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The Study of Community Water Management : Case Study of Nongphon Village, Kudkhonkaen Sub-district, Phuwiang District, Khonkaen Province, Thailand

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The aim of this research was to compare the adequacy of runoff with water consumption in various activities in the area of Nongphon village, Phuwiang district, Khonkaen province. By considering the details of each monthly, volume of water use of all activities were calculated such as water consumption and crops water use. Inflow runoff was calculated by SCS-CN method. And water balance equation was used to compare water requirement of all activities with water budget. It was found that, the population in the area mostly used water for agriculture. From calculation, the maximum water use for agriculture was 521,360.09 cubic meters which it was in December amount of inflow runoff was 5,081,285.49 cubic meters and amount of water use for all activities are 3,040,614.74 cubic meters. The accumulative average runoff data were analyzed. There were remaining volumes of runoff during July to February due to using less water. Water was used for agriculture more than water consumption. Therefore, it can be used the remaining water could be used for the other months which have less water. From results this study, could be a guide for water management in non-irrigated area such as improve the delivery of water to reduce water loss through evaporation and leakage, modify irrigation methods, good cultivation planning, planting an appropriate crops, dig the ponds more, dredging water ways to increase water conveyance efficiency, etc.

Keywords: water management, drought, SCS CN method

Introduction

Water is an important resource to agriculture and it will not be successful if there is no water. The rainy season usually starts in May and ends in November but has a dry spell in July. Nowadays, however, there is dry spell

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for a long time due to environmental change (Rundawe, 2014). This particularly occurs in the area where upstream forest is destroyed for farming. Consequently, there are impacts on an amount of water and water flowing in the dry season. In addition, the El Niño phenomena causes change in the climate condition which has impacts on a decreased amount of rain or drought condition. Thus, there is lack of waster for household consumption and agricultural purpose.

Therefore, this study aims to analyze an amount of water so as to be a guideline for water management in the non-irrigated area of Nongphon village, Kudkhonkaen sub-district, Phuwiang district, Khonkaen province. This can be an alternative for readiness preparation to prevent lack of water in the dry season. In fact, Nongphon village has a water storage source for household consumption and agricultural purpose in the dry season. Nevertheless, it is not good enough to store water which results in inadequate water. Thus, this study also investigate adequacy of water in the area comparing with an amount of water use of all activities in each month. Besides, it aims to analyze an amount of water so as to be a guideline for water management in the non-irrigated area. This can make the village has enough water for sustainable consumption.

Study area

Nongphon village is located in a low alluvial plain covering an area of 3,874 rai. It is in the area of Kudkhonkaen Local Administrative Organization, 25 km. away from Phuwiang district. Kudkhonkaen Local administrative organization consists of 2 villages: Baan Nongphon and Baan Phonpattana with the total population of 1,240. Most of the people there are engaged in agriculture such as rice, sugar cane, and cassava growing. However, these villages are non-irrigated areas so people there have to be dependent on the rain for household consumption and cultivation. They often face the problem of drought condition n the dry season.

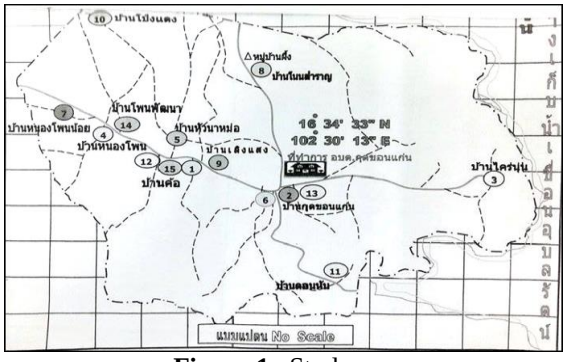

Figure 1 Study areas

Methodology

Conceptual Framework

This study consists of the following steps:

– Area, community context, and village cultivation area survey;
– Water catchment area, river flowing area, an amount of rain, and areas having impacts on drought survey;
– Computation of needs for water for household consumption and agricultural purpose;
– Computation of water balance in the areas to find an amount of over water and lack of water; and
– Finding a guideline for solving the problem based on water balance analysis.

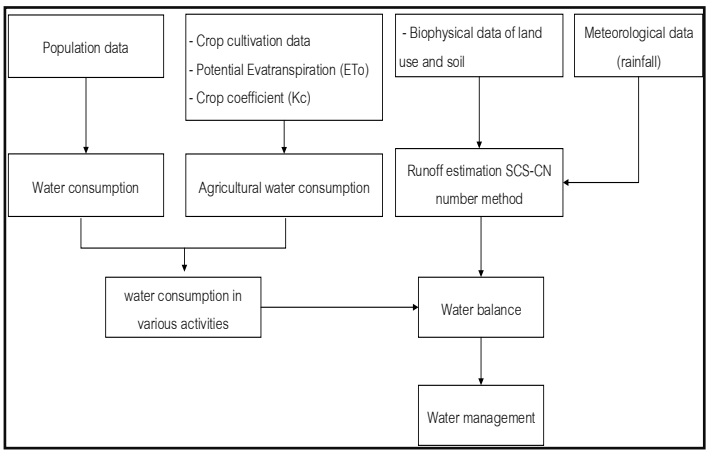

Figure 2 Flow chart of Methodology

Water consumption various activities

Water use in the watershed comprises household consumption and agricultural purpose (Thanapakpawin, 2008) and the following are its details:

1) An amount of water used for household consumption

Based on a number of populations in the study areas, the water consumption rate is 50 liters/head/day (operational manual and a manual on the estimation of water use in various activities).

Need of water = Number of population x average water use rate (1)

2) An amount of water used for agricultural purpose

The computation of an amount of water use for agricultural purpose has the following components: The value of water use by each crop variety is

obtained for equation 2. The value of water use by the reference crop is obtained from Penman – Monteith equation, crop growing calendar, and areas used for each crop variety growing (Table 1 and 2).

$$ETc = Kc \times ETo \quad (2)$$

Where ETc = Crop Evapotranspiration (mm/day)
Kc = Crop Coefficient
ETo = Reference of Evapotraspiration (mm/day)

Table 1 Cropping calendar in the area

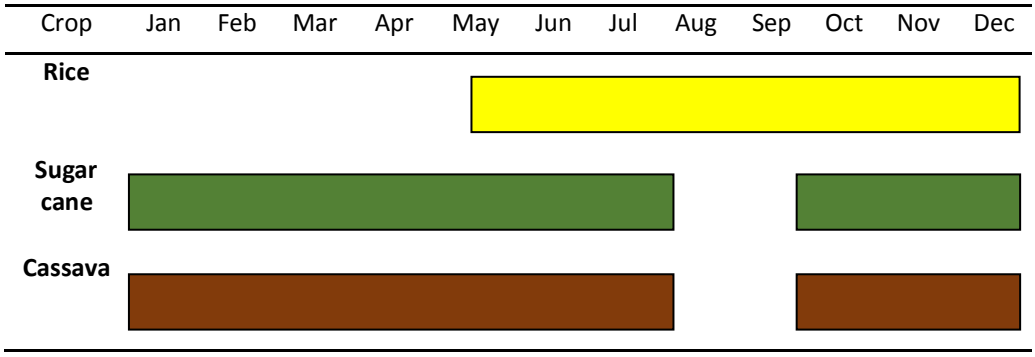

Table 2 Cultivation area

Village No.	Village	Total area	Cultivation area (rai)				
			Paddy fields	**Farm**	**Orchard**	**Public land**	**Other**
4	Nongphon	2,624	1,025	1,500	28	71	-
14	Phonpattana	1,250	831	363	41	15	-

Analysis of amount of water by using SCS – CN method

SCS – CN method is developed for a sum of rain. It is the estimation of an amount of water value comprising space in the soil, surface water, and the ratio of unknown value of surface water. The SCS-CN number method is the assumption that it is the basis of water balance equation (Natural Resources Conservation Service, NRCS.Z., 2004). The principle of the SCS – CN method is that the rain aside from the storage will be drained to the downstream area in the form of surface runoff and subsurface flow or it can be said "direct runoff". Water storage in the upstream area depends on topographic condition, soil type, and type/an amount of soil-covered plant. Below is the equation used in the principle of SCS – CN method (Mishra and Singh., 2003).

$$\frac{F}{S} = \frac{Q}{P - I_a} \quad (3)$$

An amount of loss rain (F) is obtained from

$$F = P - I_a - R \quad (4)$$

An amount of excessive rain (Q) is obtained from

$$Q = \frac{(P - I_a)^2}{(P - I_a) + S} \quad (5)$$

The initial loss l_a has a relationship with a highest amount of sorted water S as the equation :

$$I_a = 0.2S \quad (6)$$

- A highest capacity of water storage (S) is obtained from :

$$S = \frac{25400}{CN} - 254 \quad \text{(mm.)} \quad (7)$$

The value of Curve Number (CN) depends on land used type, study area, soil type, and humidity of the watershed area. Generally, the SCS-CN method is good for not too big watershed area (Tekeli, *et al*., 2007).

$$\Delta S = I - O \quad (8)$$

Where I = Amout of water inflow
O = Amout of water outflow
ΔS = Amout of water change

Results of the Study

Analysis of an amount of water use of all activities in the areas

Amount of water used for household consumption

According to data on population during 2009-2015, there are 1,240 people on average and they consumed water for 62 cubic meters per head per day (Figure 3).

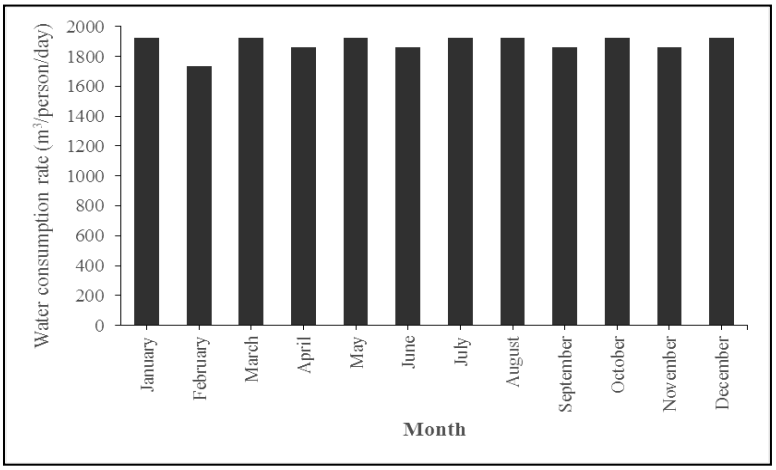

Figure 3 Water consumption from 2009 –2015

Amount of water used for agricultural purpose

Most of the agricultural areas in Nongphon village, Kudkhonkaen sub-district, Phuwiang district, Khonkaen province are rice fields (3,874 rai). Besides, farmers there prefer to grow sugar cane, cassava, vegetable, etc. (Table 3).

Table 3 Consumption in various activities

Month	Consumption in various activities (m^3)			Total (m^3)
	Rice	Sugar cane	Cassava	
January	0.00	454,904.36	0.00	454,904.36
February	0.00	477,507.47	0.00	477,507.47
March	0.00	348,043.28	0.00	348,043.28
April	0.00	219,327.26	0.00	219,327.26
May	0.00	26,883.54	0.00	26,883.54
June	145,021.31	0.00	0.00	145,021.31
July	124,722.01	0.00	0.00	124,722.01
August	70,251.23	0.00	0.00	70,251.23
September	0.00	0.00	0.00	0.00
October	0.00	0.00	126,382.94	126,382.94
November	0.00	251,823.95	264,033.30	515,857.25
December	0.00	382,328.44	138,070.66	520,399.09

Analysis of amount of water

According to data on an amount of rain during 1999-2013, an average monthly amount of rain is computed for finding an amount of water by using the SCS-CN method. It is found that there is the highest amount of rain in September on average (1,385,453.05 m^3) as shown in Table 4.

Table 4 Water balance in the study area

Month	Water balance (m^3)		Amount of water (m^3)	
	Runoff in the area)Inflow)	Water consumption in various activities (Outflow)	Excess water	Lack of water
January	46.83	455,865.36	0.00	-456,779.53
February	510.01	478,375.47	0.00	-478,733.46
March	111,112.61	349,004.28	0.00	-238,852.66
April	292,973.71	220,257.26	71,786.45	0.00
May	612,077.26	27,844.54	583,271.73	0.00
June	473,482.43	145,951.31	326,601.13	0.00
July	770,057.07	125,683.01	643,413.05	0.00
August	943,599.14	71,212.23	871,425.91	0.00
September	1,385,453.05	930.00	1,383,593.05	0.00
October	480,966.71	127,343.94	352,661.77	0.00
November	10,722.67	516,787.25	0.00	-506,994.57
December	283.99	521,360.09	0.00	-522,037.10
Total	**5,081,285.49**	**3,040,614.74**	**4,232,753.08**	**-2,203,397.33**

Analysis of water balance

Based on the computation of an amount of water use in the whole area (Outflow), it can be seen that December is the month which water is needed for agricultural purpose most (1,385,453.05 cubic meters). However, there is least water use in the area (930.00 cubic meters).

Comparing an amount of water needed and water budget in each month, it is found that water budget is adequate for water management in each month. During July-February is the period which there is the most accumulated water. This is because it is the time when there is a low level of needs for water in the area. Besides, people there need water for agricultural purpose rather than household consumption. Hence, there is enough accumulated water and it can be stored in ponds.

A guideline for solving the problem

People in the area should use artesian well water together with surface water during the dry spell period. Besides, they should make a survey of the watershed for digging a water storage pond. However, it must have an increase in the efficiency of water storage because the village pond had a low level of the capability in it. Therefore, an increase in the efficiency of the pond is an increase in water budget storage. That is, the pond must mostly have clay material (montmorillonite/betonies/synthesized clay sheet). In addition, water supply method should be adopted and an appropriate plan for cultivation should be made for increased efficiency in water use. Not only this, soil nourishment and water supply improvement should be done before the cultivation to reduce loss of water, seeping, and evaporation.

Conclusions

Regarding the study on the community water management in Baan Nonphon village, Kukdkhonkaen sub-district, Phuwiang district, Khonkaen province, it is found that people there mostly use water for agricultural purpose. It can be seen that water is needed for agriculture in December most (521,360.09 cubic meters). According to the sum of an average of amount of rain in the area, it can be seen that September is the month which there is an amount of water inflow most (1,385,453.05 cubic meters). However, an amount of water is least needed (930000 cubic meters). According to data on an amount of monthly accumulated water, it can see that during July-February is the period when there is the most accumulated water. This is because there is a low level of needs for water is the area. Therefore, obtained data can be used as a guideline for cultivation planning in order to increase the efficiency in water use. Besides, soil nourishment and adaptation of water supply method, should be done. Aside from this, pond digging and increased efficiency in water storage can help the village has adequate water for household consumption and agricultural purpose.

Suggestions

The provision of additional water for the area should be taken into consideration. This can be done by making use of the contour map for pond digging (size and a number of ponds).

For pond digging, it should have a method to increase the efficiency in water storage.

Concerned local agencies should prepare a systematic database beneficial to an analysis of various projects. It is necessary to use accurate data for assisting local people or target groups.

The water supply method should be improved and planning on cultivation appropriate with an amount of water in the area should be made for effective water use.

Soil nourishment should be done before the cultivation. Also, water supply method should be improved to reduce loss of water, seeping, and evaporation.

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