10. Keynote address by Dr. Tushaar Shah, Senior Fellow, IWMI, India, on "Groundwater Governance in Sri Lanka: Lessons from Around the World"

Good morning! All the secretaries of ministries of the Government of Sri Lanka, distinguished guests, ladies and gentlemen, I am delighted to be here. I want to congratulate Manthri and IWMI for finally initiating some work on groundwater in Sri Lanka. I have been a groundwater watcher for about 30 years. When I first came to Sri Lanka from India to work as a researcher at IWMI I went around talking to see what work was being done about groundwater. I represented South Asia. Groundwater had come to play a very important role in the agricultural life of this country. But whom should I ask about groundwater in Sri Lanka? Those whom I met said groundwater is not important to Sri Lanka. They have here a hydraulic civilization and large tank and irrigation systems which are thousands of years old.

There was a colleague, Hilmy Sally in the Colombo IWMI office; he and I took off to meet farmers who used hand pumps. But there had to be some lifting of water. At the end of the day Hilmy and I came back and we presumed that about 500 pumps were selling in Colombo around the year 2000. And we gathered that there was a great deal of activities going on. Shop dealers also told us pumps, particularly small pumps, were used to lift groundwater. There was also a good deal of groundwater being lifted from shallow wells. In 2003, we carried out a more systematic study in Sri Lanka. We came with this startling conclusion; there were about 50-55 thousand agro-wells in operation there, of course with variations across regions. So I knew there was a very active groundwater irrigation economy already in place in Sri Lanka. Then we needed to understand how this would work in order for us to manage it. So, I am very glad that we are talking about it today. And I hope it is not only in Jaffna Peninsula but also in other parts of Sri Lanka including in command areas of canal irrigation systems that there is a good deal of groundwater irrigation going on.

When we talk about groundwater governance we need to take necessary steps not only to maximize the benefit of groundwater use but also to minimize the use of harmful attacks on groundwater use. For doing it effectively people should understand not only about the resources or the supply side but also about the demand side. In India and other parts of the world I find too much attention given to it. It is important for us to understand the resources, also who is drawing groundwater, why, in what type, by how many numbers, and the drivers of groundwater demand.

In the next few minutes I will focus only on the demand side of groundwater. I will go into the global picture of the problems we have encountered, and the attempts made to fix them. I hope my discussion would be a kind of complement to what we will be talking today. What is important is the explosive growth of groundwater use and groundwater drought prevailing worldwide over the past 50-60 years. We have no estimate as such but groundwater is mostly used for domestic, agricultural and drinking purposes. Figure 10.1 shows the natural rates of groundwater recharge developed by some international researchers.

Highlights

- Explosive growth in groundwater use today from less than 100 billion cubic meters (Bm^3) in 1950 to more than 1,050 Bm^3 per year.
- Groundwater meets more than 70% of the rural and urban drinking water requirements; "strategic resource."
- Groundwater use in irrigation has grown from less than 50 Bm^3 to 750 Bm^3.
- South Asia is at the forefront of using groundwater irrigation.
- Low-yielding hard-rock aquifers are unfit and not suitable for intensive groundwater use but in 1970 Peninsular India developed these. Now, northern and eastern provinces of Sri Lanka too are witnessing the growing groundwater use in agriculture.
- Since groundwater irrigation expands quietly by private initiative, it is called a "silent revolution."

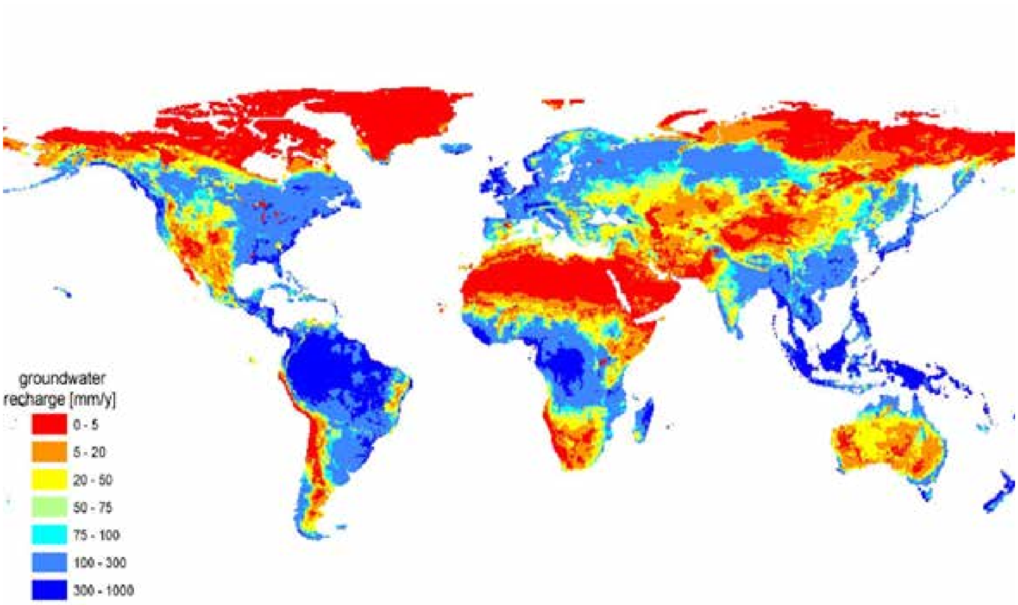


Figure 10.1. Natural rates of groundwater recharge developed by some international researchers.

- Groundwater governance is a "wicked problem." By the time we are ready to do something about groundwater everything that needs to happen has already happened. By the time we understand what is happening there is very little we could do to change it. I think Sri Lanka is in a favorable situation: it is catching up with the revolution.

Groundwater recharge is high in humid areas and low in arid areas. What is important is that intensive groundwater development has occurred around the world. Figure 10.2 shows the long-term average groundwater recharge.

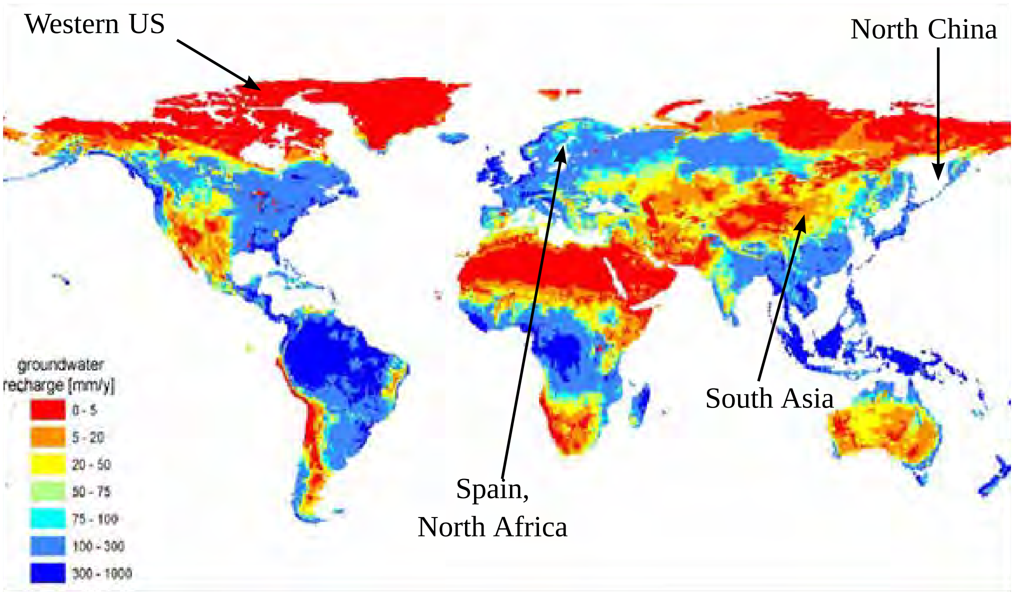


Figure 10.2. Long-term average groundwater recharge.

For decades, groundwater use for agriculture seems to have moved inversely with natural recharge. Eastern India, Bangladesh and Nepal terai have jumped this bandwagon and, now in South Asia, Sri Lanka is following suit.

There are four contexts of agricultural groundwater use: Arid agrarian, industrial agricultural, smallholder intensive farming and extensive agro-pastoral systems (Table 10.1 and Figure 10.3).

Table 10.1. Four contexts of agricultural groundwater use.

	Arid agrarian systems	Industrial agricultural systems	Smallholder intensive farming systems	Extensive agro-pastoral systems
Examples	Jordan, Iran, Saudi Arabia	California, Australia, Spain, Mexico	South Asia, North China	Sub-Saharan Africa, South America
Groundwater use	Mostly nonrenewable	Managed depletion	Unsustainable use	Under-developed resource
Driver	Only source of water	Wealth creation	Intensive diversification	Stock watering
Contribution of groundwater to poverty alleviation	Low	Very low	Very high	High

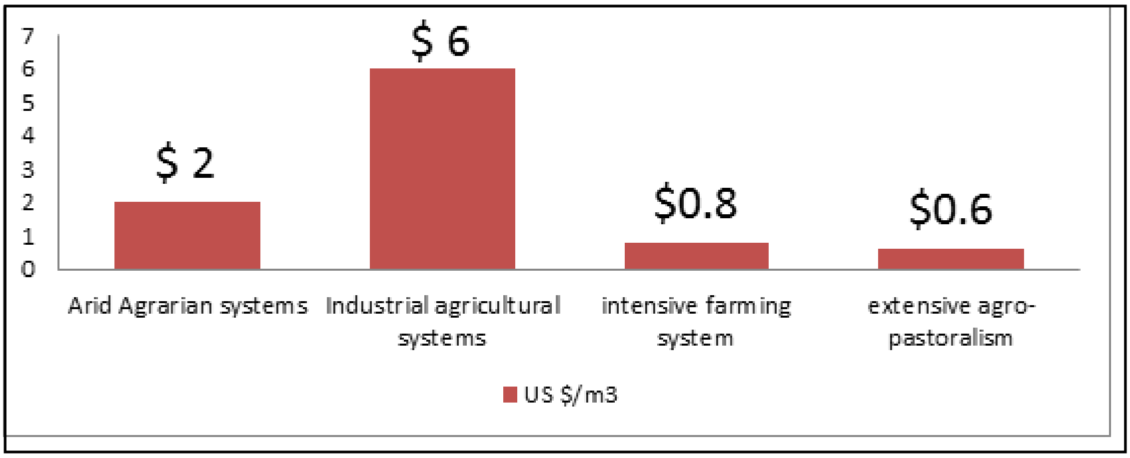


Figure 10.3. Four contexts of agricultural groundwater use.

Groundwater productivity is very high in the US, Australia and Spain, that is in commercialized agriculture. When it comes to South Asia and sub-Saharan Africa it is limited. The groundwater development drive is a consequence of the demographic expansion in the world.

Groundwater population density in 1700 was 5 persons per square kilometer (Figure 10.4), but in 2000 it was about 500 persons. Around 2000 the croplands expanded worldwide to provide food and livelihoods for the people. Basically, expansion of croplands is essentially linked with the demographic expansion ratio and crop limit function (Figure 10.5). Figure 10.6 shows the drivers of groundwater intensive use.

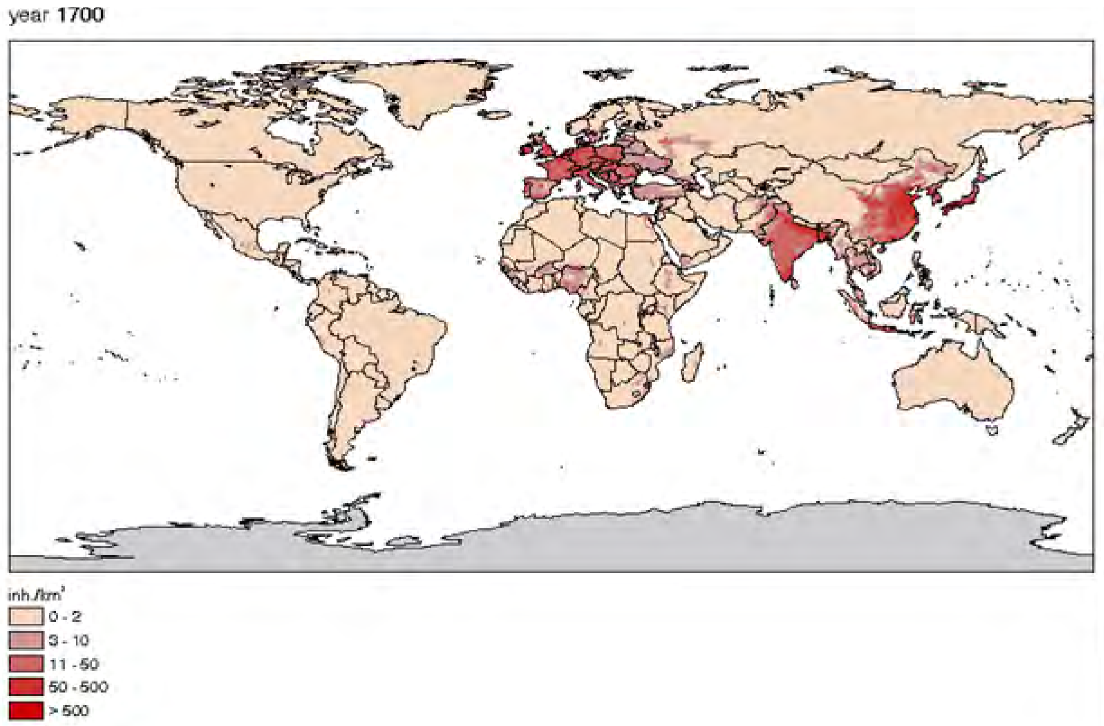


Figure 10.4. Growth in population density around the world (persons/km^2), (year 1700).

Note: inh/km^2 = inhabitants/km^2.

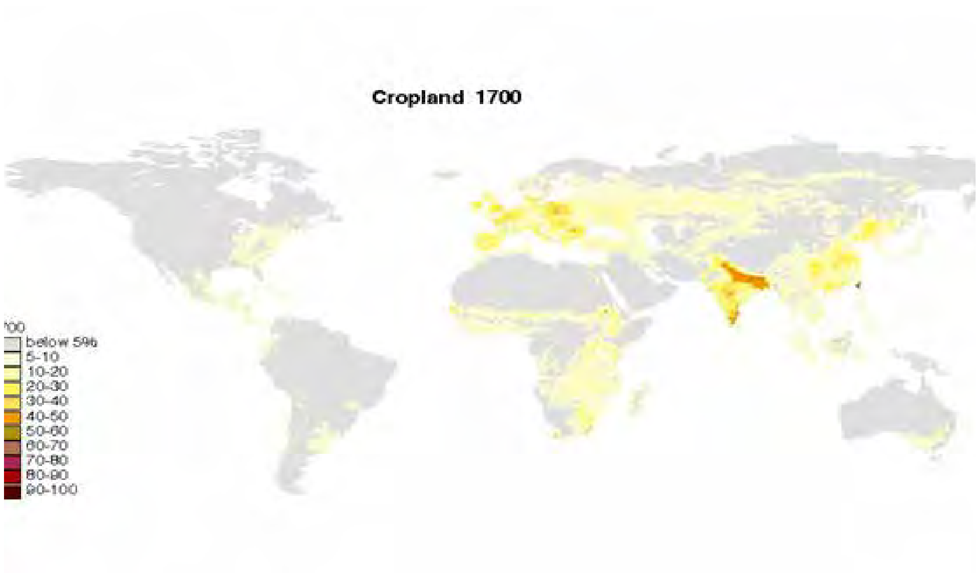


Figure 10.5. Expanding cropland 1700-1990 - Fraction of grid cell in croplands.

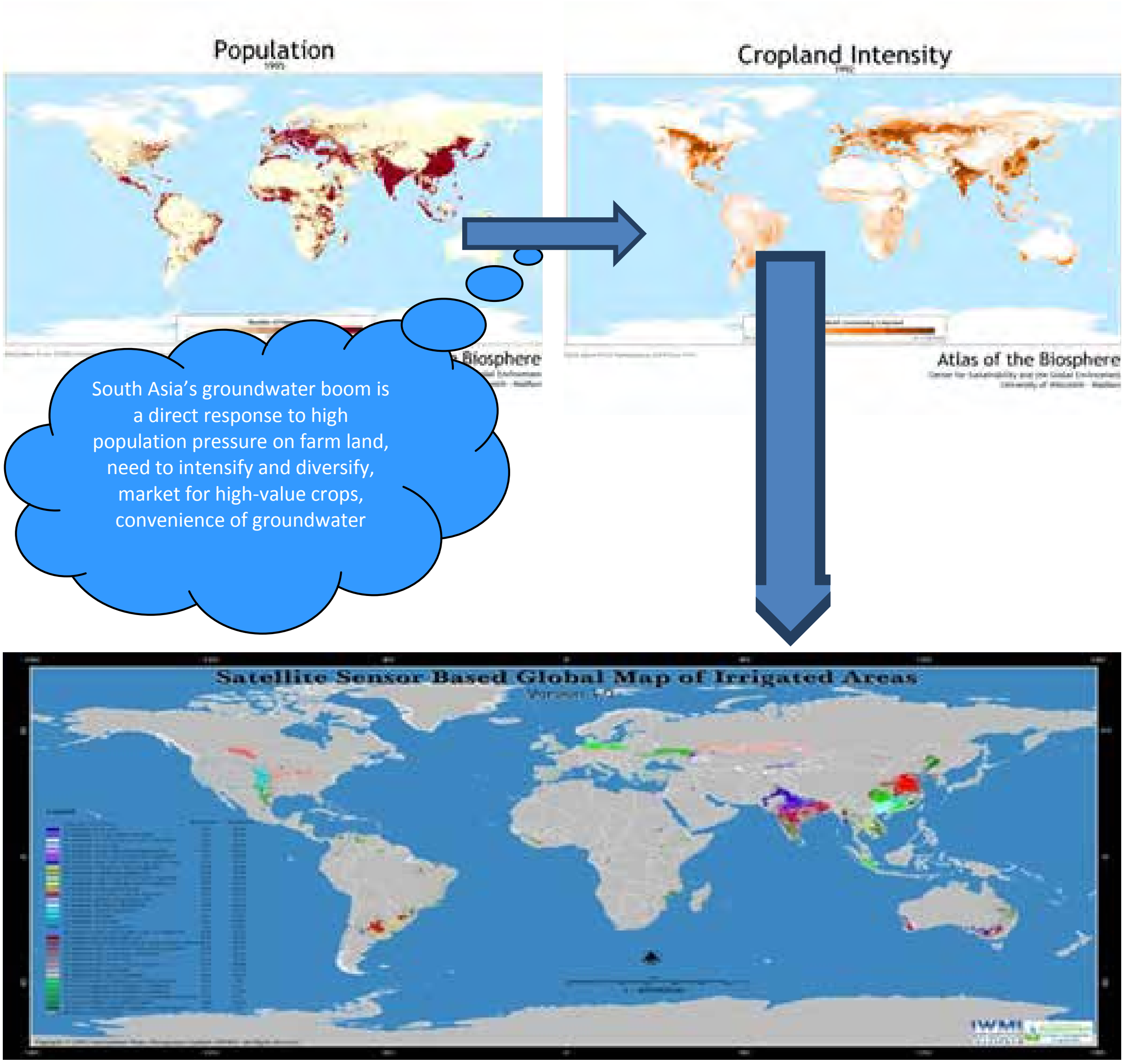


Figure 10.6. Drivers of groundwater intensive use.

Like Sri Lanka, India and Pakistan too invested mainly in surface irrigation. Yet, today, groundwater irrigation has emerged as the mainstay of agriculture in these countries.

In 1960, US and India were the biggest groundwater withdrawers at 100 Bm^3/year and about 20 Mm^3/year, respectively. But today India is withdrawing about 250 Mm^3/year. In 1970, groundwater development was intensive and largely done by private investors. Today, groundwater irrigation has transformed Bangladesh to a rice exporter from a rice importer. Sri Lanka is a rainfall-rich country and the recharge rate of groundwater is high. So no one thought Sri Lanka would develop so much of groundwater for agriculture. In Sri Lanka, highland cultivation in *maha* (during the northeast monsoon) and lowland cultivation in *yala* (during the southeast monsoon) were done with groundwater for high economic crops. The income is 4-5 times in Sri Lanka groundwater farming compared to other South-Asian countries. But India and Pakistan grow rice with groundwater which has no economic sense at all. Figure 10. 7 shows the groundwater use in ten countries.

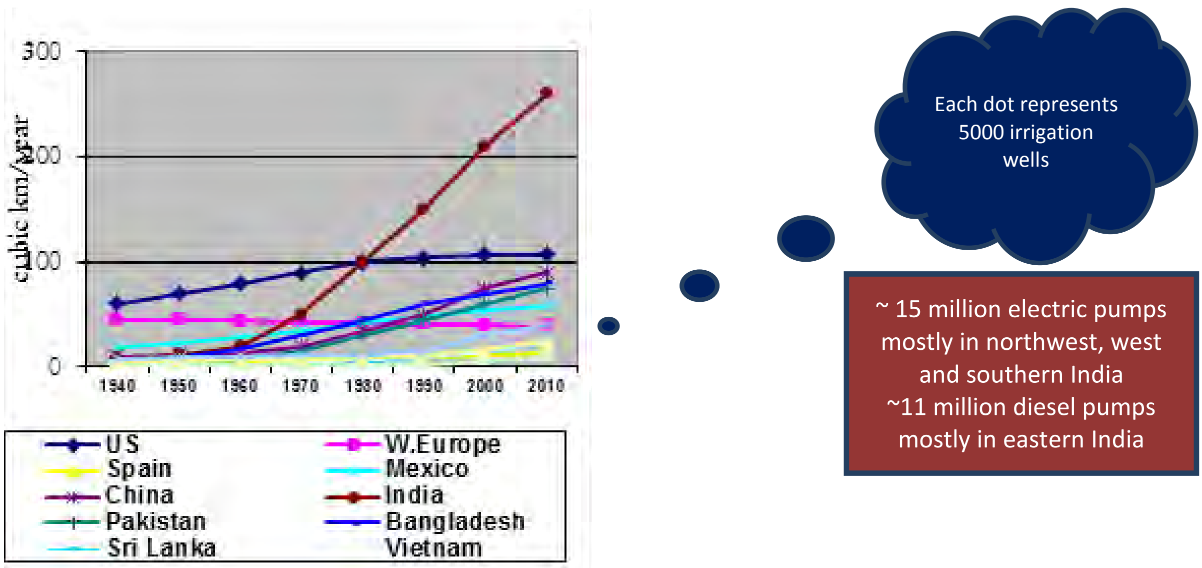


Figure 10.7. Groundwater uses.

Acceleration in agro-well irrigation in dry zones of Sri Lanka

- In an IWMI study Kikuchi et al. (2003) estimated that Sri Lankan farmers had invested Rs 0.8 billion in digging 50,000 agro-wells by 2000. The number of wells is likely 200,000-250,000 by now.
- Agro-wells have transformed highland agriculture and made yala cultivation more lucrative than maha cultivation. A typical agro-well irrigates 0.2- 0.8 hectares (ha).
- In Anuradhapura, agro-wells in one acre of land have irrigated 5-15 acres of irrigated paddy in terms of net farming income.
- The number of agro-wells per 100 ha varied from 2.7 in Ratnapura to 31.2 in Anuradhapura in 2000.

From 1965 to 2000, there has been a meteoric rise in private agro-wells and farmers' investments in agro-wells in Sri Lanka (Kikuchi et al. 2003). Figure 10. 8 shows the groundwater use from 1965 to 2000 while Figure 10. 9 shows the income from groundwater cultivation during the same period.

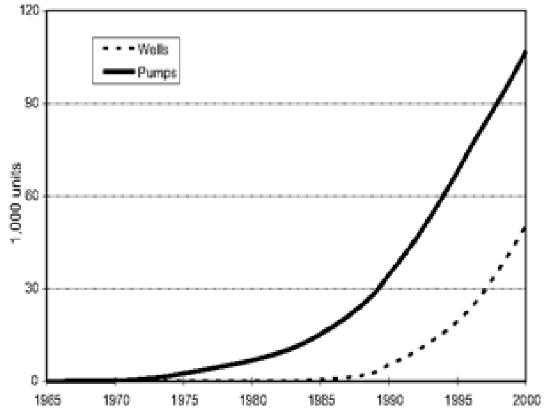


Figure 10.8. Groundwater use.

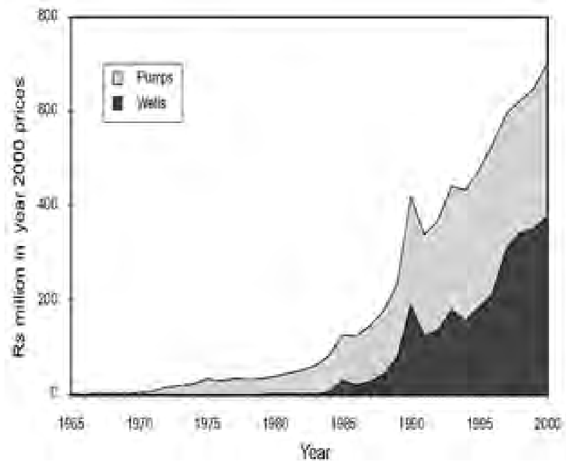


Figure 10.9. Income from groundwater cultivation**.**

Table 10.2. Agro-ecological transformation of Galenbindunuwewa in Sri Lanka after the boom in agro-wells.

	Before the boom in agro-wells	Now
Lowland maha season paddy cultivation	+++++	+++++
Lowland yala paddy cultivation	+++++	+++++
Supplemental irrigation to rice	++	+++
Mung bean and cowpea cultivation in chena (slash-and-burn) land	+++++	++
Vegetable cultivation	++ only for home consumption	+++++ for market
Other market crops	+	+++++
Cattle	++	+++++
Focus of cattle husbandry	Milk for home consumption; work animals	Milk production for the market
Approach to cattle husbandry	Extensive, based on grazing	Intensive based on stall-feeding
Green fodder cultivation as mulch for cattle	+	+++++
Tree crops	+++	++++

Sri Lanka and Kerala are the only countries that use groundwater for high-value garden cultivation with less environmental impact. But in India groundwater has been depleted creating a groundwater drought. So farmers are deepening the boreholes every year due to lowering of the groundwater level. And this is where groundwater governance is necessary – to manage the demand with its availability.

Everywhere in the world various systems are used to manage groundwater. There had been attempts to price groundwater. In Jordan, Israel and Iran wells are metered and abstraction of groundwater is being closely monitored and farmers have to pay a price. In a pilot project, China had recently introduced a progressive price regime where a farmer has to pay a price if he abstracts more than his entitlement and after that the rate increases (if he abstracts more). Groundwater governance is a very logical tool to achieve a balance between abstraction and availability. It works only where the governments are very persistent. Another method tried is stable groundwater entitlement in the US (in Kansas and Colorado), Australia and Mexico for larger farms. After exceeding one's entitlement he or she has to pay a thinner price, or abstraction from the well will be stopped. This is being monitored using computer systems.

Table 10.3. Four groundwater and livelihoods scenarios in South Asia.

E-I-L Zones of South Asia	Energy footprint	Groundwater structures	Type of agriculture	Net income /ha (US$)	Groundwater externality
Kerala, Dry Zone of Sri Lanka (mostly humid and hard rock)	Very small (500-700 kWh/ha)	Shallow, open wells, 1-2 horse power pumps in millions	Garden cultivation of high-value market crops	US$ 2,000-3, 500/ha	Nil or insignificant
Eastern India, Bangladesh, Nepal (humid and alluvial)	Small (800-1,100 kWh/ha)	Shallow tube wells with 5-7 horse power diesel pumps	Mostly rice-wheat; some market vegetables	US$500-1,000/ha	Nil, barring arsenic; opportunity lost
Indian Punjab, Haryana, west Rajasthan (alluvial) Gujarat, Pakistan Punjab and Sind (arid and alluvial)	Very high (5,000-7,500 kWh/ha)	Deep tube wells; 10-120 horse power electric pumps	Mostly wheat-rice; average-value farming	US$800-1,000/ha	Depletion; fluoride and other geogenic contaminants
Hard rock peninsular India (semiarid and hard rock)	Quite high (3,500-5,000 kWh/ha)	Dug-cum-bore/ bore wells with 5-12 horse power electric pumps	Mostly grains and Bt cotton; average-value farming	US $800-1,200/ha	Huge negative

Groundwater-stressed blocks of India

Groundwater-level recovery is tried without harassing individual farmers. A large number of open wells were constructed to collect monsoonal rainwater but farmers were allowed to abstract water only during daytime.

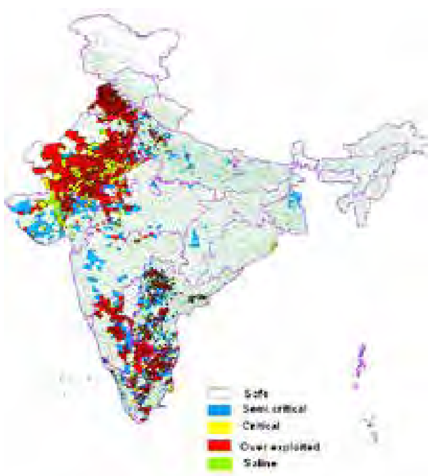


Figure 10.10. Groundwater-stressed blocks of India.

Table 10.4. Groundwater governance experience around the world.

	Instrument	Where tried	Challenge
1	Pricing groundwater abstracted	Jordan, Israel, Iran, China pilot projects in Shaanxi and Hebei	Monitoring groundwater withdrawals by numerous dispersed pumpers
2	Tradable groundwater entitlements	Kansas, Colorado, Australia, Mexico	Works with large abstractors; high transaction costs; have to exclude small users; scope for malpractices
3	Community aquifer management	Mexico, Spain, Andhra Pradesh	Strong authority needed for sustained enforcement of norms (China's state-di rected community aquifer management)
4	Legal and administrative regulation	Yemen, China, India, Spain, Mexico, Morocco	Success depends on enforcement; difficult with numerous, small, dispersed abstractors; political costs
5.	Indirect instruments	Energy policies; output and input subsidies; conjunctive management of surface water, groundwater and rainwater	Has been tried in India with variable success

1. In monsoonal Asia, groundwater development first amplifies intra-year fluctuations in static groundwater levels (Figure 10.11).
2. Sustained overdraft over natural recharge results in secular decline in water levels.
3. Managed aquifer recharge can ensure monsoonal recovery of water-levels to near pre-development levels.
4. Sri Lankan dry zones ensure precisely this.

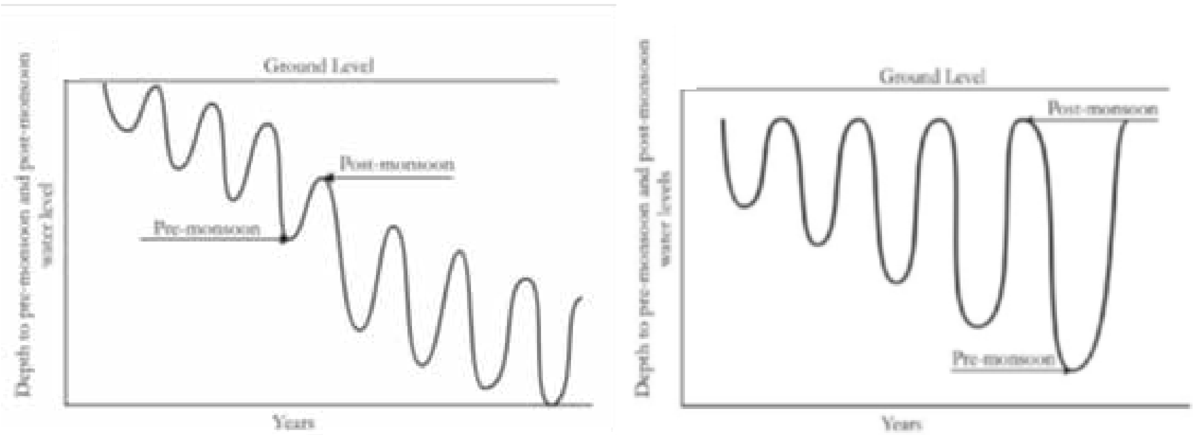


Figure 10.11. Groundwater development first amplifies intra-year fluctuations in static groundwater levels.

Saurashtra Region of Gujarat in western India has experienced a mass-movement in decentralized managed aquifer recharge (MAR) since 1990. Farmers, with support from religious leaders, diamond merchants, cement companies and government have modified 400,000 open wells for monsoonal recharge and constructed more than 300,000 check dams, percolation ponds, and other recharge structures. A few examples are given below (Figures 10.12 to 10.14):

Figure 10.12. Dudhara Village in Saurashtra. Photo credit: Tushaar Shah.

Figure 10.13. Gadh Village in Banaskantha.

Saurashtra receives some 700 mm of rainfall in 60 hours of torrential downpour. Profusion of small dams and ponds impound the monsoonal floodwater and fills up the dewatered Vadose zone of limestone and basalt aquifers. Sri Lanka's dry zones already have such profusion of recharge structures in the form of tanks.

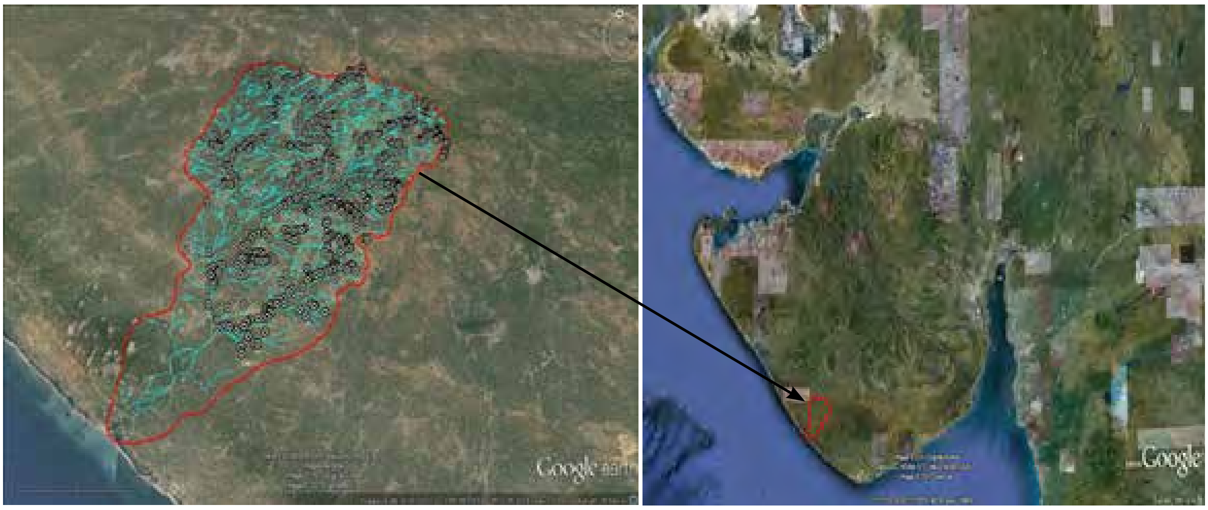
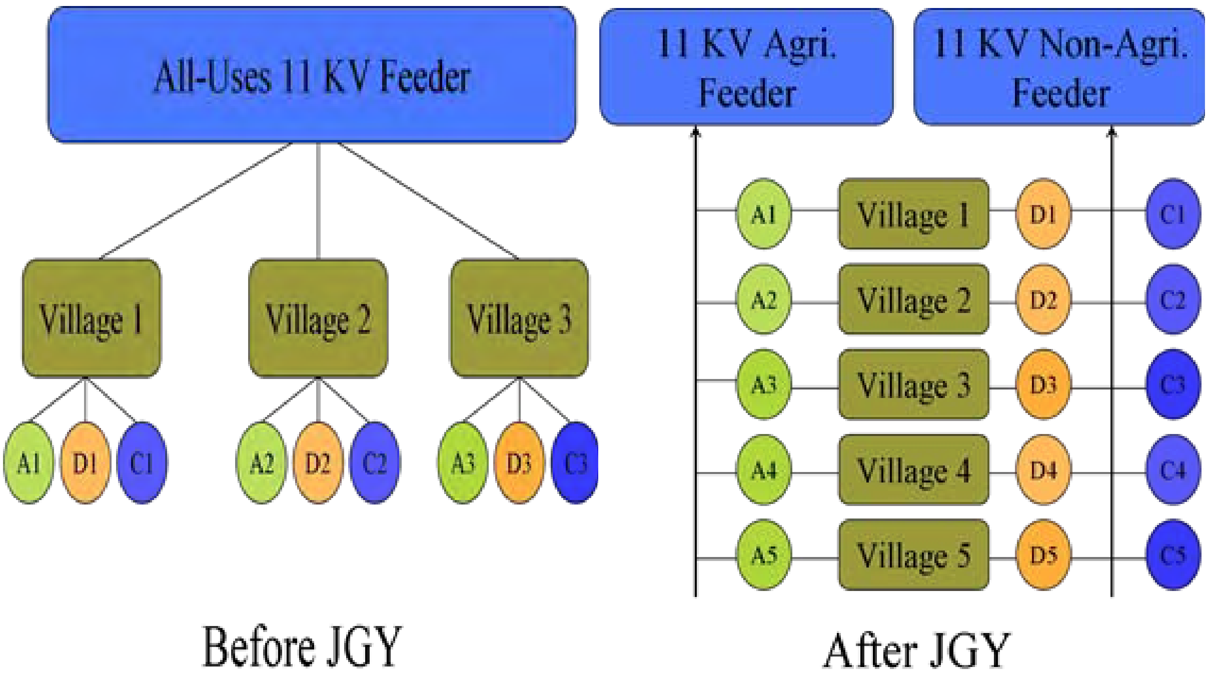


Figure 10.14. Map of Saurashtra.

Photo credit: Tuhsaar Shah.

To manage demand for groundwater, Government of India invested US$250 million in separating 800,000 tube wells from other rural connections and imposed a power ration of 8 hours per day but of top quality and full voltage. This reduced aggregate groundwater draft. Figure 10.15 shows the electricity networks before and after GJY.



Electricity network before Electricity network after

A – Agriculture, D – Domestic, C – Other, JGY – Jothi Gram Yojana

Figure 10.15. Electricity networks before and after GJY.

Gujarat is the only state in India where growing areas are witnessing monsoonal recovery in groundwater levels.

Figure 10.16. shows monsoonal changes in groundwater level in 2000 while Figure 10.17 shows the same in 2008. Figure 10.1.18 shows the mean MAI for South Asia for June, 1999.

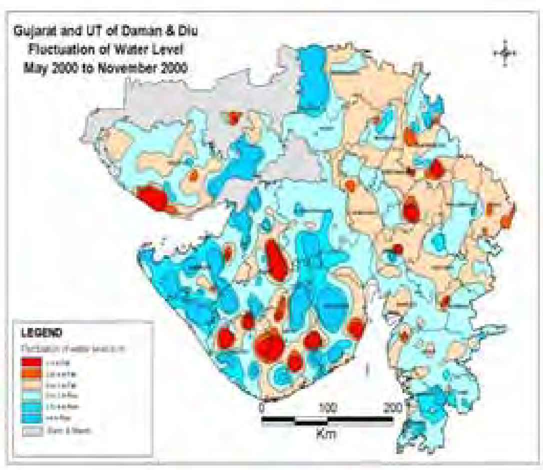


Figure 10.16. Monsoonal changes in groundwater level: 2000.

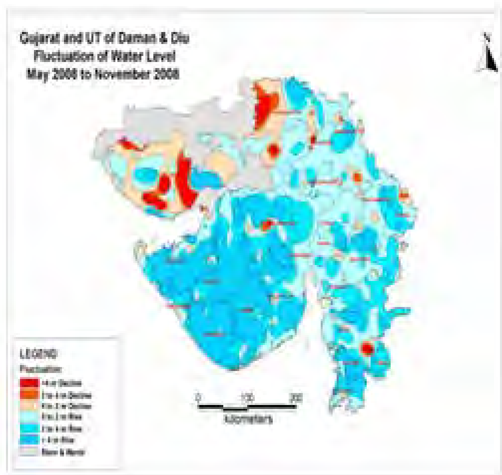


Figure 10.17. Monsoonal changes in groundwater level: 2008.

Groundwater governance in Sri Lanka

- Tank irrigation is central to sustainable groundwater use in Sri Lanka.
- Managing the dynamic balance between tank irrigation of paddy fields and agro-well irrigation

in uplands can enhance sustainability of groundwater.

- Manage the impact of perverse subsidies; impact of fertilizer subsidy policy on agro-well irrigation needs to be closely monitored.
- Focus on supply as well as demand side.
- Farmer organizations to manage both surface water and groundwater? Need more thinking.
- Distinguish between island-wise generic issues versus location-specific groundwater stress.

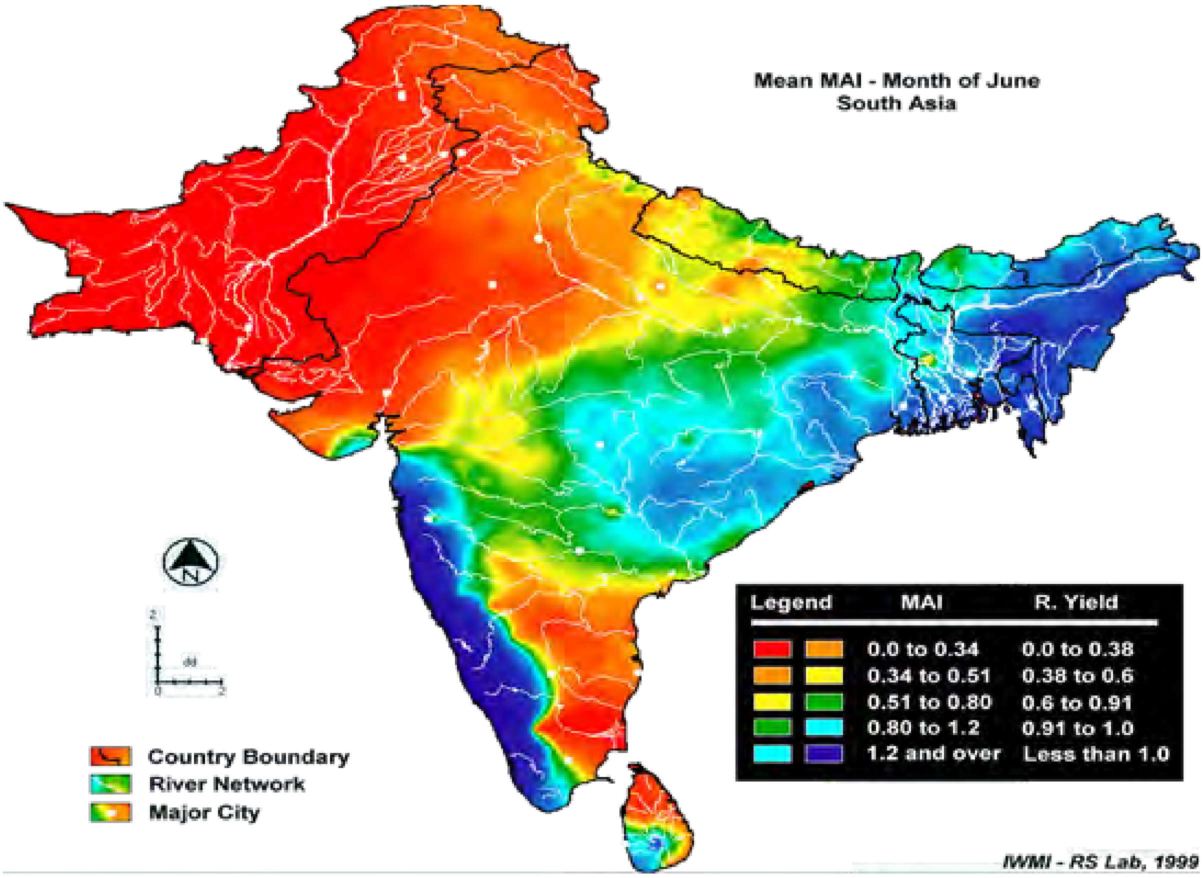


Figure 10.18. Mean MAI for June (1999), South Asia.

Groundwater contribution to poverty alleviation in South Asia and sub-Saharan Africa is very high. So we need to protect groundwater for today and tomorrow.

Sri Lanka has strong farmer organizations to manage surface water and we have to find out whether we can use them to manage groundwater too. We need to identify groundwater resources islandwide.