

Comprehensive Assessment Management of Water for Agric and Ecosystems

ICID's initiative on Country Policy Support Programme and emerging outcome as "Contributions to CA"

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Montpellier, June 2005

A historic background which initiated ICID's Country Policies Support Programme (CPSP)

- World Water Vision for food and rural development was prepared by ICID in 2000 and presented at WWF2.
Three sectors addressed were: food , people, nature.
- Anomalies between WFFRD and Overview vision
- **ICID's strategy from vision to action and CPSP.**
- CPSP to synergise international expertise for policy support
- To commence with 'select' countries with a large scale of irrigated agriculture for food security. Chosen country set include: **China, India, Egypt, Mexico, Pakistan. (43 % people and 51% irrigated)**

How CPSP expectations are achieved?

- Through scientific assessment of water needs for three sectors, viz. food, people and nature – for the present and for the year 2025.

(Two sample basins in China and India were chosen in an attempt to project country level scenes in Phase I, so far; interesting results)

- Take the studies further to more basins in Egypt, Mexico and Pakistan and in its first phase have National Consultations, Choose a basin for CPSP

Overall Objectives of ICID's CPSP Studies

- Country Policies can be revisited to show sensitiveness to sharing aspects;
- International Organisations concerned with water sharing might find in ICID-CPSP model, an added tool to enhance the 'Knowledge Base' and help solving conflicting interests of environmental sustainability and food security
- Aim is to evolve a rapid scenario analysis for the "Water Sector Strategy" by integrating land and water uses at basin level – given their dynamic nature

THE POLICY ISSUES

Water for Food

- Shift in the concept of "Water Resources".
- Accounting water use by the sector, and integration.
- Proper accounting of return flows, indicator of hazard (PQW).
- Consumptive use (evapotranspiration) management.
- Watershed Management and water harvesting.
- Integrating surface water and groundwater use in irrigation.
- Integrated management of land and water resources.

Water for People

- Dimensions of priority, water allocation by uses, treatment of waste water at source and reuse for irrigation.

Water for Nature

- Terrestrial (CU) / Aquatic needs (NCU)- Quantification / No dilution of waste water. Zero effluent for industries.

Water Resource Assessment - Scope

- Basin/Regional/Country/Global scale
- Integrated and holistic at Basin Level (reasonably small)
- Assessment and integration of sectoral demands of water including EFRs
- Impact of land and water use and climate changes on resources
- Development and analysis of scenarios to evaluate effects of water policies
- Linkages with socio-economic and environmental aspects

BHIWA Model

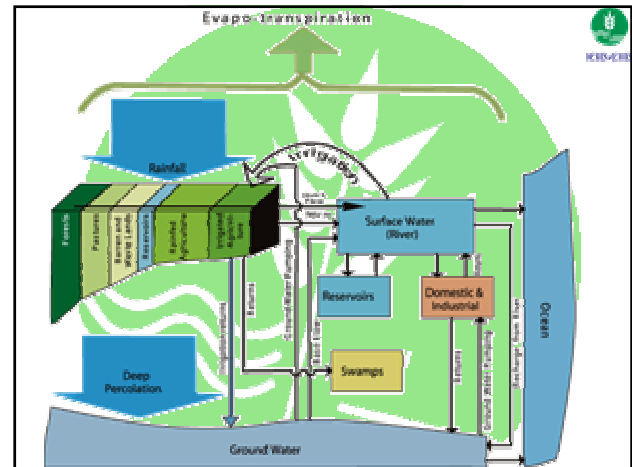
- Simple concept
- Deals with the entire land phase of the hydrologic cycle:
 - Precipitation
 - Evapo-transpiration
 - Outflow to sea
 - Withdrawals
 - Returns

BHIWA Model

- Allows
 - Changes in land use
 - Water infrastructure development
 - Irrigation expansion
 - Changes in domestic and industrial withdrawals and consumption
 - Changes in water use efficiencies

BHIWA Model

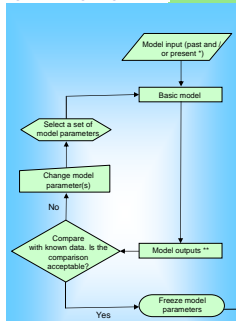
- Allows
 - Surface water balance
 - Groundwater balance
 - Surface water – groundwater interaction
 - Storage and withdrawals
 - Changing environmental flow requirements
 - Gradual changes in rainfall and evapo-transpiration (climatic changes)



ICID's BHIWA Model

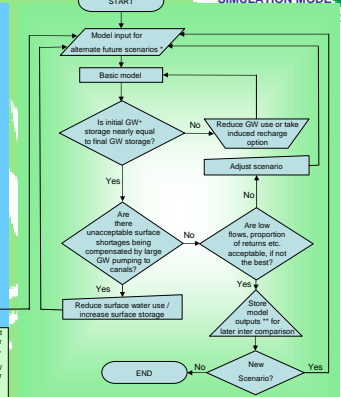
- Acknowledge that basically
- River Basin is a better way to address the Challenges and Decision Making
 - Precipitation as the main source (and not the river flow or aquifer recharge)
 - Capturing both land and water uses of River Basin is important; ET management is the best way to appreciate the issues/tradeoffs
 - Potential development strategy through policy intervention, either for improving river flows for ecology and Scenario Development help the cause

CALIBRATION MODE



* Model inputs include hydrological, demographic, DMI related land use, crop related (both related and impervious), water development and management information, including imports, exports and environmental flows required.
 ** Model outputs include monthly flows, inter and intra annual GW fluctuations, GW recharge, surface and ground water withdrawals, and water balance (overall, surface & GW)
 + Ground Water

SIMULATION MODE



Logical Sequence

Modules in the Model

- The natural module
- The module depicting hydrologic impacts due to anthropogenic influences.
- Modules for withdrawals, consumptive uses and returns for irrigation and D&I sectors.
- Module for accounting evapo-transpiration by "use Sectors".
- Modules for separate and combined balances for river waters, ground waters and total sub-basin / basin.

Capabilities

- Quantification and integration of sectoral needs
- Water Balances for Surface and Ground Water systems and for the overall basin
- Interaction between surface and Ground water system
- Effects of land use changes on supplies
- Impact of sectoral policies
- Maintenance of prescribed Environmental flows (EFR)

Limitations

- Not a distributed hydrologic model
- Not to be construed as a rigorous basin planning tool
- Need for additional modules to evaluate socio-economic impacts ; IWMI together with IFPRI have proposed to bring in global trade aspects on food production but modeling results are awaited
- Simple analysis of possible impact of climate change is feasible but more works are required

Information required for building scenarios

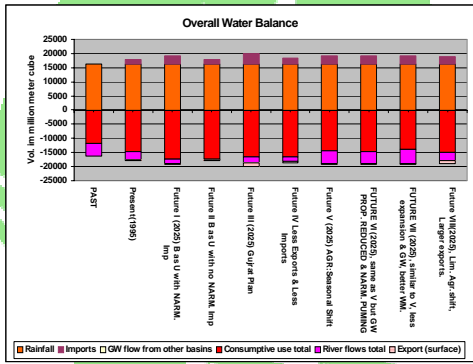
- Engineering possibilities for in basin development, and inter basin imports and exports, efficiency improvements etc.
- Population and demand projections.
- Land development potentials.
- Ecological and environmental considerations regarding land use changes, low flow regimes and water quality.

Information required for building scenarios

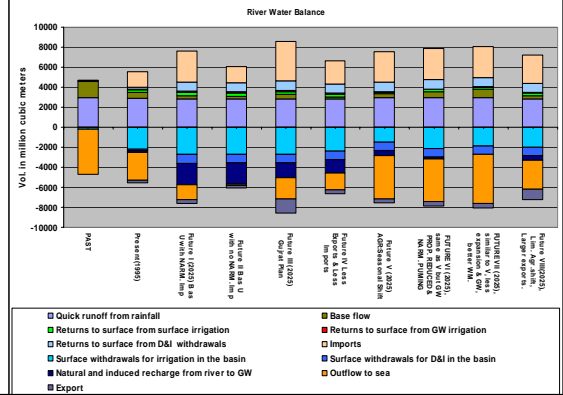
- Agronomic possibilities in diversification, productivity improvements, changes in varieties etc.
- Possibilities and desirability's of industrial development.
- Possibilities and desirability of rain water harvesting, watershed management and insitu water conservation

INDIA Sabarmati River Basin Study

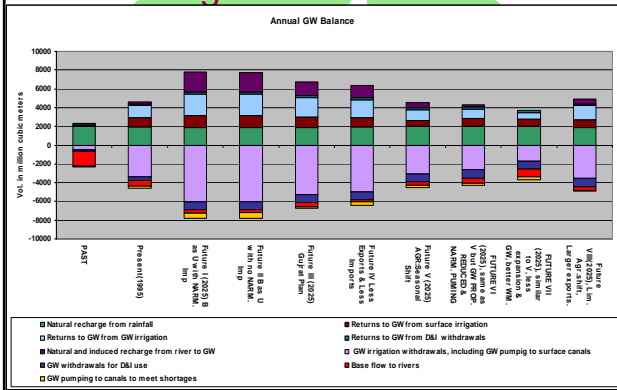
Overall annual water



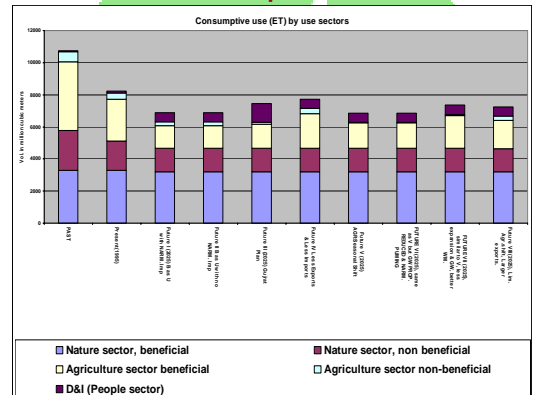
Annual river water balance



Annual groundwater balance



Consumptive use

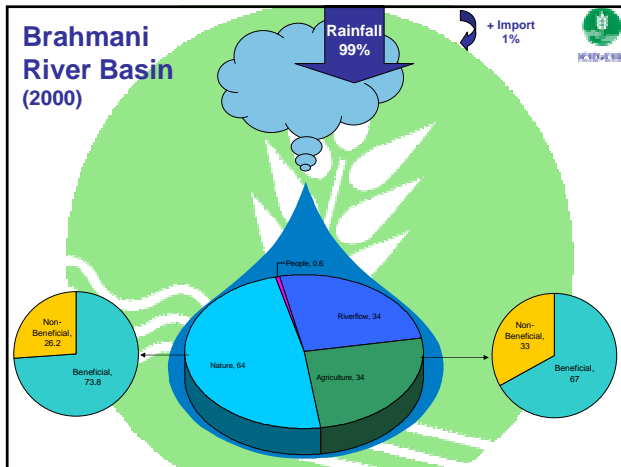
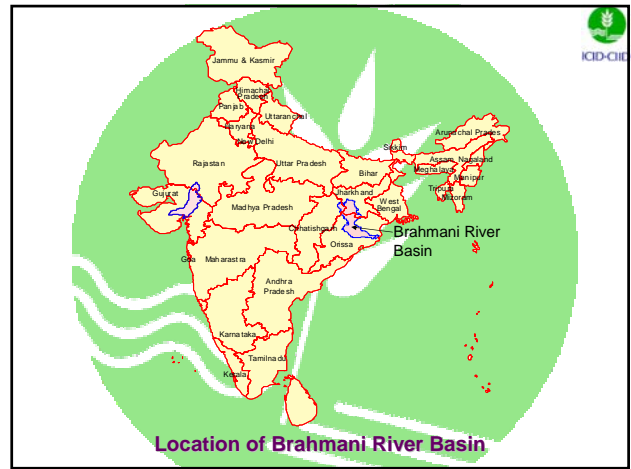
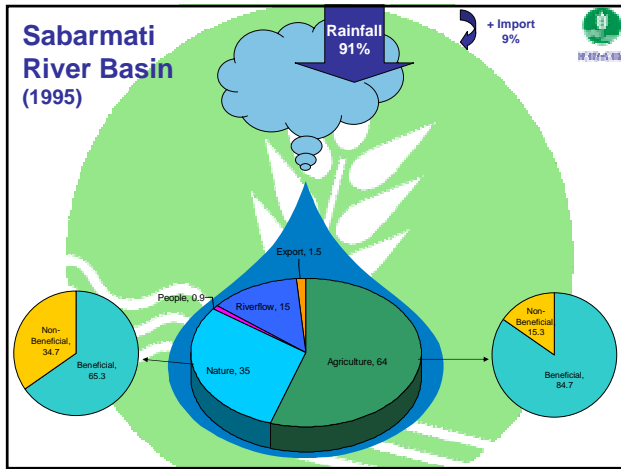


Main Findings

- Non-beneficial ET in the nature and agriculture sectors exceeds quantum of annual river flow
- Reduction of non-beneficial ET through rain harvesting, soil and agriculture management is a potential strategy for improved water management

Main Findings

- Import of Narmada water is necessary to sustain the present withdrawals and meet future needs, including that for improvement of low flows
- Present ground water use is unsustainable
- While the situation would improve slightly in future due to large additional Narmada imports, composition of return flow indicates much higher risk of ground water pollution



Up scaling to National Level?

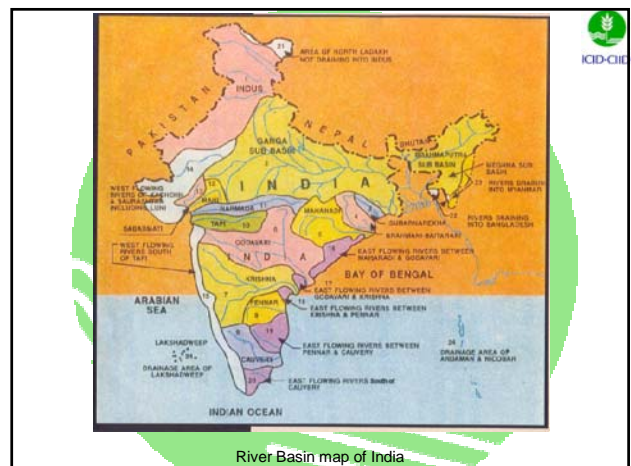
- Some attempts to extrapolate for other basins in the country to obtain a Macro scenario
- Essentially, the effort is restricted to obtain a general, just understanding of the implication on water stress in future, basin wise, with growing and competing demands
- Can this be some use to Policy Planners –
 - Short term strategy
 - Long term strategy
- Options available are factored to the extent feasible

Suggested Indicators

Four indicators proposed for describing state of water resources

Indicator 1: Withdrawals/total input to S.W
 Indicator 2: Returns/total input to surface water
 Indicator 3: Withdrawals/total recharge to G.W
 Indicator 4: Returns/total recharge to G.W

**Indicators 1&3- depict quantitative stress due to withdrawals;
 Indicators 2&4- depict hazard to water quality**



India Case Study -- Indicators

Surface water resources

S. No	Basin	Total input 109m ³	Total returns 109m ³	Total withdrawal 109m ³	Withdrawal/ Input (I1)	Returns/ Input (I2)
1	Indus	185	3	42	0.23	0.02
2	Ganga	525	19	146	0.28	0.04
3	Brahmaputra	633	1	12	0.02	0
4	Subarnarekha	12	---	4	0.33	0
5	Mahanadi	50	1	13	0.26	0.02
6	Godavari	126	3	21	0.17	0.02
7	Krishna	99	3	26	0.26	0.03
8	Pennar	7	1	7	1	0.14
9	Cauvery	28	2	19	0.68	0.07
10	Tapi	18	1	4	0.22	0.06
11	Narmada	51	1	7	0.14	0.02
12	Mahj	13	0	2	0.15	0
13	Sabarmati	7	0.7	2	0.4	0.09
14	Brahmani	17	0.6	2	0.14	0.04

India Case Study – Indicators...

For Ground water resources

S. No	Basin	Total input 109m ³	Total return 109m ³	Total withdrawal 109m ³	Withdrawal input to (ratio)	Return to input (ratio)
1	Indus	48	33	29	0.6	0.69
2	Ganga	251	115	118	0.47	0.46
3	Brahmaputra	33	7	2	0.06	0.21
4	Subarnarekha	4	3	2	0.5	0.75
5	Mahanadi	23	9	6	0.26	0.39
6	Godavari	49	15	12	0.24	0.31
7	Krishna	37	17	10	0.27	0.46
8	Pennar	9	5	2	0.22	0.56
9	Cauvery	22	13	8	0.36	0.59
10	Tapi	9	3	3	0.33	0.33
11	Narmada	15	4	4	0.27	0.27
12	Mahi	9	2	2	0.22	0.22
13	Sabarmati	5	2	4	0.87	0.54
14	Brahmani	6	1.5	1	0.11	0.3

Basin grouping by selected indicators

Class description	Value of indicator	Basin
a) Surface withdrawals	very high stress	Indicator 1>0.8 Pennar
b) Surface withdrawals	high stress	0.4 < Indicator 1<0.8 Cauvery
c) Surface withdrawals	Moderate stress	0.2 < Indicator 1<0.4 Indus, Ganga, Subarnarekha, Mahanadi, Tapi, Sabarmati
d) Surface water quality	low stress	Indicator 1<0.2 Brahmaputra, Godavari, Brahmani
e) Surface water quality	low stress	Indicator 2 < 0.05 All basins, in good
f) Surface water quality	moderate stress	0.05 < Indicator 2 < 0.1 Cauvery, Tapi, Sabarmati, Pennar
g) Groundwater withdrawals	very highly stressed through withdrawals	Indicator 3>0.7 Sabarmati
h) Groundwater withdrawals	highly stressed through withdrawals	0.4-Indicator3<0.7 Indus, Ganga, Subarnarekha
i) Groundwater quality	moderately stressed	0.2-Indicator3<0.4 Mahanadi, Godavari, Krishna, Pennar, Cauvery, Tapi, Narmada, Mahi
j) Groundwater quality	under very high threat	Indicator 4>0.8 None
k) Groundwater quality	under high threat	0.4-Indicator 4<0.8 Indus, Ganga, Subarnarekha, Krishna, Pennar, Cauvery, Sabarmati
k) Groundwater quality	under moderate threat	0.2-Indicator 4<0.4 Brahmaputra, Mahanadi, Godavari, Tapi, Narmada, Mahi, Brahmani

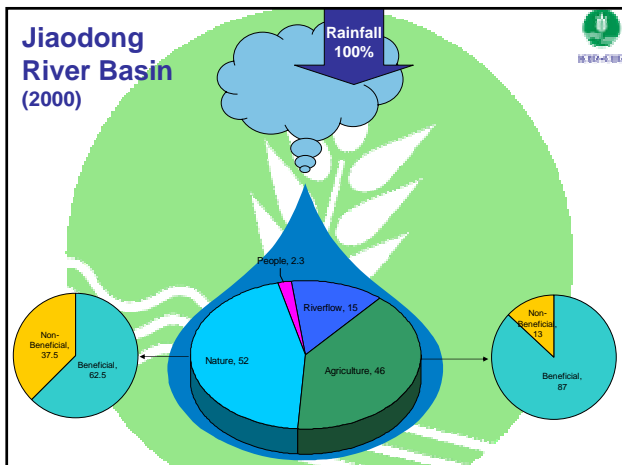
Findings of Extrapolation

- Inferences drawn from Sabarmati assessments are of much relevance to Pennar, Cauvery, Indus, Ganga, Subarnarekha, Mahanadi and Tapi in regard to surface water
- Ground water problems of Indus, Ganga, Subarnarekha, Krishna, Pennar and Cauvery have similarity with Sabarmati
- Problems of Brahmani resulting out of the high flows and low use of ground water have similar implications for Brahmaputra and Godavari

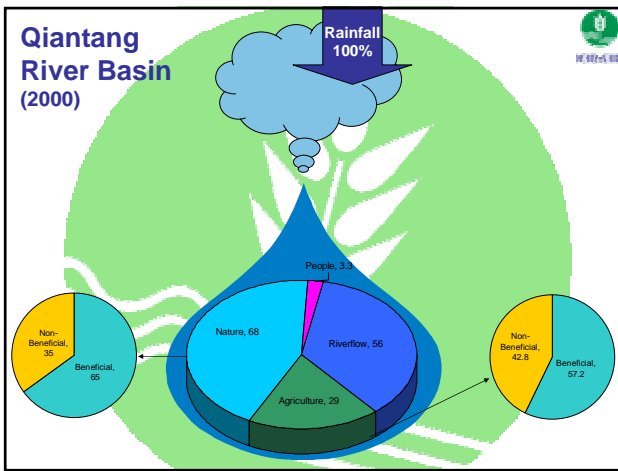
River Basin Map of China



Jiaodong River Basin (2000)



Qiantang River Basin (2000)



Assessment for Qiantang basin - findings

- Nature sector consumes major part of the primary resource (rain water).
- Consumptive use under nature sector is expected to increase significantly in future due to the expansion of forest area. This in turn would tend to reduce reduce river flow. Part of this decrease can however be restored through better soil and water management.
- Due to abundant surface water resources almost entire irrigated agriculture including fisheries is presently dependent on surface water resources.
- Groundwater use is presently restricted to D & I sector. There exists a huge potential for groundwater development in this basin.
- Surface withdrawals constitute a small fraction of available supplies and seems to be constrained by availability of cultivable land.

Extrapolation of Qiantang assessment to other similar basins

Basin Classification/grouping by water situation indicators

Class description	Indicator value	Basin
Low stress through surface withdrawal	Indicator 1 < 0.2	Yangtze, Zhujiang, Southeast, Southwest, Qiantang
Surface water quality, low stress	Indicator 2 < 0.05	Yangtze, Zhujiang, Southwest, Southeast, Inland, Qiantang
Groundwater low stressed through withdrawal	Indicator 3 < 0.2	Yangtze, Zhujiang, Southeast, Southwest, Inland, Qiantang
Groundwater quality under low threat	Indicator 4 < 0.2	Yangtze, Zhujiang, Southeast, Southwest, Inland