Study on water interventions for improving smallholder farming and rural livelihoods in China

Literature review for Hunan Province

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1. Introduction

1.1 Water constraints, poverty and food security

This study will identify the linkages between poverty and water constraints in the Hunan Province of People's Republic of China. It will analyze poverty and water constraints in the Province and explore policy, institutional, technical and financing options for the water intervention to support rural livelihood. And will guide investment policies and programmes in food security and poverty reduction.

1.2 The location and geographical information of Hunan Province

Hunan Province is located in the middle of Southern China, by the middle stretch of the Yangtze River (24 39'-30 08'N and 108 47'-114 15'E). With an area of 211,800 square kilometers, it is ranked 11th among all the provinces and municipalities in coverage.

Figure 1 Map of China

Most of its territory lies south of the famous Dongting Lake. Hence the name Hunan, which literally means south of the lake in Chinese. Xiangjiang River is the largest river in this region. It adjoins with Jiangxi Province on the east, Chongqing Municipality and Guizhou Province on the west, Guangdong Province and Guangxi Autonomous Region on the south, and Hubei Province on the north. The east-west distance of the province is 667 kilometers; the north-south distance is 774 kilometers. Changsha is the provincial capital city.

Figure 2 Dongting Lake and Xiangjiang River

Sheltered by mountain ranges to the east, west and south, the center of Hunan comprises hills and basins, and the north is composed of plains. The landform of the province therefore takes the form of a horseshoe, open to the north, low in the center, and high in the other three directions. Hunan's highest mountain Huping in Shimen County, Changde, reaches 2,009 meters above sea level, while its lowest area. Huanggai Town in Yueyang, lies at an altitude of only 21 meters.

Figure 3 Map of Hunan Province
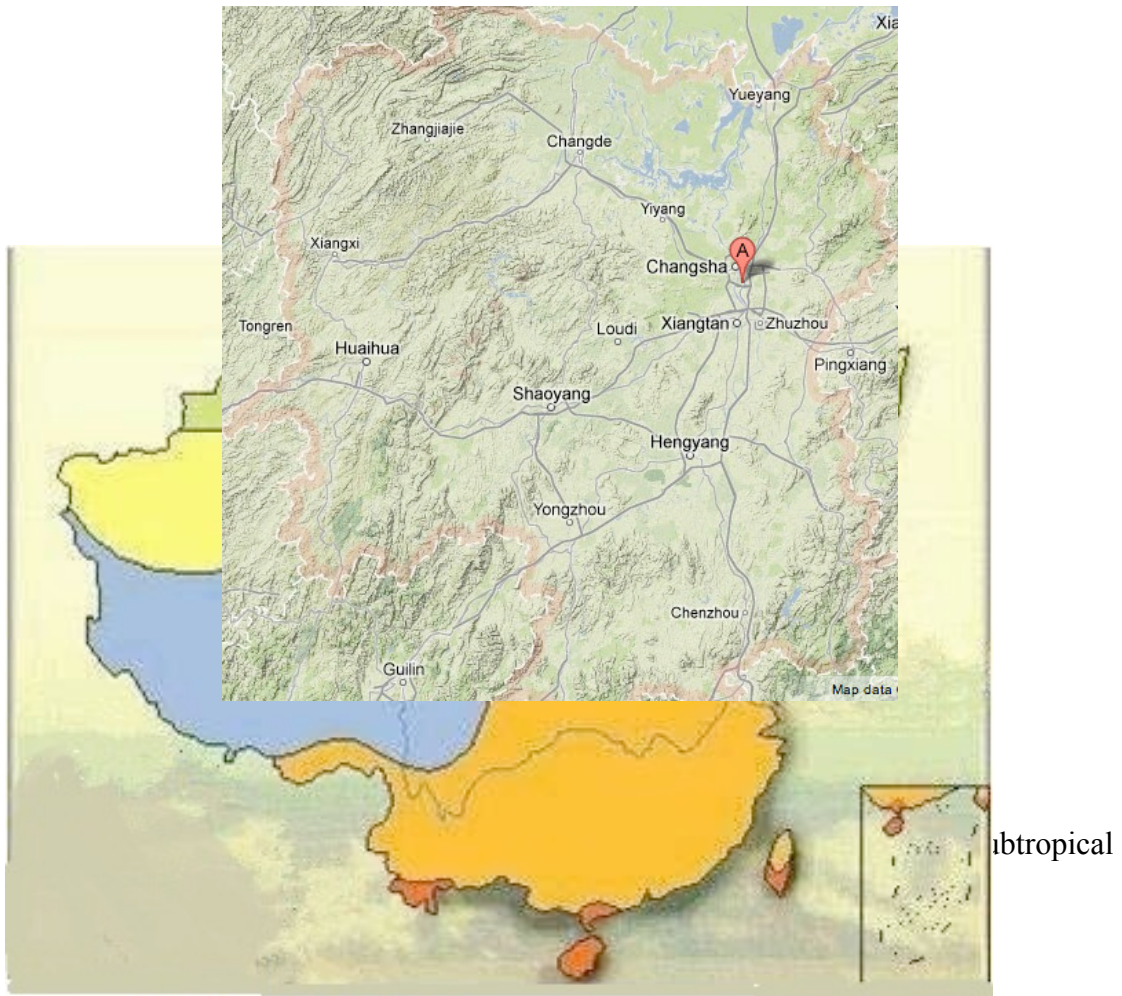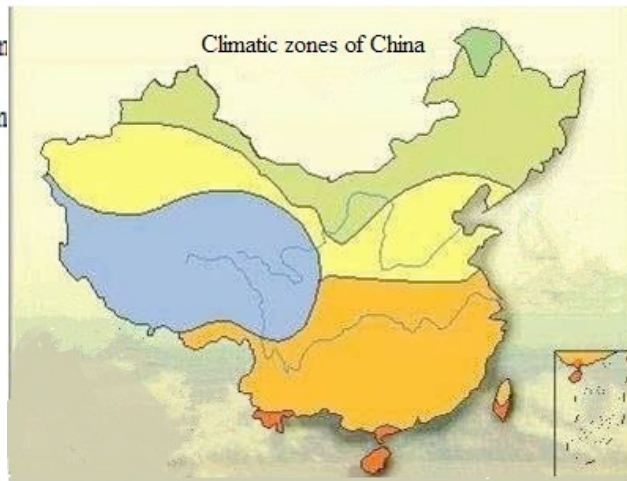
It has a humid continental and subtropical monsoon climate. The annual average temperature is between 16 C - 18 C and the annual rainfall is between 1,200 and 1,700 mm. It has four distinct seasons (Summer, Autumn, Winter, and Spring), abundant sun. The total number of annual sunshine hours is between 1300 and 1800. The frostless period is as long as 260-310 days. This is favorable for the growth of agricultural crops and green plants.

Figure 5 The monthly average temperature in Hunan Province

The monthly average temperature in Hunan Province

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
The monthly average temperature	5.3	6.9	11.2	17.2	21.7	25.3	28.2	27.5	23.6	18.2	12.7	7.4
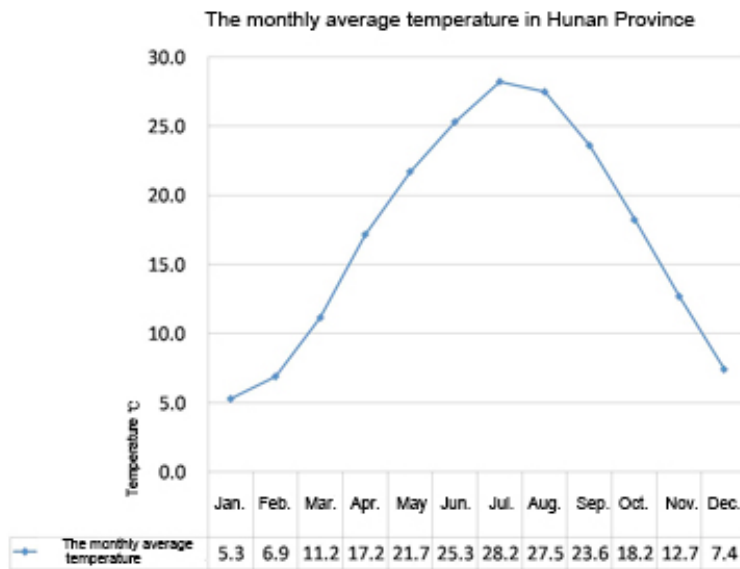
Figure 6 The monthly average rainfall in Hunan Province

The monthly average rainfall in Hunan Province

Monthly Average Rainfall	60	82	121	177	209	207	142	133	73	88	69	43
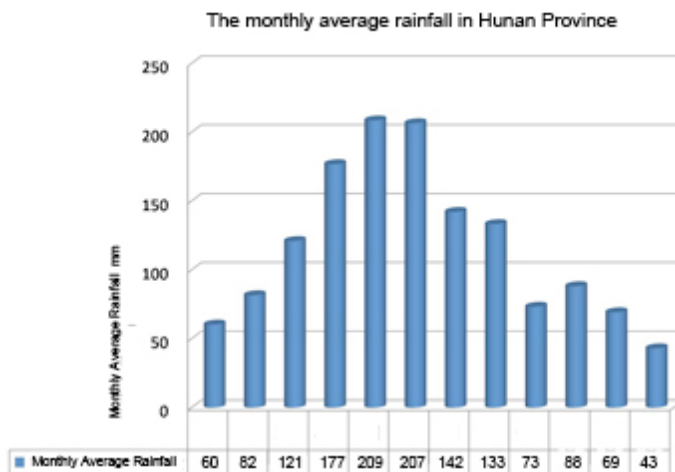
1.3 Basic social and economic information of Hunan Province

Hunan has long been known as the granary of China, with only 3 percent of Chinese farmland. As an old saying goes, when Huguang (now is called Hunan and Hubei Provinces) has a bumper harvest of rice, there will be sufficient food for all the Chinese people. Huguang was a province in the Ming Dynasty and roughly included the area of what is now Hunan and Hubei Provinces.

Hunan contains about 5 percent of China's population, ranking No.7 in China. At the end of 2010, the total population of Hunan is 65.701 million. There are 13 Cities and 1 Autonomous Prefecture of Hunan Province.

Table 1 The basic social and economic information of Hunan Province

Cities and A.P. (Autonomous Prefecture)	No. of towns	No. of villages	No. of rural HH (ten thousands)	Rural population (ten thousands)	Arable lands (thousand hectares)	Total population (ten thousands)	Rural population /total (%)
Changsha	111	1493	113.8	396.26	279.98	704.07	56.28
Xiangtan	59	1734	59.46	208.42	139.1	275.22	75.73
Zhuzhou	106	2047	70.97	273.45	202.52	385.71	70.90
Hengyang	184	5217	156.08	586.92	370.87	714.84	82.11
Yueyang	156	3359	109.74	405.84	319.89	547.61	74.11
Yiyang	85	1963	96.07	356.8	274.01	430.79	82.82
Changde	208	4122	130.13	435.72	461.95	571.46	76.25
Chenzhou	250	3165	100.68	364.07	270.2	458.35	79.43
Yongzhou	188	5323	121.65	473.44	328.26	519.48	91.14
Shaoyang	196	5804	169.8	621.7	395.63	707.17	87.91
Loudi	80	3498	89.77	338.34	171.18	378.46	89.40
Zhangjiajie	94	1659	36.34	130.23	104.31	147.81	88.11
Huaihua	286	4050	106.3	407.62	299.23	474.17	85.96

Xiangxi	158	2134	53.77	227.42	173.54	254.96	89.20
Total	2161	45568	1414.56	5226.23	3790.67	6570.10	79.55

Data Resource: Hunan Rural Statistic Yearbook 2011; Arable lands from Hunan Rural Statistic Yearbook 2010（N.A.in Hunan Rural Statistic Yearbook 2011）; Total population from Hunan Statistic Yearbook 2011（N.A.in Hunan Rural Statistic Yearbook 2011）; A.P. =Autonomous Prefecture

According to the literature "Rural poverty distribution of Hunan Province (2008)", Hunan Province was divided into 4 zones: west, south, east, and north. The following table shows the four zones division for the 13 cities and 1 autonomous prefecture.

Table 2 Four zones of Hunan Province

City and A.P.	Prefecture level cities and autonomous region
West	Zhangjiajie City, Shaoyang City, Huaihua City, Xiangxi A. P.
South	Hengyang City, Chenzhou City, Yongzhou City, Loudi City
East	Changsha City, Zhuzhou City, Xiangtan City
North	Yueyang City, Changde City, Yiyang City

Data Source: Rural poverty distribution of Hunan Province, 2008

Among the four zones, the total populations are not quite different. The rural population ratio of the west and the south zones are much higher than the others.

Table 3 The basic social and economic information of the four zones

Cities and A.P. (Autonomous Prefecture)	No. of towns	No. of villages	No. of rural HH (ten thousands)	Rural population (ten thousands)	Arable lands (thousand hectares)	Total population (ten thousands)	Rural population/total (%)
West	734	13647	366.21	1386.97	972.71	1584.11	87.56
South	702	17203	468.18	1762.77	1140.51	2071.13	85.11
East	276	5274	244.23	878.13	621.6	1365	64.33
North	449	9444	335.94	1198.36	1055.85	1549.86	77.32

Total	2161	45568	1414.56	5226.23	3790.67	6570.1	79.55

Data Resource: Calculated based on following data: Hunan Rural Statistic Yearbook 2011; Arable lands from Hunan Rural Statistic Yearbook 2010（N.A.in Hunan Rural Statistic Yearbook 2011）; Total population from Hunan Statistic Yearbook 2011（N.A.in Hunan Rural Statistic Yearbook 2011）; A.P. =Autonomous Prefecture

Following is the table reveals the structure of rural household income for the 14 regions of Hunan Province. Rural net income per capita includes four parts: wage income, self-business income, transfer payments and property income. Except Changsha, Zhuzhou, and Loudi, self-business incomes (include agriculture income) are the highest part among all of the components of the rural net income.

Table 4 The structure of rural HH income of Hunan Province (2007-2010)

Unit: yuan

City and A.P.	Rural net income per capita	Wage income	Self-business income	Transfer payments	Property income
Changsha	8813.47	4187.708	3640.94	484.145	500.6775
Xiangtan	6477.04	2797.425	3139.69	301.8075	238.115
Zhuzhou	6260.135	2966.778	2772.293	296.245	224.8225
Hengyang	6012.045	2773.305	2952.963	169.4575	116.3125
Yueyang	5115.738	2068.998	2734.645	162.6225	149.4725
Yiyang	4749.203	1921.478	2509.06	203.9225	114.7425
Changde	4739.368	1601.973	2809.853	203.995	123.5475
Chenzhou	4416.735	1802.463	2298.58	180.07	135.62
Yongzhou	4193.008	1343.545	2572.25	153.005	124.205
Shaoyang	3363.333	1346.62	1714.665	194.4675	107.5775
Loudi	3134.993	1606.743	1255.663	183.3375	89.255
Zhangjiajie	3123.593	1334.603	1549.438	161.465	78.0875
Huaihua	2895.398	1003.338	1669.773	140.5475	81.74
Xiangxi	2714.99	895.0675	1499.653	203.575	116.695

The following figure shows two curves:

1) One is standardized rural income per capita (the calculation of the standardization for the rural income per capita: among all of the regions, pick the maximum of rural income per capita as the denominator. The rural income per capita of each region as the numerator is divided by denominator to calculate the standardized rural income per capita);

2) The other is proportion of self-business income to total household income.

These cities are in descending order according to standardized rural income per capita, accompany with the total income decline, the self-business income slightly increase. Since agricultural income was counted in the self-business income, and usually compare with richer areas, more self-business income of poor area came from agriculture, so we conclude that the agricultural income is more important for the poor area.

Figure 7 Rural income and self-business income ratio of Hunan Province（2007-2010）
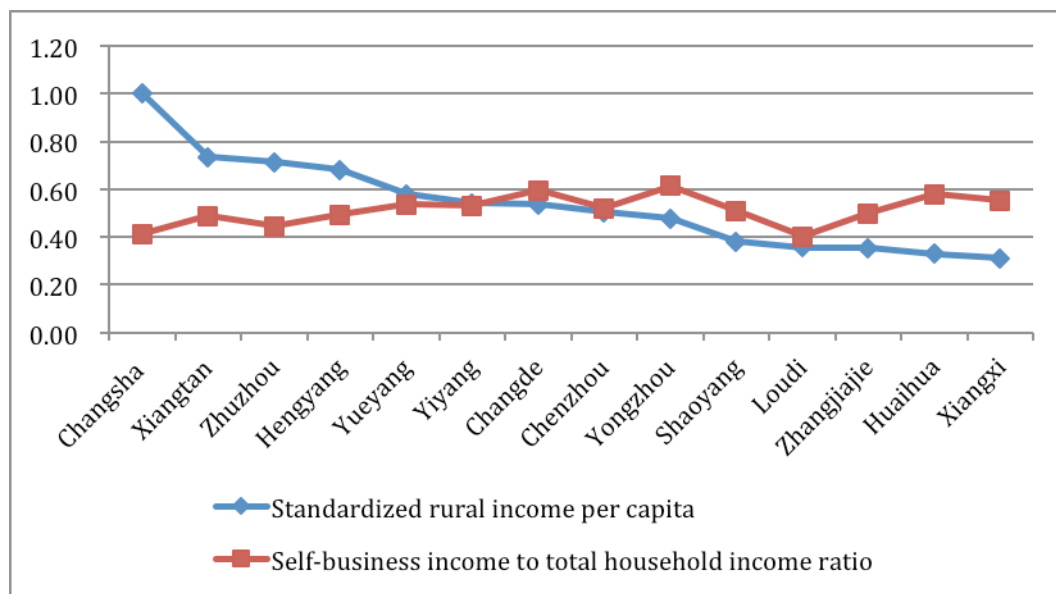
The following table shows the income structure for the four zones. The rural net income per capita of the west is the lowest among the four zones. Furthermore, except the transfer payments, all of the subentries of the west are the lowest as well.

Table 5 The structure of rural HH income of the four zones (2007-2010)

Unit: Yuan

City and Region	Rural net income per capita	Wage income	Self-business income	Transfer payments	Property income
West	12097.31	4579.63	6433.53	700.06	384.10
South	17756.77	7526.06	9079.46	685.87	465.39
East	21550.65	9951.91	9552.92	1082.20	963.62
North	14604.31	5592.45	8053.56	570.54	387.76

Data source: Calculated based on Hunan Rural Statistic Yearbook 2008-2011

2. Grain loss and area affected by floods and drought

The following are the data about the areas affected by floods and drought at national level and provincial level. Besides, the grain loss caused by floods and drought of Hunan Province are listed.

2.1 Floods and drought affected areas at national level

The following table shows the areas affected by floods and drought for the different regions of China. From this table, we found that Hunan Province is suffering both floods and drought. The areas affected by floods of Hunan Province ranked the second of China. The areas affected by drought ranked 9th of China.

Table 6 Floods and drought affected areas at national level (2007-2010)

Regions	Areas affected by floods	Areas affected by drought	Regions	Areas affected by floods	Areas affected by drought
	1000 ha.	1000 ha.		1000 ha.	1000 ha.
Beijing	N.A.	8.33	Hubei	661.00	148.25
Tianjin	3.00	10.00	Hunan	469.50	407.50
Hebei	99.75	701.00	Guangdong	106.75	79.50
Shanxi	51.00	765.75	Guangxi	216.75	380.25
Inner Mongolia	111.50	1556.75	Hainan	76.50	25.50
Liaoning	147.00	556.50	Chongqing	130.25	84.75
Jilin	82.00	941.75	Sichuan	343.25	296.25
Heilongjiang	249.50	1686.50	Guizhou	86.50	361.75
Shanghai	N.A.	N.A.	Yunnan	109.00	794.25
Jiangsu	134.00	95.67	Tibet	4.33	15.50
Zhejiang	63.75	12.50	Shaanxi	91.25	373.50
Anhui	428.50	29.00	Gansu	74.75	622.00
Fujian	59.50	27.50	Qinghai	4.25	31.50
Jiangxi	387.50	259.00	Ningxia	16.25	200.33
Shandong	276.00	379.00	Xinjiang	33.25	360.50
Henan	262.75	246.00			

Data source: Calculated based on National Statistic Yearbook, 2007-2011

Note: these data of Hunan Province are different from the data in Hunan Rural Statistic Yearbook (different data sources)

2.2 Floods and drought affected areas and the grain loss in Hunan Province

Then we tried to break down the floods and drought affected areas and the grain loss to the four zones. The following table shows the average of floods and drought

affected areas and the grain loss for the 14 regions of Hunan Province in 2007-2010 (the data are different from last table, due to the different data sources). We found that although Hunan Province has a plenty water resources, it still suffering the drought and cause the huge grain loss. The average areas affected by drought for 2007-2010 was 610550 ha, and the average grain loss caused by drought for 2007-2010 was 1150368.08 ton. Meanwhile, the average area affected by floods was 438730 ha, and the average grain loss caused by floods was 777902.25 ton.

Table 7 Floods and drought affected areas and the grain loss in Hunan Province (2007-2010)

City and A.P.	Areas affected by floods	Areas affected by drought	Grain loss caused by floods	Grain loss caused by drought
	1000 ha.	1000 ha.	Ton	Ton
Changsha	0.15	91.56	N. A.	150241.25
Xiangtan	25.96	17.90	9640.75	21507.33
Zhuzhou	13.21	7.81	59964.25	35594.75
Hengyang	39.04	61.13	102039.00	148856.00
Yiyang	50.98	33.36	72562.75	50164.00
Changde	51.62	19.81	36347.50	37310.50
Yueyang	35.79	25.21	55372.50	47343.25
Yongzhou	43.00	62.42	111405.50	138442.25
Chenzhou	31.88	35.87	130444.75	92588.25
Shaoyang	63.35	75.62	81603.50	229985.00
Loudi	25.14	74.45	38937.75	43498.75
Zhangjiajie	8.10	42.36	13540.00	74424.00
Huaihua	33.62	42.35	36844.00	46489.75
Xiangxi	16.89	20.70	29200	33923.00
Total	438.73	610.55	777902.25	1150368.08

Data source: Calculated based on following data: Hunan Rural Statistic Yearbook 2008-2011;Areas affected by floods of Changsha City is only available in Hunan Rural Statistic Yearbook 2009 (not available in Hunan Rural Statistic Yearbook 2008, 2010,2011); Grain loss caused by floods of Changsha City is not available in Hunan Rural Statistic Yearbook 2008-2011.

Compare with the four zones, we found that the west and the south suffered the most by water hazards. 9.45% sown area of the west affected by drought. 6.37% sown area of the west affected by floods. The grain loss caused by drought of the west is 0.33 ton per ha sown area of grain. And the grain loss caused by floods of the west is 0.14 ton/ha.

Table 8 Floods and drought affected areas and the grain loss for the four zones (2007-2010)

City and A.P.	Areas affected by floods/Total sown areas	Areas affected by drought/Total sown areas	Grain loss caused by floods/Sown area of grain	Grain loss caused by drought/Sown area of grain
	%	%	Ton/ha	Ton/ha
West	6.37	9.45	0.14	0.33
South	5.22	8.78	0.22	0.25
East	3.08	9.19	0.08	0.24
North	5.28	2.99	0.11	0.09
Total	5.18	7.20	0.15	0.22

Data source: Calculated based on following data: Hunan Rural Statistic Yearbook 2008-2011; As for the east zone, areas affected by floods of Changsha city only counted the year of 2008 (available in Hunan Rural Statistic Yearbook 2009, others not available); Grain loss caused by floods of east zone, only counted Zhuzhou and Xiangtan (The data of Changsha is not available in Hunan Rural Statistic Yearbook 2008-2011).

3. Poverty and rural livelihood

3.1 Poverty distribution at national level

In the following figure, the red area indicates the national level poverty county. And the shaded area is the ecological fragile region. This figure indicates the strong link between poverty and ecological vulnerability. This kind of the linkage could be also found in Hunan Province.

Figure 8 Map of poverty and ecologically fragile area of China
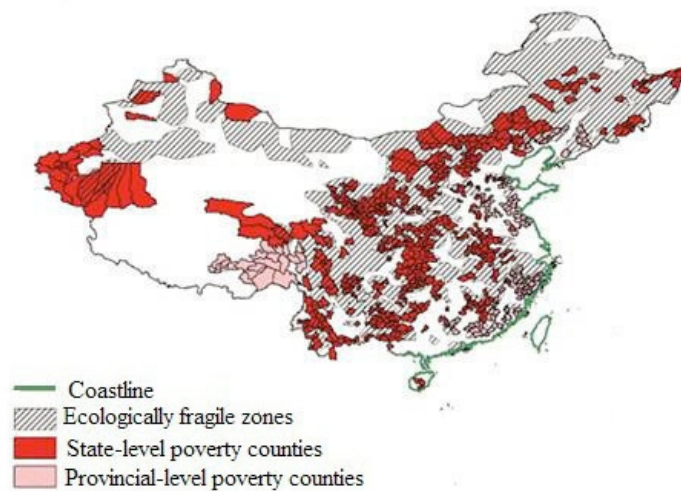
Map Source: Climate change and poverty: a case study of China

3.2 Poverty distribution of Hunan Province

At the end of 2011, China central government raised the poverty line from RMB 1274 to 2300 Yuan. This change is huge, but does not influence this research. Because the latest poverty data about Hunan Province we found in Hunan rural statistical yearbook 2011, is the data of 2010.

The following chart indicates that the poverty counties (national level poverty county in brown and the yellow areas are the provincial level poverty county) located in the mountainous and hills areas. These areas are ecological vulnerable compare with other areas.

Figure 9 Slope map and poverty map of Hunan Province

Hunan Province terrain slope distribution map   Hunan Province poverty counties distribution map
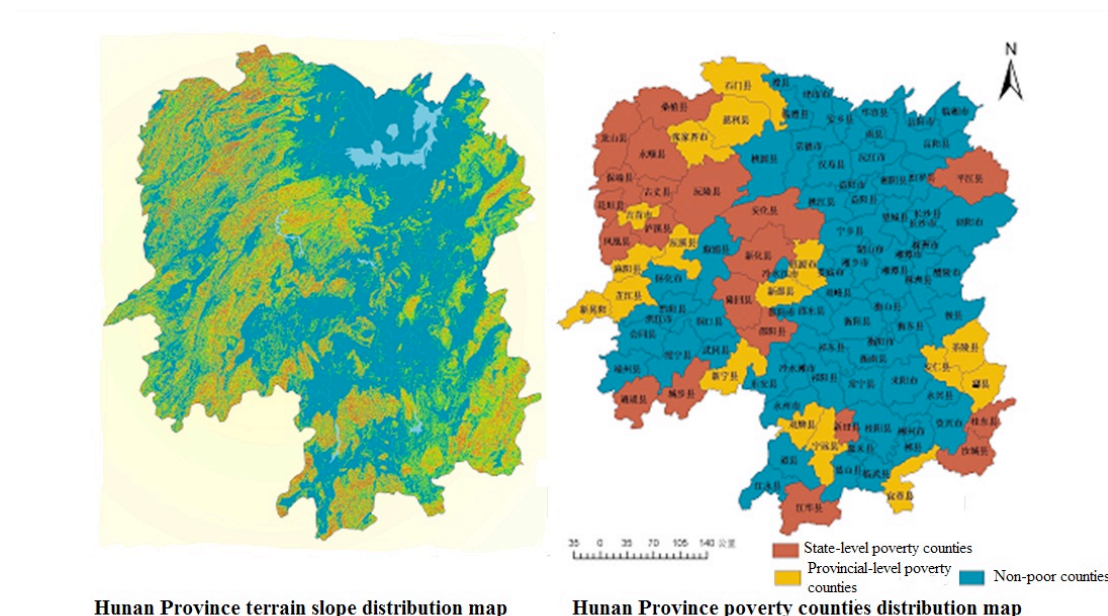
Map Source: Rural poverty distribution of Hunan Province, 2008

The following table indicates the poverty county's distribution of Hunan Province. Most of the poverty counties located at west and south of Hunan Province. The poverty ratio of counties in the west takes the 62%. Rural per capita net income of the west is the lowest, and the Engel coefficient of the west is the highest. The poverty ratio of counties in the south takes the 37%.

Table 9 Poverty counties' distribution of Hunan Province

Area	Prefecture level cities and autonomous region	National level poverty county	Provincial level poverty county	Ratio of poverty county （%）	Rural per capita net income (Yuan)	Engel coefficient
North	Yueyang City, Changde City, Yiyang City	2	1	12	4059.92	0.46
East	Changsha City, Zhuzhou City, Xiangtan City		2	16.7	5770.91	0.43

South	Hengyang City, Chenzhou City, Yongzhou City, Loudi City	5	5	37	3851.91	0.534
West	Zhangjiajie City, Shaoyang City, Huaihua City, Xiangxi Autonomous Prefecture	13	10	62	2653.64	0.55

Data Source: Rural poverty distribution of Hunan Province, 2008

Since county's poverty population is not available, we only counted the total population of national and provincial level poverty counties. The total population of poverty counties in the west and the south are much more than the other zones.

Table 10 Total population of poverty counties of four zones（2010）

(Unit: 10000 persons)

	Total population of national level poverty county	Total population of provincial level poverty county	Total
West	640.8	444.5	1085.3
South	287.6	322.5	610.1
East	0	80.8	80.8
North	207.9	68.4	276.3

Data source: Calculated based on Hunan Rural Statistic Yearbook 2011

4. Agro-ecological zones

4.1 Agro-ecological zones of China

The farming zone map of China indicates that Hunan Province mainly in the blue area, which is Southern Hills area planting double cropping of rice, tea, citrus.

Figure 10 Farming zoning map of China
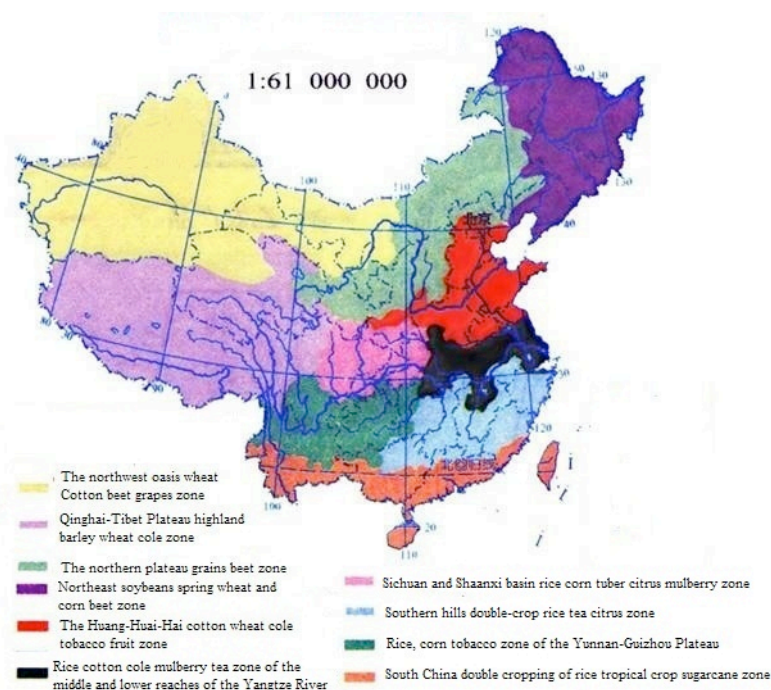
4.2 Agricultural products of Hunan Province

According to the Hunan Statistic Yearbook 2012, the gross output of 2011 is 4871.203 billion Yuan. Among it, primary industry is 450.82 billion, the secondary industry is 3181.767 billion, and the tertiary industry is 1238.616 billion. Primary industry includes agriculture, forestry, animal husbandry, fisheries and the services for primary industry. Following is the detailed gross output of the primary industry. Agriculture takes 1/2 of the total.

Table 11 Detailed gross output of the primary industry（2011）

	Gross output	billion Yuan
	Total gross output of primary industry	450.820
1	Agriculture	239.167
2	Forestry	23.911
3	Animal husbandry	142.560

4	Fishery	255.04

The following list shows the yields of the main agricultural products. Grain has the highest yield, much more than the others.

Table 12 The yields of the main agricultural products（2010）

	Main agricultural products	Yields (10000 ton)
1	Grain	2689.20
2	Cotton	22.70
3	Oil plants	195.26
4	Yellow red hemp	0.08
5	Ramie	6.33
6	Flue-cured tobacco	21.26
7	Tea	11.77
8	Citrus	377.60
9	Pork, beef and lamb	439.29
10	Aquatic products	198.89

Following table shows the main crops and their sown areas of different regions of Hunan Province. It tells that rice is the most important crop of Hunan Province, and it has the largest sown area, which is much more than other crops.

Table 13 The main five crops of different regions of Hunan Province（2010）

Changsha	Crops		rice	vegetables	oil seeds	green manure	potato
	Sown area	1000 ha.	351.33	139.27	42.29	31.05	13.19
Xiangtan	Crops		rice	vegetables	oil seeds	green fodder	green manure
	Sown area	1000 ha.	211.56	51.26	18.49	10.49	10.34
Zhuzhou	Crops		rice	vegetables	oil seeds	green manure	green fodder
	Sown area	1000 ha.	251.53	56.25	21.47	13.16	6.69

Hengyang	Crops		rice	oil seeds	vegetables	beans	green manure
	Sown area	1000 ha.	502.12	136.97	93.31	27.25	24.82
Yueyang	Crops		rice	oil seeds	vegetables	green manure	cotton
	Sown area	1000 ha.	475.78	109.86	82.55	36.24	33.76
Yiyang	Crops		rice	oil seeds	vegetables	cotton	green manure
	Sown area	1000 ha.	372.36	120.2	79.87	34.8	14.14
Changde	Crops		rice	oil seeds	cotton	vegetables	maize
	Sown area	1000 ha.	581.11	289.62	88.57	88.21	33.63
Chenzhou	Crops		rice	vegetables	oil seeds	maize	green manure
	Sown area	1000 ha.	264.43	87.82	42.96	42.84	36.02
Yongzhou	Crops		rice	vegetables	beans	potato	maize
	Sown area	1000 ha.	438.85	150.34	47.36	42.43	38.54
Shaoyang	Crops		rice	vegetables	maize	oil seeds	potato
	Sown area	1000 ha.	426.07	95.29	67.1	60.06	29.78
Loudi	Crops		rice	maize	vegetables	oil seeds	potato
	Sown area	1000 ha.	191.15	38.78	28.98	24.38	18.92
Zhangjiajie	Crops		rice	maize	oil seeds	potato	vegetables
	Sown area	1000 ha.	54.02	38.02	32.15	30.78	26.23
Huaihua	Crops		rice	oil seeds	vegetables	maize	green fodder
	Sown area	1000 ha.	233.61	105.43	63.63	59.82	31.12
Xiangxi	Crops		rice	vegetables	oil seeds	maize	potato
	Sown area	1000 ha.	90.72	56.18	47.75	38.87	38.71

Data Source: Hunan Rural Statistic Yearbook 2011

4.3 Structure of the industries and the primary industry for the four zones

Following is the structure of GDP for the four zones. This table shows that GDP per capita of the west is the lowest among the four zones. Usually, the poor area has higher ratio of primary industry. As usual, the primary industry GDP ratio of the west

takes 18.85%, ranked second of the four zones. Among the four zones, the east has the lowest primary industry ratio, other three zones' primary industry ratios close to 20%.

Table 14 Industry structures for four zones (2010)

	GDP per capita	GDP	Primary industry		Secondary industry		Tertiary industry	
	Yuan	Billion Yuan	Billion Yuan	%	Billion Yuan	%	Billion Yuan	%
West	10304	163.2246	30.77273	18.85	59.44597	36.42	73.0059	44.73
South	15545	321.95919	60.58476	18.82	142.65002	44.31	118.72401	36.88
East	40359	550.90398	37.65559	6.84	284.16464	51.58	229.08345	41.58
North	20021	310.29987	59.04054	19.03	140.3183	45.22	110.94133	35.75
Total	20493	1346.38764	188.05362	13.97	626.57893	46.54	531.75469	39.49

Data Source: Calculated based on Hunan Rural Statistic Yearbook 2011; Data of population from Hunan Statistic Yearbook 2011（N.A.in Hunan Rural Statistic Yearbook 2011）

Following table (table 15) is the structure of the gross output of the primary industry for the four zones. The total gross output of primary industry includes agriculture, forestry, animal husbandry, fishery, and service for primary industry. Agriculture takes the highest ratio of the primary industry. Agriculture gross output and agriculture gross output per ha (table 16) of the west are the lowest among the four zones.

Table 15 Detailed gross output of the primary industry for the four zones（2010）

Unit: Billion Yuan

	Agriculture	Forestry	Animal husbandry	Fishery	Service for primary industry	Total gross output of primary industry
West	30.25559	3.76937	19.66120	1.49514	0.77454	55.95584

South	51.52267	7.23397	47.47066	5.75354	1.95107	113.93191
East	31.48212	3.26337	27.65017	2.70805	1.61785	66.72156
North	47.09753	2.83720	37.61591	12.13344	2.02197	101.70605
Total	160.35791	17.10391	132.39794	22.09017	6.36543	338.31536

Data source: Calculated based on Hunan Rural Statistic Yearbook 2011

Table 16 Agriculture gross output per ha for the four zones (2010)

	Agriculture gross output	Total sown area	Agriculture gross output/total sown area
	Billion Yuan	1000 ha.	Yuan/ha.
West	30.25559	1915.2275	15797. 39
South	51.52267	2662.2975	19352. 71
East	31.48212	1276.355	24665. 65
North	47.09753	2620.7375	17971. 10
Total	160.35791	8474.6175	18922. 14

Data source: Calculated based on Hunan Rural Statistic Yearbook 2011

5. Water and agriculture

5.1 Water resource distribution at national level

National level water resources' distribution map indicates that Hunan Province is in the multi-water zone. The pink and yellow areas are water shortage areas, and the pink area is more severe.

Figure 11 Water distribution map of China
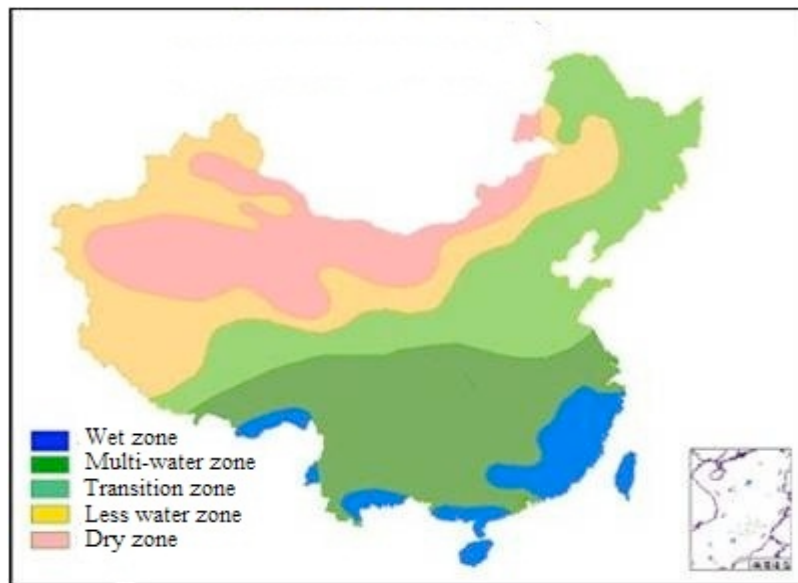
5.2 Irrigation access and rural income

In this section, we try to link the water access with the rural income. The following table shows the rural net income per capita, effective irrigation area, total sown areas and drought-affected area. For clearly see the relationship among these data, the rural income was standardized. And the ratio of effective irrigation area and the ratio of drought-affected area were calculated (displayed in next table).

Table 17 Water access and agriculture of Hunan Province (2007-2010)

	Rural net income per capita	Effective irrigation area	Total sown areas	Drought affected area
	Yuan	1000 ha.	1000 ha.	1000 ha.
Changsha	8813.47	224.27	615.7625	91.5575
Xiangtan	6477.04	116.095	299.95	17.9025
Zhuzhou	6260.135	144.775	360.6425	7.81
Hengyang	6012.045	251.99	873.2575	61.13
Yueyang	5115.738	251.1025	827.6825	25.2075

Yiyang	4749.203	221.1425	658.8075	33.36
Changde	4739.368	388.675	1134.2475	19.8075
Chenzhou	4416.735	166.835	564.68	35.8675
Yongzhou	4193.008	238.85	868.2325	62.4225
Shaoyang	3363.333	250.4525	782.1925	75.6175
Loudi	3134.993	109.5825	356.1275	74.4525
Zhangjiajie	3123.593	48.8525	208.3225	42.36
Huaihua	2895.398	181.135	572.355	42.3475
Xiangxi	2714.99	79.73	352.3575	20.7025

Data source: Calculated based on Hunan Rural Statistic Yearbook 2008-2011

The following table shows the standardized rural income, the ratio of effective irrigation area and the ratio of drought-affected area of different regions for Hunan Province. Now we explain the calculation of the data.

1) Standardize the rural income per capita: among all of the regions, pick the maximum of rural income per capita as the denominator. The rural income per capita of each region as the numerator is divided by denominator to calculate the standardized rural income per capita.

2) Ratio of effective irrigation area: effective irrigation area of each region is divided by the total sown area.

3) Ratio of drought affected area: drought affected area of each region is divided by the total sown area.

Table 18 The ratio of irrigated and drought area (2007-2010)

	Standardized rural income per capita	Ratio of effective irrigation area	Ratio of drought affected area
Changsha	1.00	0.36	0.15
Xiangtan	0.73	0.39	0.06
Zhuzhou	0.71	0.40	0.02
Hengyang	0.68	0.29	0.07
Yueyang	0.58	0.30	0.03

Yiyang	0.54	0.34	0.05
Changde	0.54	0.34	0.02
Chenzhou	0.50	0.30	0.06
Yongzhou	0.48	0.28	0.07
Shaoyang	0.38	0.32	0.10
Loudi	0.36	0.31	0.21
Zhangjiajie	0.35	0.23	0.20
Huaihua	0.33	0.32	0.07
Xiangxi	0.31	0.23	0.06

Data source: Calculated based on Hunan Rural Statistic Yearbook 2008-2011

Next, we draw the figure to show the linkages among the rural income and the water access. The following figure shows three curves: standardized rural income per capita (the income was standardized for easier comparison), effective irrigation area ratio, and the drought affected area ratio.

This figure shows the linkages among the rural income, irrigation and the drought. Accompany with the decline of the rural income, the ratio of effective irrigation area decline as well. But, the ratio of drought area appears the trend of increase.

Figure 12 The ratio of irrigated and drought area of Hunan Province (2007-2010)
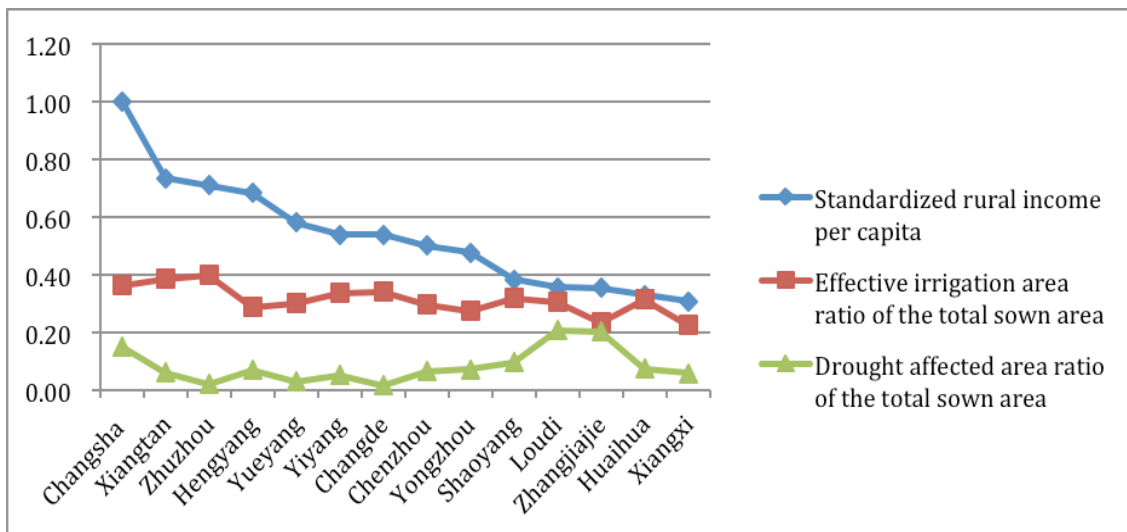
5.3 Irrigation access for the four zones

The economic and social development analysis of the poor counties in Hunan in 2011 pointed out the arable land per capita of the poor counties was 0.0547 ha (0.82 mu), which is 0.0013 ha (0.02 mu) more than the provincial average. However, the effective irrigation area per capita of poor counties was 0.0033 ha (0.05 mu), less than the provincial average (Hunan Statistic Bureau, 2012).

The following table shows that the poor zones (the west and the south) are less irrigation access than the richer zones (the east and the north). The ratios of effective irrigation area of the west and the south are 29.25% and 28.82%. The ratios of effective irrigation area of the east and the north are 38.01% and 32.85%. Compare with the poor zones and the richer zones, the effective irrigation areas are quite similar. However, the poor zones' sown areas are larger than the richer zones. The effective irrigation area for the poor zones is 1327427.5 ha, and 1346060 ha for the richer zones. The total sown area for the poor zones is 4577525 ha, and 3897092.5 ha for the richer zones.

Table 19 Irrigation and the sown areas for the four zones (2007-2010)

	Effective irrigation area	Total sown areas	The ratio of effective irrigation area
	1000 ha.	1000 ha.	%
West	560.17	1915.2275	29.25
South	767.2575	2662.2975	28.82
East	485.14	1276.355	38.01
North	860.92	2620.7375	32.85
Total	2673.4875	8474.6175	31.55

Data source: Calculated based on Hunan Rural Statistic Yearbook 2008-2011

5.4 Structures of water resources and water uses in Hunan Province

From the last column of the below two tables (table 20, 21), we could find that the west has the most abundant water resources among the four zones. However, the total water consumption and water use per capita of the west is the lowest (table 22). Meanwhile, the agriculture water use of the west is the lowest as well (table 22). In addition, from the above analysis, we knew that accompany with the decline of the rural income, the ratio of effective irrigation area also decline. Hereby, these indicate that the west needs the irrigation facilities for better using of the water resources.

Table 20 Water resources for the four zones (2007-2010)

	Total surface water	Total Ground water	Double counted	Total
	(1)	(2)	(3)	(1)+(2)-(3)
	0.1 billion m^3	0.1 billion m^3	0.1 billion m^3	0.1 billion m^3
West	561.15	132.36	132.36	561.15
South	492.45	130.16	130.76	492.45
East	216.85	48.39	48.33	216.91
North	306.46	68.07	61.15	313.38

Data source: Calculated based on Hunan Water Resources Bulletin 2007-2010

Table 21 Water resources per capita for the four zones (2007-2010)

	Surface water per capita	Ground water per capita	Double counted	Water resources per capita
	m^3	m^3	m^3	m^3
West	3359.54	792.42	792.42	3359.54
South	2267.45	599.31	602.08	2267.45
East	1628.96	363.50	363.05	1629.41
North	1907.09	423.60	380.53	1950.15

Data source: Calculated based on Hunan Water Resources Bulletin 2007-2010; Data of population from Hunan Statistic Yearbook 2008-2011（N.A.in Hunan Rural Statistic Yearbook 2008-2011）

Table 22 Water use for the four zones (2007-2010)

	Water use in agriculture	Industrial use	Domestic consumption	Total water use	Water use per capita
	0.1 billion m^3	0.1 billion m^3	0.1 billion m^3	0.1 billion m^3	m^3
West	38.99	8.88	7.50	55.37	331.49
South	63.80	24.39	10.21	98.4	453.08
East	40.38	27.74	7.31	75.43	566.62
North	53.26	23.47	7.57	84.3	524.60

Data source: Calculated based on Hunan Water Resources Bulletin 2007-2010; Data of population from Hunan Statistic Yearbook 2008-2011（N.A.in Hunan Rural Statistic Yearbook 2008-2011）

6. Poverty alleviation and water intervention

6.1 Targeting area

Based on the above analysis, we made the following table to combine all of the results, to find the targeting area for poverty alleviation and water intervention.

Among the four zones, the west is mountainous area, has the highest poverty rate, water hazard is high. Although the west has plenty water resources, but the water utilization is low, and the effective irrigation ratio is low as well. So, the water intervention is most in need for the west.

The south is hilly mountainous region, also has high poverty rate. The water hazard is the high as well. Water resources for the south are plenty, but the utilization is

moderate and the effective irrigation ratio is low. Hereby, the south also needs water intervention.

Table 23 Poverty and water intervention priority

Regions	Poverty	Water hazard	Effective irrigation ratio	Water resources per capita	Water use per capita	Altitude
West	Very high	High	Low	High	Low	High
South	High	High	Low	High	Moderate	Middle high
East	Low	Moderate	Moderate	Moderate	High	Moderate
North	Low	Moderate	Moderate	Moderate	High	Low

6.2 Poverty alleviation

"Wuling Mountain Regional Development and Anti-Poverty Plan（2011-2020）" (2011) pointed out that poverty alleviation for Wuling Mountain Area will be the demonstration pilot for other contiguous poor areas. Wuling Mountain poverty areas include 71 Counties (County-Level City, District) of 11 Prefecture-Level Cities or Prefectures of Hunan Province, Hubei Province, Guizhou Province and Chongqing City. The poverty counties of Hunan province include 8 counties of Xiangxi Autonomous Prefecture, all the counties of Huaihua and Zhangjiajie, 8 counties of Shaoyang, 3 counties of Loudi, Shimen County of Changde, and Anhua County of Yiyang.

Outline for Development-oriented Poverty Reduction for China's Rural Areas (2011-2020) pointed out that in the next 10 years the key poverty reduction areas that will be mainly supported by the government include contiguous poor areas with special difficulties like Liupan Mountain area, Qinba Mountain area, Wuling Mountain area, Wumeng Mountain area, rocky desertification areas in Yunnan, Guizhou and Guangxi provinces, mountainous border in western Yunnan, the south of

Greater Khingan Mountains, Yanshan Mountain-Taihang Mountain area, Lvliang Mountain area, Dabie Mountain area, and Luoxiao Mountain area as well as Tibet, Tibetan ethnic areas in Sichuan, Yunnan, Gansu and Qinghai provinces and Kashgar, Hotan and Kezilesu Kirgiz Autonomous Prefecture of Xinjiang, which have already been covered with special support policy. The government will channel more resources to those identified regions, step up trans-provisional guidance and coordination, pool strengths and launch projects in turn. Provinces, autonomous regions and municipalities directly under the central government should be responsible for helping contiguous poor areas with special difficulties. Guided by the central government, local governments should design and implement the plan of county-based poverty reduction projects. Departments of the State Council and local governments of all levels should facilitate better coordination, and carry out a series of welfare projects covering education, health, culture, employment and social security, cultivate and strengthen specialty and competitive industries, expedite the development of important regional infrastructure, enhance ecological and environmental protection, tackle bottlenecks that restrain the development, promote the equalization of basic public services, and put an end to the backwardness of poor areas. Provinces, autonomous regions and municipalities directly under the central government also enjoy the right to give more support to contiguous poor areas with special difficulties identified by themselves.

6.3 Water intervention

"Wuling Mountain Area Regional Development and Anti-Poverty Plan （2011-2020）" pointed out the water intervention measures. In addition, the "National Water Poverty Alleviation Planning"（2012）also emphasized these measures for coping with the water poverty.

- Soil and Water Conservation
- To strengthen the construction of small and medium-sized farmland irrigation facilities. To support the construction of small-scale irrigation facilities: small

water cellar, small pool, small reservoir, small canals, small pumping station, which called "five small-scale water conservancy projects".

– To strengthen the construction of floods control projects, and the development of water sources for coping with drought.

For the summary, we conclude that the water intervention of Hunan Province needs to target the west and the south regions by diversified small-scale irrigation (atomistic irrigation). In addition, soil and water conservation and floods control projects are also important.

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