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Water - Energy - Food Nexus Governance Adaptation to Climate Change

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Water - Energy - Food Nexus Governance Adaptation to Climate Change

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In collaboration with
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Agriculture in 20th century

- Green Revolution of 1960s
- Global food production increase 2.5 to 3 times
- Only 12% in cultivated area
- India- 50 million tons to 200 million tons
- Even after green revolution, 56% increase in food production
- Cereals -energy use i.e fertilisers and water use i.e irrigation

Aftermath of green revolution

Depletion of natural resources

Soil degradation

Greenhouse gas intensive agriculture

Agriculture has reached plateau

As we entered, 21st Century Climate Change started impacting agriculture negatively

India's Climate Change Vulnerability

- India : population- around 1.3 billion- soon to become most populous country - creating pressure on natural resources.
- Vulnerable to Climate Change
- Impact on Food security
- Impact on poor and marginal farmers, especially women.

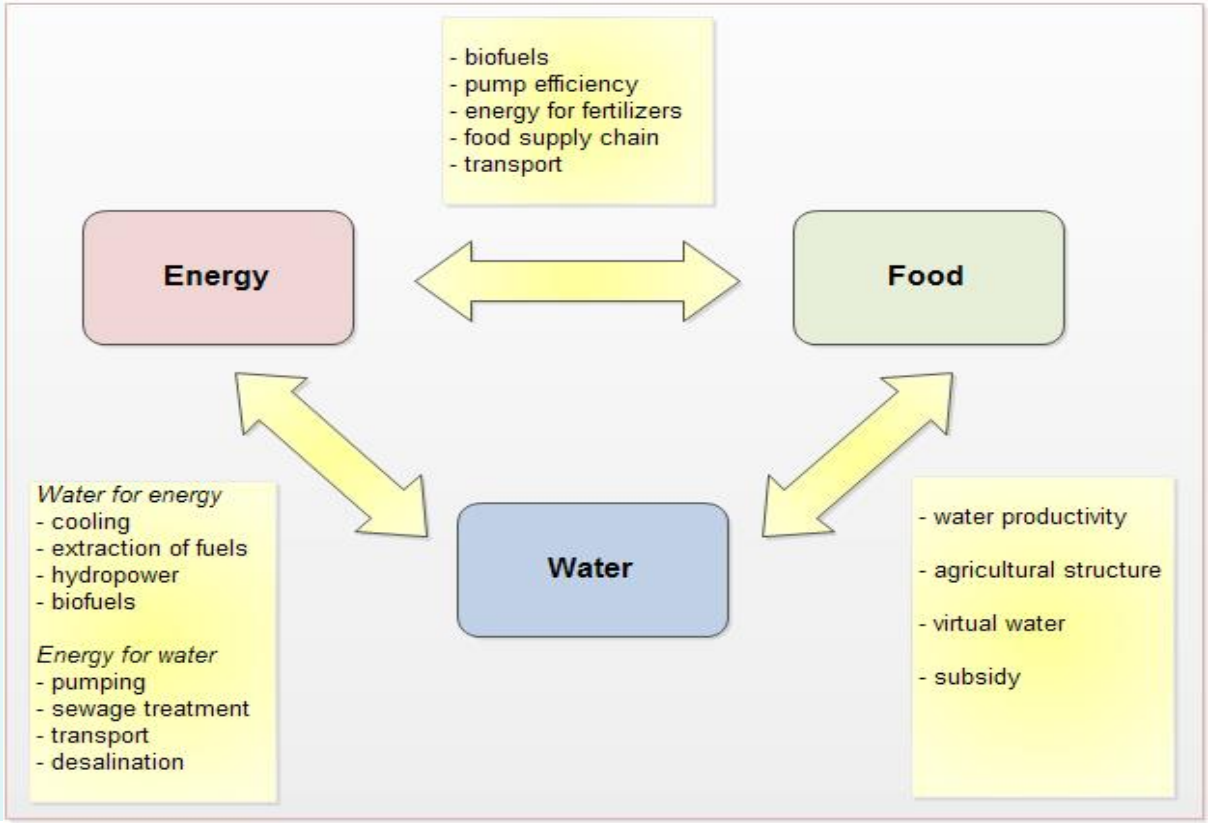
- **Impacts of Climate Change**
- **Reduction of Agriculture Yields in Medium term (2010-2039): upto 4.5- 9%**
- **Fall in GDP growth in Medium Term: up to 1.5 % per annum**

(Venkateswarlu et al, 2013)

- **Reduction of Agriculture Yield in Long Term (2040 and beyond) : > 25% if no measure is taken. (ICAR, 2009)**

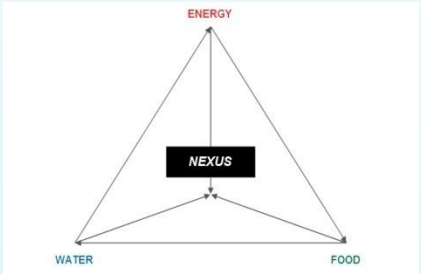
Water, energy and food resources

- Water, Energy and Food are inextricably linked
- Water is a major input for food production
- Energy is required to produce and distribute water and food; to pump ground water, to power tractors & agric machinery and also to process, transport food



- Food production is the largest user of water at the global level, responsible for 70–90% of consumptive blue water use
- Water for energy currently amounts to about 8% of global water withdrawals (45% in industrialized countries, e.g. in Europe).
- Food production and supply chain is responsible for around 30% of total global energy demand

Why these three resources?



…unsustainable pressures on these 3 strategic resources

Source: Adapted from Bazilian et al 2011

•These primary resources WEF represent global risks for agriculture in 21st century/climate change
• The approach to WEF depends on perspective of policy makers
• If W perspective is adapted- F & E are resources
• from a F perspective, E & W are inputs
• From E perspective, water and as well as bio resources are input

Some of the descriptive elements of WEF nexus include;
• All three areas have billion of people without access
• All have rapidly growing demand
• All have resource constraints
• All have different regional availability and variations in supply and demand
• All have strong inter-dependencies
• All operate in heavily regulated markets

For today's discussion I look from Water perspective; one calorie food, one liter water

Water is essential for agriculture

One apple – 70 liters

1Kg Vegetables 200 liters

One slice of bread – 40 liters

50 gms beef steak-2025 l[illegible]

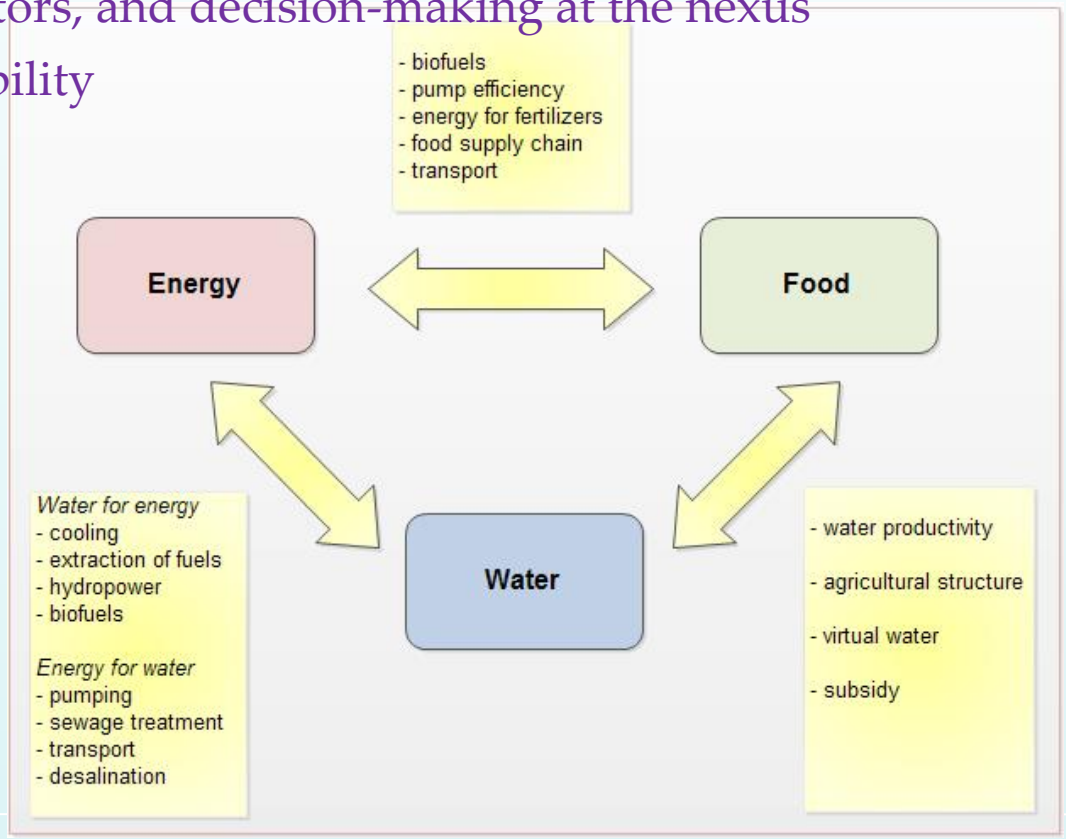
The Nexus Approach

Management of WEF have traditionally examined by researchers and addressed by policy makers in isolation of one another

Nexus approach recognizes interconnectedness of water, energy, and food across space and time. Its objectives are:

- Improve energy, water, and food security
- Address externality across sectors, and decision-making at the nexus
- Support transition to sustainability
- Multi sectoral/dimensional

The nexus approach is necessary because of projections and challenges



WEF projections and challenges

- Food demand to surge by 70% by 2050
- Population growth (70 per cent) to reach 9.5 billion by 2050
- Increased per capita calorie intake (30 per cent).
- Global meat demand increase by 60 per cent by 2030.
- About 90% increase of food production from intensification.
- Availability of Arable land!!!
- By 2050, irrigated agriculture covering 16 % cultivated land with 44% production.
- Greater competition for water from other sectors could reduce the water by 18 %
- Climate change impacts on agriculture
- Global energy demand is projected to increase by 80% by 2050.
- Energy and the food system, including land-use change, account for almost half of global greenhouse gas emissions.
- Overall, emissions will increase by 50% between 2012 and 2050.

Some 580 billion cubic meters of freshwater are withdrawn for energy production every year. This amount account for 15% of the world's total water withdrawal, coming right after agriculture. By 2035, energy consumption will increase by 35%, which will consequentially increase water consumption in energy sector by 85% (US Energy Information Administration-EIA)

Key challenges of WEF nexus and Climate Change in India

- Increasing population and declining agricultural land
- Stagnating or declining food production
- Increasingly water- and energy-intensive food production in the face of water and energy scarcity

Principles of Climate Change adaptation

Climate change adaptation should be made more relevant to policy

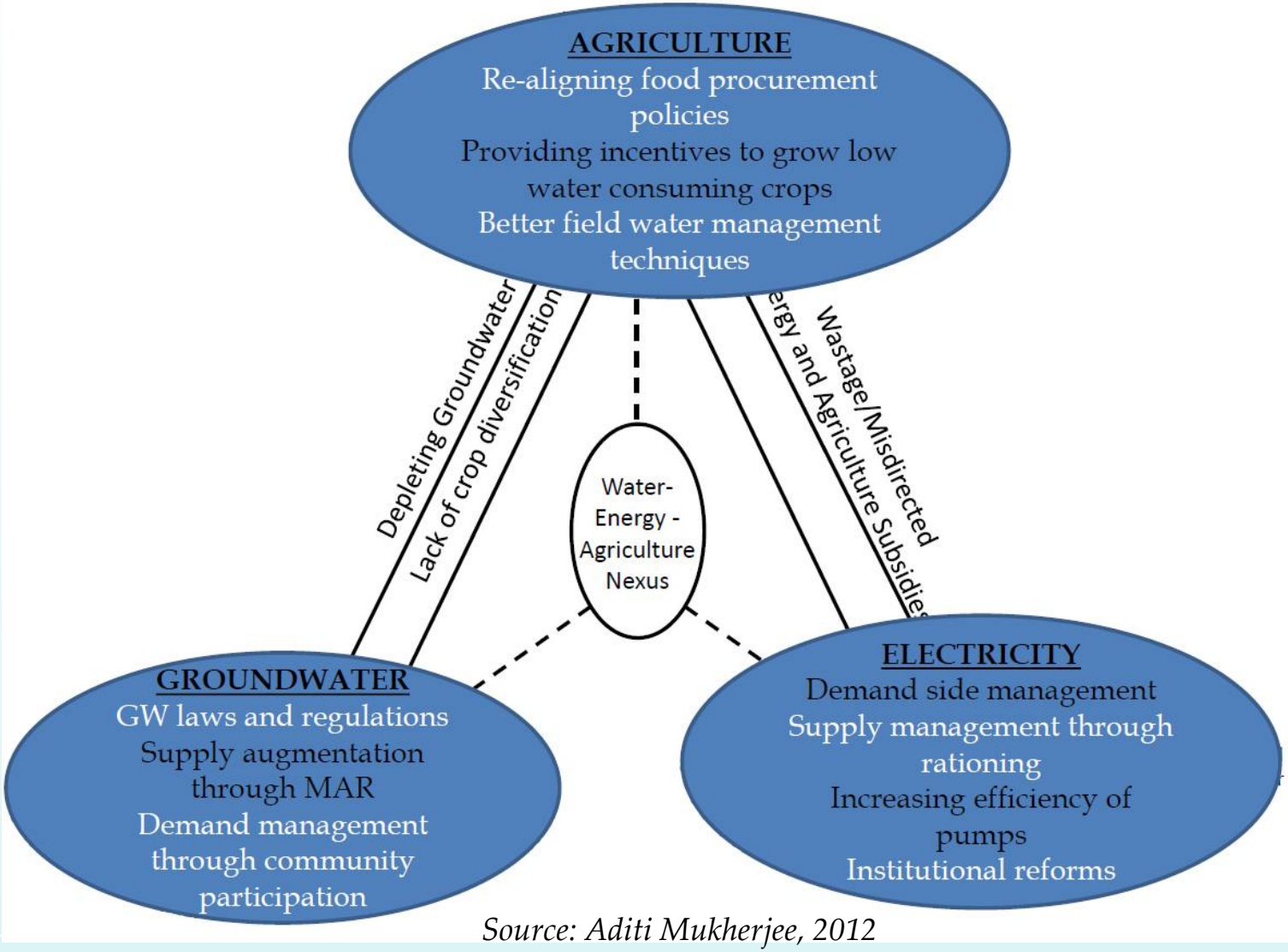
- Adaptation entails measures that reduce poverty and vulnerability and enhance long-term resilience in a changing climate.
- Adaptation comprises actions that strengthen the adaptive capacities of the poor, including the management of the natural resources on which their livelihoods depend; manages risks; and uses resources in an efficient and sustainable manner to meet the needs of present and future generations.
- Adaptation in one sector or by one community does not undermine the resilience of others.
- Adaptation responses and mechanisms do not undermine long-term sustainability.

Water and Energy in India

- India characterized as a **'high water risk'** region (World Resources Institute, 2016)
- **90% of total water withdrawal** emanates **from agriculture** (FAO-, 2016)
- However, irrigated land in India as a proportion of total agricultural land is 36.3%(World Development Indicators 2016)
- **Water use efficiency**, varies between **35-40% for surface water** and between **65 to 75% for groundwater** (Ministry of Agriculture 2013)
- At current trends it is projected **availability of water for agricultural use may be reduced** by 21% by 2020 (Indian Agricultural Research Institute, 2016)
- **Groundwater** is an important source of irrigation, with pumps and tubewells increasingly using **electricity** to pump out water (Minor Irrigation Statistics Wing, 2014)

Governance of WEF Nexus

From Governance point of view, some focus areas for integrated solutions in WEFN.



Source: Aditi Mukherjee, 2012

Solution for Water-Energy-Food Nexus

Opportunities for improving water use efficiency in the energy sector

- Increasing the use of renewable energies
- Increasing resource productivity
- Developing multi-use reservoirs
- Reducing fresh water demand in energy production

Opportunities for increasing energy use efficiency in water production and delivery

- Shifting from fossil fuels to renewable energy
- Increasing the use of co-generation plants
- Desalinizing brackish water
- Using waste as a resource in multi-use systems

Key pathways to agriculture with WEF nexus

Employing sustainable production methods

Changing diets

1 kg weight increase; 7 kg for cattle;, 4 kg for pork, 2 kg for chicken

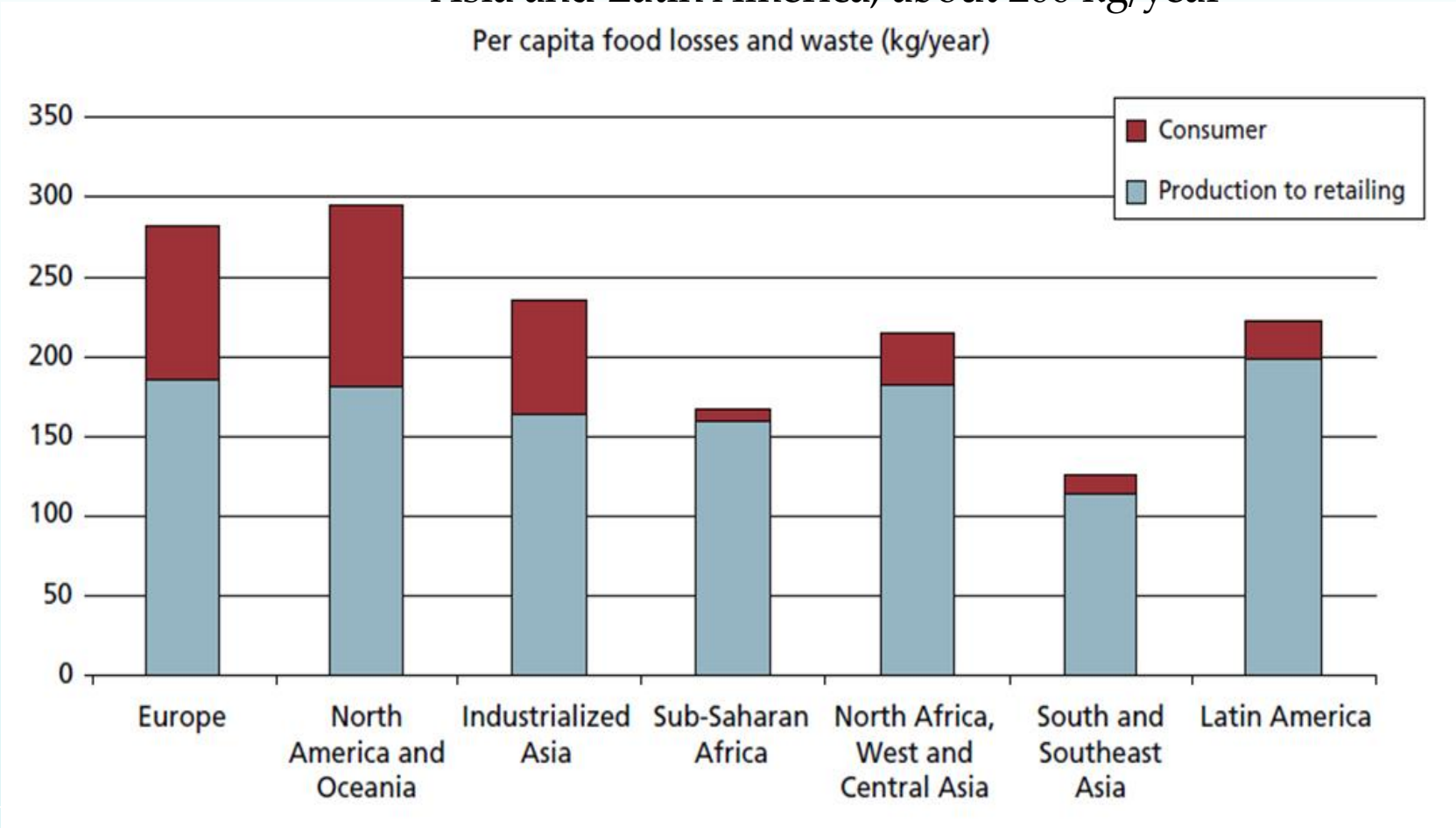
Reducing losses & wastage

Saved = Produced

Can meet challenge beyond 2050

Per capita food losses and waste, at consumption and pre-consumptions stages, in different regions

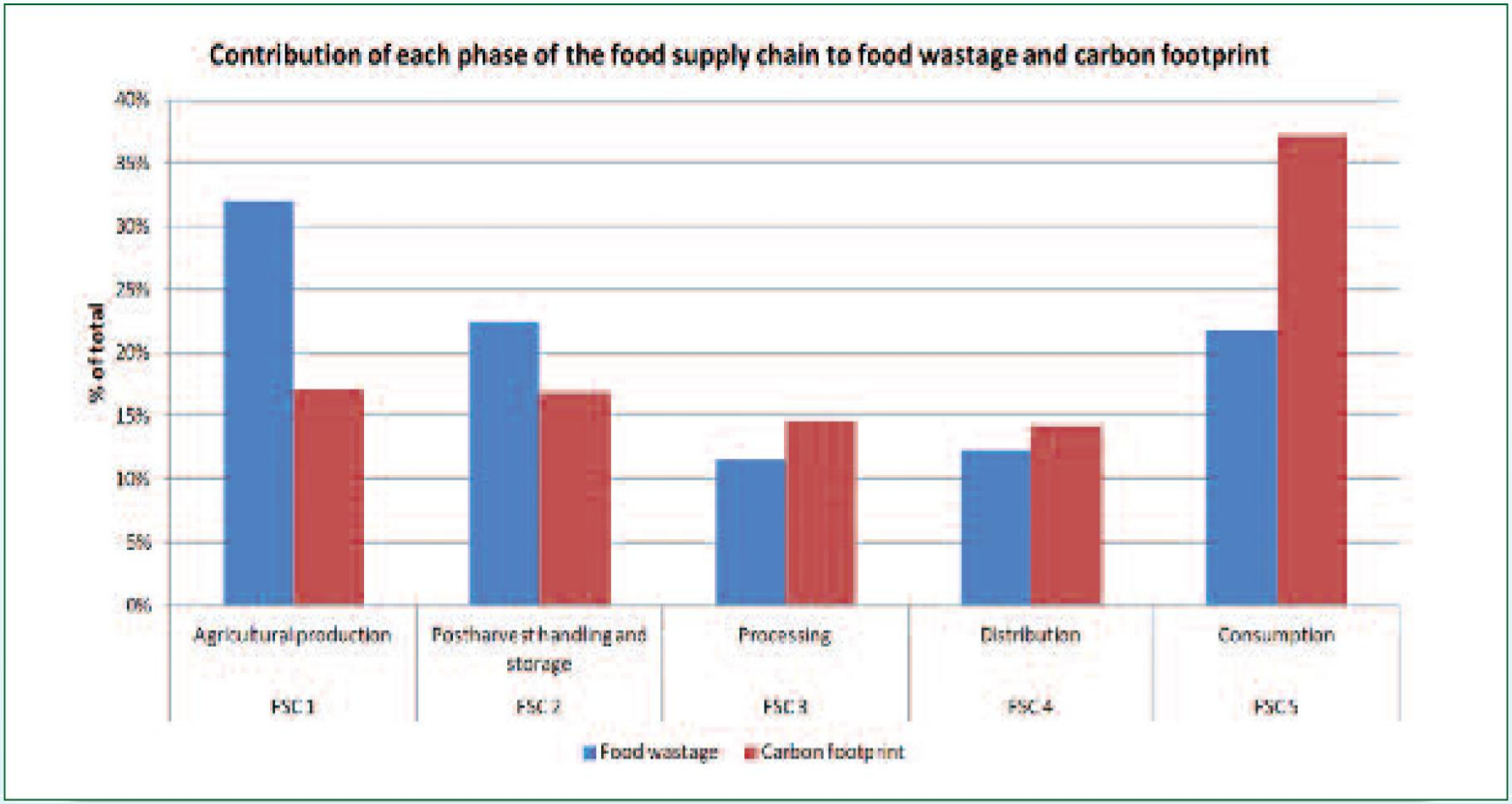
Per capita food losses and waste at pre-consumption stage are higher in Asia and Latin America, about 200 kg/year



Contribution of each phase of the food supply chain to food wastage and carbon footprint

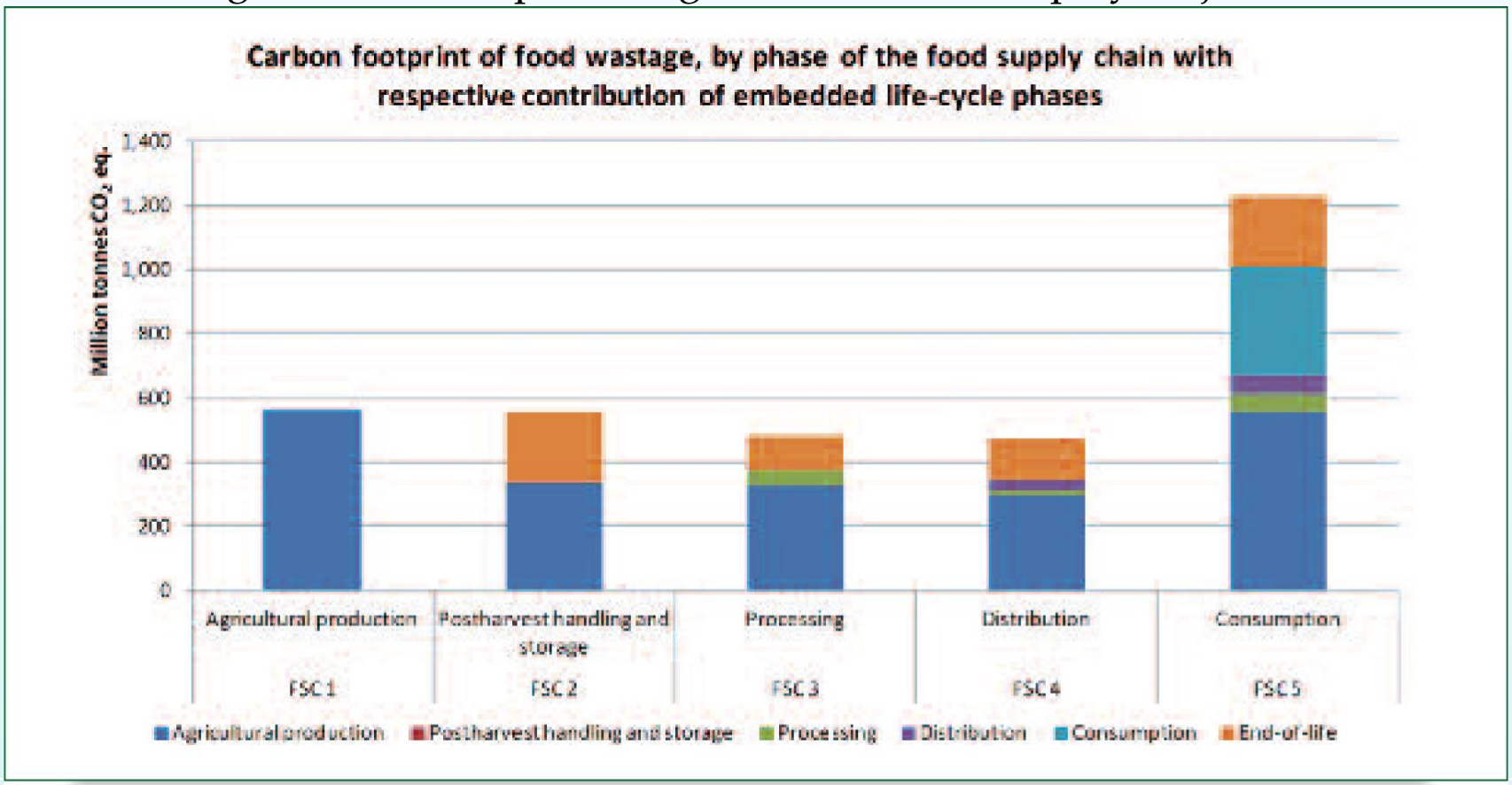
Carbon foot print waste of 37% at consumption with only22% food wastage

Because it includes energy used for processing, storage and cooking



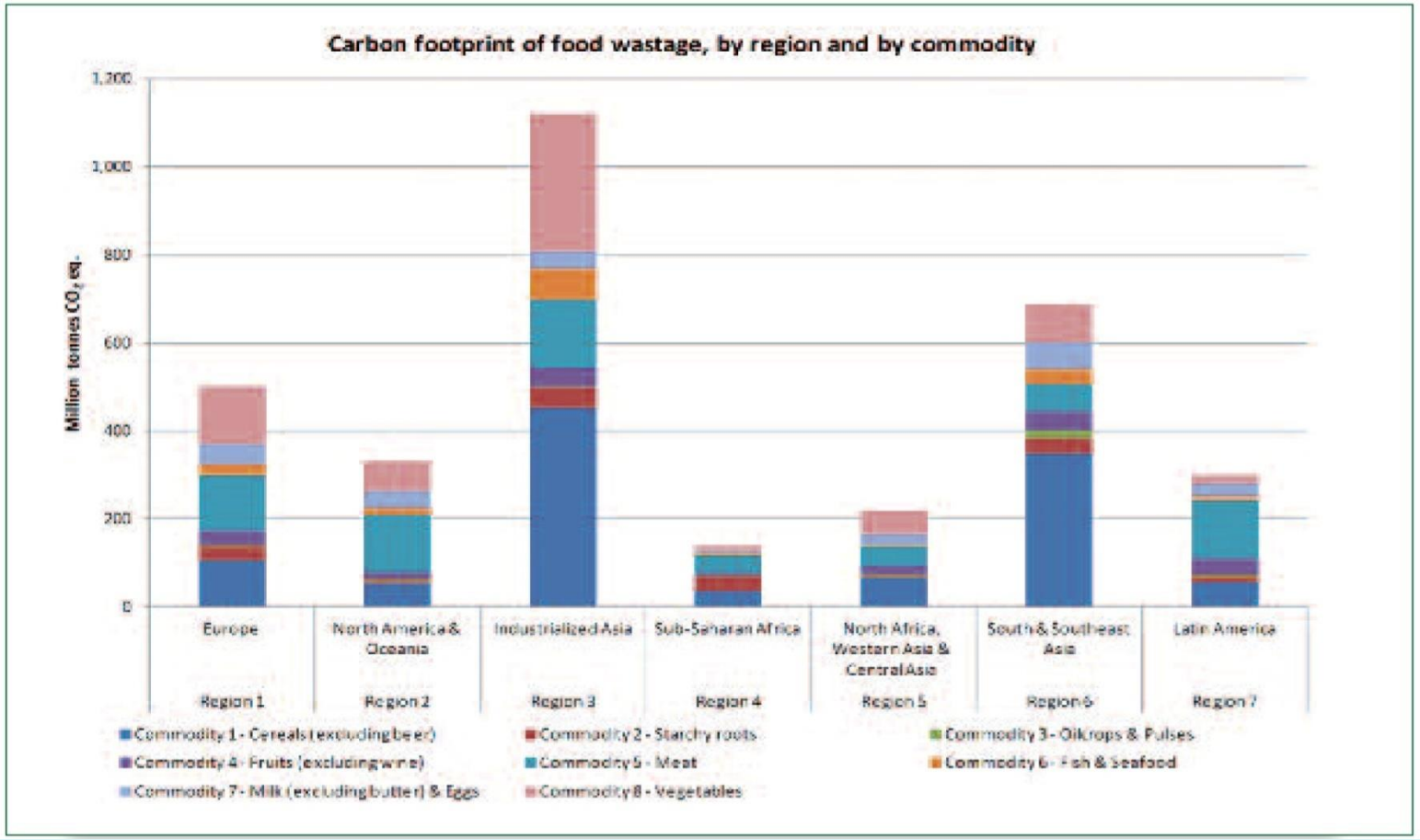
Carbon footprint of food wastage, by phase of the food supply chain with respective contribution of embedded life-cycle phases

GHG emmissions are higher from agriculture are major contributors to carbon foot print in all stages. At consumption stage, GHG emissions play major role.

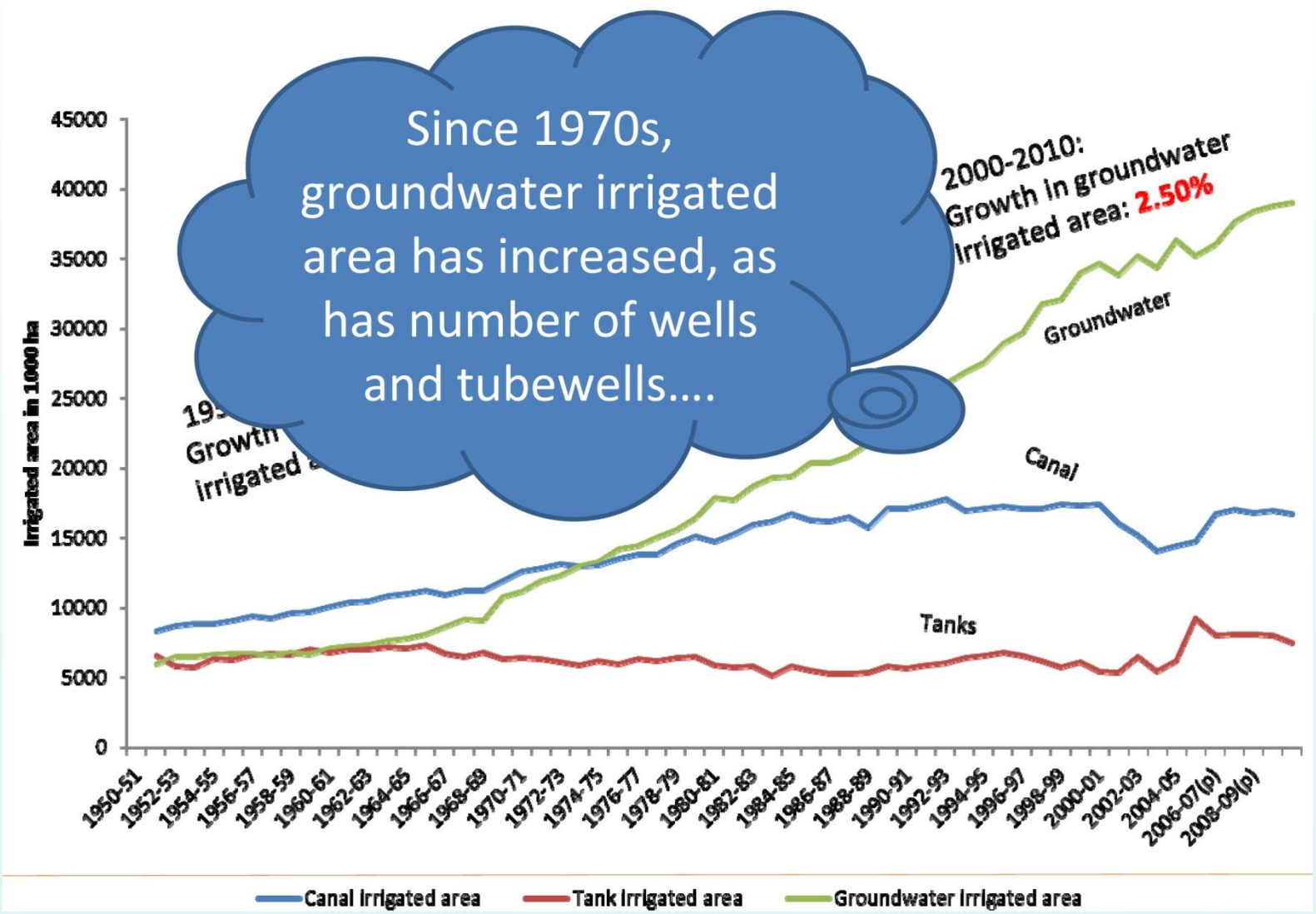


Carbon footprint of food wastage, by region and by commodity

Three foods, cereals, meat, vegetables contribute significantly to carbon foot print in all regions

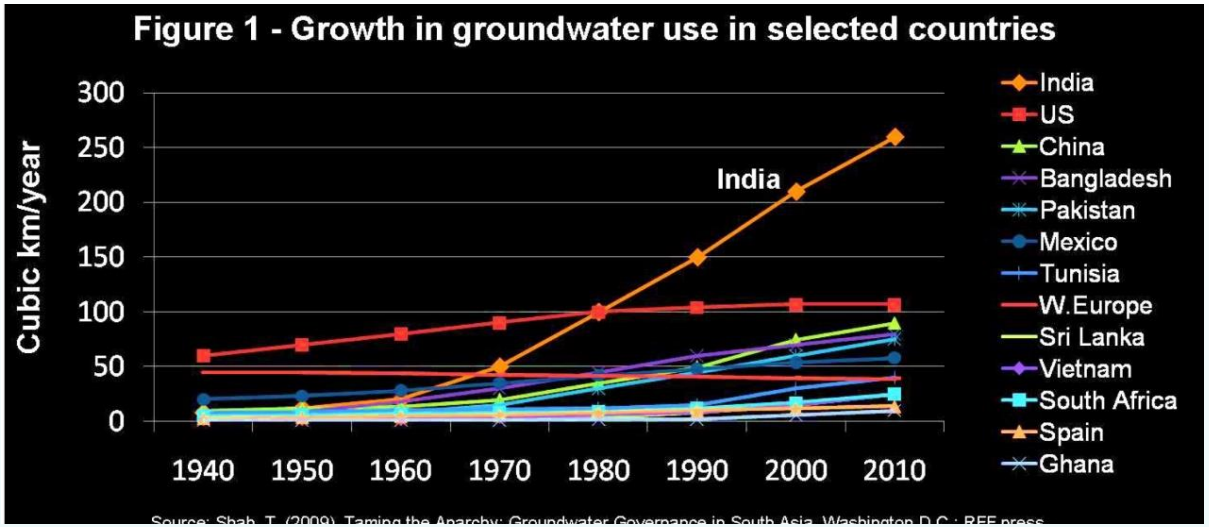


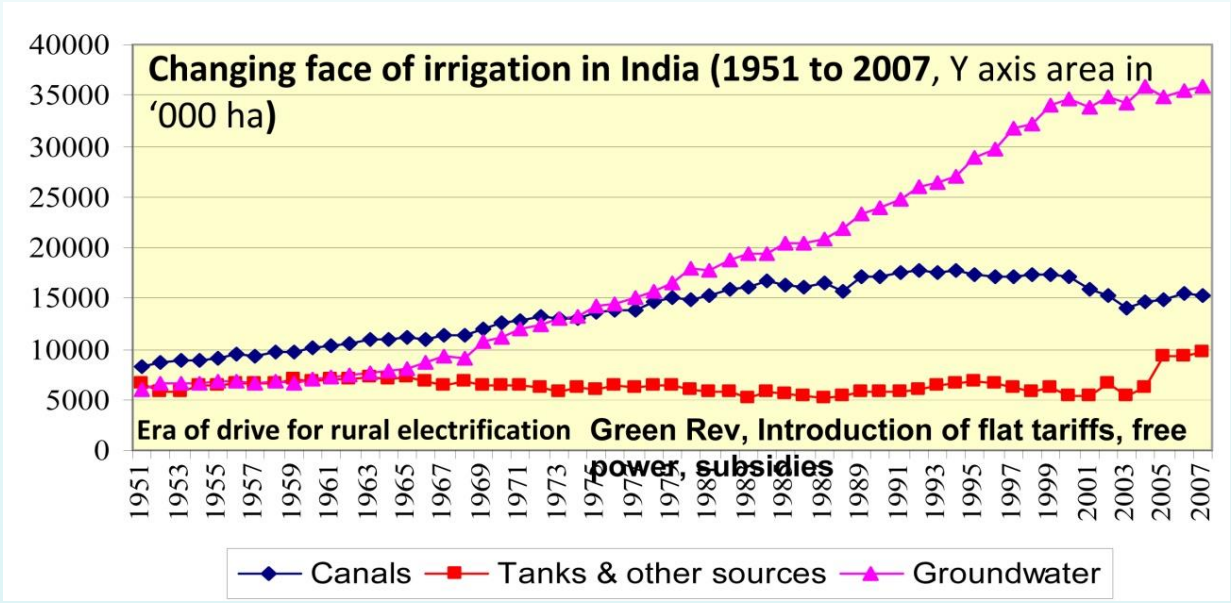
The irrigation story of India….



Water for a food-secure world

Ground water irrigation in different countries…..

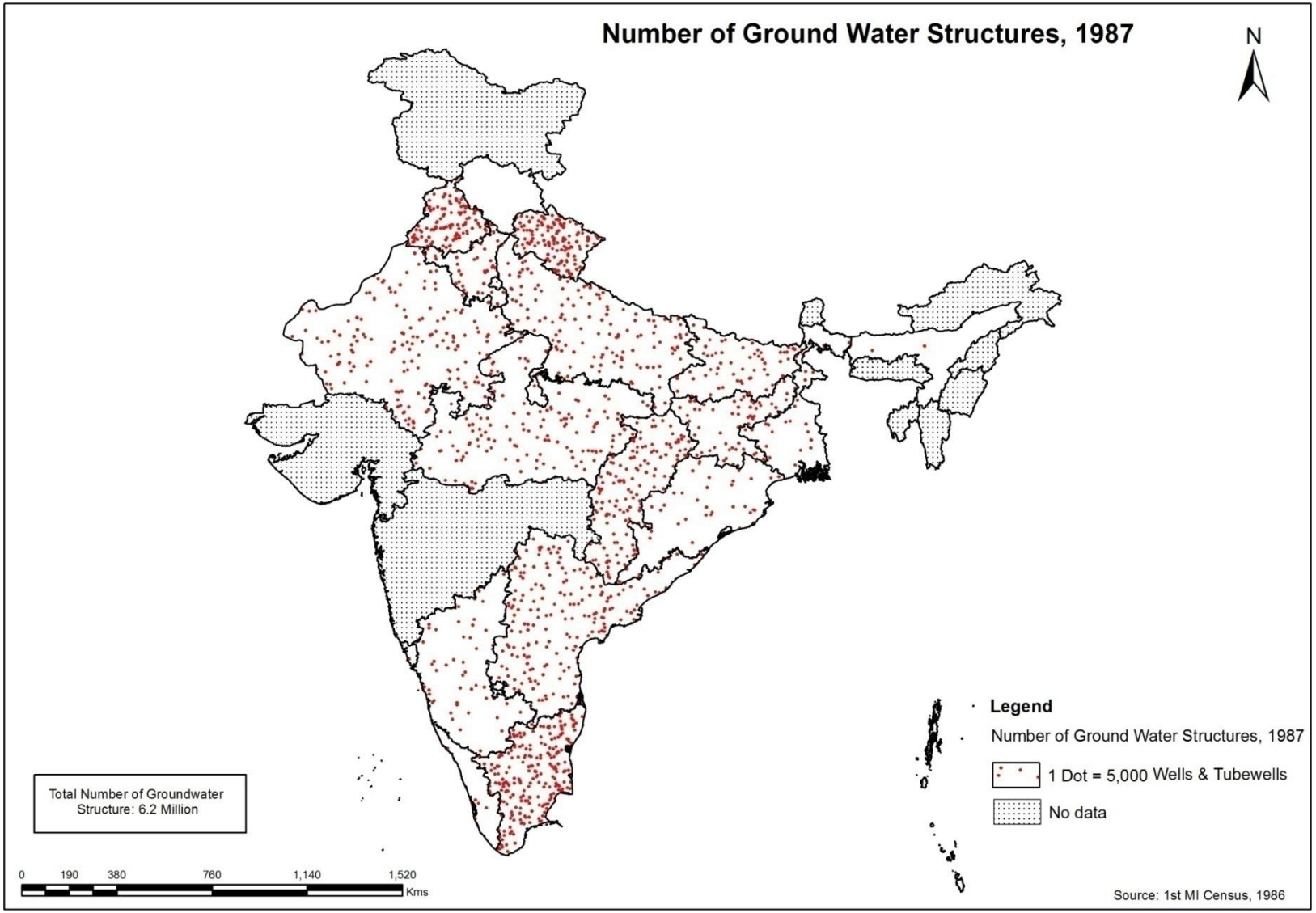




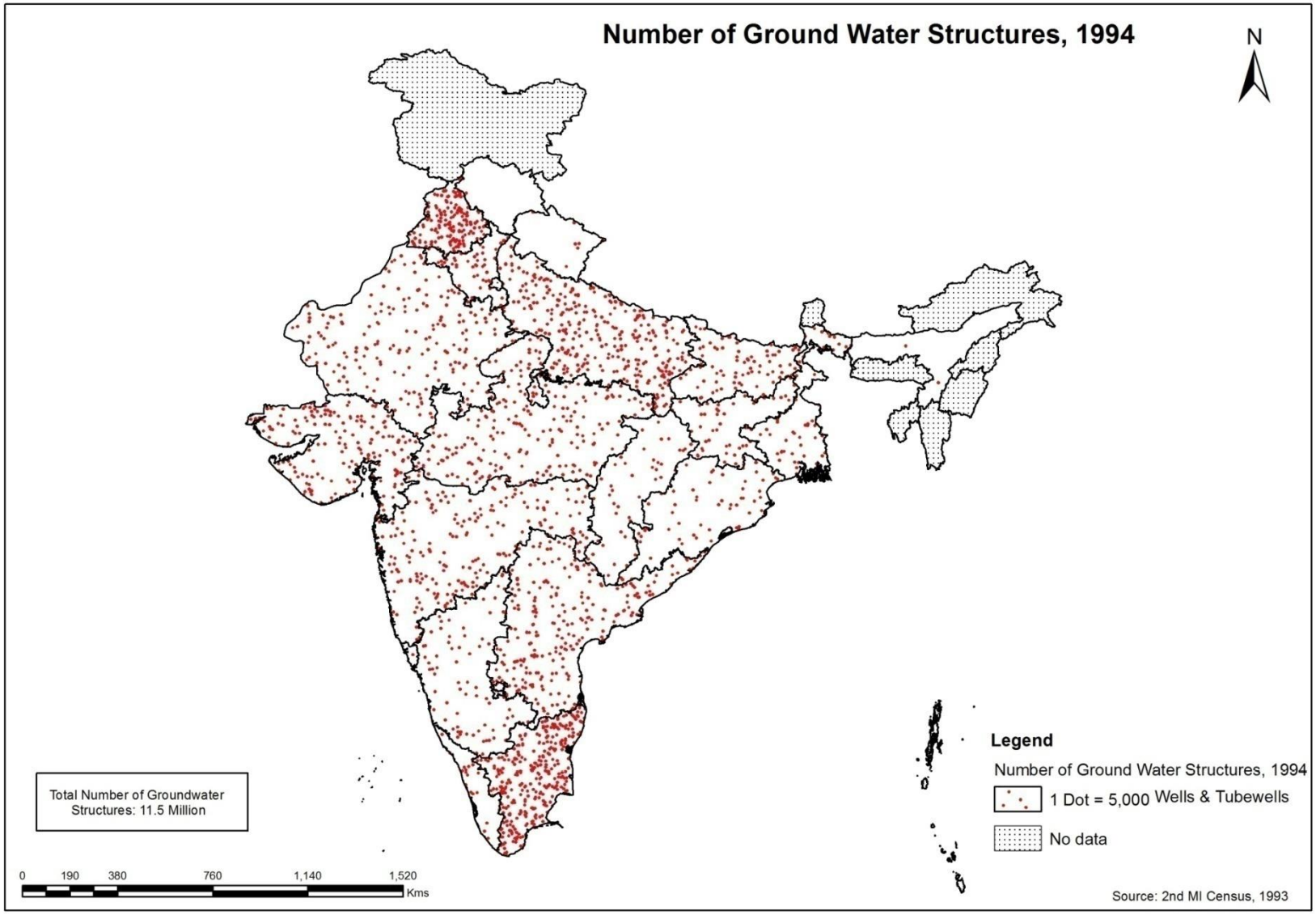
Source: Agricultural Census, GOI, several years

Groundwater use buffers climate variability but mining it kills future options

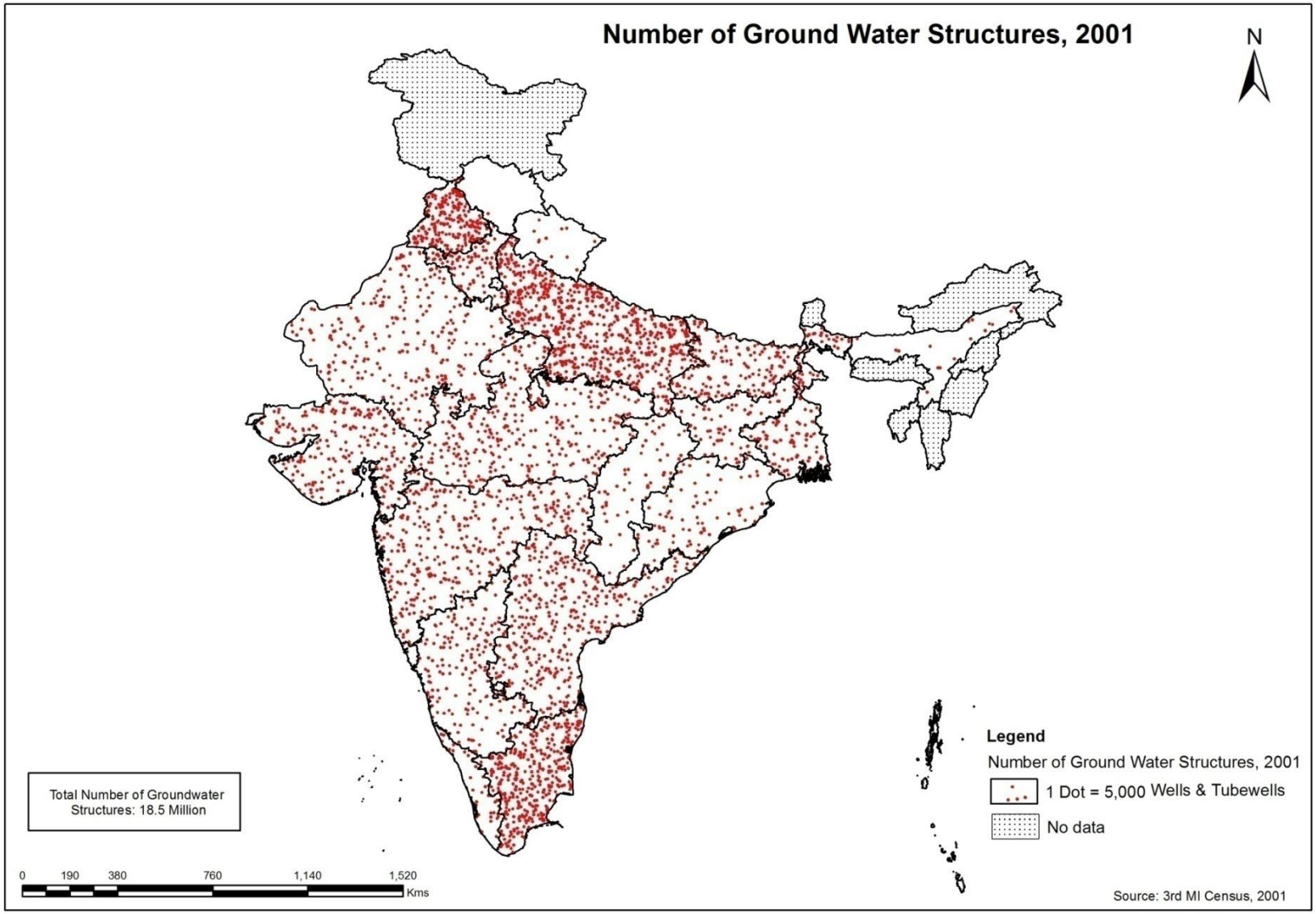
Number of Ground Water Structures - 1987



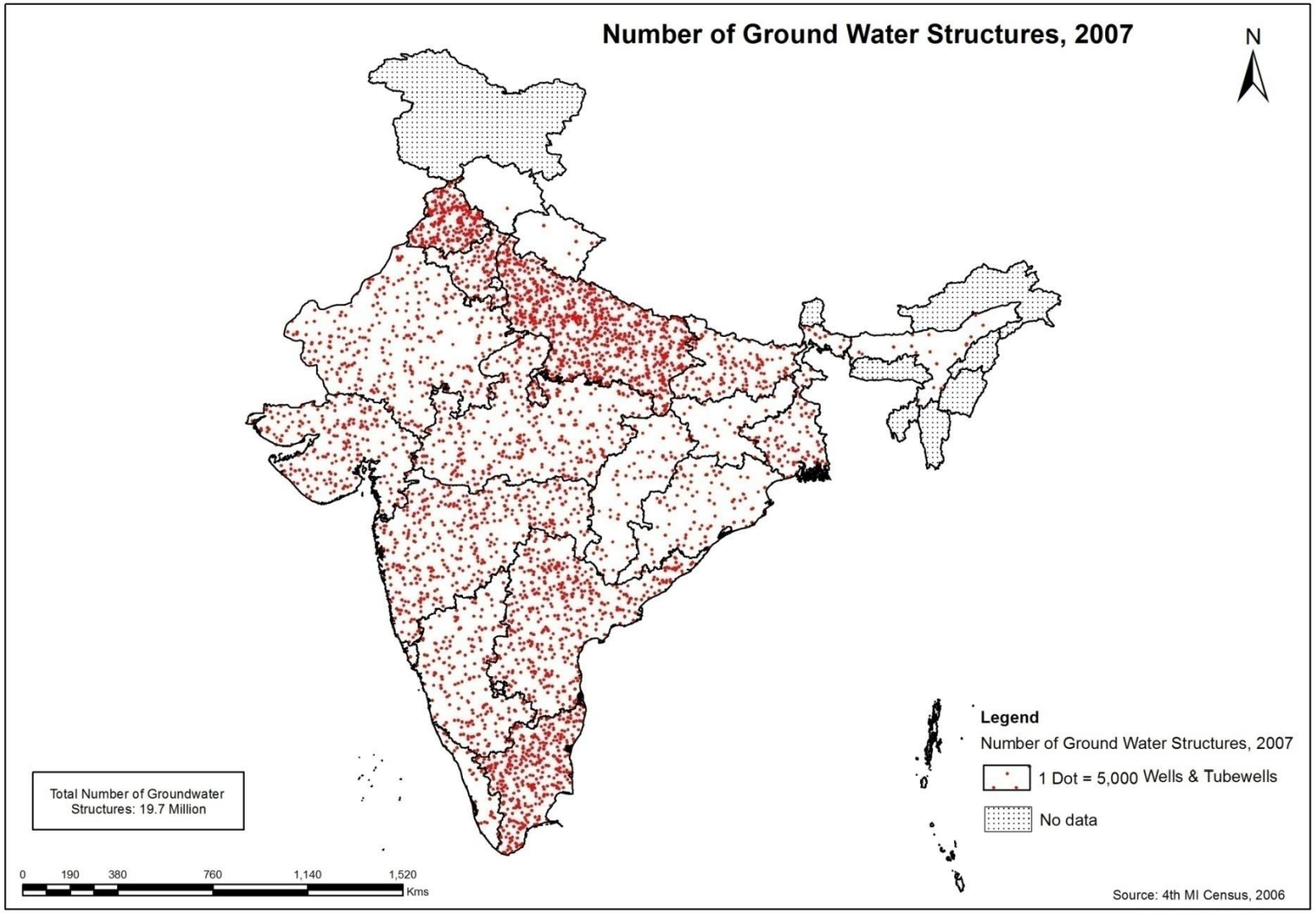
Number of Ground Water Structures - 1994



Number of Ground Water Structures - 2001



Number of Ground Water Structures - 2007



Sources of Irrigated Area in India (Ha)

- ✓ Ancient wisdom. Tanks played vital role in drought risk reduction, particularly in south for centuries- Tank and temple culture
- ✓ 4.24 lakh tanks irrigating about 46.518 lakh he. In south 1.20 lakh tanks - 28.0 lah he. Tank irrigated area started falling after green revolution in mid 60s

Period	Canal	Tank	Groundwater	Others	Total
1952-1953	8,613,000	3,468,000	6,339,000	2,588,000	21,008,000
1962-1963	10,568,000	4,651,000	7,430,000	2,420,000	25,069,000
1972-1973	12,983,000	3,822,000	12,377,000	2,313,000	31,495,000
1982-1983	15,808,000	3,165,000	18,593,000	2,406,000	39,972,000
1992-1993	17,247,000	2,817,000	25,884,000	3,114,000	49,062,000
1999-2000	17,609,000	2,916,000	32,536,000	3,223,000	56,284,000

Source: Water and related statistics, Central Water Commission, 2002.

Suitability of Tanks in Telangana

Tank-Irrigated Area in Telangana

Period	Hectares
1875	41,000
1920	1,39,511
1930	2,56,714
1940	3,73,684
1956-57	5,30,565
1970-72	3,30,920
1980-82	3,86,351
1990-92	3,80,319
2001-05	1,65,303
2005-09	2,18,124

Source (unless stated): BES, various years.

- ✓ Telangana in rain shadow regions of India.
- ✓ Topography suitable to rain water harvesting using tanks.
- ✓ Satavahana, Kakatiya, Kutubshahis, Asafzadis constructed tanks.
- ✓ WEF nexus was very well addressed/droughts were managed.
- ✓ Loss in tank irrigation from 1956-57 to 2005-09 of 58% of 3,12,441 hectare s (ha).
- ✓ Decrease of tank irrigation due to relative less importance of tanks vis a vis other modes of irrigation, as well as a decline in the actual area irrigated by them.

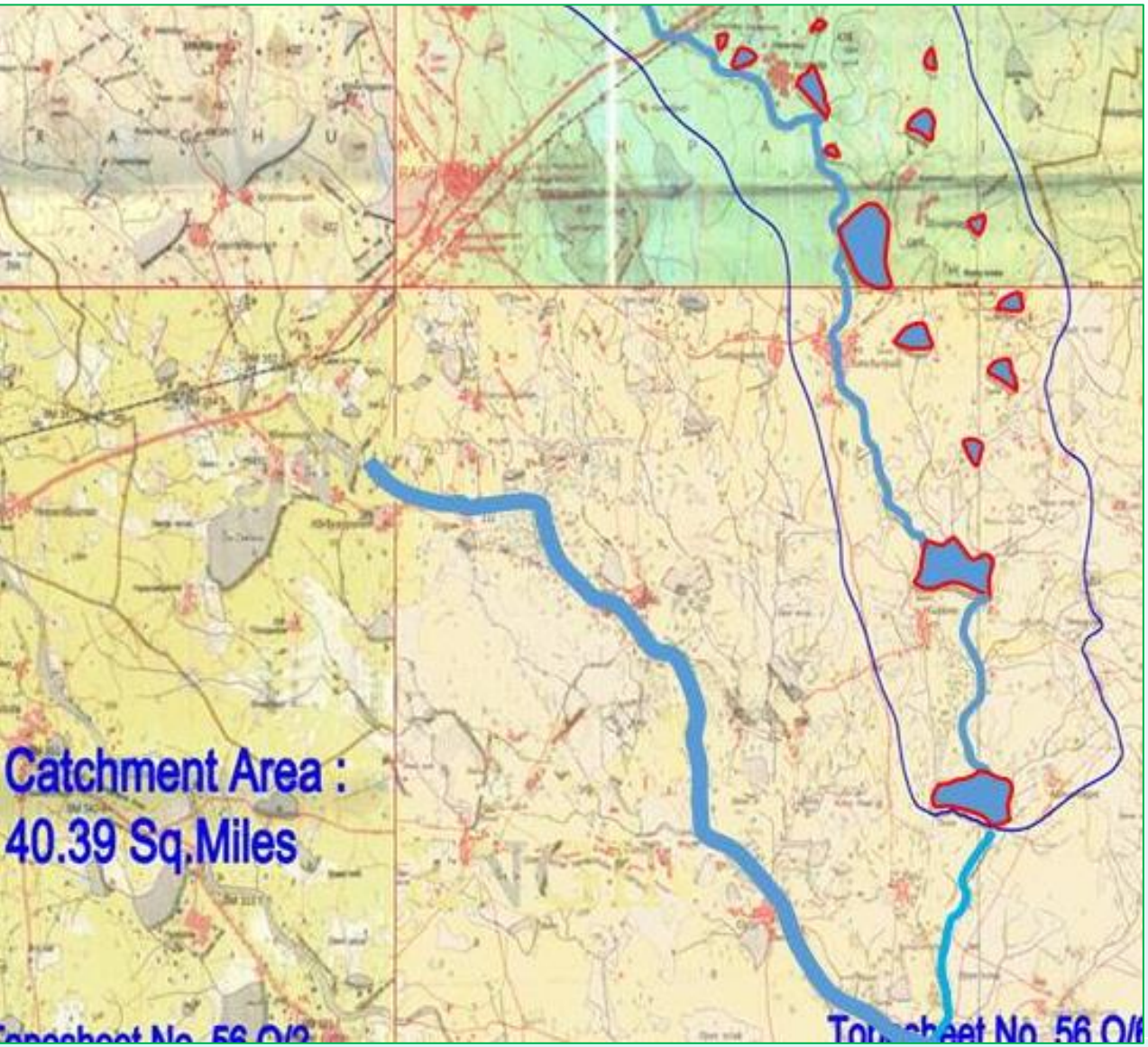
Decline in Tank Irrigated Area in Telangana (Ha)

Period	Tank	Canal	Well	Total
1875	41,000	7,000	46,000	95,000
1901				3,04,423
1920	1,39,511	27,447	1,08,535	2,75,492
1930	2,56,714	61,700	1,77,980	4,96,394
1940	3,73,684	51,417	1,94,332	6,19,433
1956-57	5,30,565	1,16,619	1,29,869	8,01,586
1970-72	3,30,920	1,98,701	2,14,500	8,50,055
1980-82	3,86,351	2,81,843	3,41,400	10,34,487
1990-92	3,80,319	3,38,276	7,04,400	14,85,795
2001-05	1,65,303	1,62,315	9,74,470	13,44,604
2005-09	2,18,124	2,59,629	12,17,642	16,95,395

Source (unless stated): BES, various years.

- ✓ Irrigated area under all sources, peaked to 14,85,795 ha in 1990-92, declined to 13,44,604 ha in 2001-15 and then rose to 16,95,395 ha in 2005-09.
- ✓ This indicates a shift of primary from tank irrigation to well irrigation.
- ✓ Four advantages of tank irrigation and four reasons for decline in tank irrigation.

Chain link Tank System in Telangana



The chain link tank system mainly exists in Telangana State. The surplus water from upstream tank flows to downstream tank in the chain and every tank is having ayacut of its own.

In the series of tanks every tank should be in good condition, if one tank is damaged it will effect total chain system of tanks in that chain.

Emergence of Mission Kakatiya

- ✓ After state was formed on 2 June 2014, priority was for irrigation sector.
- ✓ Geographical positioning for water harvesting in tanks which will drought mitigation apart from multiple functions like recharge of ground water.
- ✓ Census of minor irrigation sources – 46,531 all types of tanks
- ✓ These tanks were to irrigate 20 to 25 lakh acres Vs present 9 to 10 lakh acres
- ✓ The reasons in gap ayacut was found due to;
  - *Tank Bund: Jungle growth on slopes, reduction of top width through erosion, erosion/scouring of slopes, free-board not conforming to design, gully formation on slopes, damaged stone revetment, seepages through bund etc.*
  - *Surplus Weirs: Damaged weir structures requiring redesign and reconstruction.*
  - *Tank Sluices: Damaged collapsed sluices, damaged/non-existent screw gear shutters (water controlling arrangement), damaged appurtenant works, silt deposits.*
  - *Feeder Channels: Carrying capacity reduced due to extensive jungle growth, erosion of banks, siltation, loss of profile and bed slopes.*
  - *Due to dilapidated condition of Irrigation canals.*
- ✓ *Loss of water storage capacity of tanks due to accumulation of silt in tank beds over a long period.*
- ✓ we can add millions of hectares to irrigated land without building a new dams.
- ✓ Rulers of Kakatiya dynasty built more tanks, hence **Mission Kakatiya**

Objective of Mission Kakatiya

"to enhance the development of agriculture based income of small and marginal farmers through sustainable use of irrigation resources by restoration of Minor Irrigation sources, strengthening community based irrigation management, providing agricultural services, encouraging diversification and use of new technologies, facilitating market access"

Key performance indicators to study are:

- ✓ Increase in coverage of reliable minor irrigation facilities through surface and groundwater management
- ✓ Growth in agricultural productivity (including livestock, fisheries and horticulture) to meet food security in target areas
- ✓ Increase in the number of working days for agricultural labourers
- ✓ Increase in beneficiary household incomes.

Process of Mission Kakatiya

- ✓ De-silting the tank beds to restore original water storage capacity of tanks.
- ✓ Repairing and restoration of feeder Channels to standards for getting water freely into tanks.(Part of chain of tanks)
- ✓ Repairing dilapidated sluices, weirs etc.,
- ✓ Strengthening the tank bunds to its original standards.
- ✓ Re-sectioning of irrigation channels to standards & Repairs to CM & CD works for smooth distribution of water to fields according to their requirement.
- ✓ Raising of FTL, wherever possible.

It is planned to restore all 46,531 tanks in 5 years in a phased manner with 9,306 Tanks every year i.e 20% of total tanks each year.

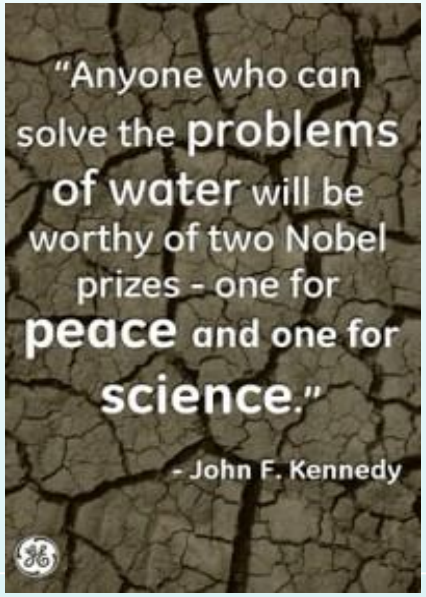
The main purpose of Mission Kakatiya is to bring the lost gap ayauct of over 10 lakh acres.

Mission Kakatiya-Climate Adaptation

- Preparedness in terms of development of village / location - specific contingency plans
- Mitigation and adaptation through improvements and innovations in irrigation management
- Diversification of rural economy towards non-farm activities and fishing to reduce farm households' excessive dependence on agriculture

Suitable modifications will be suggested like;

- Providing Village/Mandal specific meteorological forecasts
- Need for developing breeding of drought-tolerance varieties of crops



Manaa OOru-Mana Cheruvu
Our Village-Our Tank

- ✓ The Mission Kakatiya adopted a participatory approach
- ✓ Gram Sabhas (Village meetings) were conducted and proposed works under Mission Kakatiya are explained to the villagers.
- ✓ Farmers are motivated to lift the soil for field application.
- ✓ District and local level coordination committees are formed.

The mission is can be considered as governance initiative with in water, energy, food nexus as climate adaptation to help combat drought in mostly drought prone, rainfed Telangana state

Thank You

Praja sukhe sukham rajyaha
prajanamcha hitehitam,
Natma priyyam hitam rajanaha
prajanam cha hitam priyam.

(In the happiness of his public
rests the king's happiness,
in their welfare his welfare.
He shall not consider as good only
that which pleases him but
treat as beneficial to him
whatever pleases his public.)
Kautilya's Arthashastra)