FAOWATER

AGWATER SOLUTIONS
Improved livelihoods for smallholder farmers

COUNTRY INVESTMENT BRIEF

Mapping and assessing the potential for investments in agricultural water management

Ghana

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.

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Mapping the livelihood context

Different people in different places have different needs

The purpose of livelihood maps

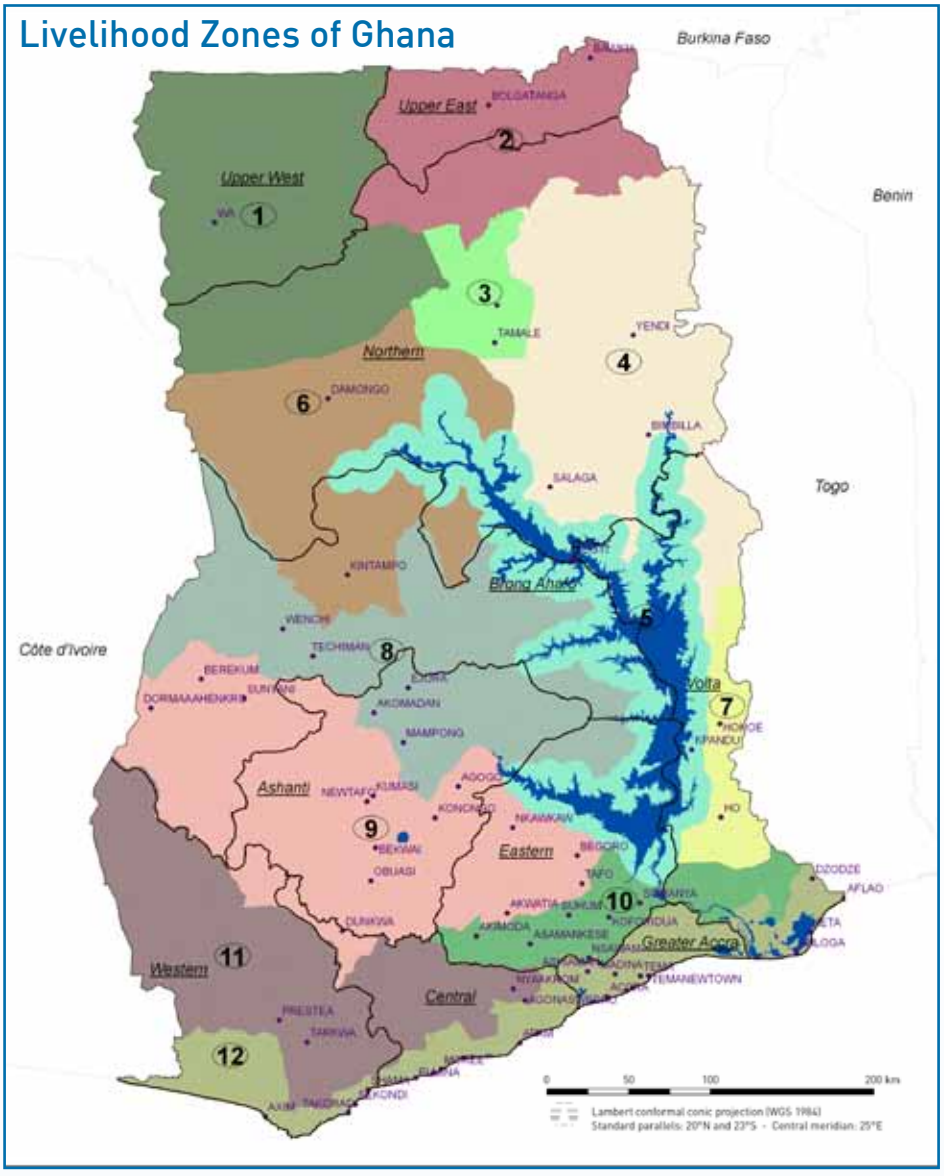
Livelihood mapping consists in identifying areas where rural people share relatively homogeneous living conditions, on the basis of a combination of biophysical and socio-economic determinants. The main criteria to establish livelihood zones are: the predominant source of income (livelihood activities); 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.

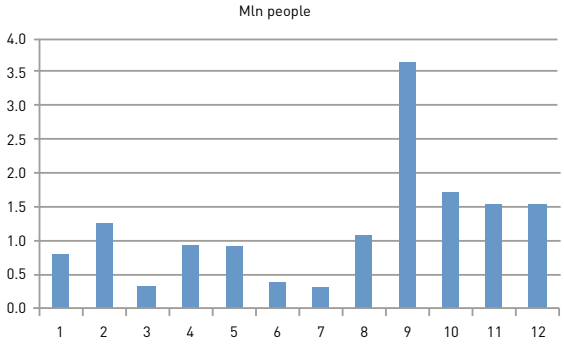
Generally, livelihood zone boundaries would coincide with administrative boundaries, but not always. In practice, homogenous agroecological and socio-economic zones often cross larger administrative units. In these cases the delineation is based on other criteria which better capture the delineation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

Livelihood Zones of Ghana



1:Cereals (sorghum/millet), legumes, yam, livestock (cattle)
2:Cereals (sorghum/millet), legumes, livestock (small ruminants and guinea fowl)
3:Maize, rice, tree crops (mango), livestock
4:Eastern corridor and Upper Volta: yam, cassava, livestock
5:Volta lake: fishing, maize, yam
6:Tubers (yam/cassava), maize, cashew, livestock
7:Middle Volta area: tree crop (cocoa/coffee), cassava, small ruminants
8:Maize (commercial), cassava and small ruminants; bimodal rainfall
9:Tree crop (cocoa/oil palm/citrus), poultry (commercial)
10:Rice (commercial) and livestock
11:Timber, tree crops (cocoa/oil palm/rubber), mining
12: Coastal zone: fishing, salt, vegetables

Key typologies of farming population



Traditional smallholder farmers:
These farmers produce mainly staple food (both crop and livestock) for household consumption and have relatively marginal connections to markets. The aim at stabilizing production and reduce risks of production failures.

Emerging market-oriented smallholder farmers
These farmers may partially subsist from their own production but whose principal objective is to produce a marketable surplus

Commercial farmers
These are large or small-scale commercial farmers and enterprises that are fully oriented towards internal and export markets

Describing the livelihood context

from expert consultations

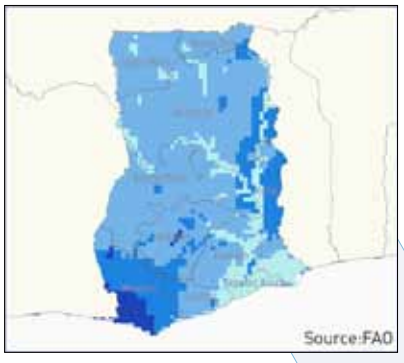
Dominant characteristics of livelihood zones

Zone	Name – Major production systems	Rural population (,000)	Key features	Main livelihood sources	Water-related issues	Main constraints for livelihoods
1	North-West Cereal based-Legumes-Cattle	780	One rainfall season, erratic, lower population desnity than zone2. Main rivers: Black Volta and Sissili	Arable crop farming; Livestock (mainly cattle) rearing; "Pito" (local beer) brewing; charcoal production	Long dry season and lack of irrigation infrastructure	Erratic rainfall, very limited irrigation infrastructure, limited potential for non-farm activities
2	North-East Cereals-Legumes-Small Ruminants/Guinea Fowl Zone (Zone 2)	1,260	Population density (and land availability), Main river: White Volta. Gold mining, Crafts	Arable crop farming, including rice; livestock (mainly sheep, goats and guinea fowls; mining; crafts	Long dry season and limited irrigation infrastructure	Erratic rainfall, broken down irrigation infrastructure, limited potential for non-farm activities, population pressure
3	North-Central Cereals-Mango-Groundnut-Small Ruminants	336	Urbanization (and thus peri-urban agriculture); Tree crop (mango);	Arable crop farming; livestock rearing; emerging commercial mango production; trading in agricultural and non-agricultural products	Long dry season and limited irrigation infrastructure	Erratic rainfall, limited irrigation infrastructure, population pressure
4	North East Corridor and Upper Volta Yam/Cassava-Groundnut- Cattle	930	Commercial yam production; extensive livestock	Arable crop farming; Livestock (mainly cattle)	Long dry season and lack of irrigation infrastructure	Erratic rainfall, absence of irrigation infrastructure, poor roads
5	Volta Lake Inland Fishing	940	Fishing and fish marketing	Arable crop farming; fishing	Poor drainage and cultivation close to bank of lake	Poor water transport system, limited infrastructure to support fishing and fish processing
6	Upper Middle Belt Maize-Yam/Cassava	380	Savanna and forest areas;	Savanna arable crops; forest arable crops	Lack of irrigation infrastructure	Poor transport system, limited support to cashew industry
7	Middle Volta Cocoa/ Coffee-Cassava-Small Ruminants	298	Mountainous; savanna and forest areas	Tree crops; arable crops; small ruminants	Limited irrigation infrastructure	Population pressure, limited available agricultural land and very limited irrigation infrastructure
8	Central Middle Belt Commercial Maize-Cassava-Small Ruminants	1,071	Commercial maize; Commercial yam/ cassava	Arable crops (commercial production); small ruminants	Lack of irrigation infrastructure	Limited mechanization equipment
9	Lower Middle Belt Cocoa/Oil Palm/ Citrus-Commercial Poultry-Mining	3,671	Tree crops; Commercial poultry; Mining; Trading	Tree crops; arable crops; commercial poultry; legal and illegal mining; trading in agricultural and non-agricultural products	Need for production intensification	Labor shortages, lack of storage facilities
10	Inland Greater Accra and Lower Volta Commercial Rice-Cattle	1,730	Commercial irrigated rice; Commercial livestock	Commercial rice; commercial vegetables; livestock	Need for production intensification	Population pressure, limited available agricultural land
11	High Forest Timber-Cocoa/Oil Palm/ Rubber-Mining	1,550	Timber; Tree crops; Mining	Timber; tree crops; mining	Drainage	Too much rain and poor road transport
12	Coastal Belt Marine Fishing-Vegetables-Salt	1,543	Sea fishing; vegetable cultivation; groundwater irrigation	Sea fishing; arable crops; vegetables	Limited irrigation infrastructure	Population pressure, limited available agricultural land

Mapping potential and opportunities for water interventions

Criteria used

1. Water availability (runoff)



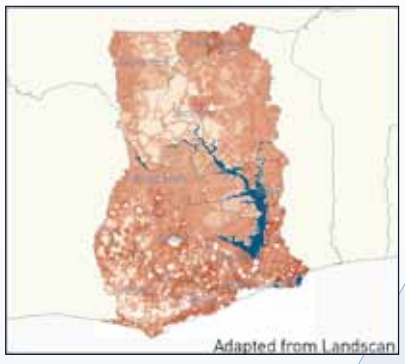
mm/y

- 0 - 100
- 100 - 250
- 250 - 500
- 500 - 750
- 750 - 1 500

2. Perception of water as limiting factor for agricultural production

- High
- Medium
- Low

3. Rural population density



P /km²

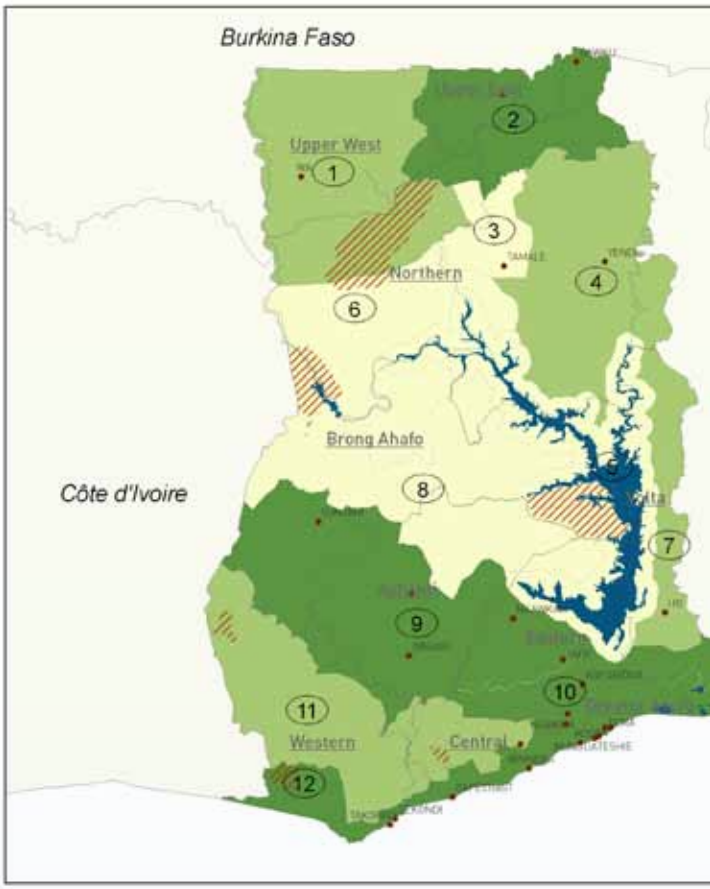
- < 5
- 5 - 10
- 10 - 50
- 50 - 100
- 100 - 200
- 200 - 500

4. Poverty (underweight prevalence)

Prelevance (among children <5)

- < - 25%
- 25% - 30%
- 30% - 35%
- 35% - 40%

Number of potential beneficiaries

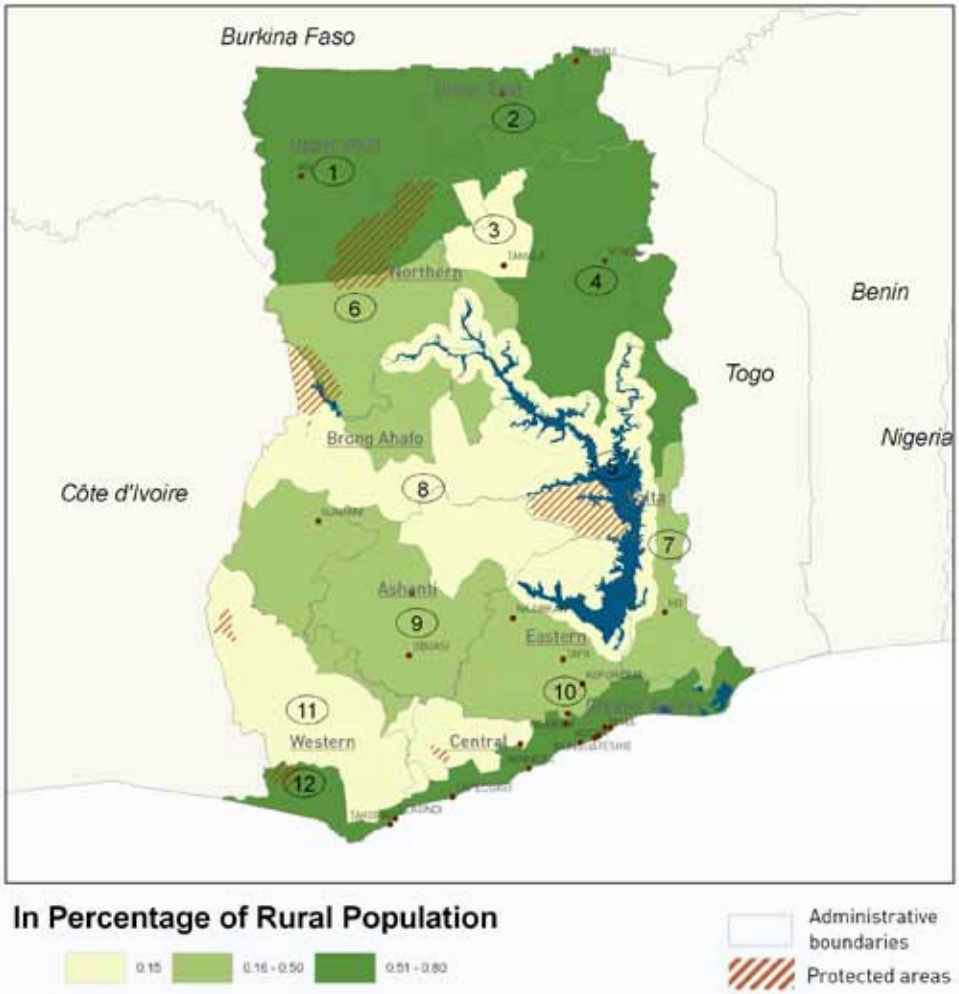


Person / km²

< 10 | 10 - 40 | 40 - 130

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)	% poor (underweight)		Person (,000)	in % of rural population
1	Cereal-based (sorghum/millet), legumes, yam, livestock (cattle)	3,588	779	29	**31.4**	High	623	80%
2	Cereal-based (sorghum/millet), legumes, yam, livestock (small ruminants and guinea fowl)	1,531	1,259	76	35.9	High	1,007	80%
3	Maize, rice, tree crops (mango), livestock	1,665	336	41	38.2	Moderate - Low	50	15%
4	Eastern corridor and Upper Volta: yam, cassava, livestock	4,222	929	34	36.7	High	743	80%
5	Volta lake: fishing, maize, yam	2,902	940	40	27.8	Moderate - Low	141	15%
6	Tubers (yam/cassava), maize, cashew, livestock	5,713	380	18	32.8	Medium	190	50%
7	Middle Volta area: tree crop (cocoa/coffee), cassava, small ruminants	2,531	298	83	24.7	Medium	149	50%
8	Maize (commercial), cassava and small ruminants; bimodal rainfall	3,097	1,071	48	24.2	Moderate - Low	161	15%
9	Tree crop (cocoa/oil palm/citrus), poultry (commercial)	1,230	3,672	100	24.4	Medium	1,836	50%
10	Rice (commercial) and livestock	295	1,731	147	22.8	Medium	771	45%
11	Timber, tree crops (cocoa/oil palm/rubber), mining	3,371	1,550	69	25.7	Moderate - Low	233	15%
12	Coastal zone: fishing, vegetables, salt	1,212	1,543	192	22.2	High	1,235	80%

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. **Low-cost motor pumps (for surface water or groundwater abstraction)**
   Motorized pumps up to 5 HP that can lift and distribute water for farming practices. Their cost in Sub-Saharan Africa ranges from 200 up to 500 US$. They can irrigate a few hectares; smallholders in SSA use pump irrigation for high value crops, although they seldom exceed 1 ha of irrigated land per household. Farmers who have access to irrigation have substantially higher incomes and better food security than their neighbors who rely on rainfall. This needs a reliable method of drawing water from an available water source, whether it be a river, a reservoir, a pond, canal or groundwater.
2. **Inland valley bottom**
   Inland valleys are low-lying areas, including valley bottoms and floodplains, receiving runoff from hills and mountains. Through the use of water capture and delivery structures the systems provide supplemental irrigation and improve soil moisture retention. The Government has shown an interest in revitalizing its domestic rice sector to meet growing demand, reduce imports and contribute to poverty reduction and youth employment. Inland valleys are a possible low cost, high potential option
3. **Small reservoirs**
   Small reservoirs are earthen or cement dams that are less than 7.5 meters high. They can store up to 1 million cubic meters of water and sometimes have a downstream adjacent irrigation area of less than 50 hectares. Capital investment is generally externally driven and community management remains the norm.

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

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:

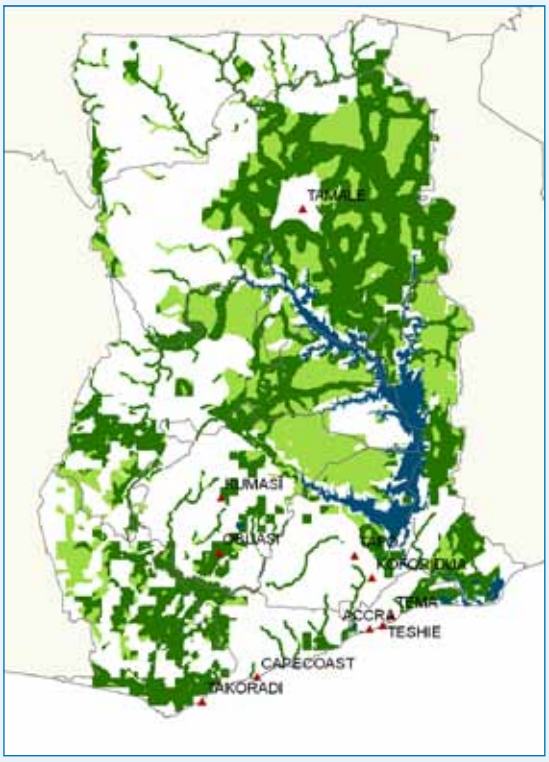
- **High suitability: areas which present optimal conditions both in terms of biophysical and infrastructure conditions for adoption of a given AWM solution.**
- **Moderate suitability: areas where there are possibilities for application of a given AWM solution, but where conditions are less favourable.**

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: Low-cost motor pumps

Biophysical suitability



High suitability
Medium suitability

Biophysical criteria and conditions

Market accessibility (h)

Travel time to market (h)
< 4 h
< 8 h
> 8 h

Shallow groundwater

Fluvisols/gleysols

Distance to surface water + runoff

Distance to surf. water
< 1 km
Runoff
< 250 mm/y
> 250 mm/y

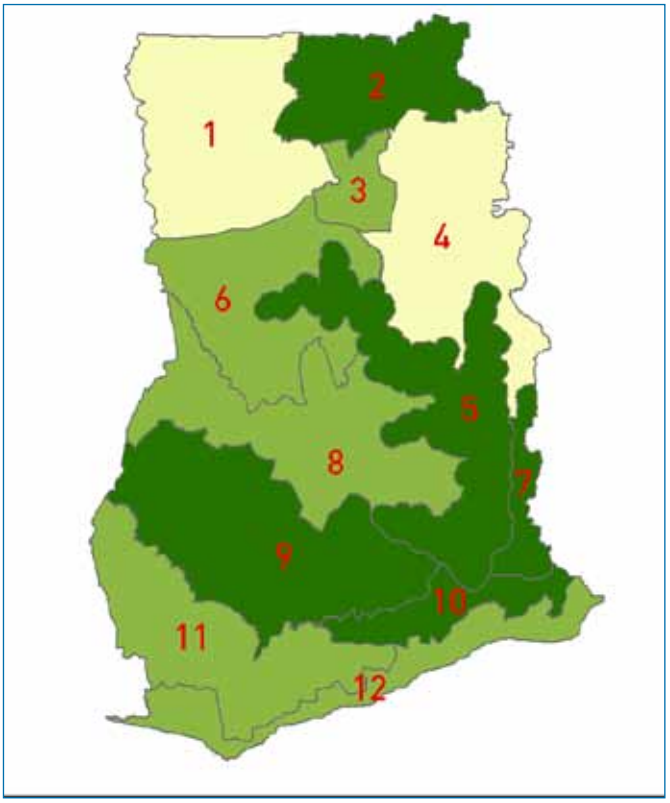
Biophysical criteria and conditions		
Soils	**Distance to surface water or runoff**	**Access to market**
Requirement: alluvial soils	**Requirement:** less 1 km distance from surface water or runoff > 300 mm/y	Highly suitable: < 4 h travel time Moderately suitable: 4 h - 8 h travel time

Physical suitability for small pumps has been assessed on the basis of: travel time to market (defined as centers of 20,000 inhabitants or more), with areas at 4 hours or less considered highly suitable and areas at more than 8 hours excluded, proximity to surface water, occurrence of soils with shallow groundwater potential (fluvisols, gleysols, gleyic subunits).

Livelihood-based demand

Small motor pumps:
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:

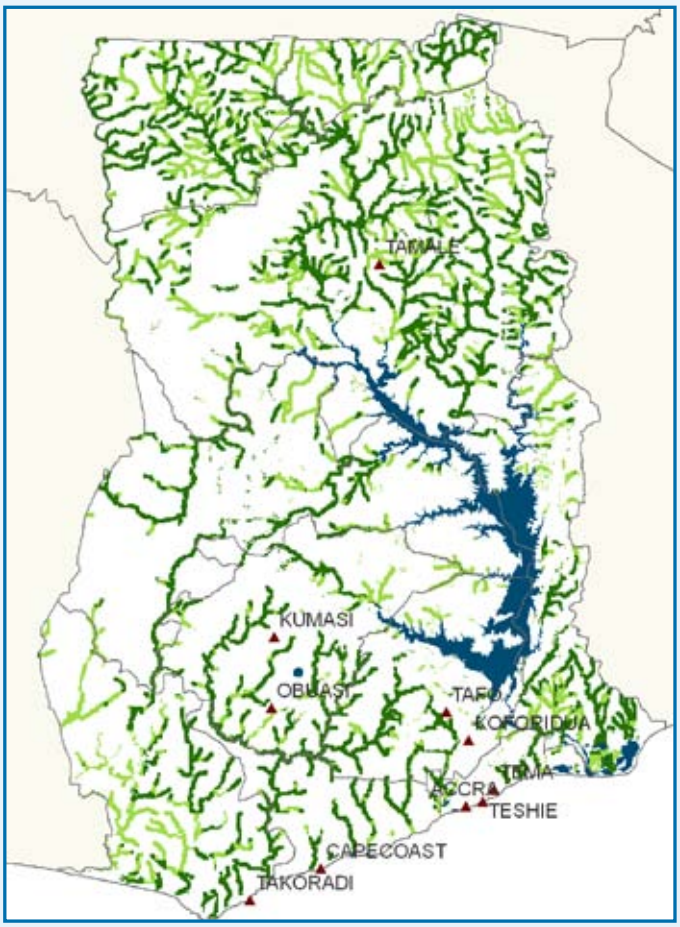
- **Smallhoders**
  This typology of farmers is considered to be more in demand of this technology
- **High population density**
  This indicates higher pressures on natural resources therefore the need for intensification which is associated to this technology
- **Small landholding size (< 2 ha)**
  Similarly to high population density, this factor indicates the need for intensification which is associated to this technology



Demand
High
Moderate to High
Moderate

Solution 2: Potential for inland valley bottom management (for rice)

Biophysical suitability



High suitability
Medium suitability

Biophysical criteria and conditions

Market accessibility (h)

< 4 h < 8 h > 8 h

Distance to surface water + slope

riv_dist1 slope_less2
< 1 km > 2 %
< 2 %

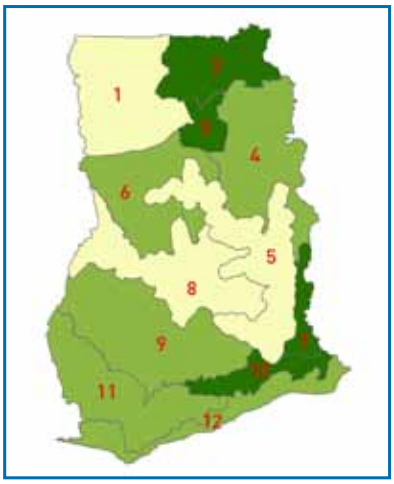
Suitability for Rice

suitrice_gaez
Moderate to High
Low to Moderate

Suiatble area for inland valley rice is here defined using slope (< 2%), proximity to rivers, and classified using the Global Agro-ecological zones index of land suitability for wetland rice. A higher score is also attributed to areas closer to market centers.

Biophysical criteria and conditions		
Land suitability for rice	**Distance to surface water and topography**	**Access to market**
Highly suitable: moderate to high suitability **Moderately suitable**: low to moderate	**Requirement**: less 1 km distance from rivers & slope < 2%	Highly suitable: < 4 h travel time Moderately suitable: 4 h -8 h travel time

Livelihood-based demand



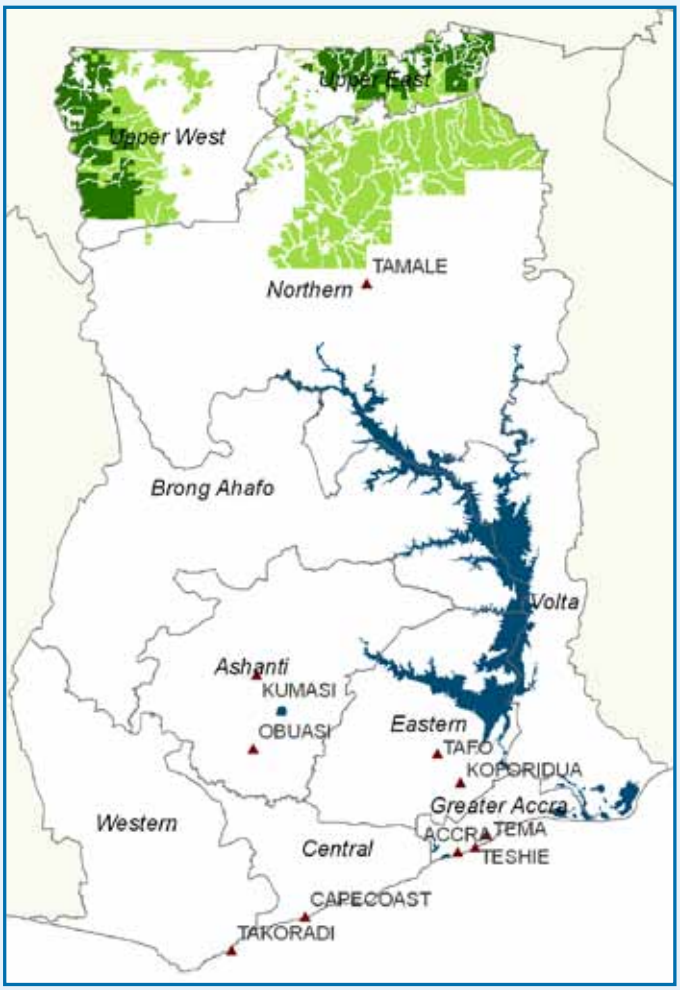
High
Medium-high
Medium-low

Inland valley bottom:
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:

- **Smallhoders**
  This typology of farmers is considered to be more in demand of this technology
- **High population density and poverty rates**
  This technology is very labor-intensive and is suitable in large communities. It can thus offer employment particularly to landless people that are often the poorest. Therefore, areas with high population density and high poverty rates can be more in demand of this technology

Solution 3: Potential for small reservoirs

Biophysical suitability



High suitability Medium suitability

Biophysical criteria and conditions

Aridity Index (P/ETref)

0.5 - 0.65 (dry-subhumid)
> 0.65 (humid)

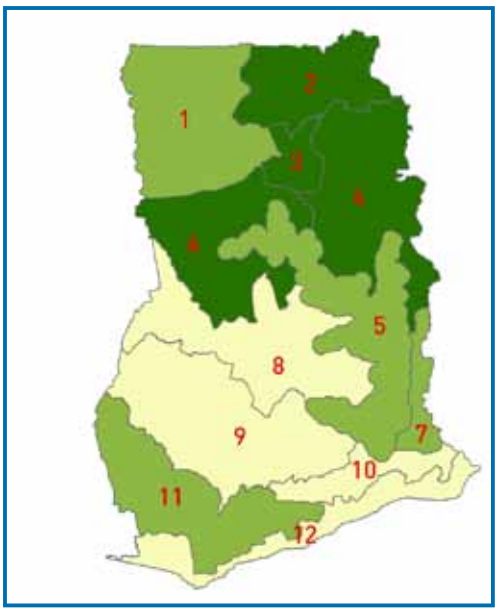
Livestock density

< 5 5 - 20 > 20

Suitable area for small dams is here defined as agricultural area where Aridity Index (yearly precipitation divided by yearly reference evapotranspiration) is between 0.2 and 0.65, semiarid to dry-subhumid; in addition, a higher livestock density is assumed to be correlated with enhanced multiple uses of small dams.

Biophysical criteria and conditions	
Aridity Index	**Livestock density**
Requirement: A.I. < 0.65	**Highly suitable:** density >=20 units/km² Moderately suitable: density < 20

Livelihood-based demand



Inland valley bottom:
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:

- **Traditional smallholder farmers with relatively higher prevalence of livestock-based livelihoods**
  Small reservoirs are one of the most important water sources for livestock in semi arid areas, particularly for traditional farmers that aim at stabilizing the production and improving nutrition rather than increasing production for sale
- **Higher poverty rates**
  this technology aims at providing water for multiple uses, i.e. cropping livestock water and domestic purposes. This multifunctional nature is crucial to contribute reduce vulnerability to shocks and increase resilience and therefore to alleviate poverty.

Quantifying the potential for investments in AWM

Potential beneficiaries, application areas

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

Livelihood zones	Low-cost motor pumps				Inland valley wetland rice				Small Reservoirs			
	(,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	7	10	3%	5%	11	19	6%	10%	26	42	14%	22%
2	34	43	11%	14%	26	48	8%	15%	47	97	15%	31%
3	16	20	19%	23%	9	11	10%	14%		15		18%
4	68	95	29%	41%	22	31	9%	13%		8		4%
5	42	63	18%	27%	5	11	2%	5%				
6	13	23	14%	24%	4	7	4%	7%				
7	21	26	28%	35%	7	9	10%	12%				
8	27	51	10%	19%	10	14	4%	5%				
9	146	172	16%	19%	74	94	8%	10%				
10	53	60	12%	14%	43	54	10%	12%				
11	60	86	16%	22%	27	42	7%	11%				
12	76	82	20%	21%	22	38	6%	10%				
Total	564	730	16%	20%	261	377	7%	10%	74	163	2%	4%

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

Livelihood zones	Low-cost motor pumps				Inland valley wetland rice				Small Reservoirs			
	(,000 ha)		(% total agric. land)		(,000 ha)		(% total agric. land)		(,000 ha)		(% total agric. land)	
	min	max	min	max	min	max	min	max	min	max	min	max
1	5	8			17	28	1%	1%	26	42	1%	2%
2	27	34	2%	2%	40	72	2%	4%	47	97	3%	6%
3	13	16	2%	2%	13	17	2%	2%		15		2%
4	54	76	2%	3%	32	47	1%	2%		8		
5	34	50	2%	3%	8	16		1%				
6	10	18	1%	1%	6	10		1%				
7	17	21	5%	6%	11	14	3%	4%				
8	21	41	1%	2%	15	21	1%	1%				
9	117	138	4%	4%	111	140	4%	4%				
10	42	48	4%	4%	64	80	5%	7%				
11	48	69	3%	5%	41	64	3%	4%				
12	61	66	8%	8%	33	57	4%	7%				
Total	451	584	2%	3%	391	565	2%	3%	74	163		1%

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. 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 inhabitants of 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 identification of a factor 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. 0.8 ha (pumps), 1.5 ha (inland valley-bottom rice) and 1 ha (Small reservoirs). 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 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, 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	Low-cost motor pumps		Inland valley wetland rice		Small Dams	
	Min	Max	Min	Max	Min	Max
1	2.7	3.9	10.2	16.8	235.1	235.1
2	13.7	17.1	23.8	43.0	258.4	258.4
3	6.5	7.8	7.7	10.3	-	150.1
4	27.2	37.8	19.5	28.0	-	318.0
5	16.8	25.1	4.9	9.8	-	-
6	5.2	9.1	3.8	5.9	-	-
7	8.3	10.6	6.6	8.3	-	-
8	10.7	20.3	8.8	12.4	-	-
9	58.5	68.8	66.7	84.2	-	-
10	21.2	24.1	38.5	48.3	-	-
11	24.2	34.5	24.5	38.1	-	-
12	30.5	32.8	19.9	34.0	-	-
Total	**225**	**292**	**235**	**339**	**493**	**962**

Investment costs

The following assumptions have been made to assess investment cost:

1. The average water amount required for irrigated agriculture is assumed at 7 500 m^3/ha/yr
2. The potential area for application of AWM options should not exceed an extent which requires more than 30% of the country Internal Renewable Water Resources.
3. 50% of adoption rate by suitable farmers due to market demand
4. For small pumps, the total investment cost is based on the number of households and not on the number of hectares
5. The investment costs only encompass the initial investment for infrastructure development and do not include the running costs and operation & maintenance costs.

vestment costs at country level		
AWM options	Unit cost	Investment costs (range) Million US$
Low-cost motor-pumps	400 US$/household	225 - 292
Inland valley wetland rice	600 US$/ha	235 - 339
Small Reservoirs	750 000 US$/m3 of water stored	493 - 962

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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