# International Symposium of the Inter-Academy Panel Water Program: "Enhancing Water Management Capacity in a Changing World"

Sao Paulo, Brazil, July 25-28, 2012

## Session II

## More with Less: Managing Water for Agriculture

Date: 25.6.2012, from 1020 to 1200 hrs

Chair: Daniela Mercedes Areliano Acosta (Cuba)

Speakers: Silvio Crestana (Brazil), C. D. Thatte (India), Jean-Marie Fritsch (France)

## Speech by Dr Thatte

# Daily Water Needs

**A human-being needs per day, for drinking: 3 litres, for domestic use: 40, for producing daily nutritious veggie food: 2000, non-vegetarian food: 10000 litres.**

**No wonder, agriculture accounts for 70 - 80% water use.**

**But must appreciate the water-food-energy Nexus.**

## Water for Agriculture, Colorful!

**Blue – SW (stream discharge) + GW (safe yield); Green – rainwater stored in soil and abstracted by plant roots; Grey – discharge from WW treatment plants; Silver – output of desalination plants. Also the Ever-Green (sustained food production), White (milk) revolutions.**

# More food production with relatively less water, managing water for agriculture

- For backlog, more mouths, less unused waters.
- Improve water use efficiency in both food / people sectors. Improve both supply / demand management (SM/DM).
- SM – increase supply against availability / potential developed through better: reservoir operation, distribution schedules, canal O&M. Artificial recharge of groundwater.
- DM – reduce gap between need / demand, improve crop pattern, irrigation methods, WUA, CADAM, awareness / participation.

# More with less (continued)

- Reduce water use to suit possible impact of CC, increase WLP, release water / land saved for people/nature sectors, avoid land spoiling.
- Land consolidation, increase holding size, wean pop away from agri.

The Session subject cuts across most of other sessions & hence is crucial.

Above all, recognise that water right goes with need and duties.

# WR use efficiency reflects level of Governance

**Water use / unit water supply. Basin efficiency accounts for reuse in d/s.**

**Proportion of volume of water coming out to that entering each component of Water System: viz. (S) storage, pump houses, (C) conveyance, (D) distribution, (A)application. Overall WUE efficiency = multiplication of ES, EC, ED, EA.**

**Other Contexts, (struggle between +ves, -ves), management (M) centric, relatively difficult.**

**WATER USE EFFICIENCY (WUE)- Scientific / Technologic / Engineering (STE), managerial, social contexts.**

**STE inputs: Infrastructure - development (D) centric, relatively easy for assessment. Efficiency = sectoral outputs / (STE + socio-economic) inputs. Give speedy - optimal results. Other contexts - sub-optimal, slower results.**

**Generally, developing countries display lower efficiency for different reasons. STE inputs there are OK. But other inputs are weak. Initial concentration was on augmenting utilities / assets, and less on WUE.**

# IWRDM and Food Security (FS)
# for
# in context of Developing world and India

## Coverage of Speech by Dr C. D. Thatte

**Security for - Food, Feed, Fodder, Fiber, Fish, Fuel**
**- staple crops, cotton, sugarcane, tobacco**

1. **FS related global events: starting with UN Env meet 1972 at Stockholm, Rio (1992), World Water Vision 1999, MDGs 2000, WEHAB 2002, ICID CPSP 2002-3 & FS 2005, Rio+10 VWT 2010, WWF (Mar 2012), Rio+20 SDGs (2020), Qatar CoP (June 2012).**

2. **Population, poverty, suicides, mal-nutrition, water/land productivity, food basket: needs-demands-supplies.**

# Coverage of Speech by Dr Thatte (continued)

3. Role of IWRDM, AWR, scarcity, VW, trade, irrigation – mega to micro scale – options - intra / inter basin transfers, surface / ground waters, trade-offs.

4. India status present/ultimate. Strategy for adaptation to climate change.

5. Socio-economic – political –legal – environmental issues.

6. Prospects & suggestions for plenary session.

# World Events, 1992 - 2012

Agenda 21, twelve dealt with WR, 18th- Freshwater, World Water Vision (FPN) exercise mounted by WWC / GWP and Water related organisations in 1999.

MDGs followed next year (by 2015, reduce poverty, hunger, thirst, unemployment by half).

WEHAB adopted at Rio+10 (Johannesberg), VWT.

ICID – CPSP (FPN), FS (2005). WWF – FS 2012.

Now Rio+20 (16-19 June: dialogues, 20 June - State Heads), SDGoals. COP 18 – Qatar?

An innovative, multi-stakeholder WR Group set up recently at IFC (World Bank), by WEF (Davos).

For FS, a side issue 'CC' - Carbon emissions protocol – voluntary, non-binding, aspirational; responsibility –common but differentiated.

Yet, UN WATER COURSES convention unratified (10 more needed). Not entered force!

Famine can recur. Conflicts growing but must be defused. Wars may not as demonstrated by prudence of WR professionals / politicians. Build a Negotiators' cadre.

# NUTRITION - FOOD SECURITY, in kcal/capita

(Human Food Basket: carbo-hydrates, proteins, fats, vitamins, minerals through: cereals, vegetables, pulses, nuts, roots, fruit, oilseeds, milk, meat, fish, poultry) + cash crops: cotton, cane, tobacco.

World: 2860 kcal.

Developed World: 3500.

Developing world: 2700: India, (like entire world) needs doubling of food production (to 500 Mt) in 2050. Tied up with poverty line, buying capacity?

MDGs to reduce insecurity by half in 2015. Slide back - Needs urgent steps to make-up.

Instrument for thought



# Integrated Water Resources Development and Management (IWRDM)

**Natural resource needs development to meet spatial/temporal deficit. Management follows.**

**(Covered food & rural dev., drinking water / sanitation, urban dev., CC.)**

1. **FACILITIES: structures- MEGA to MICRO, each at its place; intra-interbasin.**
2. **DEMANDS and SUPPLIES (SW/GW, u/s & d/s, within/inter-basin).**
3. **Beneficial needs - CONSUMPTIVE & NON-CONSUMPTIVE- F, P, N.**
4. **Socio-economic, environmental, institutional, legislative, equitable, administrative, financial.**
5. **Assessment, planning, augmentation, conservation, O&M, RECYCLING and REUSE, MODERNISATION, REPLACEMENT, safety.**
6. **BENEFITS / COSTS to produce maximum at minimum cost, more with less.**
7. **RIVER-BASIN as a planning unit.**
8. **HUMAN & ECOSYSTEMS.**

# Integration with synergy for fruition

- For IWRDM we need synergy of: 6 Ms – Man, Machine, Materials, Money, Methods, Management; 5 Es – Economy, Efficiency, Efficacy, Ecology, Education.
- Through it alone, we achieve IWRDM that is safe, durable, with long service/economic life to speedily augment Goods & Services, provided by nature.

# RIO MANTRA - 2



## SUSTAINABLE DEVELOPMENT



## for WEHAB (Water, Energy, Health, Agriculture, Biodiversity)

Economic development decisions without compromising capacity of future generations to take own decisions. Ensuring funds for infrastructure and sustenance of services. Building resiliency, flexibility in decision making. D&M to meet needs of ultimate population, without irreversibly affecting resource base. Plans for intra & inter-basin development, augmentation, use, conservation, treatment, reuse; to counter natural disasters.

Participatory, inclusive approach for SHs & Civil Society. None left behind.

Transparency. A discrete mix of Top down / Bottom up approaches.

Need to develop Performance Indicators (UN), IHA protocol. Rio+20?

Precautionary Principle (PP) is by and large incorporated in compensating uncertain impacts.

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Involve local community, deploy S&T. Develop transparent institutions / regulations. Introduce Grievances Redressal Authority (GRA - SSP), improve Governance.

## If and when fully 'Integrated', WRD becomes 'Sustainable'.

Such **Development** has to be – techno-economically viable, socially needed / acceptable, environment conserving and eco-friendly. **Tailored to sustain LIFE & not just development on earth. Also must be inclusive – no one left behind.**

If one tries to satisfy 3 conditions simultaneously and fully, one may get **sub-optimal or sustained under-development**. Is it not like the fabled cow that yields more milk, consumes less fodder, and has short horns?!

**Trade-offs are inescapable and balance between the 3 is needed.**

# 3rd Rio Mantra – Equity

**Defined as – fairness / balance in meeting needs with supply, application of principles of justice to correct / supplement rules. Both intra and inter-generation equity (rights of future against rights of present). But, are Natural Resources fairly distributed?**

**Human effort essential to make it fair. Perhaps users relocation is needed! But, 'right' comes with 'duty' to meet with needs.**

**Irrigation: i) Spatial equity - Spread over large rural area - below a contour for flow, and above it at justified affordable cost for lift. ii) Per capita entitlement / water right – depends upon land entitlement.**

**Rural W/S: Physical endowments dis-similar.**

**Urban & industrial W/S: Concentrated in pockets.**

**Nature and energy sector: Users are dispersed.**

**Is relocation of users possible to bring it about?**

## Key Targets (2015-20), set by WWF 6 Marseilles (March, 12)

1. Increase LP/WP of rainfed area in Af/As 20/15%.
2. For irrigated area, increase yearly yield (kg/cub m/ha) by 15%.
3. Decrease unit cost of WM to get higher yield.
4. Increase safe use of PQW (WHO/UNEP/FAO guidelines) 25% (2015).
5. Enhance environmentally sufficient and socially sound storages.

## Specific

6. Deal with 2 hot-spot aquifers of countries.
7. Develop 2 macro-regional visions.
8. Provide care for small-holder farms.

**May be considered for adoption in Plenary Session.**

# Rio+20, recommendations on Water Dialogue

**WWC affirmed underlined issues.**

Strengthen solidarity financing mechanisms.

Adopt more ambitious global policies to address the needs for water that is really safe and for sanitation.

Expand and strengthen global mechanisms for the monitoring of water, sanitation and hygiene.

Implement the right to water. Promote sustainable water usage and health.

People need access to sustainable water and hygiene to ensure the sustainable growth of a nation.

Build a common vision and adopt an action plan at the global level regarding wastewater management. Improve water and sanitation facilities to ensure the education of children.

Secure water supply by protecting biodiversity, ecosystems and water sources.

Assert the importance of integrated water, energy and land-use planning and management at all scales.

Put water at the heart of future development goals.

# Challenges / Opportunities

- **Drought creeps, floods sudden. Damage potential. Kennedy, President IAHR – feminine rivers. Care / Respect – bliss/bounty, neglect – disaster.**

- **Archaic laws. Water, GW- Easement, LAQ & R&R, market forces, tenancy, urban land ceiling, long term leasing.**

- **Transform affected population into beneficiaries. Massive funds for infra/healthcare, shun nexus: politicians – business – bureaucracy – curb corruption, controls, liberalise. 50% self employed worker force, weaker sections of society (ST/SC/Minorities - victims. Not allow cornering of natural resources by 'haves').**

**Let me recapitulate legitimate achievements of water sector professionals in the last 60 years, while population grew 3 times in countries such as India):**

**banishing of famines; drought-flood proofing; reversal of desertification; growth in food-milk-sugar-non food produce; substantial reduction of hunger, mal-nutrition; increase in water/land productivity, immense growth in w/s for drinking, domestic, industries; growth in energy generation.**

**Three main water user sectors & nature of use C/NC : food (C), people (NC), nature (C) – plant life, NC – residence for animals.**

# Food Security (FS)

**Water, Land, Energy, Climate, Disasters – Natural inputs/drivers for food production.**

**Agriculture, Process, Storage, Prices, Trade, Governance – External inputs to sustain production, meeting with minimum nutrition level for healthy & productive life, with requisite growth in terms human population.**

**Availability, Access, Stability – 3 pillars of FS.**

**Agriculture uses WR consumptively. FS calls for its optimal use ensuring high Water/Land Productivity (WP/LP) WLP in kg / cub m of water / ha of cropped land.**

- Household Food Security (FS) requires – Availability of food supply, Stability of production, Access (buying?).
- National FS requires: self-sufficiency on internal production, self reliance with adequate trade balance. (China example.), silos, rotting.
- Global FS: declining production (WP/LP) growth rate, stocks (>20% to care for lows, CC, disasters, wars).
- Urbanisation of rural / agri area, agro-based industry.
- Industrialisation, economic growth, consumption, wastage, increasing feed for meat.
- Poverty line, subsidy

# Management of Risks

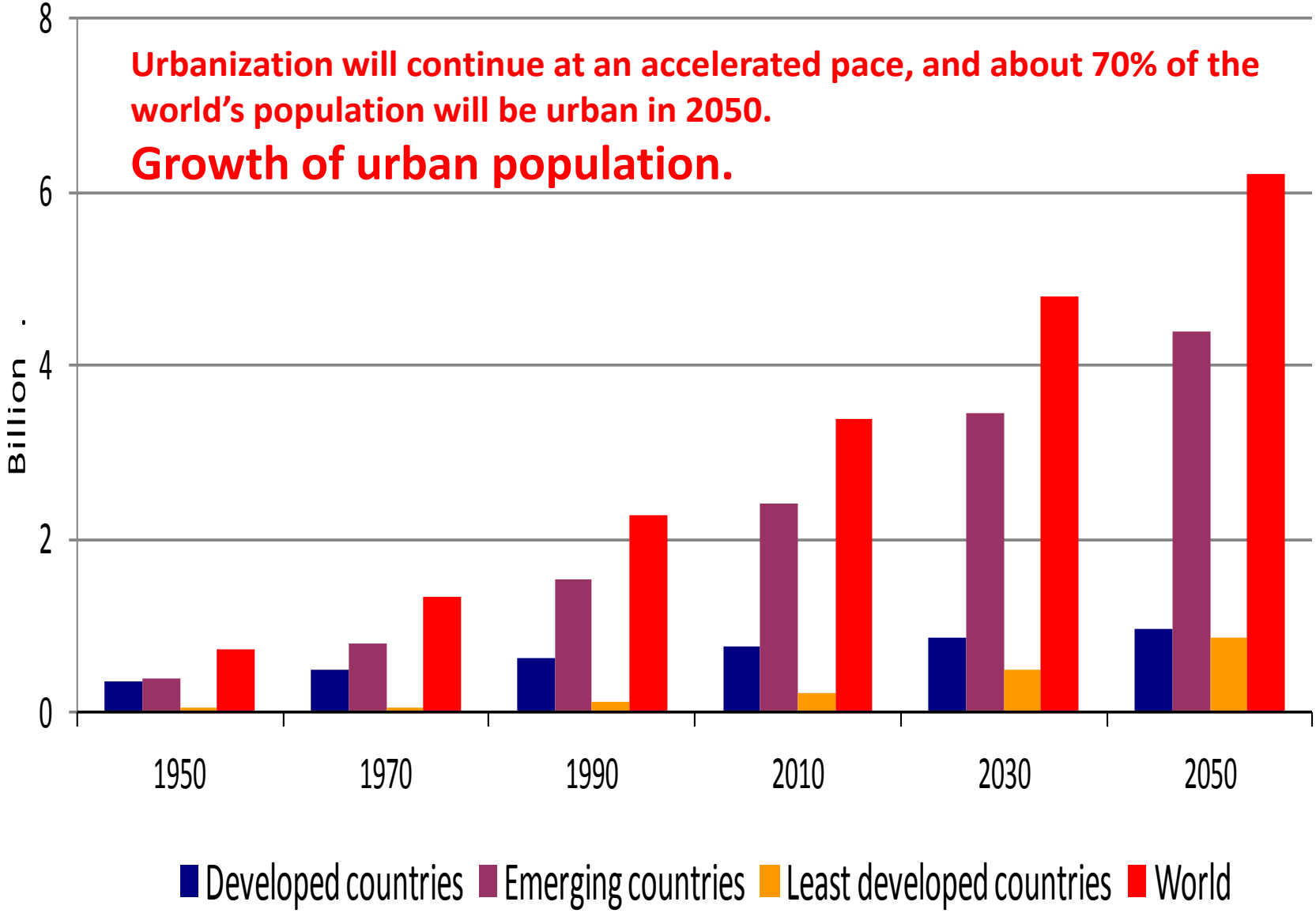
- **Risks - agricultural land (LP): flood, drought, water-logging, salinisation, loss of forests – bio diversity, fertility, pollution, reduction in availability.**
- **Risks - agricultural waters (WP): new storages & water transfer difficult, pollution, growth in PQW & its recycling, inequity in supply, CC, uneconomic use, wastage. Uncertainty – RU/KU.**
- **Neglect / discrimination is perceived in handling risks. Calls for courage, determination, foresight. Cost of inaction high, due to risk & uncertainty.**

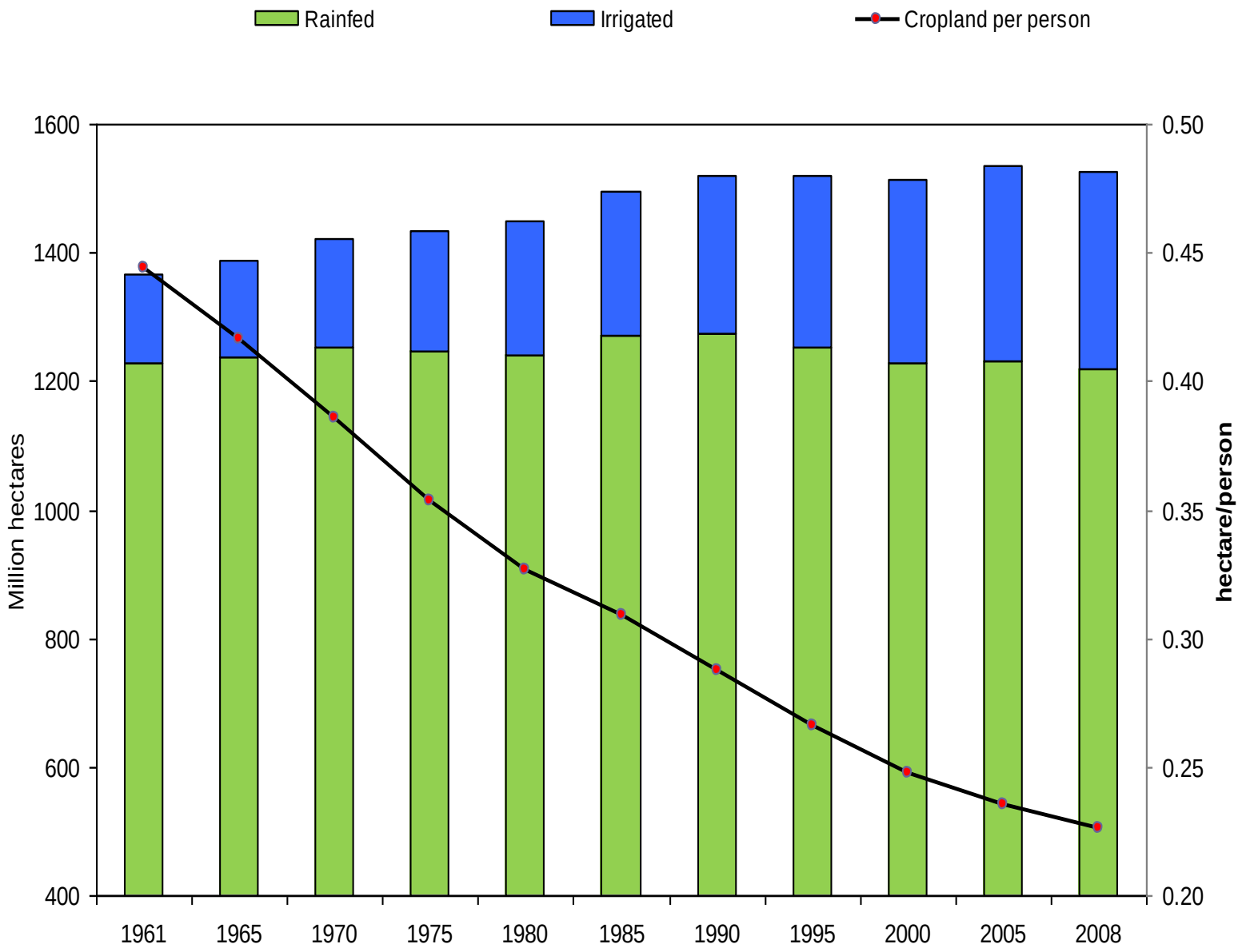
# Population, Under-nourishment

- **World population grew to 1B in 50 centuries, 2B by 1730, 3B by 1960, 4B by 1975, 5B by 1986, 6B by 1999, 7B in 2010-11.**
- **May grow & stabilise at 9-10B by 2050. Present growth mostly in Developing / LDC.**
- **Presently 1 B out of 7 B (10-12%) is under-nourished, in Developing countries, proportion is about 20%, in sub-Saharan LDCs it is 35-40%.**
- **Children < 5 yr age, girl child, women, aged – vulnerable.**
- **Urban/rural divide.**

**Urbanization will continue at an accelerated pace, and about 70% of the world's population will be urban in 2050.**

## Growth of urban population.






**Evolution of cropland surface area between 1961 and 2008 (FAO, 2011c).**

# Strategy for FS (ICID 2005)

| Countries | Self-sufficiency | Economic Growth | Population | WRD Status | Govt | Strategy |
|---|---|---|---|---|---|---|
| LDC | Low | L | H | L | L | Infrastructure |
| Emerging | Suff | M | M | M | M | Infra-IWRDM |
| Developed | Surplus | H | L | H | Good | Trade |

**Last 50 years, food production doubled, due: expansion of cropped / irrigated area; intensive cropping; increased yield – seeds, crops; improved WM.**

**Last 2-3 decades increased emphasis on WSD / RWH. Moving away from Infra Dev to improved WUE / WM. But can move water, not people.**

**Shared rivers – UN convention needs 10 more signatories. No need to 'cry wolf'.**

# Water Management Status

- **Global cropped area = 1534 Mha. 18% irrigated, 12% drained = 30% WM, for 70% no WM (rain-fed), yet. Partly provided with WSD/RWH, but more vulnerable to CC, provides Green Water with lower economic value, compared to Blue Water.**
- **Its dependability low. ET disproportionately high. Affects R-R-R for d/s. Water productivity (kg/cub m) relatively low. Yet, serves local areas for other needs also.**

## PODIUM - IWMI

### Global 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**

# Agriculture, Industry, Services sectors contribution in % of GDP

## SOME SELECTED COUNTRIES

**Indicators: With economic progress, i) agri % reduces, ii) pop % in agri reduces, iii) land holding (ha/farmer) increases.**

Argentina - 5, 28, 67

France - 3, 23, 74

Brazil - 9, 31, 61

I Venezuela – 5, 36, 59

Japan - 2, 36, 72

Italy - 3, 26, 71

S. Korea - 5, 44, 51

Mexico - 5, 28, 67

Russia - 9, 36, 55

UK - 1, 25, 74

China – 18,49, 33

Zambia - 25, 24, 51

India - 28, 26, 40

Pakistan - 27, 23, 50

Zimbabwe - 20, 25, 55

# Annual Water Availability (AWR) - cub m/cap/year.

**People spread unevenly in basins. Growth also uneven.**

**(Falkenmark 1989, definition for temperate climate. Flood/Drought? No account for storages / development that make it available. IWMI – closed basins? Not really.)**

- **If around 1700, shortage is local and rare.**
- **If less than 1000, well being & economic development problems arise.**
- **If less than 500, it is a primary constraint to life.**
- **In both China, India, and African countries, several basins have AWR less than 1000 cub m. Declining due to population.**
- **In 1800 AD, AWR India was 7000, in 2009 it may be 1300, in 2050, it may be only 1000. Eschew alarmist view. (Sabarmati)**
- **But, decline is not felt due to storages / energy / GW etc.**

# AWR (continued)

**UNCSD 1997- annual withdrawals / AWR, if greater than 40%, country was considered water scarce.**

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

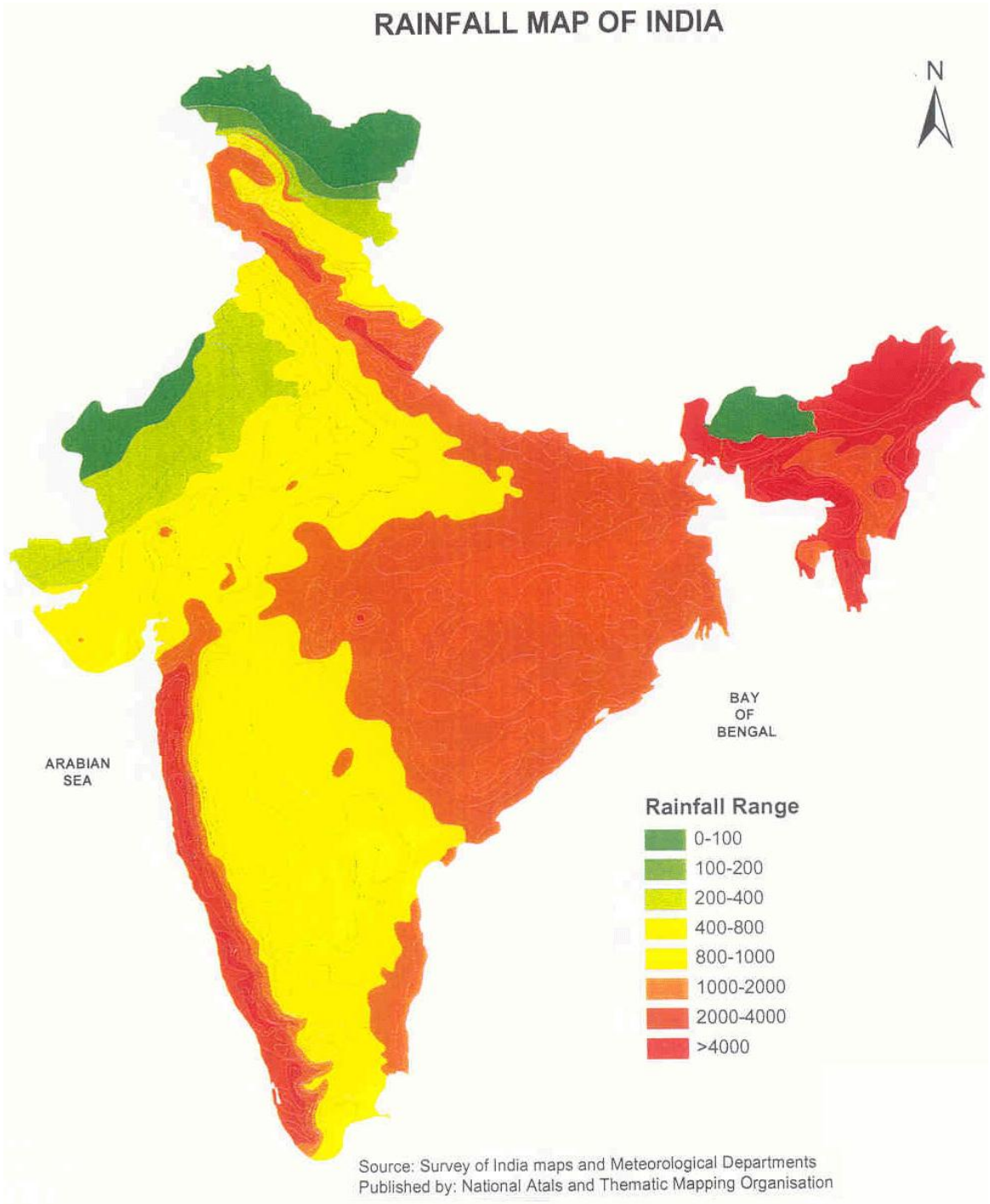
**IWMI INDICATORS revised 2002 in 3 groups of 45 countries covering 83% of world population. : I - 33% people may have physical scarcity even with maximum of efficiency and productivity. Will need imports, desalination, transfer from agriculture, aid. II - 45% people will face economic scarcity. Will need funds for development of storages more than 25%of present. III - 22% of people may increase productivity and not need more water. Some will need less.**

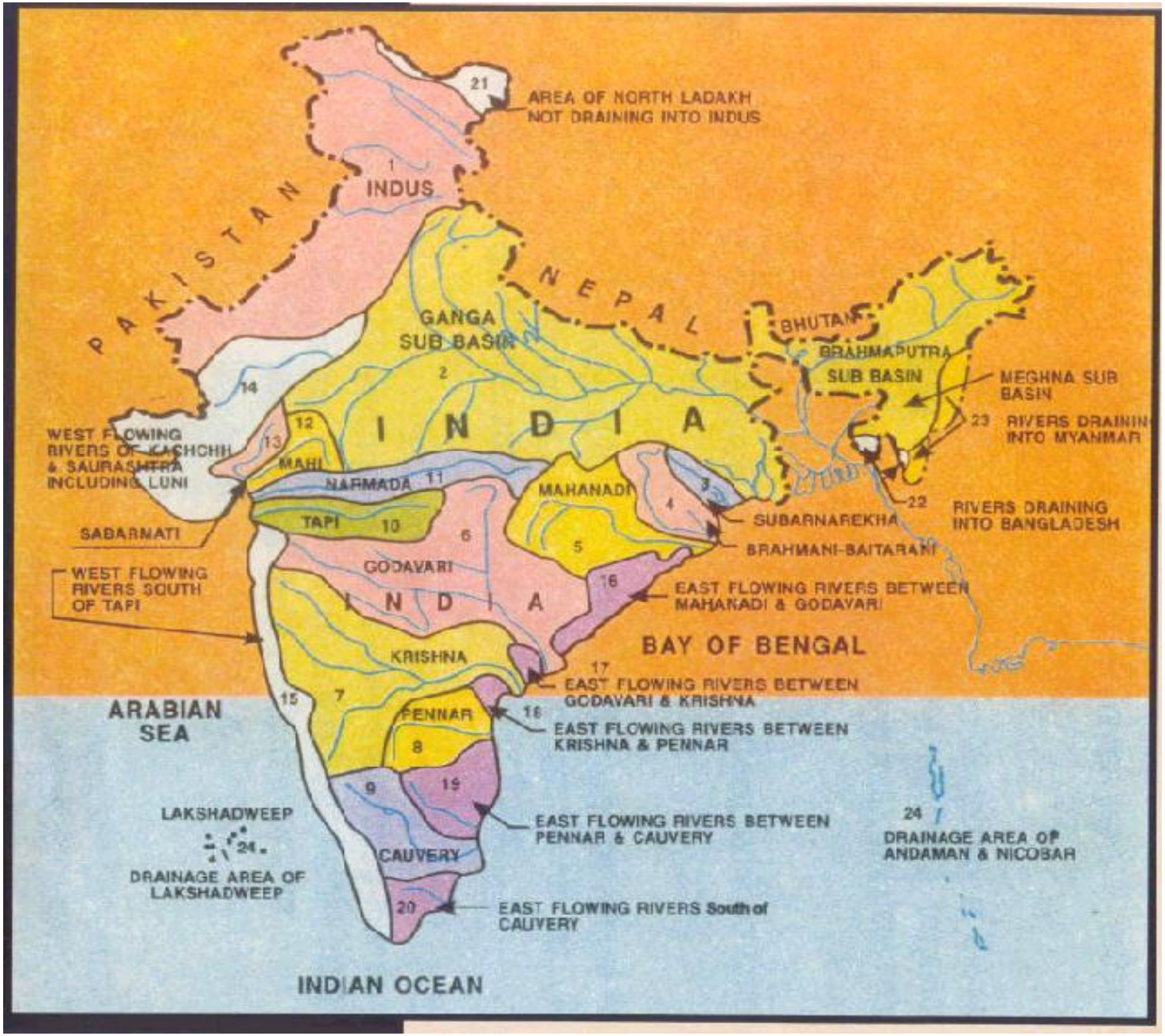
# World Countries, Water Thresholds

Depending upon national income (high to low), water needs vary from low (1300) to high (1900) cm pc py. Same time, proportion of agriculture needs rise from 70 to over 90%, while municipal needs drop from 8 to 3%. Situation grave where pop. growing.

Shared rivers between and within nations remain a concern in spite of UN Convention. Still, shared interests avoid Wars & conflicts.

In the meantime, scholars continue to grapple with definitions to describe water availability: scarcity, stress, strain, characteristic curves, water modulus, poverty, footprint, virtual / shadow, closure of basins. However, no attempt to harmonise them. Also some use a color code for source: Blue, Green, Grey, silver.


RAINFALL MAP OF INDIA
N
BAY
OF
BENGAL
ARABIAN
SEA
Rainfall Range
0-100
100-200
200-400
400-800
800-1000
1000-2000
2000-4000
>4000
Source: Survey of India maps and Meteorological Departments
Published by: National Atals and Thematic Mapping Organisation


21
AREA OF NORTH LADAKH NOT DRAINING INTO INDUS
1
INDUS
PAKISTAN
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
16
EAST FLOWING RIVERS BETWEEN MAHANADI & GODAVARI
BAY OF BENGAL
KRISHNA
17
EAST FLOWING RIVERS BETWEEN GODAVARI & KRISHNA
15
7
ARABIAN SEA
PENNAR
18
EAST FLOWING RIVERS BETWEEN KRISHNA & PENNAR
8
9
19
EAST FLOWING RIVERS BETWEEN PENNAR & CAUVERY
24
DRAINAGE AREA OF ANDAMAN & NICOBAR
LAKSHADWEEP
24
DRAINAGE AREA OF LAKSHADWEEP
CAUVERY
20
EAST FLOWING RIVERS South of CAUVERY
INDIAN OCEAN

## India Water Account

**Annual Rainfall = 1170 mm, Precipitation = 4000 BCM, Runoff = 1900 BCM, Exploitable 1200 + 300 (IBWT) BCM, Presently Developed = 600 BCM. Remaining Potential adequate for 2050 AD, if developed quickly and managed adequately. Time short.**

# BENEFITS - KALPSAR PROJECT – terminal structures for future.



- Irrigation
- Tidal Power Generation
- Domestic and Industrial water supply
- Saline land reclamation for agriculture, habitats
- Groundwater recharge & better water quality
- Transportation, short route to Saurashtra
- Fishery
- Navigation

# 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

**Spatial / Temporal variability large. Storages inescapable.**
**Inter-basin transfer of water : a key need**

# STORAGES IN INDIA

**Discrete combination of mega to micro / multi to single purpose.**

**Existing major, medium = 177 BCM, Under construction & ongoing = 76 BCM, proposed = 70 BCM, Total= 323 BCM,**

**Likely sedimentation by 2050 = 53 BCM. Nett available = 270 BCM, total storage needed= 450, Nett to be added= 180 BCM. Better sediment management undertaken. BAGLIHAR, CHAMERA. Fish culture – migration – passes. Redistribution.**

**Conventionally identified dams will add 132 BCM, non-conventional dams will augment 48 BCM.**

**In addition to the present 4000 large dams, India will need another 2500 large dams. Just think status without dams.**

**One can't imagine Maharashtra minus Koyna, likewise India's States without dams.**

## LIVE STORAGES REQUIRED (continued)

**HP IC deficit is about 9%. India consumes av. 240 units, world 2000 units. Minimum energy deficit about 20%. Multiplier 1.9.**

**All villages to be electrified by 2007, households by 2012 – under programme 'Power for All'. Aims to achieve in 10 years, what was achieved in 50 years.**

**India 200, USA/Australia 5000 cub m/capita storage.**

**Addition to Live Storage essential in India but progress is slow. Storages – remain a 'dirty' word even after WC against Dams (WCD). Damage is not undone. Need for advocacy groups all round the country. Professional bodies have a major responsibility.**

# Storages in some countries compared with India

**Arid Rich Countries : Australia (4733), Spain (1410), USA over (5000) cub m / capita. Carryover – Hoover (also Nile & others).**

**Middle income countries like Brazil (3145), Russia (6103), Turkey (1739), South Africa (753), Mexico (1245), Morocco, China (1111) about 1000 cub m / capita.**

**India at about 200 cub m / capita. Possibly lowest amongst G7 countries. Practically no carry over.**

**Hydropower potential tapped in industrialised countries is over 80% of their economically viable size. In India it is about 20%.**

**Some European countries totally dependednt on HP.**

# INDIA'S LAND RESOURCE, IRRIGATION & FOOD PRODUCTION

India has 2% of world's land, 4% of freshwater, 16% of population, and 10% of its cattle. Present Rural/Urban population : 65/35, Ultimate 2050 could be 45:55?

Geographical area = 329 Mha of which 47% (142 Mha) is cultivated, 23% forested, 7% under non-agri use, 23% waste. About 33% should be forested. Logic? Firewood collection – a major cause for cutting. Provide solar cookers!

Several Hydro projects held up as feared to be affecting eco-sensitive zones. Mechanisms being developed. Green technologies remain un-deciphered. Tissue-culture considered for conserving exotic species. Bio-technology to rescue.

Waste land is to be reclaimed, may remain rain-fed. But, some rain-fed land will receive irrigation.

Gross irrigated area with in-basin development may reach 115 Mha, but rise to 140 Mha with IBWT.

# INDIA - LAND, WATER, FOOD - continued

Per capita availability of land 50 years ago was 0.9 ha, could be as low as 0. 3 ha in 2050.

India land ownership (perpetual lease) with individuals. China, with STATE, less difficult. India Land Acquisition Act 110 year old, under revision - includes R&R complex process.

In 2050 AD (ultimate), irrigated: rainfed proportion could be 50:50 producing 75:25 of 500 M t of required food. Land consolidation, weaning away people from Agriculture necessary to upgrade LP.

Land rate appreciates with irrigation. LAQ has to provide for sharing it. Proposal for part payment / part renting is being considered.

# CPSP: Basin classes (12 nos.) by Water Stress

## Need to modify definition of closed basins

| | 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)

# SECTORWISE WATER REQUIREMENT TILL 2050 (BCM)

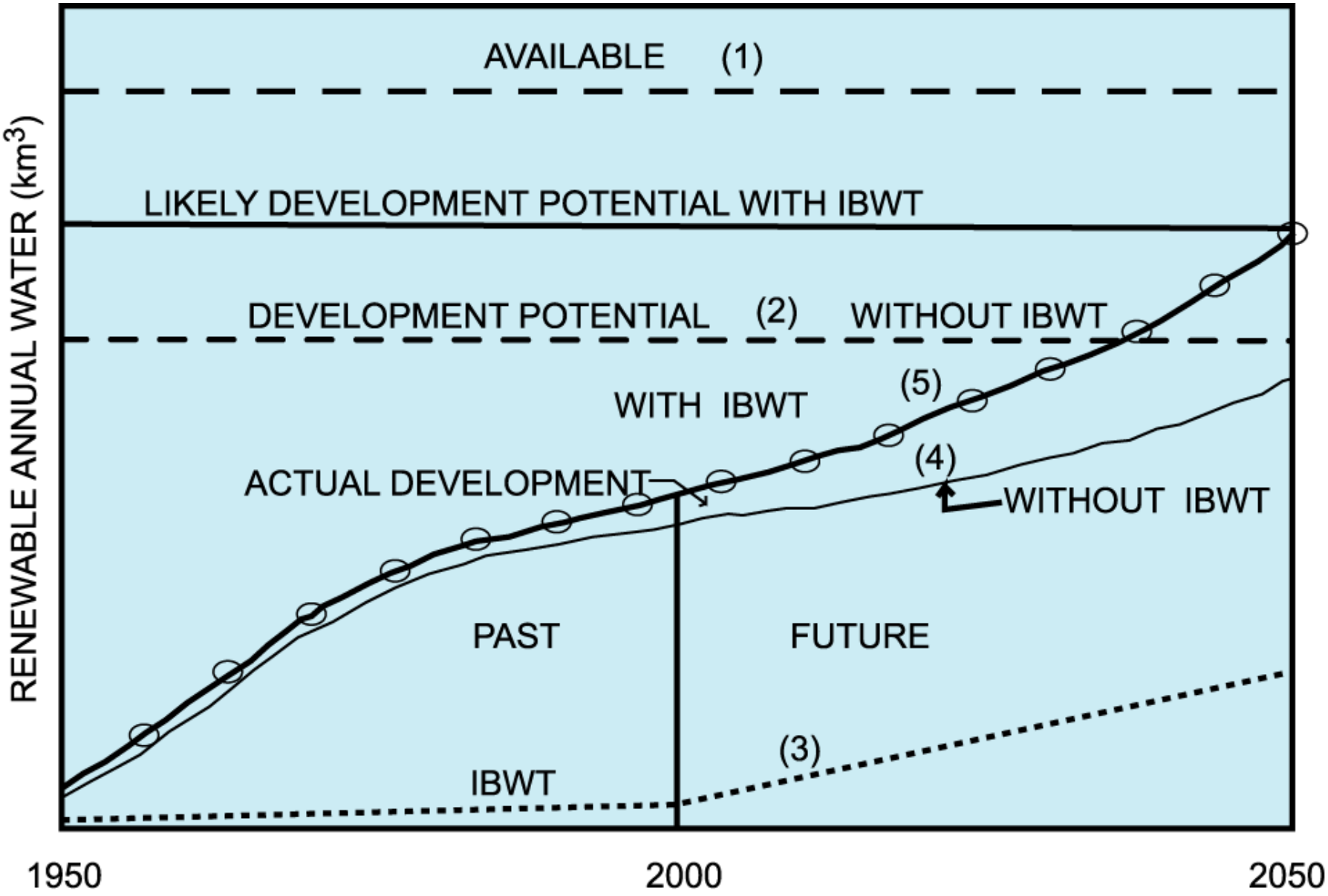
| SECTOR/YEAR | 1998 | 2010 | 2025 | 2050 | Growth |
|---|---|---|---|---|---|
| Irrigation | 524 (83) | 550 (77) | 590 (73) | 770 (68) | 1.4 |
| Domestic | 30 (4) | 43 (6) | 59 (7) | 100 (9) | 3.3 |
| Industry | 30 (4) | 37 (5) | 67 (7) | 81 (7) | 2.7 |
| Power | 9 (2) | 18 (3) | 32 (4) | 68 (6) | 7.5 |
| Navigation | 0 | 7 (1) | 10 (1) | 15 (1) | |
| Ecology | 0 | 5 (1) | 10 (1) | 20 (2) | |
| Evap / Losses | 36 (7) | 42 (7) | 50 (7) | 76 (7) | |
| Total | 629 (100) | 702 (100) | 898 (100) | 1130 (100) | |

*Note: Figures in brackets indicate proportion (%). Practicable increase in efficiency and productivity accounted in the figures.*

**INTER-BASIN WATER TRANSFER – Not a magic wand. On-going in isolated manner for more than 100 years. Now envisaged as a programme in India. Salient Features below.**

- **Drought proofing & reversal eco-degradation – 2.5 lakh ha.**
- **Flood peaks will reduce by about 30% due to reservoirs.**
- **Gross irrigation potential will go up from 140 to 175 Mha.**
- **Hydropower installed capacity – Addition of 34000 MW.**
- **Drinking, M&I needs – About 12 BCM of Water-Supply.**
- **Reversal of migration, rural - urban : about 5 crores people.**
- **WRD presently hampered, gets alternative IBWT route.**
- **R&R – about 5 to 7 lakh people.**
- **No hostile species of flora expected to move inter-basin.**

# A TYPICAL SCHEMATIC FOR IWRDM (IBWT)



## ULTIMATE IRRIGATION POTENTIAL (Mha)

| Sector | Present Plans | Revised |
|---|---|---|
| M&M | 58 (51) | 58 (41) |
| Minor | 55 (49) | 82 (59) |
| **Total** | **113 (100)** | **140 (100)** |
| Minor- surface | 15 (13) | 18 (13) |
| Minor-ground | 40 (36) | 64 (46) |

(Note: WUE in minor sector is relatively high. But reliability is lower.)

## Table - 3.22

### Future Foodcrop Yield Projections

(in tonnes per ha)

| Year | 2010 | 2025 | 2050 |
|---|---|---|---|
| Rainfed foodcrop yields | 1.1 | 1.25 | 1.5 |
| Irrigated foodcrop yields | 3.0 | 3.4 | 4.0 |

*Source: See text.*

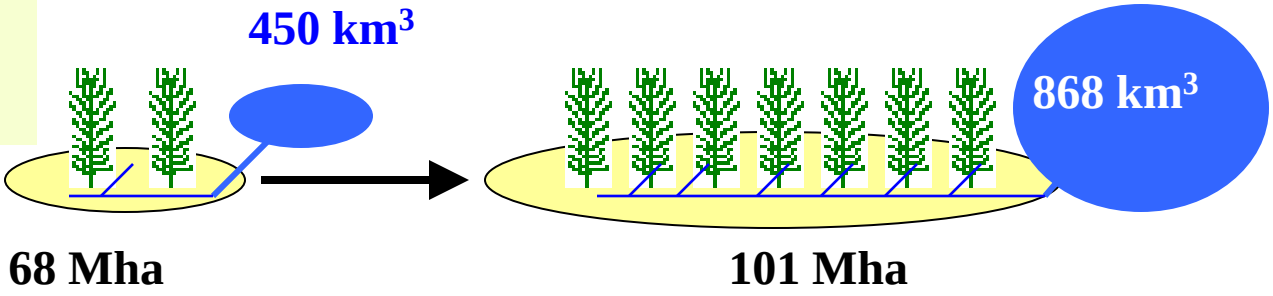
## ENHANCING PRODUCTION FOR FS (510 MT)

| | |
|---|---|
| Water use efficiency, drainage, saving | - 30 |
| Fertiliser use efficiency | - 30 |
| Reclamation, soil health care | - 40 |
| Realignment of cropping pattern | - 30 |
| Rain-fed area (WSD) | - 30 |
| Expansion of irrigation, ILR | - 100 |
| TOTAL | - 260 |

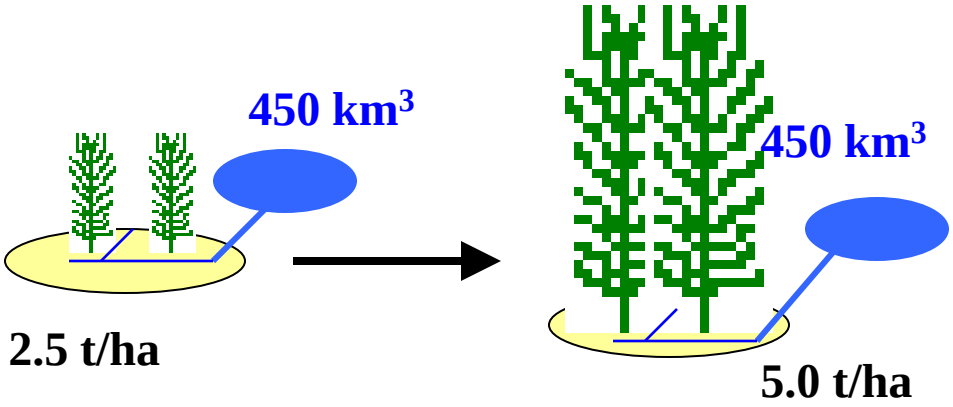
***D&M ought to go on hand in hand.***

## Options for IRRIGATION

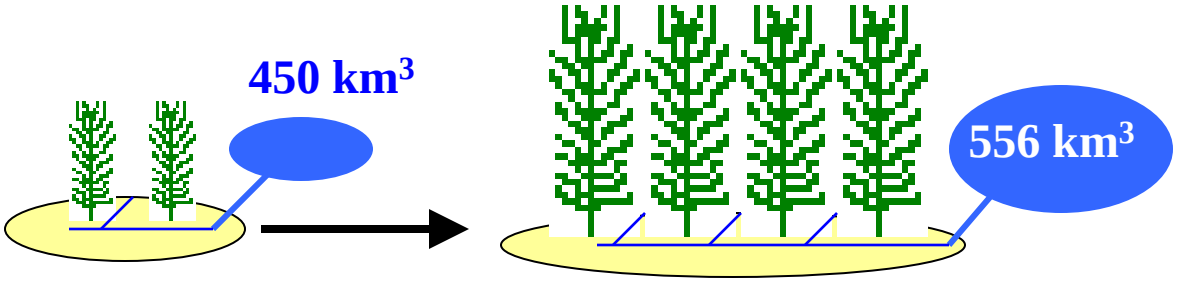
# 1. Area Increase:




# 2. Yield Increase:




# 3. Middle:



# Where will the water come from?

- New infrastructure- dams (key structures in WRD) & canals, intra & inter-basin.
- Basin terminal reservoirs – Kalpsar (Gujarat)
- Groundwater – under-developed basins.
- Water savings - increase in efficiency, reduce evaporation – demand – consumption.
- Recycled wastewater from domestic & industries use.
- Increase water productivity - crop per drop; treat, recycle drainage water.
- Trade (virtual water), import food.
- Enough for needs, not greeds.

# Food / Cash crops / Ethanol

Now, need to assess competition between food / cash crops (sugar/ tobacco / plantations / ethanol (maize/molasses/bagasse/food grains). It is critical if the cash crops consume 7-10 times water against food crops. When food production is in deficit, demand for with-drawl of irrigation water supply for cash crops to food crops grows.

Brazil an exception using over 55% cane produced for ethanol largely exported(?), South-Central Brazil producing 85% of cane. But it is a rain-fed crop, unlike India where it is an irrigated crop using heavy water dose.

May be only 10% of India's cane is used for ethanol. Large proportion of sugar / jaggery / molasses produced consumed as such. No chance of growth in ethanol. Effort to divert coarse grain for ethanol raises increase in market price which is counter-productive.

Decision has to be based on tradeoffs between food/cash crops, also on international prices of oil, food, sucrose.

# Agriculture, land use, WLP

- Only a small fraction of agriculture dependent population has a choice of leaving land fallow, as India has small operational holdings.

- Though urbanisation is fast, absolute rural number is not declining. Weaning away people from Agriculture is slow. Mechanisation too.

- **As rural population may not stabilize soon, a large proportion will continue to depend on agriculture; land use may intensify, leaving little chance for increase in farm size.**

- Though studies show that the average farm size increase is a function of GDP growth rate, it seems it will take longer in India, contributing to delayed LP.

## Anomalies

- **Water-rich regions in India are fed by water-scarce regions; water scarce regions are agriculturally prosperous, with high productivity.**
- Peninsular India has high per capita arable land, but low water availability. It can be cultivated, if irrigation water is made available.
- So, transfer water from surplus to such deficit regions, even if it is at the cost of reducing renewable water.
- This would make the country food surplus as overall water resource utilization & gross cropped area increase

# Anomalies - contd

- Small water harvesting structures are neither hydrologically feasible, nor economically viable in naturally water-scarce regions.
- Naturally water-scarce regions have low mean annual rainfall, fewer rainy days, high inter-annual rainfall and stream flows variability. The RWH/WSD/AR schemes there, are too expensive and water supply from them is unreliable.
- More importantly, as river basins in such regions are "closed", negative downstream impacts are caused. The economic viability of WHS reduces further with increasing system capacity

# Anomalies - contd

- A lot can be done in rain-fed areas to enhance agricultural production, merely by focusing on rain-fed crop varieties.
- However, world over, improvements in crop technologies and water management have come from irrigation which sustains crop yields.

# WATERSHED DEVELOPMENT, Rain-fed Agriculture

**(Ref: Hargreaves, Seckler, M Dinesh Kumar, Katyal)**

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 reduces infiltration.Threshold intensity, duration, frequency affect it.
4. Dependability low; costs high, mortality high.
5. Farmers don’t invest on other inputs in absence of irrigation.

## WATERSHED DEVELOPMENT- continued.

6. In drought, failure. Prices rise. 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 in irrigated command.

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Some say that traditional wisdom/culture is being allowed to die.

WISDOM DOES NOT DIE. IF IT IS DYING, IT IS NOT WISDOM. Is 'Traditional' necessarily 'Appropriate'? If so, when population was a third, why imports. No culture keeps people hungry / mal-nourished / deprived.

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

## CAD PROGRAMME- (demonstrative, motivating)

STARTED IN 1974-75 TO PROMOTE INTEGRATED, COORDINATED DEVELOPMENT OF IRRIGATED AREA WITH **OFD WORKS, AGRI INPUTS, EXTENSION SERVICES** through multi-disciplinary teams below outlet level, where main constraints were seen.

THRUST AREAS IDENTIFIED WERE: **REDUCE GAP BETWEEN Potential Created (PC) and Utilised (PU), INCREASE AGRI PRODUCTION, INCREASE PRODUCTIVITY.**

ONGOING M&M PROJECTS increased over years, several not getting completed.

**It has caused thin spreading of resources.** Although a state subject, centrally sponsored . How long? Core components covered under Central Sector. States did not provide matching funds.

**RESULT IS PARTIAL COVERAGE OF PROJECTS.**

## CAD CORE COMPONENTS

Field channels, Warabandi, Field drains, Land leveling/shaping.

PIM –WUAs set up, mostly at minor level. Lot remains to be done. Coverage is unbalanced & due to largely, legislation and WB intervention.

Reclamation of Water Logged Area in M&M Projects included in CADP as late as 1996

OUT OF approx WATER LOGGED AREA OF 2.5 Mha in India, CADP aimed at covering a sample area. Seemingly coverage of one scheme varies from 4 ha to 800 ha, treating part of the malady, never making it possible to reclaim comprehensively any waterlogged area.

Another instance of thin spreading. Total revamp necessary.

# Global Sanitation History

**In 1950's drinking / domestic water supply was easy to achieve. Treatment of waste generated lagged behind. Lot done, backlog substantial, plus growth, much more remains.**

**1st toilet seat 1600, Cholera 1857, Drainage schemes 1859-65, Filtration 1868, Trickling filter 1901, Secondary treatment 1920-40, Nutrient removal – activated sludge – digester – post 1960.**

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## Developing world / India

**Fast urbanisation, migration, industrialisation. Gap increasing.**
**Open defecation, squalor. Liquid /solid waste collection, transport, treatment, recycling, reuse. Phyto-reed based sewage treatment (NEERI).**

**One child dies every 9 minutes due to mal-nutrition and water borne diseases.**

**Biggest degrader, poverty, pollutants. Need for quicker economic growth.**

**ADDITION OF NEW INFRASTRUCTURE SLOWED DOWN. EXISTING INFRASTRUCTURE IS FAST AGEING. INADEQAUTE O&M. SUSTAINABILITY AFFECTED.**

**GW lowering, Reservoir Siltation, Overuse of Irrigation-water.**

**CRISIS OF GOVERNANCE. FREE LUNCHES –WATER & ENERGY. LOW CHARGES. POOR RECOVERY.**

**CAD, IMT, WUA, WUE – SLOW PROGRESS.**

**Public funding reducing. 23% in 5$^{th}$ plan to 16% in 9$^{th}$ plan.**

**OVER-EMPHASIS ON SOFT OPTIONS : participatory approach, peoples participation, demand management, WSD-RWH, local resources at the cost of basin plans, transparency.**

***Notwithstanding prejudiced opposition, there is acute need for -***

**Growing more crop per drop, improving WUE through micro & precision irrigation, expanding and intensifying Irrigation & Drainage,**

**Soil conservation.**

**Treating and recycling waste water. Go for zero effluent.**

**Integrating 3 sectors of water use. Improve efficiency. Mopping up conjunctively surface and ground-water in-basin and inter-basin resources through storages.**

**Resolving water-sharing disputes in spirit of co-operation.**

**Economy/ Ecology: Eikos- Home: Practice / Science. Avoid exploitative nature of economic growth, make it inclusive**

# AGENDA

**Plan and complete basinwise structural measures - Mega to Micro. Expedite resolution of inter-state disputes. Increase WUE, cut losses, enforce conjunctive use, ensure supply equity, participatory WUAs in all sectors, IMT, reclaim waste land, consolidate land holdings. Continue with food & energy sufficiency agenda. When surplus help Africa.**

**Treat pollution at source, including lining of solid waste dumps & recycle waste-water, go for zero-effluent strategy for industry, try bio-remediation, nano-technology, provide regional piped w/s for villages, stop washing in rivers. Go for PSS, claim carbon credits for avoided deforestation, set up RBAs. Promote agro-industry to increase GDP contribution.**

**Remember mankind is at the centre of eco-system, not an outsider - adversary!**

# SUMMARY

- Get to know water sector – fascinating, complex, challenging.
- Need to finance infrastructure – new, upkeep of existing.
- Integrate food, people, nature sectors for SD.
- SD & trade-offs. O&M, WUAs, WMT, WUE, Audit - A/C.
- Plan & implement from whole to part and back to whole.
- Care for human needs, curb greeds. Humans will care for nature. Ensure sustainable service & full cost collection.
- Make every PAP, a IWRDM beneficiary.
- STE as corner-stones. Social – economic – environmental care is the edifice. Everybody is fallible – French Revolution.
- Nobel Laureate Khurana's mantra – Work Hard. Harder.