Madhya Pradesh State - India

DRAFT

Assessment of investment potential for selected AWM interventions

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.

This note presents the result of the national analysis and mapping. National livelihood maps have been established through an in-depth consultation process. Opportunities to invest in AWM at the national level to improve rural livelihoods have been mapped, and the potential and suitability of different AWM solutions have been quantified.

More specifically, the work aimed to:

1. Map the main livelihood contexts in each project country or state, responding to the following questions:
   - what are the main constraints and needs in the different rural livelihood contexts?
   - what are the different farmer typologies and rural livelihood strategies?
2. Map the potential to improve smallholders' livelihood through water interventions:
   - where to invest in AWM to have the maximum impact on rural livelihoods?
   - where is AWM the entry point for improving rural livelihoods?
3. Map the geographical domain of specific AWM solutions:
   - where the specific AWM solutions have highest potential impact on rural livelihoods?
4. Estimate the potential benefits of investing in AWM:
   - how many potential beneficiaries for each AWM solution?
   - how much is the potential application area for each AWM solution?

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 workshops 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.

For more information contact Guido Santini (guido.santini@fao.org) or Livia Peiser (livia.peiser@fao.org)

Mapping the livelihood context

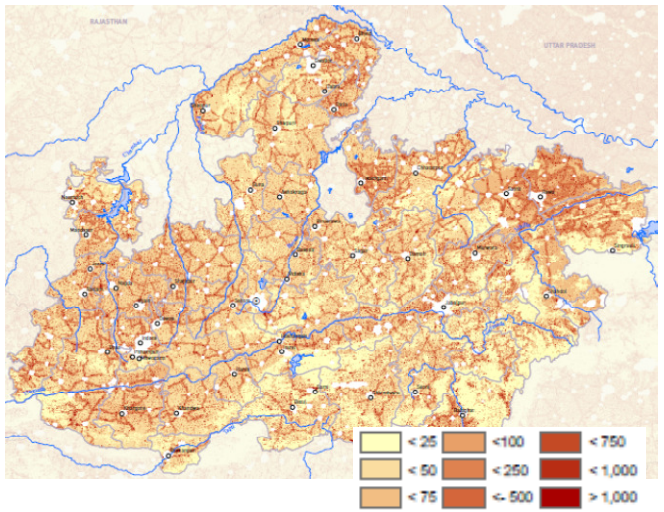
different people have different needs

1. North Malwa-Chittor zone - Opium-silica production
2. Western Malwa Hill Zone - Bhil tribe predominant
3. Nimar Plains Zone - Hot dry Cotton Chilli Banana Sugarcane
4. Malwa Plateau plain zone - Traditional agriculture (spices production)
5. Eastern malwa extension zone - quality wheat and pigeon pea production
6. Industrial/Urban Sub Zone of Malwa (Indore and Bhopal)
7. Northern Chambal Ravines Zone - Irrigated mustard predominant
8. Gwalior Zone - Pastoral and dry degraded mining area
9. South Chambal Zone - Progressive farming, wheat-soya
10. Lower Bundelkhand Zone – low socioeconomic development, low productivity wasteland
11. Upper Bundelkhand Zone – low socioeconomic development, low productivity wasteland
12. Western Baghelkhand zone - Forest, game reserve and energy production
13. Eastern Baghelkhand zone - Forest, game reserve and energy production
14. Central Narbada Sub Zone - Irrigated Intensive agriculture production (horticulture)
15. Satpura Hills Mahakaushal Zone – Tribal forest gatherers and dry land farmers
16. Mahakaushal Maikal Hill Zone – Forest, water rich, subsistence (millet) tribal zone
17. Upper Narbada Sub Zone – Mixed commercial tribal farmers, industrial activities

Livelihood zoning 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; and the prevailing agroclimatic conditions that influence farming activities. Patterns of livelihood vary from one area to another, based on local factors such as climate, soil or access to markets. The analysis delineates geographical areas within which people share similar livelihood patterns: source of living, access to food, farming practices, including crops, livestock and access to markets.

The map of livelihood zones is the main output from a participatory mapping workshop and forms the basis for the overall assessment. It describes and geographically locates the different livelihood contexts in the state, focusing on the main smallholders' livelihood strategies, their water-related problems and other constraints for development, and the role agricultural water management plays for their livelihoods. An attribute table provides a detailed description of each livelihood zone.

Rural population density (p/sq km)



Mapping the livelihood context
different people have different needs

Key characteristics of livelihood zones

Zone	Key livelihood aspects	Main farmers typology	Rural Population	Poverty rate	Main constraints for development	Vulnerability to droughts
1.	North Malwa-Chittor zone - Opium-silica production	Commercial farmers	2 476 460	Low	lack of watershed management, groundwater recharge	High
2.	Western Malwa Hill Zone - Bhil tribe Predominant	Traditional farmers and landless	1 379 170	High	lack of watershed management, agricultural inputs	High
3.	Nimar Plains Zone - Hot dry Cotton Chilli Banana Sugarcane	Traditional and commercial farmers	3 797 030	Moderate	water infrastructures and management, market regulation	High
4.	Malwa Plateau plain zone - Traditional agriculture (spices production)	Traditional and commercial farmers	5 763 740	Moderate	lack of watershed management, groundwater recharge	High
5.	Eastern malwa extension zone - quality wheat and pigeonpea production	Traditional and commercial farmers	3 111 900	Moderate	water infrastructures and management, agricultural inputs	Moderate
6.	Industrial/Urban Sub Zone of Malwa (and)	Commercial farmers and landless	1 059 100	Low	water conservation, groundwater recharge	High
7.	Northern Chambal Ravines Zone - Irrigated mustard predominant	Traditional farmers and landless	2 786 660	High	irrigation infrastructures, land reclamation	Low
8.	Gwalior Zone - Dry degraded mining and Pastoral	Traditional farmers	1 203 090	High	irrigation infrastructures, lack of watershed management	High
9.	South Chambal Zone - Progressive farming, wheat-soya	Commercial and traditional farmers	2 722 420	Low	irrigation infrastructures, extension services	Low
10.	Lower Bundelkhand Zone – low socioeconomic development, low productivity wasteland	Traditional and commercial farmers	2 560 280	Moderate	access to water, irrigation infrastructures	High
11.	Upper Bundelkhand Zone – low socioeconomic development, low productivity wasteland	Traditional farmers	2 492 840	High	watershed management, tanks renovation, water distribution	High
12.	zone - , game reserve and energy production	Traditional farmers	4 640 360	High	water conservation, extension services	High
13.	zone - , game reserve and energy production	Traditional farmers	2 820 120	Moderate	water infrastructures and management, extension services	Moderate
14.	Central Narbada Sub Zone - Irrigated Intensive agriculture production (horticulture)	Traditional and commercial farmers	1 273 340	Moderate	irrigation infrastructures, extension services	Moderate
15.	Satpura Hills Mahakaushal Zone – Tribal forest gatherers and dry land farmers	Traditional and commercial farmers, landless	2 793 130	High	water infrastructures and management, credit	Moderate
16.	Mahakaushal Maikal Hill Zone – , water rich, subsistence (millet) tribal zone	Traditional farmers	4 137 440	High	water infrastructures and management, extension services	Moderate
17.	Upper Narbada Sub Zone – Mixed commercial tribal farmers, industrial activities	Commercial farmers	2 651 370	Moderate	water infrastructures and management, extension services	Moderate

Mapping the AWM potential

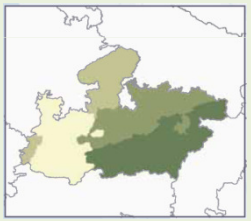
This map shows where AWM can be the entry point for improving livelihoods and where to prioritize investments in AWM to have the maximum impact on rural livelihoods. High potential areas are those showing the highest potential for AWM investment. These areas are identified on the basis of three guiding principles: i) where water is available ii) where the target beneficiaries are mostly located; and iii) where water is key for livelihoods.
More specifically:

i) **Physical availability of water** (rainfall, surface or shallow groundwater). It shows where water is physically available to be used for AWM. It takes into account surface water and shallow groundwater resources and their current state of use.

ii) **Presence of target beneficiaries** (rural population, rural poverty). It shows where the target beneficiaries of AWM investments are mostly concentrated. It is assessed using population density and rural poverty rate.

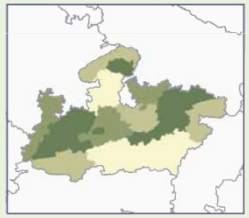
iii) **Water is a limiting factor for livelihoods**: To what extent livelihoods depend on secure access to sufficient water, and where lack of water is a major constraint for rural populations. Population pressure on water, erratic rainfall and seasonality, vulnerability to droughts and dry spells are examples of situations where the lack of secured access to sufficient water represents a major constraint for rural livelihoods. It is assessed mainly on the basis of the description of the livelihood zones and farmers typologies. This criterion is based on expert judgment jointly with the assessment of human pressure on water resources (based on the available annual runoff per person).

i) Physical availability of water



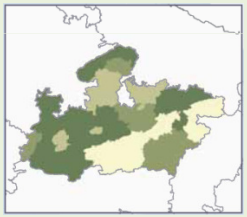
Physical availability of water		
LZ	Surface water availability (km3/yr)	Shallow groundwater potential (% of LZ area)
1	7.8	20%
2	3.7	100%
3	11.8	80%
4	17.6	20%
5	18.6	60%
6	4.4	50%
7	7.1	100%
8	3.6	100%
9	12.5	100%
10	13.7	100%
11	9.3	95%
12	17.5	95%
13	16.0	100%
14	9.4	100%
15	17.2	95%
16	29.8	100%
17	13.1	100%

ii) Presence of target beneficiaries



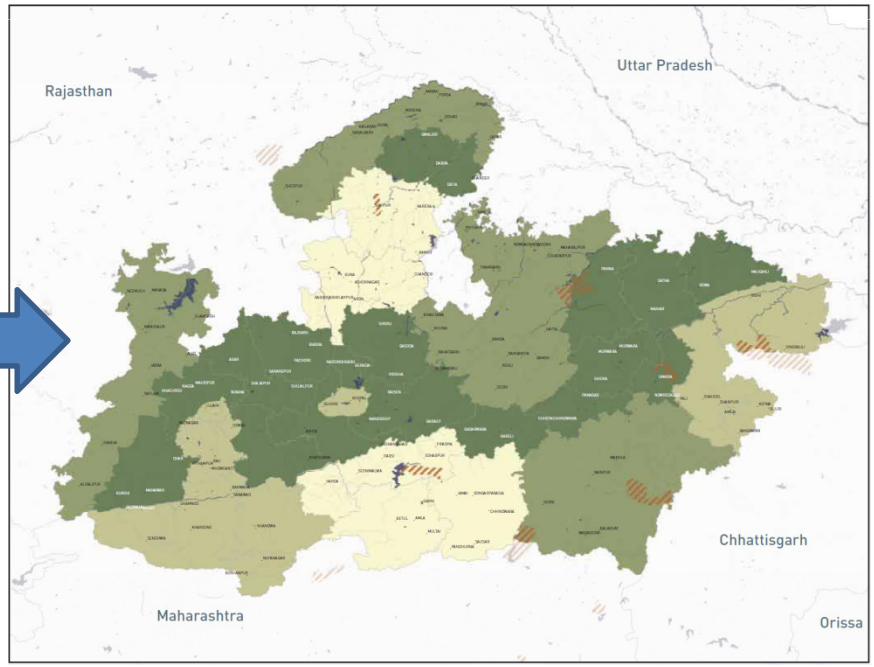
Presence of target beneficiaries		
LZ	Rural population (million people)	Rural poverty (based on Underweight Prevalence)
1	2.5	54.9%
2	1.4	54.8%
3	3.8	54.9%
4	5.8	55.2%
5	3.1	55.2%
6	1.1	55.2%
7	2.8	55.0%
8	1.2	55.2%
9	2.7	55.1%
10	2.6	55.2%
11	2.5	54.9%
12	4.6	55.1%
13	2.8	55.1%
14	1.3	55.2%
15	2.8	55.1%
16	4.1	55.1%
17	2.7	55.2%

iii) Water is a limiting factor for livelihoods



Water is a key constraint for livelihoods		
LZ	Pressure on water resources	To what extent livelihoods are depending on water (expert judgment)
1	moderate to high	high
2	high	high
3	moderate to high	high
4	high	high
5	low	moderate
6	low to moderate	moderate
7	high	high
8	high	high
9	low to moderate	low
10	low to moderate	moderate
11	moderate to high	moderate
12	moderate to high	moderate
13	low	low
14	low	low
15	low	low
16	low	low
17	low to moderate	low

Potential for investments on AWM for smallholders



Mapping the suitability and demand for specific AWM solutions

The potential for application of the following AWM solutions at national level was assessed on the basis of the case study conducted by the project:

- Ex-situ water harvesting

For this AWM option, a biophysical suitability and the potential demand based on livelihood conditions have been mapped

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.

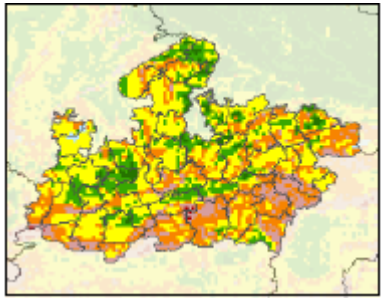
Livelihood-based Demand

The expert consultations allowed assessing factors that express the potential demand for a technology among the population living in the livelihood zone and provided more in-depth information on the potential adopters. These are for instance: farmer typology and attitude, 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, identifies areas where a given AWM solutions is more likely to improve livelihoods.

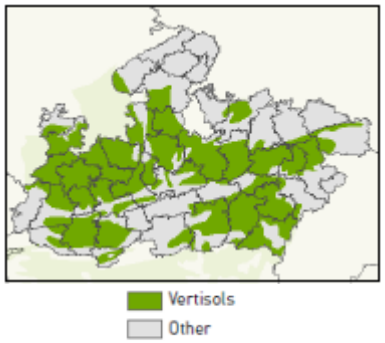
Ex-situ water harvesting
Rewa sagar* water harvesting model

Biophysical criteria and conditions

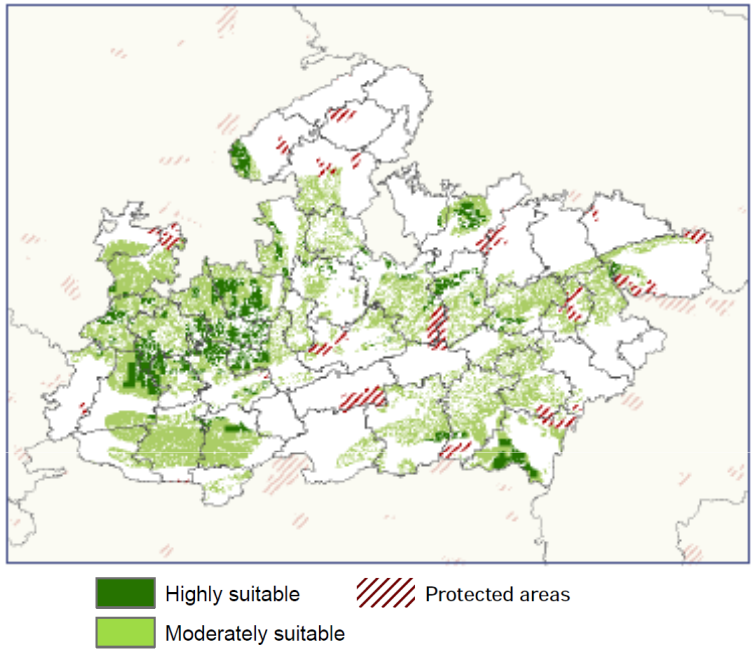
Topography (Slope)



Soils



Biophysical suitability

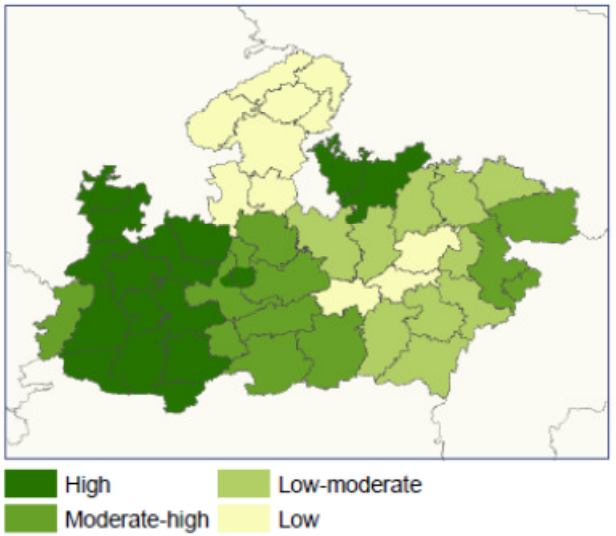


Biophysical criteria and conditions	
Soils	Topography
Requirement: presence of vertisols	**High:** < 5% slope; **Moderate:** >5% slope

Physical suitability for ex-situ water harvesting and, in particular, Rewa sagar model, has been assessed on the basis of soils (vertisols) and steepness (slope < 5 % is assumed to be more suitable). Vertisols, due to their clay content and compactness, are assumed to be more suitable for water harvesting.

**individual on-farm ponds, about 1/10 to 1/20 of land holding size*

Livelihood-based demand



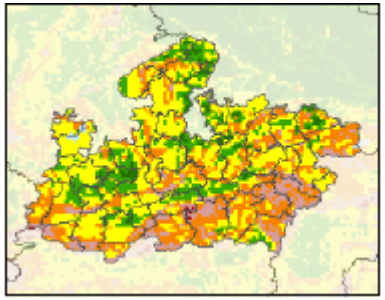
Livelihood-based demand

The context is assumed to be more favourable in zones with relatively higher vulnerability to droughts and in areas where groundwater resources are partially or totally depleted.

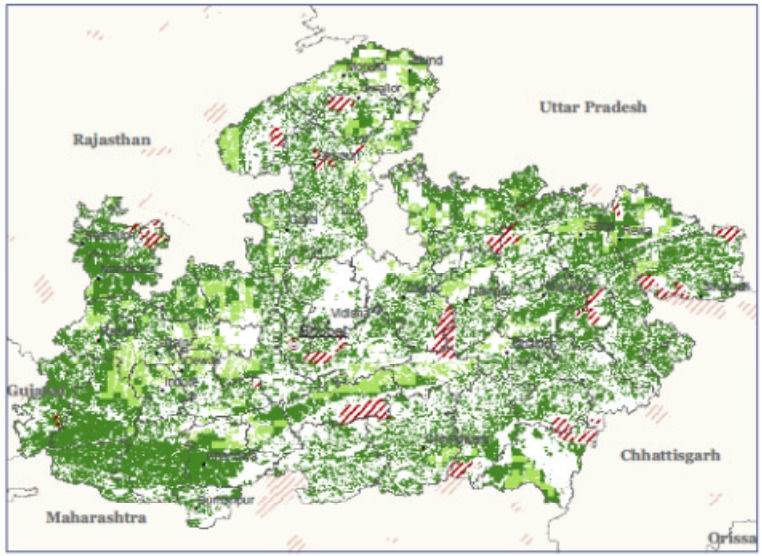
Soil and Water conservation (field bunding)

Biophysical criteria and conditions

Topography (Slope)



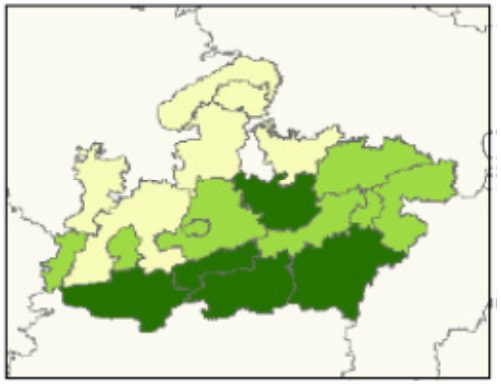
Biophysical suitability



Biophysical criteria and conditions
Topography
High: > 5% slope; **Moderate:** > 2% slope

Physical suitability for soil and water conservation (field bunding) has been assessed on the basis of slope: moderately suitable with slope > 2% , and highly suitable with slope > 5%.

Livelihood-based demand



Livelihood-based demand

The context is assumed to be more favourable in zones with relatively higher vulnerability to droughts and in areas with higher poverty rates.

Estimate the potential benefits of investing in AWM

Potential beneficiaries, application areas and investments costs

Potential beneficiaries (rural households) - 50% of adoption rate								
Livelihood zones	Rewa sagar				Soil and Water conservation			
	(,000 households)		(% total househ.)		(,000 households)		(% total househ.)	
	min	max	min	max	min	max	min	max
1	19	162	1%	7%	144	170	6%	7%
2	2	16	0%	1%	77	83	6%	6%
3	11	184	0%	5%	204	240	5%	6%
4	131	334	2%	6%	241	360	4%	6%
5	15	60	0%	2%	61	87	2%	3%
6	23	49	2%	5%	30	55	3%	5%
7	14	21	0%	1%	44	102	2%	4%
8					23	41	2%	3%
9	7	62	0%	2%	65	98	2%	4%
10	21	89	1%	3%	81	107	3%	4%
11	9	27	0%	1%	85	128	3%	5%
12		47	0%	1%	167	232	4%	5%
13	4	62	0%	2%	135	157	5%	6%
14		1		0%	41	78	3%	6%
15	3	52	0%	2%	107	124	4%	4%
16	33	194	1%	5%	200	248	5%	6%
17	8	78	0%	3%	86	124	3%	5%
Total	**299**	**1 436**	**1%**	**3%**	**1 791**	**2 435**	**4%**	**5%**

Potential application area (ha) - 50% of adoption rate								
Livelihood zones	Rewa sagar				Soil and Water conservation			
	(,000 ha)		(% total agric. land)		(,000 ha)		(% total agric. Land)	
	min	Max	min	max	min	max	min	Max
1	28	243	3%	24%	320	377	32%	38%
2	3	24	1%	6%	170	184	40%	43%
3	16	275	1%	18%	452	532	30%	35%
4	197	500	9%	24%	536	800	26%	38%
5	22	89	2%	10%	135	194	16%	22%
6	34	73	10%	21%	66	123	19%	35%
7	21	31	2%	4%	98	226	11%	26%
8					52	91	13%	23%
9	11	93	1%	9%	145	219	13%	20%
10	31	133	4%	18%	181	238	24%	31%
11	13	40	1%	4%	189	285	20%	30%
12		70	0%	5%	370	516	27%	37%
13	6	94	1%	8%	299	349	27%	31%
14		2			91	172	19%	36%
15	5	79			238	275	27%	31%
16	49	290	4%	24%	444	550	37%	45%
17	12	118			190	275	26%	37%
Total	**449**	**2 155**	**3%**	**13%**	**3 976**	**5 406**	**23%**	**32%**

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. These calculations represent a 'gross' potential and do not take into account demand-side aspects of agricultural production. Therefore a possible adoption rate is not applied. The calculations are performed as follows:

1. 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
2. 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.
3. 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 Rewasagar water harvesting and 2.22 ha (state average) for soil and water conservation. 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 country average household size is 4.5 persons.
4. 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.
5. the factors derived from sub-national statistics and livelihood mapping exercise (eg. farmers typology, poverty, land holding size etc.) are applied as de-multiplying factors.

Investment costs

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

1. 50% of adoption rate by suitable farmers due to the high investment cost needed.
2. For Rewasagar model, the land allocated for water harvesting is calculated as 1/15 of the number of potential benefitted households multiplied by the state average landholding size (2.22 ha/household).
3. For Rewasagar , for each ha allocated for water harvesting there are 30 000 m3 of water stored.
4. For Rewasagar, 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 .

Investment costs at state level		
AWM options	**Unit cost**	**Investment costs (min-max) Million US$**
Rewasagar	1 000 000 US$/per Mm^3 of water stored	1 350 - 7 700
Soil and water conservation	300 US$/ha	1 200 – 1 600

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