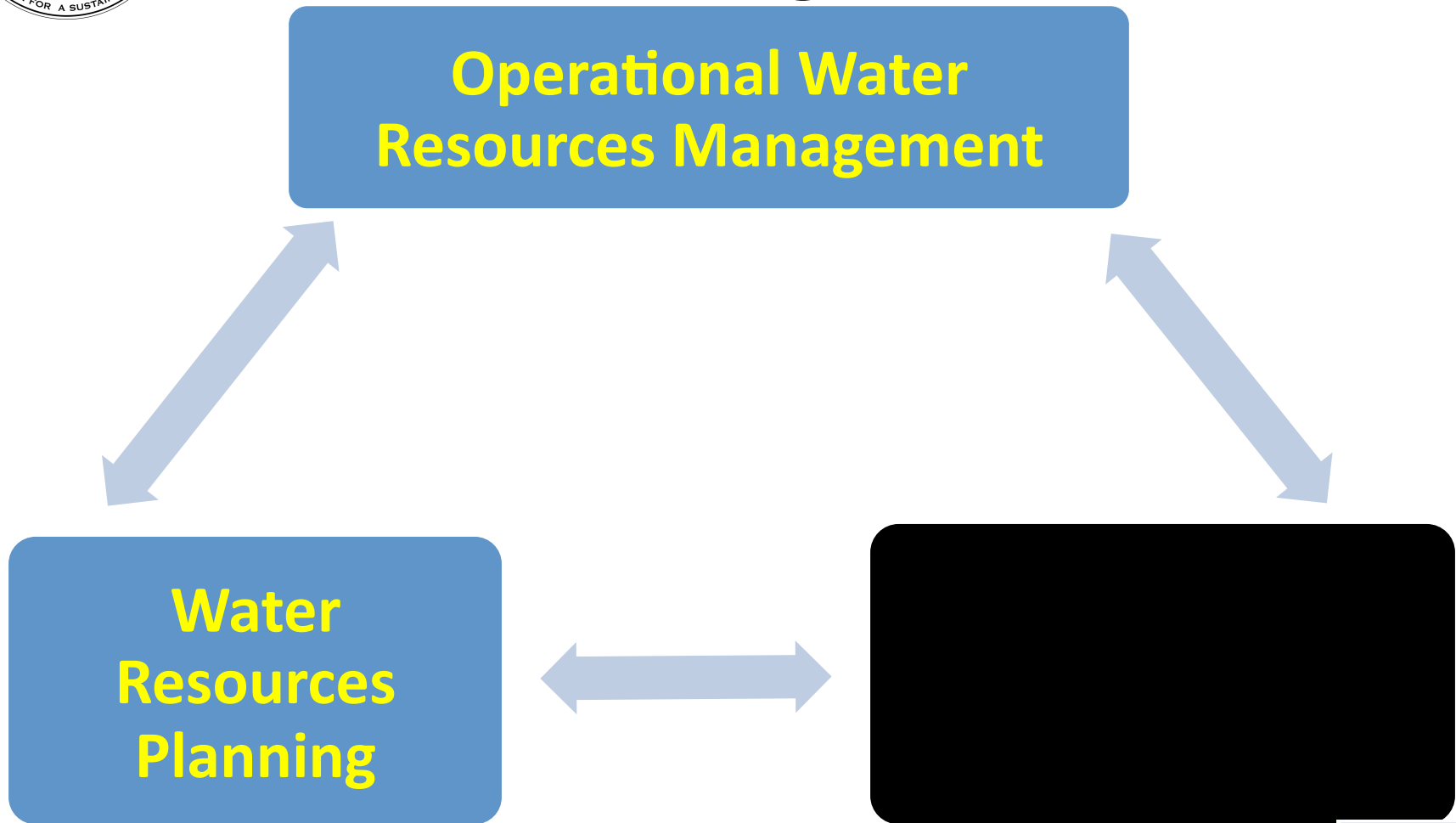


# Three Levels in Water Resources Management





# Three Levels in Water Resources Management





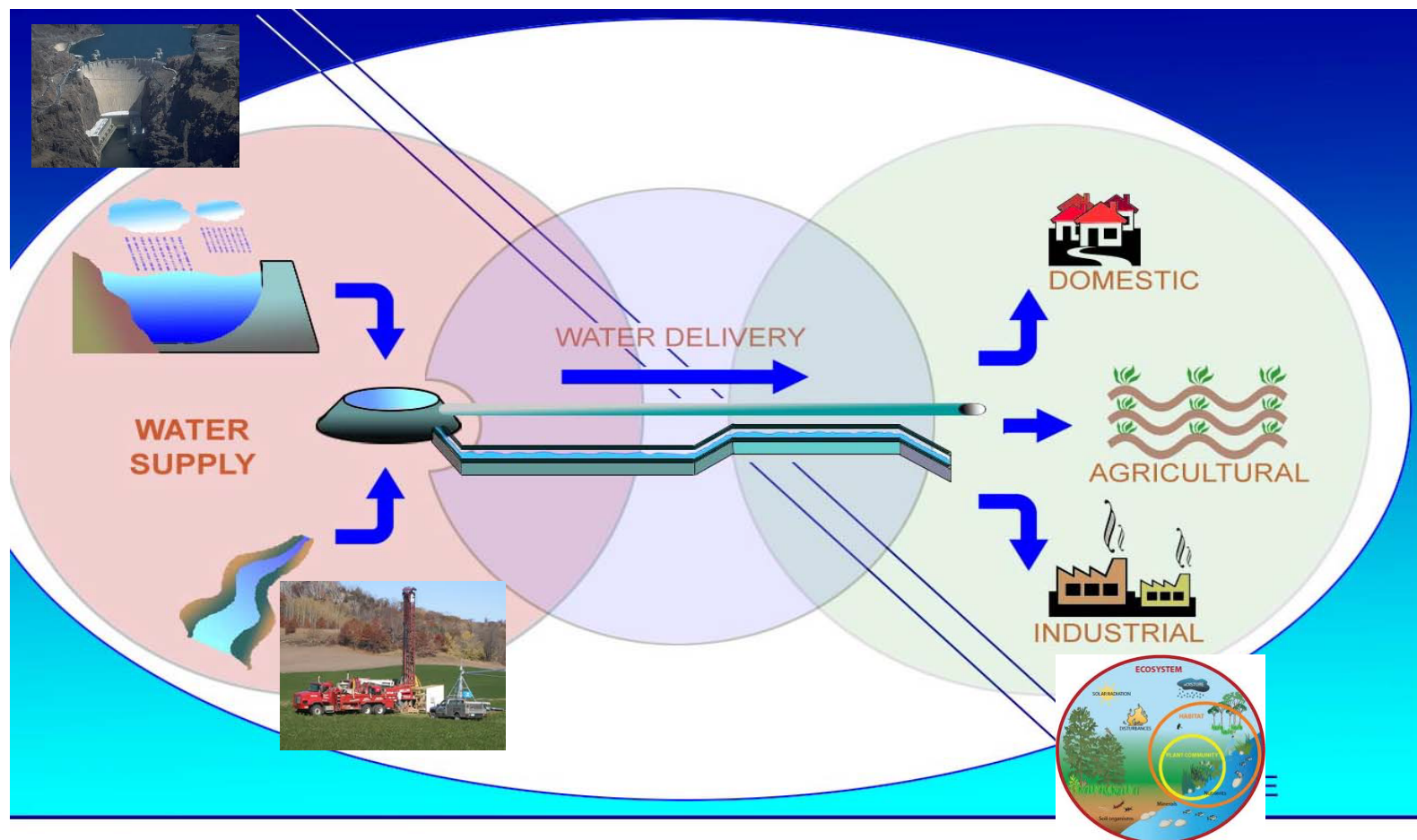
# Water Quantity / Allocation



- 1) How much water do we have?
- 2) How much water do we need?



# Operational Water Management







# Defining the Resource - Primary Data

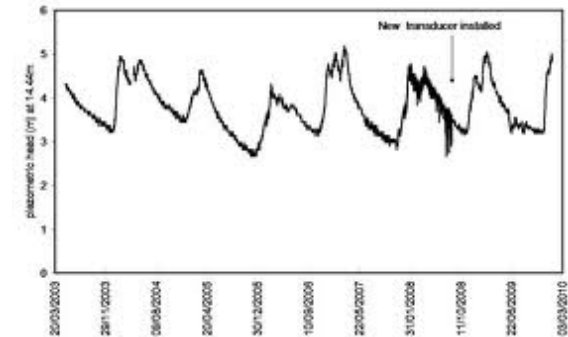
## River Flow Data – Water Levels



Automatic and Manual Water Level Recorders



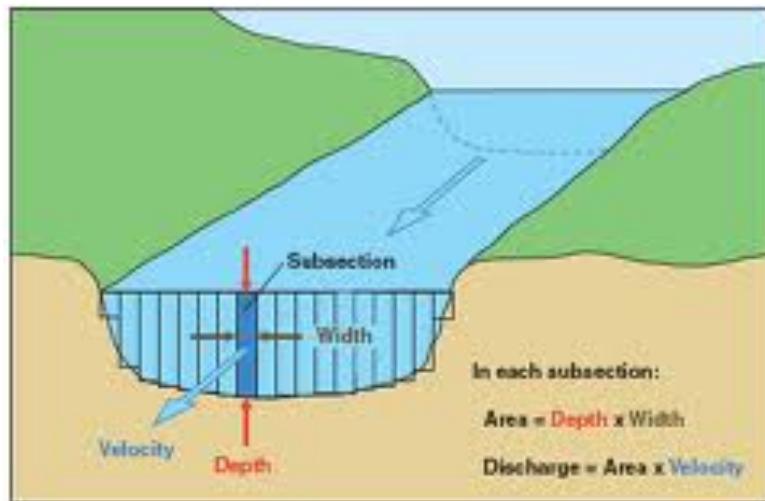
Streamflow Measurements for rating  
curve development



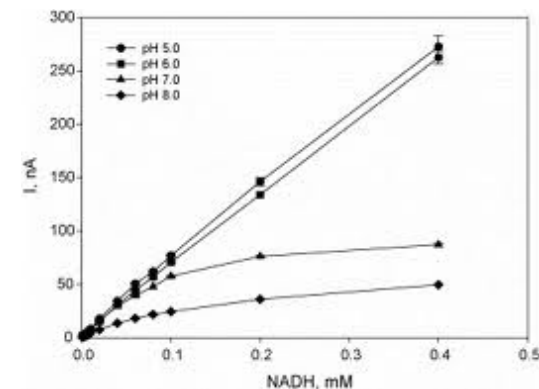
AWLR trace diagram

# Defining the Resource - Primary Data

## River Flow Data – Rating Curves



Current-meter discharge measurements are made by determining the discharge in each subsection of a channel cross section and summing the subsection discharges to obtain a total discharge.



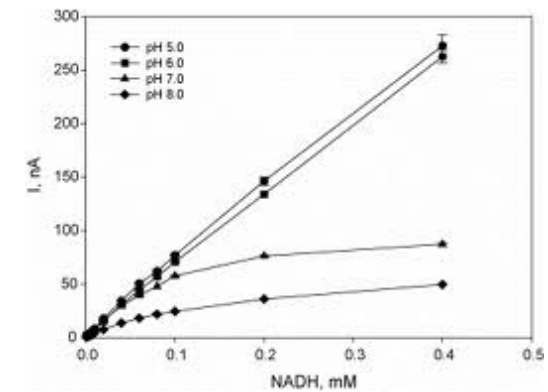
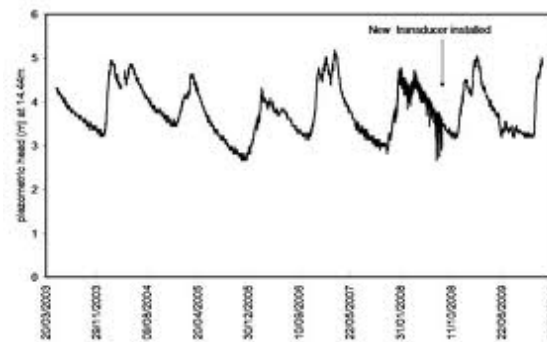
## Development of Rating Curves





# Defining the Resource - First Level Assessment

## River Flow Data – Rating Curves to Hydrographs



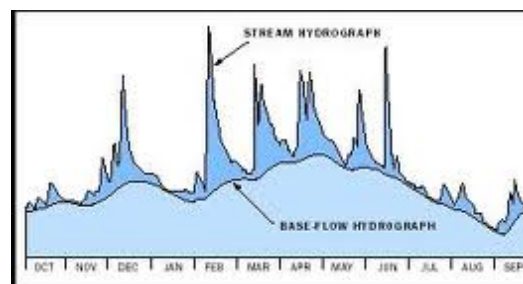
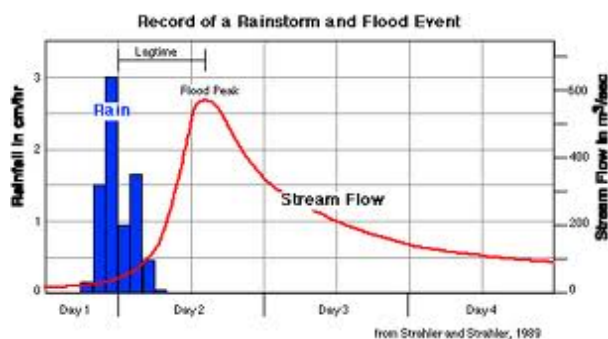
Rating Curves

Development of Hydrographs



# Defining the Resource – First Level Assessment

## River Flow Data – Hydrographs and Flow Statistics



### Storm Hydrographs

Error Statistics Exercise

N = 5

Forecast Flow	Observed Flow	Difference $(f_i - o_i)$	Absolute Difference $ f_i - o_i $	Squared Difference $(f_i - o_i)^2$	
500	600	-100	100	10,000	
350	250	+100	100	10,000	
400	350	+50	50	2,500	
750	900	-150	150	22,500	
600	600	0	0	0	
Sum ( $\Sigma$ )	2600	2700	-100	400	45,000

$$MAE = \frac{1}{N} \sum_{i=1}^N |f_i - o_i|$$

$$ME = \frac{1}{N} \sum_{i=1}^N (f_i - o_i)$$

$$RMSE = \sqrt{\frac{1}{N} \sum_{i=1}^N (f_i - o_i)^2}$$

$$Bias = \frac{\sum_{i=1}^N f_i}{\sum_{i=1}^N o_i}$$

©The COMET Program

### Annual Hydrographs

ARI (years)	Probability of occurrence in any given year	Percent chance of occurrence in any given year
1000	1 in 1000	0.1%
500	1 in 500	0.2%
100	1 in 100	1%
50	1 in 50	2%
20	1 in 20	5%
10	1 in 10	10%
5	1 in 5	20%
2	1 in 2	50%
1	1 in 1	100%

### Flow Statistics



# Defining the Resource Primary Data



**...including snow and ice data**





# Defining the Resource Primary Data



**...there may be reservoirs**

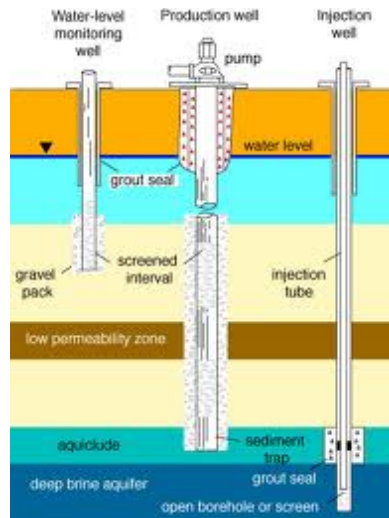




# Defining the Resource Primary Data



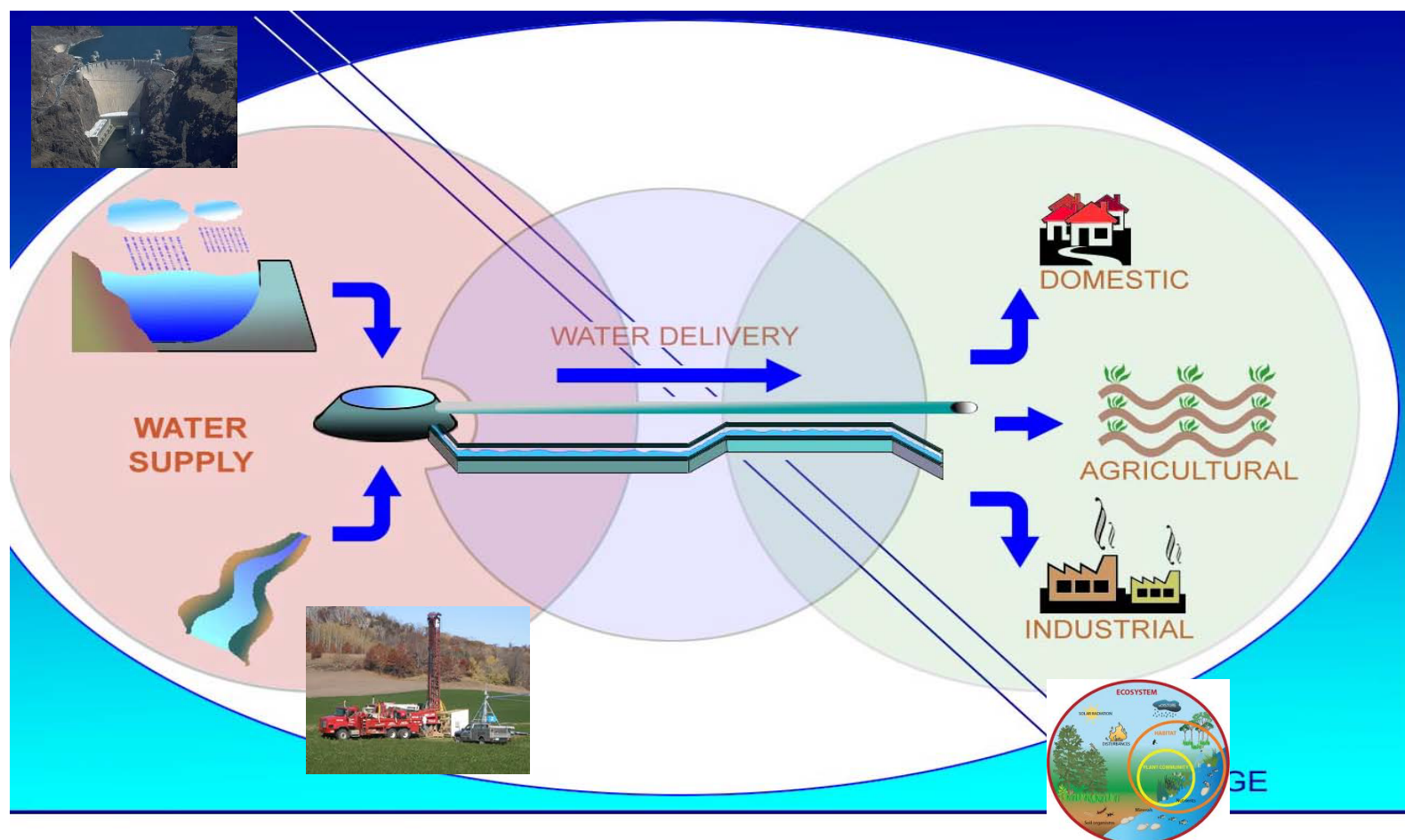
...groundwater sources







# Operational Water Management







# Defining Demands



## Irrigation....



large scale.....small scale





# Defining Demands



## Domestic water supply and sanitation



Urban and Rural



# Defining Demands



## Industry





# Defining Demands



## Environment







# Defining Demands



## Hydropower





# Supply – Demand Balance

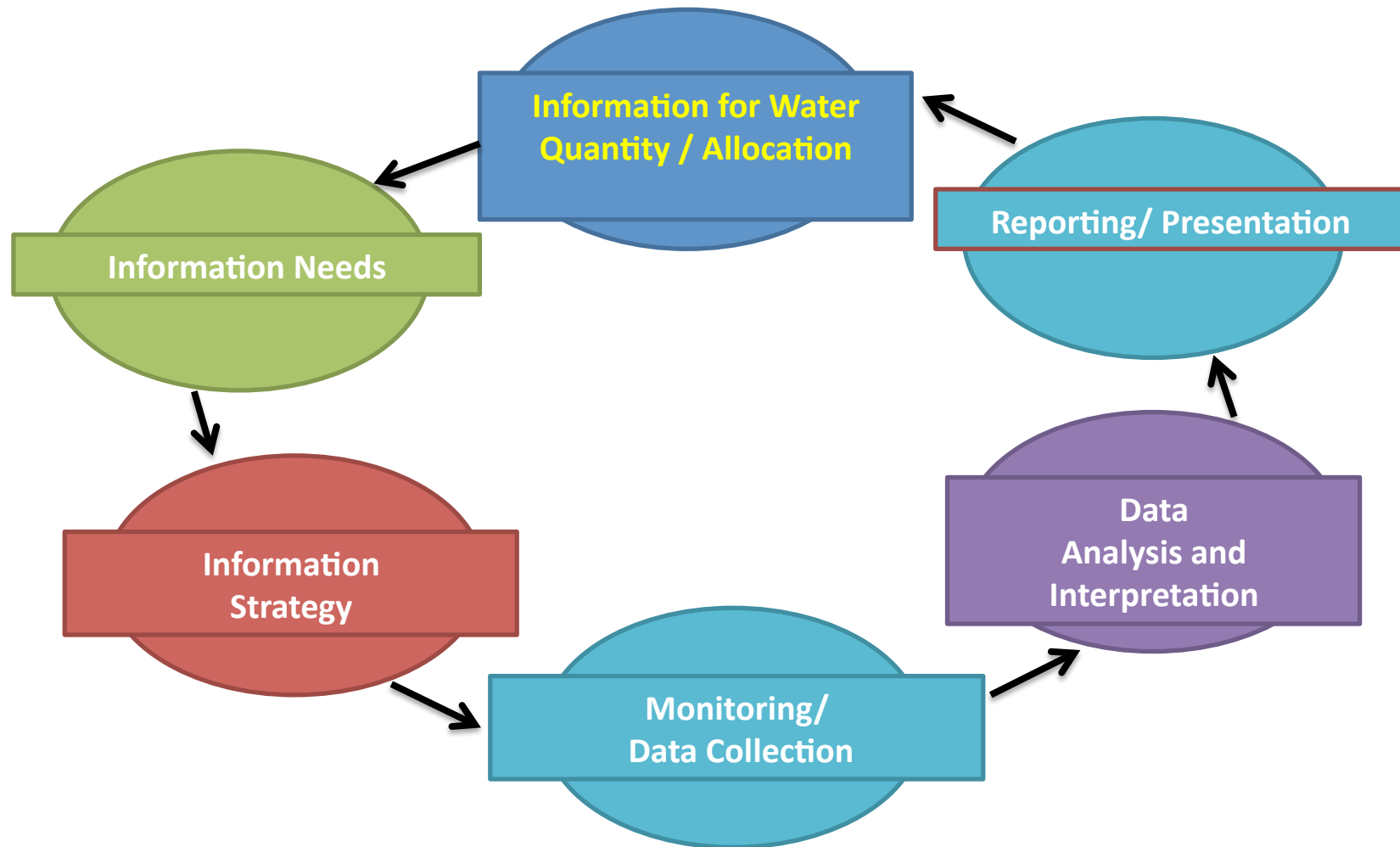


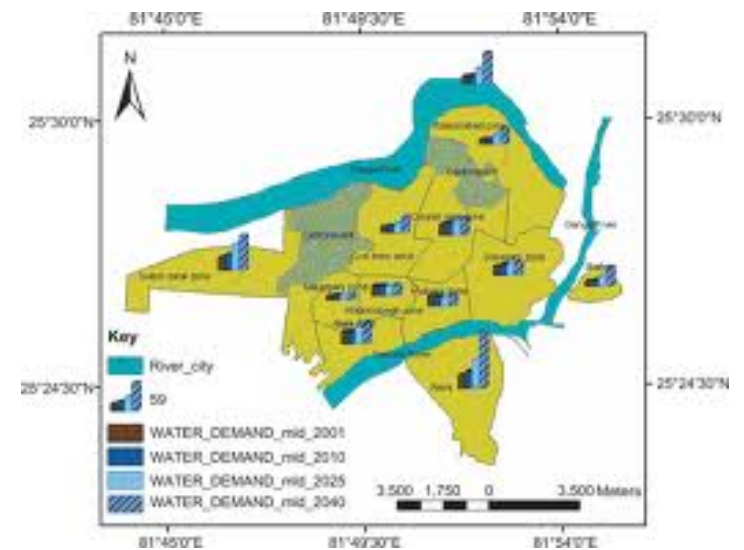
Resource Type	Data Quality	Demand Type	Quantity Information
River Flow	Medium	Irrigation	Inaccurate
Groundwater	Limited	Water Supply	Accurate
Reservoirs	Accurate	Industry	Inaccurate
		Environment	Inaccurate





# Information Cycle



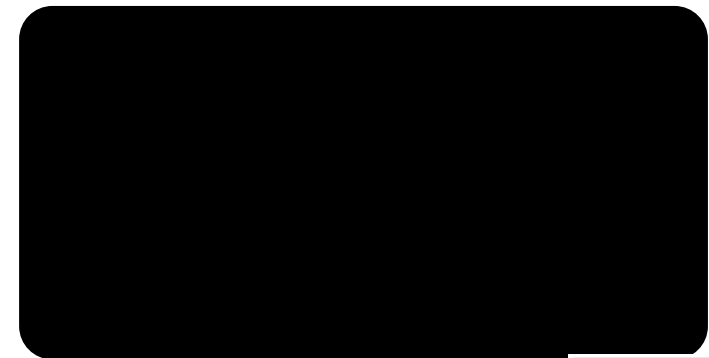




# Three Levels in Water Resources Management

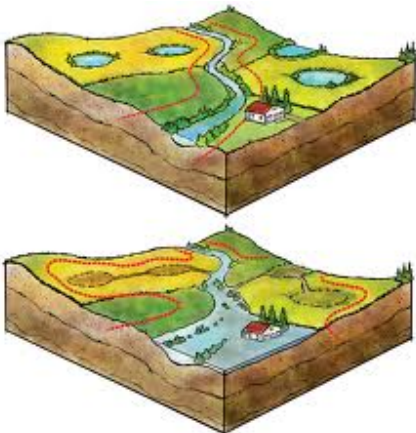
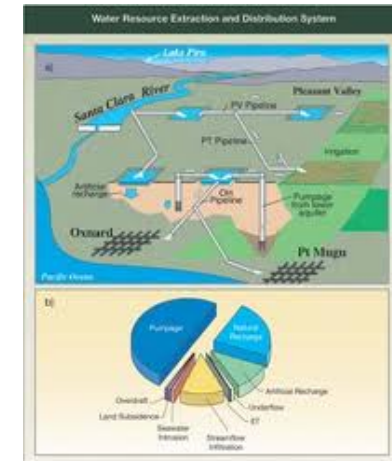
**Water Resources Planning**

**Operational  
Water Resources  
Mgmt.**





# Water Resources Planning





# Defining the Resource For Planning



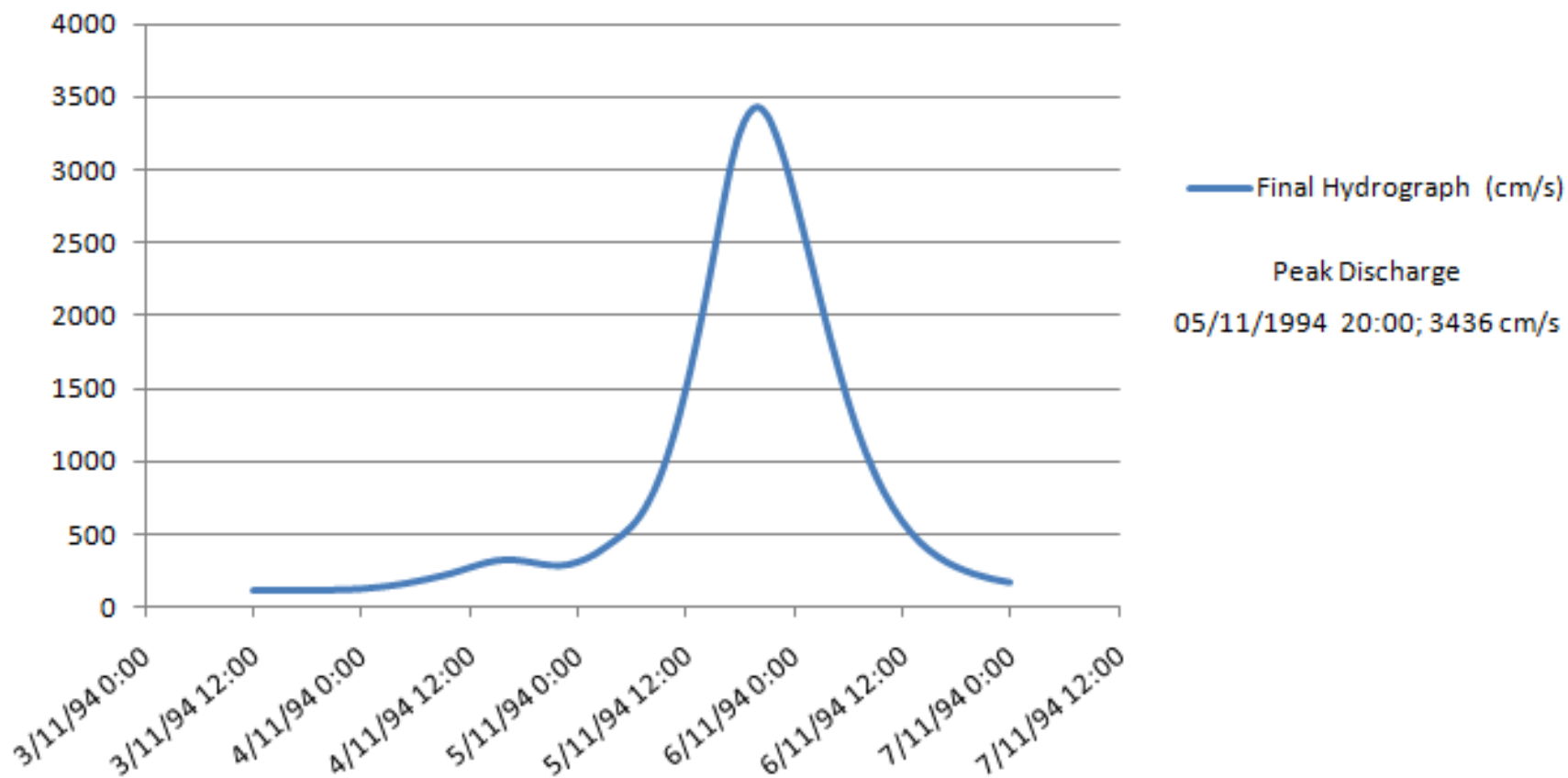
## Meteorological Data





# Information for Planning

**Final Hydrograph (cm/s)**

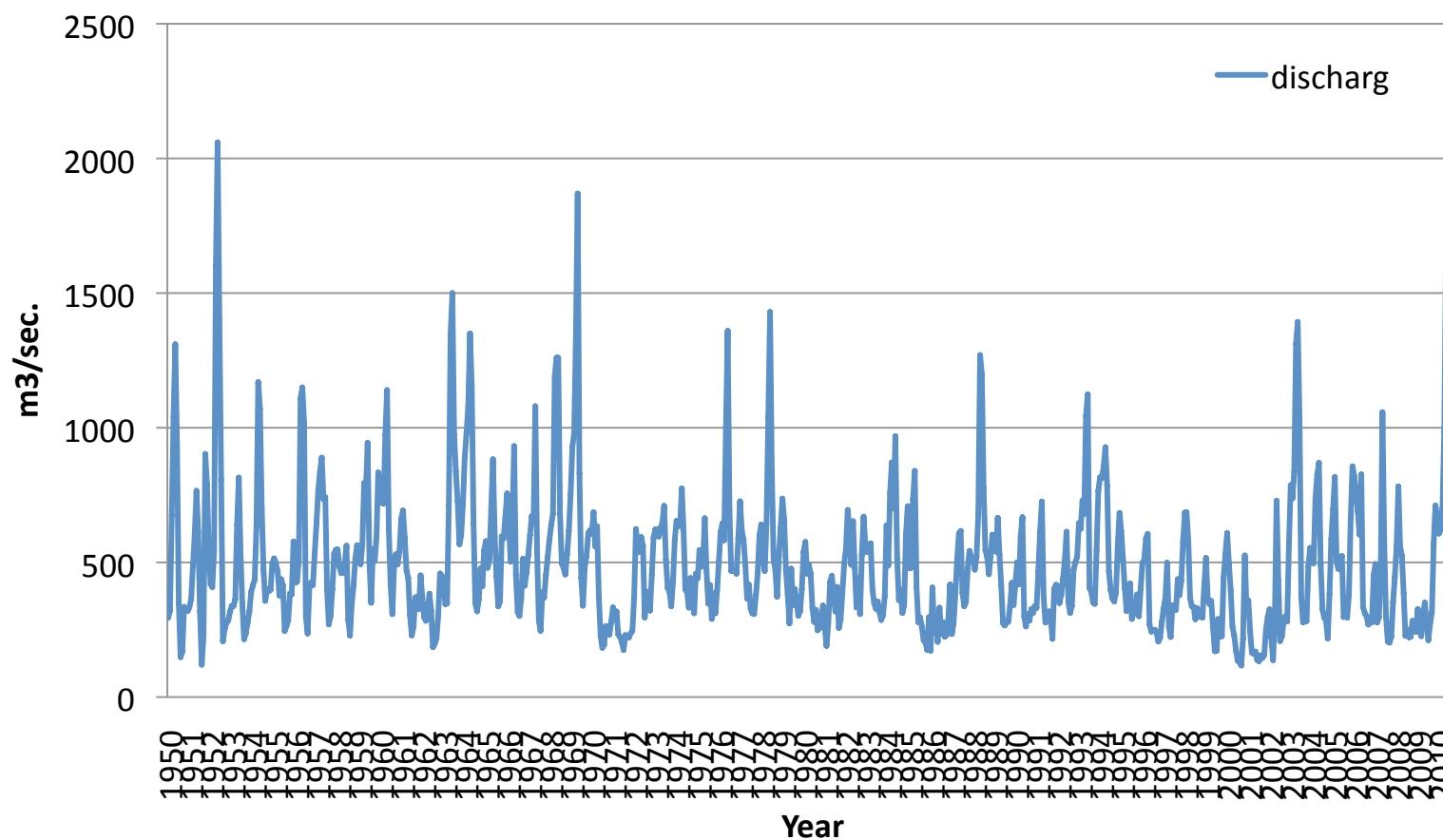






# Information for Planning

Historical Discharge in Surra, Azerbaijan (1950-2010)

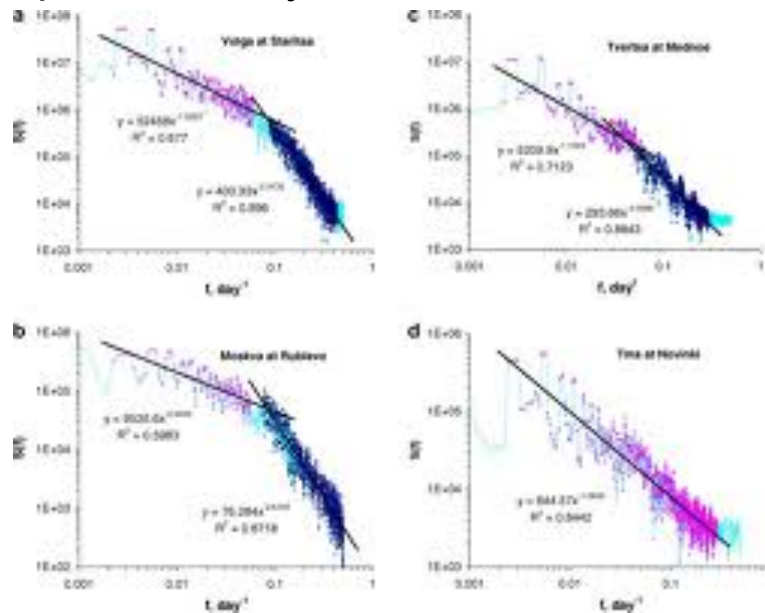




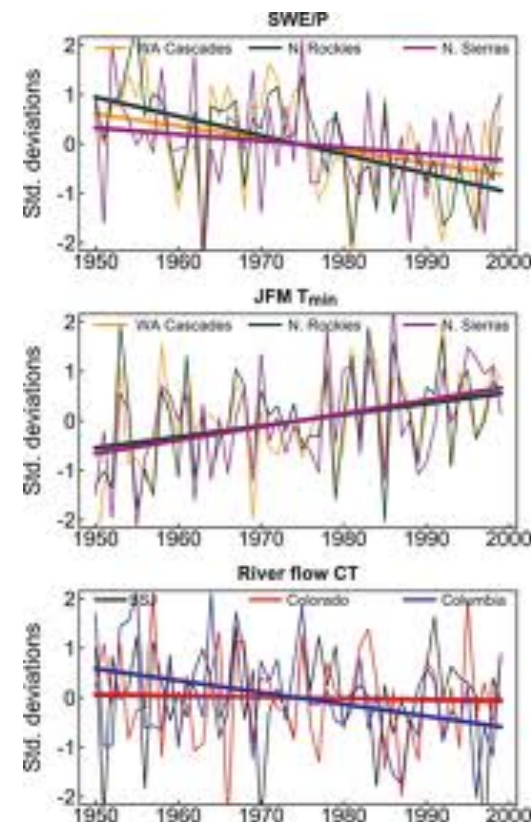
# Information for Planning – Third Level Assessment

## River Flow Data – Time Series and Trends

### Spectral Analysis of Flow



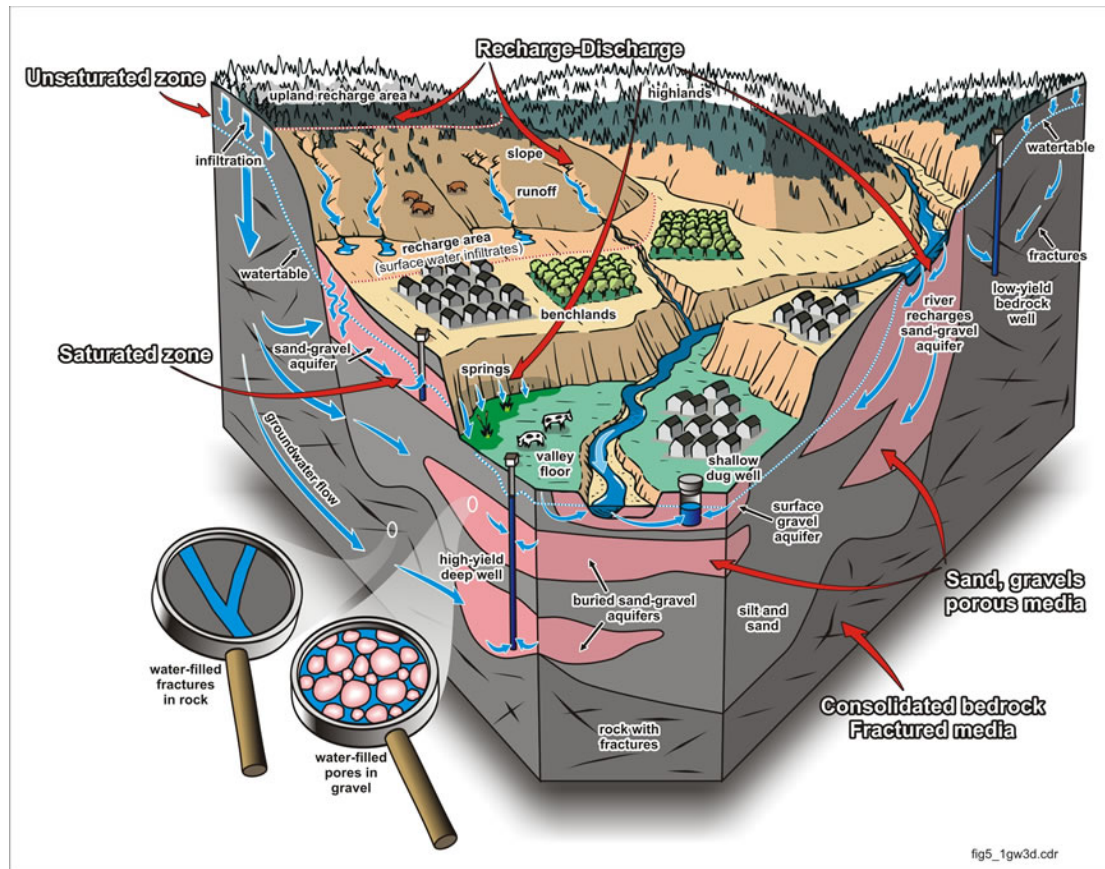
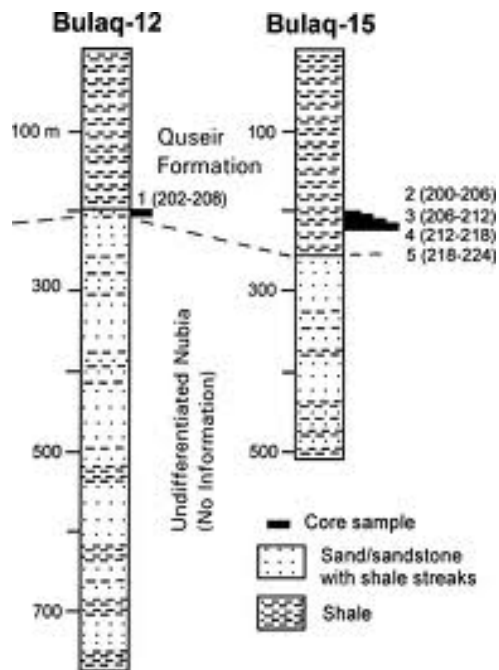
### Trend Analysis of Flow



# Information for Planning



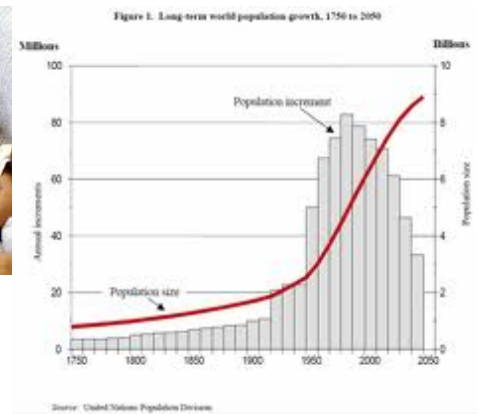
## Groundwater Analysis and Information





# Information for Planning

## Population Growth



## Industrial Development



## Economic Trends







# Information for Planning

## Land use and change



## Climate Change







# Information Cycle

