WATER AND WELFARE

By

NITIN DESAI

SHRI H M PATEL MEMORIAL LECTURE, VALLABH VIDYANAGAR, 13 MARCH 2018

DEDICATION

Shri HM Patel was a distinguished figure in India's public life. As a member of the ICS he served in many capacities in the fields of trade and finance. In the years around Independence he played a critical role in many areas. He was part of the government committee that oversaw the resolution of the administrative issues arising from partition. He served as Secretary in the Home Ministry and worked with Sardar Vallabhbhai Patel in consolidating the newly independent state. In 1977 when the Janata Party came to power in Delhi he became the finance minister under Shri Morarji Desai and later as home minister under Shri Charan Singh. Apart from his work at higher levels administration and politics, he played a big role in establishing new institutions in the field of education and health. His legacy of public service lives on in these institutions. This lecture is dedicated to his memory.

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Life, as we know it, is not possible without freshwater. In fact, when we look for life elsewhere in the universe the clue we look for is the presence of water. Its centrality to life is recognised by religions which treat water as holy in their rituals, in the location of their places of worship and, sometimes, in investing a river or a lake with sacred qualities. Our word for holy places in India, "tirtha', in Sanskrit literally means a ford, a place where one can cross a river. We also invest our rivers like Ganga, Jamuna, Narmada, Kaveri with sacred qualities, though we do not always treat them with the respect that such sacredness deserves. In Islam the Zam Zam, well, where Abraham's wife Hagar found water for the thirsty Ishmael, is an important religious symbol and its waters are believed to have miraculous properties. In Christianity and Judaism, the River Jordan is of special significance as that is where Jesus was baptised and where Israelites crossed over into the Promised Land.

The centrality of water means that the great and little centres of human population have come up along river valleys, lakes and similar water bodies and, where these are not available, at the foot of mountains where water can be collected. When it comes to production, habitat and environmental management, water is strategic resource. Get water management right, particularly at the local level, and a lot else falls in place.

Understanding and managing the hydrological cycle in all its dimensions— precipitation, run off, fresh water flow, ground water, recharge and drainage— is the key to flood and drought protection and meeting water demands for agricultural, domestic and industrial use. Ensuring universal access and sharing water equitably is the key to social justice, poverty reduction, good health and even education. The latter point can be illustrated with two examples. The availability of safe water does more for children's health status, as measured by the incidence of undernourishment, then supplementary nutrition. Access to water supply improves attendance of children, particularly girl, in schools as they have to spend less time in getting water for the family from afar. Hence rational water management is central the key objectives of development–growth, equity, and sustainability.

Water should not be treated simply as an input for production and consumption. Water management has to be seen as part of an eco-system approach which looks at the use of land, water and biotic resources in an integrated way so as to preserve eco-system services that they provide which can be grouped into the following:

- Provisioning: supplying basic necessities like food, water, fibre and fuel.
- Regulating: climate, water flow, drainage, species movements
- Psychic satisfaction: sacred spots, cultural value, aesthetic pleasure

Take the utilisation of river waters for instance. It is sometimes argued that fresh water running into the sea is in some senses a waste. This argument is false. An ecosystem approach that looks at human needs in the context the needs of the ecosystem through which the river passes requires that water withdrawals leave behind sufficient water flow in the river to maintain the riverine ecosystem, including silt movement and deposition, the flora and fauna in the river, groundwater recharge and reflow, etc.

This is the context within which the development of water resources has to be planned. In doing so we have to recognise that water is a shared resource, an increasingly scarce resource and also a resource threatened by the impending risks of climate change. These are the dimensions that are explored below to see how water use can promote public welfare now and in the future.

Water: a scarce and threatened resource

Water is a renewable resource and the quantity available in any isolated area is set by the natural hydrological cycle of precipitation, evapotranspiration and run off. If the area is not isolated, then the quantity also depends on the inflow from neighbouring areas. If these inflows change then the quantity available in the area will also change. However, in a large area like India, these inflows from neighbouring areas do not change by an amount large enough to make a substantial difference.

The quantity available from precipitation can be treated as fixed by nature, though the average will vary from year to year because of the usual variations in precipitation. The current assessment of India's water resources is as follows:

TABLE 1

WATER RESOURCES OF INDIA

Annual precipitation (including snowfall)		4000 billion cum
Average annual potential in rivers		1869 billion cum
Estimated utilisable water		1123 billon cum,
(i) **Surface**	690 billion cum	
(ii) **Ground**	433 billion cum	
Water demand/ utilization (for year 2000)		634 billion cum
(i) **Domestic**	42 billion cum	
(ii) **Irrigation**	541 billion cum	
(iii) **Industry, energy & others**	51 billion cum	

Source: *Preliminary Consolidated Report on Effect of Climate Change on Water Resources,* Central Water Commission & National Institute of Hydrology, Ministry of Water Resources Government of India, New Delhi, June 2008 Table 1 pg.5.

These numbers have been questioned by some experts on the grounds like possible double counting between surface and groundwater flows and underestimation of evapotranspiration. However, they are considered good enough a basis for planning and projections.

At independence India's per capita water availability was over 5000 cum per annum. Since then this availability has come down to about a quarter that. The current assessment of availability upto 2050 is as follows:

TABLE 2
PER CAPITA WATER AVAILABILITY

Year	Population (millions).	Per capita water availibility (cum)	
2001	1029	1816	
2011	1211	1545	water stressed condition*
2025	1394	1340	water stressed condition*
2050	1640	1140.	water stressed condition*

*A**ccording to the Falkenmark Water Stress Indicator, a per capita availability of less than 1700 cubic metres (cum) is termed as a water-stressed condition, while if per capita availability falls below 1000 cum, it is termed as a water scarcity condition.**

Indeed, several river basins in India are already physically water-scarce, which include the Indus, Western Flowing Rivers Group 1(WFR1), Mahi and Sabarmati. The Indus Basin is physically water-scarce; but it produces a substantial part of the nation's grain requirement. The Western Flowing Rivers, Group 1 (WFR1), Mahi and Sabarmati basins are physically water scarce and are also recording deficits in crop production. Many river basins in India also experience unsustainable regional groundwater use. The groundwater abstraction ratios—the ratios of total groundwater withdrawals to the total recharge from rainfall and return flows—of many basins are significantly high. This indicates that certain regions experience unsustainable groundwater depletions. (See Annex II for details)

The river linking project to divert the flood waters of the Ganga-Brahmaputra system to the drier areas in the Deccan plateau. has been thought of as a way of meeting this challenge of availability. But the water surplus in the Ganga-Brahmaputra basin arises in July-October and cannot be made available in the Deccan at the time needed, which is January–May without huge holding reservoirs, which are hardly possible in the plains and would require agreements with Nepal, Bhutan and the Himalayan hill States. It would also require an enormous amount of energy to pump the water from the plains of Northern India to the Deccan Plateau. Questioning the grandiose project of linking the Northern and Southern rivers does not mean an opposition to more limited linking projects based on careful studies of need, feasibility and net benefits.[1]

[1] Nitin Desai, Falling Prey to Giganticism, Business Standard, September 20, 2012

The assessments of water availability rest on the basis of long-term historical data on precipitation, run off and evapotranspiration. All of these will be affected by the emerging threat of climate change. The Intergovernmental Panel on Climate Change (IPCC) has so far prepared five assessments, each one of which has been a cause of increasing concern. This is now widely recognised, despite the efforts of climate sceptics, and is reflected in the global agreement that was reached at Paris in 2015.

The driving force of climate change is the expected rise in average global temperature because of the accumulation of greenhouse gases in the atmosphere, largely due to the rapid rise in fossil fuel consumption. The earth has undergone temperature changes in the past, but over long periods of time running into thousands of years. The difference now is that the changes that are expected will take place over decades rather than centuries and the time available for human systems and ecosystems to respond and adjust is so short that disruption is inevitable. Each one of the past three decades has been warmer than any previous decade since records started to be kept in the mid nineteenth century.

The degree of disruption will depend on the extent to which we succeed in mitigating the extent of change by implementing the measures that having agreed in the Paris accord. Even with the temperature increase limited to the agreed goal of 2^0C, the extent of impact will require that the management of agriculture, forests, water resources, human settlements, coastal areas and fragile ecosystems will require substantial changes from past practices. Right now, the prospects of staying below the agreed goal are not very bright and it would be prudent to plan for substantial disruptions in the behaviour of all ecosystems.

In India the average temperature has risen by about 0.57^0C in the twentieth century. The global trend of rising temperatures in recent decades is also found in India.

Table 3

Climate Change Projections for India

Scenario		Increase in temperature (^{0}C)	Change in rainfall (%)
2020s	Annual	1.00 – 1.41	2.16 – 5.97
	Winter	1.08 – 1.54	(-)1.95 – 4.36
	Monsoon	0.87 – 1.17	1.81 – 5.10
2050s	Annual	2.23 – 2.27	5.36 – 9.34
	Winter	2.54 – 3.18	(-)9.22 – 3.82
	Monsoon	1.81 – 2.37	7.18 – 10.52
2080s	Annual	3.53 – 5.55	7.48 – 9.90
	Winter	4.14 – 6.31	(-)24.83 – 4.50
	Monsoon	2.91 – 4.62	10.10 – 15.18

Source: Preliminary Consolidated Report on Effect of Climate Change on Water Resources, Ministry of Water Resources, Government of India, New Delhi, Jume 2008

A major difficulty in working out the required changes at the river basin level is the lack of reliable temperature and climate forecasts even at the river basin level. The available forecasts from the global climate models used to make long-term projections only give results for relatively large areas. However, the forecast for the monsoon which is central to the hydrological cycle in India can be summarised as follows[2]:

- The Indian summer monsoon circulation will weaken, but this is compensated by increased atmospheric moisture content, leading to more precipitation.
- The increase of the Indian summer monsoon rainfall and its extremes throughout the 21st century will be the largest among all monsoons. Studies based on the observed precipitation records of India Meteorological Department (IMD) have shown that the occurrence of extreme precipitation events and their variability has already gone up in many parts of India.
- The hydrological cycle is predicted to be more intense, with higher annual average rainfall as well as increased drought.
- The analysis of two major water balance components of water yield and actual evapo-transpiration indicate that the majority of the river systems show increase in the precipitation at the basin level. Only Brahmaputra, Cauvery and Pennar show marginal decrease in precipitation in the mid-century projection while all the river systems exhibit an increase in precipitation in the end century projection. A majority of the river systems are predicted to have an increase in evapotranspiration by more than 40%.[3]
- There is an increase in the moderate drought risk for Krishna, Narmada, Pennar, Cauvery, and Brahmini basins, and moderate to extreme drought severity (Scale 2) has been pronounced for the Baitarni, Sabarmati, Mahi, and Ganga river systems, where the increase is ranging between 5% and 20% for many areas despite the overall increase in precipitation.[4]

Some of the outcomes relevant for water resources that can be predicted with confidence, even without the benefit of more geographically disaggregated climate models, are that:

- Glacier melts in the Himalayas will increase and impact on the timing and quantum of flow in snow-fed rivers.
- The timing and quantum of precipitation will become more uncertain and we can expect more rain on fewer days raising the risks of floods and long er periods of dormancy during the rainy season.
- Higher temperatures will lead to greater evaporation losses.
- Water demand in agriculture will increase to make up for the predicted productivity lowering.

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[2]Intended Nationally Determined Contributions: Template for Vulnerability Assessment, Mitigation and Adaptation, Government of India, Ministry of Water Resources, River Development and Ganga Rejuvenation National Water Mission, 2015, pg 14
[3]Intended Nationally Determined Contributions:Template for Vulnerability Assessment, Mitigation and Adaptation,*ibid* pg 15
[4]Intended Nationally Determined Contributions:Template for Vulnerability Assessment, Mitigation and Adaptation,*ibid.* pg.17

- Domestic water use in households will go up because of higher ambient temperatures.

TABLE 4

BUSINESS AS USUAL DEMAND PROJECTIONS						
Sector	**2000**		**2025**		**2050**	
	Total in billion cum	**Percentage from Groundwater**	**Total in billion cum**	**Percentage from Groundwater**	**Total in billion cum**	**Percentage from Groundwater**
Irrigation	605	45	675	45	637	51
Domestic	34	50	66	45	101	50
Industrial	42	30	92	30	161	30
Total	680	44	833	43	900	47
Source	Amarasinghe, U. A.; Shah, T.; Turral, H.; Anand, B. K. 2007. India's Water Future to 2025-2050 Sri Lanka: International Water Management Institute. 47p. (IWMI Research Report 123)					

- All the hypothetical climate change scenarios would cause impairment in water quality. due to the impact of climate change on temperature and flows, even when discharges were at the safe permissible levels.
- The potential impacts of 1m sea-level rise include inundation of coastal areas as well as significant losses of coastal ecosystems, affecting the aquaculture industry, particularly in heavily-populated mega-deltas.

Recognising the impact of climate change on water management requires (a) greater urgency in tackling the threat of water stress and scarcity, (b) adaptive strategies to manage surface waters and reservoirs to cope with the greater uncertainty of flows (c) protection of coastal wetlands that can mitigate the impact of sea level rise.

Water Demand: Emerging Stresses

The assessments of water availability have to be compared to the projections of demand. One such estimate based on a business as usual approach is given in the Table 3.

Irrigation demand accounts for nearly 90% of water demand. However, looking at the future domestic and industrial demand become much more important- they account for 85% of the increase 2000-2050 period and a significant part of the surface flow will be diverted for the large bulk demands of cities in factories. However, irrigation will remain the principal draft on water resources accounting for about 70% of the use even in mid-century.

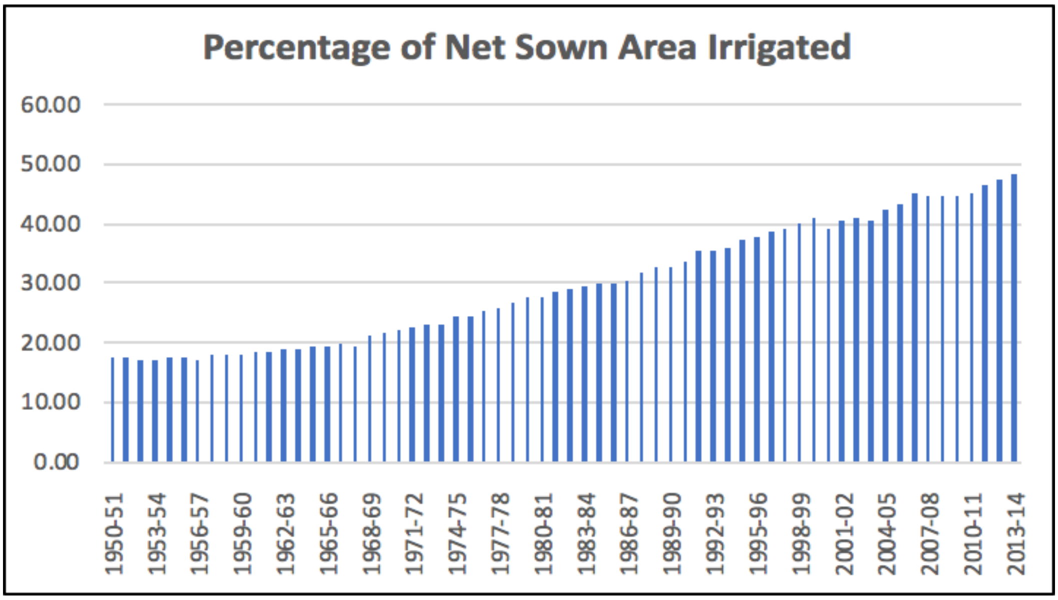
Irrigation

Irrigation development has been the main source of growth and advancement in Indian agriculture in the post-independence era and even earlier. The particular nature of the monsoon regime, 50% of the precipitation being received in one or two months and 90% of the river flow in 4 months of the year. has led to this role for irrigation. An even more important factor has been the pressure on cultivable land from a growing population and rising demands on an agricultural system as it integrates with national and international markets. Irrigation has helped to raise land productivity, raising production and enhancing the incomes of farm households. However, even now, around half of our cropped area remains rain-fed.

Much of the earlier irrigation was done from wells and tanks built by individuals, or the community or local potentates. Large scale canal irrigation became more widespread in colonial times. But most of these large canal irrigation projects were diversion works which involved minimal storage.

After independence the emphasis shifted to projects where water was impounded and stored behind large dams. As of end 2011, 4818 large dams had been built, more than 90% of them after independence. These completed and on-going and contemplated projects would raise this to 390.34 billion cum against total utilizable surface water resources availability of 690.31 billion cum in the river basins of the country. The storage capacities as percentage of average annual flow exceed 50% for Krishna, Tapi and Narmada basins. The large scale of hydrological intervention, the extent of displacement of people and disruption of eco-systems changed substantially.

The growth in irrigated acreage has a been a key element in India's agricultural strategy, particularly in the Green Revolution that came after the mid-60s and the net sown area irrigated, which rose by an average of 0.1% per year till the mid-sixties, has increased by an average of 0.6% per year since then.



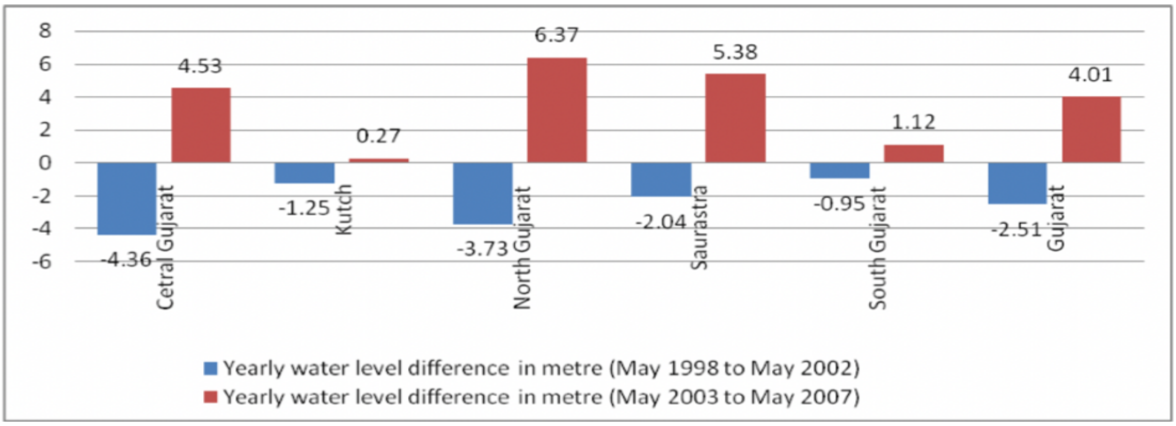
An important development particularly in the past two decades has been the growing importance of groundwater irrigation whose share in the total irrigated area has increased substantially since 1960-61. At that time tubewells were rare and traditional wells accounted for about 29% of the net irrigated area. Groundwater irrigation now accounts for over 60% of the net irrigated area, mainly from tube wells as the share of traditional wells has dropped to 19% of the net irrigated area. The growing use of tubewell is attributable to inefficiency in the publicly managed irrigation system, the greater control that the farmer can exercise in the timing and quantum of irrigation with a tubewell, the availability of free electricity in many States and the advantages of a tubewell when pressure is required for irrigation methods like sprinkler irrigation or drip irrigation.

The rapid growth in groundwater irrigation poses many problems. The situation with respect to groundwater resources as of March 2013 (latest available information on the official site) is give in Annex III. It shows that we are now exploiting 62% of our useable groundwater resources and about 20% of the 6584 blocks are in a critical or over exploited state.
Though aquifers are shared each farmer is free to draw water as and when he or she likes and this leads to a classic tragedy of the commons. This has led to a serious depletion of groundwater and in the states/UTs of Assam, Daman & Diu, Meghalaya, Pondicherry, Tamil Nadu, Tripura and Uttarakhand where more than 50% of the wells have registered decline in ground water level, when compared with decadal average of (2004-2013). Decline of more than 4 m has also been observed in pockets in the states of Delhi, Gujarat, Haryana, Karnataka, Meghalaya, Rajasthan and Tamil Nadu. A detailed groundwater recharge study of four water-stressed basins – Lower Indus, Sabarmati, Cauvery, and Godavari – indicates substantial increase in groundwater development over the past 10 years. Two of the river basins – Sabarmati and Indus – have recorded groundwater development of more than 100% of the annual replenishment in some areas. In such over-exploited areas, the water table shows continuous decline. Groundwater development in the coastal areas can induce saline ingress.[5]

[5] Intended Nationally Determined Contributions: Template for Vulnerability Assessment, Mitigation and Adaptation, *op.cit* pg.13.

The conjunctive use of surface water and groundwater is very important for managing the hydrological cycle. These two sources of water are not part of independent hydrological cycles. They feed into one another. If groundwater aquifers are over exploited then the flow of water from them to maintain river flow in the dry season is affected. “The single most important factor ex- plaining the drying up of post-monsoon flows in India’s peninsular rivers is the over-extraction of groundwater.”[6] The reverse effect, as more accessible surface flows improve groundwater recharge can be seen in the improvement in groundwater in North and Central Gujarat and Saurashtra after the start of supply of Narmada waters,

IMPACT OF NARMADA WATERS ON GROUNDWATER LEVELS IN GUJARAT



Source: Dr. Rajiv K Gupta. The role of water technology in development: a case study of Gujarat State, India, paper presented at UN-Water International Conference, Zaragoza, Spain, October 2011

Water use in agriculture will change as production shifts from field crops to horticulture and animal husbandry. Given emerging scarcities, policies to discourage cropping patterns inappropriate for the local water regime are necessary. Above all efficiency has to be promoted so as to get “more crop per drop”. At present the efficiency of surface irrigation is 30 to 40% and groundwater irrigation is 65%, where efficiency is the proportion of supply water that reaches the root zone of the plant. In the case of surface irrigation losses can be reduced by reducing leakages from the source to the field and moving from flood irrigation more economical methods of delivering water to the root zone. Pump based groundwater irrigation has the capacity to deliver water though methods like sprinkler and drip irrigation that greatly enhance the efficiency of delivery of water to the root zone.

Measures to discourage inappropriate cropping patterns and to promote efficiency of water use will help. However the real need is for a change in the governance of water use at every level from the local to the national, a matter that will be dealt with later in this paper.

Domestic & Industrial Use

Water demand for domestic use is only about 5% of total water demand in the country at present; but by 2050 the share of domestic demand will rise to around 11%, mainly because

[6] Mihir Shah, Water Governance, The Way Forward, Economic & Political Weekly Dec 24, 2016 vol lI no 52pg.57

of urbanisation. Per capita urban water use tends to be higher than in rural areas because of higher incomes, different habitation patterns and greater use of waterborne sewage disposal. Distribution losses, estimated to be 25-40%, also tend to be higher because of the longer and often poorly maintained piping systems The long distance from which surface water is transported for major metropolitan cities, where the demands are far too large to be met by local water sources, also involves substantial transmission losses. Delhi gets a significant part of its water supply from Tehri Dam, which is 320km away, Mumbai from Vaitarna, 120km away, Chennai from the Krishna, 200km away, Bangalore from the Cauvery 100km away and Hyderabad from the Krishna, a 100km away.

According to the 2011 census data 49% of urban households have access treated tapwater within the premises. Another 13% received treated tapwater outside the house. The remaining households, many of whom live an unauthorised colonies and urban slums, are dependent on untreated water from a variety of sources. Often, they have to depend on expensive private tankers which supply untreated water from private borewells or even illicit theft from public sources. For these poor people water supply is in effect privatised with no regulatory controls.

The deterioration in water quality in urban habitations is becoming an increasingly serious problem. The amount of domestic waste water generated in 893 Class I & II Cities is around 29 million litres per day (MLD), of which 23 million litres goes into the hydrological cycle untreated.[7]

Industrial water use in India is rising very rapidly. Thermal power plants account for a very large proportion of this use. The water demand figures given about, based on information with the Ministry of Water Resources suggest that industry accounts for 6% of water use. However, the Central Pollution Control Board estimates the share to be at 8% and a World Bank study has set it higher at 13%. Industry is also a major source of water pollution. As for industrial waste water, out of the estimated 13.5 million litres per day generated nearly 13 million litres per day goes untreated.[8] There are two further points that can be made about industrial water use – the productivity of water use in industry in India compares very unfavourably with other countries and that water charges and compliance pressures are too low to encourage efficiency in water use and pollution management.[9]

The threat of domestic and industrial water pollution is perhaps the greatest hazard that our rivers have to face. It cannot be tackled by end of the pipe solutions, as we have seen with great difficulty that we have had in cleaning up the Ganga despite action programs that began as far back as 1986. The impact of this concentrated pollution is far greater than the quantum off discharge because one litre of effluent pollutes 5 to 8 litres of fresh water.[10] Since both urbanisation and industrial growth will make rising demands on surface waters we need to address the problem at the source with policies that enforce greater responsibility for water

[7] Intended Nationally Determined Contributions: Template for Vulnerability Assessment, Mitigation and Adaptation, *op.cit*

[8] Intended Nationally Determined Contributions: Template for Vulnerability Assessment, Mitigation and Adaptation,*op.cit*

[9] Suresh Chand Aggarwal & Surender Kumar, Industrial Water Demand in India, India Infrastructure Report, 2011, IDFC and references cited therein.

[10] Centre for Science and Environment [CSE] (2004), 'Not a Non-Issue', *Down to Earth*, Vol. 12, No. 19, February.

economy, water recycling and reuse as well as efforts to reduce the pollution load of effluents. In urban areas, sewerage treatment must become the norm rather than the exception. If we do not do this our river waters may become unusable. “Instead of killing rivers first and then trying to revive them, we must learn to let them live and remain in a healthy state.”[11]

The situation with regard to rural water supply shows substantial improvement since the launch on the National Rural Water Supply Programme in 1972-73. As of now more than 90% of the 14 lakh habitations are fully covered (per capita water supply of 40litres per day or over) or partially covered (per capita water supply of 10- 40 litres per day or over) within 1.6 km in the plains or within a 100m risen the mountains. However, there are two problems that remain. The first is the fact that villages often slip from fully to partially covered or from partially covered to not covered. The second is that more than 200,000 villages suffer from ground water contamination of various sorts.[12] For the past few years sanitation and the provision of latrines and the elimination of open defecation has become a major part of public effort, particularly in rural areas.

Eco-system flows

“A river must flow. If it does not flow, it is not a river.” [13] The idea that river water that flows to the sea unused by humans is wasted is naive. This fails to comprehend the ecosystem use of water for maintaining the health of the river, particularly its capacity to cope with pollution. Groundwater aquifers fill up during the peak flow period and make that water available in the lean season. Holding back water in reservoirs may worsen pollution stress downstream and transferring water from one basin to another may carry pollution where at present it is not a problem. The water flowing into the sea is a necessary part of the littoral circulation of water and any drastic reduction may have severe ecological consequences on fisheries, wetlands and even shore installations like ports.

Respecting ecosystem requirements of rivers requires not just the maintenance of water flow at the level which will maintain the health of the water. It also requires ecologically sensitive management of the river bed, without excessive sand removal or encroachment on floodplains, so as to maintain the channel capacity required to accommodate seasonal variations in flow.

This eco-system dimension off river water demand has not been well studied and it is only now receiving some attention when the outcome of neglect can be seen as in the upper Himalayan rivers and in some of the rivers in the Deccan drylands. Hence no the clear estimate is available of how much this ecosystem demand will reduce what is it available for other purposes. It is a need which will have to be studied more systematically as we are getting close to what could the limit for water withdrawal and impounding in our rivers.

[11] Ramaswamy R Iyer, National Water Policy: An Alternative Draft for Consideration, June 25, 2011, Economic & Political Weekly, Vol,XLVI Nos 26 & 27

[12] According to information on the site of the Ministry for Water and Sanitation the figures for contamination in rural water supply are: Excess Fluoride 31306 Excess Arsenic 5029 Excess Salinity 23495 Excess Iron 118088 Excess Nitrate 13958 Multiple quality problems 25092 Total 216968

[13] Ramaswamy R Iyer, National Water Policy: An Alternative Draft for Consideration, June 25, 2011, Economic & Political Weekly, Vol,XLVI Nos 26 & 27

Managing a shared resource

The water that we use may come from or through our neighbour's property; so also what we dispose off as waste. Hence, we have to cooperate with our neighbours in managing the use of water and its drainage. In fact, the institutions that manage local water resources are sometimes the only manifestation of social order in lawless areas. This need to cooperate extends beyond the local to the regional, national and global level. But where cooperation is needed, conflicts could also arise. That is why managing water use and disposal is a political matter, subject to relationships of power.

We need arrangements that will ensure cooperation for sustainable and equitable water management at the level of the micro water-shed, the aquifer and the river basin. These will cut across political jurisdictions and property rights and will require legal changes that will modify existing provisions for rights and obligations with respect to water and that will not be easy. At the same time the responsibility for policies that affect water demand rests with local bodies and State and Central governments. Putting together this jigsaw off connecting the hydrological geography of the country with the political geography of power will require institutional innovations in three key areas: village level water users associations, aquifer users associations and river basin authorities authorities.

At the village level the arrangements for water and drainage management rest on community cooperation through panchayats and water cooperatives. An inspiring example can be found in Ralegan Siddhi where, under the leadership of Annasaheb Hazare, a poor village with deteriorating land resources was transformed by community effort to a state of high prosperity. This bringing together of the community rested on the establishment of a youth society, water cooperatives of small farmers, and an agreement to choose panchayat leaders by consensus. Contributory labour from the villagers, government support for watershed development and borrowed funds were used for water harvesting, lift irrigation, tree planting and agricultural improvements leading to an increase in per capita income from Rs.271 in 1975, when the project started, to Rs. 2257 ten years later in 1985, a growth rate of 23.6% er annum. The heavy dependence on community support and involvement also led to other gains like innovative energy use, improved education and health, social harmony, etc. Many attempts have been made replicate this success in other areas and there are examples of similar success.[14]

In many ways what was is reproduced in these villages was the traditional system that prevailed before the intrusion of market forces and population expansion led to a breakdown. The key government intervention was the financial and technical support for watershed development based on community effort, organised through cooperatives and panchayats.

The next level for organizational reform, the aquifer poses more challenges. Securing sustainable, equitable and cooperative use of groundwater aquifers will take quite some time to evolve in India. Our laws confer rights to the water below the ground to the landowner

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[14] Aasha Kapur Mehta & Trishna Satpathy, Escaping Poverty, The Ralegan Siddhi Case, Chronic Poverty Research Centre, Working Paper No. 119, Indian Institute of Public Administration, New Delhi, September 2008

even when the aquifer from which the landowner draws water is shared with others. This has to change, if nothing else by applying the principle of holding a person responsible for the damage caused to another. But our aim has to be higher – our long-term goal must be to provide a legal basis requiring all users and stakeholders to join in the cooperative effort to manage the shared resource. We may learn by studying the experience of countries that have introduced a system of aquifer contracts involving everyone who wants to use water from the aquifer and those, who may not be users, but are affected by how the aquifer is used., with public authorities playing a regulatory, facilitating and financing role to secure an agreement. This will take a long time to develop in India; but he goal must be stated and actively promoted. In order to do this, the task of mapping aquifers must be taken up as a matter of urgency. Without that little progress can be made. In the meantime, cooperative aquifer management should be taken up in publicly funded watershed development projects.

Securing agreement on joint management of river basins, the third area of governance development mentioned above, will be at least as difficult. Water is a State subject in the Constitution of India. Yet all the major river basins of India listed in Annex 1 are shared by two or more States. Integrated management of a river basin has been reduced to securing agreement on water sharing. The Centre has not made much use of the potential for legislation and executive action given to it by the Constitution in respect of inter-state rivers and river valleys. The River Boards Act 1956 has remained a dead letter. There is no real river basin authority and there has been no basin-wide planning. The constitutional provisions may need to be reviewed in the light of the environmental, social and other concerns which have acquired great importance in recent years, but till then we have to see whether more can be done within the present framework.[15]

In the recent Supreme Court judgement on the Cauvery dispute the Court has reaffirmed the principle of water apportionment it enunciated in its opinion in the Presidential Reference on the Cauvery Water Disputes Tribunal) that "the waters of an inter-State river passing through the corridors of the riparian States constitute national asset and cannot be said to be located in any one State. Being in a state of flow, no State can claim exclusive ownership of such waters or assert a prescriptive right so as to deprive the other States of their equitable share. It has been propounded therein that the right to flowing water is well-settled to be a right incident to property in the land and is a right *publici juris* of such character, that while it is common and equal to all through whose land it runs and no one can obstruct or divert it, yet as one of the beneficial gifts of Nature, each beneficiary has a right to just and reasonable use of it. "[16]

The Supreme Court's clear rejection of territorial ownership of surface water rights can provide a legal basis for moving towards a system of cooperative river basin management. However, the emerging stresses in water availability will reinforce the politics of State level control and moving forward will require cooperative federalism and a clearer demonstration that an eco-system centred approach to the conjunctive management of surface and groundwater resources will be in every person's long-term interest, particularly with the uncertainties due to the threat of climate change. As a first step, river basin associations of

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[15]Ramaswamy R. Iyer (2007) Indian federalism and water resources, International Journal of Water Resources Development, 10:2, 191-202

[16] Supreme Court of India Judgement in the case of civil appeal Not 2453/2454/2456 of 2007 para 363.

the concerned states can be formed for information and research leading to more substantial transfer of authority as mutual confidence builds up. The need for this type of cooperation will greatly increase as more and more surface waters are required for domestic and industrial purposes.

At the national level a recent report by a Committee headed by Shri Mihir Shah on the restructuring of the Central Water Commssion (CWC) and the Central Ground Water Board (CGWB) has recommended the creation of a new National Water Commission (NWC) as the nation's apex facilitation organisation dealing with water policy, data, and governance. Annex IV lists some of the key elements in the mandate of this proposed Commission. This would bring technical capacities for surface and groundwater under one umbrella and lead to better conjunctive use of these sources. But more than this the report also recommends a different approach to water development that moves away from an instrumental, command and control approach to one that is much more people-centred and eco-system oriented.[17]

The crisis that is looming in India's water systems is not just one of demand supply imbalance. It is crisis that is the product of short-term considerations dominating political discourse and economic policy. It is crisis because one group of people can pass on the costs of meeting their needs do some other group of people. It is crisis that has arisen because the people who will be victims of our collective mistakes, the generations to come, do not have a vote in our elections or a voice in the policy debates. It is crisis that is the product of an instrumental view of nature instead of seeing humans and their needs as part of nature so that anything which hurts nature also hurts humans now and in the future. Nature will protect us and look after us if we protect and look after nature.

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[17] Mihir Shah, The Way Forward, Economic & Political Weekly, December 24, 2016 vol lI no 52

ANNEX I
MAJOR RIVER BASINS SHARED BY TWO OR MORE STATES

MAJOR RIVER BASINS OF INDIA				
	Name of the River	**Length (km)**	**Catchment Area (sq. km)**	**States falling in the catchment**
1	Indus	1,114 +	3,21,289	J&K, Punjab, Himachal Pradesh, Rajasthan and Chandigarh UT
2	a) Ganga	2,525 +	8,61,452	Uttaranchal, Uttar Pradesh, Himachal Pradesh, Haryana, Rajasthan, Madhya Pradesh, Bihar, West Bengal and Delhi UT.
	b) Brahmaputra	916 +	1,94,413	Arunachal Pradesh, Assam, Meghalaya, Nagaland, Sikkim,West Bengal, Mizoram and Tripura
	c) Barak & other rivers flowing into Meghna		41,723	Assam, Meghalaya, Nagaland, Manipur, Mizoram and Tripura
3	Sabarmati	371	21,674	Rajasthan and Gujarat
4	Mahi	583	34,842	Rajasthan, MP and Gujarat
5	Narmada	1,312	98,796	Madhya Pradesh, Maharashtra and Gujarat
6	Tapi	724	65,145	Madhya Pradesh, Maharashtra and Gujarat
7	Brahmani	799	39,033	Madhya Pradesh, Bihar and Orissa
8	Mahanadi	851	1,41,589	Madhya Pradesh, Maharashtra, Bihar, Chattisgarh and Orissa
9	Godavari	1,465	3,12,812	Maharashtra, Andhra Pradesh, Madhya Pradesh, Orissa and Pondicherry
10	Krishna	1,401	2,58,948	Maharashtra, Andhra Pradesh and Karnataka
11	Pennar	597	55,213	Andhra Pradesh and Karnataka
12	Cauvery	800	81,155	Tamil Nadu, Karnataka, Kerala and Pondicherry
	Source: Hydrology and Water Resources Information System for India, http://nihroorkee.gov.in/rbis/rbis.htm			

ANNEX II
SURFACE AND GROUND WATER RESOURCES OF RIVER BASINS IN INDIA

ANNEX 1 SURFACE AND GROUNDWATER RESOURCES OF RIVER BASINS INDIA

S.No.	Name of the river basin	Population (million)	Catchment area (km^2)	Average annual surface water potential (km^3)	Estimated utilizable surface water (km^3)	Estimated replenishable groundwater resources (km^3)	Total utilizable water (km^3)	Surface storage potential, (km^3)	Total surface and groundwater storage (km^3)	Per capita water available (2010)
1	Indus (up to the border)	59.01	3,21,289	73.31	46	26.49	72.49	19.14	45.63	1,242
2	Ganga	505.54	8,61,452	525.02	250	170.99	420.99	94.35	265.34	1,039
2.1	Brahmaputra, Barak, others	49.71	2,36,136	585.6	24	35.07	59.07	52.94	88.01	11,782
3	Godavari	76.02	3,12,812	110.54	76.3	40.65	116.95	41.89	82.54	1,454
4	Krishna	85.62	2,58,948	78.12	58	26.41	84.41	49.61	76.02	912
5	Cauvery	41.27	81,155	21.36	19	12.3	31.3	12.96	25.26	518
6	Subernarekha	13.23	29,200	12.37	6.81	1.82	8.63	3.93	5.75	935
7	Brahamani & Baitarni	13.80	39,033	28.48	18.3	4.05	22.35	13.72	17.77	2,063
8	Mahanadi	37.45	1,41,589	66.88	49.99	16.46	66.45	26.52	42.98	1,786
9	Pennar	13.67	55,213	6.32	6.86	4.93	11.79	4.82	9.75	462
10	Mahi	14.78	34,842	11.02	3.1	4.2	7.3	5.21	9.41	746
11	Sabarmati	14.80	21,674	3.81	1.93	3	4.93	1.56	4.56	257
12	Narmada	20.70	98,796	45.64	34.5	10.83	45.33	27.14	37.97	2,205
13	Tapi	20.85	65,145	14.88	14.5	8.27	22.77	12.26	20.53	714
14	West flowing rivers From Tapi to Tadri	36.33	52,900	87.41	11.94	8.7	20.64	16.42	25.12	2,406
15	West flowing rivers From Tadri to Kanyakumari	45.91	56,200	113.53	24.27	9	33.27	13.81	22.81	2,473
16	East flowing rivers between Mahanadi & Pennar	33.25		22.52	13.11	9	22.11	4.24	13.24	677
17	East flowing rivers between Pennar and Kanyakumari	63.29	1,00,100	16.46	16.73	9.2	25.93	1.38	10.58	260
18	West flowing rivers of Kutch, Saurashtra including Luni	31.10	3,21,900	15.1	14.98	11.23	26.21	9.59	20.82	486
19	Area of inland drainage in Rajasthan desert		60,000							0
20	Minor river basins draining into Bangladesh & Myanmar	2.11	36,300	31		18.8	18.8	0.31	19.11	14,679
	Total		31,84,684	1,869	690	431	1,122	411.81	843.21	1,588

Source : Anjali Gaur & U Amarsinghe, India Infrastructure Report 2011, IDFC, based on data from Central Water Commission and Central Ground Water Board.

ANNEX III
GROUNDWATER RESOURCE SITUATION AS O F 31 MARCH 2013

	Groundwater Resources	
1	Total Annual Replenishable Ground Water Resources	447 bcm
2	Net Annual Ground Water Availability	411 bcm
3	Annual Ground Water Draft	253 bcm
4	Stage of Ground Water Development	62%

	Categorization of Assessment Units (Blocks/ Mandals/ Firka/Taluks)	
	Total No. of Assessed Units	6584
1	Safe	4520
2	Semi Critical	681
3	Critical	253
4	Over-Exploited	1034
5	Saline	68

Source: Central Ground Water Board, http://www.cgwb.gov.in/gwresource.html, accessed 06-03-18

ANNEX IV

MANDATE OF THE PROPOSED NATIONAL WATER COMMISSION

The key mandate and functions of the NWC include:

(i) Enable and incentivise state govern- ments to implement all irrigation projects in a participatory mode, with an over- arching goal of *har khet ko paani* (liter- ally, water for every field; or equitable and universal access), and improved wa- ter resource management and water use efficiency, not just construction of large- scale reservoirs.

(ii) Lead the national aquifer mapping and participatory groundwater manage- ment programme. (iii) Insulate the agrarian economy and livelihood system from the pernicious effects of drought, flood, and climate change, and move towards sustainable water security.

(iv) Develop a nationwide, location-spe- cific programme for rejuvenation of In- dia's rivers to effectively implement the triple mandate of *nirmal dhaara, aviral dhaara, swachh kinaara* (unpolluted flow, continuous flow, clean river banks).

(v) Create an effective promotional and regulatory mechanism that finds the right balance between the needs of develop- ment and the environment, protecting the ecological integrity of the nation's rivers, lakes, wetlands, and aquifers, as well as coastal systems.

(vi) Promote cost-effective programmes for appropriate treatment, recycling and reuse of urban and industrial waste water. (vii) Develop and implement practical programmes for controlling point and non-point pollution of waterbodies, wet- lands, and aquifer systems.

(viii) Create a transparent, accessible, and user-friendly system of data man- agement on water that will support the attempt of citizens to devise solutions to their water problems.

(ix) Operate as a world-class knowledge institution, available on demand for advice to state governments and other stakeholders.

(x) Create world-class institutions for broad-based capacity building of water professionals and primary stakeholders in water.

Source: Mihir Shah, The Way Forward, Economic & Political Weekly, December 24, 2016 vol lI no 52