International Commission on Irrigation and Drainage, ICID

COUNTRY POLICIES SUPPORT PROGRAMME (CPSP)

Special Session, Montpellier, France

A REPORT ON WORK DONE FOR CPSP

in Central Office

and for ‘India Component’ of CPSP

Presentation by

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Date : 17th September 2003

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CPSP - ***ICID believes in success of an 'integration process' for needs and supplies for three sectors to achieve sustainable development. Consumptive use (CU) has to be considered as the basis for assessment.*** **Dialogue is Bimodal: Food/Environment. Present status - KB, local, basin, national in progress.**

Equity, efficiency, economy and efficacy are the touchstones.

ICID believes in the need to develop all available water resources for this purpose, within basins and including inter-basin water transfers (IBWT), while living with minimised adverse impacts after their mitigation to the extent possible.

Food sector: quantify CU for rain-fed agriculture, more efficient SW use affects GW availability, food sufficiency, treatment of collected drainage water. Non point sources difficult to treat.

People sector: All NCU must be treated for reuse by user. If not, treat it at his cost.

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Nature Sector

Water use comprises both CU and NCU. CU starts with ET even as rain reaches earth, and it is substantial. Our model tries to quantify it for the first time.

NCU is basin-wide reservation (EFR) sought for aquatic eco-system. It is more for habitat and less for consumption. No quantification. It is lost for CU for both eco and human systems.

Need to change modeling approach. Fundamentalists propose water for food+people= MAR-EFR. I proposed at Kyoto adoption of EFR= MAR-(food+people needs).

Eco-system use must produce goods and services for human systems. CU for it can then be compared with that for food+people CU.

Estimating water requirement of ‘Nature’ sector

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Terresstial ecosystem

Cover almost 95% of nature sector use. Assess it.

Why 15% or 30% forests?

Preventing further reduction appears to be a pragmatic goal.

Maintaining acceptable GW fluctuation regime appears important.

Riverine ecosystem

First satisfy human system needs. Treat all waste-waters.

Estimating EFR: Requires methodological development .

Approach used: Low flows in future, for wet basins, may not reduce significantly.

For water deficient basins, improve low flows.

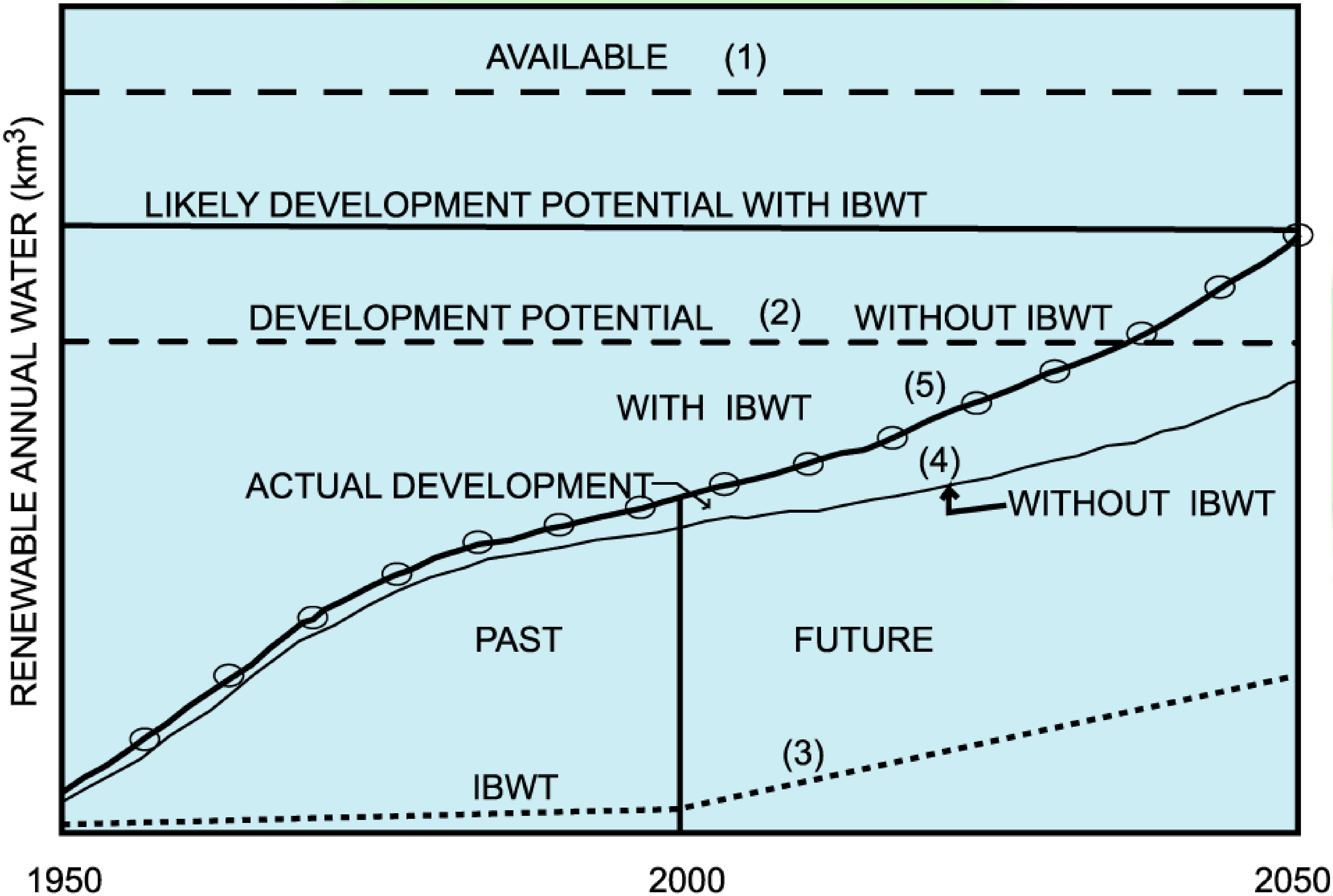
EFR - Definition and Scope

- **EFR : refers to water reservation desired for maintaining an aquatic system and the ecosystem dependent on it in good health to protect hydrologic integrity of the natural environment and conserve its bio-diversity.**

- **Scope of EFR : expanded to cover socio-economic and cultural values and the computations based on assessment-EFA.**

- **Presently, EFR does not include use of water by terrestrial or land based natural eco-systems.Traditionally, EFR referred to minimum or mandatory flows for downstream uses including drinking water, ecological needs, and trans-boundary flow requirements.**

A TYPICAL SCHEMATIC FOR IWRDM (IBWT)



ICID's Country Policies Support Programme (CPSP)

- World Water Vision for food and rural development at WWF2. Three sectors - food , people, nature. Consumptive?

- Anomalies between WFFRD and Overview vision

- PODIUM / IMPACT, WATERSIM - both supply/demand

- ICID's strategy from vision to action and CPSP.

- ICID NETWORK SPREAD OVER 100 COUNTRIES. Works through National Committees hosted by Governments and stakeholders including farmers organisations, NGOs, S&T bodies of many countries. ICID works also with World Bank.

- Many countries in the process of revising their water policies. World Bank revising their strategy. ICID serves as catalyser.

- CPSP synergises international expertise for policy support in selected countries viz. China, India, Egypt, Mexico, Pakistan.

Policy Dialogue Model (PODIUM), IWMI

Global Base Projections

Year	1995	2025	Percent Change
Net Irrigated Cereal Area (Mha)	260	340	31 in 2025 (55 in 2050)
Irrigation Diversions (BCM)	2374	2775	17 in 2025 (30 in 2050)

FOOD REQUIREMENT: ALMOST DOUBLE THE PRESENT

Concentrate on those amongst top 20 countries, where productivity is low.

ICID HAS SET UP FIVE TASK FORCES : (1) TO PREPARE FOR THIRD WWF, (2) ICID POSITION ON FOOD PRODUCTION, SECURITY, TRADE & (3) SUSTAINABLE DEVELOPMENT OF IRRIGATION, DRAINAGE and FLOOD CONTROL(4)BENCHMARKING (5) DAMS

ICID's CPSP

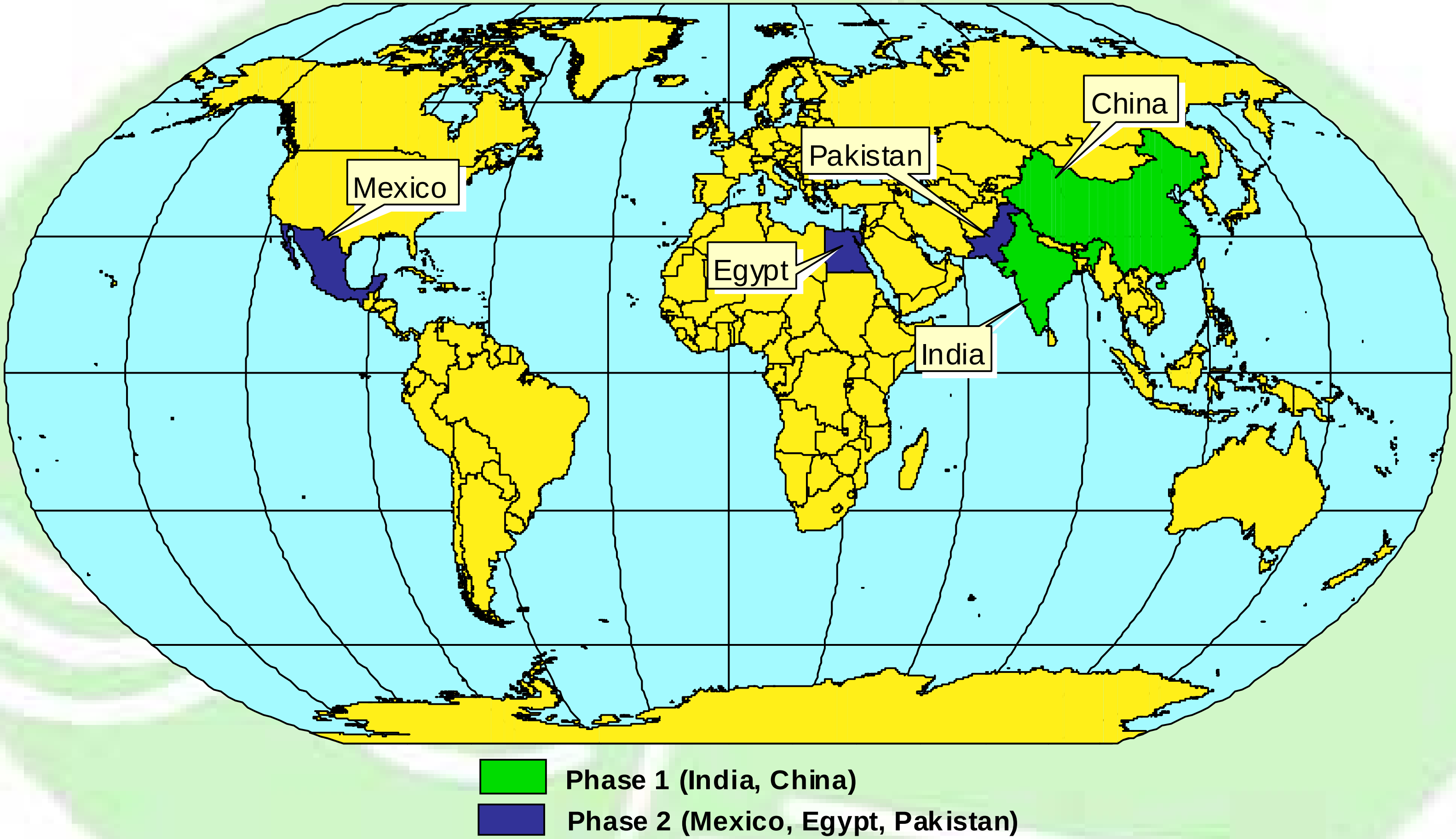
- CPSP contributors - IWMI, FAO, IFPRI, World Bank.
- Why basin studies? Why one relatively Water-short and one Water-rich?- to represent basins for country projection.
- Drawing lessons and their projection to national level. To vet,
- National Reports, Revised Water Policies.
- To open Dialogue with Governments, World Bank, other funding agencies on water policies.
- ICID's Task Forces - Food Production, Sufficiency, Security & Trade, Sustainability of Services (Pricing), Benchmarking, Dams. Work nearing completion.
- Phase I funding by Dutch Government Euro 1.02 M for 2 years. Phase II proposal being formulated.

Salient Steps in the CPSP - *on a fast track*

- High level meeting with Secretary, MoWR - Sept 02; Orientation Workshop: IWMI with CNCID-INCID teams - 3 Oct 02; PW - 4,5 Oct 02; Launch of 2 basin studies of India - 5 Oct 02; High level meeting in China and launch of basin studies - Nov 02.

- Basin level consultations in India - Jan 03; in China - Feb 03; WWF 3 - Mar 03; Reorientation workshop with IWMI / IFPRI - August 03 (postponed); Preparatory consultation on hydrologic modeling - 29-30 August 03; 2nd phase of assessments - upto June 04.

- Report at the 54th IEC events in M'Pellier, France-Sept 03; National dialogues - China and India Nov 03; High level meetings with - Govts of China, India and World Bank - Dec 03; National dialogues with Egypt, Mexico, Pakistan - 2004.



CPSP Participating Countries

PRESENTATION COVERS WORK BY CENTRALOFFICE

and includes work done by INCID. CNCID presentation follows.

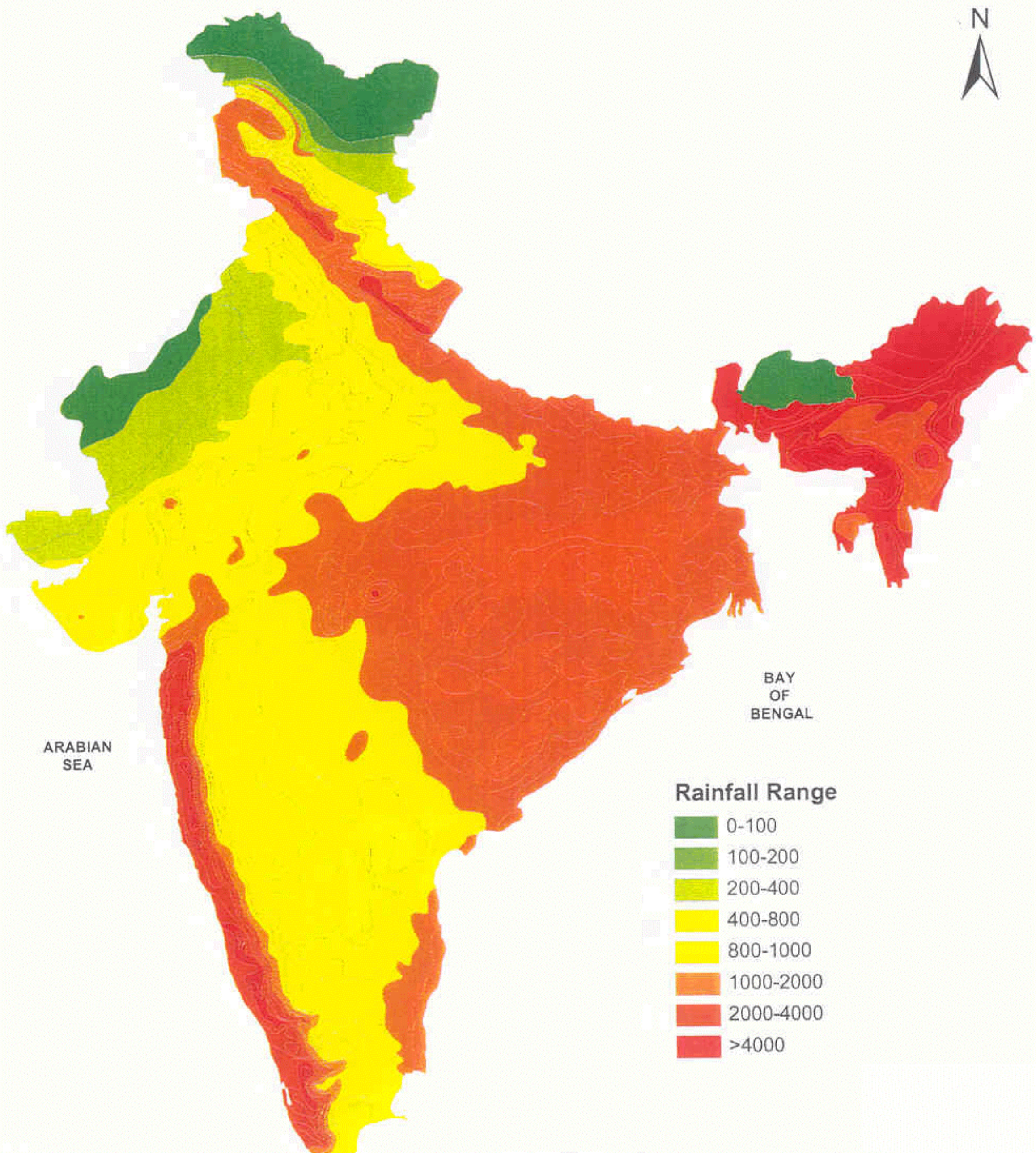
Country income: Low < 2 $/day, LM= 2-8, UM= 8-24, H>24 $/day

India, Pakistan=L; China, Egypt, Mexico= LM.

Continentwise info. about Irrigation & Unused Waters

Continent.	Pop(M).	Irr Mha	% arable.	No System%.	Unused potent.%
America	757	040	11	72	0-10
Europe	703	027	09	74	0-10
Africa	598	011	07	90	90
Asia	3508	178	34	57	30-50

RAINFALL MAP OF INDIA



Source: Survey of India maps and Meteorological Departments
Published by: National Atals and Thematic Mapping Organisation

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SKEWED DISTRIBUTION - WATER AVAILABILITY

SKEWED DISTRIBUTION OF WATER RESOURCE IN THE COUNTRY

Basin	Area, Mha	Water Resource, Km^3	Utilisable Surface Water Resource, Km^3
Ganga-Brahmaputra-Meghna	110.13 (33.5 %)	1202 (62 %)	274 (40%)
West Flowing Rivers south of Tapi	11.31 (3.5%)	201 (10%)	36 (5%)
Other Basins	207.29 (63%)	550 (28%)	380 (55%)
TOTAL	**328.73**	**1953**	**690**

Note : Figure in the bracket is percentage of the total under the column.

Source : NCIWRD Report

Inter-basin transfer of water : a key need

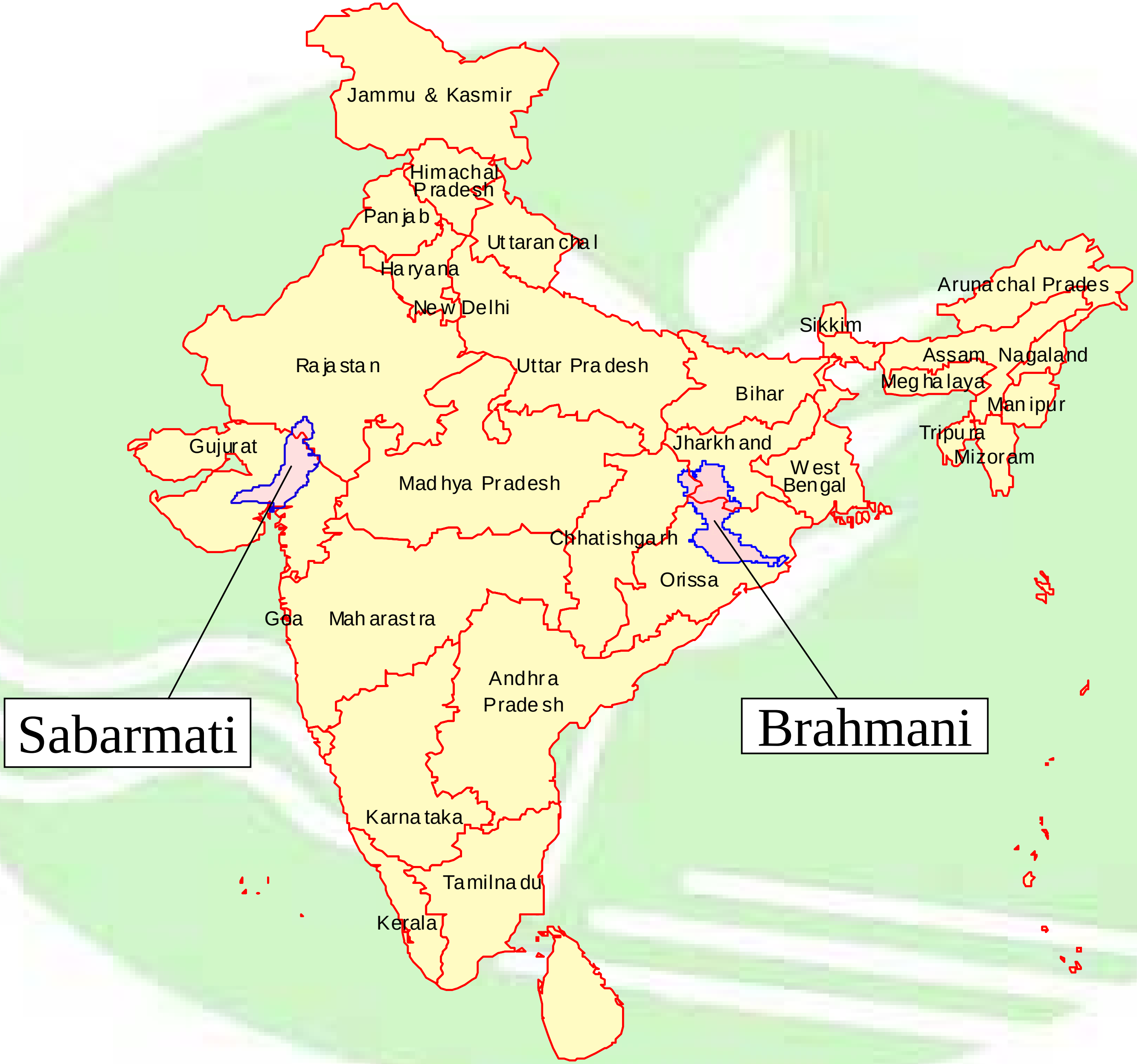


Figure 3. Location of Brahmani and Sabarmati River Basins

INDIAN BASIN STUDIES

The assessments for the two basins are almost complete, but illustrative and *not for basin planning*. Study Teams - IAH, CWC, State teams, NEERI.

Brahmani- Sabarmati basins comparison

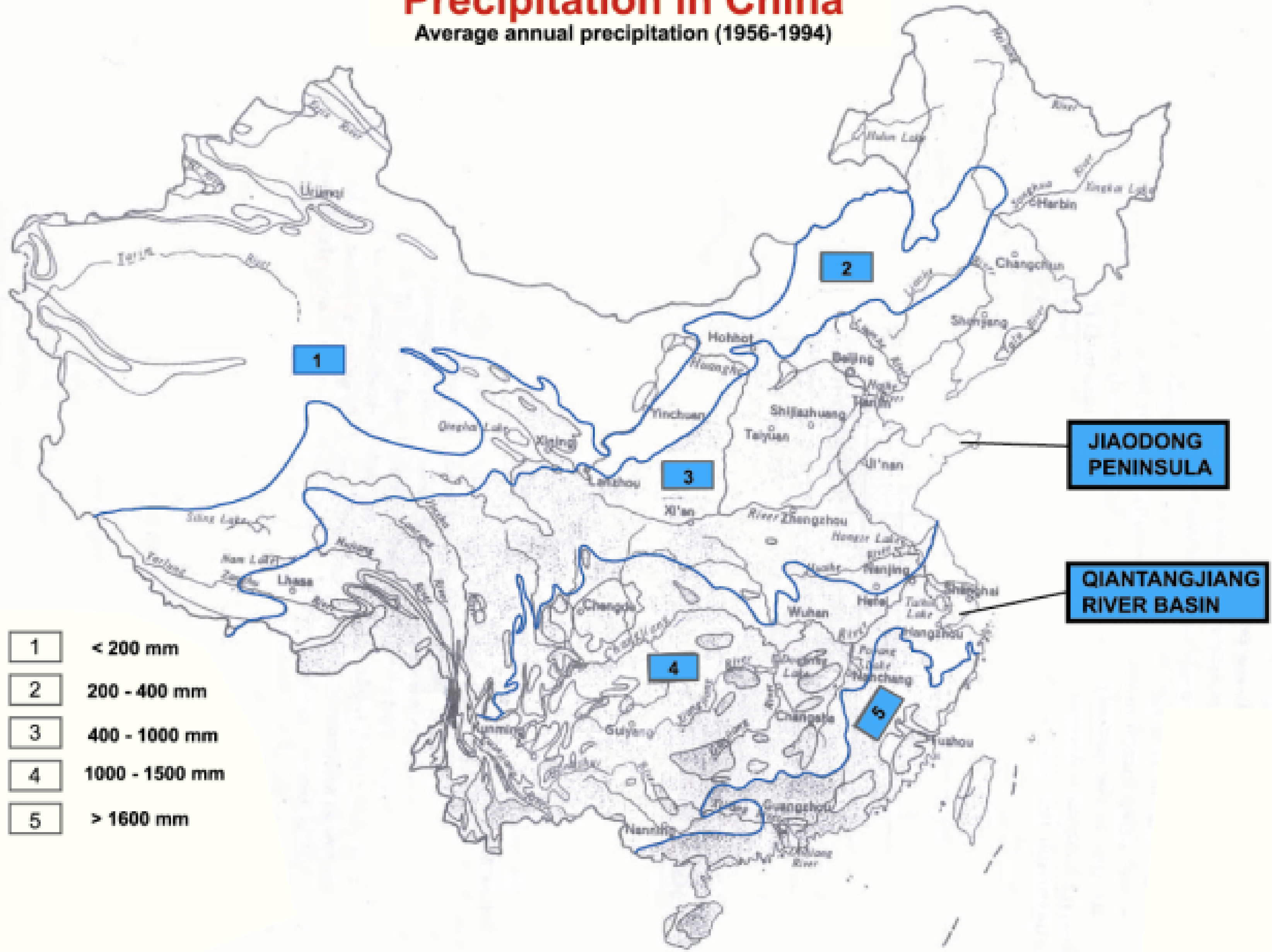
Catchment:- 2:1, Rainfall:- 2:1, Population:- 1:1.4, Freshwater av.:- 6:1, Arable area:- 2:1, Sown area:- 1.1:1, Net irrig:- 1:2, Rainfed:- 2.4:1, Forest:- 8:1, Present water use:- 1.5:1, Outflow to sea:- 9:1.

Based on the basin studies, projections for the country as a whole have been attempted. Possible policy interventions also considered.

The effort is based on a new modeling approach, viz. landuse based consumptive quantities of water for three sectors.

Precipitation in China

Average annual precipitation (1956-1994)



SKEWNESS IN WATER AVAILABILITY IN CHINA

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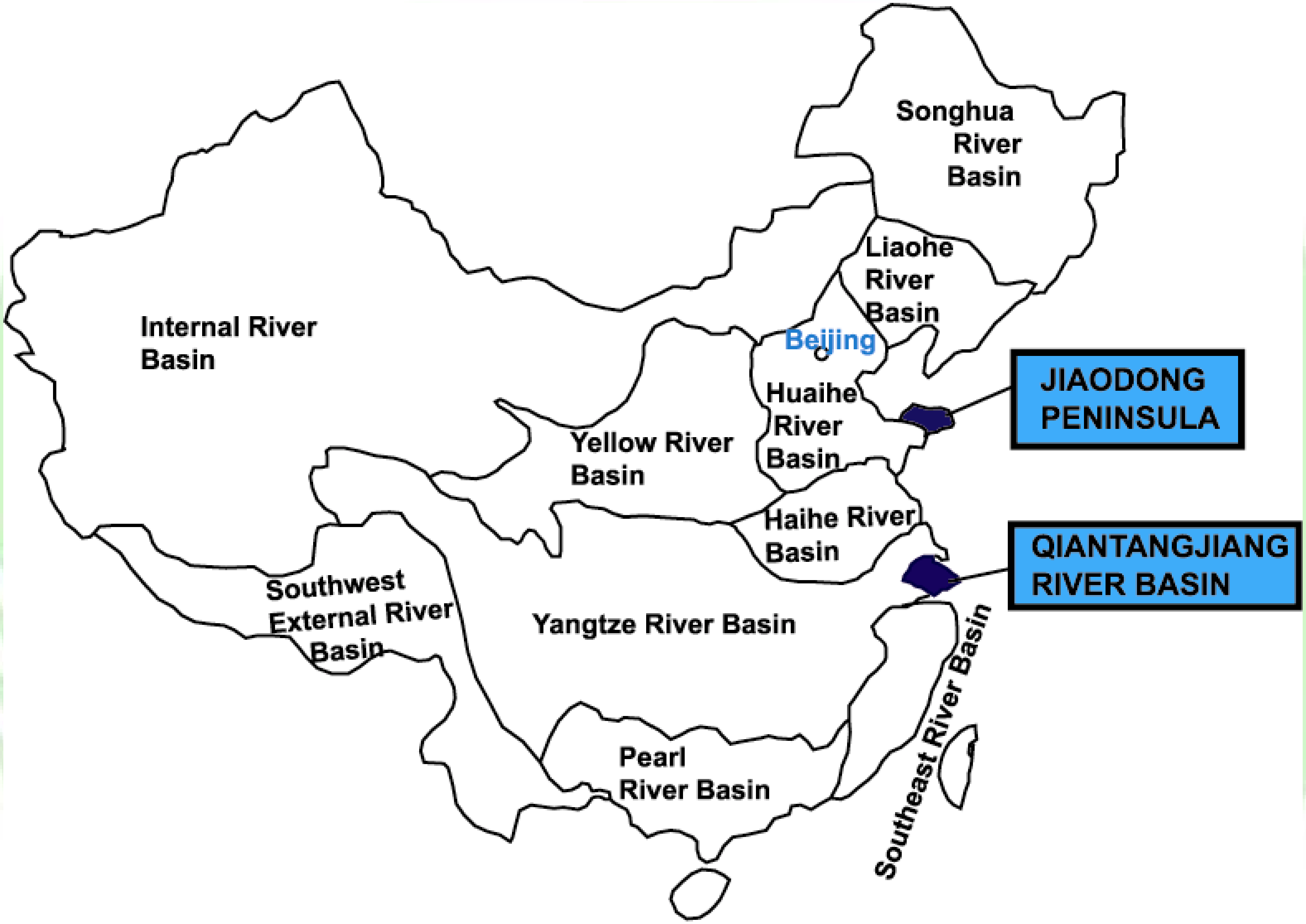
Humid South upto Yangtse, population = 770 M, crop land 1/3 of the country, water 80% of the country. Per capita avilability =12 times that in the north.

North of Yangtse region is arid to semiarid, population = 550 M, crop land 2/3, water only 20%.

To overcome the skewed distribution, China has prepared inter-basin water transfer plans with three alternatives from South to North. Work on some components is ongoing.



River Basin Map of China

COUNTRY POLICY SUPPORT PROGRAMME (CPSP)

CPSP : Phase I

Schedule of Activities (September 2003 to June 2004)

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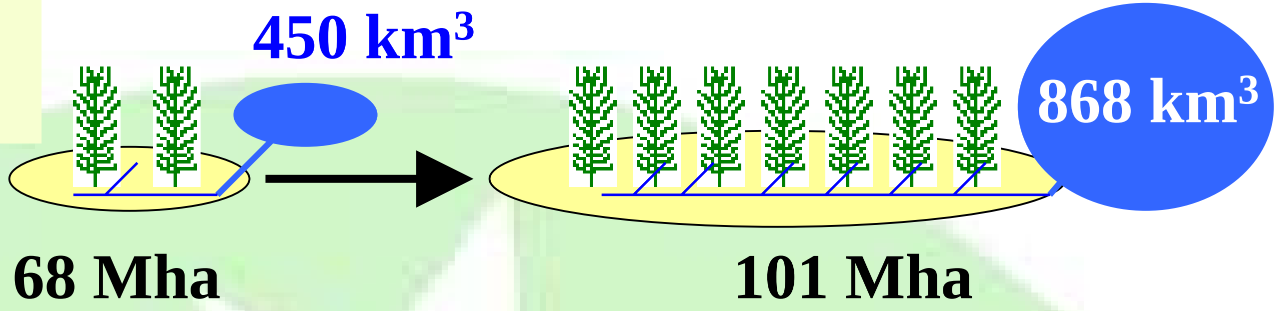
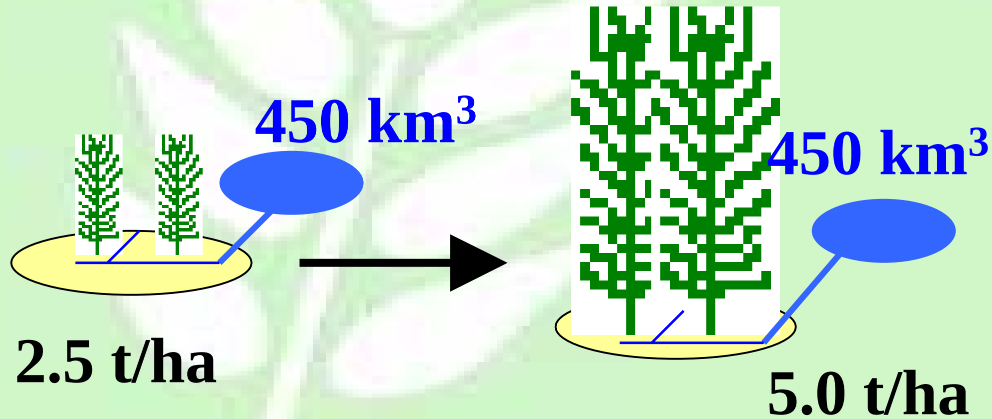
S. No	Activity	9/3	10/3	11/3	12/3	1/4	2/4	3/4	4/4	5/4	6/4
1.	Improvement in the CPSP hydrologic model										
2.	Refinements in basin studies										
3.	Integration of CPSP hydrologic model with PODIUM and IMPACT										
4.	Broad based National Consultations										
5.	Preparation of National Consultation draft reports										
6.	Meetings with the World Bank and other financing institutions										
7	*Additional basin studies in India and China (two basins each)-- now proposed*										
8.	*Studies in one basin each of Egypt, Mexico and Pakistan-- now proposed*										
9.	Meetings with Governments and stakeholders to consider CPSP recommendations										
10.	Finalization of reports and dissemination										

Options for IRRIGATION

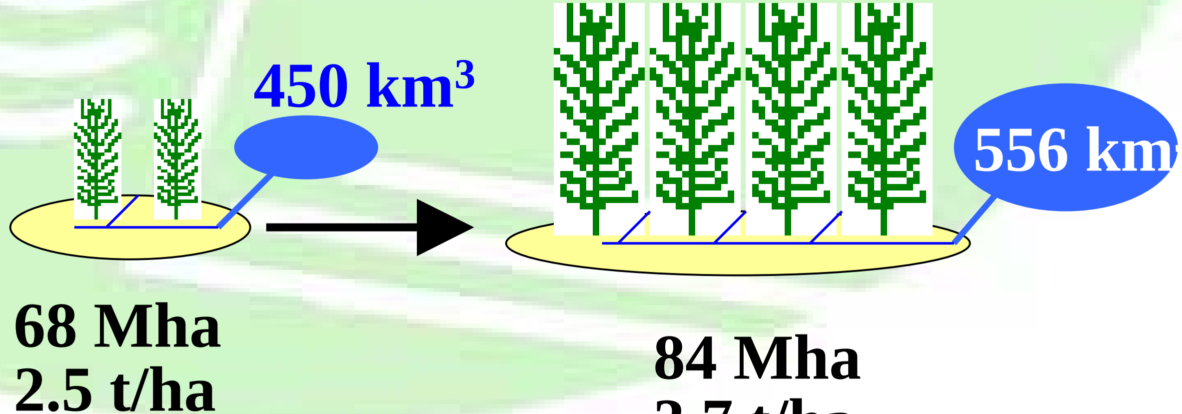
1. Area Increase:



2. Yield Increase:

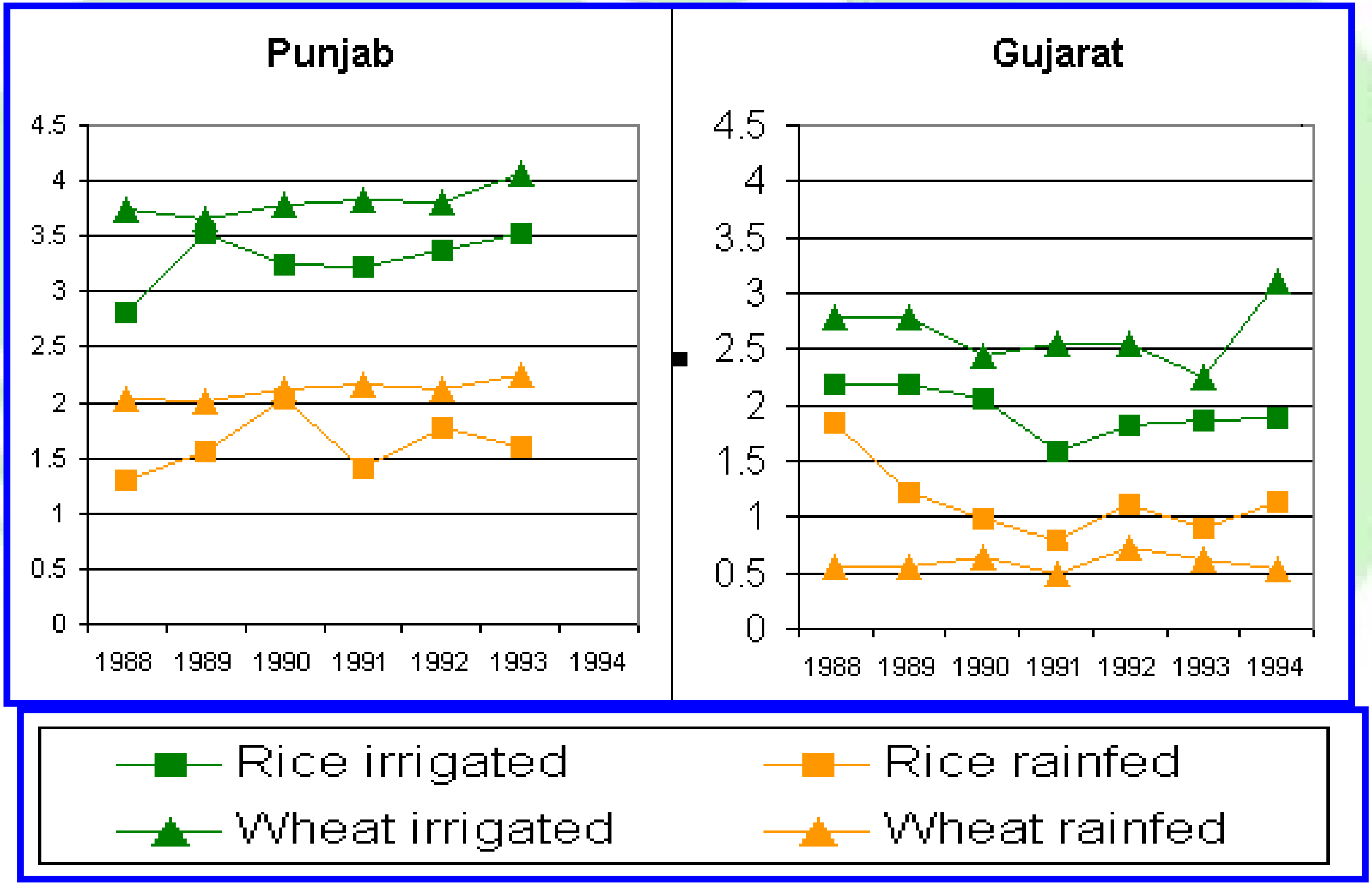


3. Middle:



Irrigated and rainfed grain yield in ton/ha

Source: Water & Related Statistics-1998



PODIUM CAN EXPLORE THE OPTIONS BY CHANGING

- Irrigated area
- Gross cropped area
- Yield of Irrigated area
- Yield of Rainfed area
- Intensity of Cropping

SCENARIOS CREATION

- All major variables can be changed
- Basin or Sub-basin an ideal unit for analysis
- Maximum sixty River basins
- Five scenarios for each basin at a time

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.

SOME SUGGESTED INDICATORS

OR FRESHWATER SUSTAINABILITY

1. Proportion of development against sustainable need based development potential. National water balance. Self-reliance.
2. Water use efficiency in a river basin level.
3. Level of integration between different facets and sectors.
4. Waste water treatment for downstream use.
5. Goods and services provided by eco-systems for human systems.
6. Equity, economy, efficacy level of freshwater deployment & use.
7. Level of sustenance attained for infrastructure, products, natural resources, biomass, human society.

Need for a Better Hydrologic Tool

- Expansion of irrigation to rain-fed lands and conversion of barren lands to forest lands increases evapo-transpiration and reduces water availability.

- Rainwater harvesting and soil & water conservation practices both in irrigated and rainfed conditions influence the total as well as inter-distribution of surface and groundwaters availability.

- These impacts of soil and water conservation can be studied when water balance for the entire land phase of the hydrologic cycle is made.

The Hydrologic Model

The choice of the hydrologic model was made to serve the following attributes:

- Simplicity.
- Capability to deal with the entire land phase of the hydrologic cycle, from precipitation to evapo-transpiration and outflow to sea including withdrawals & returns.
- Flexibility, to allow depiction of changes in land use, and human interventions.
- Capability to depict surface and groundwater balances, interaction between them, impacts of storage and depletion through withdrawals.

LAND PHASE AND EVAPOTRANSPIRATION

The need for depicting the entire land phase, stems from basic hydrologic premise (our view) that precipitation (and not river flow/ aquifer recharge) constitutes the primary resource, and evapo-transpiration represents the real consumptive use by different sectors. Also, it is a potential development strategy to encourage policy intervention.

Approach-
Background review contd.

- **Integrated framework needed**

- **Modelling approach evolved for CPSP is a step for integrated and hydrologically more appropriate assessment**

- **Hence the need for extrapolation**

WATER SCARCITY INDICATORS

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1. Standard Indicator: Water flowing out from a country, AWR, if greater than 1700 cub m per person = local and rare shortage; if less than 1000, it hampers health, well being and economic development; if less than 500, it is a primary constraint to life. Advocated by Falkenmark (1989), and used by Shiklamanov, Kulshreshtha, Gleick.

1997- Stress in 28 (300 M). 2025- in 50 countries (3000M affected)

2. UNCSD 1997- Raskin et al: annual withdrawals / AWR, if greater than 40%, the country is considered water scarce.

3. IWMI (1998-2000): assesses water that can be saved in irrigation by improving efficiency= A. If future needs are B, B-A= C, water resources that need to be developed. IWMI indicator = C / AWR. Relates to needed development.

IWMI'S WATER SCARCITY INDICATORS, 1998.

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The IWMI indicator is close to the ground as it projects the potential to effect economy in present use, considers available potential and then groups countries (93% coverage) into 5 groups. Barring group I (8% pop), the world has enough in 2025.

First time, it recognised deficiencies of past indicators, voiced by developing world as : significant reuse of agriculture waters and double accounting, interdependence of surface and ground waters, need and possibility for more storages.

Constraints : short rainfall period, high intensity, shortage of GW storage, problems with surface storages, need for inter-basin transfer, population-poverty-malnutrition-health pressures, lack of finance.

IWMI's GROUPS OF COUNTRIES, 1998

I. West Asia / North Africa: 8%, major problem for food, drinking, health. Will need diversion from agriculture: world's problem area. Will need imports,(virtual waters)

II. Sub-Sahara, N of S Am: 7%, need develop twice the present use.

III. Spread out in developing world: 16%, need develop 25 to 100%.

IV. Americas, W.Europe: 16%, need develop upto 25%.

V. Rest 12% don't need development. Can divert.

India (17%), China (24%): have potential and need development including inter-basin transfers.

IWMI INDICATORS- continued

IWMI revised in 2001-02 its projections into 3 groups of 45 countries covering 83% of world population. : I - 33% people may have physical scarcity even with maximum of efficiency and productivity. Will need imports, desalination, transfer from agriculture, aid. II - 45% people will face economic scarcity. Will need funds for development of storages more than 25%of present. III - 22% of people will increase productivity and won't need more water. Some will need less. Present diversions 2120, in 2025 will need 2720 cub km. In addition, to make up for sedimentation loss 60 cub km needed. For replacing GW overdraft, will need 200 cub km. Thus in all, will need 3000 cub km = 40% increase= 5.5 HADs every year.

AWR= RWR. Utilisation factor due to variability= Potential. A maximum of 75% is considered as primary water supply possible.

Water Stress (Withdrawals) Indicators

Alcamo (2002) –

WSI= Withdrawal/MAR

where MAR is the mean annual runoff for the pseudo natural conditions.

Smakhtin (2002)-

WSI=Withdrawal/(MAR-EWR)

where EWR represents the environmental water requirements for the aquatic system.

Thatte (2003), Kyoto proposal.

EWR= MAR- (Food + People) needs.

Water Stress Indicators- Considerations

- Large ground water use in some countries. Gives rise to the need for indicators for both S&G water.
- WSI proposed by Alcamo based on withdrawals out of which a substantial part may return. Indicator to be based either on Net consumptive use or natural runoff corrected to reflect returns.
- Smakhtin presupposes overriding priority for environmental water requirement which may not be appropriate specially for the many water deficit basins.
- Thatte's alternative practicable.

Other Methodologies at Basin or larger scale in a Global Perspective

WaterGAP model (Water-Global Assessment and Prognosis) of Centre for Environmental Systems Research (Kassel University), with National Institute of Public Health and Environment (Dutch).

Model computes water use & availability for 4000 river basins of the entire terrestrial surface of the world, Alcamo 1999.

No explicit consideration to EFR. Instead, "Critically ratio" (CR) high values indicate greater pressure depicting scarcity for in-stream flow. Conversely, it reflects shortage for development and the need for imports.

Other Methodologies (contd.)

- **Modeling approach used for Global Water Demand and Supply Projections by Ximing Cai and Mark W Rosegrant (June 2002) :**
- **Model accommodates shortages due to ‘source’, ‘development’, ‘environment’ and can be used to track their importance through the constraints equation.**
- **Base value of IFR is taken as 10 % of MAR. It is increased by 20-30 % where navigation is significant, by 10-15% for environment and by 5-10% for semi-arid and arid regions for salt leaching.**
- **Concepts of Total Water Availability (TWA), Maximum Allowable Water Withdrawal (MAWW,) Realisable Water Withdrawal (RWW) and Effective Water Supply for Irrigation (EWIR) are introduced.**

Other Methodologies (contd.)

"Putting the water requirements of freshwater ecosystems into the global picture of water resources assessment" by Vladimir Smakhtin, et al., 2002 for a pilot global assessment of EWR.

Derived from Hughes and Munster (2000) for preliminary EFR estimation in SA which recommended EF for each month and for several components of high and low flow regime. Long term variability and stability of river flow (proportion of base flow) considered.

EFR comprises two components HFR and LFR

- LFR - Q_{90} based on Flow Duration Curve
- HFR linked to flow variability and stability, where

Q_{90} < 10 % of MAR, HFR = 20 % of MAR

Q_{90} < 10-20 % of MAR, HFR = 15 % of MAR

Q_{90} < 10-20 % of MAR, HFR = 7 % of MAR

Q_{90} > 30 % of MAR, HFR = 0 % of MAR

CPCB SURVEY OF WASTE-WATER,94-95, 644 CITIES

Class	Nos	GENERATED(mld)	% COLLECT	%TREATED
I	299	17000	72%	24%
II	345	1700	66%	4%
Total	644	18312	71%	22%

PRESENT STATUS? WORST OR BETTER?

Israel reuses more than 65% of municipal waste water. They plan to reach 90% reuse by 2010. Also, they plan to cover 70% of total agricultural demand to be met with by effluent by 2040.

China treats 30% of waste-water. In 2010, plans to reach 60%. Irrigates 1.33 Mha by WW. Hereafter will spend more money on treatment than on w/s.

India can irrigate about 1 Mha through treated WW.

ILLUSTRATIVE GOODS & SERVICES FROM RIVERS

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Goods-

Freshwater : pumped, diverted from weirs, abstracted from reservoirs. Hydropower: run-of-river, storages, pumped storages. Fish: naturally occurring, migratory, reservoir breeding. Fruit-Vegetables grown in river beds in dry season. Bathing, washing, drinking (human and cattle). Mangroves. Vegetation. Firewood. Construction material like : soil (brick making), sand, gravel, cobbles, rock.

Services-

Transportation and dilution of human and industrial waste and pollutants. Partial purification. Riverbank stabilisation. Erosion (-ve). Flood damage (-ve). Soil wetting / fertilisation. Flood flow storage. Delta erosion control. Life support for flora-fauna. Bio-diversity. Faith and aesthetics. Playground. Laundry.

EFR Status : India
NCIWRD

NCIWRD (1999) consider two types of water requirement under environment and ecology head.

Overall provision is about 1%.

(A) for afforestation and tree planting and

(B) for abatement of water pollution in the rivers.

- No provision is made for type A as they are rain dependent.
- Some ad-hoc provisions made for maintenance of water quality and keep the BOD level of treated effluents to safe limits through dilution.

EFR Status : India (contd.)

India Water Vision 2025

- Considers two important dimensions of environmental degradation - Land/Soil degradation and loss of forest area.
- It also discusses both positive and negative impacts of water resource development particularly the problems of water logging and salinity caused by irrigation projects.
- It suggests the need for provision of **minimum flows in rivers** to check problems caused by creation of dams and uncontrolled extraction of groundwater.

Conclusions

Observations and Approach used in EFR.CPSP

- Water for nature includes both the terrestrial and aquatic systems. The former consumptive, latter non-consumptive.
- Former contributes 95% of basin waters. WRD gives it back.
- Reservoir aquatic life can replace river life.
- These can be accounted only when there is shift in the basic agreement about ‘rain as water resource of a basin’.
- Recent modeling approaches for EFR are area specific. Need to test them.
- Mangroves degraded due to encroachment/ refugees. Study not available to decide freshwater required for mangroves.

MANGROVES OF THE WORLD (Source - FAO, 2003)

Indonesia 2.9 Mha, Brazil 1.01, Nigeria 0.99, Australia 0.95, Cuba 0.53, India 0.48, Mexico 0.44, Papua/New Guinae 0.43 Mha.

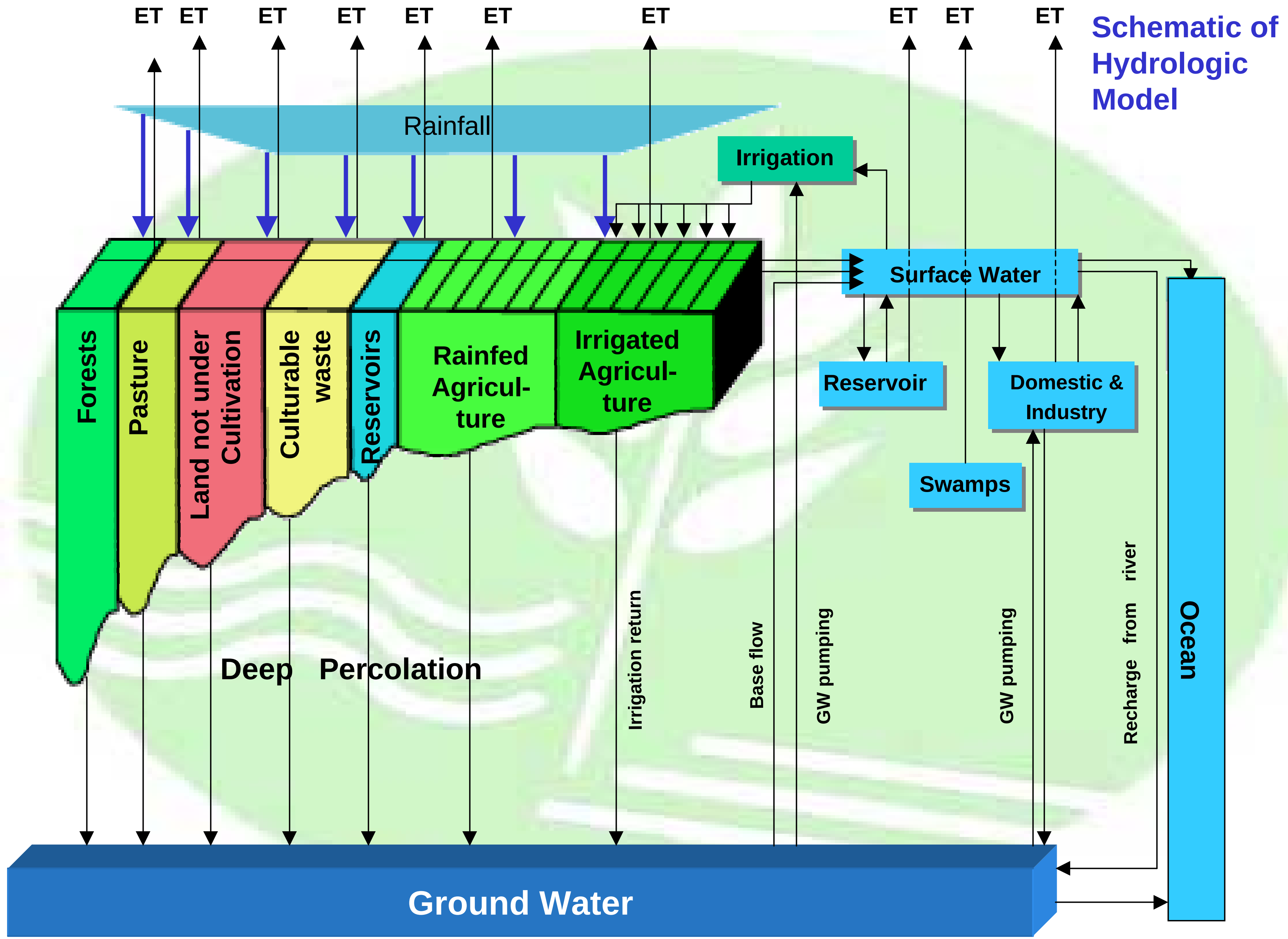
Top 8 countries account for 7.73 Mha of area, which is 49% of the world's total area and 7% of numbers of countries having mangroves.

Continentwise distribution is: Asia and Oceania 8.3 in 46 countries, Africa 3.4 in 33 countries, Americas 4.1 in 42 countries. Total for the world= 15.8 Mha in 121 countries.

Two India basins have about 22000 ha of mangroves mostly in Brahmani basin, which is a Ramsar site. In the whole of China, mangroes account for only 37000 ha. The area in the two sample basins is not clearly known.

Brahmani mangrove gets adequate freshwater in ultimate stage.

Schematic of Hydrologic Model



Remarks on the model

It is not a 'distributed model'. Each land use was geographically distributed throughout the basin. All such parcels were conceptually lumped into a single land use unit.

The model does not depict the spatial variations in rainfall, potential evapo-transpiration, intensities of cropping or irrigation.

It also does not depict the slow horizontal groundwater movement, from under one area to another.

These deficiencies were overcome through application of model to study of each sub-basin.

Land uses

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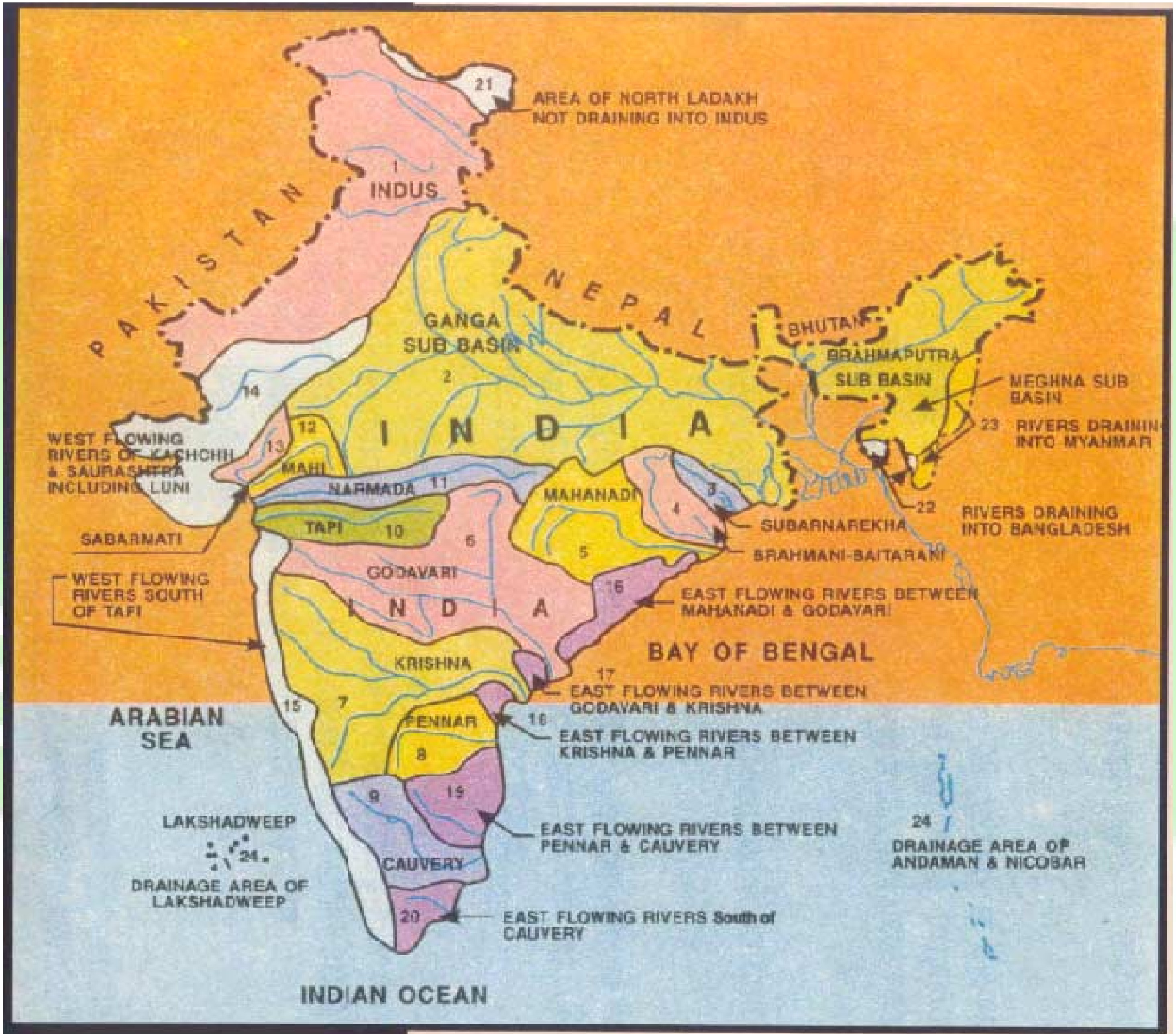
Following twenty standard land use types were used:

P1	Forest and misc. trees
P2	Permanent pastures
P3	Land not available for cultivation, waste, & fallow
P4	Land under reservoirs
P5	Kharif Paddy (rainfed) only.
P6	Rainfed two seasonals (kharif and rabi)
P7	Rainfed perennials
P8	Rainfed other kharif followed by rabi
P9	Rainfed other kharif only.
P10	Rainfed other kharif, irrigated rabi and fallow
P11	Irrigated kharif paddy only.
P12	Irrigated perennials.
P13	Irrigated two seasonals(kharif-rabi)
P14	Irrigated two seasonals(rabi-hw)
P15	Irrigated other kharif, irrigated rabi and fallow
P16	Fallow in kharif, irrigated rabi & irrigated hw
P17	Fallow in kharif, irrigated rabi & irrigated hw paddy.
P18	Irrigated rabi only.
P19	Irrigated other kharif only.
P20	Irrigated other kharif, fallow in rabi, irrigated hw

Combinations used	Rainfall situation	Development situation
Combination No 1	Average year	Present(1995)
Combination No 2	Bad year	Present(1995)
Combination No 3	Good year	Present(1995)
Combination No 4	Average year	Past(1960)
Combination No 5	Average year	Future. Business as usual. Irrigation expansion. Reduction in rainfed lands. Predominance of GW irrigation. Narmada imports in addition to Mahi.
Combination No 6	Average year	Future. Same as above, but : Part Narmada water pumped in reservoirs in SB1 & SB2. Partial shift from ground to surface irrigation.
Combination No 7	Average year	Future. Same as Comb 5, but : a) Narmada for D&I, and effluents for irrigation. b) Mark shift from ground to surface irrigation. c) Management of barren lands to reduce non-beneficial ET. d) Deficit and drip irrigation to reduce NIR by 15%
Combination No 8	Average year	Future. Same as Comb 7, but without c) and d)
Combination No 9	Average year	Future. Same as Comb 7, but without b) and d)
Combination No 10	Average year	Future. Same as Comb 7, but without c) and b)



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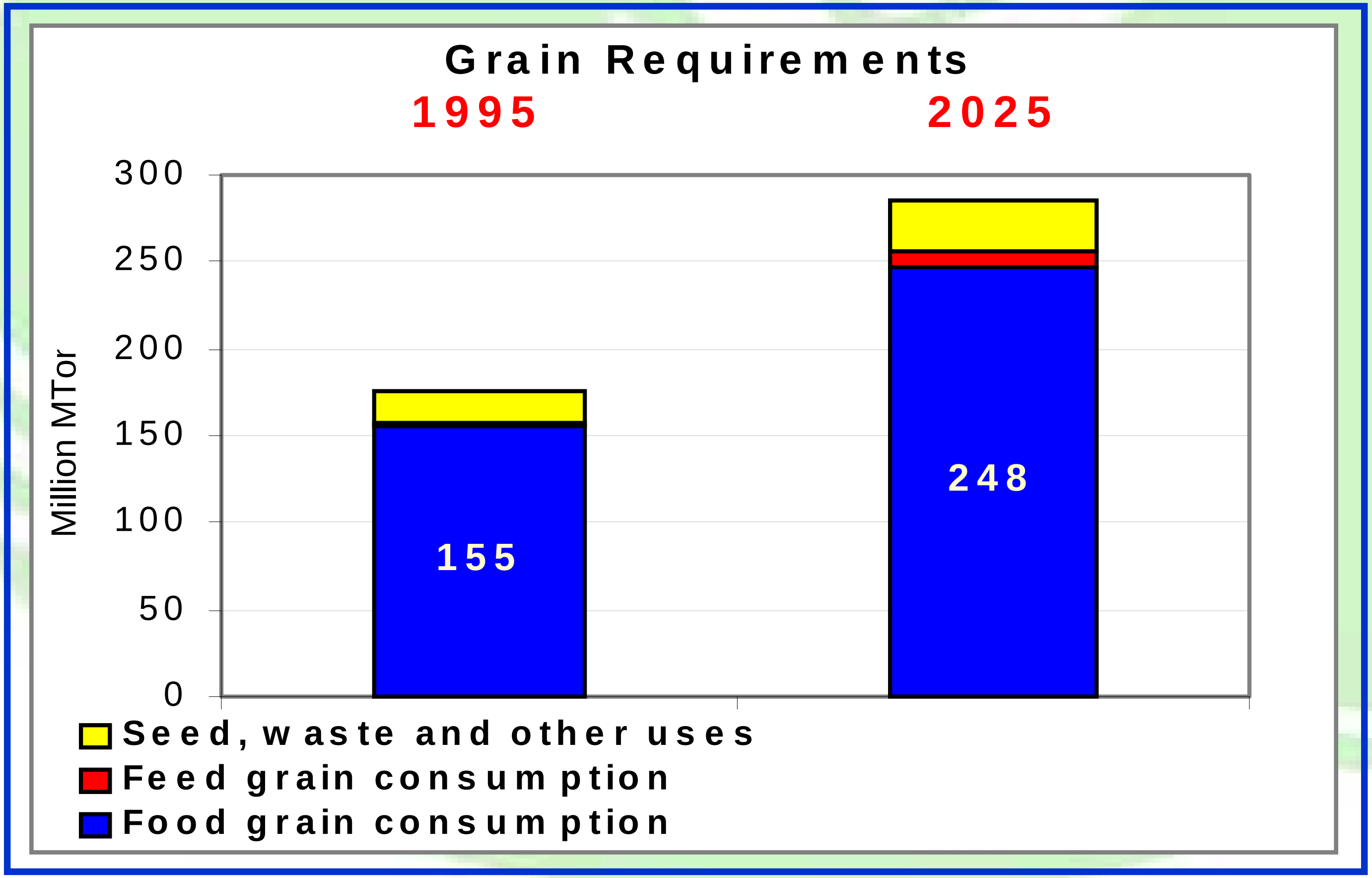
AREA OF NORTH LADAKH NOT DRAINING INTO INDUS
PAKISTAN
1
INDUS
NEPAL
BHUTAN
GANGA SUB BASIN
2
BRAHMAPUTRA SUB BASIN
MEGHNA SUB BASIN
23 RIVERS DRAINING INTO MYANMAR
INDIA
14
12
13
WEST FLOWING RIVERS OF KACHCHH & SAURASHTRA INCLUDING LUNI
MAHI
NARMADA 11
MAHANADI
3
4
22
RIVERS DRAINING INTO BANGLADESH
SUBARNAREKHA
SABARMATI
TAPI 10
6
5
BRAHMANI-BAITARANI
GODAVARI
WEST FLOWING RIVERS SOUTH OF TAPI
INDIA
18
EAST FLOWING RIVERS BETWEEN MAHANADI & GODAVARI
BAY OF BENGAL
KRISHNA
17
EAST FLOWING RIVERS BETWEEN GODAVARI & KRISHNA
ARABIAN SEA
15
7
PENNAR
16
EAST FLOWING RIVERS BETWEEN KRISHNA & PENNAR
8
9
19
LAKSHADWEEP
24
DRAINAGE AREA OF LAKSHADWEEP
EAST FLOWING RIVERS BETWEEN PENNAR & CAUVERY
24
DRAINAGE AREA OF ANDAMAN & NICOBAR
CAUVERY
20
EAST FLOWING RIVERS South of CAUVERY
INDIAN OCEAN

PODIUM FOR INDIA

Food Sector Vision for 2025

- No prediction. Helps in “What if analysis”.
- Projections for the year 2025
  - Food grain requirement and production.
  - Water requirement.
  - Availability or shortage of surface and ground water.
  - Water balance situation.

Grain Requirement in Million tonnes, INDIA



INDIA PODIUM DEVELOPMENT

- **Jointly by Central Water Commission (CWC), India and IWMI, Sri Lanka.**
- **Customisation of India Podium Model to suit Indian conditions by CWC, India.**
- **Some basin studies conducted by CWC, India.**

INDIA PODIUM

- Disaggregated at river basin or parts of units.
- More crop categories introduced.
  - Grains (Rice, Wheat, Maize, Other cereals, Pulses)
  - Oil crops
  - Roots and Tubers
  - Vegetables
  - Sugarcane
  - Fruits
  - Cotton
- Monthly irrigation demand for different crops

Main Contributions of CWC

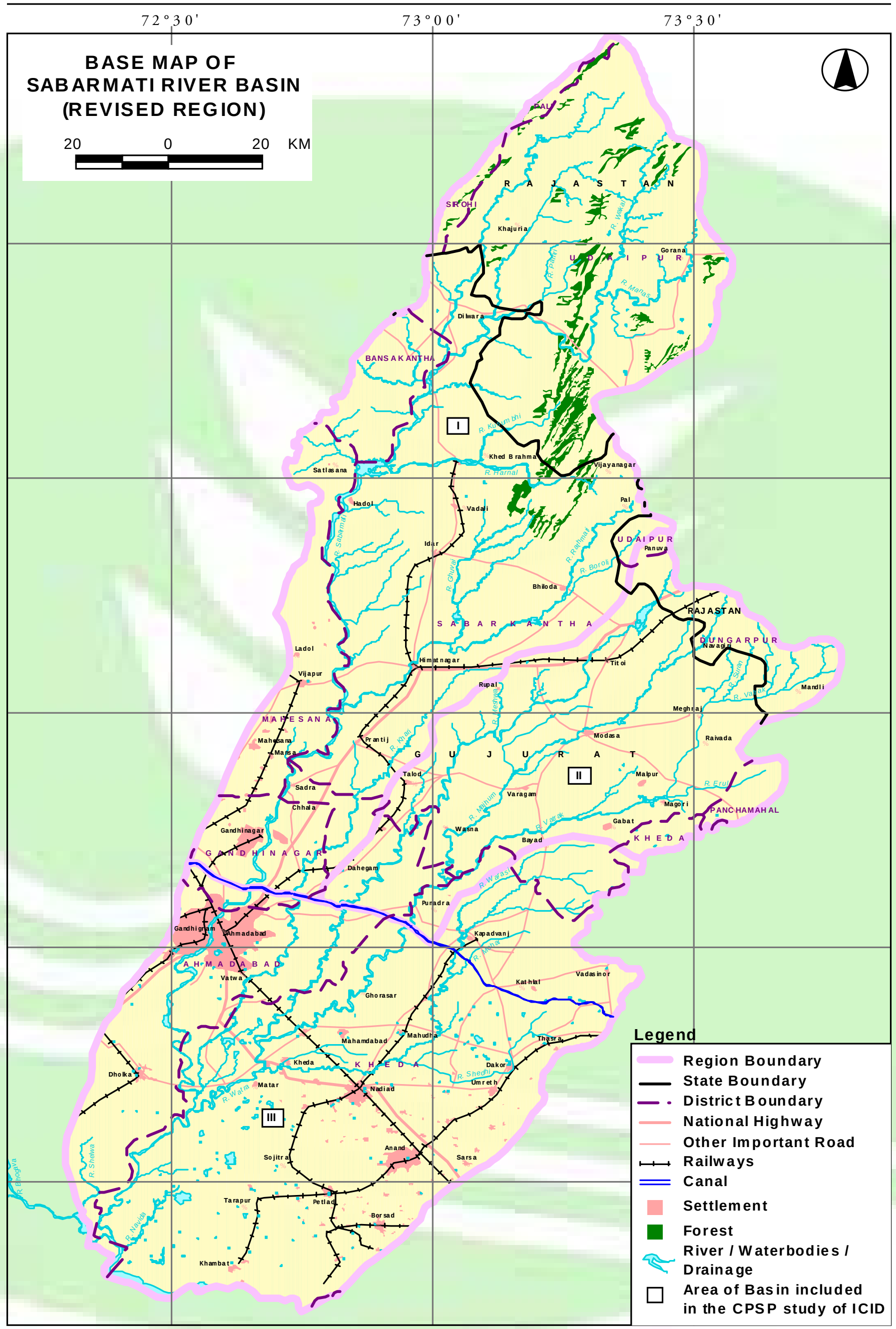
- Model modified to operate basin wise or state wise.
- Model accounts two crop seasons and perennial crops.
- Percolation losses due to paddy, recharge of ground water and return flow into the rivers incorporated.
- Evaporation from the reservoirs computed on the percentage of live storage
- Computation of food grain requirement in grams/day/capita.

Contd.

- **CWC CONTRIBUTIONS (CONTINUED)**

- **Includes water required for non-consumptive use.**
- **Indicates surplus/deficit surface water as well as ground water in basin.**
- **Indicates all sectoral water requirements in a basin.**

Basin Map of Sabarmati River



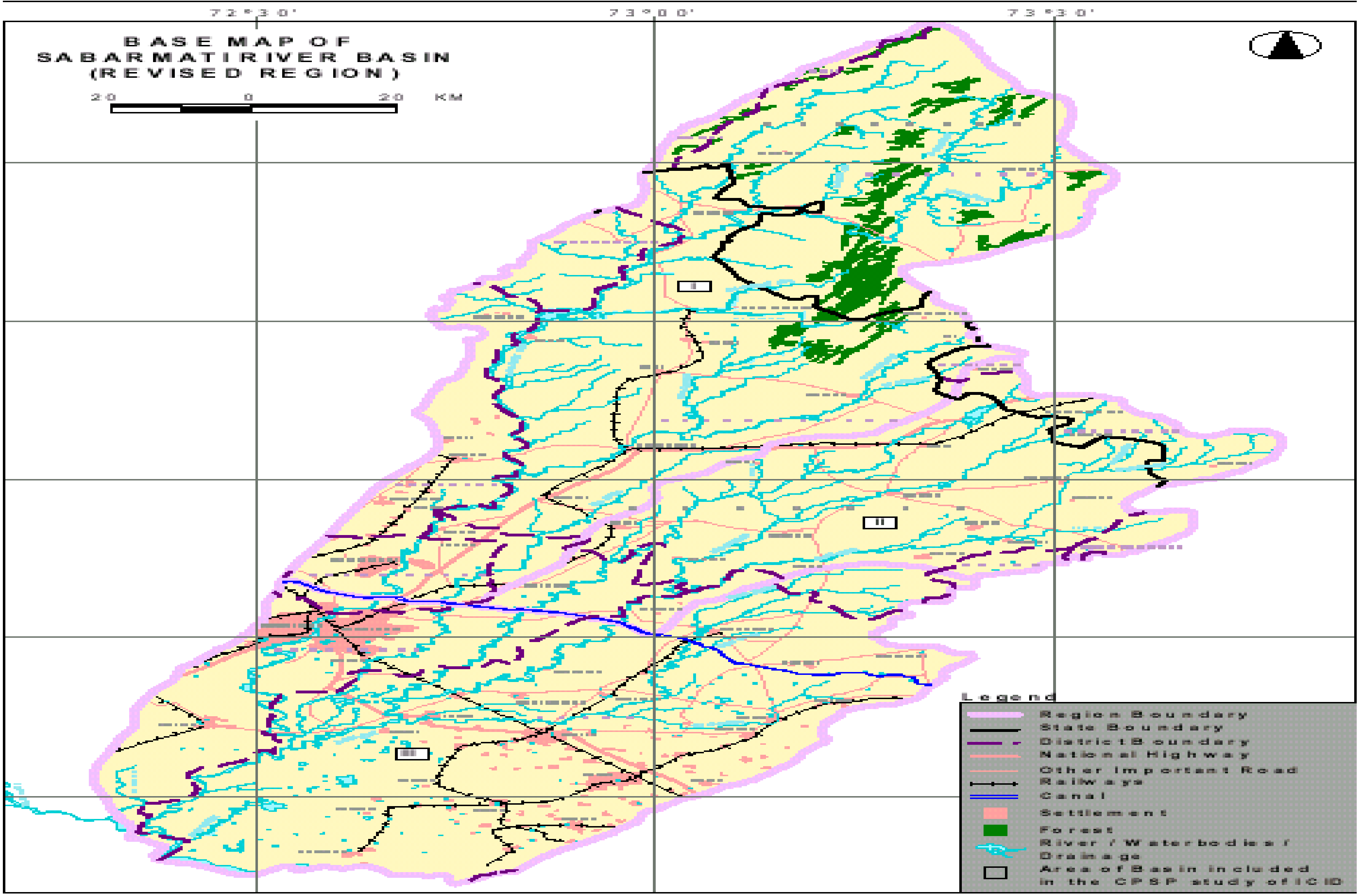


Figure 2: Sabarmati River Basin

HEAD-WATERS TO DELTA-HEAD

Denuded area, low quality forest, some sand dunes, ground sloping = 2m/km, then 1 m/km.

Dharoi, Harnav I, II, Guhai, Hathmati, Meshwo, Mazam, Waidy and Watrak are the main reservoirs with 1471 MCM of gross storage. Besides, there are diversion weirs on Harnav, Hathmati, main Sabarmati (Wasna, Raipur). Additional likely storage will be 150 MCM.

Dharoi and Fatewadi command areas extend on right bank beyond basin boundary into Banas, Saraswati basins.

Narmada main canal crosses the area at the delta head, between Gandhinagar and Ahmedabad.

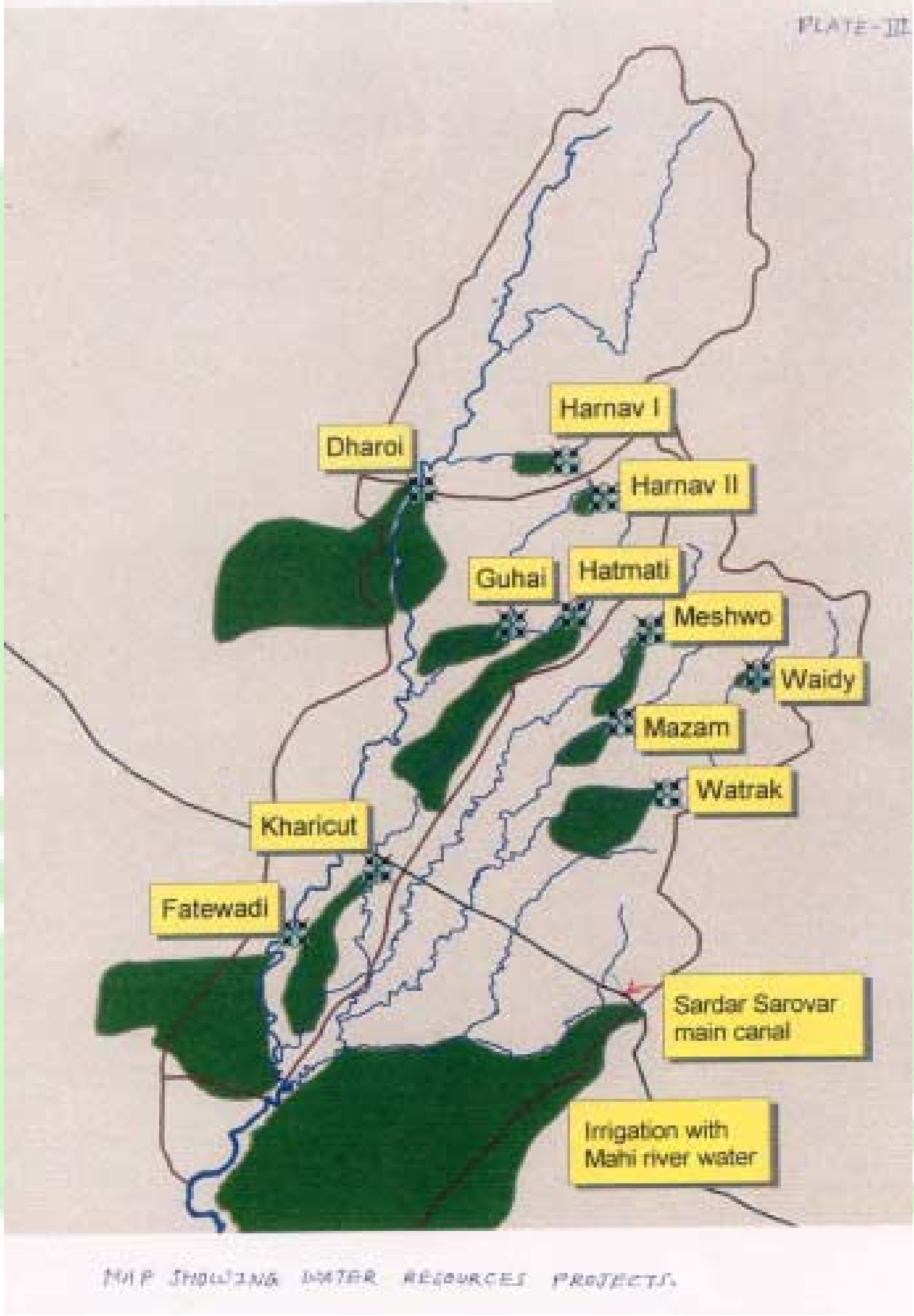
DELTA, GULF and TERMINAL RESERVOIR

Right bank delta comprises saline tract between Bhogavo tributary joining close to the mouth and draining a sizeable area form the Saurashtra.

Left bank delta lies between Mahi right bank and irrigated for the last 40 years from Mahi river system.

Some effort has been made for reclaiming saline area lacking drainage. Lot remains to be done.

Feasibility study of a terminal reservoir is done to capture unused waters of the Sabarmati, Mahi and Narmada on left bank and Bhogavo on right bank. A 40 km long, 50 m high earth dam is envisaged across the gulf with a tidal power station to utilise the 11 m tidal range, and a freshwater reservoir to serve another 0.5 Mha area with irrigation along the gulf coast.



Mahi River Basin Reservoirs, Narmada.

Sub basinwise Monthly rainfall (millimeters)

ICID·CIID

Month	SB1			SB2			SB3		
	Good	Av.	Bad	Good	Av.	Bad	Good	Av.	Bad
June	69	31	25	94	55	29	152	65	71
July	279	267	223	385	272	256	408	259	187
August	266	317	134	271	356	135	245	294	195
September	88	128	166	131	116	93	129	86	102
October	104	2	0	104	7	0	45	0	0
November	0	2	0	0	3	0	0	0	0
December	0	1	0	0	2	0	0	0	0
January	0	1	0	0	1	0	0	0	0
February	0	1	0	0	0	0	0	0	0
March	0	1	0	0	1	0	0	0	0
April	0	0	0	0	0	0	0	0	0
May	0	2	0	0	1	0	0	0	0
Total	806	753	549	985	815	512	979	704	555

Monthly Reference Evapotranspiration, ETo (mm)

ICID·CIID

Month	SB1	SB2	SB3
June	231	220	220
July	141	145	150
August	124	134	135
September	138	144	150
October	154	163	170
November	111	121	125
December	95	101	100
January	108	116	120
February	120	124	125
March	183	196	200
April	195	208	210
May	244	249	250
Total	1844	1921	1955

Sub-Basin/ Basin	Average flow computed by the model ($10^6 m^3$/yr)	Observed average flow ($10^6 m^3$/rec)
SB 1	1104	984 (Indira bridge)
SB 2	821	341 (Watrak at Khera)
Total basin (included in SB3)	2705	1609/ 1369

Overall Annual Water balance for the Sabarmati Basin
(Steady state, Average rainfall year)

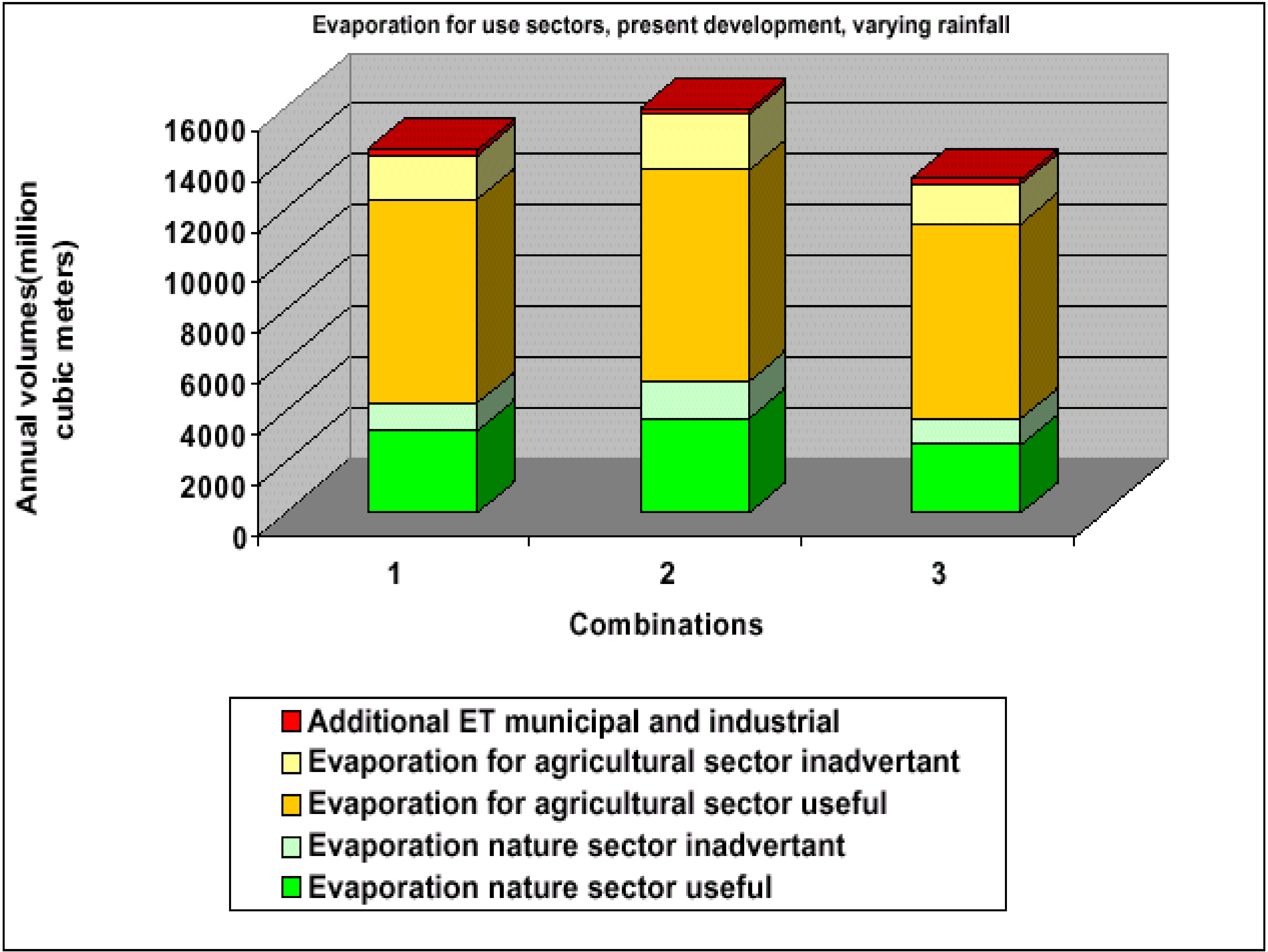
(All units in $10^6 m^3$)

Component	Past (1960)	Present	Future Scenario					
	Combination (4)	1	BAU 5	6	7	8	9	10
A. Inputs								
1. Precipitation, total	15459	15459	15459	15459	15459	15459	15459	15459
2. Imports from outside the basin	0	1581	3081	3081	3081	3081	3081	3081
TOTAL 'A'	15459	17040	18540	18540	18540	18540	18540	18540
B. Outputs								
3. Evapotranspiration, total	10778	14324	13744	13791	13038	13489	13740	13352
* Nature sector (Forest Pasture and other lands not available for agriculture)	4893	4336	3956	3957	3904	3956	3904	3957
* Agriculture sector (Cultivated lands including current fallows)	5801	9782	9434	9481	8780	9178	9481	9040
* People sector(Domestic and Industrial water supply)	85	205	355	355	355	355	355	355
4. Exports to outside the basin	0	260	425	425	425	425	425	425
5. Runoff to the sea total	4681	2456	4371	4324	5077	4626	4375	4763
TOTAL 'B'	15459	17040	18540	18540	18540	18540	18540	18340

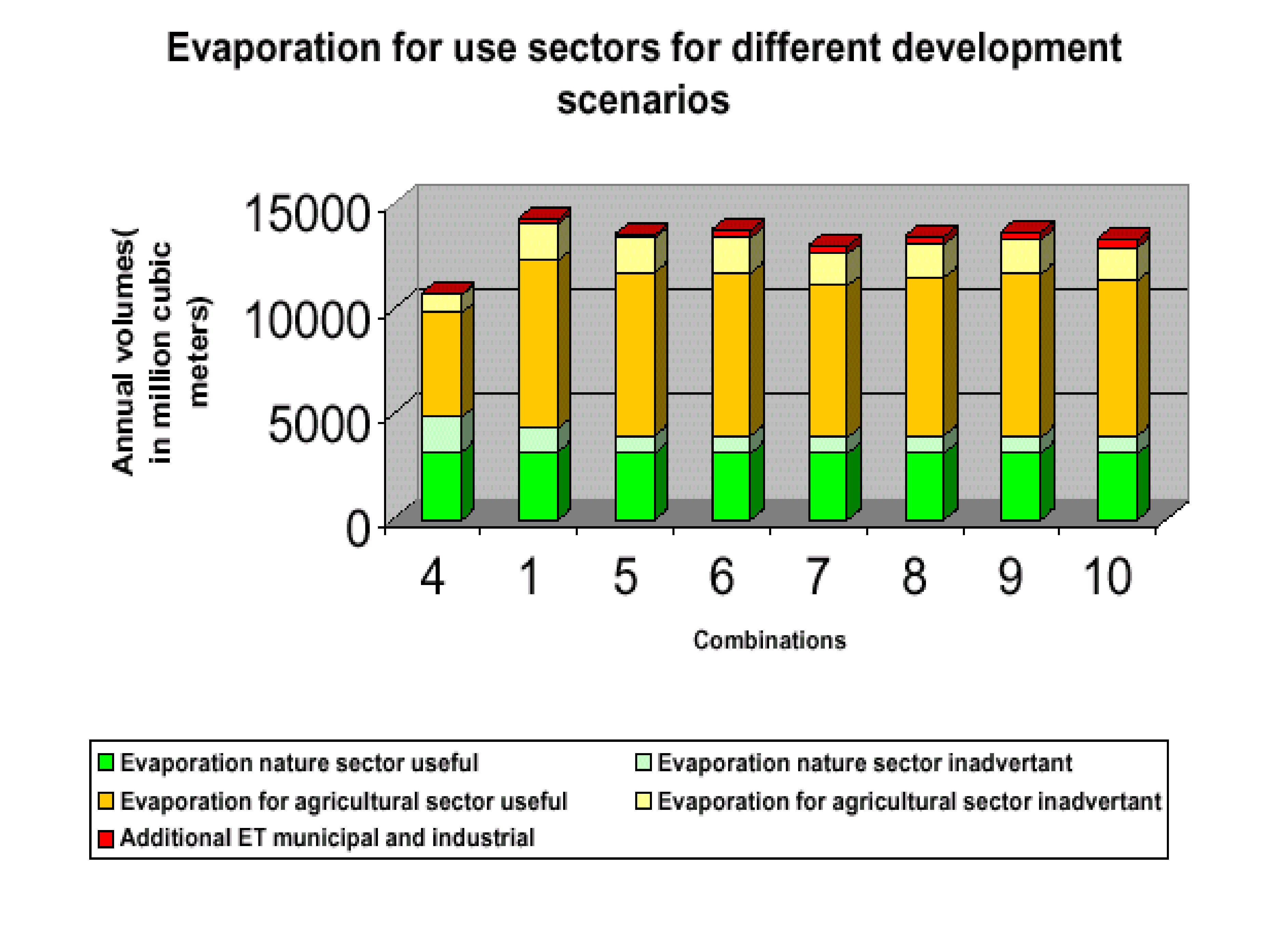
Dry season (November-May) low flows

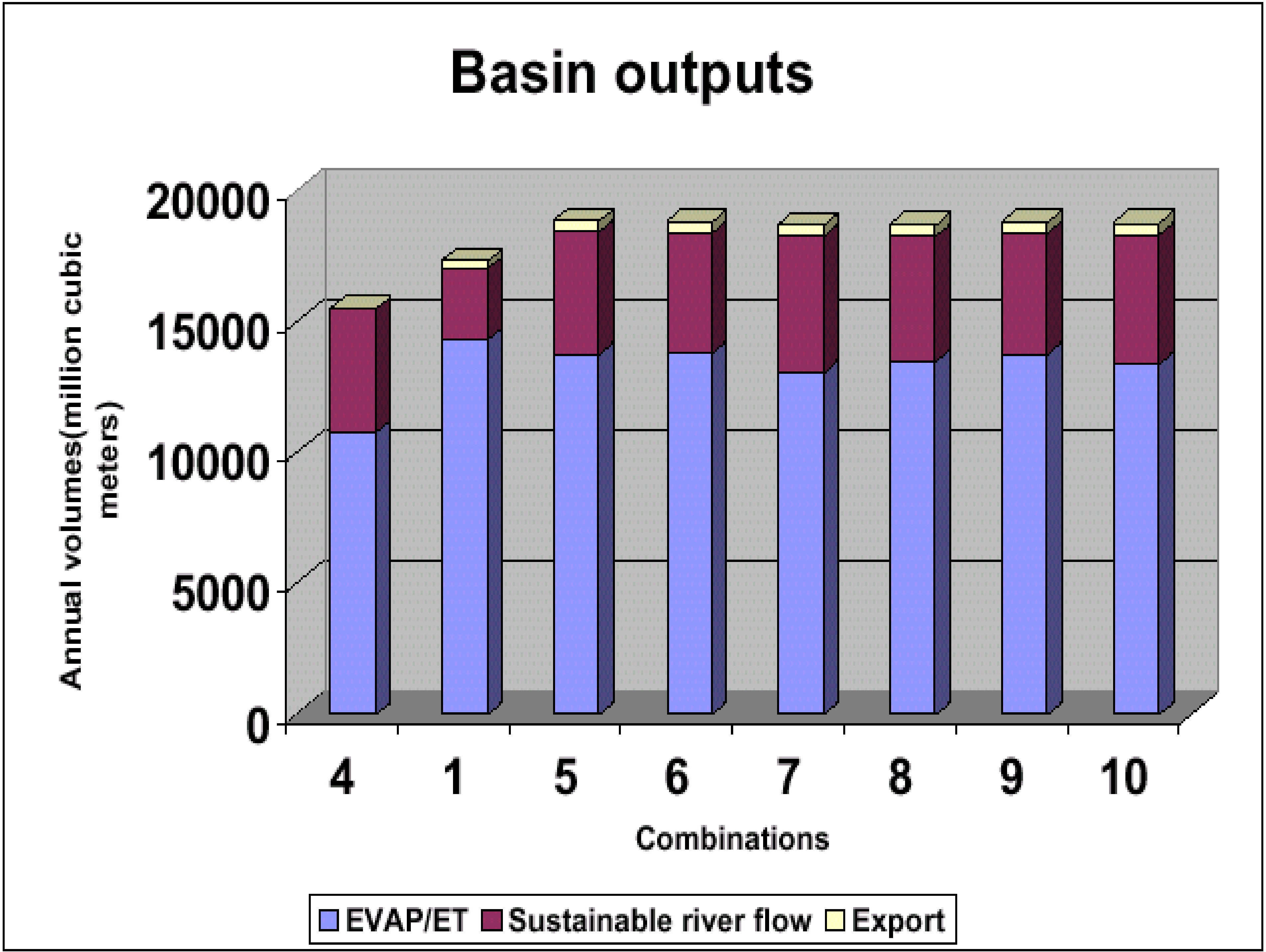
$(10^6 m^3)$

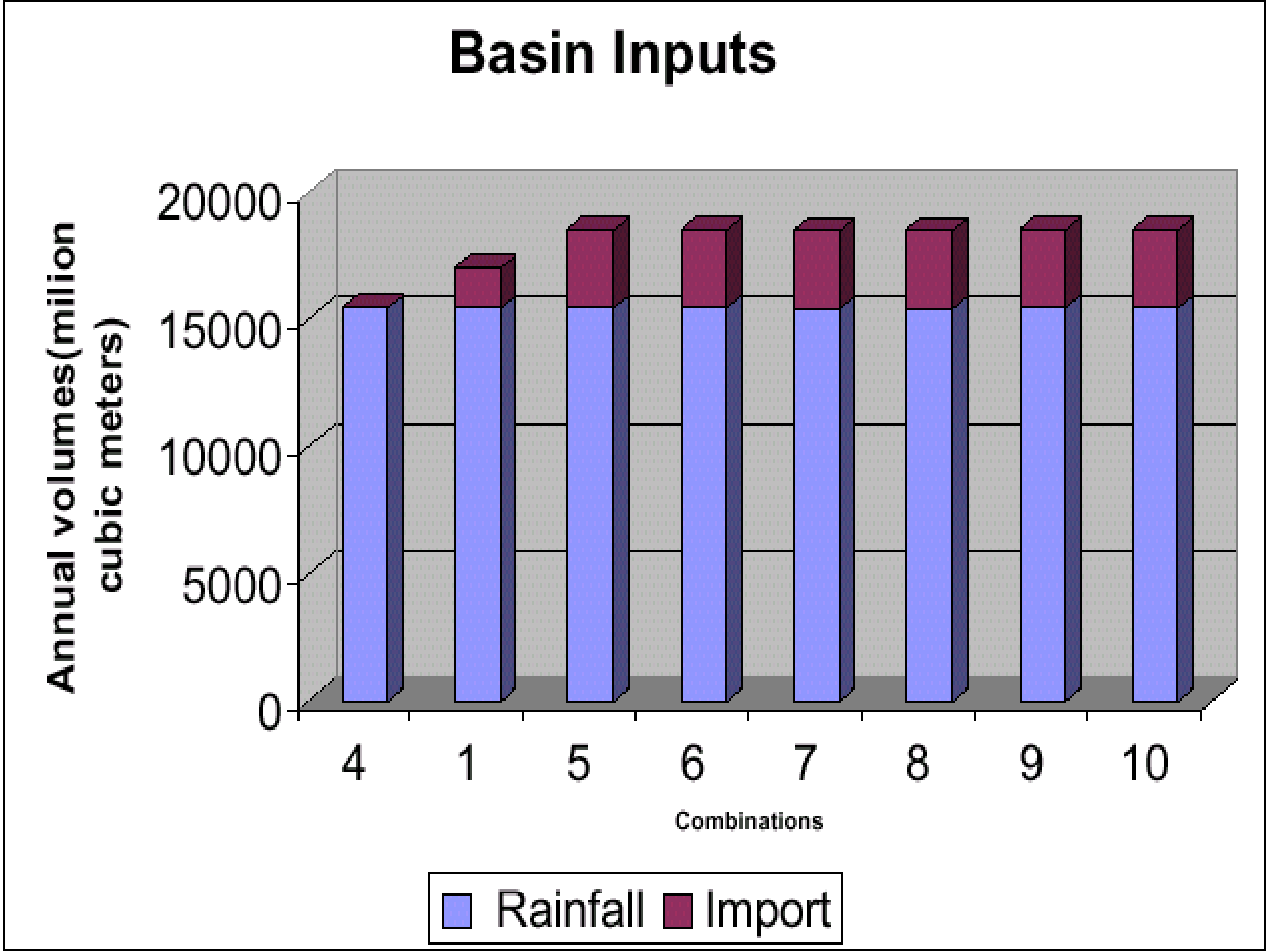
Condition/ Combination	SB1	SB2	SB3	Whole Basin
Current, av. rain (1)	89	124	382	595
Past, av. rain (4)	784	289	102	1175
Future I (BAU) av. Rain (5)	232	219	497	948
Future II, av. rain (6)	559	109	334	1088
Future III, av. rain (7)	271	153	424	849
Future I with III b only (8)	193	116	311	619
Future I with III c only (9)	163	111	334	608
Future I with III d only	236	145	430	811



Evaporation for use sectors, present development, varying rainfall
Annual volumes(million cubic meters)
16000
14000
12000
10000
8000
6000
4000
2000
0
1
2
3
Combinations
Additional ET municipal and industrial
Evaporation for agricultural sector inadvertant
Evaporation for agricultural sector useful
Evaporation nature sector inadvertant
Evaporation nature sector useful

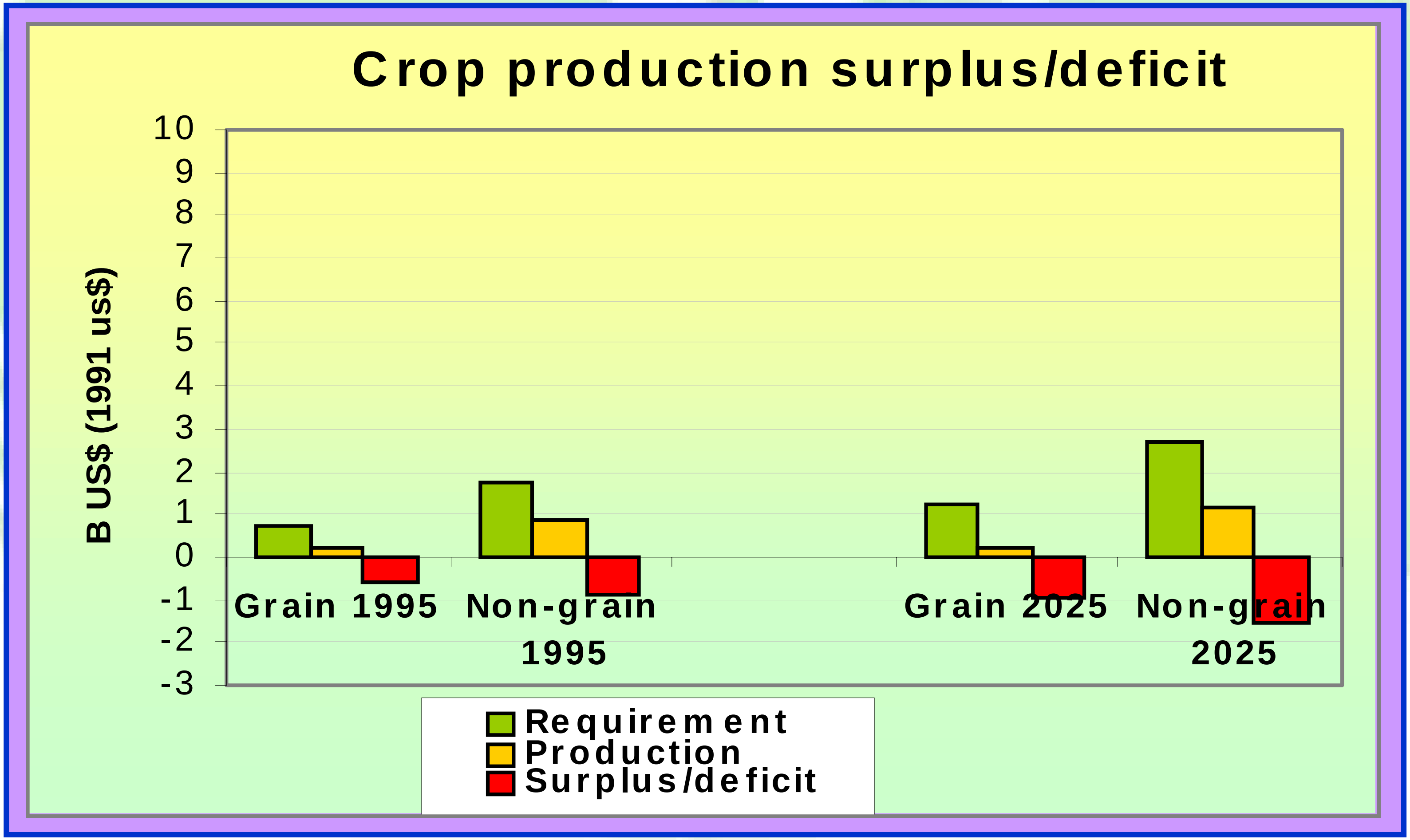

Evaporation for use sectors for different development scenarios
15000
10000
5000
0
Annual volumes(in million cubic meters)
4
1
5
6
7
8
9
10
Combinations
Evaporation nature sector useful
Evaporation nature sector inadvertant
Evaporation for agricultural sector useful
Evaporation for agricultural sector inadvertant
Additional ET municipal and industrial


Basin outputs
Annual volumes(million cubic meters)
20000
15000
10000
5000
0
4
1
5
6
7
8
9
10
Combinations
EVAP/ET
Sustainable river flow
Export

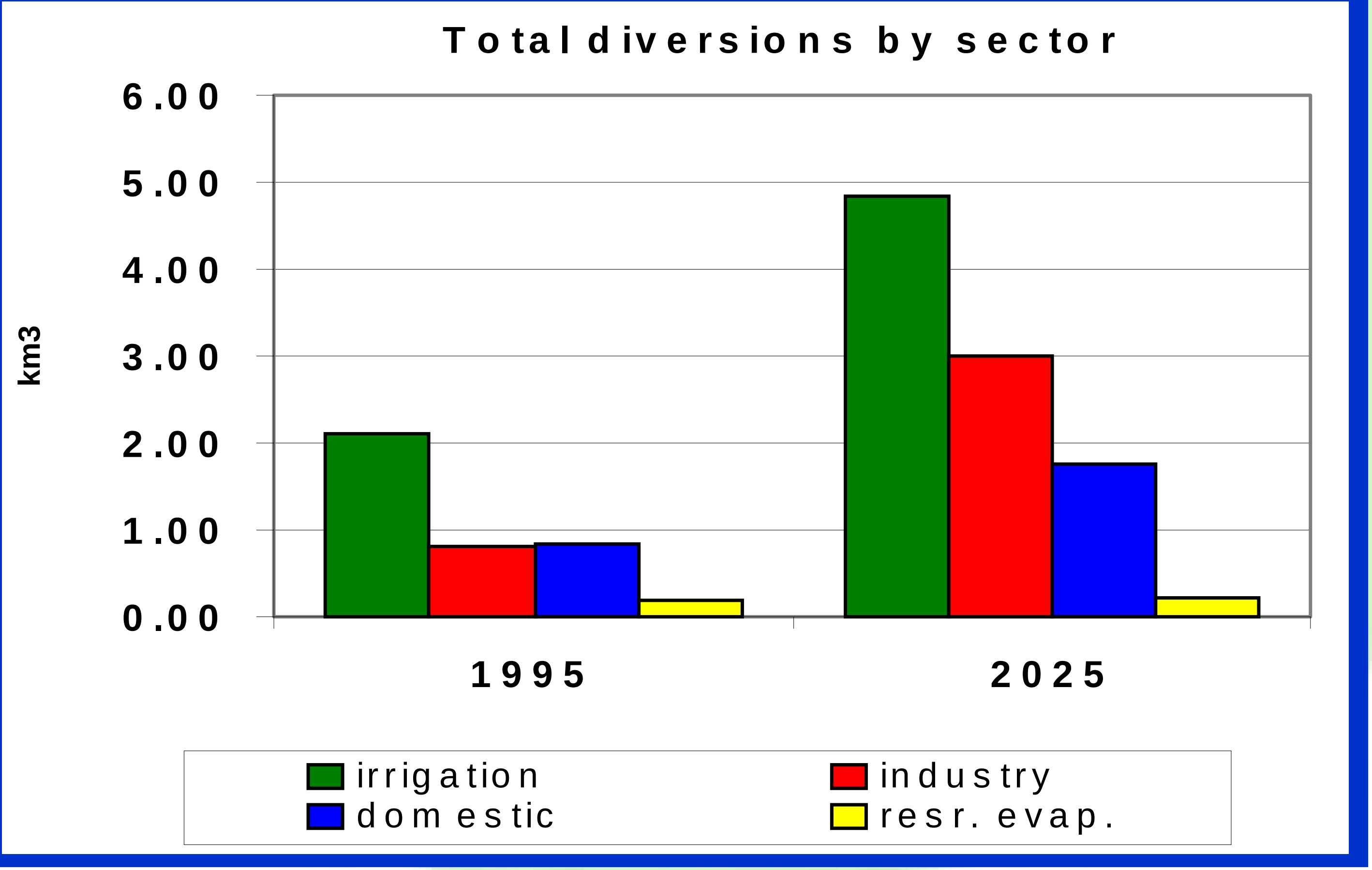


Basin Inputs
Annual volumes(milion cubic meters)
20000
15000
10000
5000
0
4
1
5
6
7
8
9
10
Combinations
Rainfall
Import

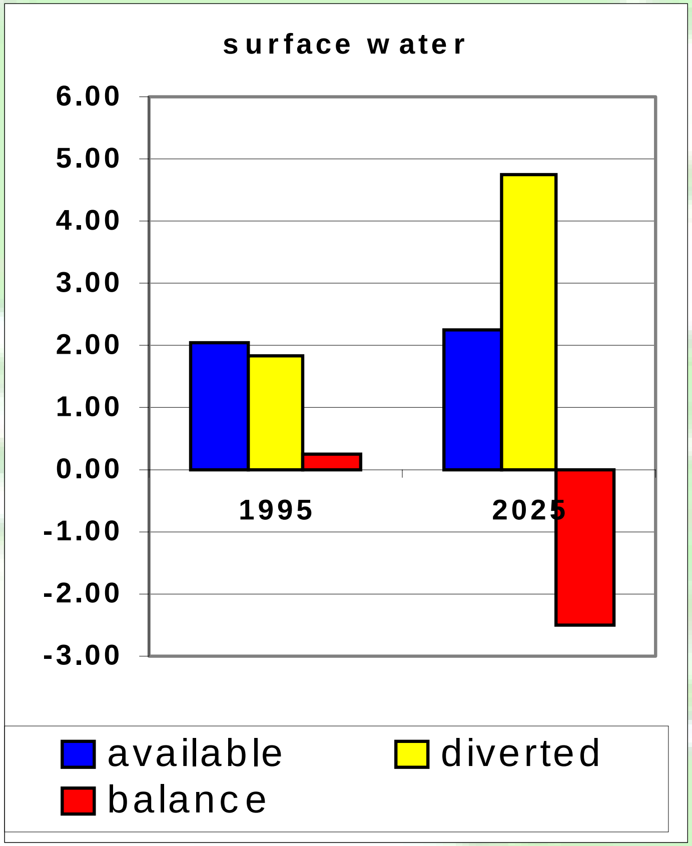
SABARMATI BASIN

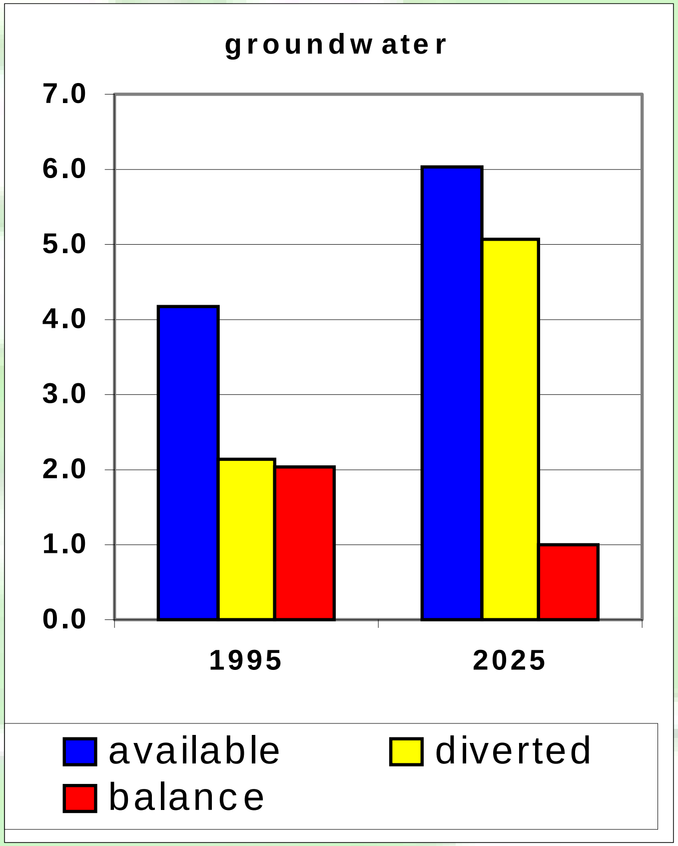


OVERVIEW OF DIVERSIONS SABARMATI

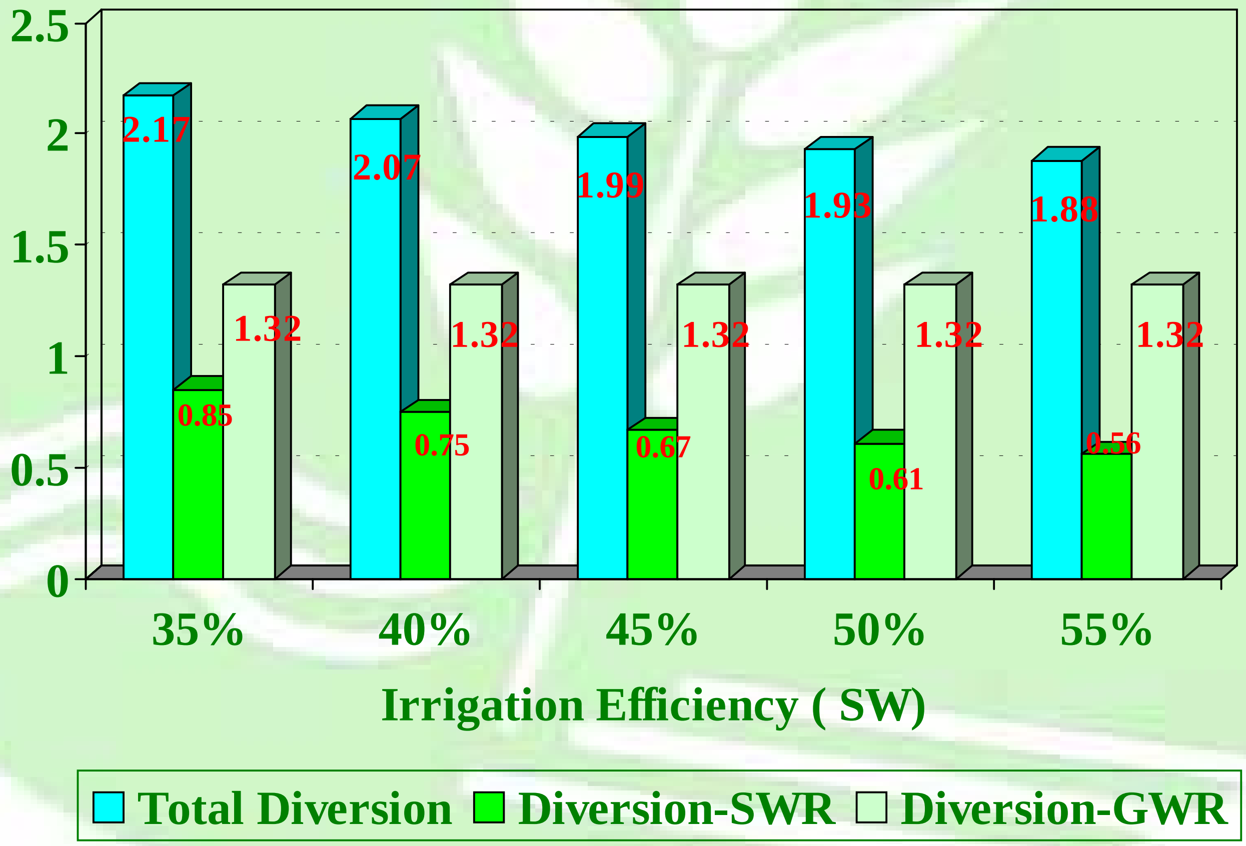


AMOUNT OF WATER AVAILABLE AND DIVERTED (in km3), SABARMATI

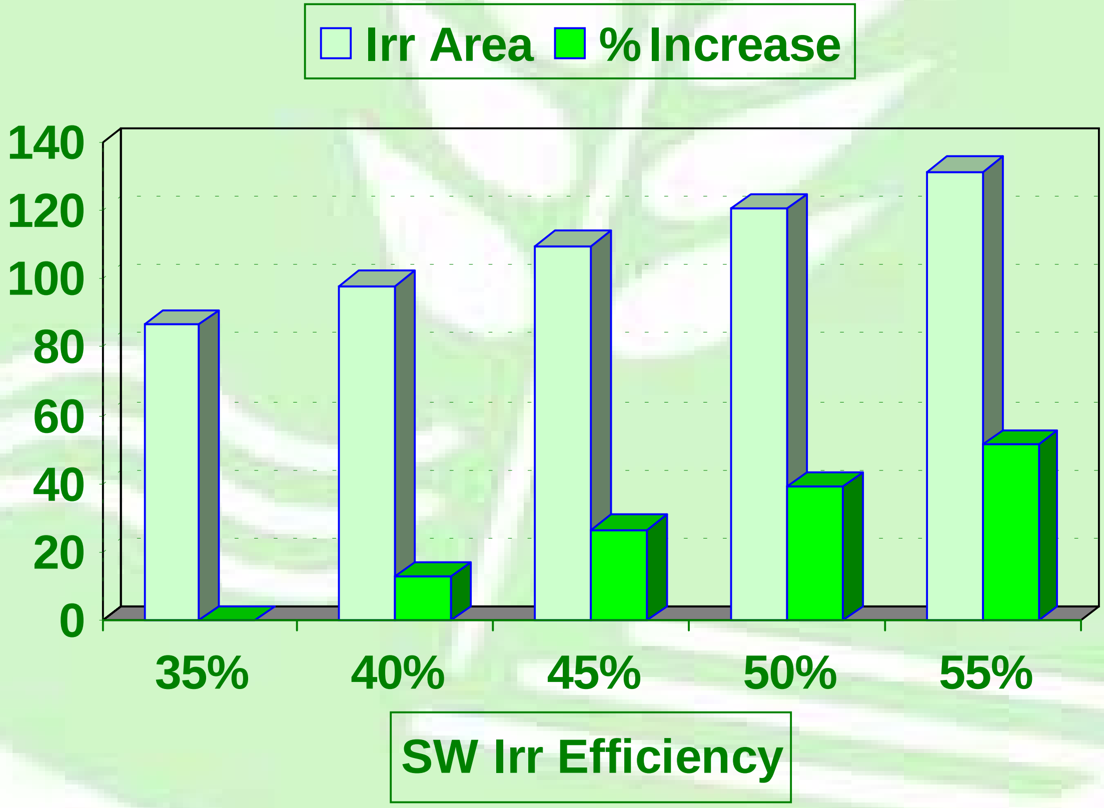




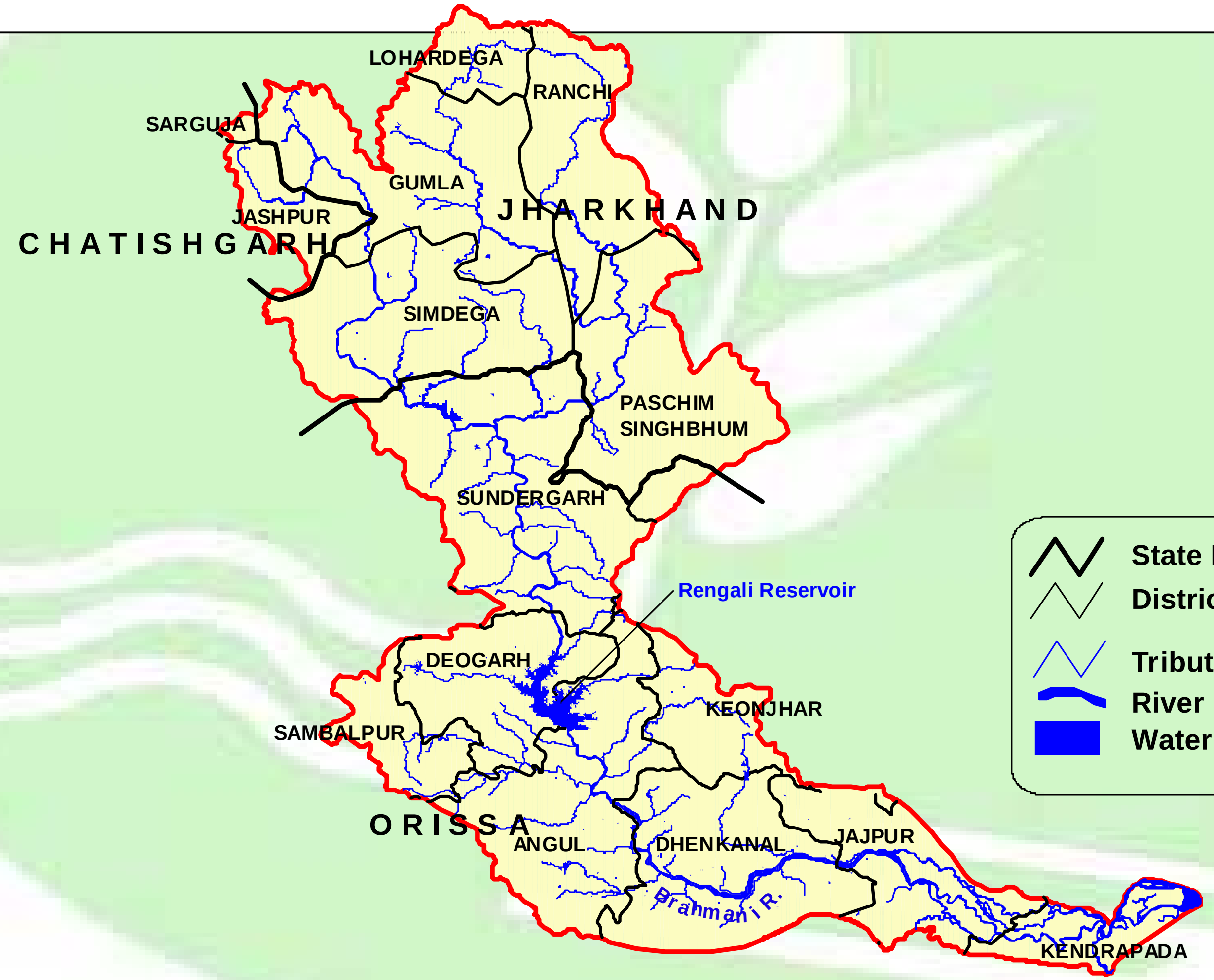
Total Diversion for Irrigation Sabarmati (Km^3)



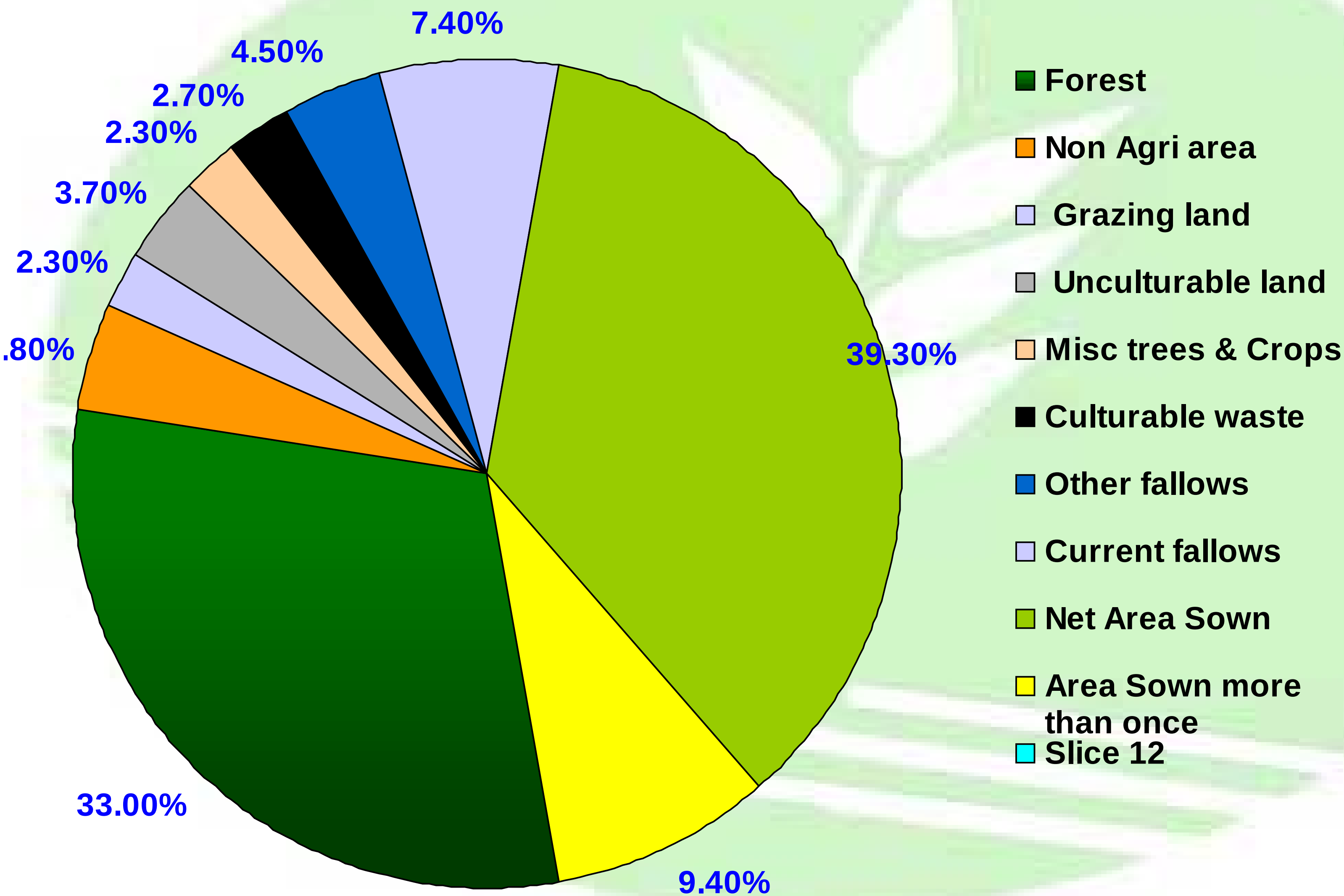
Irrigated Area by same amount of Surface Water - Sabarmati Basin



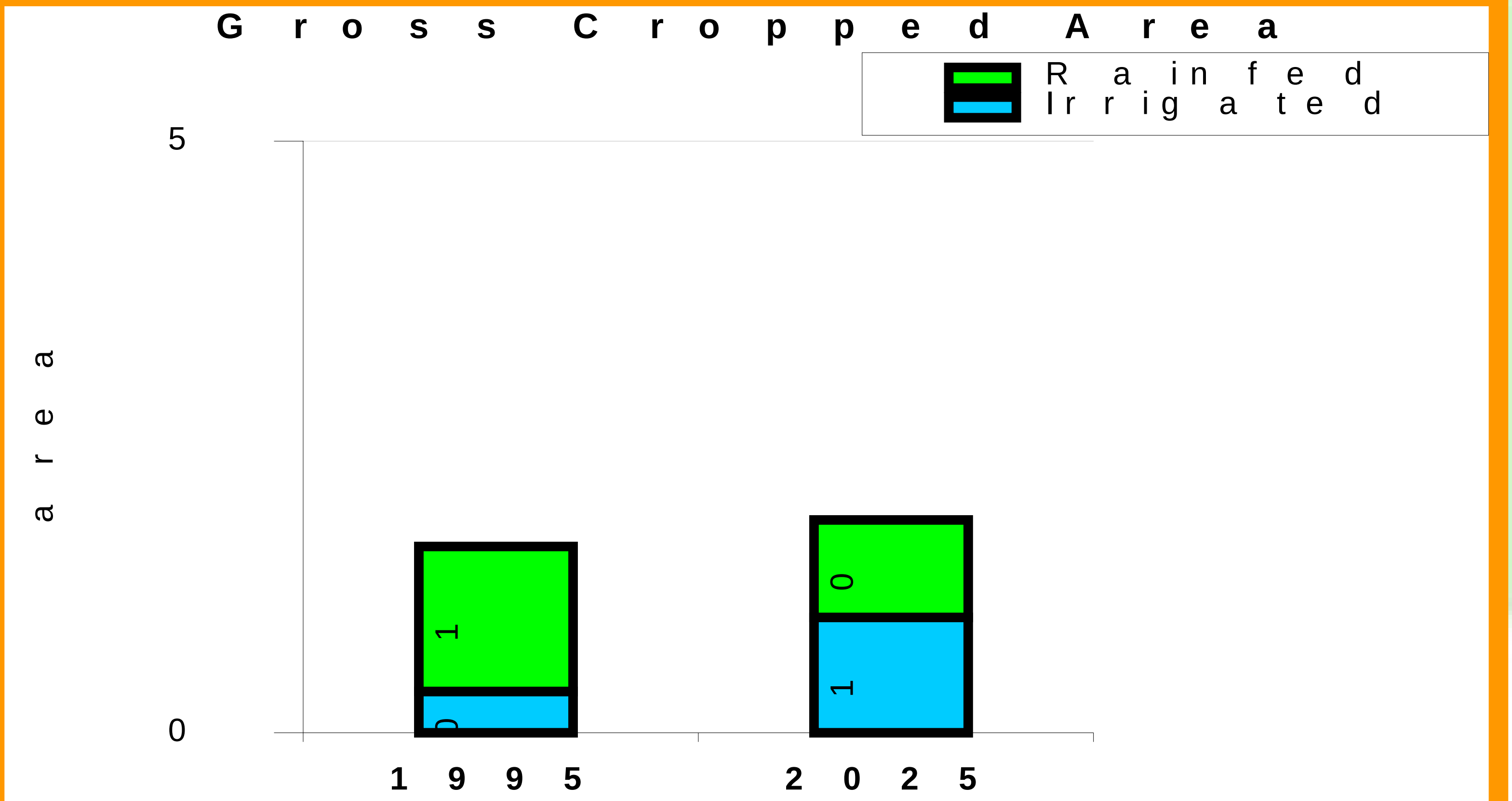
Index Map of Brahmani Basin



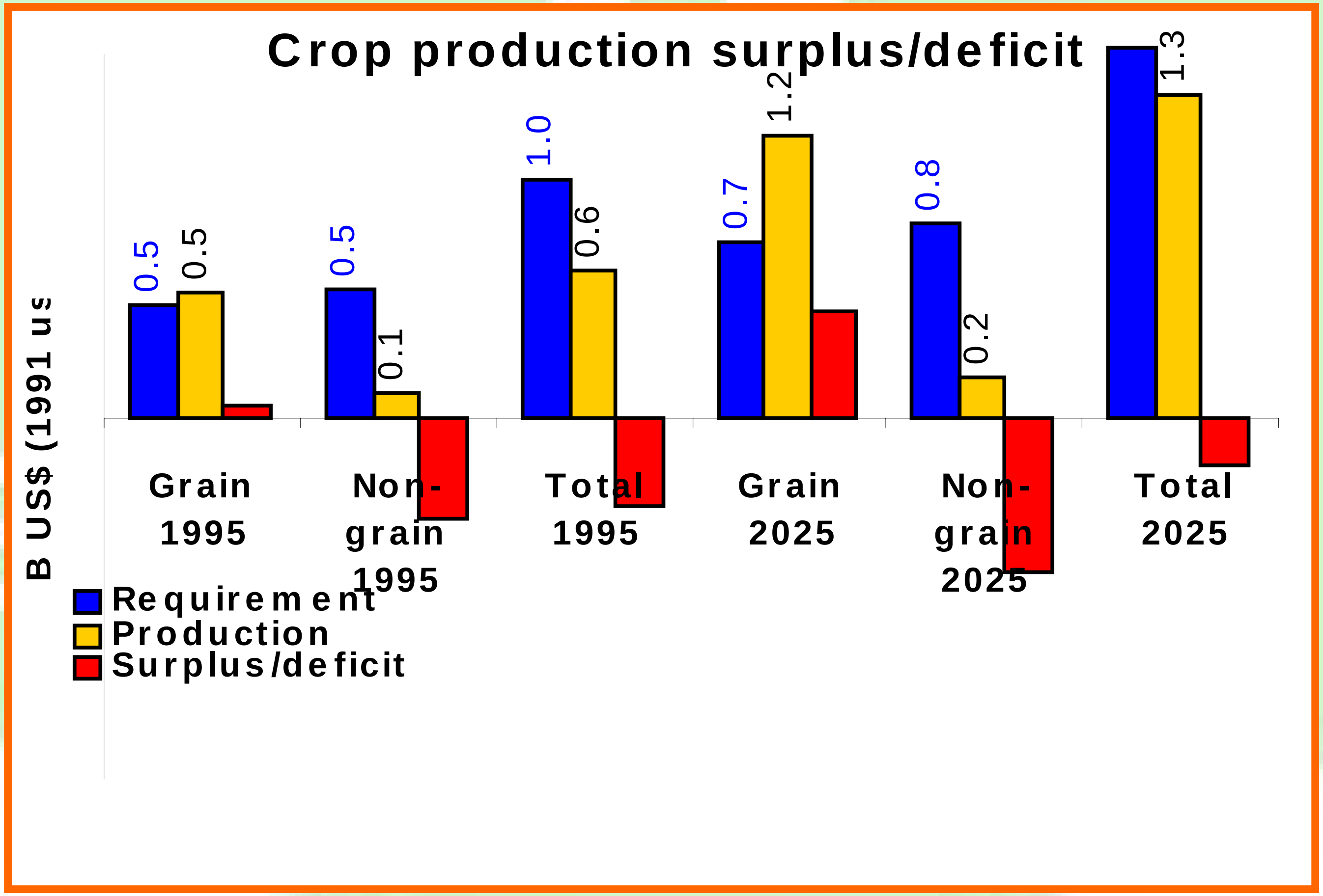
Brahmani Basin: Land Use Statistics



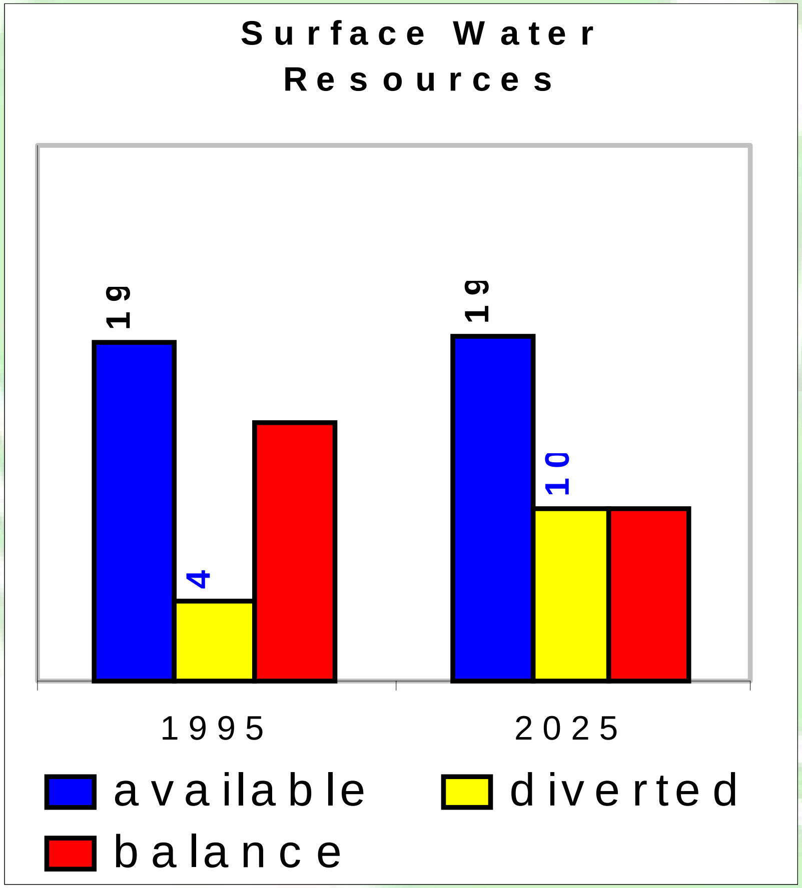
Gross Cropped Area - Brahmani

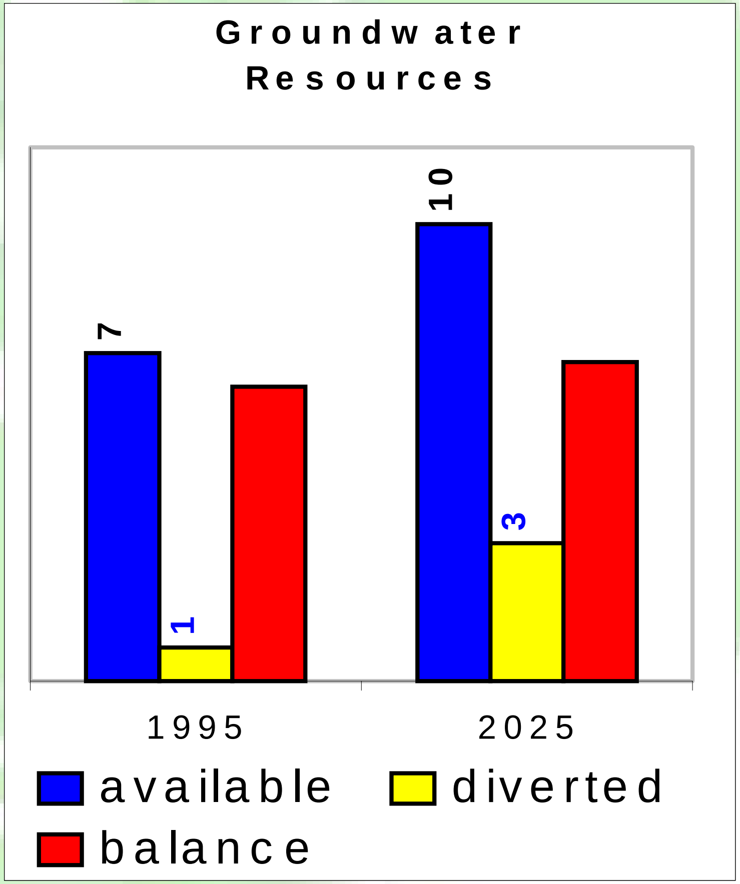


BRAHMANI BASIN

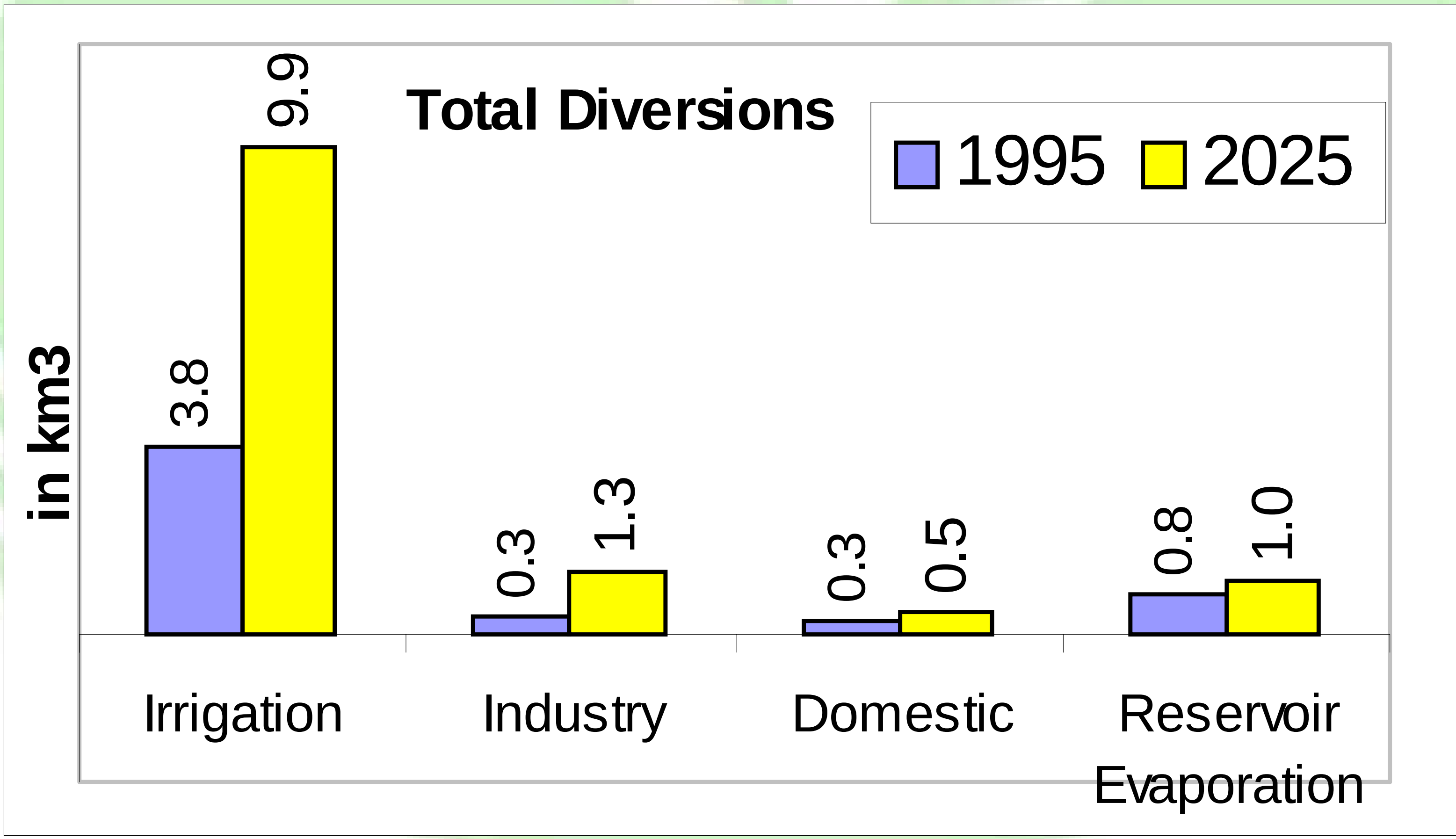


AMOUNT OF WATER AVAILABLE AND DIVERTED (in km3)
BRAHMANI BASIN

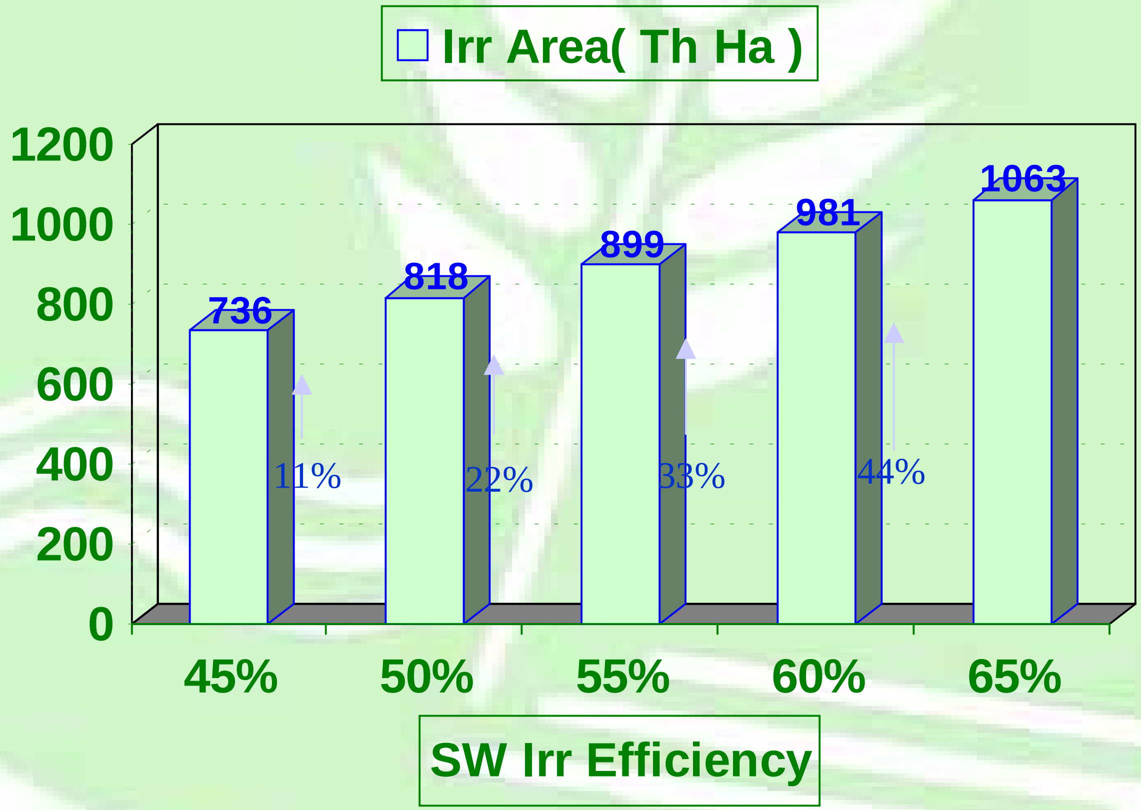




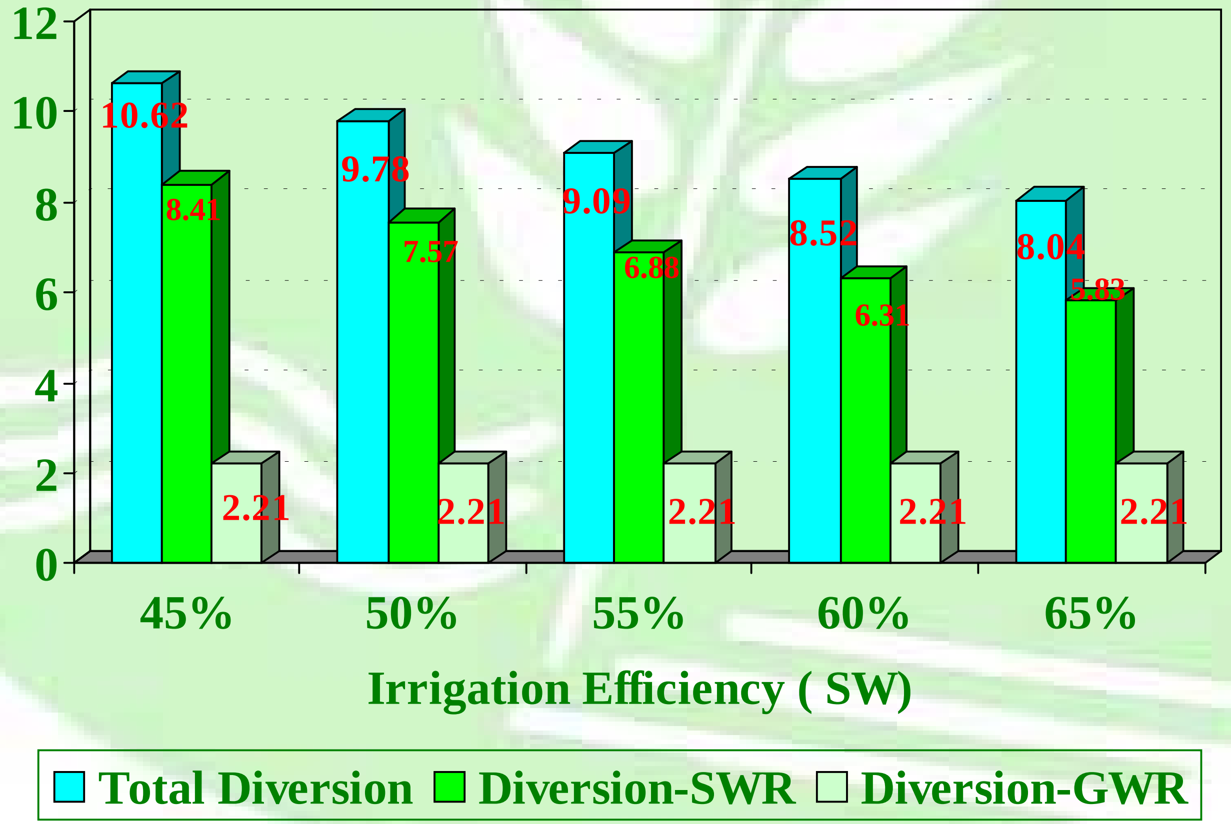
OVERVIEW OF DIVERSIONS
BRAHMANI BASIN



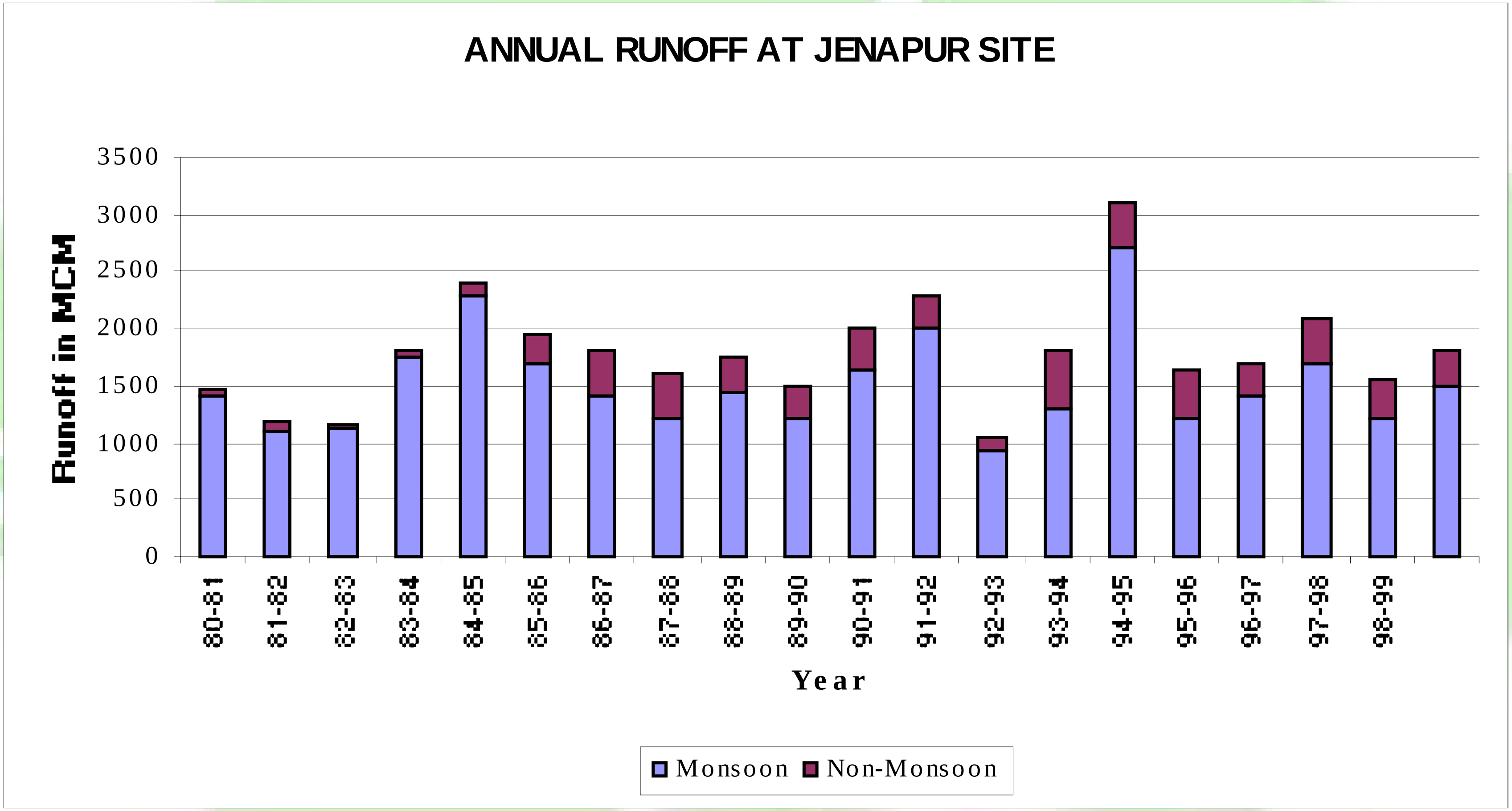
Irrigated Area by same amount of Surface Water (8.41 Km^3) - Brahmani Basin



Total Diversion for Irrigation Brahmani (Km^3)



ANNUAL RUNOFF AT JENAPUR SITE



Brahmani Basin- Two different approaches

Unit : Ml Cu metre

Scenario Diversion of Water		Study done by Sri A.D.Mohile, Ex. Chairman C.W.C.	Study based on Podium Model	% Variation
1995	Irrigation	4049.00	3800.00	- 6.55 %
	Domestic	324.72 for Year 2003	270.00	
	Industrial	322.00	322.00	Nil
2025	Irrigation	10297.00	9870.00	- 4.32 %
	Domestic	492.00	490.00	-0.04 %
	Industrial	1281.90	1282.00	Nil

Water Stress Indicators, level of development ignored at present.

Four indicators used.

Indicator 1: Withdrawals / total input to surface water.

Indicator 2: Returns / total input to surface water.

Indicator 3: Withdrawals / total recharge to ground water.

Indicator 4: Returns / total recharge to ground water

1&3- quantitative, 2&4 - qualitative stress.

Summary of the WSI evaluations

- Surface water resources

S. No	Basin	Total input input $10^9 m^3$	Total returns $10^9 m^3$	Total with-drawal $10^9 m^3$	Returns/ Input (ratio)	Withdrawal/ Input (ratio)
1	Indus	185	3	42	0.02	0.23
2	Ganga	525	19	146	0.04	0.28
3	Brahmaputra	633	1	12	0.00	0.02
4	Subarnarekha	12	--	4	0.0	0.33
5	Mahanadi	50	1	13	0.02	0.26
6	Godavari	126	3	21	0.02	0.17
7	Krishna	99	3	26	0.03	0.26
8	Pennar	7	1	7	0.14	1.0
9	Cauvery	28	2	19	0.07	0.68
10	Tapi	18	1	4	0.06	0.22
11	Narmada	51	1	7	0.02	0.14
12	Mahi	13	0	2	0.00	0.15
13	Sabarmati	6	0.5	2	0.08	0.33
14	Brahmani	30	0.3	3.6	0.01	0.13

Summary of the WSI evaluations

- For Ground water resources

S. No	Basin	Total input $10^9 m^3$	Total return $10^9 m^3$	Total withdrawal $10^9 m^3$	Return to input (ratio)	Withdrawal to input (ratio)
1	Indus	48	33	29	0.69	0.60
2	Ganga	251	115	118	0.46	0.47
3	Brahmaputra	33	7	2	0.21	0.06
4	Subarnarekha	4	3	2	0.75	0.50
5	Mahanadi	23	9	6	0.39	0.26
6	Godavari	49	15	12	0.31	0.24
7	Krishna	37	17	10	0.46	0.27
8	Pennar	9	5	2	0.56	0.22
9	Cauvery	22	13	8	0.59	0.36
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	0.40	0.80
14	Brahmani	9	2.1	1	0.23	0.11

Basin classification by Water Stress

Class description	Value of indicator	Basin
a) Very highly stressed through surface withdrawal;	Indicator 1>0.8	(Pennar)
b) Highly stressed, through surface withdrawal	0.4 < Indicator 1<0.8	(Cauvery)
c) Moderately stressed, through surface withdrawal	0.2 < Indicator 1<0.4	(Indus, Ganga, Subarnarekha, Mahanadi, Tapi, Sabarmati)
d) Low stress, in regard to surface withdrawal;	Indicator 1<0.2	(Brahmaputra, Godavari, Brahmani)
e) Surface water quality, low stress;	Indicator 2 < 0.05	(All basins)
f) Surface water quality, moderate stress;	0.05 < Indicator 2 < 0.1;	(Cauvery, Tapi, Sabarmati, Pennar)

BASINS & WATER STRESS - continued.

g) **Groundwater very highly stressed through withdrawals:**
   Indicator 3>0.8   (Sabarmati).

h) **Groundwater highly stressed through withdrawals; 0.4<Indicator3<0.8 (Indus, Ganga, Subarnarekha).**

i) **Groundwater 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).**

l) **Groundwater quality under moderate threat; 0.2<Indicator 4<0.4; (Brahmaputra, Mahanadi, Godavari, Tapi,Narmada, Mahi, Brahmani)**

Conclusions

- **Sabarmati assessments are of relevance to Pennar, Cauvery, Indus, Ganga, Subarnarekha, Mahanadi and Tapi surface waters.**
- **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.**

Limitations of extrapolation

- **Large and heterogeneous basins treated as single entities.**
- **Secondary data from CWC do not account for imports and exports, e.g.- Pennar.**
- **Significant differences could arise when drawing inferences for future scenarios due to variations in attributes other than hydrological, e.g.- land and water constraints.**

RAIN-FED AGRICULTURE

There are two distinct groups; one in the far upstream above the reservoirs, the second in between the irrigated areas and the urban complex of Ahmedabad and Gandhinagar.

The lower one will get irrigated from Narmada waters. The upper one could partly be serviced from the lift systems under planning, based on surplus Narmada waters.

A large chunk will remain permanently rain-fed. Watershed development based on rainwater harvesting could help this area with moisture augmentation to allow one crop which could provide livelihood and reduce environmental degradation. Also, it could reverse rural-urban seasonal and permanent migration.

WATERSHED DEVELOPMENT, Rain-fed Agriculture

1. Most of the moisture adequate area is fully harnessed.
2. Remaining area is moisture deficient (0.4x) where yields are (0.3y).
3. High intensity rainfall - high evaporation rates - antecedent rainfall condition reduces infiltration.Threshold intensity, duration, frequency affect it. Can’t meet with all demands.
4. Dependability low; costs high, mortality is high.
5. Farmers don’t invest on other inputs in absence of irrigation.

WATERSHED DEVELOPMENT- continued.

6. In drought, prices rise but there is little production to sell. In good years, prices drop, harvests exceed subsistence needs, there are few takers.
7. Operates on a narrow band of possibilities.
8. Productivity can rise from say 0.8 to 1.4 t/ha. Can't replace irrigation.
9. Complementary. Use also in irrigated command for supplementation.

Some say that traditional wisdom is being allowed to die.

WISDOM DOES NOT DIE. IF IT IS DYING, IT IS NOT WISDOM.

Marry ancient wisdom with modern S&T outputs to reach new heights.

NEEDS- DRINKING, DOMESTIC, INDUSTRIES

Drinking and domestic - Presently urban sector is supplied 510 MCM. It is expected to rise to 1500 MCM by 2025 for the projected population growth. Rural population will grow relatively less. Presently, some 921 villages don't have source. This deficit will be removed through various schemes. Narmada waters will be used for these needs.

Industrial annual needs are expected to grow from present level of 100 MCM to about 300 MCM.

Out of the total need of 1800 MCM, 1200 MCM is expected to be met through surface including lift schemes; the rest through ground-waters.

All treated water will possibly be used for irrigation.

FLOODS

Flood prone area of the basin is close to the urban area of lower downstream concentration. By now, it is fairly well protected. A scheme for river front protection in Ahmedabad is under planning. It will be paying for itself through prime area development.

Remaining reservoirs will reduce floods further.

Increased urbanisation will call for improved efforts for urban drainage separately for storm waters as low lying area is filled up during the process.

FORESTS, BIO-MASS, MANGROVES

Forests lie on the north east fringe of the basin adjoining Rajasthan forests. Efforts for afforestation could result into increase from present area 9% to 12% area. Water needs will be met with by rainwater harvesting except where they could be provided through reservoir fringe irrigation.

There is little biomass growth around the riverine regime. With Narmada import, the situation will be much improved.

Mangroves covering about 79 ha are being preserved. With the terminal reservoir whole lot of new eco-system is expected to develop around its periphery.

SUMMARY

ICID-CIID

New model landuse based ET, useful to decide sectoral allocation. Inter-basin transfer important for deficit basins.

M&I waste main cause for eco-and GW- degradation . It needs treatment & recycling. Adopt zero effluent policy for industry.

Nature sector terrestrial consumption predominant. Runoff-sea high. Use MAR - (food / people need) for nature. Not otherway.

WRD redeploys river flow to terrestrial source. Should not grudge. Extrapolation based on new indicators for all basins.

Integration helps equity in all sectors for sustainable development. Integrate irrigation with watershed development.

No need to play one against other.