

# CLASSIFICATION OF THE RAINFED AREAS FOR THE WATER DEVELOPMENT PROJECTS IN THAILAND

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**Abstract**—The water resources management in Thailand is currently managed by area-based consideration composed of irrigation and rainfed areas. However, the water supplies in the rainfed areas are mainly related to rainfall, small-waterbodies and ground water resources. Therefore, the rainfed agriculture is under the water deficit risk due to the climate variability and uncertainty. For this reason, the main propose of this work is to analyze and classify the potential of rainfed areas based on land-uses, household incomes, water resources risks and household locations. The classification results showed that the rainfed areas were classified into 7 types by prioritizing the water resources risk levels (severe, moderate-low or normal levels), special economic zone, household income (higher or lower than poverty line) and revenue structures (agriculture sector or other sectors). Additionally, the rainfed classification results can be applied to support the decision maker for allocating the water resources development projects in the critical rainfed areas. Therefore, the Department of Water Resources, Thailand, was applied the rainfed classification to implement the water distribution projects by using solar-powered irrigation systems in the critical rainfed areas to provide environmentally sustainable, and reliable access to energy, and water resources, to create the agricultural innovation, and to alleviate small and medium farmer's income and livelihood.

**Keywords**—*Rainfed areas; Water Management; Solar-Powered Irrigation System*

## I. INTRODUCTION

Water is the essential natural resources for contributing human living included domestic, agriculture, industry, transportation, tourist uses and environmental flow for conservation. However, water demand is significantly increased because of the population growth and economic expansion. According to this reason, the Royal Thai's Government had established and lunched the Strategic Plan on Thailand's Water Resources Management 2015 (hereinafter referenced to as "the Strategic Plan") for managing and utilizing the water resources development projects consisted of domestic use, water security for agriculture and industry, flood management, water quality, forest rehabilitation and administrative management. The main objectives of the Strategic Plan are related to solve the water resources problems effected to the socio-economic and water utilization in terms of river basin potential [1].

Currently, the water resources management in Thailand is managed by area-based consideration on irrigation and rainfed agriculture areas. Therefore, the agriculture areas in Thailand approximately are 238,720 km<sup>2</sup> consisted of the 2 types of agriculture areas. The first type of agriculture area is irrigation area which is about 48,350 km<sup>2</sup> or 20% of the agriculture area in Thailand whereas the other 80% or the main proportion is the rainfed agriculture area covered around 190,440 km<sup>2</sup> [1]. The agriculture area details [2] are illustrated in Fig. 1..

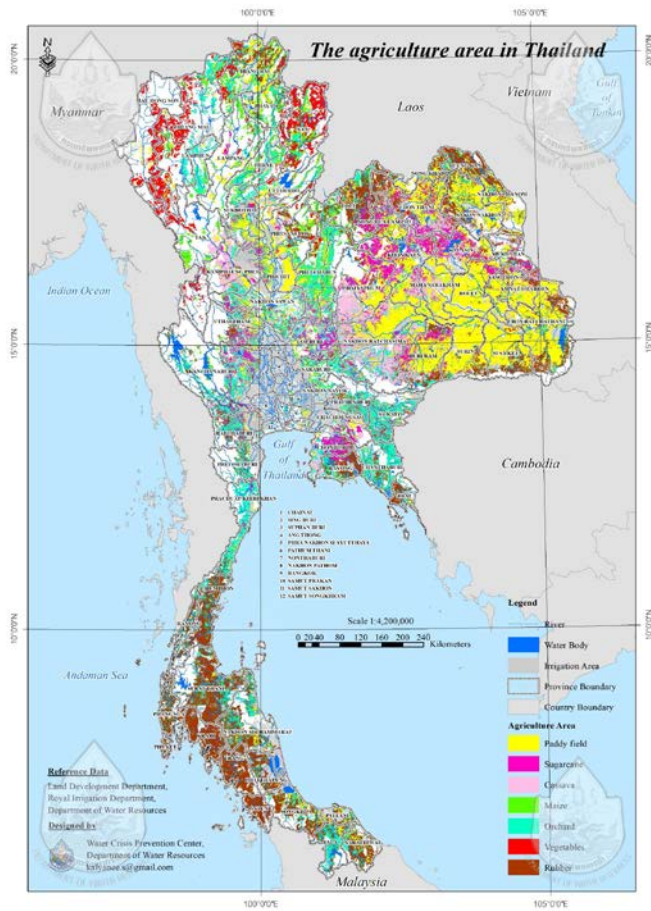


Fig. 1 The agriculture area in Thailand

However, the main water supplies are in the irrigation area which are approximately 77,680 MCM in terms of storage capacity in the large and medium reservoirs. On the other hand, the main water supplies in the rainfed agriculture are related to rainfall, waterbodies and ground water resources. Therefore, the rainfed agriculture is under the risk due to uncertainty and limitation of water from the climate variability and increase domestic, industrial, and environmental water demands, respectively.

For the above reasons, the main propose of this work is to analyze, classify and prioritize the potential of rainfed agriculture based on land-use, household income, revenue structures, water resources risk areas, specific economic zones and household locations. Furthermore, the water distribution projects by solar-powered irrigation system (hereinafter referenced to as “SIS”) are planned for implementing by the Department of Water Resources (hereinafter referenced to as “DWR”) in the severe areas to provide environmentally sustainable and reliable access to water and to alleviate farmer’s income and livelihood.

## II. METHODOLOGY

This section provides the overviews of data collection, spatial analysis and rainfed agriculture classification.

### A. Data collection

Data of land-use, flood and drought risk areas, special economic zones, household incomes and revenue structures from the Royal’s Thai Government was collected for this work. The details of data sources are as following;

- Land-use from Land Development Department [2]
- Irrigation areas from Royal Irrigation Department [3]
- Water resources area-based management from Department of Water Resources and Office of National Water Resources [4,5]
- Personal income in the village level from Community Development Department [6]
- Personal income in the provincial level from Office of the National Economic and Social Development Board [7]
- Number of households, National Statistical Office [8]
- Households location, The Geo-Informatics and Space Technology Development Agency (Public Organization) [9]

### B. Spatial analysis

Based on the dataset in the previous section, the data were analyzed by spatial analysis. The Geographic Information System was employed to classify the rainfed agriculture areas. Additionally, the concept of spatial analysis was expressed as the following processes (Fig. 2.);

1) Define the rainfed agriculture by eliminating catchment area with irrigation area, forest, urban area, gesture, waterbody and transportation, etc.

2) Classify the rainfed agriculture using the risk level, personal annual income and revenue structure. Therefore, the rainfed agriculture was defined into 7 types as following;

a) Type 1: the server areas or special economic zones, which the majority income of the local people come from the agriculture sector while the annual personal income is less than the poverty line (1,000 USD per year) [7].

b) Type 2: the server areas or special economic zones, which the majority income of the local people come from the agriculture sector while the annual personal income is higher than the poverty line.

c) Type 3: the moderate and low risk areas, which the majority income of the local people come from the agriculture sector while the annual personal income is less than the poverty line.

d) Type 4: the moderate and low risk areas, which the majority income of the local people come from the agriculture sector while the annual personal income is higher than the poverty line.

e) Type 5: the normal areas, which the majority income of the local people come from the agriculture sector and the annual personal income is less than the poverty line.

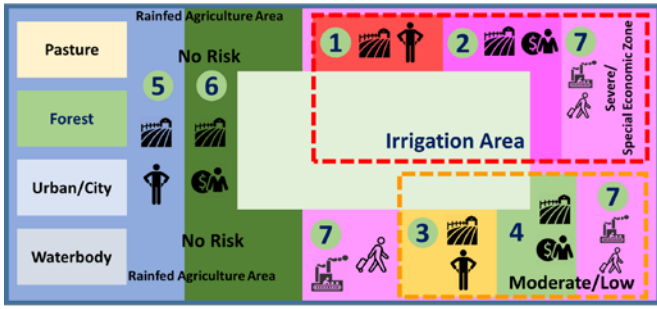


Fig. 2. The concept of spatial analysis for rainfed agriculture area

f) Type 6: the normal areas, which the majority income of the local people come from the agriculture sector while the annual personal income is higher than the poverty line.

g) Type 7: the other areas in the rainfed agriculture, which the majority income of the local people come from the industrial and service sectors.

### III. RESULTS

The rainfed agriculture, personal income distribution and rainfed agriculture risk classification are expressed in this section.

#### A. Rainfed agriculture

The water resources risk classification in the rainfed agriculture was determined by the area-based management [4, 5]. The analysis result showed that, the rainfed agriculture was classified into 4 risk levels. The first level is the severe areas and special economic zones with approximately 53,760 km<sup>2</sup> or 28%, the second level is the moderate area with approximately 39,810 km<sup>2</sup> or 21%, the third level is the low risk area with approximately 30,640 km<sup>2</sup> or 16%, and the last level is the no risk area or the largest proportion of the rainfed agriculture with approximately 66,230 km<sup>2</sup> or 35%, respectively. Details are shown in Fig. 3.

For the land-use information, this study showed that the majority vegetation area is the paddy field with approximately 79,000 km<sup>2</sup> or 41% following by rubber and palm trees with 41,180 km<sup>2</sup> or 22%. The other 37% of areas were shared by planting economic vegetation, fruits and vegetables composed of sugarcane 18,300 km<sup>2</sup> or 10%, cassava 17,300 km<sup>2</sup> or 9%, fruits 17,780 km<sup>2</sup> or 9%, corn 10,200 km<sup>2</sup> or 5%, and vegetables 6,680 km<sup>2</sup> or 4%, consecutively. Details were exhibited in Fig. 1.

#### B. Personal income distribution

The personal income in the sub-district level, number of households and the household locations were applied to analyze and determined the personal income distribution.

The results presented that the 19.20 million households or 90% have the personal income higher than the poverty line. On the other hand, 2.12 million households or 10% of national households have personal incomes lower than the poverty line. The personal income distribution is expressed in Fig. 4. The

DWR analysis results in terms of the number of households and people, which are lower than the poverty line are around 2.12 million households and 5.85 million people are consistent with the Office of the National Economic and Social Development Board Report [7].

#### C. Rainfed agriculture classification

The rainfed agriculture is defined by the 7 classifications mentioned in the section 2.2. The classification results in each regional are illustrated in TABLE I. and Fig. 5. For the results, Type 1, 3 and 5 are approximately 3,264 km<sup>2</sup> or 2%, 4,848 km<sup>2</sup> or 3%, and 5,568 km<sup>2</sup> or 3%, respectively. Additionally, Type 2, 4 and 6 are roughly 45,616 km<sup>2</sup> or 24%, 62,032 km<sup>2</sup> or 33%, and 56,896 km<sup>2</sup> or 29%, consecutively. Furthermore, Type 7 is about 12,208 km<sup>2</sup> or 6%.

### IV. DISCUSSION

After the rainfed agriculture was classified by spatial analysis as mentioned in the previous sector. The DWR applied the rainfed classification area to implement the SIS for distributing water to small farm land and increasing the annual household income in the rainfed agriculture

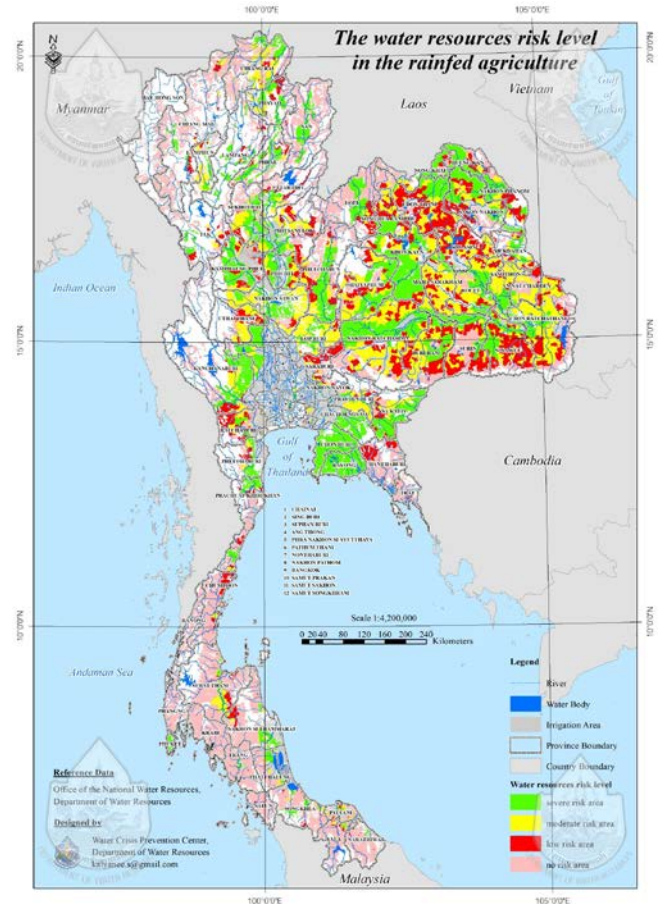


Fig. 3. The water resources risk level in the rainfed agriculture

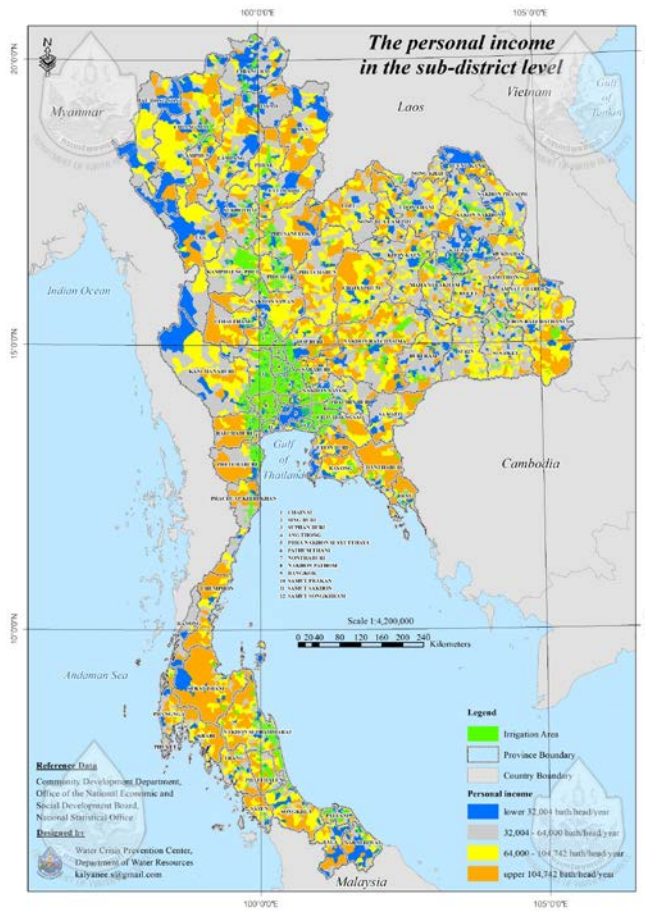


Fig. 4. The personal income in the sub-district level

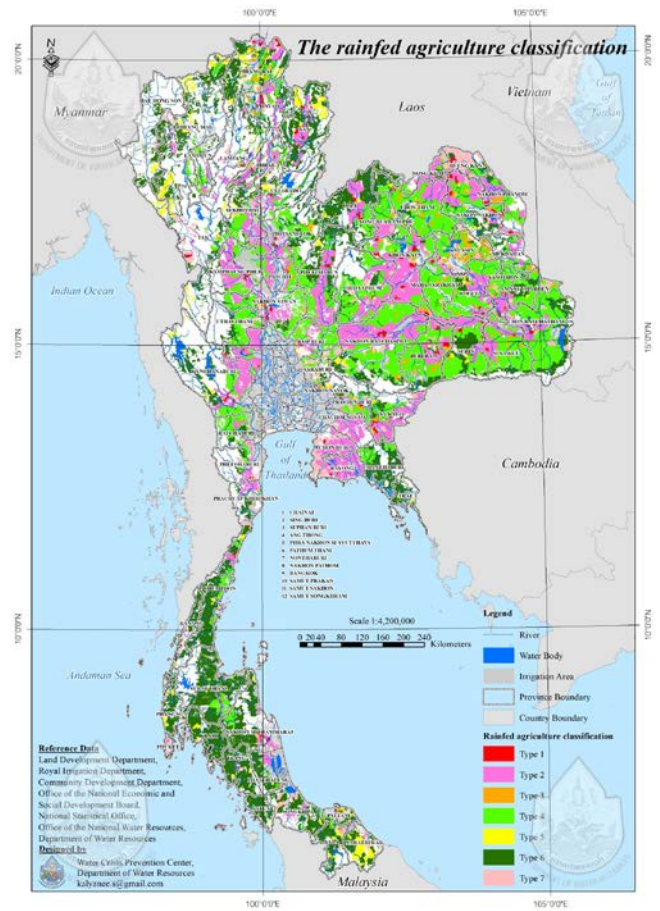


Fig. 5. The rainfed agriculture classification

TABLE I. THE RAINFED CLASSIFICATIONS IN THE EACH

Regionals	Area (km <sup>2</sup> )						
	Type 1	Type 2	Type 3	Type 4	Type 5	Type 6	Type 7
North	896	9,920	912	10,736	2,048	11,776	1,184
Central	512	6,272	480	6,208	480	3,856	2,176
East	64	5,088	16	640	128	3,088	2,112
Northeastern	1,664	23,088	3,328	42,624	1,040	14,848	5,088
South	112	896	64	1,600	656	17,568	800
Deep South	16	352	48	224	1,216	5,760	848
Total	3,264	45,616	4,848	62,032	5,568	56,896	12,208

The overview for specification of SIS are as following:

- The coverage area approximately 60,000 m<sup>2</sup>/system covered 25 households
- The water body with capacity larger than 30,000 m<sup>3</sup>
- The water pump with capacity 100 m<sup>3</sup>/day and 5 horse power or 4 k Watt
- The solar power with capacity 300 watts

As a result, the system can increase household annual income around 1,560 US dollar/year according to the previous survey from existing project in Nakhon Ratchasima and Kanchanaburi by DWR.

To solve water shortage in rainfed agriculture risk and alleviate income for the household that have income lower than the poverty line, the DWR and the Local Administrative Department are cooperated to set the urgent plan to implement 3,482 projects of SIS from 2017-2021. The expect outcomes are to apply SIS to cover 224 km<sup>2</sup>, which will benefit 85,600 households and to increase water capacity in the rainfed agriculture approximately 122 million m<sup>3</sup>.

According to the strategic plan on Thailand Water Resources Management, one of the main strategies is focused on the water security for production sector, which is related to increase the water storage and agriculture area. For this reason, the DWR planned to implement the SIS for the long-term plan in 20 years (2017-2037), which is expected to support the people in the rainfed agriculture areas who have the annual income lower than the poverty line as mention in previous section. Therefore, the 18,100 projects of the SIS are planned to implement in the rainfed agriculture area to improve the quality of life of 2.12 million households who have income lower than poverty line.

## V. CONCLUSION

The classification of the rainfed areas for the water development projects was classified and prioritized by land-use, household income, revenue structures, water resources risk

areas, special economic zones and household locations. For the classification results, the potential rainfed agriculture areas were defined into 7 classifications. Type 1, 3 and 5 are the key areas for Thailand to carry out target poverty alleviation. Therefore, the technology and innovation are needed to boost rural revitalization and modernization. Currently, Thailand is transforming its traditional agriculture sector, using science and technology by considering ecological restoration and protection to drive rural revitalization and modernization. Consequently, the solar-powered irrigation system has played an important role in ensuring national food security, high-quality crop varieties, automate machines, water efficiency, pollution control and agriculture waste recycling.

For the potential rainfed agriculture areas, the Royal's Thai Government by Department of Water Resources, Ministry of Natural Resources and Environment and Local Administration Department, Ministry of Interior was planned to implement the solar-powered irrigation system in the urgent plan in 3,482 projects with a planned investment approximately \$218 million, which will take 5 years to complete from 2017 to 2021. Moreover, the projects are expected to help boost the local economy and support the other alleviation projects. In addition, the other 18,100 projects of the solar-powered irrigation system were planned in the 20 years plan to implement in the rainfed agriculture areas to improve well-being of 2.12 million households who have income lower than the poverty line in Thailand.

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