International Water Management Institute

IWMI-TATA Water Policy Program

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POLICY PAPER
JUNE 2016

HAR KHET KO PANI
(*Water to Every Farm*)
Rethinking Pradhan Mantri Krishi Sinchai Yojana (PMKSY)

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Executive Summary

Har Khet Ko Pani?

In its manifesto for 2014 parliamentary elections, Bharatiya Janata Party gave pride of place to universalizing irrigation access by including *Har Hath Ko Kam*, *Har Khet Ko Pani* as one of its commitments. After the NDA government came to power, this commitment took the form of *Pradhan Mantri Krishi Sinchai Yojana* with an allocation of ₹ 50,000 crore over 2015-2020 period with an additional ₹ 20,000 crore placed at the disposal of NABARD. As currently designed, PMKSY has four components: Accelerated Irrigation Benefits Program (₹ 11,060 crore), 'per drop, more crop' component (₹ 16,300 crore) to support micro-irrigation, watershed program (₹ 13,590 crore) and a new component called *Har Khet Ko Pani* (₹ 9,050 crore) to construct one water harvesting structure per village by 2020. The implementation of PMKSY was to be kicked off with the preparation of District Irrigation Plans (DIPs) by state governments using a format provided by Government of India. Some 240 district plans are apparently ready although only Chhattisgarh and Nagaland have placed their DIPs in public domain.

Is PMKSY on the right path? Does it have the potential to deliver *Har Khet Ko Pani?* Does it reflect the current irrigation reality of India? Is there a better way to design and implement PMKSY to target effort and resources where it matters most? This IWMI-Tata Policy Paper offers an early analysis to help implement a better PMKSY with greater potential for socio-economic and livelihood impacts.

Infirmities in current design

This policy paper highlights several infirmities with the current strategy as well as implementation roadmap for PMKSY.

1. The promise of *Har Khet Ko Pani* had invoked expectations about bold new irrigation thinking; but PMKSY's current *avtar* is a *hotchpotch* of pre-existing schemes such as AIBP and micro-irrigation subsidies with an indifferent track record. The only new component, *Har Khet Ko Pani*, is neither clear in objectives nor is adequately funded.
2. As BJP chief ministers of Gujarat and Madhya Pradesh, Prime Minister Modi and Shivraj Singh Chauhan had created veritable irrigation miracles in their states with their irrigated area as well as agricultural GDP growing at double-digit rates post-2000. The expectation was that PMKSY will replicate these sterling achievements on the national scale by learning from irrigation strategies these states followed; in its current design, PMKSY betrays no such learning.
3. PMKSY also overlooks that especially since 1990: [a] the gap between Irrigation Potential Created (IPC) and Irrigation Potential Utilised (IPU) under government-managed Major, Medium and Minor Irrigation Projects (MMMIPs), the so-called Type I irrigation, steadily increased, resulting in little or no benefits from public irrigation investments to Indian agriculture; [b] that the bulk of the 40 million hectares (mha) of new irrigation has come from wells/tubewells and private lift irrigation (Type II irrigation); [c] that farmers prefer Type II irrigation because it can be created quickly, cost-effectively, by private investment and offers year-round on-farm water control; [d] government action can sustain Type II irrigation importantly by investing in groundwater recharge and by improving the Management, Operation and Maintenance (MO&M) of public and community structures such as watersheds, irrigation tanks, canals — all of which sustain Type II irrigation.
4. The irrigation strategies of Gujarat and Madhya Pradesh were built on this reality. Under Modi, Gujarat targeted half a million electricity connections for tubewells to SC/ST farmers; gave a fillip to irrigation by improving the quality of farm power supply; invested in groundwater recharge and began desilting 5,000 reservoirs/tanks every year; increased area under micro-irrigation from less than 50,000 ha in 2002 to 13 lakh ha in 2015, and began

Figure ES.1: Percentage *Adivasi* holdings and access to Type II irrigation in 112 districts

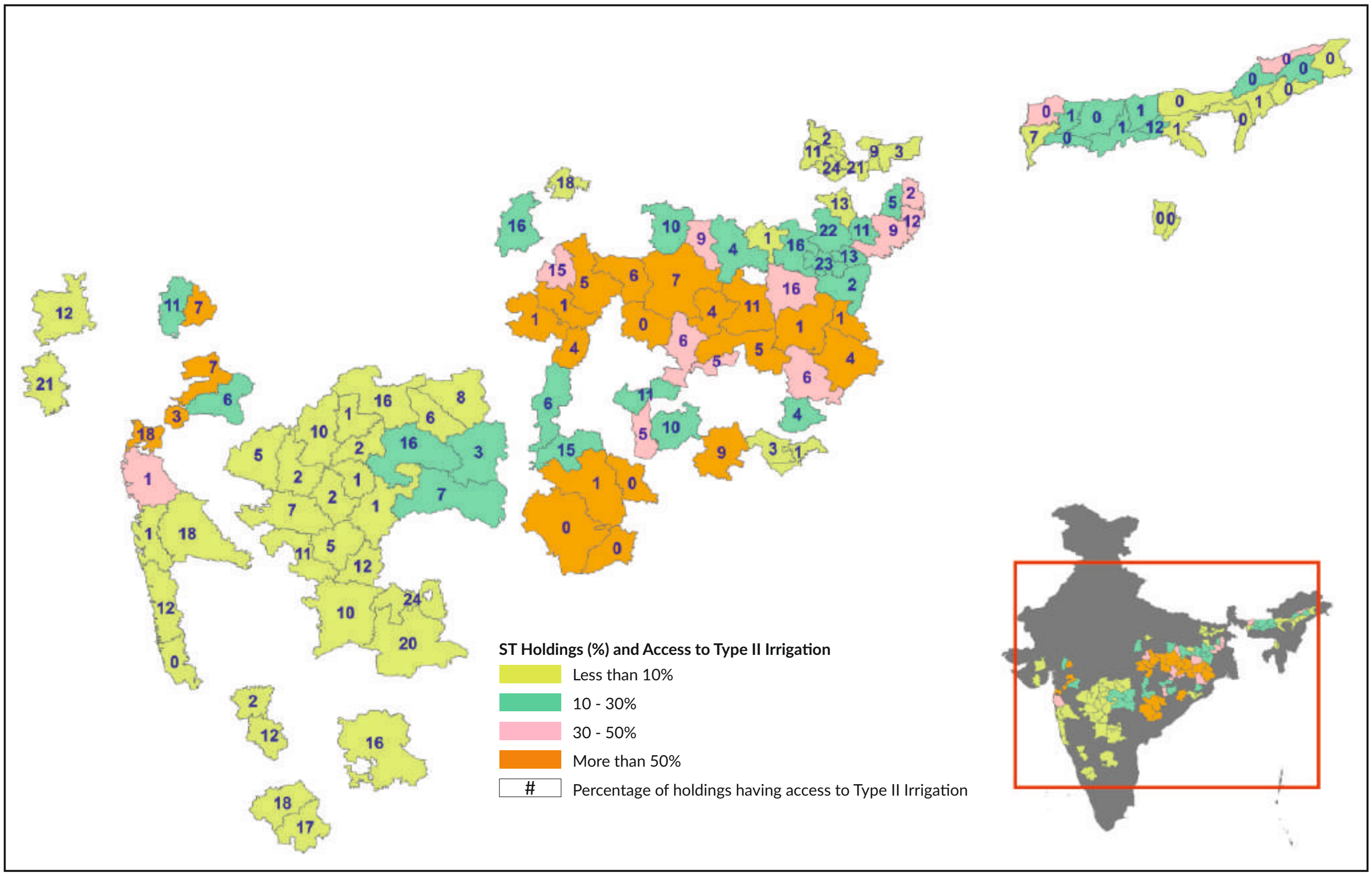
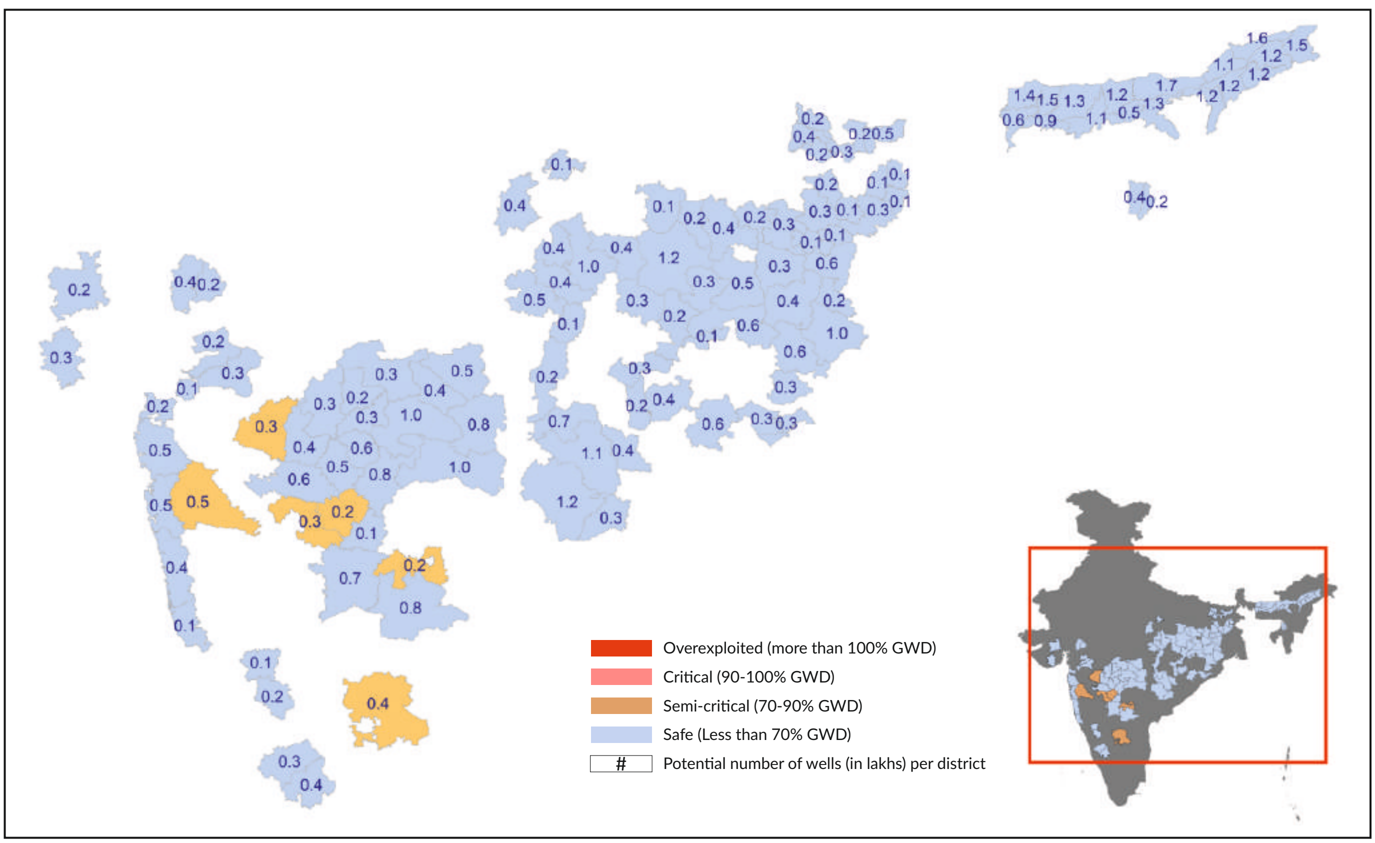


Figure ES.2: Potential for 10,000 m^3/year wells (in lakhs) from available surplus groundwater resources



laying buried pipelines to take Narmada water close to farms. Under Chauhan, similarly, Madhya Pradesh began issuing a million temporary winter season electricity connections for wheat irrigation, subsidized farm ponds, revived 4,000 defunct minor irrigation projects and introduced major reforms in canal irrigation management. Both the states implemented a broad-based multi-pronged irrigation development strategy that maximized farm holdings under Type II irrigation.

5. The 30-odd DIPs available on the internet show no such urgency to provide year-round on-farm water control to farm holdings as Gujarat and MP strove for. DIPs are variable in quality; most are comprehensive, long term water resource plans rather than plans for ensuring *Har Khet Ko Pani* with urgency. They vary also in ambition level; the DIP for Raipur in Chhattisgarh demands only ₹ 352 crore; Bargarh's indent is for ₹ 2,800 crore; and Rajnandgaon in Chhattisgarh wants ₹ 4,900 crore. If we go by DIPs, Chhattisgarh alone requires over ₹ 45,000 crore over 2015-2020 period for PMKSY, with little left for other states from the total allocation of ₹ 50,000 crore.

Recommended Strategy

1. Instead of spreading resources thin, PMKSY should focus on the **unirrigated half of India's agrarian landscape.** Leave alone ensuring *Har Khet Ko Pani*, the current design of PMKSY will add no more than 5 mha of new assured irrigation. The 23 priority AIBP projects bypass most irrigation-deprived districts of the country. Micro-irrigation subsidies will go only to geographies that already have Type II irrigation. Watershed programs might benefit the deprived geography; but past experience shows that the watershed benefit that farmers value most is in improved groundwater recharge; in districts with few irrigation wells, watershed programs will stabilize *kharif* crop but offer no irrigation for *rabi* and summer crops. PMKSY interventions must be sequential: first expand access to affordable Type II irrigation from wells, pumps and pipes; then promote micro-irrigation; and support this irrigation economy by investing in watershed treatment, groundwater recharge, and conjunctive management of groundwater and surface water from tanks and canals.

2. Within the unirrigated half, PMKSY should prioritise ***Irrigation Deprived Districts.*** In 170 best irrigated districts of India, 70 per cent or more of farm holdings have Type II irrigation access from one source or the other. Those without a captive source here benefit from vibrant decentralised markets for irrigation service. These have to be contrasted with 112 districts of the country where less than 30 per cent of farm holdings have access to irrigation. Here, irrigation service markets are primitive or non-existent; and not having captive irrigation source condemns a farmer to vagaries of rainfed farming. Before all else, PMKSY should focus on these districts and increase the proportion of holdings with captive source of Type II irrigation.

3. Even within these districts, PMKSY should proactively target ***Adivasi farm holdings which are more irrigation-deprived*** than the rest. As Figure ES.1 shows, even within irrigation deprived districts, often less than 10 per cent of *Adivasi* farms have irrigation compared to the district average of up to 30 per cent.

4. The quickest and most cost-effective way of ***providing Type II irrigation*** to these holdings is by helping them aquire a well/borewell and a pump with 500 meters of distribution pipe. Since most of these districts have poor electricity grid development, a major challenge is of providing affordable energy. PMKSY should design a loan-subsidy scheme to enable *Adivasi* farmers to own a dug well, a 3.5-5 kWp solar pump and 500 meters of flexible distribution pipe. Each such system can be purchased for ₹ 4.5-5 lakh and can provide high quality supplemental irrigation to a gross area of 3-5 hectares.

5. All 105 out of the 112 irrigation deprived districts are cleared by the Central Groundwater Board as 'safe' (<70% development) for groundwater development with more than half of the estimated groundwater available for further development. As Figure ES.2 shows, these 112 districts have enough unutilised groundwater to sustain

5.7 million new irrigation wells with an average annual water output of 10,000 m^3 without any threat of over-exploiting the aquifers. With watershed programs, tank desiltation, and Managed Aquifer Recharge, this potential can be further enhanced. PMKSY should aim at 1-1.5 million solarized irrigation wells in target 112 districts by 2020. These will add 5-7.5 mha of Type II irrigation in the country's most 'irrigation deprived' districts.

6. India's towns and cities release some 15 BCM of wastewater per year. Because wastewater offers year-round, on-farm water control and high nutrient content, towns have the potential to become peri-urban irrigation systems par excellence. India's wastewater irrigation economy is already booming, but by default, rather than by design. PMKSY should pilot a range of cost-effective treatment technologies for wastewater to facilitate its safe use in irrigation.
7. There is a need to rethink the role of AIBP. During the past three five-year plan periods, our investments in government irrigation projects are largely funded by state governments with the central contribution being 10-15 per cent, mostly under AIBP. However, because states invest little in proper management and maintenance, these systems are stuck in a 'build-neglect-rebuild' syndrome. Instead of supplementing state investments in constructing new systems, AIBP should focus on incentivising and supporting state governments in improving the management and maintenance of Major, Medium and Minor irrigation systems to quickly close the gap between IPC and IPU. A proposal to catalyse this through the National Irrigation Management Fund (NIMF) already exists in the XII five-year plan.
8. With diverse geography, hydrogeology and socio-economic conditions, different parts of the country face different irrigation-water challenges and therefore require differentiated program strategies. Annexure A.1 proposes and explains a clustering of districts along various parameters for better planning and targeting of PMKSY interventions (see Table A.1).
9. Table 9 in section 8.3 of this paper outlines a broad-based, multi-pronged irrigation strategy with a set of 15 interventions that PMKSY should help India implement in order to truly scale out BJP governments' irrigation success in Gujarat and Madhya Pradesh. Table 10 in section 8.4 tries to fit the proposed interventions to their unique irrigation-water realities. It identifies which of the interventions are most critical for each district cluster. Ensuring *Har Khet Ko Pani* in India is hard to achieve in a long time; but if we have any chance of reaching that goal, we need to rethink the current strategy of PMKSY as outlined in this policy paper.
10. Finally, the implementation of PMKSY must be supported through independent, third-party reviews. Credible civil society organizations, philanthropic trusts, NGOs and CSRs can play a crucial role in this. Especially in the 112 'most irrigation deprived' districts, the Tata Trusts have a strong presence and an elaborate network of field partners. PMKSY can draw lessons from their field experience, synergize investments to build on their work, and also use the network to conduct periodic, transparent reviews of program implementation.

1. Pradhan Mantri Krishi Sinchai Yojana

In the 2014 run up to Parliamentary elections, the BJP manifesto gave pride of place to irrigation development. *'Har Haath Ko Kaam, Har Khet Ko Paani'*[1] was the declared credo of the Party's agrarian strategy. Given that nearly half of India's farm holdings are totally rainfed, this is an ambitious goal indeed, and consonant with the government's declared goal of doubling farmers' incomes in five years. Speedy execution of the river linking project, at least one new water conservation structure per village, speedy completion of irrigation projects and massive expansion of micro-irrigation systems to achieve 'more crop per drop' were advanced as the instruments to achieve the vision.

A political manifesto is not expected to detail operational strategy. However, upon assuming power, the new Government announced *Pradhan Mantri Krishi Sinchai Yojana* (PMKSY) and in 2016-17 Union Budget, the Finance Minister provided a more detailed explanation of how the NDA government plans to use PMKSY to ensure *"Har Khet Ko Pani"*. Table 1 outlines the overall profile of the PMKSY and its components. The total outlay proposed is ₹ 50,000 crore over 2015-2020, spread over four key components. Components 1, 3 and 4 are pre-existing programs and receive 80 per cent of the outlay. The only new components is that of creating a water harvesting structure in every village – *Har Khet Ko Pani* – but it is allocated less than 20 per cent of the total resources.

Table 1: Profile and components of PMKSY

PMKSY Components	Ministry / Department	Physical Target (in lakh ha)		Indicative Outlay (in ₹ crores)	
		2015-20	2015-16	2015-20	2015-16
1. AIBP	MoWR, RD&GR	7.5	1.2	11,060	1,000
2. Har Khet Ko Pani		21.0	2.8	9,050	1,000
3. Per Drop, More Crop	Dept. of Agriculture and Cooperation	100.0	5.0	16,300	1,800
4. Watershed development	Dept. of Land Resources	11.5	4.4	13,590	1,500
TOTAL	-	-	-	**50,000**	**5,300**

In overall terms, PMKSY total outlay compares reasonably well with X Plan central sector outlay of ₹ 9,661 crore and XI Plan outlay of ₹ 24,759 crore (at 2006-07 prices)[2]. But it is less than total central allocation (at current prices) of ₹ 66,530 crore to PMKSY type programs in the XII Five Year Plan that included ₹ 42,171 crore for Major, Medium, and Minor Irrigation Projects (MMMIP), ₹ 4,600 crore for National Irrigation Management Fund (NIMF), ₹ 5,000 crore for revival of traditional water bodies and ₹ 15,359 crores of central sector allocation for watershed development.

For a program that aims to ensure *Har Khet Ko Pani*, funding of PMKSY by itself has less significance than the underlying thinking and strategy. When the object of irrigation development is achieving national food security, it is important to concentrate resources on districts with highest potential for agricultural production. This was done under Intensive Agricultural Development Program (IADP) during the 1960s that ushered in our Green Revolution beginning in north-western parts. When the object of irrigation planning is to fully develop available water resources to the benefit of the nation, it is natural that energy and resources are invested in geographies which have water resource potential for large dams and canal systems. This has been the mandate of Central Water Commission and National Water Development Agency in planning large multi-purpose irrigation and hydro-power projects.

[1]http://www.bjp.org/index.php?option=com_content&view=article&id=4412&catid=68:press-releases&Itemid=494
[2]http://planningcommission.gov.in/plans/planrel/12thplan/pdf/12fyp_vol1.pdf table 3.15; but these numbers are at 2006-07 prices.

Today, however, national food security is not a burning issue; India is emerging as a farm exporting power. The country still has a great deal of hunger but that is arguably not due to lack of food production. Similarly, since 1830, we have kept investing large sums in developing our surface water resources by constructing MMMIP at appropriate sites. Our challenge today is that despite all these investments, nearly half of our farm holdings are deprived of any irrigation source, and are therefore vulnerable to low productivity and drought risks. When the object of irrigation is stabilizing and improving agrarian livelihoods by ensuring *Har Khet Ko Pani*, it makes sense to focus energy and resources on geographies and social classes which remain most 'irrigation deprived'. PMKSY should then be centrally about addressing and overcoming 'irrigation deprivation' in India's smallholder agrarian economy.

2. Type I and Type II Irrigation

Over the past 50 years, Indian agriculture has witnessed two distinct patterns in irrigation development; these can be called Type I and Type II irrigation. Type I irrigation is typically based on government constructed, owned, and operated structures as MMMIP. In addition, Type I irrigation also includes flow irrigation from 600,000 traditional irrigation tanks, numerous hill irrigation systems and *kuhls*. These are typically supply-driven and score low on year-round, on-farm water control to the farmer. Type II irrigation, in contrast, is demand-driven, created through private investment, commands much smaller area per structure, is privately owned and managed but offers the farmer high level of year-round, on-farm water control. Some key differences between Type I and Type II irrigation are highlighted in Table 2.

Table 2: Key differences between Type I and Type II irrigation

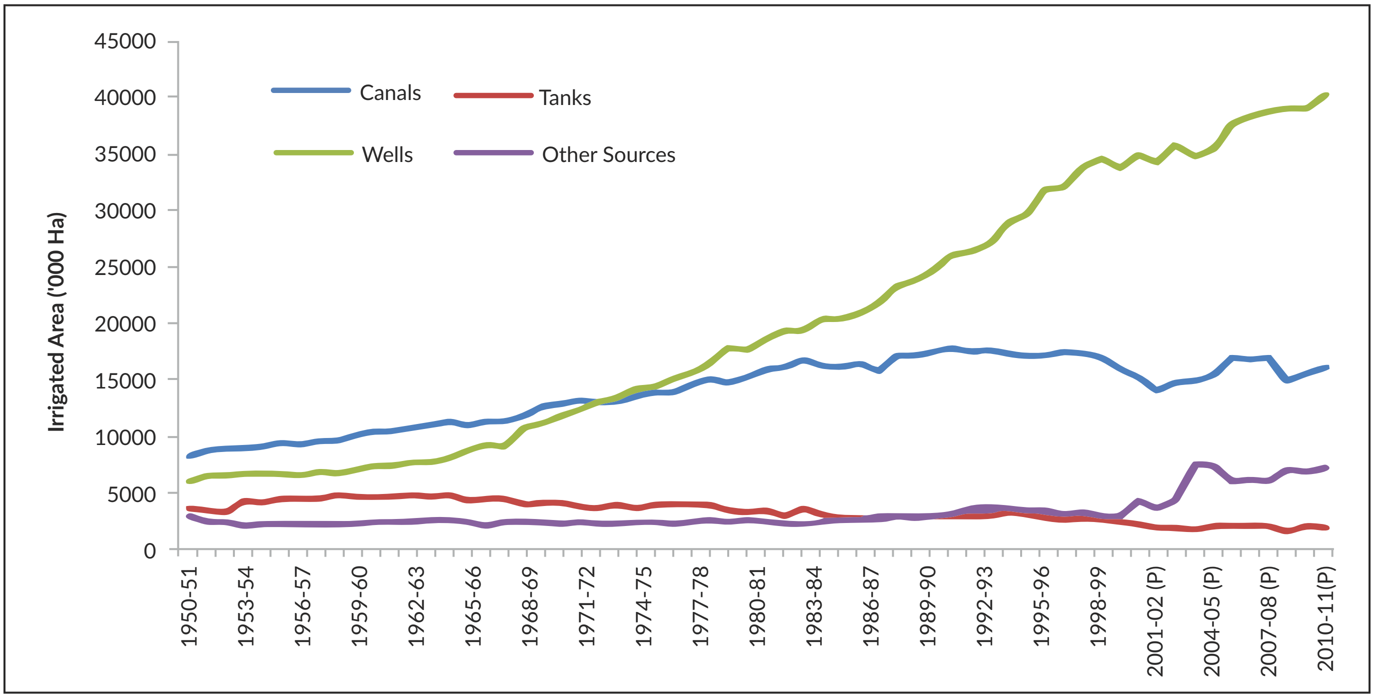
Type I Irrigation	Type II Irrigation
Public / CPR	Private / Group / Market
Single system may service 20 – 1,500,000 Ha	Typically serves 1 – 20 ha
Head – Tail inequity endemic	Head – Tail inequity rare
Level of irrigation service tied to effectiveness of irrigation bureaucracy	Immune to bureaucratic lethargy, but affected by fuel prices or anarchy in electricity distribution
Surface	Ground / Surface / Surface Flow
Gravity flow in open channels	Piped water delivery with mechanical or kinetic energy
Unsuited for micro irrigation without pressure	Ready for micro irrigation
On-farm water deliveries 6-12 times /year	On-farm water deliveries, at-will, year-round
Farming system adapts to the irrigation regime	Irrigation regime adapts to farming system

Not only India, but all of South Asia and many other parts of the world, have witnessed explosive growth in Type II irrigation during recent decades. It has grown entirely in response to demand-pull from farmers, but is made possible by availability of affordable rigs and drilling equipment, pumps, pipes. Governments at centre and in states have supported Type II irrigation creation not under its irrigation programs but under agricultural and rural development programs. All evidence available shows that especially since 1990, over 95 per cent of new irrigated farm holdings have been delivered through Type II Irrigation from privately owned groundwater wells or lift irrigation schemes powered by electricity or diesel (see Figure 1).

Initially, groundwater based Type II irrigation emerged in command areas of MMMIP and tanks to recycle and benefit from canal and tank irrigation recharge; but soon, the tail began to wag the dog as farmer preference for Type II irrigation soared. In areas outside canal and tank commands, watershed development programs attracted participation because they offered work opportunities and recharged wells. Gradually, check dams, percolation ponds and other such structures began to be constructed to help sustain groundwater-based Type II irrigation. The role of Type I public and community irrigation schemes has changed increasingly to support Type II irrigation.

The year-round, on-demand water control offered by Type II irrigation makes small farms far more productive and resilient compared to Type I irrigation. Type II irrigation is mostly dependent on groundwater wells; but there is also growing spread of lift irrigation and piped delivery of water on many MMMIP as well as rivers and streams. Table 3 reports results of a survey undertaken in the command of *Sardar Sarovar* project in Gujarat and compares farmers who received Type I irrigation and those who lifted canal water for Type II irrigation from the same canal system. The table shows the vast difference in the income effect of Type I and Type II irrigation.

Figure 1: Irrigated area by source, 1950 - 51 onwards



Data Sources: Ministry of Agriculture, Central Water Commission, Water Resources Information System Directorate, Ministry of Statistics and Programme Implementation, Government of India. Data retrieved from www.indiastat.com

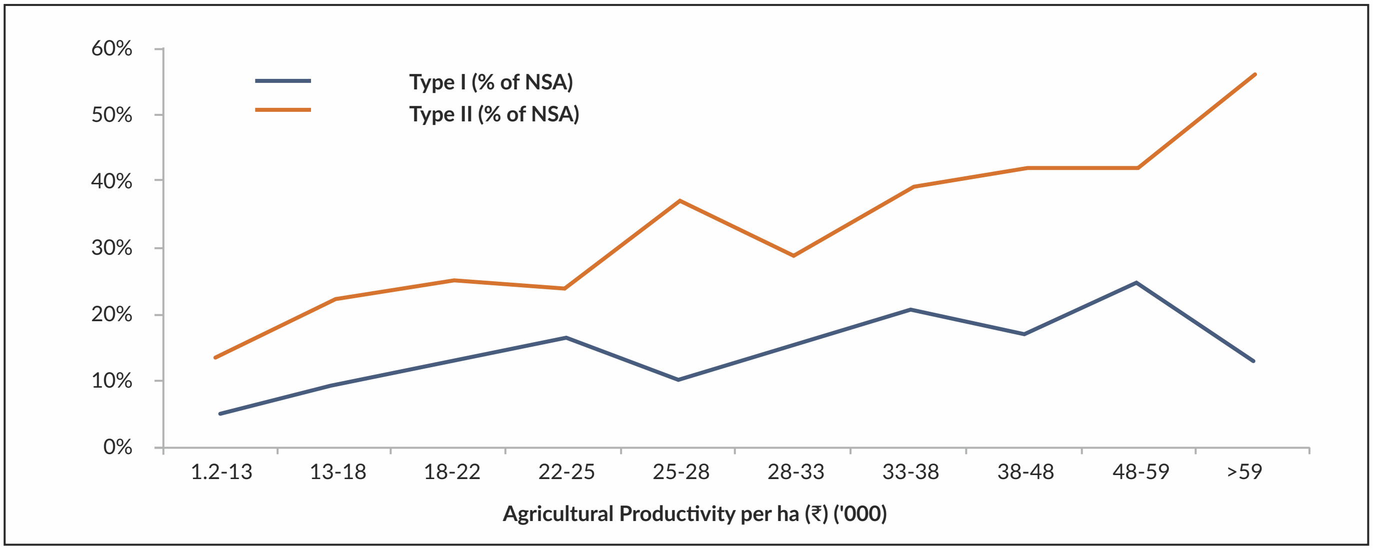
Table 3: Income impacts of Type I and Type II irrigation in Sardar Sarovar project

	Type I **Gravity flow** Bharuch, Panchamahal, Narmada and Vadodara	Type II **Canal lift** Ahmedabad, Vadodara, Narmada, Mehsana, Bharuch, Surendranagar
Number of farm families surveyed	179	254
Before SSP: Average Gross Cropped Area (ha)	3.71	3.75
After SSP: Average Gross Cropped Area (ha)	4.02	10.30
Average household income from crops and dairying before SSP (₹)	47,580	57,229
Average increase in household income from crops and dairying due to SSP (₹)	169,003	461,749
Percentage increase in average household income	355%	807%

Source: Created by authors based on data presented in Jagadeesan and Kumar (2015)

In his 2003-04 and 2004-05 work, Ramesh Chand analysed drivers of inter-district variations in agricultural productivity in 477 districts of India. What is the role of Type I and Type II irrigation in explaining inter-district productivity variation? To understand this question, we arranged districts in ascending order of their value of farm output, divided them into 10 classes and explored if access to Type I and II irrigation have any role to play in productivity rise. The chart in Figure 2 shows the results. As we move from low to high productivity classes, the proportion of area under Type I irrigation grows, but that under Type II irrigation grows much faster. In the highest productivity class, the role of Type II irrigation is greatly accentuated while that of Type I irrigation declines. The reason is not far to seek: year-round, on-farm water control plays a major role in improving productivity of farming systems and agrarian livelihoods especially in a context of constantly shrinking size of the holding.

Figure 2: Access to Type I and Type II irrigation across agricultural productivity categories



Politicians in India with their ear to the ground are more alive to Type II irrigation than irrigation planners. This is why state leaders like in Gujarat and Madhya Pradesh (MP) allocate large funds to provide farmers electricity connections, to fill up irrigation tanks, to increase groundwater recharge, to offer piped water supply for irrigation rather than in open channels. They realise that even after investing billions in Type I structures, farmers will still crave for Type II irrigation. For example, consider Gujarat's 2016-17 budget whose allocation for providing on-farm water control is more in tune with the *Har Khet Ko Pani* ambition: ₹ 9,050 crore for *Sardar Sarovar* piped distribution, ₹ 5,244 crore for canal maintenance, lift irrigation schemes, check dams and pipelines for filling up tanks; ₹ 2,000 crore for filling up 215 reservoirs in Saurashtra with Narmada water; ₹ 765 crore for micro-irrigation on 3 lakh ha; ₹ 4,010 crore towards farm power subsidies; ₹ 1,643 crore for 1 lakh new tubewell connections, all of which add up to ₹ 22,700 crore for a single year[3].

[3]http://anandibenpatel.com/wp-content/uploads/FM-Speech-Formatted1.pdf

3. The Geography of Irrigation Deprivation in India

Nobody has done the sums but since Independence, India's central and state governments together would have easily invested ₹ 800-900 lakh crore (at current prices) in public (Type I) irrigation projects of various sizes. These investments have produced vast benefits; deserts of Punjab, Haryana, western Rajasthan which earlier could support nothing but nomadic livestock economy have transformed into lush green, highly productive agrarian economies in our north-west. In the southern region, too, many MMMIP have created pockets of agrarian riches. During recent decades, a silent groundwater irrigation revolution has taken irrigation to regions outside the command areas, too.

But after all these investments, our agrarian economy today is still characterised by 'irrigation-have' and 'irrigation-have-not' districts and farm-holdings. According to 2011 Agricultural Census, 48 per cent of our farm holdings do not have irrigation from *any* source; while 52 per cent benefit from one or more sources. Our 'irrigation deprived districts' fall in two categories. The first comprises hill farming systems — in Kashmir, Himachal, Uttarakhand, North-eastern states, and districts like Darjeeling, Coorg, Nilgiris, Idukki, Wayanad — where the value-productivity of farming is already among the highest in the country. Here, irrigation is not a binding constraint on productivity increase and there seems no urgent need for irrigation expansion although these systems may benefit from other development interventions. The second category is of semi-arid and arid districts of the plains in peninsular India—Maharashtra, parts of Karnataka, Andhra Pradesh and Telangana, Gujarat, MP, Chhattisgarh, Jharkhand and Orissa. Some water-rich humid districts—in North Bihar, Assam, coastal Orissa—too suffer high level of irrigation deprivation.

3.1 The most irrigation deprived districts in India

Figure 3 highlights the geography of severe irrigation deprivation in the country. As outlined earlier, in Hill districts, irrigation-deprivation is not a productivity-depressant and therefore less of a problem. However, it is in the central Indian tribal highlands, Tribal Rajasthan and in the Deccan region that India's real irrigation have-not districts and farm holdings are concentrated. Indeed, according to the 2011 Agricultural Census, more than 60 per cent of India's totally 'irrigation-deprived' farm holdings are concentrated in the states of Assam, Bihar, Chhattisgarh, Jharkhand, Maharashtra, Karnataka, Andhra Pradesh (especially, Rayalaseema), Telangana and Orissa.

Figure 3: The most irrigation deprived districts with proportion of unirrigated holdings

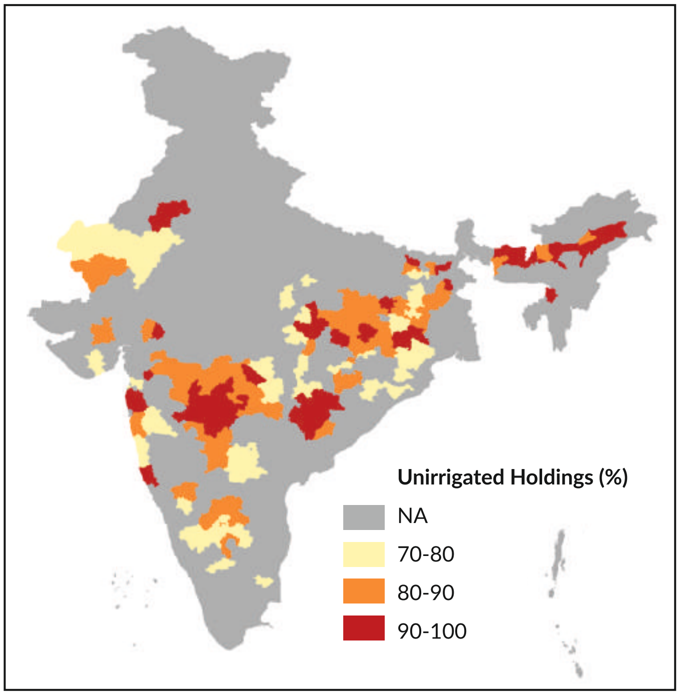
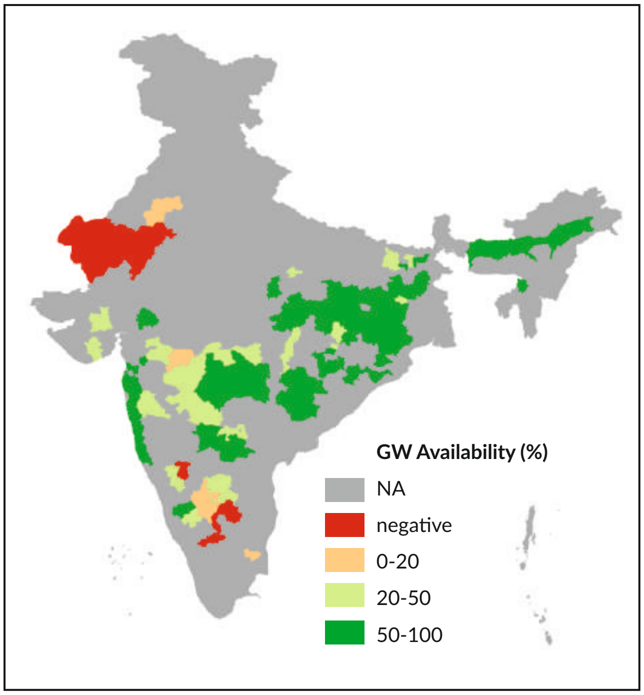


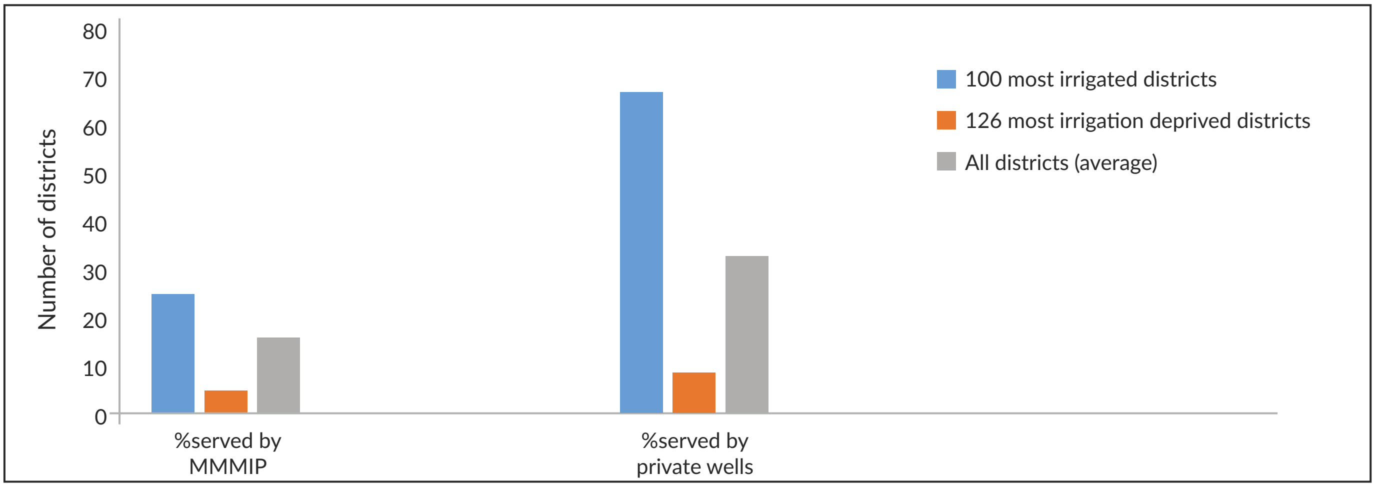
Figure 4: Groundwater availability in India's 126 most irrigation deprived districts



Of the 126 most irrigation deprived districts, 14 districts (mostly in Rajasthan and some in Peninsular India) are already utilizing more than 80 per cent of their annual renewable groundwater resource (see Figure 4). This leaves 112 most deprived districts that have surplus groundwater available for future irrigation development (Cluster #01[4]).

The chart in Figure 5 compares 100 best-off and 126 worst-off districts in terms of irrigation access. The latter are substantially worse off in terms of both access to irrigation from MMMIP as well as from private groundwater wells and lift irrigation systems.

Figure 5: Differences in irrigation access in India's best-off and worst-off districts



There are other markers of 'irrigation deprivation' too. Table 4 uses the 2003-04 and 2004-05 data set compiled by Ramesh Chand and others (2011) and data from the 4th Minor Irrigation Census (2006-07; GoI 2014) to examine differences in irrigation access in these two classes of "Irrigation Have" and “Irrigation Have-not” districts. The Irrigation have-not districts have 1/3rd the agricultural output/ha, 25 per cent lower cropping intensity, a quarter of energy use in agriculture and 1/5th of the groundwater irrigation pumping capacity compared to the 'Irrigation have' districts.

Table 4: How disadvantaged really are irrigation-deprived districts?

Parameters	100 most irrigated districts (average)	126 most irrigation deprived (average)	National (average)
Agricultural Productivity (₹ per hectare)	47,142	17,837	27,500
Cropping Intensity (%)	170	125	136
Energy consumption (kWh)/Net Sown Area (NSA)	1134	278	513
Groundwater wells per 1000 operational holdings	247	107	143
Groundwater pump horse power (HP) per 100 ha NSA	206	40	90

3.2 Irrigation deprivation of India's *Adivasi* farmers

Apart from this spatial concentration, there is also a social dimension to irrigation deprivation as outlined in Table 5 which again draws upon data sets from the Agricultural Census 2011. Of India's 138 million farm holdings, 12 million are owned and operated by *Adivasi* farmers; these are bigger in size than our average farm holdings but are seriously deficient in irrigation access. Indeed, *Adivasi* farm holdings are substantially more 'irrigation-deprived' than Dalit-operated farm holdings.

[4]For a detailed discussion on clustering of districts for PMKSY, see Annexure A1.

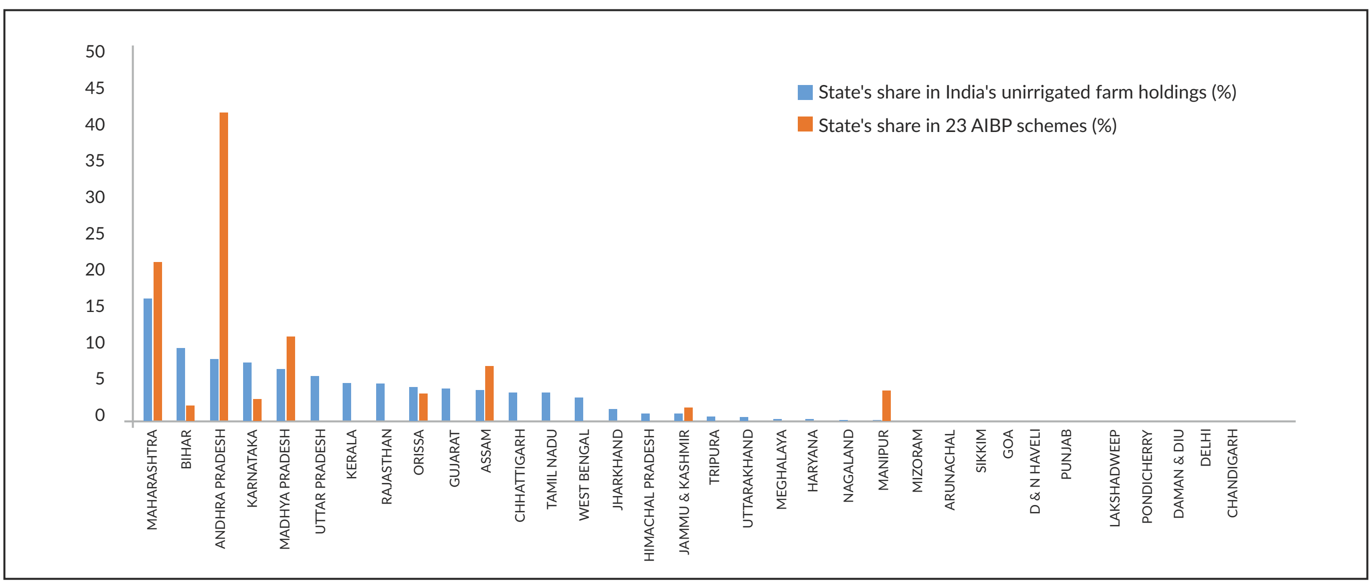
Table 5: Adivasi farm-holdings are most 'irrigation-deprived'

	ALL	SC	ST
Number of farm holdings (million)	138.3	17.1	12.0
Average size of farm holding (hectares)	1.15	0.80	1.52
Percentage holdings receiving any irrigation	52	54	30
Percentage of land under irrigation	52	40	19
Percentage holdings irrigated by canals and tanks	16	18	10
Percentage holdings irrigated by wells, tubewells and other sources	38	36	23

All in all, the social and spatial dimensions of 'irrigation deprivation' come together in 126 districts we have identified in Figure 3. These should ideally be top priority districts for PMKSY because, without targeting them, there is no way to reach *Har Khet Ko Pani*. Under its present design, PMKSY has little to offer to these districts. Its large outlay on micro-irrigation under *Per-drop-more-crop* is of little benefit to these districts because access to pump irrigation, which is a pre-condition for adopting micro-irrigation, has limited spread in these districts. The micro-irrigation program will have most impact in districts which are already densely populated by tubewells. There is a gradual move to introduce micro-irrigation in canal commands too; however, this requires reconfiguring the distribution systems, replacing open channel water transport by piped transport under pressure. If and when this is done, it is likely that pre-existing command areas will be the first to benefit from such technologies.

Similarly, the AIBP component of PMKSY has little to offer to the 'most irrigation-deprived' districts. The chart in Figure 6 shows that 23 priority AIBP projects which will receive 1/5th of PMKSY funds during 2015-2020 period will offer little to Jharkhand, Chhattisgarh, Assam, Bihar, Karnataka, Tribal Rajasthan, and tribal Gujarat which have bulk of the irrigation-deprived districts of the country. In effect, then, the only components which will offer some support to these districts are *Har Khet Ko Pani* and watershed development. India's irrigation experience shows that productivity and livelihood impacts of watershed development and water harvesting structures is much greater in areas where these support intensive groundwater irrigation through recharge rather than in areas where such structures are used for direct irrigation or soil moisture management. Indeed if tank irrigation were so much of a draw for farmers, peninsular India's 600,000 irrigation tanks would not have fallen into disrepair as they have during recent years. And if their value as groundwater recharge structures were not a big draw for farmers, we would not see such an upsurge of interest in desilting tanks as for example, Telangana's *Mission Kakatiya* signifies

Figure 6: Mismatch between AIBP allocation (23 priority projects) and irrigation deprivation of states



4. Water Resources of 'Irrigation-deprived' Geography

Type I irrigation potential takes a long gestation period extending in some large projects to 30-40 years. The investment required too is large at ₹ 5-7 lakh/hectare. Finally, India (and many other countries) are increasingly realising that the area actually benefited by Type I irrigation structures turns out to be considerably smaller than planned, partly because of erroneous assumptions about future farmers behaviour but equally because of complex irrigation management challenges these projects present.

The best thing about Type II irrigation is that its potential can be easily expanded, quickly, at a much lower capital cost than Type I irrigation. A Type II system can be commissioned in a week, if not a day. Because they are owned and operated by farmers or their groups, they are easier to manage and perform to their potential. Political leaders like Devi Lal with an earthy sense of what farmers want recognised the potential of shallow tubewells (STWs) in expanding Type II irrigation in the Ganga basin. His Million Wells Scheme launched during the 1980's provided borewells and diesel pumps to hundreds of thousands of farmers in the Ganga plains and explains why density of groundwater structures is so high in that region. Such a program would be ideal for India's 'irrigation-deprived' geography, too; but does this geography have the water resource, especially groundwater to support expansion on groundwater-based Type II irrigation?

Our irrigation deprived geography does not have the abundant groundwater resources that the Ganga basin has; but only a small portion of the water resource it has is developed; and it has significant scope to augment groundwater recharge that is not yet recognized. None of India's 58 'dark' or 89 'over-exploited' groundwater districts is in the irrigation-deprived geography. These are mostly in Punjab, Haryana, Rajasthan and Tamil Nadu, all of which are outside the target geography. True, in these danger zones, further expansion of groundwater use for Type II irrigation will only aggravate groundwater depletion. If anything, our focus here should be on enhancing water use efficiency and productivity, improving aquifer recharge, and enlarging areas under conjunctive management of groundwater and surface water where possible.

CGWB's 2011 estimates of dynamic groundwater resources, however, show that the 112 districts of India's irrigation-deprived geography, where more than 70 per cent of the farm holdings are un-irrigated, have substantial scope for expanding Type II irrigation without posing any threat of resource over-exploitation even without Managed Aquifer Recharge (MAR) works. Half or more of the estimated groundwater potential in these districts is available for development. Moreover, many of these districts receive more precipitation than India's driest districts leaving room for augmenting groundwater resource through MAR interventions.

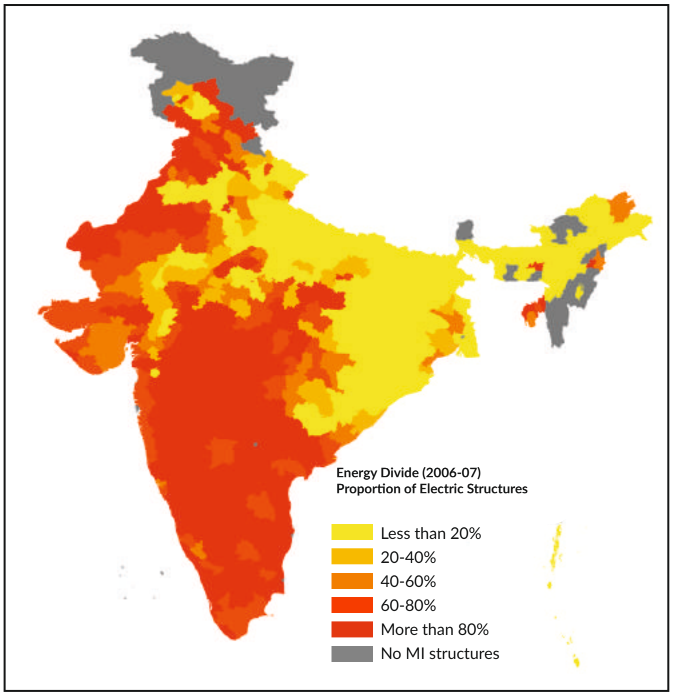
If these districts have so large unutilized groundwater resource, why do they suffer irrigation deprivation on such a large scale anyways? In our analysis, four factors get implicated:

- *Scarcity of pump capital:* Many of these districts have much lower density of energized wells/ borewells at less than 9 structures per 100 hectares of net sown area compared to India's average of 14; the difference becomes even larger if we compare installed horsepower (HP) per net sown area.
- *Prohibitive energy costs:* India's Type II irrigation economy is marked by an energy divide (see Figure 7). In India's western states, Type II irrigation is energized by subsidized electricity supply as the main driver. In eastern India too, all states bar West Bengal offer farm power subsidies; however, these have little electricity to offer and no grid network to reach it to farmers. Type II irrigation in eastern India is thus run on diesel which, when efficiency differences are factored in, costs ₹ 8-10/kWh compared to ₹ 0-1/kWh that farmers in western India pay. High energy costs not only deepen 'irrigation deprivation' in 126 pump-capital-scarce districts but also some 36 districts where pump-density is comparable to the national average but utilization rate of pumps-borewells is low.
- *Energy scarcity:* Then there are 24 odd districts which have high pump density, subsidized electricity and comfortable groundwater balance, and quite high 'irrigation deprivation' simply because they get too little power

supply, of very poor quality (frequent interruption, low voltage), mostly during the night on a schedule neither predictable nor reliable. Parts of Karnataka, Vidarbha, Rayalaseema are illustrative of this condition.

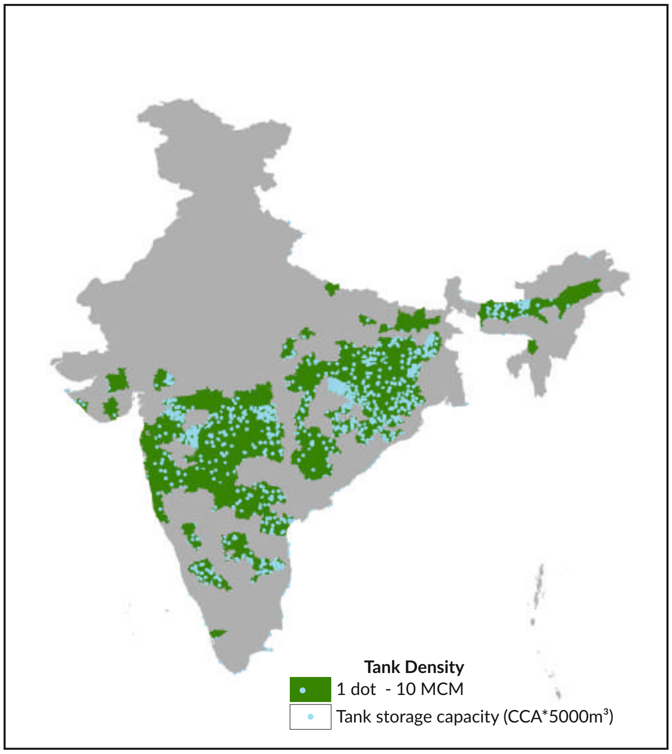
- *Dry Season Recharge Scarcity:* Finally, especially in hard-rock peninsular India, Type II irrigation deprivation is caused by insufficient groundwater recharge relative to demand. Many of these are based on shallow fractured aquifer systems with limited storage and infiltration rates that circulate monsoonal recharge in an annual cycle. After a good monsoon, wells and bores come alive during winter and, at times, even summer; after a bad monsoon, wells become dry.

Figure 7: The energy divide in India's Type II irrigation economy



When the focus of policy is only on Type II irrigation expansion based on groundwater, much of India's hard-rock geography is bound to experience periodic (not permanent) recharge-scarcity. However, the experience of Saurashtra region in Gujarat over the past two decades has shown that, *pari passu* with groundwater development, investments in storing rainwater and accelerating groundwater recharge can contribute greatly to reducing aquifer stress. Saurashtra's recharge movement was based on constructing large number of new check dams, percolation ponds, and such other rainwater harvesting and recharge structures. However, the 'Irrigation-deprived geography' of India already has hundreds of thousands of traditional irrigation tanks, each much larger than a typical Saurashtra check-dam. Figure 8 shows massive concentration of irrigation tanks in the irrigation-deprived geography of India. Each dot represents surface storage of 10 million cubic meters. In a good monsoon, these can have more than one fillings and, if prepared for enhanced percolation and infiltration, these can contribute much to enhanced groundwater resource. As a result, tank-groundwater conjunctive management can offer many possibilities of sustainable Type II irrigation development that are yet to be fully explored.

Figure 8: Estimated net storage capacity of irrigation tanks and surface water bodies in PMKSY target districts



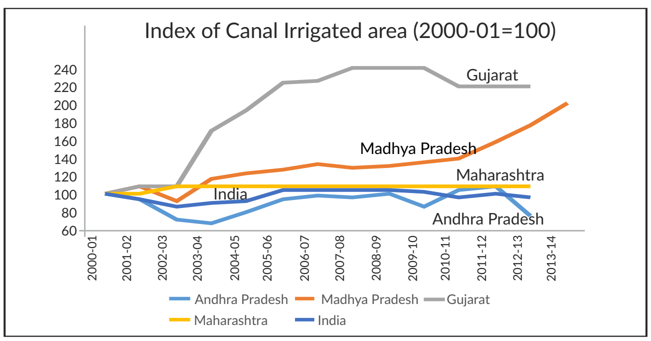
The import of this discussion is that achieving the ambition of *Har Khet Ko Pani* in the irrigation-deprived geography will require a broad-based, multi-pronged strategy of achieving fuller utilisation of Type I irrigation investments, rapid expansion of Type II irrigation structures, and a variety of interventions that make Type I and II irrigation expansion sustainable. And nobody knows this better than BJP governments. During recent years, BJP governments in Gujarat and MP have set new records in accelerating irrigation benefits by pursuing such broad-based, multi-pronged strategy which arguably ought to be the template for PMKSY.

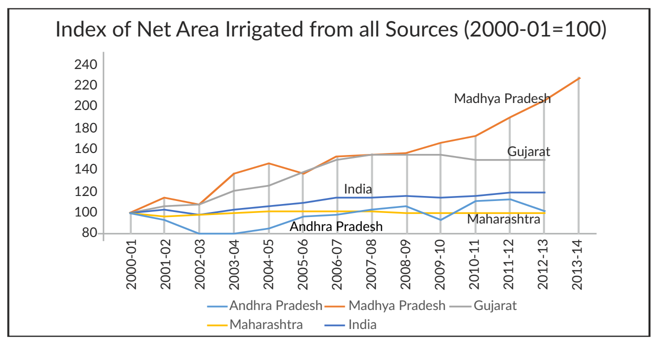
5. Accelerated Irrigation Benefits in Gujarat and Madhya Pradesh post-2000

Post-2000, India has witnessed some glorious irrigation successes and disastrous failures. Politics has played a part in both. Throughout history, India's rulers and overlords have used irrigation to consolidate political power. In contemporary politics, BJP and UPA governments too have been doing it but in sharply different ways. Post-2000, UPA governments used irrigation to create a spoils system. In 2004, the UPA government in Andhra Pradesh launched ₹ 1.86 lakh crore *Jala Yagnam* to irrigate 12 million acres. Eight years later, however, a scathing CAG audit concluded that there was not much to show for ₹ 72,000 crore spent until then on *Jala Yagnam* and pronounced that its 'benefits are illusory'. The scheme got notoriety as chief minister's *Dhana Yagnam.* In Maharashtra, similarly, the Congress-NCP government got mired in a ₹ 70,000 crore irrigation scam in drought-prone Vidarbha that produced no new irrigated area. Top ministers and their cronies were accused of swindling half the funds spent in the name of irrigation.

In Gujarat and MP, BJP chief ministers Narendra Modi and Shivraj Singh Chauhan also used irrigation as a political strategy. But neither is accused of an irrigation scam. Both Modi and Chauhan directly drove the irrigation-agriculture growth agenda. Both their governments ran massive media campaigns claiming personal credit for double-digit agricultural growth under their stewardship. Both won three successive presidential-style assembly elections largely with support from the agrarian classes. During 2001-2014, they spent nothing like the massive sums blown up on irrigation by Maharashtra and Andhra Pradesh. Yet, their index of net irrigated area soared while it remained flat for the two UPA states and for India as a whole (see the chart in Figure 9).

Figure 9: Rapid increase in the index of net area irrigated in Gujarat and Madhya Pradesh after 2000

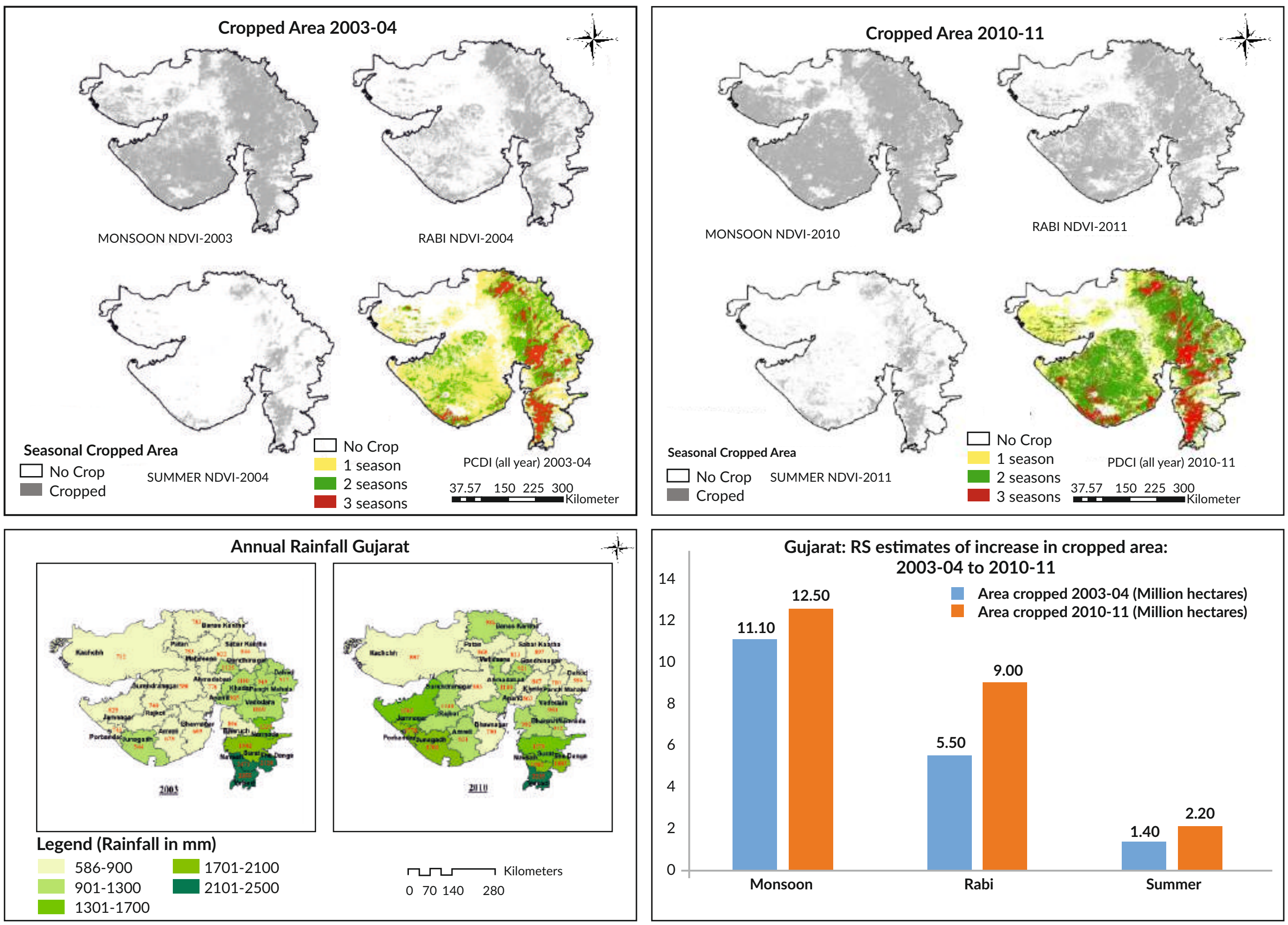




The accuracy of land use data on irrigated area is often questioned but Figure 10 presents remote sensing assessment by Gourav Misra of areas cropped in *kharif*, *rabi* and summer seasons in Gujarat during 2003-04 and 2010-11. These also show clear evidence of increased cropping intensity, even after allowing for some pockets of higher rainfall in the latter period. Thanks to accelerated irrigation, gross cropped area in Gujarat increased by over 30 per cent in 7 years. Similar was the impact of accelerated irrigation development in MP too as is evident in Gourav Misra's remote sensing maps of land cover 'greenness' in the winter of 2009 and 2014 (Figure 11).

How did Modi and Chauhan accelerate irrigation so successfully in their states? By devising a broad-based multi-pronged strategy with single-minded focus on reaching irrigation to as many farm holdings as possible. Both realised that big dams and canals are no use unless farmers have year-round, on-farm water control. In improving these, both also realised the criticality of groundwater and quality farm power supply. Under his famous *Jyotigram Yojana*, Modi invested ₹ 1,250 crore in rural feeder separation to ensure full-voltage, uninterrupted farm power supply for 8 hours daily to farmers. In power-deficit MP, Chauhan began forward-contracting power purchase from the national grid for winter season and issued hundreds of thousands of winter-season, 110-day pump connections per year for wheat irrigation, MP's main winter crop. These farm power innovations alone did much to accelerate irrigation. Modi (and his successor chief minister Anandiben Patel) also supported village communities to construct 166,000 Check-dams, 261,785 farm ponds and 122,035 Bori Bunds for irrigation and groundwater recharge. Gujarat government has ensured that 2,5000 irrigation tanks and reservoirs were desilted and deepened over the past decade; and thousands of tanks have been connected with Sardar Sarovar canals to create a mellon-on-a-wine irrigation regime. In her two year rule, Anandiben Patel issued 2.10 lakh farm power connections, brought 4.02 lakh hectares under micro-irrigation on 2.51 lakh farm holdings, completed 332 km long Sujalam Sufalam Recharge canal, began piped distribution of Sardar Sarovar canal command in 3.64 lakh ha, and initiated 1,150 km SAUNI pipeline project to fill 115 medium-scale reservoirs of Saurastra with surplus Narmada water[5]. In sum, their strategy for *Har Khet Ko Pani* is: get water close to the farmer, give her Type II irrigation structures, and irrigation benefits will accelerate.

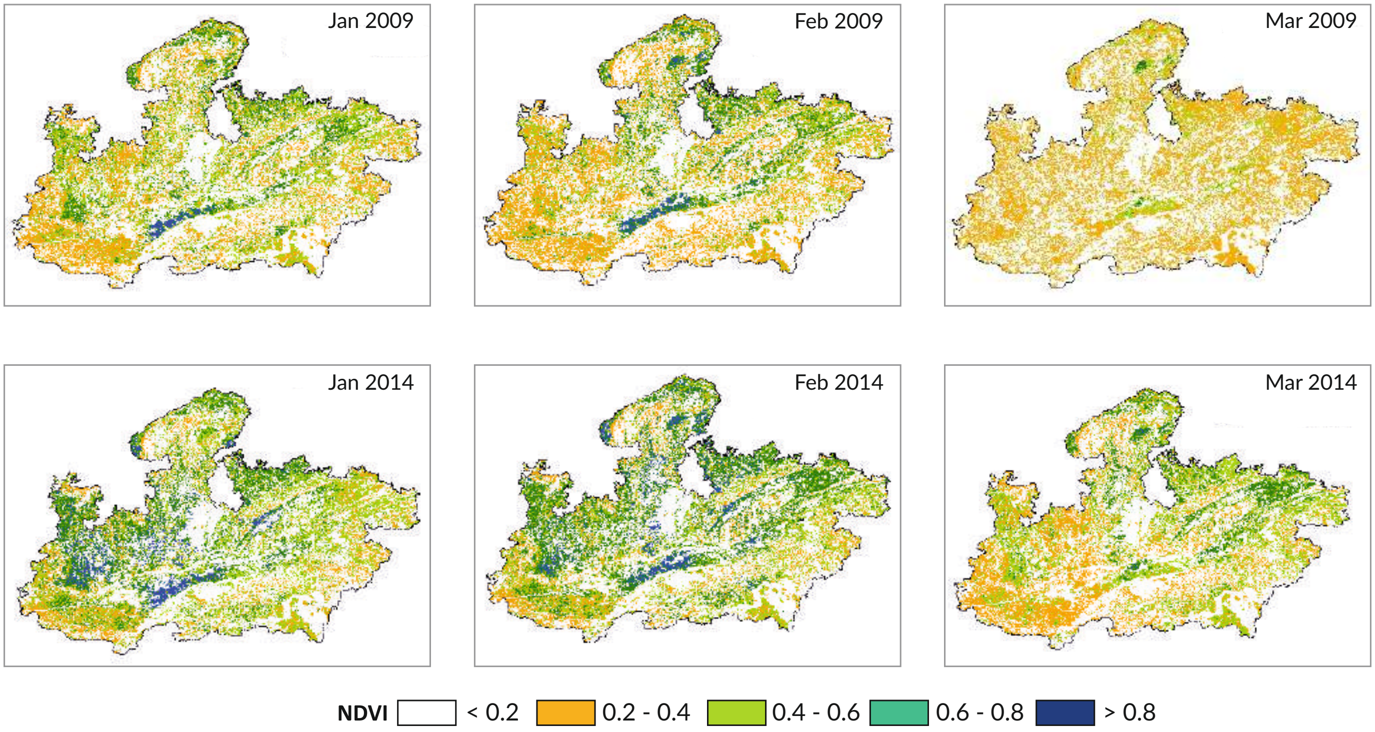
Figure 10: Remote sensing assessment of changes in single, double and triple cropped areas in Gujarat between 2003-04 and 2010-11



Both Modi and Chauhan used improved governance to accelerate irrigation. Modi revitalised DISCOMs while Chauhan rejuvenated the irrigation bureaucracy. Chauhan realised that government canals operate at a quarter of their potential, thanks to poor maintenance and management. He energized his irrigation department to radically improve their management. A tough IAS officer as irrigation secretary and CM's personal handling of local political interference helped to tame the anarchy in canal commands. After years of decline, government canals began to operate as they should and water reached tail-ends like it had never done before. Irrigated area in MP's canal commands increased from less than 1.0 million hectare (mha) in 2010 to 1.56 mha in 2011, to 2.02 mha in 2012, and 2.33 mha in 2013 and 2.83 mha in 2014, which was a drought year!

[5]http://gujaratinformation.net/downloads/farmers_agri_201617.pdf

Figure 11: Remote-sensing images of increase in land-cover 'greenness' in MP between winter 2009 and winter 2014



Government of India's Accelerated Irrigation Benefits Program (AIBP) needs to take a leaf out of Madhya Pradesh's book. During Chauhan's first decade, MP government spent a total of ₹ 36,689 crore on irrigation, far less than Andhra Pradesh and Maharashtra had done in that period; yet, MP tripled irrigated area in canal commands (from all sources) from 0.808 mha in 2006 to 2.5 mha in 2012-13. One might suspect that large increase in canal irrigation resulted from new projects commissioned on Narmada. However, as Figure 12 shows, canal irrigated area increased in all of MP's river basins rather than just Narmada. Figures from MP irrigation department would be expected to show rapid increase; but even LUS figures show the rapidly increasing trend in canal irrigation (Figure 11). Figure 13 compares the irrigation data for MP compiled by NSSO round #59 for 2002-03 and round #70 for 2012-13. These too show near doubling of rabi irrigated area from all sources and a near 6-fold increase in canal irrigation for the farmers sampled.

Figure 12: Area reported irrigated by public canals in different river basins of MP (2011-12 to 2013-14)

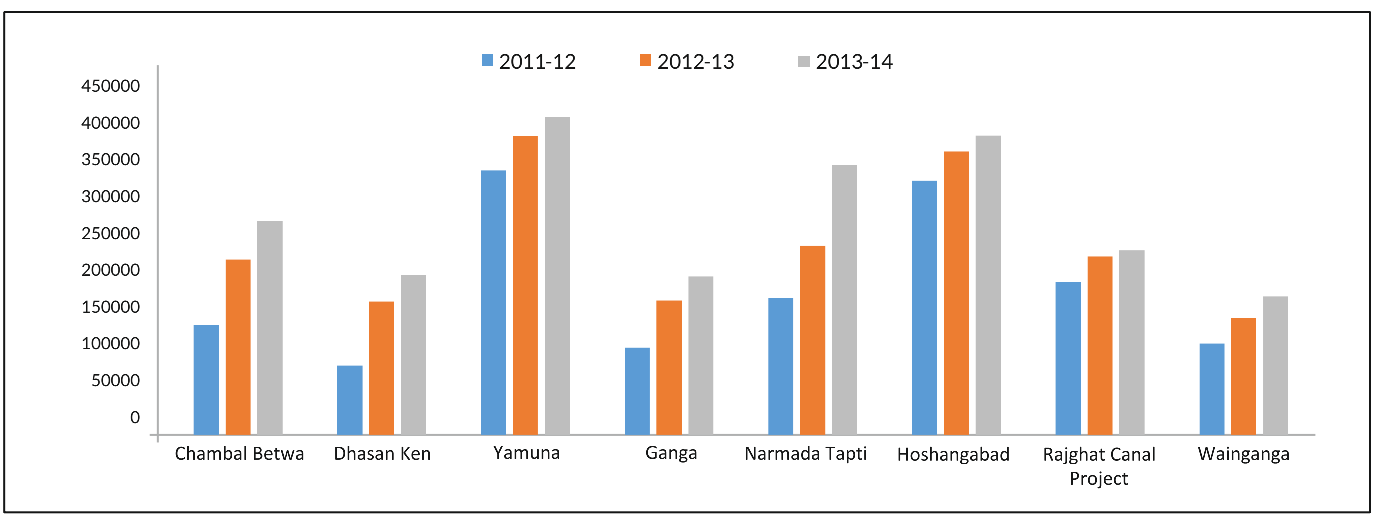
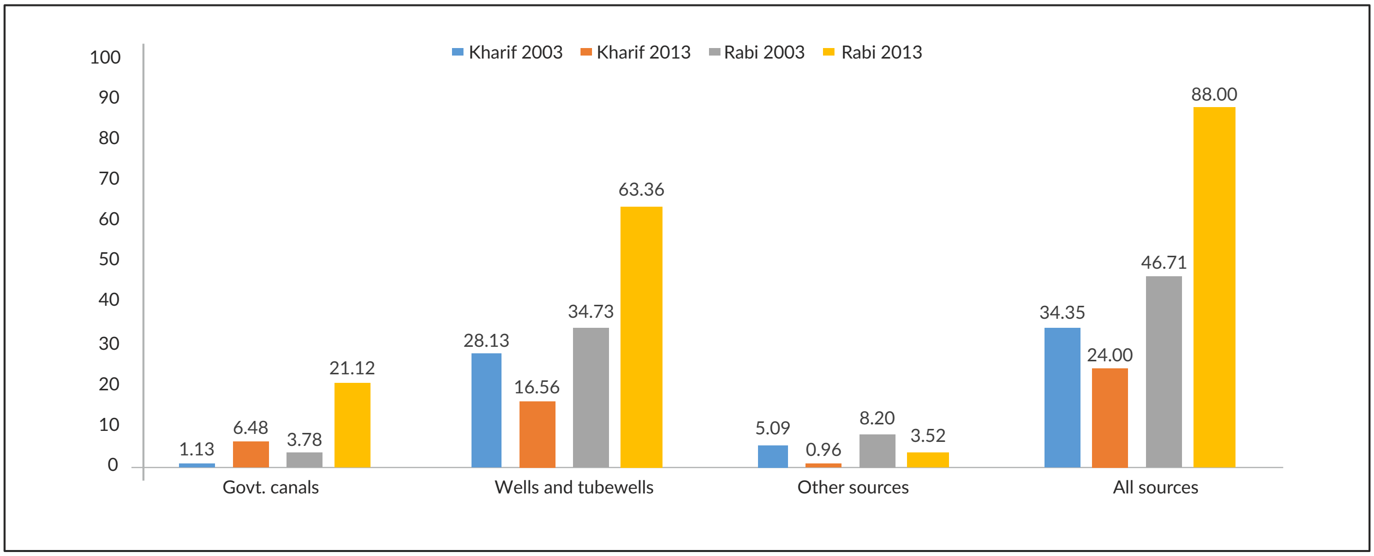


Figure 13: Increase in percentage of cultivated area under irrigation by different sources in MP; comparing NSSO Round #59 (2002-3) with NSSO Round #70 (2012-13)



In 2003, government canals in MP irrigated around 0.65 mha. Under Chauhan's prodding, irrigation inched up. In 2008 assembly elections, Chauhan reaped rich electoral dividends from farmers for his irrigation policies. So in 2010, after sacking a corrupt irrigation secretary, Chauhan brought an upright and pushy officer to run the irrigation department, with promise of stable tenure and total support in stamping out political interference in running canals. This move delivered. The area irrigated by government canals jumped from less than 1.00 mha in 2010 to 1.56 mha in 2011, to 2.02 mha in 2012, and 2.33 mha in 2013. In 2014, despite being a poor monsoon year, MP expects the state will have 3.00 mha irrigated in canal commands (by all sources), more than even the potential created of 2.83 mha.

How did MP achieve such miraculous expansion in canal irrigated area? Sheerly by improving irrigation management involving Principal Secretary and Superintending Engineers down to 'chawkidars'. The top political and administrative leadership implemented reforms by making performance-linked demands (PLD) on the bureaucracy and offered performance-linked supports (PLS) so that the department could rise to the challenge. The PLD-PLS strategy involved six components:

[1] *Restoring canal management protocol:* MP restored the primacy and insisted on full enforcement of four forgotten rules of effective canal system operation viz., rationalized irrigation schedules, tail-to-head irrigation, *osarabandi* (operating canals by strict rotation) and operating canals at full-supply level (FSL). Obsolete irrigation schedules were revised. Water allowances were adjusted to reflect new cropping patterns. Areas served by lift irrigation from surface and groundwater in command areas began to get counted as canal irrigated areas. Irrigating tail-end first removed the head-tail inequity endemic to canal irrigation. FSL canal operation meant that water reached tail-ends and could be distributed in an orderly manner. Enforcing *osarabandi* ensured that distributaries could be operated at FSL during their rotations. The most difficult of all, in early years, was enforcing the 'tail-end first' rule because it challenged the long-entrenched power relations. In some projects, tail-end farmers were asked to complete land preparation a week or so in advance so that water could be released in advance when head-end farmers were not ready. Restoring the primacy of 'tail-end-first' required a massive thrust but once it got accepted, things began to fall in place; farmers adjusted planting schedules; water demand in head began lagging that in tail. Earlier, when canals ran non-stop at low-supply, it was a winner-take-all game for head-end farmers who had no pressure to time planting or save water. Now, *osarabandi* delivers full-supply for specific pre-determined time slots that drives farmers to manage water better. Over time, there is greater appreciation among farmers for the discipline of 'tail-end-first' irrigation and o*sarabandi* since with greater discharge of water, the fields are irrigated faster saving the farmer time and labour.

[2] *Last mile investments:* To enforce the three core-rules requires that systems are well-maintained and in good repair. A World Bank loan and internal resources were found to prioritise and quickly complete last-mile projects with high potential. Lining big earthen canals on old systems helped reach water to tail ends quickly. Small investments in rehabilitating over 4000 Minor Irrigation Schemes doubled the area served by them in just two years from 367,000 hectares to 7,60,000 hectares.

[3] *Reducing deferred maintenance:* Canals can be operated at FSL only if they are regularly maintained and will not breach. In most states, after salaries are paid, irrigation departments are left with no resources for Management, Operation and Maintenance (MO&M). In MP, the department was provided resources to undertake proper MO&M. Two months ahead of every irrigation season, the department would be mobilized to desilt and clean all main canals while Water User Associations (WUAs) cleaned sub-minors and field channels. Even then, in older systems, risks of canal breach remained. Engineers were enjoined to run FSL and, if they occurred, fix the breaches within a stringent time limit; in doing so, they were backed by the department bosses.

[4] *Constant Monitoring:* The hallmark of new management was relentless monitoring. Potential created was taken as the target for irrigation. Regular weekly video-conferences taken by the Secretary and newly introduced ICT systems created pressure for performance. The long abandoned practice of engineers overseeing irrigation operations in the field got revived with the secretary and chief engineer themselves frequently heading out in the field. Irrigating tail-end areas became an obsession and from the Secretary down, the key variable monitored was whether tail-end fields were watered. In a masterful innovation, the Engineer-in-Chief would randomly call any of the 4000 odd mobile numbers of tail end farmers to enquire if water reached her/his field.

[5] *Animating the irrigation bureaucracy*: Unstinted support of the chief minister empowered the irrigation bureaucracy to establish order and rule of law in canal commands. Local political interference was firmly crushed, when needed with direct intervention from the chief minister. This had magical effect on the department's morale which was further enhanced by a new system that recognized and felicitated high performing staff. The Chief Minister's backing also made coordination with agriculture, forest, revenue departments and district collectors easier, quicker and result-oriented. Time-consuming peripheral issues were decluttered. An invigorated irrigation bureaucracy was focused on the core task of delivering water to as many farmers as possible especially in the tail-ends.

[6] *Vitalizing farmer organisations:* Under a new law made in 1999, some 2000 WUAs were formed but mostly lay defunct. WUAs' had little role when poorly managed main system failed to deliver water to many parts of the command for years. Now that the MO&M of the main system improved, water began reaching the tail-ends and defunct WUAs sprung to life. By involving them in pre-rabi desilting of minors and sub-minors, the department enhanced its outreach and WUAs became critical partners in irrigation scheduling, maintenance below outlets and orderly water distribution.

Type I irrigation development strategy of central and state governments has all along emphasized only construction to the total neglect of Management, Operations and Maintenance (MO&M) of MMMIPs. This is the key reason for the widening gulf between Irrigation Potential Created (IPC) and Irrigation Potential Utilised (IPU). Central share in MMMIP is just around 15 per cent of total investment in MMMIP, with states contributing 85 per cent. Given that central government has no means to compel state governments to devote greater energy and funds to improve MO&M of MMMIPs, it makes much greater sense for PMKSY to devote central funds only to incentivize state governments for MO&M improvements in public irrigation systems and leave it to states to find resources for construction, especially with greater devolution of funds to states under XIV Finance Commission report. Many states with large MMMIPs have starved their irrigation departments of funds, professional staff and capacity building even as they spend massive sums in new construction. This is an old syndrome of India's MMMIP. David Seckler had remarked 40 years ago that, "*As the rug of irrigation development is rolled out ahead through construction of new facilities, it will roll up behind through poor maintenance and management of existing facilities*" (cited in Wade 1984, 286).

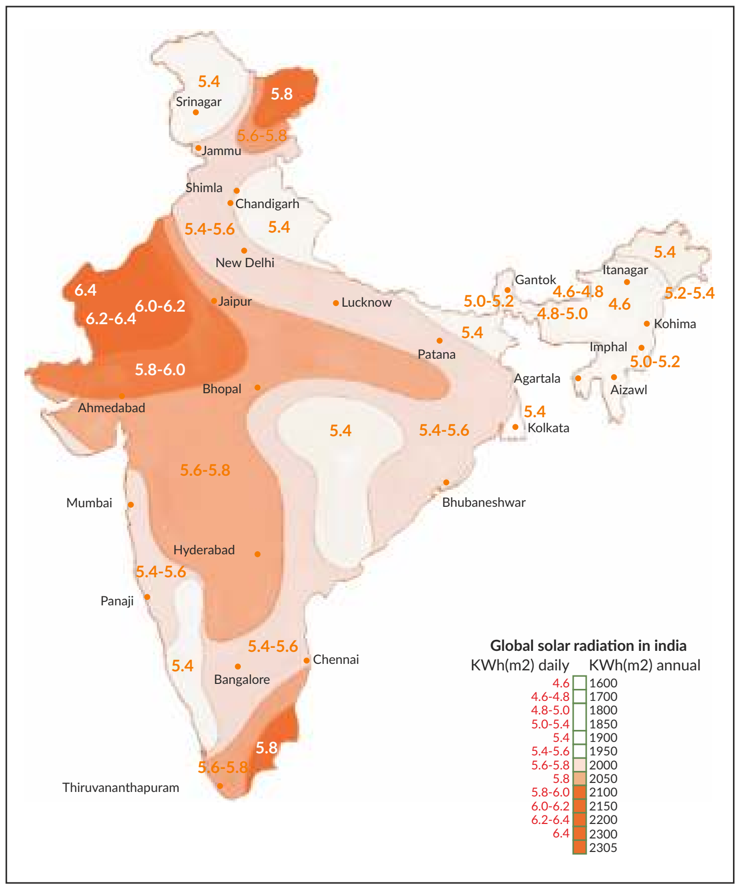
There is little the Central Government can do to fight this syndrome because MMMIPs are managed by state Irrigation Departments. However, what it can do is encourage and incentivize irrigation management improvements by spreading word about innovations and best practices that have succeeded elsewhere. The abandoned XII Five Year Plan had created a NIMF under which central government had offered to reimburse state irrigation departments for all Irrigation Service Fee (ISF) they collected from farmers on a 1:1 basis, and for ISF collected through WUAs on a 1: 1.3 basis provided resources so mobilised were made available to respective irrigation systems and WUAs for improving MO&M and level of irrigation service. The underlying thinking was that such an incentive scheme would restore the accountability loop between farmers and irrigation department staff that have got eroded due to free or subsidized irrigation policies that have taken root in all states. NIMF needs to be the core of AIBP in PMKSY.

6. New Opportunities for Type II Irrigation: The Promise of the Solar Pump

A major opportunity for expanding and sustaining Type II irrigation in our target geography that PMKSY has ignored is the promise of solar irrigation pumps. For a long time, solar pump has been tried on research farms; but now, the falling costs of panels are mainstreaming the technology. Until 2012, India had less than 1000 solar pumps; but at the end of 2015, we already had 35,000. The numbers are expected to grow in geometric progression because solar pumps overcome key pitfall of diesel pumps, viz., high fuel cost, and of subsidized grid power, viz., frequent interruptions, low voltage and 6-7 hours of mostly nightly supply. Solar pumps, in contrast enjoy 7-9 hours of uninterrupted, reliable, daytime power free of operating cost (Figure 14). Being off-grid, they are also easier to install and require little maintenance. As panel prices fall with market expansion, solar pumps can be expected to make deeper inroads in our Type II irrigation economy.

Solar pumps can be a boon for our energy-scarce districts which have ground and surface water available for Type II irrigation development. Most of these districts have low grid-penetration; as a result, prospects of reaching grid power for Type II irrigation any time soon are small and distant. Even when villages are connected to the grid, connecting individual tubewells/wells with grid entails capital investment of the order of ₹ 2.0-2.5 lakh. Even though solar panels are expensive in absolute terms, a solar pump is a cost-effective alternative to a grid-connected pump if connection costs are included in the cost of energizing a structure. Districts in Bihar, Chhattisgarh, eastern Uttar Pradesh, Orissa, Assam, MP and Jharkhand—in sum, much of the irrigation-deprived geography—have 153 pump-sets per 1000 ha of net sown area, most suffer from low operating factor because of high cost of diesel and fuel that drive 88 per cent of them. Farmers here use only 500-600 kWh (equivalent)/hectare of energy in pump irrigation compared to 2000 kWh/hectare in districts with subsidized electricity. No wonder farm worker productivity and cropping intensities are low in these districts.

Figure 14: Global solar radiation in India (kWh/m^2)



Source: http://www.tnsea.in/solar-energy-in-india.html

As solar pump numbers swell, a major threat is that their owners will mimic the economic behavior of grid connected pumps with rationed free power, but with the additional benefit of better quality, day-time power for 2500-2800 hours/year. The legitimate fear is that as solar pumps numbers grow, the pressure on groundwater resources will increase enormously. Governments try to counter this danger by limiting subsidy to small-size solar pumps and making it conditional to farmer buying micro-irrigation system. In Rajasthan, with the largest number of solar pumps, these conditions have already been watered down: under pressure from farmers, solar pump subsidy has been raised from 2 kWp to 3 kWp and now to 5 kWp. As panel costs fall making solar pumps affordable without subsidy, these conditionalities will any way not alleviate the groundwater threat of solar pumps.

PMKSY needs to respond to the solar pump's mixed bundle of opportunity and threat in a foresightful manner. The only way to ensure sustainable water use under solar pumps is to incentivize farmers to conserve free solar power and groundwater. This can be done by connecting solar pumps to the grid and giving farmers long-term buy-back guarantee for surplus solar energy at an attractive feed in tariff. Electricity companies will resist having to buy small amounts of solar power from individual farmers due to the high transaction and vigilance costs involved. However, a cluster of solar pump irrigators brought together in a cooperative-owned micro-grid can overcome this resistance. This concept has been piloted in village Dhundi in Gujarat through a Solar Pump Irrigators' Cooperative Enterprise (SPICE). Such a SPICE presents a win-win game for farmers, for power sector and for sustainable groundwater management. Farmers get quality power for irrigation and a stable, remunerative market for their surplus solar energy. DISCOMs can use SPICE to do away with power subsidies and create a smart grid. The groundwater economy can become more sustainable by doing away with perverse power subsidies and incentivizing farmers for conservation of energy and water.

In groundwater-rich eastern India, solar pumps can help create competitive irrigation service markets if young farmers in every village are supported to acquire a 6-8 kWp solar pump and a 1,000 meter buried pipe distribution system to operate as entrepreneurial Irrigation Service Providers (ISPs). Such ISPs having diesel pumps are already playing a dominant role in the irrigation economy of the region but their high water prices put water buyers in a seriously disadvantageous position. The same ISPs would slash their water prices down if their diesel pumps were replaced by solar pumps with comparable water output. By expanding a competitive market for irrigation services, the solar ISP model can accelerate Type II irrigation development but in some areas result in groundwater over-development by increasing demand for irrigation.

The SPICE model has relevance in groundwater-rich districts as well as groundwater-stressed districts. The surplus energy buy-back guarantee gives solar pump irrigators two options: use it to sell irrigation service to neighboring farmers or evacuate it to the grid. In groundwater rich-districts, a low feed-in tariff will strengthen incentive to sell irrigation service, intensify competition on solar ISPs and make irrigation service available to buyers at affordable prices. In groundwater stressed districts, a high feed-in tariff for power buy back will raise the opportunity cost of using solar energy to pump water for own use as well as for selling to others, raise water prices, and force all water users to conserve water. In sum, the feed-in tariff offered for solar power buy-back will act as a surrogate water price to signal the scarcity value of water. All perverse impacts that the country has witnessed all these years due to invidious energy-irrigation nexus can, in principle, be neutralized by proper promotion and governance of solar pumps through SPICE pattern.

7. New Opportunities for Type II Irrigation: Peri-urban Wastewater Irrigation

Municipal wastewater has been used world over for irrigation, for a long time. Around the mid nineteenth century, 'sewage farms' were common in many parts of Europe and United States. For decades, the wastewater (WW) from Paris was transported in canals for spreading on a 5,000 ha plot which developed into a highly productive vegetable growing area. The large size and superb quality of the vegetable produce attracted great interest among farmers and citizens. In India too, evidence of sewage farms exists in and around several cities including Amritsar, Delhi, Hyderabad, Ahmedabad, Jamshedpur and Trivandrum. Twenty-five years ago, Strauss and Blumenthal (1990) estimated that 73,000 Ha in peri-urban India was subject to wastewater irrigation; the number is likely to be many-fold today. IWMI studies in 17 locations estimate that more than 57,000 hectares of area is being irrigated with wastewater in that sample of locations alone (see Table 6).

Table 6: Extent of wastewater irrigation in the periphery of urban centers

Location			Net Wastewater Irrigated Area (Ha)	Source
01.	Gujarat	Ahmedabad	9,450	Palrecha *et al.* (2012)
02.		Vadodara	3,875	
03.		Rajkot	3,252	
04.		Gandhinagar	769	
05.		Bhuj	248	
06.		Bhavnagar	195	
07.		Surat	70	
08.	Maharashtra	Purandhar LI Scheme	25,498	Ramola *et al.* (2016)
09.		Pune	5,580	
10.		Jalgaon	1,232	
11.	Jammu & Kashmir	Srinagar	4,227	Shaheen (2016)
12.		Jammu	1,817	
13.	Tamil Nadu	Tiruchirapalli	260	Leaf Society (2016)
14.		Salem	240	
15.	Karnataka	Dharwad	210	Gupta *et al.* (2016)
16.		Hubli	186	
17.		Vijaypura	35	
TOTAL			**57,144**	

Several municipalities have devised formal and informal arrangements with peri-urban farmers for requisitioning their freshwater for municipal use and supplying them wastewater for irrigation. Rajkot Municipal Corporation, for instance, has been supplying water to two registered wastewater cooperatives since 1962. Smaller municipalities like Unjha in north Gujarat are auctioning their wastewater to entrepreneurs who then deliver it to farmers. Thus, wastewater irrigation is not just common, it is happening everywhere. Driven by freshwater scarcity, growing competition from domestic and industrial users and rapid urbanization, farmers around the country are embracing wastewater and benefiting from its reliability and nutrient content.

A 2008 estimate of sewage generated by class I and class II Indian cities (CPCB 2009) shows that more than 38,000 million litres of wastewater is generated every day; annually, this amounts to nearly 14 billion cubic meters (BCM). This is sufficient to irrigate 2 mha of land, equivalent to 200 medium irrigation schemes. Unlike canal irrigation, this mode of irrigation does not require any kind of storage; and there are hardly any evaporation or conveyance losses. However, to recognize wastewater irrigation and promote it further, it is essential to take cognizance of some pertinent public health and soil quality concerns.

7.1 Addressing public health and soil quality concerns

Irrigation with untreated wastewater has raised some public health and soil quality concerns. In wastewater irrigation literature and during our fieldwork, we encountered two types of health concerns: [a] direct exposure to untreated sewage may cause rashes, irritation and skin problems for wastewater farmers; and [b] it is widely suspected that contaminants in wastewater may enter the food chain, especially when farmers use wastewater to grow food crops, in particular leafy vegetables.

Concerns pertaining to direct exposure can be addressed relatively easily through awareness campaigns and basic precautions. Farmers using wastewater should be encouraged to implement sieving and settling protocols; and should be advised to wear safety boots and gloves while on the field. For minimizing the indirect exposure risks, several steps can be taken:

[a] The municipal administration should make sure that domestic wastewater is not mixed with industrial wastewater;

[b] To be completely safe, farmers may be asked to grow only non-food crops using wastewater;

[c] In cases where food crops are being grown, leafy vegetables and crops that grow close to the ground should be avoided; and finally,

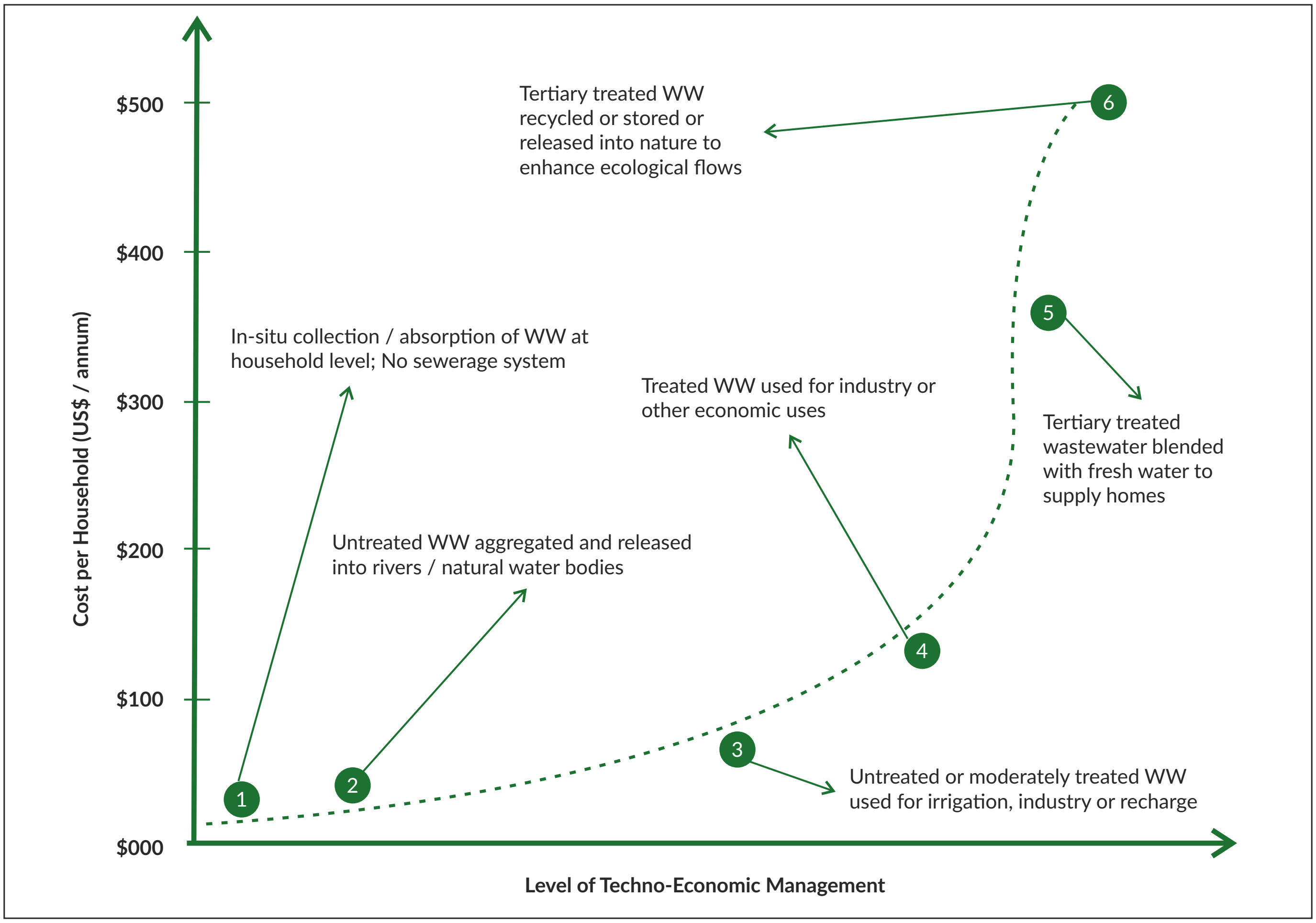
[d] A systematic study of the long-term health impacts of consuming wastewater irrigated food crops should be undertaken.

Our field studies indicate that farmers do not perceive the health risks or risks to soil quality to be very severe. Despite decades of wastewater irrigation, few cases of the harmful effects of direct or indirect exposure have been reported. All farmers unanimously report significant increase in yield and reduction in fertiliser costs with chemical free wastewater use for irrigation.

7.2 Opportunities for PMKSY

How an economy manages its wastewater correlates strongly with its stage of economic development. A global bird's eye view suggests a ladder of techno-economic options in wastewater treatment; management and reuse (see Figure 15). In most villages of South Asia and Sub-Saharan Africa, there is hardly any infrastructure for collection, aggregation and treatment of wastewater; disposal is without any treatment and at the household level. As villages grow into towns, rudimentary infrastructure begins to come up for collection and aggregation of wastewater and disposal outside the settlement. However, in many towns and cities of the developing world, the infrastructure for collection, aggregation and transportation is unable to keep up with the rapid growth of the settlement area. In these communities, wastewater is a huge threat to the environment as well as to peri-urban quality of life. If managed well, however, wastewater can be a great resource while also minimizing its negative ecological impact. In very high-income societies, urban wastewater is totally recycled by intensive, multi-stage treatment that low-income societies can ill-afford.

Figure 15: Techno-Economic Ladder of Urban Wastewater Management



The current discourse on municipal water management in India envisages leapfrogging from the current highly rationed public urban water supply to 24/7 supply; from near-zero tariff to a metered tariff regime; from minimal wastewater treatment to 100 per cent treated wastewater being released into rivers. The discussion is about creating a world-class, Europe-like systems (where the average household pays about US $1000 per annum for water supply and sanitation) for a population where more than 80 per cent cannot even afford to pay 10 per cent of that as service fee. A more realistic scenario is that India will go through a long intermediate phase before it reaches this ideal state. It seems very likely that self-provision, informal markets, and wastewater irrigation will continue to grow in this phase. The challenge is to create governance regimes that meaningfully integrate the informal economy and public provisioning into a viable and sustainable system.

7.3 Agenda for Action

Our current wastewater treatment capacity is less than a third of wastewater generated. Further, most treatment plants do not operate at full capacity owing to poor operation and maintenance (O&M) and high running costs. It is therefore very likely that tertiary treatment of wastewater for reuse within cities will not happen anytime soon. Land application of wastewater is a well-recognised treatment process which needs to be embraced in policies and urban development plans. In the medium run, this might also allow us to manage municipal wastewater without investing in capital and energy intensive treatment plants. Properly managed wastewater irrigation in peri-urban India offers to:

[1] Add irrigated areas without adding pressure on scarce freshwater resources;

[2] Provide reliable and nutrient rich irrigation water to farmers, especially during drought years or where groundwater is of poor quality;

[3] Improve farm incomes by reducing expenditure on fertilizers and enhancing crop yields;

[4] Co-manage the water and nutrient cycles by returning them to their source;

[5] Alleviate the need for capital and energy intensive wastewater treatment plants;

[6] Reduce environmental pollution caused by releasing untreated wastewater into freshwater streams; and

[7] Convert a *disposal headache* for municipalities into a valuable *resource*.

Thus, over the next several decades, wastewater reuse in agriculture offers the best option for cities to act as smart, high performance irrigation systems for peri-urban farmers. A pre-requisite for wastewater irrigation is that the cities / municipalities should have effective wastewater collection and aggregation systems. Several field pilots can be taken up as part of PMKSY (see Table 7) to arrive at the best alternatives for achieving *har khet ko pani*.

Table 7: Options for wastewater irrigation pilots under PMKSY

Wastewater Pilot	Treatment	Management	Delivery
1a. Auction; on-demand delivery	Primary treatment: Sieving and Settlement / Stabilisation / Aeration Pond	Wastewater entrepreneur responsible for conveyance and delivery	On-demand; through open channels / pipes
1b. Auction; rotational scheduling of wastewater supply			Wastewater and freshwater supplied on a rotation schedule
2a. Reverse Auction; on-demand delivery	Primary treatment: Sieving and Settlement / Stabilization / Aeration Pond	ULB manages both treatment and delivery	On-demand; through open channels / pipes
2b. Reverse Auction; rotational scheduling for wastewater supply			Wastewater and freshwater supplied on a rotation schedule
3. Horizontal flow constructed wetland (High land-footprint)	DEWATS model	ULB or private entity owns, maintains and manages the treatment facility; treated wastewater is supplied to farmers for irrigation	On-demand; through open channels / pipes
4. Vertical flow constructed wetland (Low land footprint)	IARI-model[5]		On-demand; through open channels / pipes
5. Planned drainage and plumbing for optimal wastewater irrigation	Separation of grey and black water leading to minimal treatment requirement		On-demand; through open channels / pipes

[5]IARI has developed an "eco-friendly wastewater treatment facility" that uses wetland plants and engineered microorganisms to treat up to 2.2 million liters per day while enjoying low land and energy footprints vis-à-vis conventional wastewater treatment plants (See IARI *nd*.).

8. PMKSY: Practical Ways Forward

8.1 Reality of Indian Irrigation

When the BJP manifesto for 2014 parliamentary election assured *Har Khet Ko Pani*, it was widely expected that the new NDA government will make a fresh start in India's irrigation thinking based on the sterling experience of BJP-ruled Gujarat and MP in rapidly expanding irrigation coverage on a scale that was unprecedented. However, as conceived now, the *Pradhan Mantri Krishi Sinchai Yojana* focuses mostly on converging pre-existing schemes rather than envisioning a bold new program appropriate to our needs and challenges. To scale out the irrigation success of Gujarat and MP post-2000, PMKSY needs to respond to the following aspects of our irrigation reality:

1. *Target Irrigation-deprived Farm-holdings*: After 67 years of aggressive planning of irrigation projects, 48.2 per cent of our farm holdings are totally deprived of irrigation from any source. There are spatial as well as social imbalances in irrigation access; our adivasi farmers and *adivasi*-dominated districts are our irrigation have-nots. PMKSY needs to prioritize rainfed farm holdings' in India's Irrigation Deprived Geographies and social groups.
2. *Focus on Irrigation-deprived districts*: But the bulk of our 'Irrigation Deprived' holdings are concentrated in 126 districts of the country where less than 30 per cent of farm-holdings have any source of irrigation. These contrast with 170 top districts where over 70 per cent of farm holdings benefit from irrigation from one source or another. PMKSY needs to target energies and resources to these districts. In the current design, it does not. Lion's share of PMKSY allocated to 23 AIBP priority projects, for instance, have nothing for Assam. Bihar, Karnataka, UP, Rajasthan, Chhattisgarh, Jharkhand, West Bengal which together have a large chunk of our rainfed farm-holdings.
3. *Recognise Changing Role of Type I and Type II Irrigation*: India's irrigation strategy has so far targeted expansion of IPC in pockets which can be turned into command areas of MMMIP. These, however, deliver Type I irrigation for which there is little or no demand. All evidence available shows that since 1990, over 95 per cent of new irrigated farm holdings have been delivered through Type II Irrigation from privately owned groundwater wells or lift irrigation schemes powered by electricity or diesel. The role of Type I public and community irrigation schemes is increasingly to support Type II irrigation. The year-round, on-demand water control offered by Type II irrigation makes small farms far more productive and resilient compared to Type I irrigation.
4. *Recognise the Game-Changing Potential of Solar Pumps*: With rapidly falling solar panel prices and growing acceptance among farmers, solar pumps are certain to be a game-changer in India's near-term irrigation future. The Modi government has already set ambitious targets for renewable energy generation; the question is whether it will also recognize how solar irrigation pumps can play a critical role in achieving those targets while at the same time: [a] incentivize efficient use of groundwater in water-scarce regions; [b] significantly reduce irrigation deprivation in groundwater-abundant, energy-scarce regions; [c] bring additional, climate-proof income to farmers; [d] reduce the carbon footprint of India's groundwater irrigation; [e] reduce the land footprint of India's solar ambitions; and [f] reduce India's farm power subsidy burden.
5. *Develop Peri-urban Wastewater Irrigation Potential*: As India urbanizes, towns and cities are emerging as reservoirs that release constant, year-round wastewater supply to sustain Type II irrigation of high value crops on a perennial basis. According to Central Pollution Control Board, our cities already release some 14 BCM of wastewater annually, nearly twice the storage of *Sardar Sarovar* dam. A lot of this is already in use for irrigation with uncertain health impacts for irrigators as well as consumers. With minimal investment in primary treatment of urban wastewater, it is possible to eliminate these health risks and create a win-win irrigation economy. Our target irrigation-deprived geography is also lowest in urbanization rates; many of its growing towns and cities have yet not begun investing heavily on drainage and treatment. PMKSY needs to be proactive in piloting

drainage investments designed to support in a planned manner treated wastewater irrigation rather than retrofitting pre-existing drainage systems or allowing unplanned wastewater irrigation by default.

6. *Emphasize Scale, Speed, Cost-effectiveness*: Type I irrigation is costly (₹ 10 lakh/ha) in terms of capital investment, takes 20-30 years to commission, is increasingly fraught with land acquisition problems and suffers from severe MO&M problems. In contrast, Type II irrigation requires lower investment (₹ 0.5-2.0 lakh/ha), can be commissioned quickly, needs no land acquisition, and can be owned and managed by farmers. It therefore makes great sense for PMKSY to target rapid expansion of Type II irrigation.

Table 8: Clustering of Districts for PMKSY Interventions

Geographies	Defining aspect	Number of Districts	Critical Objective/s
Cluster #01	Groundwater surplus districts with high share of farm holdings without any source of Type I or Type II irrigation	112	1
Cluster #02	Groundwater-surplus districts where Type II irrigation is constrained by high energy cost	36	1
Cluster #03	Groundwater surplus districts where Type II irrigation is constrained by inadequate electricity supply	24	1
Cluster #04	Groundwater-deficit alluvial districts where Type II irrigation will further deplete aquifers	103	2, 3
Cluster #05	Groundwater deficit hard-rock districts with excessive groundwater depletion (dark or over-exploited zones)	27	2, 3
Cluster #06	Districts with dense network of MMM systems and large canal irrigation areas	114	2, 5
Cluster #07	Districts with high density of irrigation tanks, check-dams, and water harvesting structures	161	2, 5
Cluster #08	Districts with Class I or II towns	-	4
Cluster #09	Hill districts, mostly in Himalayas, where agro-climatic conditions are not conducive for conventional irrigation	100	6
Cluster #10	Districts with high irrigation incidence and high agricultural productivity	54	-
Cluster #11	Districts with high irrigation incidence and low agricultural productivity	41	-
Cluster #12	Urban and UT districts with little agriculture and missing or patchy data	25	-

8.2 Objectives PMKSY should pursue and their Contextual Fit

Given this reality, PMKSY should be designed to achieve following six objectives, in that order of priority:

1. Provide affordable Type II irrigation access to irrigation-deprived farm holdings in the country's irrigation-deprived geographies;
2. Maximise areal spread of conjunctive management of ground water and surface water in command areas of MMMIP, irrigation tanks and large water harvesting structures such as check dams;
3. Enhance efficiency and productivity of irrigation water use especially in groundwater-stressed geographies through micro-irrigation and piped-conveyance;
4. Develop integrated peri-urban irrigation to promote planned wastewater irrigation as a major Type II irrigation solution;
5. Improve the financial and institutional sustainability of public and community irrigation systems; and
6. Promote traditional and innovative water harvesting and diversion systems and support spring-shed development especially in hill agro-ecologies.

Different district-clusters face different irrigation-water challenges and require differentiated program strategies (see Table 8). There are scores of districts which already have high coverage of Type II irrigation but face threat of serious resource depletion and deterioration. These need one kind of response. But there is also a large number of districts where the spread of Type II irrigation is still minimal. For example, many districts in Jharkhand or western Orissa fall in cluster #01 which needs a critical PMKSY intervention very different from what most districts in Punjab and Haryana in cluster #04 need. Likewise, irrigation access in Telangana, Rayalaseema, Karnataka is constrained by an entirely different set of factors that need targeted response. Table 8 attempts a clustering of India's districts according to their irrigation challenges and suggest critical objectives PMKSY should follow in each cluster.

8.3 PMKSY Interventions

Until now, conventional irrigation planning has focused mostly on large surface water development projects that are capital and land intensive and have long gestation periods. Moreover, farmers are increasingly lukewarm to these because these offer Type I irrigation while farmers demand Type II. To cater to these differentiated needs of different geographies, PMKSY needs to deploy a broader and diversified repertoire of programmatic instruments. We suggest 15 action items as instruments in this repertoire as outlined in Table 9. Not all these have equal relevance to different clusters; for each cluster of districts, some are critical but others can play a supportive role.

In some of the best irrigated districts of the country, 60-70 per cent of farm holdings have their own wells, pumps and pipe distribution systems or have private or shared lift systems drawing water from a perennial source for Type II irrigation. Irrigation deprived districts, 112 in our Cluster #01, are characterized by a majority of farm holdings lacking such apparatus for Type II irrigation. We propose that this cluster be targeted as the primary beneficiary of PMKSY (see Box 8a).

Box 8a: Special Focus on Cluster #01

During the 1980's and early 1990's, GoI's Million Wells Scheme offered liberal subsidies and bank loans to small farmers to develop groundwater-based Type II irrigation. Uttar Pradesh's “Free Boring Scheme” of the 1980's is the reason eastern and central UP have high density of shallow tubewells today. The same strategy has also worked to expand irrigation access in tribal districts of Gujarat where over the past decade over half a million new power connections were issued specifically to *Adivasi* and SC groups. The quickest and most cost-effective way to expand irrigation in these Cluster #01 districts is through a program to provide Type II irrigation assets to poor farm households (Action Item #1).

Our analysis shows that in the 112 most irrigation deprived districts, there is potential for 5.67 million new irrigation wells with an annual yield of 10,000 m^3/year (see Figure ES.2). Doing this can bring an additional 11.34 mha under irrigation without in any way threatening the sustainability of groundwater resources. This would also wipe away the irrigation deprivation in these districts, taking irrigated area from the current 11.6 per cent to 43.3 per cent, making the region at par with the national average. However, at an average cost of ₹ 50,000 per well, 5.67 million new irrigation wells would cost ₹ 28,350 crores; an unlikely allocation in the current PMKSY. As a first step, a more realistic plan would be to budget for 1.0-1.5 million new irrigation wells in Cluster #01 under PMKSY by 2020.

Jharkhand has used MGNREGA funds to dig nearly 100,000 wells on *Adivasi* holdings in recent years. The constraint however is that they all have diesel pumps; and diesel is expensive and troublesome to procure. PMKSY can leverage existing efforts by the Ministry of Energy and the Rural Electrification Corporation to bring electrification to these villages and energize pumps. Complete electrification is a long-term goal and requires substantial resources, especially providing electricity connections to remote irrigation wells. In contrast, there are opportunities to fulfil at least part of future pump electrification demand by subsidizing solar-powered irrigation pumps *in lieu of* electric connections. PMKSY needs to initiate a special subsidy-cum-loan solar pump promotion program for *Adivasi* farmers in these districts. Such a program should support off-grid individual solar pumps, grid-connected solar pumps under the SPICE model, as well as solar ISPs, as discussed in section 6.

Together the million wells and solar promotion package will add 5.0-7.5 mha to the region's gross irrigated area; and will lift millions of *Adivasi* farmers out of poverty. In the short run, such public investments can be reinforced with CSR and philanthropic interventions. Over time, these will also trigger hundreds, if not thousands, of crores of private investments in Type II irrigation; reduce distress migration and cause improvements on various socio-economic parameters.

In cluster #02 and #03 districts, irrigation access is constrained by affordability and availability of energy. Bihar, Assam, Eastern Uttar Pradesh, Coastal Orissa, North Bengal are all flush with groundwater but have significant Type II irrigation deprivation mostly because these are dependent on expensive diesel which delivers power at an effective cost of ₹ 8-10/kWh. This obliges small holders either to avoid irrigation or to use it sparingly. In Vidarbha, Telangana, Marathawada, Rayalaseema, much of Karnataka, there is a fairly high density of Type II irrigation structures connected to the grid. However, irrigation here is constrained by erratic, low-voltage electricity supply.

Table 9: Proposed PMKSY interventions

#	Action Item	Details of activities
1	Support for Groundwater/ Lift Irrigation	Targeted support to Irrigation-deprived farm households to make wells/ borewells and install irrigation pumps with 500 meters of piped distribution system on the lines of Million Wells Scheme during early 1990's
2	Affordable, assured power for peak season irrigation	7-8 hours of assured, uninterrupted, full voltage power supply to irrigation wells; supply of single season power connections for lift or well irrigation
3	Support to Solar Pump Irrigators' Cooperatives	Promote grid-connected solar farmers cooperatives with attractive power-purchase guarantee in grid-networked areas with high tubewell density and groundwater depletion
4	Support to Solar Pump-based ISP	ISP in groundwater-rich but energy-scarce villages (as in Bihar), promote in each village a group of solar pump-based ISP with a 6-8 kWp solar pump with 1000 meters of buried pipe network
5	Support to Micro-irrigation	GGRC-pattern in micro-irrigation promotion especially in groundwater-stressed districts
6	Closing IPC-IPU gap in existing MMM irrigation systems	Support for annual pre-monsoon desilting of minor and sub-minor canals; lining of main and branch canals; desilting of minor and medium reservoirs; last-mile investment in completing incomplete distribution system
7	Supporting conversion to last-mile piped-canal water supplies	Delivering canal supplies to individual or common sumps for piped irrigation (*à la* Indira Gandhi Nahar) or through buried pipe network as in Sardar Sarovar project
8	Tank-groundwater conjunctive management	Regular desilting of irrigation tanks (as in Telangana's *Mission Kakatiya*); removal of encroachment on tank-beds and supply channels; buried pipe supply channels; linking tanks with canals; recharge-shafts and percolation tanks
9	Water harvesting and groundwater recharge	Centralized: *Sujalam Sufalam*, recharge shafts, recharge tubewells, infiltration wells Decentralized: Anicuts, tiny check dams, farm ponds, well-recharge
10	Watershed treatment with accent on groundwater recharge	Shift focus from stabilizing *kharif* crop through improved soil-moisture regime to enhanced groundwater recharge for *rabi* and summer irrigation by investing in *nala-plugs*, check dams, percolation ponds, well-recharge
11	Support improved management of main system in MMM projects	Establish tail-end-first irrigation protocol; operate the canal system at full-supply level; announce irrigation schedule in advance; enforce rotational water supply
12	Operationalise NIMF	Incentivize WUA's to vigorously collect Irrigation Service Fee (ISF); provide resources to Irrigation Department for regular operations and maintenance of the main system
13	Peri-urban wastewater irrigation	Support pilot projects for safe peri-urban wastewater irrigation based on primary, eco-friendly treatment
14	Spring-shed Management	Support initiatives such as Government of Sikkim's *Dhara Vikas* program for revival and improved management of mountain springs
15	Traditional land and water management systems	Support revival of traditional hill water management practices such as rainwater harvesting, diversion irrigation, ice stupas / artificial glaciers etc.

Clusters #04 and #05 present altogether different challenges; these are already among the best-endowed with Type II irrigation structures but growing water scarcity and groundwater depletion is reducing their utilization factor. In Clusters #06 and #07, there is massive opportunity for conjunctive management of canal networks and irrigation tanks that can greatly expand Type II irrigation. Cluster #08 offers opportunities for systematic development of wastewater irrigation. India's hill districts in Cluster #09 have unique agro-climatic conditions where conventional irrigation development might not be practical. In these districts, traditional land and water management practices, innovations like ice stupas in Leh and spring-shed management need to be promoted.

Clusters #10 consists of 54 districts that have high irrigation coverage and high agricultural productivity. These districts have little to gain from PMKSY in terms of irrigation expansion but they highlight the potential contribution that irrigation can make in boosting a district's agrarian economy. Cluster #11, on the other hand, consists of 41 districts that too have high irrigation coverage but have agricultural productivity below national average. These districts too probably cannot benefit much from PMKSY but they underscore the fact that irrigation alone cannot guarantee high productivity. Cluster #12 is the residual cluster and includes city districts (like Hyderabad, Mumbai etc.), urban / UT districts (like Daman, Diu, Chandigarh etc.) and island districts (such as Lakshadweep, Andaman and Nicobar).

8.4 PMKSY: Practical Ways Forward

Table 9 outlines the contours of a PMKSY strategy designed to make significant progress along all six objectives in a 5-7 year time horizon. Indeed, the most critical objective of providing basic Type II irrigation access to a majority of India's irrigation-deprived farm holdings can be achieved in 2-3 years in a campaign mode. More difficult and time-consuming may be objectives 2, 3, 4, 5 and 6. Table 10 identifies from our 15 action items those which are most critical for each cluster of districts. In addition, it also suggests supportive action items that will enhance the effectiveness and sustainability of the critical action items for each cluster.

Table 10: PMKSY clusters of districts and interventions

Geographies	Critical PMKSY Interventions (Action Item #)	Supportive Interventions (Action Item #)
Cluster #01	①④	②③⑧
Cluster #02	②④	①③⑤
Cluster #03	②③	⑤⑧⑨⑩
Cluster #04	③⑤	⑦⑧⑨
Cluster #05	③⑤	⑧⑨⑩
Cluster #06	⑥⑦	⑪⑫
Cluster #07	⑧⑨	⑩⑪
Cluster #08	⑬	
Cluster #09	⑭⑮	⑨⑩

In conclusion, then PMKSY as designed now is unlikely to ensure *Har Khet Ko Pani*, leave alone double farm incomes in five years. Many pre-existing schemes such as AIBP that the current design converges had doubtful track record during the UPA regime. In contrast, the current design learns nothing from the outstanding irrigation successes post 2000 of BJP governments especially in Gujarat and MP where irrigated farm holdings grew at double digit growth rates.

In order to ensure *Har Khet Ko Pani*, PMKSY should stop chasing irrigation potential creation under Type I irrigation projects. Since states contribute over 85 per cent of capital investment in MMMIP and neglects their MO&M, it makes sense for the PMKSY to use the central funds primarily to improve MO&M of MMMIP. Moreover, the biggest near term priority for PMKSY should be to accelerate provision of Type II irrigation access to some 67 million of India's 138.5 million farm holdings that have no irrigation from any source. Even among these, we need to first concentrate on reaching out to rainfed farm holdings in pre-dominantly rainfed districts. Rainfed farm holdings in irrigated districts can generally purchase Type II irrigation and save their crops. But rainfed farmers in predominantly rainfed districts do not even have that option. This calls for focussing energy and resources in 112 cluster #01 districts. This priority can be met in a 3-5 year campaign to provide Type II irrigation assets to these. However, these households are mostly *Adivasi*, are concentrated in tribal-dominated states, and have not coalesced into vocal demand systems. It is important to remember that even in 112 cluster #01 districts, what type II irrigation systems are there at present are owned mostly by non-adivasi farmers. These can get Type II irrigation access only if their state governments can implement boldly targeted plans to implement a strategy to provide them year-round, on-farm water control quickly.

There is also need to rethink where to make investments if the idea is to target irrigation have-nots. Quick results for *Har Khet Ko Pani* are possible only by targeting farm holdings rather than dams and canal systems. Again, Gujarat and MP have exemplified how to target farm holdings for immediate water control rather than mega–schemes with distant and uncertain irrigation benefits. If PMKSY remains driven by AIBP and 'per-drop-more-crop', it is certain that India's irrigation-deprived geography will be left with only watershed development programs. Doing these well will help stabilize *kharif* crops; but it will leave *Adivasi* farmers deprived of the full benefits of year-round, on-farm water control. For that, PMKSY must rapidly expand Type II irrigation in clusters #01, #02 and #03 with groundwater development, solar pumps, wastewater irrigation, MAR, piped water delivery, micro-irrigation and conjunctive management of water from rain, canals, tanks and groundwater.

8.5 PMKSY: Implementation, Monitoring and Evaluation

As with any program of this size, implementing PMKSY will be a managerial challenge. If the district irrigation plans are any indication, states and districts are likely to draw up unrealistic plans which will be impossible to implement with the given resources and within the 2015-2020 time frame. The central administration of PMKSY will have to make some hard choices in prioritizing investments and giving a realistic shape to district plans. There is also a real danger of multiple levels of overlaps with on-going central and state schemes as well as other donor-driven programs. For instance, as PMKSY district plans are being prepared, the GoI is also developing an ambitious US$ 1 billion National Groundwater Management Improvement Program (NGMIP) in partnership with the World Bank. Given that NGMIP will focus on groundwater over-exploited regions and focus on community-based demand management, it might be better to link the *'per drop, more crop'* component with NGMIP, rather than PMKSY. Likewise, the Bharat Rural Livelihood Foundation (BRLF), set up in 2013 with the objective to "*foster and facilitate civil society action in partnership with government for transforming the livelihoods and lives of people in areas such as the Central Indian Adivasi belt*", can be a useful partner for targeting Cluster #01 under PMKSY.

Emphasis on scale, speed and cost-effectiveness will require transparency in transactions and operational flexibility in implementation at the ground level. Involvement of donors, CSR, CSOs and grassroots NGOs can help in effective program implementation, monitoring, review and evaluation. For instance, in Cluster #01 districts of central India, the Tata Trusts have set up CInI (Collectives for Integrated livelihood Initiatives) which works with a large network of grassroots organisations to promote agriculture-based tribal livelihoods. Similarly, Arghyam, a public charitable foundation set up by the Nilekanis is working with a large network of NGOs and CSOs in the hill districts of India (Cluster #09) on an initiative to revive Springs. Partnerships between PMKSY and such institutions can leverage useful synergies with their programs.

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ANNEXURE A1: Clustering of Districts

With its diverse geography, hydrogeology and socio-economic conditions, different parts of the country face different problems in sustainably accessing water resources for productive uses in agriculture. This means that a '*one-size-fit-all*' design cannot work for any nationwide program. Based on data from the 9th Agricultural Census (2010-11) and the Minor Irrigation Census (2006-07), we have compiled a list of 590 districts and divided them into 12 clusters as shows in Table A.1.

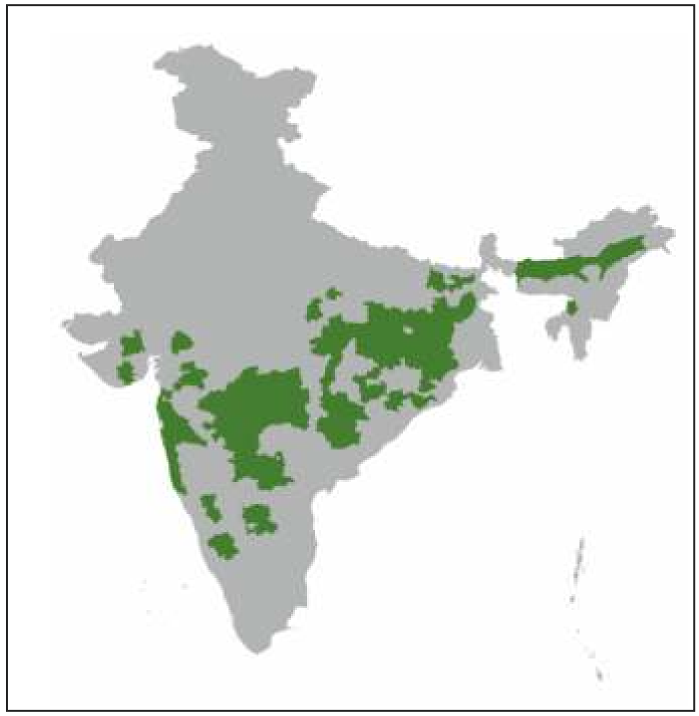
Table A.1: Clustering of Districts for PMKSY Interventions

Geographies	Defining aspect	Number of Districts
Cluster #01	Groundwater surplus districts with high share of farm holdings without any source of Type I or Type II irrigation	112
Cluster #02	Groundwater-surplus districts where Type II irrigation is constrained by high energy cost	36
Cluster #03	Groundwater surplus districts where Type II irrigation is constrained by inadequate electricity supply	24
Cluster #04	Groundwater-deficit alluvial districts where Type II irrigation will further deplete aquifers	103
Cluster #05	Groundwater deficit hard-rock districts with excessive groundwater depletion (dark or over-exploited zones)	27
Cluster #06	Districts with dense network of MMM systems and large canal irrigation areas	114
Cluster #07	Districts with high density of irrigation tanks, check-dams, and water harvesting structures	161
Cluster #08	Districts with Class I or II towns	-
Cluster #09	Hill districts, mostly in Himalayas, where agro-climatic conditions are not conducive for conventional irrigation	100
Cluster #10	Districts with high irrigation incidence and high agricultural productivity	54
Cluster #11	Districts with high irrigation incidence and low agricultural productivity	41
Cluster #12	Urban and UT districts with little agriculture and missing or patchy data	25

Each cluster represents a set of districts that exhibit a particular characteristic. In this section, we explain how we have identified districts in each cluster.

Cluster #01: Most Deprived, Groundwater Surplus Districts (112)

Figure A.1: Cluster #01 (112 Districts)

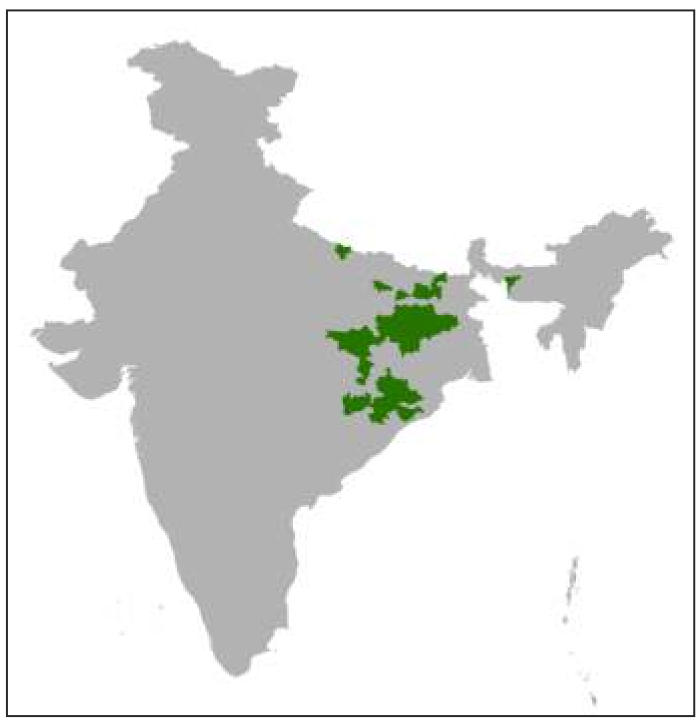


The agricultural census (2010-11) provides data on irrigated and unirrigated holdings in each district. From the 590 districts in the country, we first picked out the 192 most irrigation deprived districts, i.e. districts which have the least proportion of holdings with access to any irrigation – Type I or Type II. Among these districts, none have more than 30 per cent of their holdings as irrigated.

Since hill ecosystems might not be conducive for conventional irrigation development programs, we decided to separate them into a different cluster (see Cluster #09). A few others among the 192 were urban districts, islands or union territories that have limited agriculture and patchy or missing data (Cluster #12). After removing these, we arrived at 126 most irrigation deprived districts. Of the 126, we further excluded 14 districts where groundwater development is already more than 80 per cent and where further development of groundwater-based irrigation would lead to depletion. The remaining 112 districts form this cluster as "most irrigation-deprived, groundwater surplus districts".

Cluster #02: Groundwater Surplus; High Pump Density; Type II Irrigation Constrained by High Energy Cost (36)

Figure A.2: Cluster #02 (36 Districts)



Much of the irrigation-deprived districts in Cluster #01 have sparse irrigation infrastructure. However, there are also districts that have abundant groundwater and relatively high density of groundwater structures but little Type II irrigation. Irrigation development in these districts is constrained not by physical resource scarcity but by the high cost of energy. One would expect to find such districts in eastern India where rural electricity grids are often missing and farmers are forced to rely on expensive diesel to operate their irrigation pumps.

For reasons discussed above, we excluded Cluster #09 and Cluster #12 districts from the 590 district dataset; we then selected districts that have more than 12 groundwater structures per 100 hectares of NSA (national average: 14); less than 20 per cent electric pumps; and less than 50 per cent irrigated farm holdings. The cluster of 36 districts thus formed is Cluster #02. The districts in this cluster can benefit most through interventions that ensure a reasonably priced and reliable energy source for irrigation.

Cluster #03: Groundwater Surplus; High Pump Density; Type II Irrigation Constrained by Inadequate Electricity Supply (24)

Like in the case of Cluster #02, there are districts in peninsular India that have high density of groundwater structures and the potential to further develop groundwater (Type II) irrigation but less than 50 per cent of their farm holdings are irrigated. These districts are constrained due to inadequate hours of electricity supply or due to the poor and erratic farm power delivery regime.

As earlier, we begin by removing mountain and urban districts (Clusters #09 and #12) . We then selected districts that have more than 12 groundwater structures per 100 hectares of NSA); more than 80 per cent electric pumps; and less than 50 per cent irrigated farm holdings. The cluster of 24 districts thus formed is Cluster #03. These districts would immensely benefit if the rural power supply environment was to improve or if they had access to better quality and quantity of farm power.

Figure A.3: Cluster #03 (24 Districts)

Cluster #04: Groundwater Deficit Alluvial Districts (103)

Several districts in the western Indo-Gangetic basin are using deep, fossil groundwater. These districts are characterised by low to medium rainfall, free or highly subsidized farm power supply, moderate to high density of deep tubewells and negative or near-negative groundwater balance.

As earlier, we begin by removing mountain and urban districts (Clusters #09 and #12) . We then selected districts that have more than 80 per cent groundwater development. From these, we select alluvial districts in the north and north-western states of Punjab, Haryana, western UP, Rajasthan, MP and Gujarat. The cluster of 103 districts so formed is Cluster #04. Any Type II irrigation development in these districts will lead to further groundwater depletion. Thus, the focus of interventions here needs to be on improving water use efficiency and making groundwater irrigation more sustainable.

Figure A.4: Cluster #04 (103 Districts)

Cluster #05: Groundwater Deficit hard-rock Districts (27)

Like in Cluster #04, there are similarly characterised districts in hard-rock districts of peninsular India too that have negative groundwater balance.

As earlier, we begin by removing mountain and urban districts (Clusters #09 and #12) . We then select districts that have more than 80 per cent groundwater development. From these, we select hard rock districts in the peninsular Indian states of Maharashtra, Andhra Pradesh, Karnataka and Tamil Nadu. The cluster of 27 districts so formed is Cluster #05. The focus of interventions here too needs to be sustainable groundwater management.

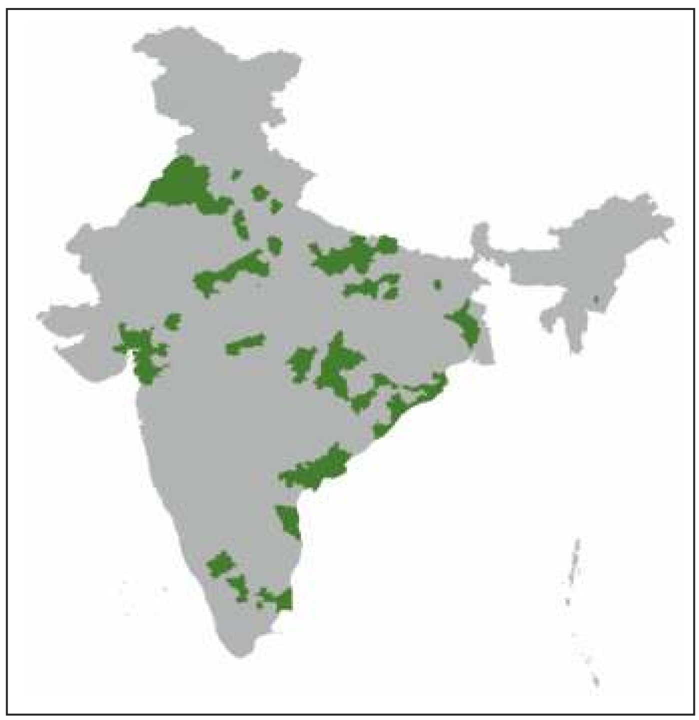
Figure A.5: Cluster #05 (27 Districts)

Cluster #06: Districts with Dense MMM Network (114)

As we discussed, much of India's public irrigation investments have gone in creating Type I irrigation infrastructure. Type I irrigation is concentrated in small pockets of canal command area and there are very few districts outside Punjab and Haryana where more than 50 per cent of the farm holdings receive canal irrigation.

In order to capture districts with dense network of MMM network, we begin by removing mountain and urban districts (Clusters #09 and #12). We then select districts that have more than 20 per cent farm holdings receiving canal irrigation. The cluster of 114 districts thus formed is Cluster #06. These districts have immense scope for improving the gap between IPC and IPU as well as interventions that would improve conjunctive management of surface and groundwater resources.

Figure A.6: Cluster #06 (114 Districts)

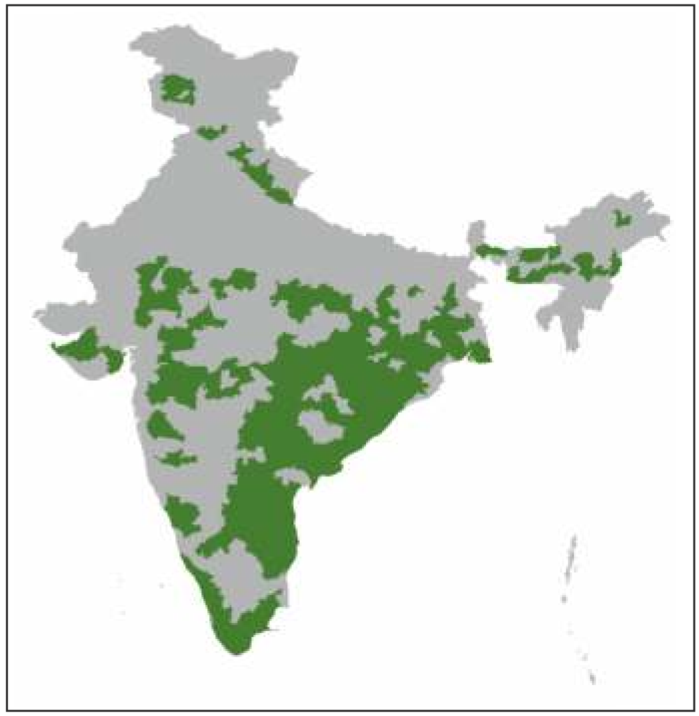


Cluster #07: Districts with High Density of Irrigation Tanks and WHS (161)

Peninsular India is well-known for its dense network of cascading irrigation tanks. The combined culturable command area (CCA) of India's irrigation tanks adds up to nearly 7 mha; of these, nearly 6 mha is concentrated in 150 districts.

As earlier, we begin by removing mountain and urban districts (Clusters #09 and #12). We then arranged the districts in descending order of tank CCA and selected the top 150 districts. To these, we added the districts of Kerala that were not already included in the top 150. We did so because Kerala has a dense network of multi-purpose ponds and village water bodies that are not designated specifically for irrigation. The cluster of 161 districts thus formed is Cluster #07. These districts have immense potential for interventions to improve tank-groundwater conjunctive management.

Figure A.7: Cluster #07 (161 Districts)

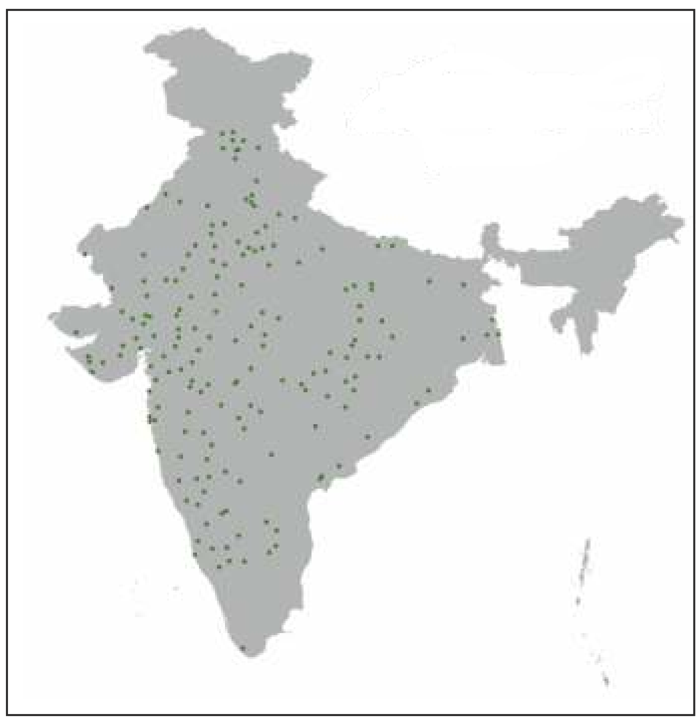


Cluster #08: Districts with Class I and II Towns

India already has more than 50 million+ cities and rapidly urbanizing. As villages become towns; and towns turn into cities, India's wastewater generation – already estimated to be around 15 BCM will continue to grow. Wastewater irrigation is already happening by default on a large scale and millions of farmers are benefitting from nutrient-rich, reliable supplies. With minimal, smart investments, it is possible to convert municipal wastewater into a nutrient-rich, year-round reliable source of irrigation for peri-urban farms.

It is difficult to quantify the potential for wastewater irrigation at the district level; hence, we do not define Cluster #08 by selecting specific districts.

Figure A.8: Cluster #08 Districts having potential for WW use (175)

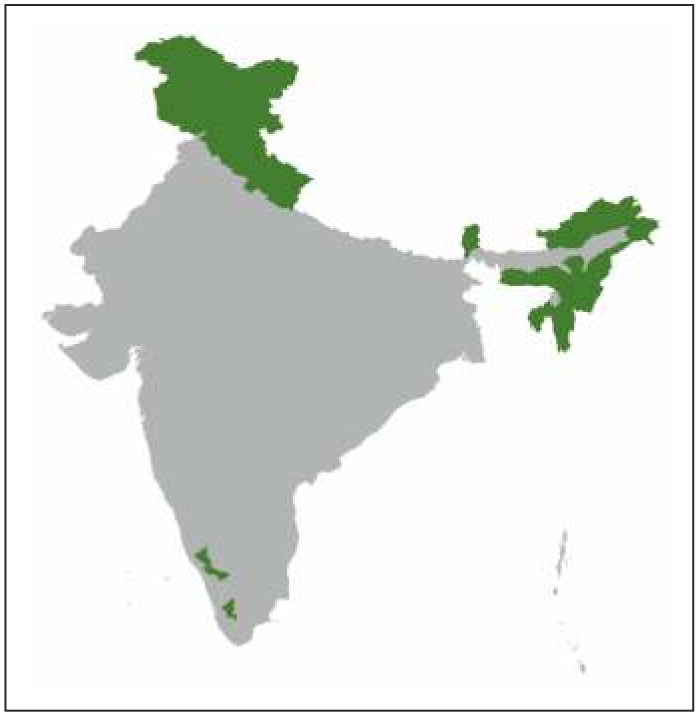


Cluster #09: Hill Districts in Eastern and Western Himalayas (100)

India's mountain geographies have a unique agro-ecosystem characterised by traditional water management practices, decentralized water harvesting, diversion-based irrigation and community management of land and water resources including springs and water bodies. These regions, especially in eastern and peninsular India have high value plantation agriculture that is mostly dependent on rain water but requires some irrigation in critical moisture stress period.

We identify the districts in this cluster by including the entire hill states of Jammu & Kashmir, Himachal Pradesh, Uttarakhand, Sikkim, Arunachal Pradesh, Manipur, Meghalaya, Mizoram, Nagaland and Tripura. To these, we add 3 hill districts in Assam (Chachr, N.C Hills and Karbi Anglong), Darjeeling (West Bengal), Idukki and Wayanad (Kerala) and Coorg (Karnataka). The cluster of 100 districts thus formed is Cluster #09.

Figure A.9: Cluster #09 (100 Districts)

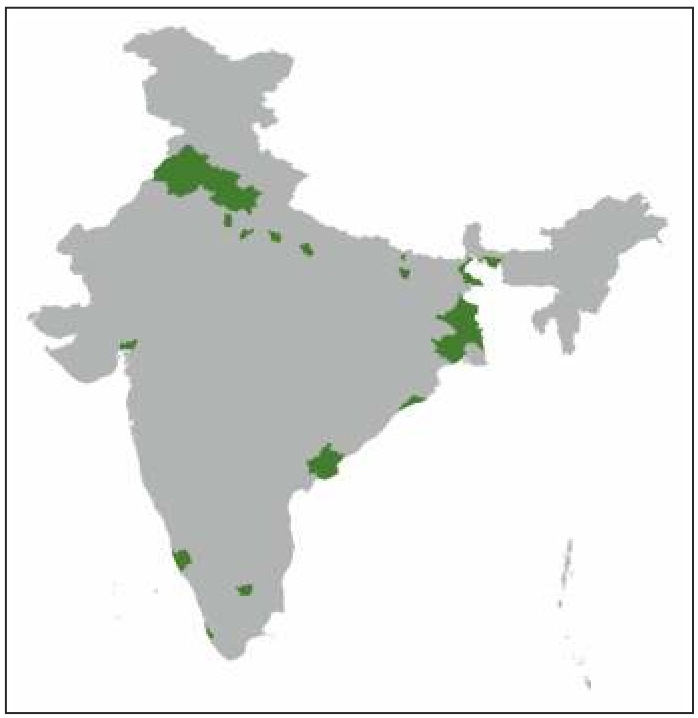


Cluster #10: Districts with High Irrigation Incidence and High Productivity (54)

Taking Type I and Type II irrigation together, there are only about 150 districts in India where more than 70 per cent of the farm holdings are irrigated.

We define Cluster #10 as the group of 54 such districts where more than 70 per cent farm holdings are irrigated and where agricultural productivity per hectare exceeds ₹ 50,000 (national average: ₹ 27,522).

Figure A.10: Cluster #10 (54 Districts)

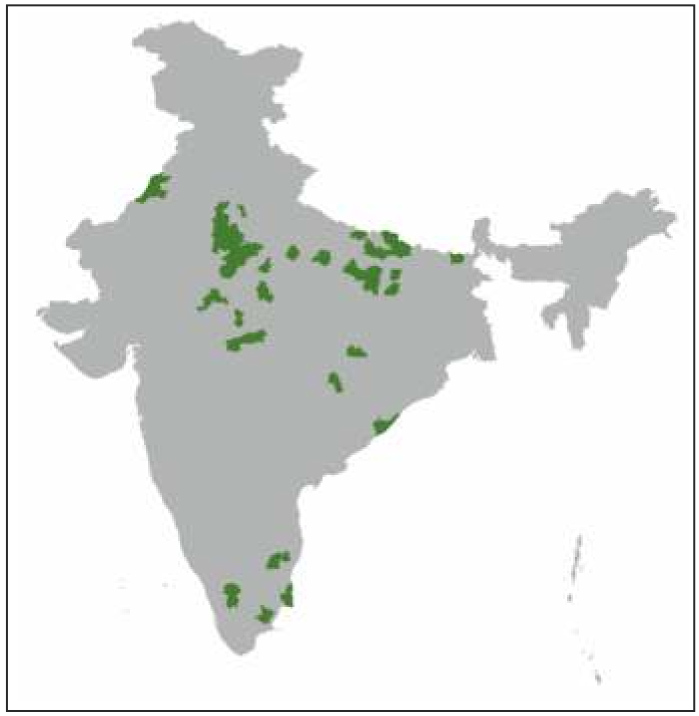


Cluster #11: Districts with High Irrigation Incidence but Low Productivity (41)

Similarly, there are about 40 districts where agricultural productivity per hectare is low despite high incidence of irrigation. These districts are unlikely to improve their agricultural productivity by adding more farm holdings under irrigation but may benefit from other development programs.

Like in Cluster #10, for Cluster #11, we select districts with more than 70 per cent irrigated farm holdings but agricultural productivity per hectare less than ₹ 30,000 (national average: ₹ 27,522).

Figure A.11: Cluster #11 (41 Districts)



Cluster #12: Urban and UT Districts (25)

Finally, we classify 25 urban districts, islands and union territories under Cluster #12. These districts have little or no agriculture and agriculture and irrigation data for these districts is either missing or very patchy.

Comparison across Clusters

Table A.2: Comparison across 10 main district clusters

Parameter	Cluster #01	Cluster #02	Cluster #03	Cluster #04	Cluster #05	Cluster #06	Cluster #07	Cluster #09	Cluster #10	Cluster #11
Clustering Criteria	Irr_H < 30% ≠ Cluster #09 ≠ Cluster #12	Irr_H < 50% GW_Devt < 80% Elec_W < 20% GWS/NSA > 0.12 ≠ Cluster #09 ≠ Cluster #12	Irr_H < 50% GW_Devt < 80% Elec_W > 80% GWS/NSA > 0.12 ≠ Cluster #09 ≠ Cluster #12	Alluvial aquifer GW_Devt ≥ 80% ≠ Cluster #09 ≠ Cluster #12	Hard rock aquifer GW_Devt ≥ 80% ≠ Cluster #09 ≠ Cluster #12	C_Irr_H ≥ 20% ≠ Cluster #09 ≠ Cluster #12	Top 150 T_CCA + Kerala districts ≠ Cluster #12	Hill states + Hill districts ≠ Cluster #09 ≠ Cluster #12	Irr_H ≥ 70% Prod_Ha ≥ 50,000 ≠ Cluster #09 ≠ Cluster #12	Irr_H ≥ 70% Prod_Ha ≤ 30,000 ≠ Cluster #09 ≠ Cluster #12
Number of Districts	112	36	24	103	27	114	161	100	54	41
Number of Holdings	26.85 m	8.02 m	10.89 m	18.95 m	9.21 m	29.72 m	49.84 m	5.17 m	12.62 m	11.58 m
Net Sown Area (million hectares)	30.57 mha	4.31 mha	11.90 mha	35.57 mha	9.42 mha	29.94 mha	45.67 mha	4.26 mha	12.62 mha	9.44 mha
Percentage Irrigated Holdings	15.35%	28.24%	32.09%	70.39%	46.02%	72.22%	47.30%	39.79%	83.89%	80.41%
Percentage Irrigated Area	11.55%	17.71%	23.08%	53.43%	33.91%	66.71%	32.66%	19.52%	84.40%	74.81%
Percentage Canal Irrigated Holdings	4.05%	5.85%	7.43%	13.86%	8.98%	36.76%	13.17%	12.75%	20.61%	26.95%
Percentage Canal Irrigated Area	3.32%	5.05%	5.43%	10.98%	7.15%	34.17%	9.58%	5.59%	22.39%	28.19%
Level of Groundwater Development	0.32	0.39	0.60	1.31	0.99	0.67	0.45	0.16	0.99	0.62
Total Tank Irrigation CCA	1.76 mha	0.45 mha	0.57 mha	0.24 mha	0.41 mha	1.35 mha	5.98 mha	0.87 mha	0.18 mha	0.36 mha
Agricultural Productivity (Rs/Ha)	Rs. 19,160	Rs. 27,273	Rs. 21,674	Rs. 27,368	Rs. 28,965	Rs. 37,376	Rs. 28,030	Rs. 39.670	Rs. 64,153	Rs. 24,705
Number of Groundwater Structures	2.73 m	0.79 m	2.16 m	5.39 m	2.37 m	4.51 m	6.79 m	0.07 m	2.46 m	1.68 m
Groundwater Structures per 100 Ha of Net Sown Area	8.94	18.35	18.18	15.15	25.12	15.07	14.86	1.75	19.50	17.83

Abbreviations

Irr_H — Percentage irrigated holdings [Source: 9th Agricultural Census 2010-11]

Irr_A — Percentage irrigated area [Source: 9th Agricultural Census 2010-11]

C_Irr_H — Percentage canal irrigated holdings [Source: 9th Agricultural Census 2010-11]

C_Irr_A — Percentage canal irrigated area [Source: 9th Agricultural Census 2010-11

GW_Devt — Level of Groundwater Development [Source: CGWB]

T_CCA — Culturable Command Area of Irrigation Tanks [Source: 4th Minor Irrigation Census]

Prod_Ha — Agricultural Productivity per Hectare [Source: Chand *et al.* 2011]

Elec_W — Percentage Electric Wells and Tubewells [Source: 4th Minor Irrigation Census]

Diesel_W — Percentage Diesel Wells and Tubewells [Source: 4th Minor Irrigation Census]

Oth_W — Percentage Other Wells and Tubewells [Source: 4th Minor Irrigation Census]

NSA — Net Sown Area [Source: 9th Agricultural Census 2010-11]

kWh-equiv — Energy Consumption measured in kilo-watt-hour equivalent units [Source: 4th Minor Irrigation Census]

GWS — Number of Groundwater Structures [Source: 4th Minor Irrigation Census]

ANNEXURE A2: District-wise Database

Table A.3: District-wise database with key variables used for clustering of districts

State	District	S_No	Clusters	Irr_H	Irr_A	GW_Devt	T_CCA	Prod_Ha	Elec_W	NSA	kWh-equiv.	GWS
ANDHRA PRADESH	ADILABAD	1	1 and 7	0.17	0.11	0.36	23495	19436	0.95	582886	155778909	45761
ANDHRA PRADESH	ANANTPUR	2	1 and 7	0.20	0.13	0.79	30250	16477	0.83	1101744	290498899	111566
ANDHRA PRADESH	CHITTOOR	3	3 and 7	0.38	0.28	0.71	71641	32794	0.84	379268	527253526	179536
ANDHRA PRADESH	CUDDAPAH	4	7	0.43	0.28	0.59	14894	28315	0.76	403320	472208189	89758
ANDHRA PRADESH	E.GODAVARI	5	6, 7 and 10	0.73	0.62	0.25	47093	61517	0.73	419909	159764064	35280
ANDHRA PRADESH	GUNTUR	6	6	0.67	0.62	0.19	6180	54937	0.77	637963	91566517	48013
ANDHRA PRADESH	HYDERABAD	7	12			0.00	0			0	0	0
ANDHRA PRADESH	KARIMNAGAR	8	6 and 7	0.69	0.66	0.64	41542	34577	0.99	511714	351707445	234948
ANDHRA PRADESH	KHAMMAM	9	7	0.51	0.42	0.29	62902	36108	0.91	479345	219630963	62864
ANDHRA PRADESH	KRISHNA	10	6 and 7	0.76	0.67	0.36	39022	44069	0.88	469737	117823535	49153
ANDHRA PRADESH	KURNOOL	11	7	0.31	0.22	0.28	17902	22115	0.90	889427	175934560	61449
ANDHRA PRADESH	MAHBUBNAGAR	12	1, 3 and 7	0.28	0.23	0.45	19191	15704	0.81	830805	742973757	179726
ANDHRA PRADESH	MEDAK	13	5 and 7	0.35	0.26	0.83	38706	24232	0.95	451668	889068717	148590
ANDHRA PRADESH	NALGONDA	14	3 and 7	0.49	0.35	0.59	37194	26876	0.98	562410	1159383602	185995
ANDHRA PRADESH	NELLORE	15	6 and 7	0.76	0.59	0.27	97871	37897	0.89	309347	286327405	79476
ANDHRA PRADESH	NIZAMABAD	16	6 and 7	0.60	0.53	0.69	40433	42167	0.99	672970	640606368	138583
ANDHRA PRADESH	PRAKASAM	17	3 and 7	0.32	0.24	0.28	45763	28885	0.91	236138	244607048	77642
ANDHRA PRADESH	RANGAREDDI	18	1 and 3	0.27	0.16	0.70	6885	27508	0.93	367339	233603355	78702
ANDHRA PRADESH	SRIKAKULAM	19	6, 7 and 11	0.74	0.66	0.25	94333	28711	0.28	314282	41870851	45987
ANDHRA PRADESH	VISAKHAPATNAM	20	6 and 7	0.67	0.43	0.22	95699	31855	0.55	302535	65554173	36934
ANDHRA PRADESH	VIZIANAGARAM	21	7	0.64	0.45	0.19	103632	31851	0.36	295740	58363060	44686
ANDHRA PRADESH	WARANGAL	22	7	0.63	0.53	0.62	95848	33895	0.92	528164	578655279	207761
ANDHRA PRADESH	W.GODAVARI	23	6, 7 and 10	0.93	0.90	0.36	41670	64600	0.94	439756	604723864	57141
ANDMAN & NIKOBAR	ANDAMAN	24	12	0.00	0.00	0.04	208		0.12	14067	0	1278
ANDMAN & NIKOBAR	NICOBARS	25	12	0.01	0.00	0.00	0		0.01	463	0	94
ARUNACHAL	CHANGLANG	26	9	0.30	0.08	0.00	3363	18945	0.00	27640	27800	6
ARUNACHAL	DIBANGVALLEY	27	9	0.48	0.10	0.00	5263		1.00	6340	189600	10
ARUNACHAL	EASTKAMENG	28	9	0.21	0.04	0.00	851	15396		5894	0	0
ARUNACHAL	EASTSIANG	29	7 and 9	0.56	0.23	0.00	22019	18702		21538	12667	0
ARUNACHAL	LOHIT	30	9	0.26	0.11	0.00	7970	33754	0.07	16214	62500	15
ARUNACHAL	LOWERSUBANSIRI	31	9	0.70	0.28	0.00	6809	13767		22422	0	0
ARUNACHAL	PARUMPARE	32	9	0.73	0.27	0.01	11310	31194		13685	0	0
ARUNACHAL	TAWANG	33	9	0.12	0.08	0.00	821	25485		3185	1500	0
ARUNACHAL	TIRAP	34	9	0.02	0.02	0.00	2643	8196	0.25	15227	16800	4
ARUNACHAL	UPPERSIANG	35	9	0.39	0.11	0.00	9380	16159		9435	1500	0
ARUNACHAL	UPPERSUBANSIRI	36	9	0.24	0.04	0.00	3772	14431		15573	1500	0
ARUNACHAL	WESTKAMEND	37	9	0.12	0.03	0.00	1211	16008		6061	1500	0

State	District	S_No	Clusters	Irr_H	Irr_A	GW_Devt	T_CCA	Prod_Ha	Elec_W	NSA	kWh-equiv.	GWS
ARUNACHAL	WESTSIANG	38	9	0.58	0.21	0.00	9269	9969		22296	4600	0
ASSAM	BARPETA	39	1 and 7	0.06	0.04	0.31	16415	25073	0.00	331720	31274809	17939
ASSAM	BONGAIGAON	40	1 and 7	0.05	0.06	0.11	14681	24856	0.00	67635	7376157	5808
ASSAM	CACHAR	41	9	0.03	0.04	0.05	805	29728	0.00	115386	479356	12
ASSAM	DARRANG	42	1 and 7	0.19	0.19	0.18	36372	23248	0.00	103833	23541919	8938
ASSAM	DHEMAJI	43	1	0.03	0.02	0.03	0	20099	0.00	67506	1705051	1493
ASSAM	DHUBRI	44	1 and 2	0.18	0.11	0.46	1439	23955	0.00	134349	36678290	17120
ASSAM	DIBRUGARH	45	1	0.01	0.08	0.12	0	24931	0.00	139498	8209826	5056
ASSAM	GOALPARA	46	1	0.01	0.01	0.16	8923	26513	0.00	80753	12473664	5220
ASSAM	GOLAGHAT	47	1	0.03	0.05	0.06	198	33595	0.02	119046	3614451	1927
ASSAM	HAILAKANDI	48	1	0.00	0.02	0.06	4	34515	0.00	50294	302911	12
ASSAM	JORHAT	49	1	0.02	0.02	0.07	2314	29632	0.02	120240	4348220	2435
ASSAM	KAMRUP	50	1	0.03	0.02	0.23	7661	25674	0.00	199721	17210421	9599
ASSAM	KARBI ANGLONG	51	7 and 9	0.00	0.00	0.06	28631	24433	0.00	126399	172665	46
ASSAM	KARIMGANJ	52	1	0.01	0.01	0.06	465	29037	0.00	76035	376570	61
ASSAM	KOKRAJHAR	53	1	0.02	0.01	0.04	3897	25176	0.00	86556	2448748	1769
ASSAM	LAKHIMPUR	54	1	0.11	0.09	0.05	720	22188	0.01	100169	2365404	1730
ASSAM	MARIGAON	55	1	0.19	0.18	0.25	2302	19645	0.00	92011	12649608	5219
ASSAM	NAGAON	56	1	0.06	0.04	0.23	1297	31306	0.00	235626	973424	12069
ASSAM	NORTH CACHER HILS	57	9	0.00	0.00	0.13	1970	43726		28171	13500	0
ASSAM	SIBSAGAR	58	1	0.01	0.02	0.07	226	26683	0.01	136822	3007319	2584
ASSAM	SONITPUR	59	1	0.01	0.07	0.06	4613	26405	0.02	165141	3932881	2461
ASSAM	TINSUKIA	60	1	0.01	0.00	0.07	0	27805	0.01	104714	4801844	2814
BIHAR	ARARIA	61	11	0.86	0.86	0.34	0	17399	0.00	200463	20556605	6762
BIHAR	AURANGABAD_B	62	6, 7 and 11	0.80	0.78	0.24	40491	25023	0.00	218187	25078657	12312
BIHAR	BANKA	63	None	0.57	0.39	0.37	5412	22787	0.00	82295	8653126	8021
BIHAR	BEGUSARAI	64	1 and 2	0.24	0.16	0.62	0	41743	0.00	61813	42326596	14757
BIHAR	BHAGALPUR	65	None	0.54	0.45	0.34	16	30944	0.00	128271	19175512	11828
BIHAR	BHOJPUR	66	6 and 11	0.73	0.74	0.45	60	23144	0.00	167554	48227880	23675
BIHAR	BUXAR	67	6	0.64	0.65	0.36	0	23632	0.00	108733	21418742	18723
BIHAR	DARBHANGA	68	1	0.03	0.05	0.52	0	33639	0.00	165534	15965589	10776
BIHAR	GAYA	69	2	0.41	0.39	0.49	11539	20364	0.00	218143	56434505	27048
BIHAR	GOPALGANJ	70	11	0.83	0.76	0.58	1220	26178	0.00	128165	46626622	38689
BIHAR	JAMUI	71	1 and 2	0.21	0.23	0.39	5914	17640	0.00	157927	16908704	24714
BIHAR	JEHANABAD	72	None	0.52	0.45	0.58	230	23288	0.00	55496	36770523	8222
BIHAR	KAIMPUR	73	6 and 11	0.74	0.78	0.32	5901	28537	0.00	148355	40428923	20999
BIHAR	KATIHAR	74	None	0.55	0.61	0.55	0	35215	0.00	168457	42904404	19653
BIHAR	KHAGARIA	75	1 and 2	0.26	0.32	0.46	30	39959	0.00	95364	25574876	24886
BIHAR	KISHANGANJ	76	None	0.45	0.29	0.28	0		0.00	97578	15630917	7621
BIHAR	LAKHISARAI	77	None	0.41	0.38	0.43	4	16776	0.00	60394	11373126	6887
BIHAR	MADHEPURA	78	1	0.17	0.19	0.57	0	42908	0.00	114651	29267432	6645

State	District	S_No	Clusters	Irr_H	Irr_A	GW_Devt	T_CCA	Prod_Ha	Elec_W	NSA	kWh-equiv.	GWS
BIHAR	MADHUBANI	79	6	0.38	0.29	0.34	1009	18270	0.00	219100	22838098	12879
BIHAR	MUNGER	80	6	0.55	0.48	0.29	3869	36570	0.00	24092	14254406	17885
BIHAR	MUZAFFARPUR	81	None	0.63	0.54	0.56	0	41428	0.00	167607	44043742	8400
BIHAR	NALANDA	82	None	0.96	0.93	0.66	102	33303	0.00	175156	77881696	35341
BIHAR	NAWADA	83	2 and 7	0.49	0.39	0.43	18273	27160	0.00	92547	36623298	35119
BIHAR	PASCHIM CHAMPARAN	84	6 and 11	0.83	0.76	0.27	2398	25112	0.00	296091	24082934	16823
BIHAR	PATNA	85	2	0.38	0.30	0.55	3735	32367	0.00	237096	76210821	29930
BIHAR	PURAB CHAMPARAN	86	11	0.71	0.56	0.42	4	23708	0.00	269815	0	24322
BIHAR	PURNIA	87	1	0.03	0.08	0.47	0	24008	0.00	183564	52476102	12627
BIHAR	ROHTAS	88	None	0.42	0.46	0.35	901	32321	0.00	232944	45171704	5829
BIHAR	SAHARSA	89	2	0.31	0.33	0.38	72	40025	0.00	101847	12607737	31899
BIHAR	SAMASTIPUR	90	1 and 2	0.13	0.08	0.53	24	30554	0.00	163783	76232056	29505
BIHAR	SARAN	91	None	0.60	0.57	0.56	339	26790	0.00	144374	58873733	4115
BIHAR	SHEIKHPURA	92	None	0.59	0.57	0.54	725		0.00	44628	9594267	3988
BIHAR	SHEOHAR	93	10	0.78	0.69	0.60	0	55682	0.00	28819	6058113	10490
BIHAR	SITAMARHI	94	None	0.53	0.45	0.46	1	33042	0.00	107318	20705998	26857
BIHAR	SIWAN	95	None	0.47	0.45	0.59	189	21261	0.00	126719	48813033	9405
BIHAR	SUPAUL	96	2	0.49	0.45	0.36	0	22631	0.00	113090	25866546	26933
BIHAR	VAISHALI	97	10	0.73	0.57	0.57	384	53003	0.00	112096	35702524	16677
CHANDIGARH	CHANDIGARH	98	12	0.98	0.97	0.00	0		0.90	892	0	91
CHHATTISGARH	BASTAR	99	1 and 7	0.04	0.02	0.10	17518	11970	0.21	343599	10120872	6717
CHHATTISGARH	BILASPUR_C	100	6 and 7	0.43	0.39	0.47	20270	23524	0.36	368325	4986523	28097
CHHATTISGARH	DANTEWADA	101	1	0.03	0.01	0.04	6289	9017	0.10	278112	2151116	1108
CHHATTISGARH	DHAMTARI	102	6 and 11	0.79	0.72	0.78	1082	26627	0.64	137551	1068623	16883
CHHATTISGARH	DURG	103	6 and 7	0.46	0.44	0.69	19764	22068	0.67	555880	56494509	27210
CHHATTISGARH	JANJGIR-CHAMPA	104	6, 7 and 11	0.83	0.81	0.42	44644	15406	0.21	260652	90502599	27741
CHHATTISGARH	JASHPUR	105	1	0.10	0.02	0.35	8102	11108	0.02	253755	30873198	29017
CHHATTISGARH	KANKER	106	1	0.24	0.31	0.21	7096	16349	0.28	193013	22794859	8927
CHHATTISGARH	KAWARDHA	107	1 and 7	0.12	0.06	0.66	16892	11358	0.71	209808	18620940	5748
CHHATTISGARH	KORBA	108	1 and 7	0.07	0.05	0.32	170052	15900	0.08	135498	13227032	8088
CHHATTISGARH	KORIYA	109	1 and 2	0.17	0.03	0.23	9969	15071	0.09	103526	8310896	19439
CHHATTISGARH	MAHASAMUND	110	1 and 7	0.25	0.25	0.47	16007	13277	0.54	268824	10618580	10155
CHHATTISGARH	RAIGARH_C	111	1, 2 and 7	0.15	0.12	0.53	63469	16094	0.15	271620	38548847	40774
CHHATTISGARH	RAIPUR	112	6 and 7	0.57	0.53	0.43	20065	13247	0.44	539823	1519627	27722
CHHATTISGARH	RAJNANDGAON	113	1 and 7	0.25	0.22	0.58	17220	13334	0.62	370899	88862500	10831
CHHATTISGARH	SURGUJA	114	1, 2 and 7	0.18	0.07	0.26	12410	14244	0.15	461916	63597983	63833
DADRA & NAGAR HAVELI	DADRA AND NAGAR HAVELI	115	12	0.07	0.08	0.22	15		0.82	19882	25446162	645
DAMAN AND DIU	DAMAN	116	12	0.00	0.00	0.89	0			2226	94231052	
DAMAN AND DIU	DIU	117	12	0.05	0.03	1.17	0			50	0	
DELHI	CENTRAL	118	12			0.84	0			0	0	
DELHI	EAST_D	119	12			1.79	0		0.00	0	0	277

State	District	S_No	Clusters	Irr_H	Irr_A	GW_Devt	T_CCA	Prod_Ha	Elec_W	NSA	kWh-equiv.	GWS
DELHI	NEW DELHI	120	12	0.01	0.17	0.90	0			0	0	
DELHI	NORTH EAST	121	12	0.01	0.02	0.89	0		0.43	177	0	54
DELHI	NORTH WEST	122	12	0.81	0.79	1.12	0		0.92	10300	20634251	4422
DELHI	SOUTH WEST	123	12	0.85	0.80	1.40	0		0.95	10756	7189341	3923
DELHI	SOUTH_D	124	12	0.93	0.69	1.95	17		0.99	736	1854886	765
DELHI	WEST_D	125	12	0.92	0.87	1.53	71		0.99	1264	735855	383
GOA	NORTH GOA	126	12	0.52	0.41	0.30	2102		0.58	50179	4304818	2995
GOA	SOUTH GOA	127	12	0.51	0.39	0.26	1628		0.69	37035	3420933	1428
GUJARAT	AHMEDABAD	128	6	0.51	0.46	0.78	2602	19301	0.40	573474	72613353	18946
GUJARAT	AMRELI	129	1	0.25	0.26	0.64	1648	24327	0.47	548597	206447136	72755
GUJARAT	ANAND	130	10	0.85	0.81	0.52	0	50857	0.88	207559	52673799	8599
GUJARAT	BANASKANTHA	131	4	0.59	0.52	1.07	3845	27577	0.61	735875	1070928968	79019
GUJARAT	BHARUCH	132	6	0.40	0.35	0.47	60	32827	0.73	277935	27116359	6216
GUJARAT	BHAVNAGAR	133	7	0.39	0.35	0.64	14324	28001	0.54	511824	209858292	84919
GUJARAT	DAHOD	134	1 and 7	0.10	0.06	0.50	35165	14933	0.00	208679	38033786	36165
GUJARAT	GANDHINAGAR	135	4	0.72	0.72	1.20	0	31739	0.99	157718	133907073	8634
GUJARAT	JAMNAGAR	136	7	0.36	0.37	0.64	41189	32233	0.76	619935	302854780	97437
GUJARAT	JUNAGAD	137	None	0.45	0.42	0.62	3840	44403	0.79	506583	320072232	144510
GUJARAT	KACHCHH	138	None	0.31	0.32	0.79	1855	17569	0.78	788947	157672834	28741
GUJARAT	KHEDA	139	6	0.69	0.68	0.64	377	29243	0.67	288172	94130611	27119
GUJARAT	MAHESANA	140	4	0.60	0.56	1.16	3634	26424	0.91	325450	256617218	19589
GUJARAT	NARMADA	141	None	0.34	0.34	0.30	1597	37723	0.28	117966	15122193	4900
GUJARAT	NAVSARI	142	6	0.47	0.48	0.48	0	52950	0.70	134651	21772043	20609
GUJARAT	PANCH MAHALS	143	1	0.15	0.12	0.41	1384	11538	0.26	299229	46974971	42295
GUJARAT	PATAN	144	4	0.46	0.36	1.22	1423	14263	1.00	373832	89138208	6807
GUJARAT	PORBANDAR	145	3	0.45	0.42	0.72	5923	34721	0.89	129075	42940163	27881
GUJARAT	RAJKOT	146	7	0.41	0.41	0.65	94572	38607	0.43	711268	484783985	152838
GUJARAT	SABARKANTHA	147	7	0.53	0.55	0.73	14831	23600	0.83	427223	306990128	95581
GUJARAT	SURAT	148	6	0.69	0.64	0.45	0	62395	0.98	364280	74921361	37329
GUJARAT	SURENDRANAGAR	149	1	0.18	0.18	0.60	745	21618	0.47	697822	234053963	53091
GUJARAT	THE DANGS	150	1	0.03	0.02	0.17	5	11759	0.00	44174	2202733	1519
GUJARAT	VADODARA	151	6	0.64	0.61	0.54	7863	25405	0.44	460243	156074143	29862
GUJARAT	VALSAD	152	1	0.24	0.24	0.42	0	31832	0.64	146646	11076735	12974
HARYANA	AMBALA	153	4 and 10	0.80	0.81	0.86	0	54168	0.00	102267	123910200	19041
HARYANA	BHIWANI	154	4 and 6	0.90	0.87	1.15	72	32936	0.62	391765	193629055	27475
HARYANA	FARIDABAD	155	4, 6 and 10	0.83	0.75	0.89	12	53120	0.01	168266	249570211	32482
HARYANA	FATEHABAD	156	4, 6 and 10	1.00	1.00	1.74	0	61787	0.00	202316	169833600	22124
HARYANA	GURGAON	157	4	1.00	1.00	2.26	0	39511	0.04	218891	37281955	11646
HARYANA	HISAR	158	4 and 6	0.99	0.97	0.94	0	49688	0.01	220405	139290000	23204
HARYANA	JHAJJAR	159	4, 6 and 11	0.99	0.99	1.00	0	29143	0.09	111217	117646576	20995
HARYANA	JIND	160	4	0.91	0.89	1.12	0	49691	0.01	148879	195172800	34590

State	District	S_No	Clusters	Irr_H	Irr_A	GW_Devt	T_CCA	Prod_Ha	Elec_W	NSA	kWh-equiv.	GWS
HARYANA	KAITHAL	161	4 and 10	0.96	0.95	2.14	0	53401	0.00	159372	206910000	36660
HARYANA	KARNAL	162	4 and 10	0.84	0.82	1.48	123	67825	0.00	191996	176073224	46801
HARYANA	KURUKSHETRA	163	4 and 10	1.00	1.00	2.20	0	69196	0.01	116805	262902000	32540
HARYANA	MAHENDRAGARH	164	4	0.84	0.82	1.02	0	30652	0.93	50294	130831660	20418
HARYANA	PANCHKULA	165	4	0.56	0.46	0.81	403	51350	0.03	17492	10279900	1934
HARYANA	PANIPAT	166	4, 6 and 10	0.89	0.86	1.63	0	64742	0.02	127098	75360600	19243
HARYANA	REWARI	167	4 and 11	0.72	0.74	1.13	28	26501	0.51	69680	72143224	19200
HARYANA	ROHTAK	168	6	1.00	1.00	0.70	0	35230	0.00	57035	87680400	13746
HARYANA	SIRSA	169	4, 6 and 10	1.00	1.00	1.76	0	54333	0.01	943638	218427200	27756
HARYANA	SONIPAT	170	4, 6 and 10	0.82	0.73	1.39	0	53740	0.08	205021	202069900	37487
HARYANA	YAMUNANAGAR	171	4, 6 and 10	0.88	0.88	1.38	0	65998	0.01	94658	114416400	20504
HIMACHAL	BILASPUR_H	172	9	0.14	0.06	0.00	2095	53740	0.89	33400	44975179	107
HIMACHAL	CHAMBA	173	9	0.17	0.09	0.00	3941	33030		43524	52500	0
HIMACHAL	HAMIRPUR_H	174	9	0.08	0.03	0.00	530	36719	0.91	37725	785412	175
HIMACHAL	KANGRA	175	7 and 9	0.38	0.18	0.49	30682	43128	0.88	114644	10934941	1095
HIMACHAL	KINNAUR	176	9	0.77	0.50	0.00	5787	97104		9986	0	0
HIMACHAL	KULLU	177	9	0.04	0.01	0.00	1971	102052	0.00	31912	89147	1
HIMACHAL	LAHUL AND SPITI	178	9	1.00	0.55	0.00	3579			3709	4500	0
HIMACHAL	MANDI	179	9	0.32	0.10	0.32	11641	44401	0.77	92297	219588	13
HIMACHAL	SHIMLA	180	7 and 9	0.09	0.03	0.00	15704			70772	33682	0
HIMACHAL	SIRMAUR	181	9	0.49	0.13	0.35	9542	78552	0.93	39169	3261585	619
HIMACHAL	SOLAN	182	9	0.51	0.12	0.55	6990	95329	0.89	34647	9751210	988
HIMACHAL	UNA	183	9	0.21	0.14	1.23	123	40568	0.75	36425	13300388	2083
JAMMU & KASHMIR	ANANTNAG	184	7 and 9	0.63	0.58	0.11	45278	28630		70624	1167	0
JAMMU & KASHMIR	BADGAM	185	7 and 9	0.82	0.72	0.27	24042	27617		44400	18700	0
JAMMU & KASHMIR	BARAMULA	186	7 and 9	0.74	0.52	0.10	30451	20562		81123	42160	0
JAMMU & KASHMIR	DODA	187	9	0.33	0.31	0.20	10466	11034	0.00	78078	700	2
JAMMU & KASHMIR	JAMMU	188	9	0.63	0.58	0.18	244	29191	0.96	93656	5156094	1904
JAMMU & KASHMIR	JAMMU & KASHMIR	189	9			0.00	0			0	0	
JAMMU & KASHMIR	KARGIL	190	9	1.00	0.82	0.09	9580	8473		10479	2000	0
JAMMU & KASHMIR	KATHUA	191	9	0.28	0.28	0.18	3735	29922	0.99	99513	3173336	1185
JAMMU & KASHMIR	KUPWARA	192	7 and 9	0.24	0.26	0.26	20000	12406		44426	0	0
JAMMU & KASHMIR	LEH	193	9	1.00	0.69	0.01	10058	15367		10016	0	0
JAMMU & KASHMIR	PULWAMA	194	9	0.81	0.68	0.29	3174	38220	1.00	61715	10500	2
JAMMU & KASHMIR	PUNCH	195	7 and 9	0.24	0.09	0.40	33264	21689		27378	0	0
JAMMU & KASHMIR	RAJAURI	196	9	0.15	0.05	0.31	5236	27782	0.92	54475	0	13
JAMMU & KASHMIR	SRINAGAR	197	7 and 9	0.95	0.84	0.66	12997	75936	0.20	25127	94000	25
JAMMU & KASHMIR	UDHAMPUR	198	9	0.19	0.12	0.48	3531	19385	0.92	78413	32416	26
JHARKHAND	BOKARO	199	1 and 2	0.26	0.03	0.34	5894	54310	0.00	20782	3608175	5030
JHARKHAND	CHATRA	200	1 and 2	0.02	0.04	0.36	10674	37014	0.00	25289	8698067	13195
JHARKHAND	DEOGHAR	201	1 and 2	0.14	0.04	0.35	11754	27229	0.00	31488	14139733	5835

State	District	S_No	Clusters	Irr_H	Irr_A	GW_Devt	T_CCA	Prod_Ha	Elec_W	NSA	kWh-equiv.	GWS
JHARKHAND	DHANBAD	202	1 and 2	0.19	0.02	0.56	5610	48468	0.03	6268	2607813	3357
JHARKHAND	DUMKA	203	1, 2 and 7	0.16	0.04	0.28	36097	28783	0.00	100659	33318766	32252
JHARKHAND	GARHWA	204	1	0.15	0.08	0.36	5474	27448	0.00	47381	2375946	2710
JHARKHAND	GIRIDIH	205	1 and 2	0.27	0.05	0.37	5905	40076	0.00	49213	8740499	6263
JHARKHAND	GODDA	206	1 and 7	0.14	0.07	0.45	101099	31070	0.00	42031	5853676	4659
JHARKHAND	GUMLA	207	1 and 7	0.13	0.03	0.28	14612	14752	0.00	199927	9491599	14407
JHARKHAND	HAZARIBAG	208	1 and 2	0.19	0.04	0.41	2327		0.00	28338	1300153	6287
JHARKHAND	KODARMA	209	2	0.37	0.10	0.36	2544	62954	0.03	7554	3590448	3394
JHARKHAND	LOHARDAGA	210	2	0.38	0.10	0.41	1020	32201	0.01	27402	2751351	4356
JHARKHAND	PAKAUR	211	1	0.15	0.02	0.15	2970	27776	0.14	34511	1554290	1848
JHARKHAND	PALAMU	212	1, 2 and 7	0.13	0.06	0.32	37060	26211	0.01	93186	7528574	12182
JHARKHAND	PASCHIMI SINGBHUM	213	1 and 7	0.03	0.00	0.14	21992	21633	0.00	154252	2669491	2673
JHARKHAND	PURBI SINGHBHUM	214	1	0.03	0.01	0.23	3818	33423	0.17	30442	6337118	1636
JHARKHAND	RANCHI	215	1 and 2	0.23	0.04	0.42	3802	29817	0.02	150733	15275240	20524
JHARKHAND	SAHIBGANJ	216	1	0.06	0.03	0.23	2471	30103	0.00	29699	2062924	1939
KARNATAKA	BAGALKOT	217	5	0.51	0.46	0.91	3626	14628	0.99	450144	240089360	38189
KARNATAKA	BANGLORE	218	12	0.15	0.17	1.41	1360	52839	0.94	60532	94311013	13980
KARNATAKA	BANGLORE RURAL	219	5	0.16	0.19	1.17	4211		0.92	319144	334776747	46701
KARNATAKA	BELGAUN	220	None	0.56	0.49	0.78	2054	19801	0.95	901145	427424594	100318
KARNATAKA	BELLARY	221	6	0.38	0.34	0.42	5139	18510	0.97	485381	85113064	23369
KARNATAKA	BIDAR	222	1	0.12	0.09	0.57	6025	13494	0.98	401112	69081146	26990
KARNATAKA	BIJAPUR	223	None	0.34	0.26	0.75	4510	8664	0.98	856161	1106433	54314
KARNATAKA	CHAMARAJANAGAR	224	5	0.24	0.23	0.80	1233	23067	0.94	194096	68944427	26007
KARNATAKA	CHIKMAGALUR	225	1	0.24	0.20	0.43	11607	27846	0.95	302603	56441376	24638
KARNATAKA	CHITRADURGA	226	5	0.19	0.15	1.02	5540	18205	0.98	187248	198474770	50099
KARNATAKA	DAKSHINA KANNADA	227	10	0.77	0.54	0.69	663	69707	0.73	145043	121080465	41278
KARNATAKA	DAVANAGERE	228	5	0.42	0.37	0.89	3541	26574	0.99	892885	231864704	43226
KARNATAKA	DHARWAD	229	1	0.16	0.15	0.59	1614	10492	0.98	321356	17465090	9433
KARNATAKA	GADAG	230	5	0.16	0.14	0.89	1495	8466	0.99	378565	26316717	9915
KARNATAKA	GULBARGA	231	1	0.19	0.15	0.30	3155	11183	0.74	1300572	108592557	33653
KARNATAKA	HASSAN	232	1 and 7	0.29	0.27	0.55	27963	23471	0.98	436412	135550273	47344
KARNATAKA	HAVERI	233	1 and 7	0.21	0.16	0.64	12412	17878	0.96	360945	57346768	24584
KARNATAKA	KODAGU	234	9	0.02	0.01	0.21	2642	73239	0.99	160787	9047718	1383
KARNATAKA	KOLAR	235	5 and 7	0.21	0.17	1.67	15283	53122	0.95	203536	554306775	61526
KARNATAKA	KOPPAL	236	6	0.37	0.30	0.43	3878	15246	0.85	409762	55325603	28407
KARNATAKA	MANDYA	237	3 and 6	0.42	0.39	0.47	6072	44446	0.97	281259	136759535	38828
KARNATAKA	MYSORE	238	6	0.48	0.43	0.43	6094	35957	0.97	357502	79983413	26901
KARNATAKA	RAICHUR	239	None	0.34	0.26	0.31	2814	11073	0.98	638358	22624346	11673
KARNATAKA	SHIMOGA	240	6 and 7	0.70	0.57	0.27	59687	44492	0.92	245069	68416637	26408
KARNATAKA	TUMKUR	241	5 and 7	0.28	0.21	1.00	12144	19500	0.90	559738	787203558	111718
KARNATAKA	UDUPI	242	None	0.61	0.34	0.37	4730	47718	0.93	103116	50485617	29804

State	District	S_No	Clusters	Irr_H	Irr_A	GW_Devt	T_CCA	Prod_Ha	Elec_W	NSA	kWh-equiv.	GWS
KARNATAKA	UTTARA KANNADA	243	7	0.56	0.24	0.37	12462	32732	0.95	128546	25077823	27016
KERLA	ALAPPUZHA	244	7 and 10	0.73	0.36	0.29	782	50147	0.79	50232	1860043	6216
KERLA	ERNAKULAM	245	3 and 7	0.46	0.17	0.42	2501	52478	0.98	97523	20405276	18951
KERLA	IDUKKI	246	7 and 9	0.63	0.25	0.43	4030	71546	0.82	152519	7770883	5780
KERLA	KANNUR	247	7	0.53	0.12	0.46	11715	46336	0.94	110522	10480183	19232
KERLA	KASARAGOD	248	7 and 10	0.79	0.36	0.71	12811	53476	0.87	72164	16189212	8477
KERLA	KOLLAM	249	7	0.35	0.03	0.38	4332	79182	0.74	76758	2361260	7636
KERLA	KOTTAYAM	250	7	0.34	0.11	0.29	1035	58143	0.83	107457	2911529	6116
KERLA	KOZHIKODE	251	7	0.36	0.08	0.56	2283	60376	0.94	95938	4278515	9003
KERLA	MALAPPURAM	252	7	0.65	0.26	0.57	11301	66022	0.97	109478	15965815	13896
KERLA	PALAKKAD	253	7	0.56	0.42	0.62	11308	60175	0.92	119909	26874837	11380
KERLA	PATHANAMTHITTA	254	7	0.58	0.07	0.37	3223	77809	0.64	55666	3245638	7583
KERLA	THIRUVANANTHAPURAM	255	7	0.62	0.11	0.53	14563	70845	0.82	72213	8373410	6589
KERLA	TRISSUR	256	7	0.66	0.43	0.53	12839	59129	0.99	79576	41119913	48057
KERLA	WAYANAD	257	7 and 9	0.50	0.28	0.18	4298	82604	0.75	82800	3240723	873
LAKSHADWEEP	LAKSHADWEEP	258	12	0.00	0.00	0.67	0			2409	0	
MADHYA PRADESH	BALAGHAT	259	6 and 7	0.42	0.37	0.14	31672	14817	0.87	282040	17263952	10464
MADHYA PRADESH	BARWANI	260	3	0.41	0.30	0.72	2931	12001	1.00	230817	59183448	27368
MADHYA PRADESH	BETUL	261	3	0.42	0.30	0.52	7410	13898	0.88	444363	83197268	63013
MADHYA PRADESH	BHIND	262	None	0.42	0.33	0.41	40	16021	0.55	325253	162248885	15254
MADHYA PRADESH	BHOPAL	263	11	0.70	0.73	0.75	1831	21219	0.99	144403	39774557	20527
MADHYA PRADESH	CHHATARPUR	264	7	0.68	0.57	0.67	18928	15058	0.66	444321	27748909	12225
MADHYA PRADESH	CHHINDWARA	265	3	0.46	0.30	0.53	822	21210	0.92	488216	72729199	84733
MADHYA PRADESH	DAMOH	266	None	0.69	0.48	0.62	6431	13707	0.86	280700	38005262	22052
MADHYA PRADESH	DATIA	267	6 and 11	0.98	0.94	0.48	12	17263	0.73	212259	34486267	24031
MADHYA PRADESH	DEWAS	268	4	0.51	0.47	0.82	3203	25763	0.92	413033	108461914	55438
MADHYA PRADESH	DHAR	269	4 and 7	0.55	0.49	0.82	32944	20151	0.95	488710	119462846	80997
MADHYA PRADESH	DINDORI	270	1	0.01	0.01	0.08	462	7701	0.31	224132	339560	332
MADHYA PRADESH	KHANDWA	271	3	0.38	0.28	0.66	215	27330	0.99	410841	63758987	66249
MADHYA PRADESH	GUNA	272	None	0.67	0.65	0.53	4832	12520	0.54	588807	51222134	50266
MADHYA PRADESH	GWALIOR	273	6	0.62	0.61	0.43	1281		0.88	202439	52835371	21613
MADHYA PRADESH	HARDA	274	6 and 11	0.85	0.80	0.29	1226	24288	0.86	172621	34887384	15669
MADHYA PRADESH	HOSHANGABAD	275	6 and 11	0.86	0.86	0.19	10760	25269	0.98	308434	57651619	31420
MADHYA PRADESH	INDORE	276	4	0.75	0.79	1.20	3	33077	1.00	241918	176784318	40955
MADHYA PRADESH	JABALPUR	277	None	0.55	0.51	0.49	682	20541	0.99	283615	51418600	23128
MADHYA PRADESH	JHABUA	278	7	0.46	0.22	0.38	17147	9769	0.77	357547	40008005	23082
MADHYA PRADESH	KATNI	279	7	0.37	0.33	0.41	53039	12393	0.87	216633	20566044	13217
MADHYA PRADESH	MANDLA	280	1	0.21	0.15	0.15	3236	8801	0.88	259341	1498531	2369
MADHYA PRADESH	MANDSAUR	281	4	0.61	0.40	0.96	7664	21412	0.98	345044	91656573	99266
MADHYA PRADESH	MORENA	282	6 and 11	0.81	0.77	0.41	1444	22755	0.73	268355	103012100	23007
MADHYA PRADESH	NARSIMHAPUR	283	None	0.63	0.55	0.76	1835	24634	0.97	298479	169519171	46743

State	District	S_No	Clusters	Irr_H	Irr_A	GW_Devt	T_CCA	Prod_Ha	Elec_W	NSA	kWh-equiv.	GWS
MADHYA PRADESH	NEEMUCH	284	4	0.69	0.53	0.83	4856	27190	1.00	174782	76748557	51023
MADHYA PRADESH	PANNA	285	1 and 7	0.25	0.22	0.26	14746	8556	0.46	288176	14720198	12279
MADHYA PRADESH	RAISEN	286	None	0.51	0.45	0.45	8640	14230	0.85	418148	38344459	20902
MADHYA PRADESH	RAJGARH	287	4	0.65	0.52	0.83	2454	18644	0.96	443482	106529319	76794
MADHYA PRADESH	RATLAM	288	4	0.43	0.35	1.26	2348	25030	0.96	319746	67708691	59404
MADHYA PRADESH	REWA	289	7	0.37	0.32	0.54	81615	11718	0.90	355658	40954395	25166
MADHYA PRADESH	SAGAR	290	None	0.52	0.46	0.59	13	15399	0.77	514024	87277115	65453
MADHYA PRADESH	SATNA	291	7	0.37	0.32	0.74	12965	12701	0.90	348903	60429237	32022
MADHYA PRADESH	SEHORE	292	None	0.58	0.51	0.77	11430	23051	0.97	395184	162589373	48477
MADHYA PRADESH	SEONI	293	7	0.45	0.36	0.29	275032	13062	0.71	417964	20362052	18810
MADHYA PRADESH	SHAHDOL	294	1	0.10	0.05	0.06	9979	7269	0.69	372489	2690030	5389
MADHYA PRADESH	SHAJAPUR	295	4 and 7	0.36	0.38	0.98	16787	20239	0.99	464700	121405909	59809
MADHYA PRADESH	SHEOPUR	296	6 and 11	0.81	0.77	0.37	5137	23165	0.90	168081	42157140	9325
MADHYA PRADESH	SHIVPURI	297	7	0.54	0.49	0.68	13390	18397	0.02	447927	122760763	51595
MADHYA PRADESH	SIDHI	298	7	0.42	0.26	0.34	25050	9336	0.88	375143	26869429	21656
MADHYA PRADESH	TIKAMGARH	299	None	0.61	0.55	0.72	3852	20891	0.49	205877	60479815	44822
MADHYA PRADESH	UJJAIN	300	4 and 7	0.68	0.57	0.95	13290	22654	0.98	499412	142087032	83104
MADHYA PRADESH	UMARIYA	301	1	0.22	0.13	0.11	6380	7084	0.77	120522	7176318	3501
MADHYA PRADESH	VIDISHA	302	None	0.55	0.58	0.54	7327	15478	0.32	522750	70305652	35996
MADHYA PRADESH	WEST NIMAR	303	3	0.41	0.30	0.75	258	14751	0.99	400966	2711791	67404
MAHARASHTRA	AHMADNAGAR	304	5	0.32	0.29	0.82	7079	9921	0.85	1151049	242775408	196928
MAHARASHTRA	AKOLA	305	1	0.11	0.10	0.45	1208	1266	0.96	409628	18824071	21880
MAHARASHTRA	AMRAVATI	306	1, 3 and 7	0.17	0.16	0.68	41235	20903	0.97	693406	114530679	82650
MAHARASHTRA	AURANGABAD_M	307	1, 3 and 7	0.12	0.10	0.72	127367	11076	0.99	650008	25078657	103521
MAHARASHTRA	BHANDARA	308	7	0.39	0.40	0.33	92567	25893	0.90	196540	21885223	18074
MAHARASHTRA	BID	309	1	0.07	0.07	0.51	9340	9796	0.98	738653	86192704	49627
MAHARASHTRA	BULDANA	310	1 and 7	0.13	0.13	0.70	35770	12364	0.84	655052	75193181	73414
MAHARASHTRA	CHANDRAPUR	311	1 and 7	0.26	0.16	0.16	40557	16986	0.63	523169	30351069	22577
MAHARASHTRA	DHULE	312	1, 3 and 7	0.18	0.16	0.52	54275	11921	0.92	396154	122180848	67106
MAHARASHTRA	GADCHIROLI	313	7	0.42	0.31	0.25	22774	13644	0.50	199491	22734645	13217
MAHARASHTRA	GONDIYA	314	6 and 7	0.38	0.37	0.20	66820		0.64	196650	10023022	9788
MAHARASHTRA	HINGOLI	315	1	0.02	0.01	0.37	5121		0.99	344967	32720533	32389
MAHARASHTRA	JALGAON	316	5 and 7	0.19	0.19	0.81	22522	47868	0.97	764937	263304073	135448
MAHARASHTRA	JALNA	317	1 and 3	0.07	0.07	0.53	4454	12661	0.96	570756	81765470	72464
MAHARASHTRA	KOLHAPUR	318	6	0.50	0.35	0.41	774	34446	0.84	397900	124336449	47088
MAHARASHTRA	LATUR	319	1	0.07	0.04	0.75	3745	13139	0.99	584054	67674008	53784
MAHARASHTRA	MUMBAI	320	12			0.00	0			0	0	
MAHARASHTRA	MUMBAI(SUBURBAN)	321	12			0.00	0			0	0	
MAHARASHTRA	NAGPUR	322	1, 3 and 7	0.25	0.20	0.52	86892	24590	0.94	482990	77301278	69822
MAHARASHTRA	NANDED	323	1	0.01	0.01	0.35	937	23111	0.99	767533	51195682	41090
MAHARASHTRA	NANDURBAR	324	1 and 7	0.19	0.18	0.50	48239	12357	0.95	277913	63361179	29635

State	District	S_No	Clusters	Irr_H	Irr_A	GW_Devt	T_CCA	Prod_Ha	Elec_W	NSA	kWh-equiv.	GWS
MAHARASHTRA	NASHIK	325	3 and 7	0.37	0.27	0.58	12876	33750	0.97	819665	296776610	189721
MAHARASHTRA	OSMANABAD	326	1 and 3	0.18	0.11	0.72	7017	9391	0.98	470484	84747778	63816
MAHARASHTRA	PARBHANI	327	1	0.02	0.02	0.45	10732	15125	0.99	510036	48259964	34413
MAHARASHTRA	PUNE	328	1, 3 and 7	0.25	0.24	0.73	23385	28935	0.97	926781	1947609709	137733
MAHARASHTRA	RAIGARH_M	329	1	0.20	0.18	0.13	1522	28952	0.72	291864	3873587	5033
MAHARASHTRA	RATNAGIRI	330	1	0.28	0.24	0.11	2832	46345	0.71	349806	3612972	3478
MAHARASHTRA	SANGLI	331	5 and 7	0.37	0.25	0.83	41917	23091	0.97	609000	189439283	110928
MAHARASHTRA	SATARA	332	3	0.36	0.27	0.73	5325	21327	0.92	593433	82798882	72650
MAHARASHTRA	SINDHUDURG	333	1	0.00	0.00	0.37	2041	36378	0.83	152191	7359500	7528
MAHARASHTRA	SOLAPUR	334	3	0.39	0.27	0.77	265	14677	0.97	1033729	421654604	161628
MAHARASHTRA	THANE	335	1	0.01	0.00	0.13	1246	30163	0.72	230916	9862741	10412
MAHARASHTRA	WARDHA	336	1 and 3	0.10	0.05	0.46	1699	23779	0.96	407673	76970859	47364
MAHARASHTRA	WASHIM	337	1 and 7	0.03	0.02	0.38	16520	11950	0.98	344675	26538596	27069
MAHARASHTRA	YAVATMAL	338	1	0.18	0.17	0.19	2511	13601	0.94	787666	45811674	41750
MANIPUR	BISHNUPUR	339	9	0.66	0.42	0.01	1128			19239	21000	0
MANIPUR	CHANDEL	340	9	0.00	0.00	0.00	778			9670	0	0
MANIPUR	CHURACHANDPUR	341	9	0.00	0.00	0.03	774			13706	0	0
MANIPUR	IMPHALEAST	342	9	0.08	0.07	0.00	1834			20414	27000	0
MANIPUR	IMPHALWEST	343	9	0.07	0.05	0.02	7092			21136	40500	0
MANIPUR	SENAPATI	344	9	0.00	0.00	0.00	2517			22210	0	0
MANIPUR	TAMENGLONG	345	9	0.00	0.00	0.00	753			16020	0	0
MANIPUR	THOUBAL	346	9	0.93	0.63	0.01	5709			34022	19500	0
MANIPUR	UKHRUL	347	9	0.00	0.00	0.00	1545			15225	0	0
MEGHALAYA	EASTGAROHILLS	348	9	0.29	0.18	0.00	5050	23013		29455	0	0
MEGHALAYA	EASTKHASIHILLS	349	9	0.26	0.10	0.00	7958	45669		32114	0	0
MEGHALAYA	JAINTIAHILLS	350	9	0.27	0.19	0.00	14644	23381	0.00	33307	7900	8
MEGHALAYA	RIBHOI	351	7 and 9	0.44	0.15	0.00	18749	34485		18813	0	0
MEGHALAYA	SOUTHGAROHILLS	352	7 and 9	0.14	0.08	0.00	1506	17375		19222	0	0
MEGHALAYA	WESTGAROHILLS	353	7 and 9	0.64	0.38	0.00	28729	22942	0.01	88176	267376	209
MEGHALAYA	WESTKHASIHILLS	354	7 and 9	0.24	0.08	0.00	14522		0.00	36999	6400	5
MIZORAM	AIZAWL	355	9	0.09	0.09	0.07	2167	18802		15234	0	0
MIZORAM	CHAMPHAI	356	9	0.09	0.10	0.03	3743	23443		22274	0	0
MIZORAM	KOLASIB	357	9	0.12	0.07	0.02	1834	21190		11584	0	0
MIZORAM	LAWNGTLAI	358	9	0.04	0.04	0.02	760			9671	0	0
MIZORAM	LUNGLEI	359	9	0.02	0.02	0.12	1044	18658		15772	0	0
MIZORAM	MAMIT	360	9	0.26	0.21	0.02	1166	20315		17400	0	0
MIZORAM	SAIHA	361	9	0.01	0.01	0.01	378	17004		3910	0	0
MIZORAM	SERCHHIP	362	9	0.19	0.19	0.05	2132			8945	0	0
NAGALAND	DIMAPUR	363	7 and 9	0.79	0.35	0.04	21731	21377	0.03	58346	358823	103
NAGALAND	KOHIMA	364	7 and 9	0.56	0.09	0.13	15824	18836		58194	0	0
NAGALAND	MOKOKCHUNG	365	9	0.11	0.01	0.05	5037	14333		30930	0	0

State	District	S_No	Clusters	Irr_H	Irr_A	GW_Devt	T_CCA	Prod_Ha	Elec_W	NSA	kWh-equiv.	GWS
NAGALAND	MON	366	9	0.07	0.01	0.14	2700	16096		44786	0	0
NAGALAND	PHEK	367	7 and 9	0.85	0.25	0.08	13115	17191		31383	0	0
NAGALAND	TUENSANG	368	7 and 9	0.18	0.01	0.06	11774	14354		66666	0	0
NAGALAND	WOKHA	369	9	0.06	0.01	0.05	3491	17715		18232	0	0
NAGALAND	ZUNHEBOTO	370	9	0.07	0.01	0.09	8590	18771		21717	6500	0
ORISSA	ANUGUL	371	2 and 7	0.38	0.10	0.34	25109	41929	0.09	133007	13583958	32074
ORISSA	BALANGIR	372	1, 2 and 7	0.17	0.09	0.23	41344	21428	0.03	266820	23671587	59415
ORISSA	BALESHWAR	373	None	0.49	0.29	0.53	5777	28711	0.41	219246	0	21683
ORISSA	BARGARH	374	6 and 7	0.43	0.40	0.26	45753	20960	0.14	254299	21190706	26499
ORISSA	BAUDH	375	2, 6 and 7	0.45	0.33	0.20	12639	41681	0.01	72096	5041612	12877
ORISSA	BHADRAK	376	6	0.51	0.40	0.59	3519	33815	0.27	169006	13952576	6113
ORISSA	CUTTACK	377	6 and 7	0.72	0.50	0.38	18314	41344	0.08	142287	16779490	22349
ORISSA	DEBAGARH	378	2	0.39	0.15	0.16	8452	26474	0.08	41947	2772676	7703
ORISSA	DHENKANAL	379	1, 2 and 7	0.26	0.12	0.26	25863	42838	0.16	77811	5565595	12508
ORISSA	GAJAPATI	380	7	0.42	0.29	0.27	25648	35115	0.02	54521	1727252	4558
ORISSA	GANJAM	381	6 and 7	0.76	0.67	0.30	164250	35128	0.06	272622	18656413	34738
ORISSA	JAGATSINGHAPUR	382	6	0.66	0.61	0.52	1912	51722	0.20	93751	7511354	7386
ORISSA	JAJAPUR	383	6	0.34	0.20	0.49	9342	32404	0.17	146230	10927389	9109
ORISSA	JHARSUGUDA	384	1	0.21	0.11	0.31	6739	25763	0.17	60996	3258734	6956
ORISSA	KALAHANDI	385	6 and 7	0.35	0.26	0.20	28006	23493	0.02	240493	7231431	21594
ORISSA	KANDHAMAL	386	1, 2 and 7	0.23	0.06	0.13	18283	53537	0.01	81065	3473716	9390
ORISSA	KENDRAPARA	387	6	0.54	0.44	0.57	53	39031	0.23	124750	5095080	2157
ORISSA	KENDUJHAR	388	1 and 7	0.28	0.10	0.29	24093	42945	0.04	239009	10500841	25346
ORISSA	KHORDHA	389	1, 2, 6 and 7	0.29	0.27	0.33	18956	44206	0.01	105382	5365335	16138
ORISSA	KORAPUT	390	7	0.55	0.24	0.10	31167	25820	0.01	233465	3005515	5452
ORISSA	MALKANGIRI	391	1	0.11	0.09	0.09	1139	33121	0.02	118785	993750	2228
ORISSA	MAYURBHANJ	392	1 and 7	0.27	0.18	0.30	40940	23774	0.11	342058	8659586	16765
ORISSA	NABARANGAPUR	393	1	0.09	0.10	0.15	3430	22396	0.01	187048	8659586	11717
ORISSA	NAYAGARH	394	1, 2 and 7	0.20	0.13	0.24	13399	31994	0.02	92091	7623932	16800
ORISSA	NUAPADA	395	1, 2 and 7	0.15	0.10	0.21	13731	21892	0.03	117659	5833015	14598
ORISSA	PURI	396	6 and 10	0.77	0.63	0.21	5351	52270	0.17	132216	13703147	7714
ORISSA	RAYAGADA	397	7	0.52	0.28	0.15	63050	31709	0.08	147441	2181923	2913
ORISSA	SAMBALPUR	398	2 and 7	0.39	0.19	0.16	22259	27985	0.10	132293	10038882	17991
ORISSA	SONAPUR	399	6 and 7	0.53	0.47	0.20	12886	33005	0.04	88337	7903394	13431
ORISSA	SUNDARGARH	400	1 and 7	0.20	0.08	0.22	19132	22143	0.06	255536	12337409	24241
PONDICHERRY	KARAIKAL	401	6	0.94	0.83	0.14	10105			5227	0	0
PONDICHERRY	MAHE	402	12	0.12	0.05	0.62	0			521	0	
PONDICHERRY	PONDICHERRY	403	12	0.84	0.70	1.39	0		0.99	12151	32123140	4133
PONDICHERRY	YANAM	404	6	0.62	0.41	0.00	356			500	76646	0
PUNJAB	AMRITSAR	405	4	1.00	1.00	1.81	0	48385	0.96	407329	1287933185	145251
PUNJAB	BATHINDA	406	4, 6 and 10	1.00	1.00	1.19	0	57613	0.67	272343	310277679	46772

State	District	S_No	Clusters	Irr_H	Irr_A	GW_Devt	T_CCA	Prod_Ha	Elec_W	NSA	kWh-equiv.	GWS
PUNJAB	FARIDKOT	407	4, 6 and 10	1.00	1.00	1.60	0	58046	0.93	135107	163773588	37566
PUNJAB	FATEHGARHAHIB	408	4 and 10	1.00	1.00	2.10	0	63515	0.95	100690	397297250	35814
PUNJAB	FIROZPUR	409	4, 6 and 10	1.00	1.00	1.47	0	58604	0.85	434230	559561482	96269
PUNJAB	GURDASPUR	410	4	0.97	0.98	1.27	1112	45015	0.90	228996	317550035	85028
PUNJAB	HOSHIARPUR	411	4	0.93	0.97	1.02	1226	45722	0.67	212283	255654825	58445
PUNJAB	JALANDHAR	412	4 and 10	1.00	1.00	2.31	0	53572	0.99	218221	456637287	78312
PUNJAB	KAPURTHALA	413	4 and 10	1.00	1.00	2.34	0	61381	0.88	116952	404077260	54164
PUNJAB	LUDHIANA	414	4 and 10	1.00	1.00	1.67	0	69145	0.84	313285	740304149	119521
PUNJAB	MANSA	415	4, 6 and 10	1.00	1.00	2.08	0	58906	0.59	201583	330036971	44680
PUNJAB	MOGA	416	4, 6 and 10	1.00	1.00	2.02	0	62821	0.99	168859	384309957	64233
PUNJAB	MUKTSAR	417	6 and 10	1.00	1.00	0.69	0	60394	0.42	233652	198230396	29127
PUNJAB	NAWANSHAHR	418	4 and 10	0.99	0.99	1.15	0	56807	0.78	81116	143882567	26291
PUNJAB	PATIALA	419	4 and 10	1.00	1.00	1.96	7	60818	0.98	248224	889051025	80034
PUNJAB	RUPNAGAR	420	4	0.92	0.96	1.07	120	44593	0.74	129474	127580444	36796
PUNJAB	SANGRUR	421	4, 6 and 10	1.00	1.00	2.58	0	65002	0.95	463606	1271953833	139969
RAJASTHAN	AJMER	422	4	0.35	0.18	1.44	11051	7364	0.14	456311	80576668	77112
RAJASTHAN	ALWAR	423	4 and 11	0.92	0.88	1.79	422	27727	0.41	507171	948693633	115198
RAJASTHAN	BANSWARA	424	6	0.57	0.42	0.49	11121	14383	0.16	225704	24691123	11465
RAJASTHAN	BARAN	425	4 and 7	0.85	0.85	1.20	13861	31054	0.32	338497	150259727	38735
RAJASTHAN	BARMER	426	4	0.15	0.09	1.24	167	2909	0.74	1792429	252030378	24977
RAJASTHAN	BHARATPUR	427	4 and 11	0.87	0.83	1.16	0	25350	0.18	396466	499751478	51525
RAJASTHAN	BHILWARA	428	4 and 7	0.53	0.31	1.29	38118	14604	0.23	443433	140410014	122047
RAJASTHAN	BIKANER	429	4	0.38	0.13	1.43	0	8075	0.98	1646822	454712009	9331
RAJASTHAN	BUNDI	430	4 and 6	0.81	0.77	1.00	2293		0.28	261376	104504851	35941
RAJASTHAN	CHITTAURGARH	431	4 and 7	0.63	0.46	1.40	12018	23232	0.60	313347	218106858	114046
RAJASTHAN	CHURU	432	4	0.09	0.07	0.88	0	4770	0.86	1172489	227614917	9445
RAJASTHAN	DAUSA	433	4 and 11	0.76	0.70	1.70	0	21843	0.47	229493	290040791	50079
RAJASTHAN	DHAULPUR	434	4 and 11	0.72	0.69	1.28	1592	23796	0.13	156473	123386676	16532
RAJASTHAN	DUNGARPUR	435	None	0.38	0.21	0.72	3736	12708	0.22	131617	25885792	18363
RAJASTHAN	GANGANAGAR	436	6 and 11	0.81	0.69	0.44	0	23091	0.85	769860	2415268	106
RAJASTHAN	HANUMANGARH	437	4 and 6	0.64	0.47	0.81	0	18127	0.07	832429	15887384	4440
RAJASTHAN	JAIPUR	438	4	0.64	0.44	2.07	925	18463	0.61	684431	643363074	132323
RAJASTHAN	JAISALMER	439	4 and 6	0.28	0.14	1.99	0	3317	0.96	725685	78777733	2414
RAJASTHAN	JALOR	440	4	0.50	0.35	1.94	1549	9200	0.55	699335	355173473	59726
RAJASTHAN	JHALAWAR	441	4 and 11	0.70	0.56	1.19	1722	25361	0.34	327958	103105588	75291
RAJASTHAN	JHUNJHUNUN	442	4	0.58	0.51	2.26		16027	0.88	424576	793473870	45364
RAJASTHAN	JODHPUR	443	4	0.21	0.15	2.16	1645	6616	0.77	1371703	638223284	30091
RAJASTHAN	KARAULI	444	4 and 11	0.75	0.57	1.37	70	26091	0.39	202933	166553587	37428
RAJASTHAN	KOTA	445	4 and 6	0.85	0.82	0.92	2039	32925	0.42	270112	67520831	31893
RAJASTHAN	NAGAUR	446	4	0.22	0.16	1.89	35	9085	0.75	1329398	467518061	45011
RAJASTHAN	PALI	447	4 and 7	0.23	0.14	1.15	21077	7965	0.37	648728	143655881	50219

State	District	S_No	Clusters	Irr_H	Irr_A	GW_Devt	T_CCA	Prod_Ha	Elec_W	NSA	kWh-equiv.	GWS
RAJASTHAN	RAJSAMAND	448	4	0.57	0.23	1.10	3509	9338	0.18	94697	47510804	54720
RAJASTHAN	SAWAI MADHOPUR	449	4	0.65	0.64	1.26	120	18686	0.23	290621	162997195	39986
RAJASTHAN	SIKAR	450	4	0.52	0.42	1.47	0	14157	0.84	535678	607968471	58748
RAJASTHAN	SIROHI	451	4	0.47	0.42	1.13	9383	13718	0.57	167928	89647020	20286
RAJASTHAN	TONK	452	4	0.53	0.37	0.99	2995	13538	0.12	484964	112749193	53007
RAJASTHAN	UDAIPUR	453	4 and 7	0.45	0.18	1.11	14426	14091	0.34	584587	80297649	63597
SIKKIM	EAST	454	9	0.42	0.22	0.61	6893			21697	0	0
SIKKIM	NORTH	455	9	0.41	0.08	0.38	1267			10448	0	0
SIKKIM	SOUTH	456	9	0.23	0.10	0.22	5229			21969	0	0
SIKKIM	WEST	457	9	0.41	0.21	0.13	3877			23065	0	0
TAMILNADU	CHENNAI	458	12			2.26	0			0	0	
TAMILNADU	COIMBATORE	459	5 and 11	0.70	0.43	1.21	186	29511	0.85	370256	247456675	121774
TAMILNADU	CUDDALORE	460	5 and 6	0.68	0.65	0.86	2444	53872	0.91	210393	814841559	46801
TAMILNADU	DHARMAPURI	461	5	0.40	0.29	1.33	2578	40312	0.67	335083	466706392	131710
TAMILNADU	DINDIGUL	462	5	0.58	0.37	1.19	2554	39712	0.91	235062	178380366	97607
TAMILNADU	ERODE	463	5 and 6	0.77	0.52	0.94	1645	46276	0.81	199353	816118844	137163
TAMILNADU	KANCHEEPURAM	464	7	0.94	0.75	0.66	82631	39781	0.95	113544	137192480	62642
TAMILNADU	KANNIYAKUMARI	465	6 and 7	0.38	0.41	0.19	12374	67432	0.87	79354	5255895	2634
TAMILNADU	KARUR	466	5	0.36	0.24	0.92	1192	23071	0.82	92524	135111313	44303
TAMILNADU	MADURAI	467	6 and 7	0.75	0.59	0.58	44804	34797	0.86	147195	88960528	55336
TAMILNADU	NAGAPATTINAM	468	5, 6 and 11	0.70	0.75	1.02	278	19436	0.94	139238	203865928	20081
TAMILNADU	NAMAKKAL	469	5 and 10	0.71	0.45	0.89	1517	54250	0.97	154977	268579929	70310
TAMILNADU	PERAMBALUR	470	5	0.27	0.25	0.85	2869	32197	0.80	206554	317259724	52897
TAMILNADU	PUDUKKOTTAI	471	7	0.88	0.66	0.22	81854	35130	0.85	171989	127225740	41305
TAMILNADU	RAMANATHAPURAM	472	7	0.64	0.52	0.12	62341	11353	0.75	235218	23264371	6134
TAMILNADU	SALEM	473	5	0.59	0.45	1.64	94	43227	0.87	219027	245387222	115383
TAMILNADU	SIVAGANGA	474	7 and 11	0.84	0.65	0.16	55741	21772	0.67	128038	49366658	22287
TAMILNADU	THANJAVUR	475	5, 6 and 7	0.86	0.86	1.04	14863	42398	0.88	190930	363608167	50058
TAMILNADU	THE NILGIRIS	476	9	0.01	0.00	0.10	0	98679	0.62	79718	213656	902
TAMILNADU	THENI	477	5	0.50	0.44	0.86	9894	56960	0.98	99448	86347918	28671
TAMILNADU	THIRUVALLUR	478	7	0.78	0.76	0.68	17956	48468	0.93	104573	107729355	31950
TAMILNADU	THIRUVARUR	479	6 and 11	0.99	0.99	0.71	0	18405	0.86	140106	93560951	16819
TAMILNADU	TIRUCHIRAPPALLI	480	6	0.72	0.54	0.79	8113	42680	0.85	186638	246318510	84296
TAMILNADU	TIRUNELVELI	481	7	0.70	0.45	0.58	185349	47243	0.77	137585	139176161	88580
TAMILNADU	TIRUVANAMALAI	482	5. 7 and 11	0.75	0.60	0.85	84956	29616	0.93	250565	417768624	170849
TAMILNADU	TUTICORIN	483	7	0.40	0.20	0.43	15519	34045	0.75	180147	43533631	26591
TAMILNADU	VELLORE	484	5 and 7	0.65	0.46	1.05	34834	40064	0.86	193780	435665062	120884
TAMILNADU	VILUPPURAM	485	5 and 7	0.76	0.67	1.03	97189	40846	0.92	365559	1068781301	179579
TAMILNADU	VIRUDHUNAGAR	486	7	0.63	0.41	0.69	12793	19725	0.67	132764	68550800	38756
TRIPURA	DHALAI	487	9	0.10	0.08	0.02	466		0.63	34613	1374978	8
TRIPURA	NORTHTRIPURA	488	9	0.28	0.13	0.04	118		1.00	44076	1584557	15

State	District	S_No	Clusters	Irr_H	Irr_A	GW_Devt	T_CCA	Prod_Ha	Elec_W	NSA	kWh-equiv.	GWS
TRIPURA	SOUTHTRIPURA	489	9	0.24	0.23	0.05	1765		0.72	79476	7278769	885
TRIPURA	WESTTRIPURA	490	9	0.39	0.29	0.12	821		0.89	97860	8905514	1183
UTTAR PRADESH	AGRA	491	4	0.90	0.87	1.14	0	37879	0.17	282657	375729370	70514
UTTAR PRADESH	ALIGARH	492	4	0.97	0.97	0.82	5	37008	0.28	293706	431727219	66643
UTTAR PRADESH	ALLHABAD	493	4	0.52	0.63	0.81	1682	25144	0.27	315628	254230346	43639
UTTAR PRADESH	AMBEDKARNAGAR	494	6	0.89	0.91	0.57	0	38301	0.09	167756	162758847	60090
UTTAR PRADESH	AURAIYA	495	None	0.89	0.86	0.69	0	30232	0.03	144887	196590268	37292
UTTAR PRADESH	AZAMGARH	496	6	0.86	0.86	0.65	157		0.20	301393	237702589	72866
UTTAR PRADESH	BAGHPAT	497	4 and 10	0.97	0.97	0.98	0	78106	0.82	111506	109523610	25950
UTTAR PRADESH	BAHRAICH	498	None	0.54	0.46	0.55	12	26451	0.01	327672	146253883	76404
UTTAR PRADESH	BALLIA	499	2	0.36	0.68	0.66	1279	24411	0.09	220709	166333809	45367
UTTAR PRADESH	BALRAMPUR	500	2	0.34	0.31	0.50	153	31807	0.01	217192	130529109	47673
UTTAR PRADESH	BANDA	501	None	0.49	0.40	0.55	140	15431	0.09	344693	66326591	16141
UTTAR PRADESH	BARABANKI	502	6	0.86	0.86	0.64	0	45443	0.01	259273	244657914	93988
UTTAR PRADESH	BAREILLY	503	None	0.87	0.91	0.60	789	41946	0.01	326827	285783579	125184
UTTAR PRADESH	BASTI	504	6	0.85	0.70	0.79	0	32321	0.02	200138	158217501	75811
UTTAR PRADESH	BIJNOR	505	6 and 10	0.88	0.87	0.67	0	61005	0.29	341988	353606375	92679
UTTAR PRADESH	BUDAUN	506	4	0.89	0.89	0.85	0	33420	0.01	418646	245812254	113531
UTTAR PRADESH	BULANDSHAHR	507	4	0.90	0.90	0.82	55	48865	0.53	287031	320765079	64023
UTTAR PRADESH	CHANDAULI	508	6 and 11	0.94	0.95	0.38	315	28711	0.19	132523	52021114	13045
UTTAR PRADESH	CHITRAKOOT	509	1	0.27	0.23	0.66	1314	14959	0.14	173399	26717196	8007
UTTAR PRADESH	DEORIA	510	11	0.86	0.80	0.78	27	29589	0.01	195670	149820101	90785
UTTAR PRADESH	ETAH	511	4	0.98	0.95	0.88	0	35419	0.01	322763	277954627	96660
UTTAR PRADESH	ETAWAH	512	6	0.83	0.79	0.46	0	35477	0.04	145441	256863298	34907
UTTAR PRADESH	FAIZABAD	513	6	0.96	0.95	0.62	0	38005	0.05	156547	418811189	70901
UTTAR PRADESH	FARRUKHABAD	514	4 and 10	0.80	0.88	0.80	0	55906	0.11	147460	150404359	40695
UTTAR PRADESH	FATEHPUR	515	4	0.56	0.61	0.95	368	26024	0.21	285918	309099433	43243
UTTAR PRADESH	FIROZABAD	516	4 and 6	0.96	0.96	1.17	0	41525	0.16	181941	295681393	46189
UTTAR PRADESH	GAUTAMBUDDHANAGAR	517	4, 6 and 11	0.99	0.99	0.93	0	23613	0.04	71355	59898342	25027
UTTAR PRADESH	GHAZIABAD	518	4 and 10	0.93	0.95	1.05	1242	69057	0.42	129862	172696975	36128
UTTAR PRADESH	GHAZIPUR	519	11	0.89	0.73	0.68	0	27208	0.29	256471	437599524	78921
UTTAR PRADESH	GONDA	520	None	0.80	0.79	0.71	0	31215	0.01	297835	246804883	107350
UTTAR PRADESH	GORAKHPUR	521	6 and 11	0.80	0.81	0.55	0	26897	0.02	249721	156802378	88691
UTTAR PRADESH	HAMIRPUR_U	522	None	0.37	0.37	0.64	907	16239	0.07	257006	20673410	18114
UTTAR PRADESH	HARDOI	523	None	0.82	0.85	0.69	0	31498	0.01	431956	226116929	87998
UTTAR PRADESH	HATHRAS	524	4 and 10	0.98	0.98	0.85	0	50460	0.25	148665	0	53050
UTTAR PRADESH	JALAUN	525	None	0.64	0.53	0.29	2108	26499	0.07	355350	59392244	16284
UTTAR PRADESH	JAUNPUR	526	4 and 11	0.75	0.78	0.89	77	27171	0.22	280108	287234058	78362
UTTAR PRADESH	JHANSI	527	None	0.69	0.62	0.68	1543	20677	0.01	323628	99633839	44209
UTTAR PRADESH	JYOTIBAPHULENAGAR	528	4 and 10	0.91	0.70	1.08	0	58028	0.01	173644	154015953	78690
UTTAR PRADESH	KANNAUJ	529	None	0.79	0.88	0.67	27	48129	0.09	138499	326804995	31803

State	District	S_No	Clusters	Irr_H	Irr_A	GW_Devt	T_CCA	Prod_Ha	Elec_W	NSA	kWh-equiv.	GWS
UTTAR PRADESH	KANPURDEHAT	530	11	0.72	0.73	0.68	0	27742	0.05	221263	198620122	33176
UTTAR PRADESH	KANPURNAGAR	531	4	0.88	0.77	0.85	623	42990	0.09	179574	214133697	36890
UTTAR PRADESH	KAUSHAMBI	532	4	0.52	0.69	0.91	32	24838	0.16	125885	124640629	22542
UTTAR PRADESH	KHERI	533	None	0.70	0.81	0.62	0	46379	0.04	484127	367670088	126820
UTTAR PRADESH	KUSHINAGAR	534	6	0.81	0.77	0.47	0	41922	0.00	224026	137881430	71156
UTTAR PRADESH	LALITPUR	535	11	0.86	0.85	0.62	5443	19342	0.02	292610	126532427	30971
UTTAR PRADESH	LUCKNOW	536	6 and 10	0.88	0.91	0.69	0	53651	0.05	136507	118615833	39047
UTTAR PRADESH	MAHOBA	537	4	0.41	0.41	1.12	392	15218	0.01	228350	50538210	19441
UTTAR PRADESH	MAHARAJGANJ	538	None	0.75	0.83	0.62	438	39709	0.00	203242	126326304	72175
UTTAR PRADESH	MAINPURI	539	4 and 6	0.83	0.86	0.86	0	35942	0.04	177832	447227410	59964
UTTAR PRADESH	MATHURA	540	4 and 6	0.97	0.96	0.92	0	32772	0.03	263981	556190904	62422
UTTAR PRADESH	MAU	541	None	0.60	0.71	0.70	0	28610	0.36	125750	86613184	27332
UTTAR PRADESH	MEERUT	542	10	0.98	0.98	0.70	13	81855	0.48	197202	192556051	53667
UTTAR PRADESH	MIRZAPUR	543	6	0.66	0.46	0.62	241	20768	0.18	194342	77192778	25958
UTTAR PRADESH	MORADABAD	544	4	0.89	0.74	0.85	23	48056	0.01	310490	330781602	119690
UTTAR PRADESH	MUZAFFARNAGAR	545	6 and 10	0.98	0.98	0.66	5	77353	0.35	315437	567005412	92801
UTTAR PRADESH	PILIBHIT	546	None	0.84	0.90	0.65	0	44853	0.01	223062	365815895	86179
UTTAR PRADESH	PRATAPGARH	547	4 and 6	0.61	0.65	1.41	15	25428	0.06	217324	448737257	107022
UTTAR PRADESH	RAEBARELI	548	6 and 11	0.89	0.79	0.73	0	27658	0.09	197874	364252766	79331
UTTAR PRADESH	RAMPUR	549	4 and 6	0.98	0.99	1.07	106	46369	0.01	184380	224380060	80920
UTTAR PRADESH	SAHARANPUR	550	4 and 10	0.85	0.85	1.33	1	63311	0.30	287808	453258001	87381
UTTAR PRADESH	SANTKABIRNAGAR	551	6	0.87	0.81	0.67	23	33039	0.01	121779	83910296	42024
UTTAR PRADESH	SANTRAVIDASNAGAR	552	4	0.55	0.65	0.93	63	20978	0.87	69528	56460824	8111
UTTAR PRADESH	SHAHJAHANPUR	553	6	0.95	0.96	0.59	0	39377	0.01	350718	218019908	83897
UTTAR PRADESH	SHRAWASTI	554	None	0.51	0.45	0.70	0	22391	0.00	131854	148963361	38452
UTTAR PRADESH	SIDDHARTHNAGAR	555	6 and 11	0.77	0.69	0.64	789	23122	0.01	235546	97899620	53551
UTTAR PRADESH	SITAPUR	556	None	0.73	0.78	0.70	0	37101	0.01	431176	288772643	131752
UTTAR PRADESH	SONBHADRA	557	1	0.15	0.15	0.43	5439	14575	0.11	168844	42971163	15137
UTTAR PRADESH	SULTANPUR	558	6	0.77	0.81	0.73	246	33241	0.05	176841	485252260	140769
UTTAR PRADESH	UNNAO	559	None	0.86	0.84	0.65	0	32861	0.01	308843	365882211	72422
UTTAR PRADESH	VARANASI	560	4 and 11	0.75	0.77	0.86	0	27091	0.79	94104	94903849	15401
UTTARANCHAL	ALMORA	561	9	0.28	0.06	0.00	11747	32064		78950	158606	0
UTTARANCHAL	BAGESHWAR	562	9	0.57	0.20	0.00	7473	30924		23786	6200	0
UTTARANCHAL	CHAMOLI	563	9	0.18	0.04	0.00	8915	43958	0.00	31071	11300	1
UTTARANCHAL	CHAMPAWAT	564	9	0.18	0.11	0.00	3395	28700	0.66	21464	3209260	644
UTTARANCHAL	DEHRADUN	565	7 and 9	0.73	0.50	0.12	18851	39831	0.70	43670	4284393	405
UTTARANCHAL	HARDWAR	566	9	0.88	0.89	0.56	5303	60561	0.26	109608	222859958	25776
UTTARANCHAL	NAINITAL	567	7 and 9	0.51	0.47	0.43	22073	51483	0.33	46033	4973419	749
UTTARANCHAL	PITHORAGARH	568	9	0.23	0.08	0.00	9081	29135		38173	59350	0
UTTARANCHAL	RUDRAPRAYAG	569	9	0.38	0.11	0.00	4366	26151		19947	0	0
UTTARANCHAL	TEHRI GARHWAL	570	7 and 9	0.51	0.09	0.00	25084	19424	0.00	127142	3200	16

State	District	S_No	Clusters	Irr_H	Irr_A	GW_Devt	T_CCA	Prod_Ha	Elec_W	NSA	kWh-equiv.	GWS
UTTARANCHAL	UDHAM SINGH NAGAR	571	7 and 9	0.90	0.93	0.79	80585	49185	0.02	135959	86387796	25907
UTTARANCHAL	UTTARKASHI	572	9	0.57	0.13	0.00	6772	42286		27665	26067	0
WEST BENGAL	BANKURA	573	7	0.52	0.43	0.40	107862	53966	0.21	282061	50955327	19119
WEST BENGAL	BARDDHAMAN	574	6, 7 and 10	0.90	0.88	0.36	23597	59664	0.47	465984	167127780	34641
WEST BENGAL	BIRBHUM	575	6 and 10	0.77	0.63	0.34	5875	67497	0.68	291158	65829911	11282
WEST BENGAL	DAKSHIN DINAJPUR	576	10	0.80	0.71	0.46	137	63143	0.13	189077	65360783	24096
WEST BENGAL	DARJILING	577	9	0.41	0.12	0.05	4867	81617	0.02	102551	3739715	1268
WEST BENGAL	HAORA	578	6 and 10	0.73	0.67	0.25	6951	114815	0.53	95459	25688970	791
WEST BENGAL	HUGLI	579	6 and 10	0.94	0.90	0.45	7502	75915	0.66	214412	97192071	16082
WEST BENGAL	JALPAIGURI	580	7	0.42	0.44	0.04	22766	72160	0.05	302206	20228925	10731
WEST BENGAL	KOCH BIHAR	581	10	0.78	0.61	0.17	50	69965	0.04	258737	54946869	42395
WEST BENGAL	KOLKATA	582	12									
WEST BENGAL	MALDAH	583	None	0.65	0.64	0.40	1721	75069	0.10	282094	112532307	26140
WEST BENGAL	MEDINIPUR	584	7 and 10	0.70	0.58	0.32	22838	62671	0.28	775569	230897281	61185
WEST BENGAL	MURSHIDABAD	585	10	0.92	0.86	0.79	2425	87826	0.18	433487	249781962	68711
WEST BENGAL	NADIA	586	4 and 10	0.94	0.91	0.92	1678	88997	0.13	335984	292736815	95163
WEST BENGAL	NORTH 24 PARGANAS	587	10	0.73	0.69	0.62	1573	73991	0.11	264478	189773398	52472
WEST BENGAL	PURULIYA	588	1 and 7	0.19	0.10	0.09	55544	34794	0.00	210617	2725128	3626
WEST BENGAL	SOUTH 24 PARGANAS	589	7	0.50	0.32	0.00	36661	54009	0.06	359543	38108275	6942
WEST BENGAL	UTTAR DINAJPUR	590	10	0.90	0.86	0.46	351	75599	0.03	245183	141822967	44795

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R. Sakthivadivel

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The IWMI-Tata Water Policy Program (ITP) was launched in 2000 as a co-equal partnership between the International Water Management Institute (IWMI), Colombo and Sir Ratan Tata Trusts (SRTT), Mumbai. The program presents new perspectives and practical solutions derived from the wealth of research done in India on water resource management. Its objective is to help policy makers at the central, state and local levels address their water challenges – in areas such as Sustainable groundwater management, water scarcity, and rural poverty – by translating research findings into practical policy recommendations.

Through this program, IWMI collaborates with a range of partners across India to identify, analyse and document relevant water management approaches and current practices. These practices are assessed and synthesized for maximum policy impact and published as IWMI-Tata Policy Papers, Water Policy Research Highlights and IWMI-Tata Comments. The research underlying these publications was funded with support from IWMI, Tata Trusts, CGIAR Research Program on Water, Land and Ecosystems (WLE) and CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS). The views expressed in the publications are of the author/s alone and not of ITP's funding partners. All IWMI-Tata publications are open access and freely downloadable from the Program's blog: http://iwmi-tata.blogspot.com

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