PAVITRA GANGA

USE OF DECISION SUPPORT TOOLS IN WATER MANAGEMENT

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BACKGROUND

- Water managers are often confronted with many difficult problems that are difficult to solve manually, and for which they often have to take the help of management tools to find answers
- Some of the typical questions in water management are:
  - From an irrigation reservoir with varying annual inflows, in how many out of **N** number of years, will I be able to meet the demands in the command area?
  - An irrigation channel loses a significant fraction of the water that it carries in seepage to the shallow aquifers in the area through it passes; what will be the impact of lining the canal, on the overall irrigation performance of the system, if we assume that the farmers in the command area also use wells which gets benefited by the seepage?

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- A utility is planning to introduce volumetric pricing of water supply-- which is expected to reduce the demand and therefore wastewater generation--, with increases in tariff rate in a phased manner say over 10-15 years; what will be the capacity enhancement of the WWT systems required during the same period, assuming that the population and income are also going to increase simultaneously?

- The problems are multi-disciplinary in nature, and are not amenable to simple formulations, because of the complex dynamics of interactions between various systems
- It would therefore require the application of simulation models that integrate hydrological models, econometric models and management models

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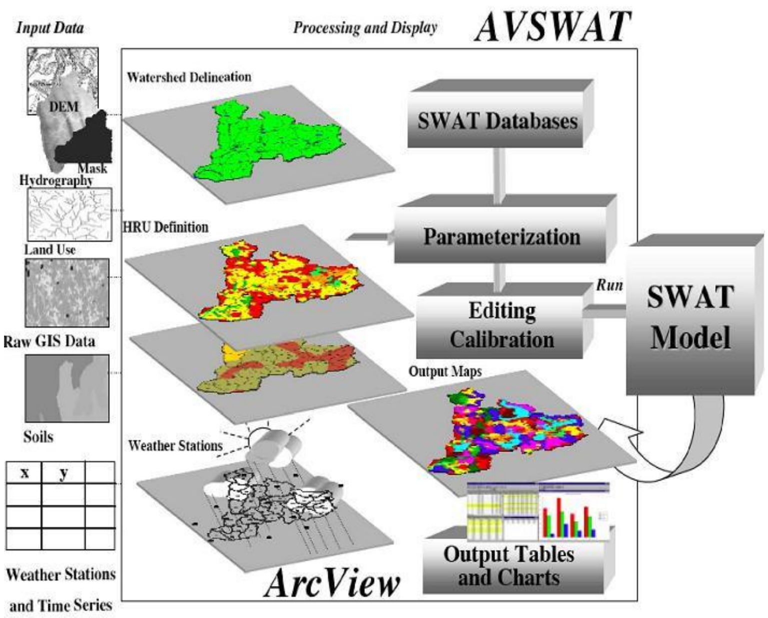
DIFFERENT SIMULATION MODELS & THEIR FUNCTIONS

- **Hydrological Models**: to predict future runoff from watersheds/catchments, used for basins that are either un-gauged or for which data are not accessible
  - Simple statistical models (rainfall-runoff regression; rainfall-WLF model); the coefficient is import. Works very well for regions with very high rainfall (above 1000mm); improves with evenness and lower aridity
  - Catchment simulation models (**SWAT model** using SCS Curve Number); data on land cover; soil type and daily rainfall are non-negotiable; data on (daily) weather parameters for estimating other variables
  - Hydrological Process models: estimating various hydrological process, E, ET, infiltration, recharge) and runoff using first principles (**SWAP model**)



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DIFFERENT SIMULATION MODELS AND THEIR FUNCTIONS

- **Groundwater flow model**: simulates the groundwater flow dynamic (well hydraulics) **and predicts the depth to WL** for different time intervals for known stresses and are governed by Darcy's law.
  - **Mode Flow**; and many tailor made soft-wares based on FEM and FDM
  - Boundary conditions are extremely important for solving the flow problem; good data on geo-hydrological parameters (S & T; water levels); comparatively easy to model homogeneous alluvial aquifers
  - Accuracy of prediction improves, with increase in size of the aquifer; better density of observation wells; and with homogeneity and isotropy
  - Inverse (parametric) modelling can also be done (parametric models)

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DIFFERENT SIMULATION MODELS & THEIR FUNCTIONS

- **Water balance and water allocation models**: used to predict future water scenarios for a basin by comparing the supplies against the demands, for predicted changes in the hydrological and socio-economic conditions
- Water Evaluation and Planning System is the most widely used water resource evaluation and water allocation model, and also shows the changes in the stock of water in the basin, along with comparison of demand; supply requirement and actual supplies
- Can also handle water quality data
- RIBASIM (River **Ba**sin **Sim**ulation) is another water allocation model
- Groundwater component is rather weak; shall not be preferred in basins where groundwater contribution to water supply is very high and too much uncertainty exist about the resource condition

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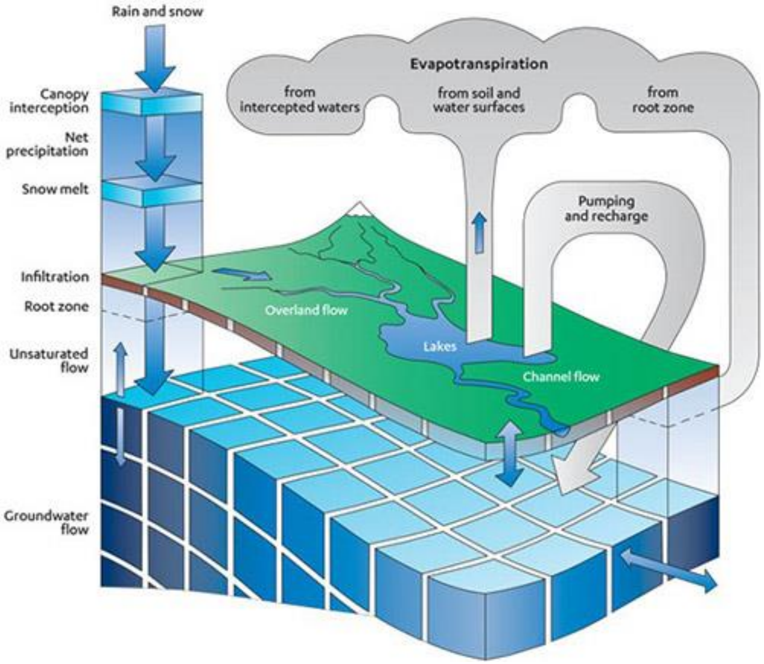
DIFFERENT SIMULATION MODELS AND THEIR FUNCTIONS

- Flood forecasting and flood inundation models, for forecasting the stage of water levels in river channels and predicting the area likely to be inundated
- They are based on computational hydraulics
  - Accurate data on channel profile is very essential
  - Calibration curve for discharge vs water level in the channel has to be accurate and should be updated with time
  - Three dimensional data on terrain conditions is important for inundation prediction
- MIKE and MIKE SHE are flood forecasting models; also integrates complex SW-GW interactions
- There are simple statistical models used by CWC, for stage predictions and are quite reliable



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BASIC AIM OF MODELLING USING WEAP

- Assess the renewable water resources in the basin and the seasonal and annual variations; analyze the extent to which various water demands in the basin are being currently met from the available water resources, including stocks and assess the impact of the water withdrawals on the resource base in terms of change in storage
- Assess the potential future trends in competitive demands in the basin in different sectors due to a variety of socio-economic processes for different time intervals
- Determine the extent to which the available water in the basin would be able to meet the future water, by comparing the potential future water flows with the estimated future demands

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BASIC AIM OF MODELLING USING WEAP

- Ascertain whether the basin will be water surplus or water deficit, say by 2031 and 2046, by comparing the total supply requirements against the utilizable water resources
- Also assess the amount of wastewater that would be generated in the basin
- Assess the magnitude of over-appropriation of river or over-extraction of groundwater in the basin by comparing the current water supplies (withdrawals) to meet the demands against the utilizable water resources
- If basin is 'water surplus', identify the infrastructure requirements in the basin by estimating the gap between the maximum water supply potential (through reservoirs, diversion structures, wells, water distribution systems, etc.) and the 'total future supply requirement

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BASIC AIM OF MODELLING USING WEAP

- Identify the potential water management interventions that can reduce the competitive water demand by creating **scenarios of water balance for the basin with new DSIs** and comparing them against the **base case**.

- This will be done for water scarcity & surplus situations, and water pollution to make sure that more (and clean) water is available for the environment

- The future scenarios of water management can consider:
  - Water use efficiency in agriculture (new crops, efficient irrigation technologies)
  - Wastewater recycling and reuse
  - Water demand management in urban areas, through water pricing, leakage reduction in distribution system

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CONFIGURING THE WEAP MODEL FOR A RIVER BASIN

- **Water Demand Programme**: identification of various water demands; demand sites; their magnitude
  - Time series data on irrigated area under different crops in different seasons; irrigation rates; or ET + non-beneficial consumptive use
  - Population size of different urban areas; decadal growth rates; per capita consumption; volume of wastewater flowing into various sinks and treatment plants
  - Rural population; per capita consumption/demand; livestock population; water demand per animal unit; decadal growth in human & animal population
  - It computes the total water demand at site sector-wise

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CONFIGURING THE WEAP MODEL FOR A RIVER BASIN

  - Different types of industries and their annual outputs; water intensity of production; wastewater return flows from industries
- **Water Supply Programme**: identification of various supply sources which cater to these demands
  - River confluence nodes: stream flows into confluence
  - Reservoirs: storage-elevation curve; historical inflows into reservoirs; pan evaporation data
  - Aquifers: sustainable yield; ultimate abstraction potential
  - Local storage tanks/lakes: storage capacity

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CONFIGURING THE WEAP FOR A RIVER BASIN

- **Network Programme**: simulates various links (drains, canals, pipelines) that take water from the supply sources to the demand sites, and wastewater from the demand sites to the sink
  - Water distribution systems: carrying capacity of canals, river channels; discharge capacity of water supply pipelines; conveyance losses in canals/river beds; leakage in pipelines
  - Demand site return links: percentage return flow from irrigated fields into aquifers; wastewater return flows into rivers/aquifers
  - Wastewater treatment systems: treatment capacity; degree of treatment
  - Treatment plant return link: discharge of treated wastewater into sinks

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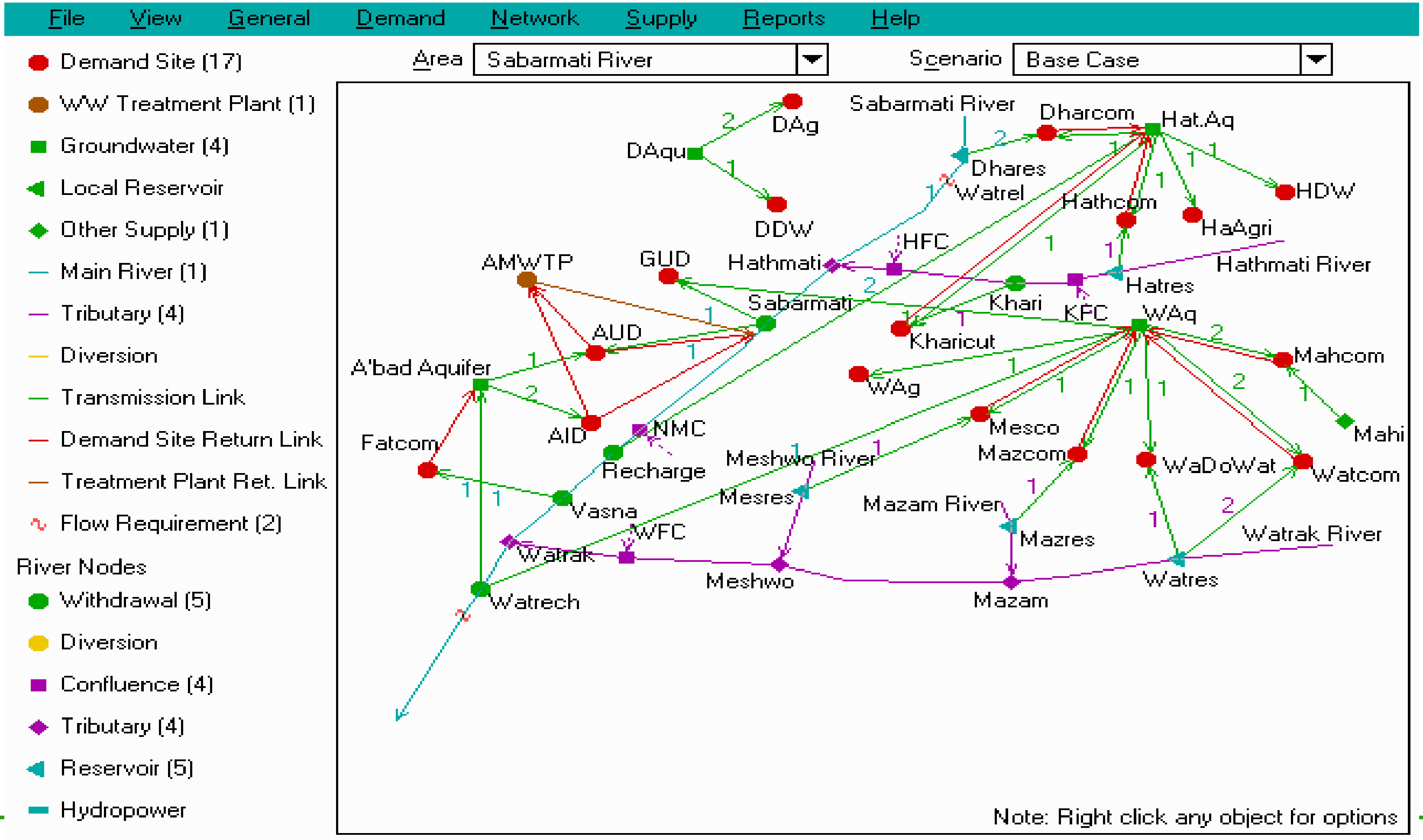
WEAP CONFIGURATION FOR A RIVER BASIN



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