FAOWATER

AGWATER SOLUTIONS
Improved livelihoods for smallholder farmers

INVESTMENT BRIEF

Mapping and assessing the potential for investments in agricultural water management

West Bengal State

IWMI International Water Management Institute
IFPRI
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Background

The Agricultural Water Solutions Project

The Agricultural Water Solutions Project aims to unlock the potential of smallholder farming by identifying, evaluating and recommending a variety of agricultural water management (AWM) solutions - including technologies as well as the necessary supporting policies, institutions, financing arrangements and associated business models. This is being achieved through a series of interlinked activities in the seven project sites in Africa (Burkina Faso, Ethiopia, Ghana, Tanzania and Zambia) and in India (Madhya Pradesh and West Bengal). These activities include:

- in-depth case studies,
- mapping areas to identify where solutions are likely to be most viable and have greatest impact,
- discussing AWM solutions and project findings with stakeholders, and
- formulating business models to turn these findings into practical plans.

The national level analysis

This note presents the result of the national analysis. The analysis gathers available thematic maps and district statistics, and combines them with national livelihood maps which have been established through an in-depth consultation process to identify opportunities to invest in AWM in support to rural livelihoods. The suitability of different AWM solutions is then assessed and quantified in terms of investment opportunities and potential number of beneficiaries.

The methodology

Contrarily to classical water investment planning processes, this approach focuses on addressing poor rural people's needs rather than focusing on the development of potentially suitable resources. In so doing, the demand for investments in water is compared to the supply (availability of water). The demand for investments in water varies according to the needs of the population. In order to capture this demand, the project has adopted a *livelihood mapping* approach. This note presents the different steps followed in the national analysis:

1. Map the main livelihood zones, responding to the following questions:
   - what are the different farmer typologies and rural livelihood strategies?
   - what are the main water-related constraints and needs in the different rural livelihood contexts?
2. Map the potential and opportunities to improve smallholders' livelihood through water interventions: estimate the number and percentage of rural households who could potentially benefit from AWM interventions.
3. Map the suitability and demand for a series of specific AWM solutions, showing where they have the highest potential impact on rural livelihoods.
4. Estimate the potential number of beneficiaries, the potential application area and total investment costs for each AWM solution in each livelihood zone.

FAO has conducted and coordinated a participatory AWM mapping process in each project country in close collaboration with national partners. These products have been developed through a stepwise approach including national level data collection and processing, case study analysis, and local consultation. The livelihood map was developed during a participatory mapping workshop which gathered a large number of national experts from different fields (agriculture, water, social sciences, geography, etc.) and institutions (government, universities, NGOs, etc.) as well as farmers groups. This process was organised in two phases: 1) the purpose of a first workshop was to set up the basis for the analysis and start depicting the relationships between rural livelihoods and AWM and 2) a second or series of events - both at national and regional levels - to review the maps and refine the criteria used to define the potential for AWM and the suitability of different technologies. The outputs of the workshop have been enhanced through further consultation with national and international experts and through secondary data analysis using available national and sub-national datasets and statistics.

Mapping the livelihood context

Different people in different places have different needs

The purpose of livelihood maps

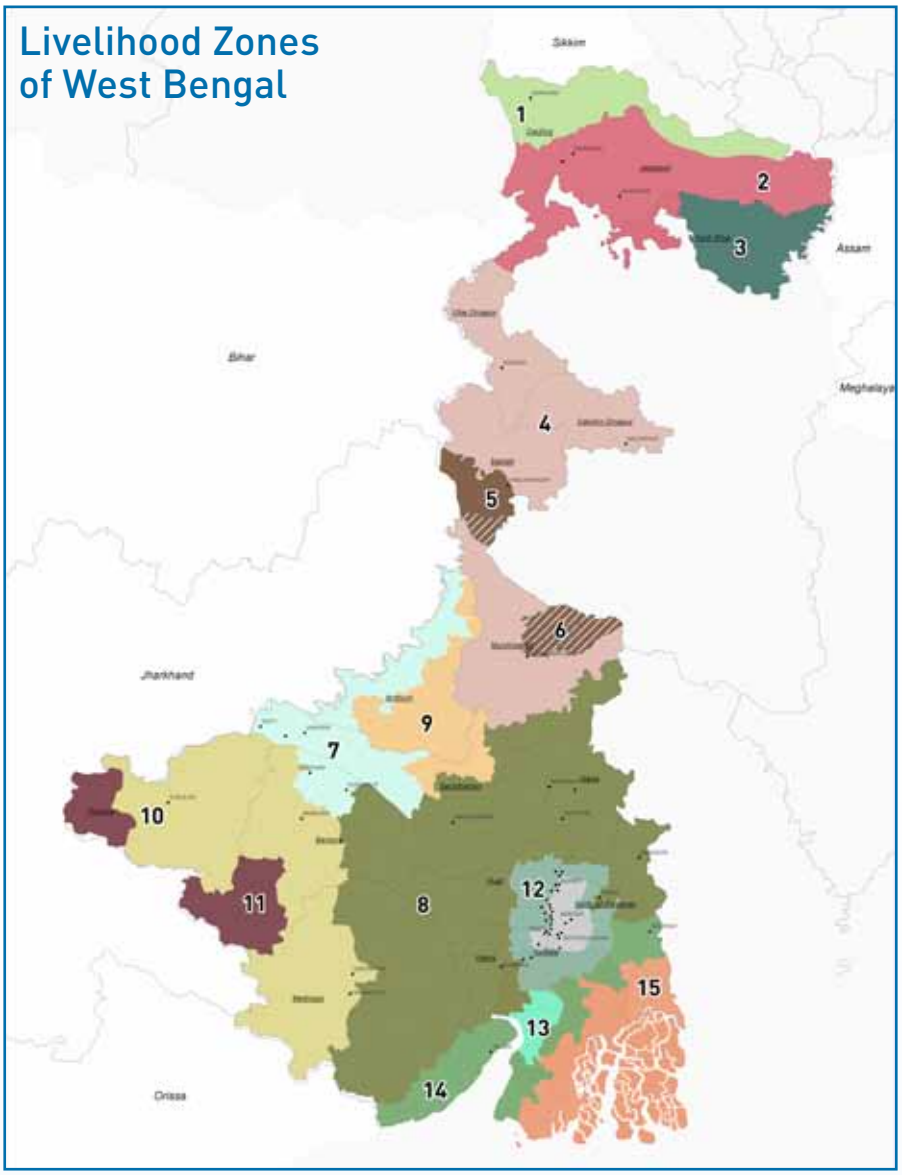
Livelihood mapping consists in identifying areas where rural people share relatively homogeneous living conditions, on the basis of a combination of biophysical and socio-economic determinants.

The main criteria to establish livelihood zones are: the predominant source of income (livelihood activities); the natural resources available to people and the way they are used; the prevailing agroclimatic conditions that influence farming activities, and access to markets.

In the absence of detailed local level statistics, the livelihood map is a useful tool to understand rural people dependence to water (access, vulnerability, resilience to shock) and the extent to which investments in water are critical to their development.

The map of livelihood zones is the result of a participatory mapping process involving a wide range of experts, professionals and farmers representatives. Each livelihood zone is described in details in terms of the main smallholders' livelihood strategies, dimensions of poverty, their water-related problems and other constraints for development, and the role agricultural water management plays for their livelihoods. Combined with the map of rural population, the livelihood map makes it possible to assess the demand for water-related interventions in each zone.

Generally, livelihood zone boundaries would coincide with administrative boundaries, but not always. In practice, homogenous agroecological and socio-economic zones often cross larger administrative units. In these cases the delineation is based on other criteria which better capture the delineation between different livelihoods patterns (topography, climatic data, land cover data, etc.).



Describing the livelihood context

Key typologies of farming population

The analysis of the livelihood context and expert consultations have allowed identifying different categories of farming and rural population. These categories have different characteristics, constraints, priorities and attitudes. In addition different AWM apporaactes and options can impact differently on their livelihoods. Assuming a degree of generalization, it is possible to identify five main typologies:

Patta-holders:

Patta" is the agricultural land donated by the Govt to the landless families. Patta-holders are landless farmers that received a small portion of land by the State. The "Patta" holders own the record of the land.

Bargadars:

Bargadars are more of the permanent sharecropper category. They cultivate in owners land and the total produce is divided in three equal parts. Two third of the total production is given to the Bargadar and one third is to the land owner. Out of the two third portion bargadar receives,50% is considered for land maintenance and rest 50% is considered as income to him/her. The owner can never sale or leaze out that particular land without the consent of the bargadar. The Bargadar can never own that particular land.

Landless:

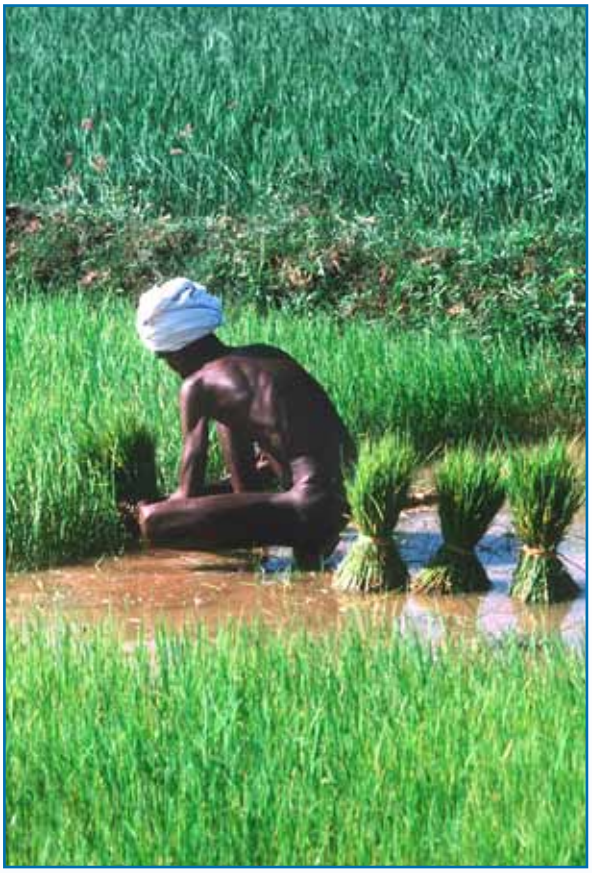
farmer who does not possess any land, depends on other's land for cultivation by providing their labour.

Marginal Farmers:

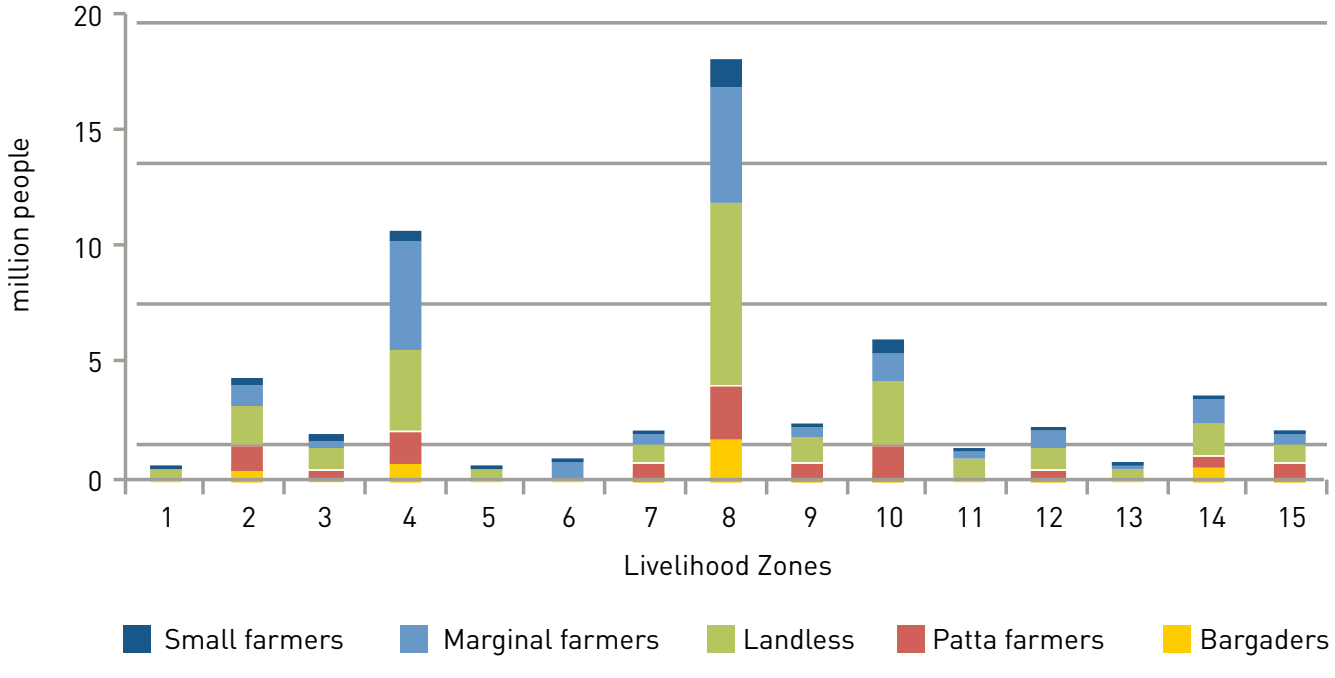
farmers with a land holding of 1 hectare or less (2.5 acres).

Small Farmers:

farmers with a land holding of 2 hectares (5 acres) or less.



Farming population distribution



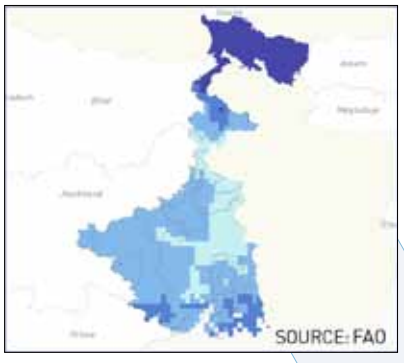
Key characteristics of livelihood zones

Zone	Key livelihood aspects	Main farmers typology	Rural population (million)	Rural Population density (pers/km²)	Main constraints for development reported	Main water-related issues reported
1	Hilly-Terai Rain-fed Grain Crops-Fruits-Vegetables-Spices- Livestock	Landless (labour), Marginal and Patta farmers	0.5	159	Roads, Governance, Erosion, Irrigation	uneven distribution of rainfall
2	Terai-Grain crops-Fiber-Vegetables-Livestock	Landless (labour)	4.3	659	Flow of capital, Local governance	uneven distribution of rainfall, lack of water from the command
3	Terai-Grain crops-Fiber-Tobacco-Vegetables-Livestock	Landless (labour)	1.9	745	Lack of irrigation facility, Industry, Inadequate employment	Scarcity of water in lean season, Water lifting devices
4	Barind Rain-fed- Grain crops-Pine apple-Fiber	Landless (labour) and Marginal farmers	10.7	972	lack of irrigation, flood prone, surface runoff, land erosion, market	Scarcity during dry season
5	Barind-Rice-Horticulture	Landless (labour) and Marginal farmers	0.5	806	Less technical knowhow, flood prone	Absence of water
6	Gangetic Alluvial & Barind- Rice-Sericulture	Marginal farmers	0.8	760	Agriculture is not the main source of livelihood. Illegal mining	decline in groundwater, heavy metal contamination
7	Ruhr & Alluvial-Grain crops-Poultry-Livestock	Landless (labour), Marginal and Patta farmers	2.0	636	Assured irrigation, Adequate storage facility and management work, Livestock - quality animals and market networks	decline in surface and groundwater, heavy metal contamination
8	Ruhr & Alluvial-Grain crops-Fishery-Poultry-Livestock-Cottage Industry	Landless (labour)	18.1	926	Water scarcity due to low irrigation coverage. Lack of improved agricultural practices, land erosion and depletion of forests.	Wells dry up in summer, Run off takes away the top soil
9	Old Vindhyan Alluvial-Grain crops-Fishery-Poultry-Livestock-Cottage Industry	Landless (labour)	2.4	664	Limited livelihood options, low irrigation coverage, depleting forest cover, political problem (Maoist insurgency). Problems created by elephants	Most sources dry up in summer
10	Ruhr & Alluvial-Grain crops-Livestock	Landless (labour)	6.0	507	Agric. inputs, quality irrigation water, lack of infrastructures absence technical knowhow, illiteracy	Presence of Toxic Chemicals incl. Heavy metal
11	Eastern Plateau & Alluvial-Grain crops-Livestock	Landless (labour)	1.2	402	Agric. inputs, quality irrigation water, lack of infrastructures absence technical knowhow, illiteracy	Salinity in drainage & irrigation canals
12	Coastal & Alluvial-Grain crops-Fishery-Floricultuer-Vegetable-Legumes-Livestock	Landless (labour) and Marginal farmers	2.2	1637	Agric. inputs, quality irrigation water, lack of infrastructures absence technical knowhow, illiteracy	Salinity in drainage & irrigation canals
13	Coastal-Grain crops-Horticulture-Livestock-Fishery	Landless (labour) and Marginal farmers	0.8	1100	Agric. inputs, quality irrigation water, lack of infrastructures absence technical knowhow, illiteracy	Salinity in drainage & irrigation canals
14	Coastal-Grain crops-Fishery-Livestock-Bund Horticulture	Landless (labour) and Marginal farmers	3.6	1113	Flow of capital, local governance	Lack of command, Lack of water for irrigation
15	Coastal-Small Scale Single crop (Grain/ Horticulture)-Capture Fishery	Landless (labour)	2.1	983	Assured irrigation, Adequate storage facility and management work, livestock – breeding quality and market networks	decline in surface and groundwater, heavy metal contamination

Mapping potential and opportunities for water interventions

Criteria used

1. Water availability (runoff)

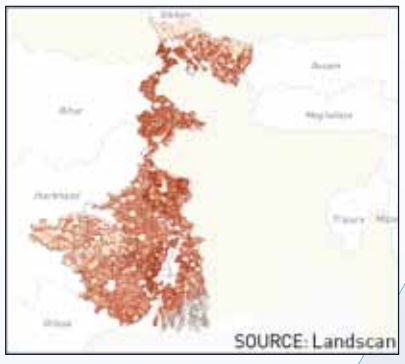


mm/y
- 500 - 750
- 750 - 1 000
- 1 000 - 1 250
- >1 250

2. Perception of water as limiting factor for agricultural production

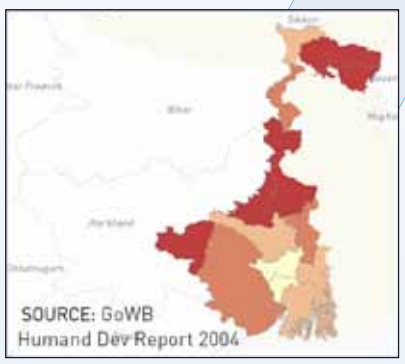
- High
- Moderate-High
- Moderate
- Low

3. Rural population density



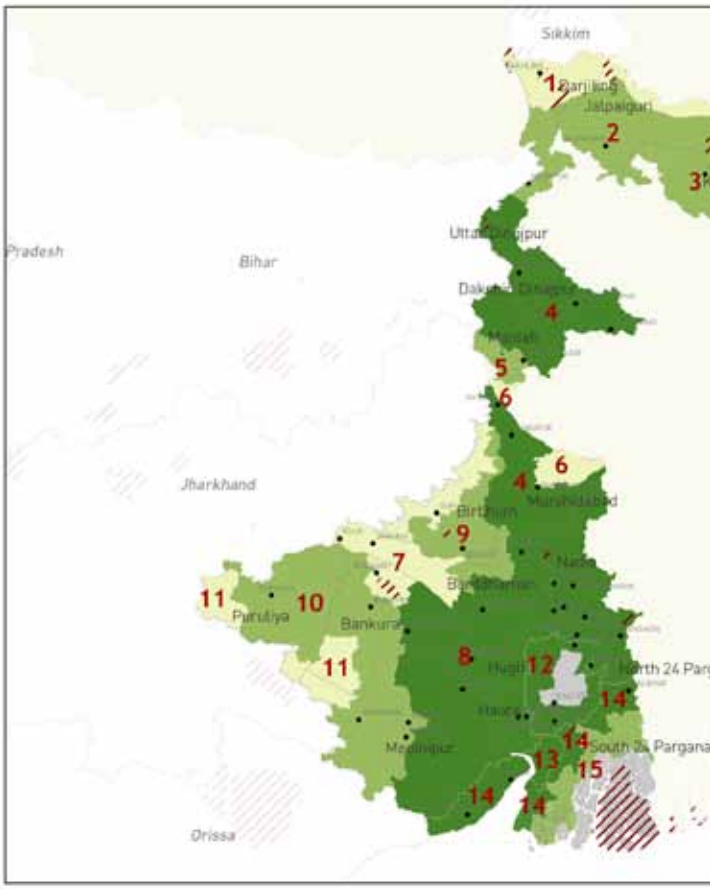
P /km²
- < 100
- 100 - 250
- 250 - 500
- > 500

4. Poverty (underweight prevalence among children)



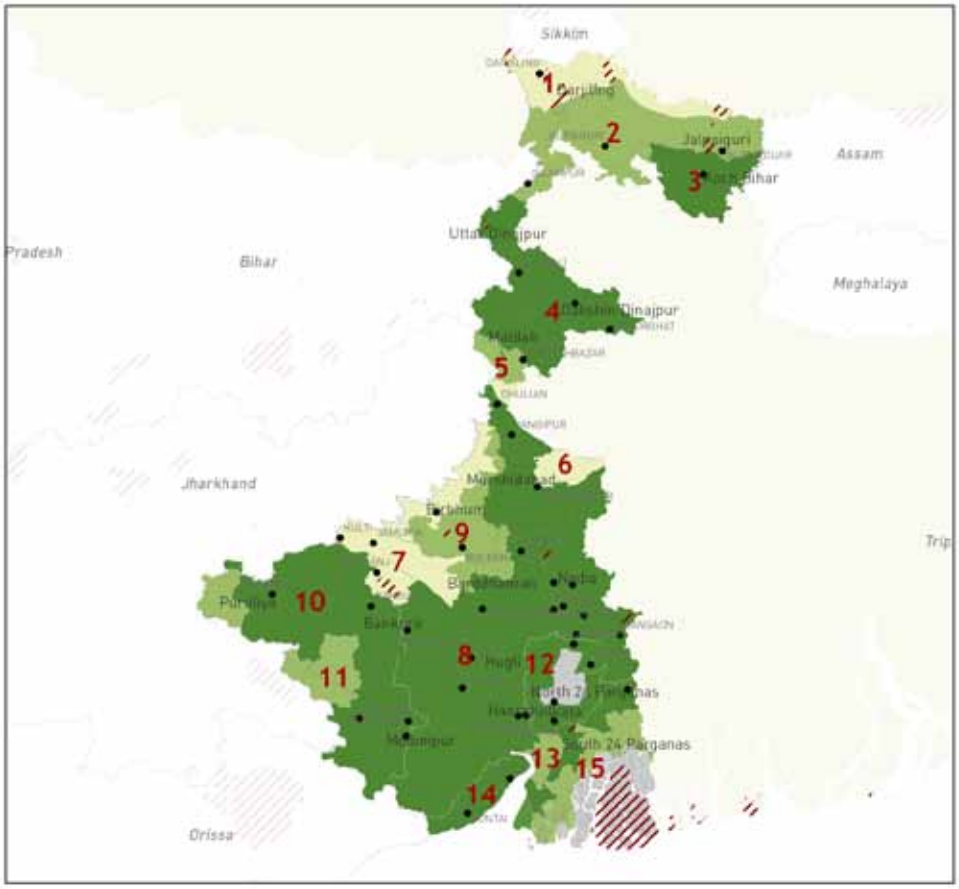
Health Index
- 0.49 - 0.61
- 0.62 - 0.68
- 0.69 - 0.74
- 0.75 - 0.82

Number of potential beneficiaries



The potential for investment in water in support to rural livelihoods is a function of the demand from rural population and the availability of the resource. The maps below show a distribution of rural population who could benefit from water-related interventions. The level of demand is based on the analysis of the livelihood zones described above, combined with poverty level.

The supply is a function of availability of water, calculated on the basis of well established thresholds of water per person (water development being constrained below 1700 m^3/pers.). These maps are generic.
The following pages show that the potential varies substantially as a function of the proposed technology.



Livelihood zone		Water availability: (m^3/p/y)	Rural population		Perception of water as limiting factor for agricultural production	Potential beneficiaries	
No	Name		Total (,000)	Density (p/ km^2)		Person (,000)	in % of rural population
1	Hilly-Terai Rain-fed Grain Crops-Fruits-Vegetables- Spices- Livestock	> 5,000	527	159	Low	79	15%
2	Terai-Grain crops-Fiber-Vegetables-Livestock	4,185	4,335	659	Medium	2,167	50%
3	Terai-Grain crops-Fiber-Tobacco-Vegetables-Livestock	3,861	1,851	745	High	1,481	80%
4	Barind Rain-fed- Grain crops-Pine apple-Fiber	906	10,717	972	High	8,574	80%
5	Barind-Rice-Horticulture	897	550	806	Medium	275	50%
6	Gangetic Alluvial & Barind- Rice-Sericulture	1,021	825	760	Low	124	15%
7	Ruhr & Alluvial-Grain crops-Poultry-Livestock	2,024	1,975	636	Low	296	15%
8	Ruhr & Alluvial-Grain crops-Fishery-Poultry-Livestock-Cottage Industry	919	18,097	926	High	14,477	80%
9	Old Vindhyan Alluvial Grain crops-Fishery-Poultry-Livestock-Cottage Indust	1,234	2,363	664	Medium	1,181	50%
10	Ruhr & Alluvial-Grain crops-Livestock	1,806	5,977	507	High	4,781	80%
11	Eastern Plateau & Alluvial-Grain crops-Livestock	2,164	1,219	402	Medium	610	50%
12	Coastal & Alluvial-Grain crops-Fishery-Floricultuer-Vegetable-Legumes-Lives*	960	2,217	1,637	High	1,774	80%
13	Coastal-Grain crops-Horticulture-Livestock-Fishery	731	753	1,100	Medium	377	50%
14	Coastal-Grain crops-Fishery-Livestock-Bund Horticulture	821	3,594	1,113	High	2,875	80%
15	Coastal-Small Scale Single crop (Grain/Horticulture)-Capture Fishery	1,060	2,094	983	Medium	1,047	50%

Mapping the suitability and demand for specific AWM solutions

The AWM options

The project selected a series of promising AWM technologies on the basis of a baseline study, validated by a national consultation workshop. The following solutions were retained and were the subject of in-depth research conducted by the project:

1. **Rural electrification for pumps**
   The solution would entail to reduce the cost of irrigation by providing a one-time capital cost subsidy to electrify 50% of pumps over the next 5 years in districts underlain by alluvial aquifers. This would also include a change in the electricity tariff structure to catalyze re-emergence of competitive groundwater markets, so that small and marginal water-buying farmers can access affordable irrigation services.

2. **Temporary diesel subsidies for pumps**
   The solution would entail the provision of a diesel subsidy to farmers owning less than 1 ha of land and no electric pumps, up to a maximum of 100 liters of diesel/ha, to help reduce the cost of cultivation.

   For the 3 options a biophysical suitability and the potential demand based on livelihood conditions have been assessed and mapped and are presented further down.

3. **Water harvesting ponds**
   The solution would entail to rehabilitate/build small water harvesting ponds (*hapas*) to store rainwater and increase recharge (see section on rainwater harvesting). The introduction of "*hapas*" would provide many benefits including enabling farmers to cultivate previously fallow land, higher crop intensity, new crops, more livestock and fish.

Biophysical suitability

The map uses a set of criteria to assess the potential geographical extent of each AWM solution. These criteria represent the distribution of the biophysical conditions under which a AWM solution can have the potential highest impact on livelihoods. The maps show two levels of suitability:

- High suitability: areas which present optimal conditions both in terms of biophysical and infrastructure conditions for adoption of a given AWM solution.
- Moderate suitability: areas where there are possibilities for application of a given AWM solution, but where conditions are less favourable.

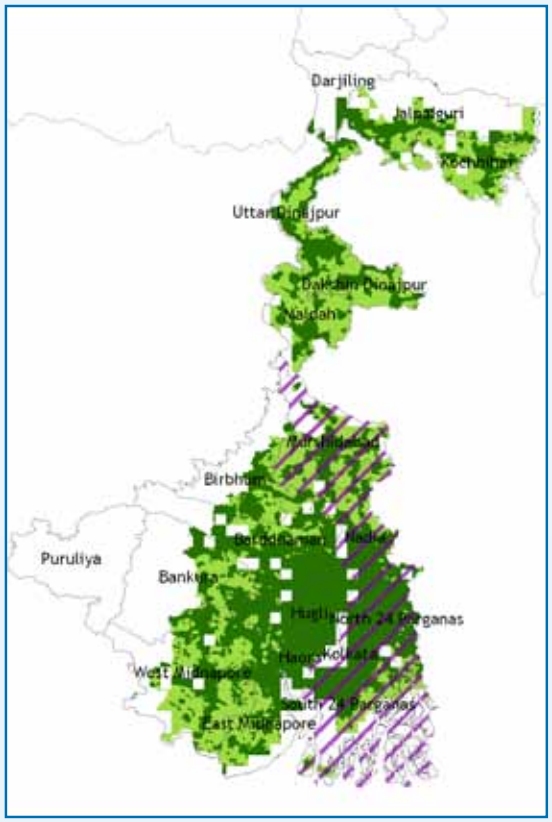
Livelihood-based demand

Local consultations and individual expert knowledge allowed expressing the potential demand for a technology among the population living in the different livelihood zone and provided more in-depth information on the potential adopters. These are for instance: farmer typology, vulnerability to shocks, dependence on water resources, and average landholding size.

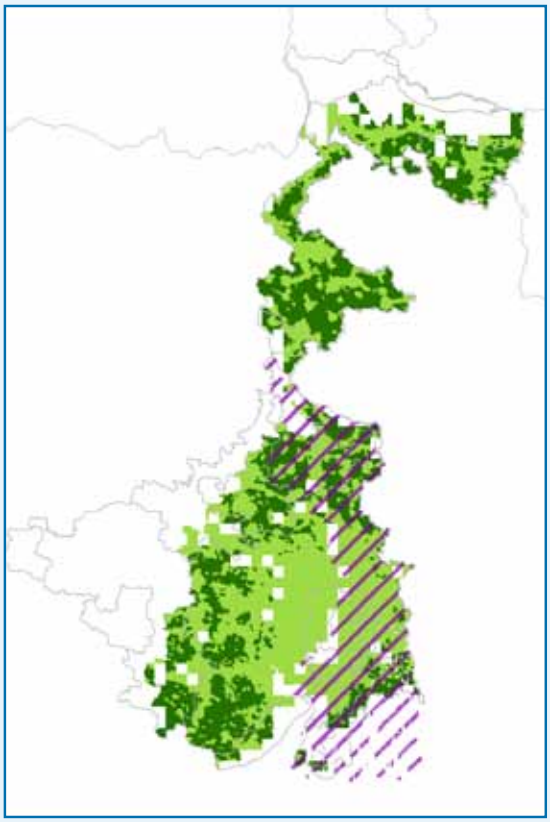
The resulting map shows distribution of these factors in the different livelihood zones which, in turn, identify areas where livelihoods conditions are more favourable for a given AWM solutions.

Solution 1: Suitability domains for small pumps

Rural electrification



Diesel subsidies



Biophysical criteria and conditions

Soil properties (HWSD)

Night lights (NOAA - DMSPv4)

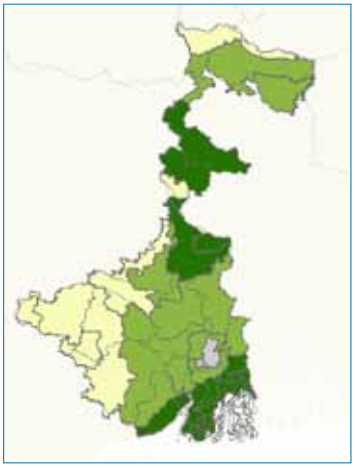
Biophysical criteria and conditions	
Soils	**Night lights**
Requirement: alluvial soils	Rural electrification: Highly suitable in areas where electricity grid is in place (night lights present)
Requirement: alluvial soils	Diesel subsidies: Highly suitable in rural areas not connected to the grid

Physical suitability for small pumps has been assessed on the basis of soil properties (alluvial soils in this area depict groundwater potential) and night lights assuming that, where electricity grid is in place, rural electrification is the most straightforward option as opposed to diesel subsidies, to be preferred in absence of electricity grid.

Livelihood-based demand

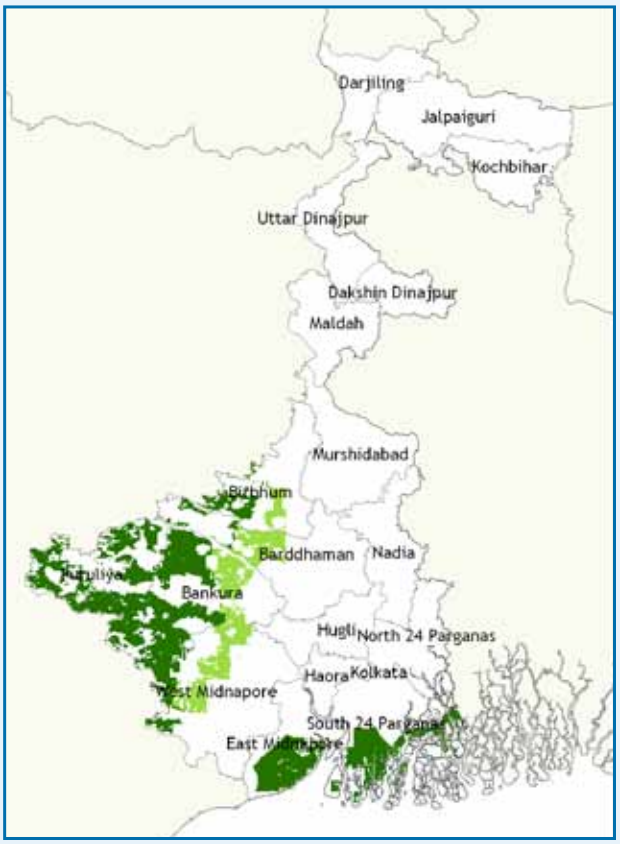
The livelihood-based demand is assessed through the analysis of the livelihood context of the zone.
In particular, the context is assumed to be more favorable in zones with relatively higher prevalence of:

- **Marginal and small farmers**
  Farmers currently owning pumps are mainly marginal farmers. In addition, given the capital investment, farmers who own the land are considered to be more willing to invest on this technology
- **Higher cropping intensity**
- **High cropping intensity is associated with this technology that implies the production of rice and high value crops for market sales.**



Solution 2: Water harvesting ponds

Biophysical suitability

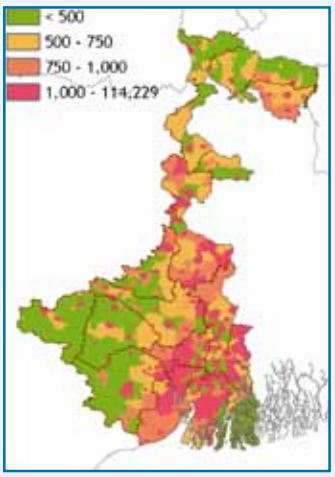


Highly suitable Moderately suitable

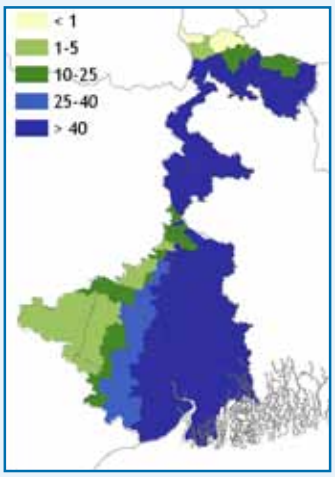
Physical suitability for water harvesting has been assessed on the basis of: low groundwater yield (block aggregated values), lower population density, length of growing period (shorter LGP area preferred), and occurrence of Thionic Fluvisols as an indication of seawater intrusion.

Biophysical criteria and conditions

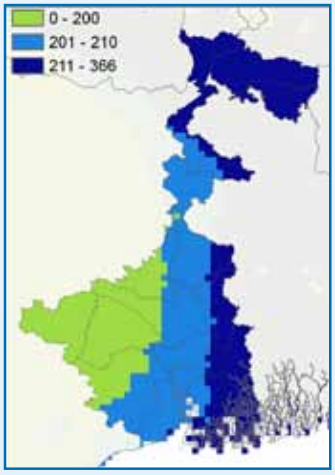
Population Density (p/sq km)



GW Yield by Block (l/s)



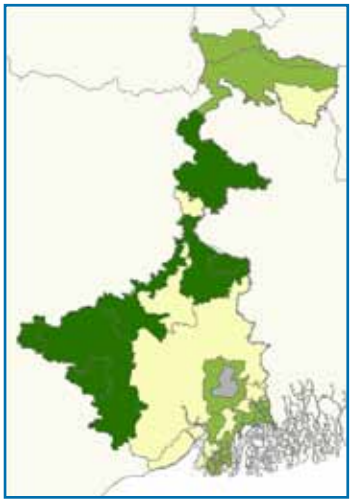
Length of Growing Period (days)



Soil (HWSD)

Biophysical criteria and conditions			
Population density	**Groundwater yield**	**LGP**	**Soil**
Required: < 500 p/sq km	Required: < 25 l/s	Highly suitable: < 200 days	Thionic Fluvisols (coast only)

Livelihood-based demand



The livelihood-based demand is assessed through the analysis of the livelihood context of the zone.
In particular, the context is assumed to be more favorable in zones with relatively higher prevalence of:

- **Marginal farmers**
  this technology would imply having sufficient land to construct the pond. Therefore, this typology of farmers is considered to be more in demand of this technology
- **Areas where groundwater resources are partially or totally depleted.**
  Farmers residing in these areas are considered to be more in demand of this technology as they cannot make use of groundwater.

High
Medium-high
Medium-low

Estimate the potential benefits of investing in AWM

Potential beneficiaries and application areas

Potential beneficiaries (rural households)
– 50% of adoption rate

Livelihood zones	Rural electrification				Diesel subsidies				Water harvesting			
	(,000 households)		(% total househ.)		(,000 households)		(% total househ.)		(,000 households)		(% total househ.)	
	min	max	min	max	min	max	min	max	min	max	min	max
1	1	2	0.20%	0.30%								
2	133	288	3.10%	6.70%	70	227	1.60%	5.20%				
3	49	151	2.70%	8.20%	73	158	3.90%	8.60%				
4	368	899	3.40%	8.40%	387	896	3.60%	8.40%				
5	20	47	3.60%	8.50%	9	35	1.60%	6.40%				
6	31	79	3.80%	9.60%	41	80	5.00%	9.70%				
7	34	65	1.70%	3.30%	7	48	0.40%	2.40%	27	70	1.40%	3.50%
8	1 018	1 799	5.60%	9.90%	273	1 386	1.50%	7.70%	21	57	0.10%	0.30%
9	72	172	3.10%	7.30%	56	165	2.40%	7.00%	8	29	0.30%	1.20%
10	51	149	0.90%	2.50%	56	148	0.90%	2.50%	157	242	2.60%	4.10%
11									74	93	6.10%	7.60%
12	151	245	6.80%	11.10%		150		6.80%				
13	43	58	5.70%	7.70%		37		4.90%	11	14	1.40%	1.80%
14	149	250	4.20%	6.90%	57	228	1.60%	6.30%	66	84	1.80%	2.30%
15	**45**	**154**	**2.10%**	**7.30%**	**94**	**169**	**4.50%**	**8.10%**	**29**	**37**	**1.40%**	**1.80%**
Total	**2 166**	**4 358**	**3.80%**	**7.60%**	**1 123**	**3 727**	**2.00%**	**6.50%**	**393**	**626**	**0.70%**	**1.10%**

Potential application area (ha)
– 50% of adoption rate

Livelihood zones	Rural electrification				Diesel subsidies				Water harvesting			
	(,000 households)		(% total househ.)		(,000 households)		(% total househ.)		(,000 households)		(% total househ.)	
	min	max	min	max	min	max	min	max	min	max	min	max
1		1	0.60%	1.00%								
2	53	115	12.10%	26.30%	28	91	6.40%	20.70%				
3	20	61	7.90%	24.10%	29	63	11.60%	25.20%				
4	147	359	13.50%	33.00%	155	359	14.20%	32.90%				
5	8	19	12.50%	29.60%	4	14	5.60%	22.20%				
6	13	32	11.60%	29.30%	16	32	15.20%	29.50%				
7	14	26	3.70%	7.10%	3	19	0.80%	5.30%	41	105	11.20%	28.60%
8	407	720	20.30%	35.90%	109	554	5.40%	27.60%	31	85	1.60%	4.20%
9	29	69	8.90%	21.00%	22	66	6.90%	20.20%	12	44	3.70%	13.40%
10	20	60	2.00%	6.00%	23	59	2.30%	5.90%	235	363	23.50%	36.30%
11			0.00%					0.00%	112	139	52.30%	65.10%
12	60	98	26.80%	43.60%		60		26.60%				
13	17	23	40.10%	54.00%		15		33.90%	16	20	37.20%	47.30%
14	60	100	27.30%	45.60%	23	91	10.40%	41.60%	98	127	44.90%	57.80%
15	**18**	**61**	**13.30%**	**45.80%**	**38**	**68**	**28.00%**	**50.40%**	**44**	**56**	**32.50%**	**41.80%**
Total	**866**	**1 743**	**13.20%**	**26.60%**	**449**	**1 491**	**6.90%**	**22.80%**	**589**	**939**	**9.00%**	**14.30%**

Note: the above potentials are considered independently for each AWM option. There is therefore a possibility of double counting, i.e. the same rural household benefitting several AWM options. The total investment potential, areas and beneficiaries for the four options is likely to be less than the sum of the options taken separately

Assumptions

The maps are used to assess the potential number of beneficiaries and the extent of land which could benefit from any of the AWM solutions.

The calculations are performed as follows:

1. The figures reflect the assumption that 50% of farmers, among those who could potentially benefit from the AWM option, are able or willing to adopt it.
2. the total number of rural people falling into the areas of high or low suitability is calculated on the basis of a rural population density map. These results are then aggregated by livelihood zone
3. the description of the livelihood zones allows for the establishment of a factors that represents the part of the rural population which is likely to benefit from a given AMW solution. The factor reflects the importance of a given solution for the population living in the livelihood zone.
4. A unit area of land per household that can benefit from a given AWM solution is established on the basis of information obtained from the case studies and literature, i.e. 1.5 ha for water harvesting and 0.4 ha for pumps i.e. both rural electrification and diesel subsidies solutions.. The number of potential beneficiaries, expressed in number of households, is then used to calculate the extent of land that could benefit from the solution. From national statistics , the state average household size is 4.5 persons.
5. The result is assessed against current extent of cropland in the suitable area, and in terms of its impact on the water balance, and adjusted downwards if needed.
6. the factors derived from sub-national statistics and livelihood mapping exercise (eg. farmers typology, livelihood typology, land holding size etc.) are applied as de-multiplying factors.

Estimate the potential benefits of investing in AWM

Investments costs

Tentative estimation of investment cost (Million USD) - 50% of adoption rate				
Livelihood zones	Diesel Subsidies		Water harvesting ponds	
	min	max	min	max
1	0	0		
2	2.2	7.1		
3	1.8	4		
4	13.2	30.7		
5	0.2	0.9		
6	1.8	3.5		
7	0.2	1.3	129	318
8	6.9	35.2	99	265
9	1.2	3.5	38	136
10	1.5	3.8	738	1,074
11	-	-	351	406
12	0	4	-	-
13	-	1	50	64
14	1.6	6.5	309	399
15	**2.9**	**5.2**	**137**	**177**
Total	**34**	**107**	**1851**	**2 840**

Calculating investment costs

The following assumptions have been made to assess investment cost for each AWM option.

1. The investment cost for rural electrification have not been calculated.
2. Water harvesting ponds:
   - based on expert knowledge the land allocated for water harvesting is calculated as 10% of the number of potential benefitted households multiplied by the country average landholding size (1.57 ha/household).
   - For each ha allocated for water harvesting there are 30 000 m3 of water stored.
   - An upper limit would apply to potential application area, should the total volume of stored water exceed 30% of total annual runoff, at state level .
3. Diesel subsidies:
   - The subsidy consist in 100 litres of diesel per ha. of diesel cost.
   - it is assumed that 75% of marginal farmers and 100% of Patta-holders would be eligible for subsidies.
   - Based on the surveys conducted by the project, it is assumed that the average landholding of pump owner is 0.4 ha and that the cost of diesel is approximately 0.75 US$/l.

Investment costs at state level		
AWM options	Unit cost	Investment costs (min-max)
		Million US$
Water harvesting	1 US$/per m3 of water stored	1 851 – 2 940
Diesel subsidies (100l/ha)	~75 US$/ha	34 – 107

For more information consult the project website **http://awm-solutions.iwmi.org**
or the FAO Water website **www.fao.org/nr/water/projects_agwatermanagement.html.**
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