

Potential of Headwater Kaeng Krachan National Park on Streamflow Distribution to Upper Phetchaburi River above Kaeng Krachan Reservoir

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Abstract

Kaeng Krachan National Park Head Watershed located in the Upper Phetchaburi Watershed above Kaeng Krachan Reservoir with area of 1,240 sq.km. There is cover with high mountainous averages elevation 700 m. with slope is more than 35% from west to east 99% is forest cover. The head watershed is origin from the forest area of Tanao Sri Mountain down to the estuary at Ban Laem District. The distance is approximately 227 km. The Phetchaburi River is very important to Phetchaburi Province such as water consumption, transportation, agriculture, household industry, maintain ecosystems downstream and auspicious water in the coronation ceremony. From 20-year average rainfall data (1999 – 2019) found that Wet-Period (monthly rainfall more than 100 mm.) was between May – October and Dry-Period (monthly rainfall less than 100 mm.) was between November – April. Rainfall data of year 2020 was collected from the SWR005 station of National Hydroinformatics Data Center (NHC). Streamflow was measured by recording staff gauge at the Phetchaburi River above Kaeng Krachan Reservoir. The objective of this research was to analyze the potential of Kaeng Krachan National Park Head Watershed. The results found that the head watershed has an annual rainfall 1,285.80 mm. and contributed an annual streamflow 491.47 MCM (396.35 mm.) or about 30.83% of the annual rainfall and contributed streamflow during Wet-Period about 384.24 MCM (309.87 mm.) or 78.18% of the annual streamflow and contributed amount of streamflow during Dry-Period about 107.23 MCM (86.48 mm.) or 21.82% of the annual streamflow. Can be concluded that Kaeng Krachan National Park Head Watershed has moderate potential on contributed streamflow compared to other head watershed in the north.

Keywords: Kaeng Krachan National Park, Phetchaburi River, Wet-Period, Dry Period

1. Introduction

The watershed is an important area that serves as a rainwater catchment and distribution area to streams for humans and living things together with providing water for consumption regularly. Phetchaburi Watershed has a total area of 6,254.45 sq.km. These is origin from the forest area in Tanao Sri Mountain with high mountainous above 700 m. Kaeng Krachan National Park is area of 2,914.70 sq.km. (National Park Office, 2021) forest cover comprising dry evergreen forests, mixed deciduous and dry deciduous forest. This area was important sources of water for the downstream areas which has water demand approximately 1,340.47 MCM/year (NHC, 2012) and supply for an irrigated area up to 958.63 sq.km. (Bureau of Project Management, 2018)

Kaeng Krachan National Park Head Watershed covers area of 1,240 sq.km. which important area to provide streamflow to the Phetchaburi Watershed. Currently, the potential of head watershed was not yet analyzed as same as Kog Ma watershed hill evergreen forest at Doi Pui can provide streamflow 65% of rainfall (Chankao, et al., 1979). Wet-Period to Dry-Period streamflow in the range of 60:40 which can be considered a good proportion for streamflow. (Department of Conservation, 2011)

Therefore, it is important to study the potential of Kaeng Krachan National Park Head Watershed in term of providing streamflow to the Phetchaburi Watershed and the distribution of streamflow from the ratio of Wet-Period to Dry-Period streamflow for management planning in the future.

2. Materials and Methods

2.1 Site selecting for streamflow measurement

From the geographical map and field survey (Figure 1), site selection for streamflow measurement where the stream is quite straight and not too wide and above Kaeng Krachan Reservoir. The stream length is should 5 times the stream width and to prevent stream overflow when highest flooding peak so the sampling point should have a riverbank above the highest flooding peak and is not influenced by the water in Kaeng Krachan Reservoir. (Figure 2)

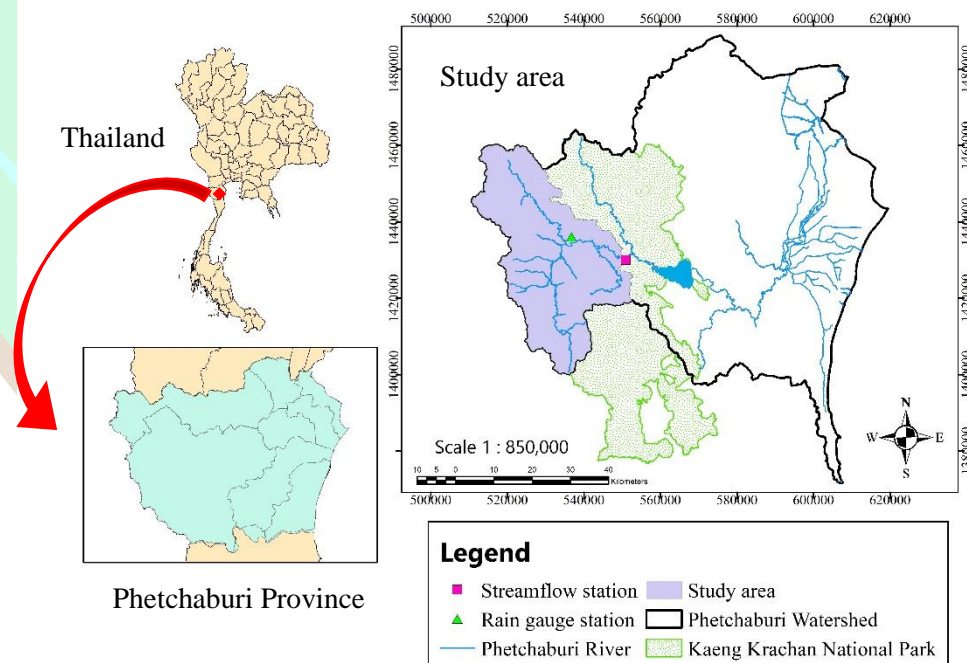


Figure 1 Study area at Kaeng Krachan National Park Head Watershed



Figure 2 Stream for streamflow measurement
Source: Chanida Ratsameejindawong

2.2 Data Collection

1) Rainfall data from 20-year average monthly rainfall data (1999 - 2019) was collected from National Hydroinformatics Data Center (NHC) but rainfall data in year 2020 was collected from Ban Pong Luek Border Patrol Police School Station (SWR005). (Figure 3)



Figure 3 Rain gauge station at Ban Pong Luek Border Patrol Police School (SWR005)

2) Streamflow data were measured by installing a Staff Gauge with Water Level Recorder to record data and measured waterflow by flow meter. (Figure 4)



Flow Meter (Valeport Model 001)



Staff Gaug



Water Level Recorder



Data Recorder



Figure 4 Tools for collecting streamflow data at streamflow station

The streamflow velocity was measured by flow meter (Valeport Model 001). If the water at stream depth less than 1 m. was measured at 0.6 of the stream depth and if the water at stream depth was more than 1 m. was measured 2 points at 0.2 and 0.8 of the stream depth and average velocity. (Bureau of Research, Development and Hydrology, 2006). The Streamflow (Q) was calculated with the cross-section area (A) (Figure 5) at that time and streamflow velocity (V) analyzed from the formula $Q = VA$ in each interval of the stream cross-section area until the entire width of the stream. Then measured flow velocity least 5 different water heights for plot the rating curve for calculate the streamflow data of each day. (Figure 6)

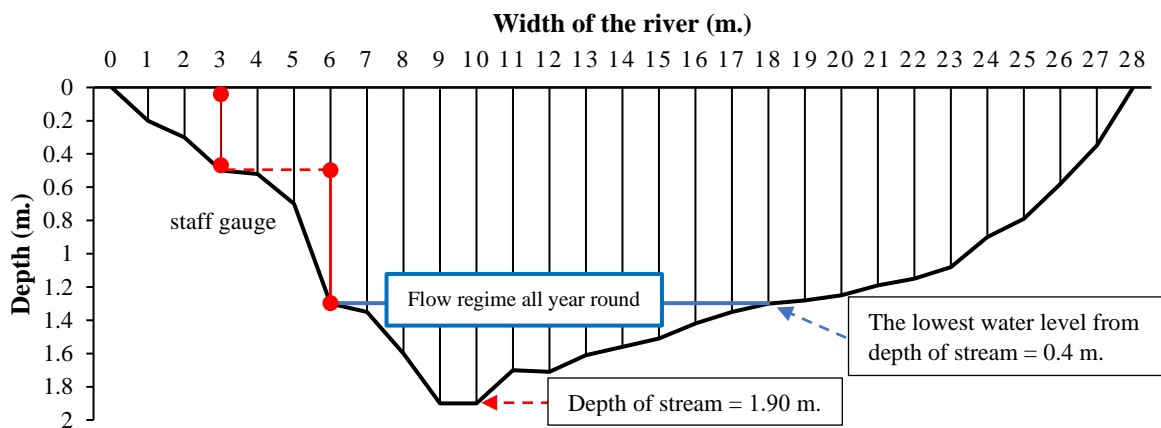


Figure 5 Cross-section of the Phetchaburi River at streamflow station

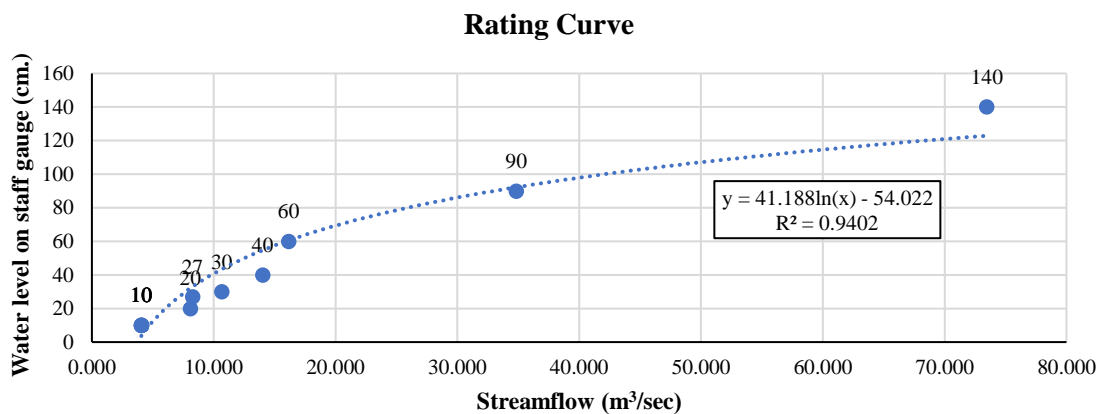


Figure 6 The rating curve show water level at staff gauge and streamflow of Phetchaburi River

2.3 Data Analysis

1) 20-year average monthly rainfall data were used to analyze Wet-Period is the month which had rainfall more than 100 mm. while Dry-Period is the month which had rainfall less than 100 mm.

2) Year 2020 rainfall data were collecting from station SWR005 and analyzed Wet-Dry Period according to the time interval from 20-year average monthly rainfall data.

3) The ratio of Wet-Dry Flow and ratio of streamflow to rainfall were analyzed.

3. Results and Discussions

3.1 Rainfall

20-year average monthly rainfall data from NHC was annual rainfall of 1,111 mm. which maximum rainfall in October of 249 mm. and minimum rainfall in January of 6 mm. and used data for divide during Wet-Dry Period was found Wet-Period in May – October and Dry-Period in November – April.

In 2020, the annual rainfall was 1,285.8 mm. which higher than 20-year average rainfall because a summer storm occurs in April which the highest monthly rainfall (232 mm.) and higher than maximum monthly rainfall in the October from 20-year average monthly rainfall of October was 249 mm. (Figure 7)

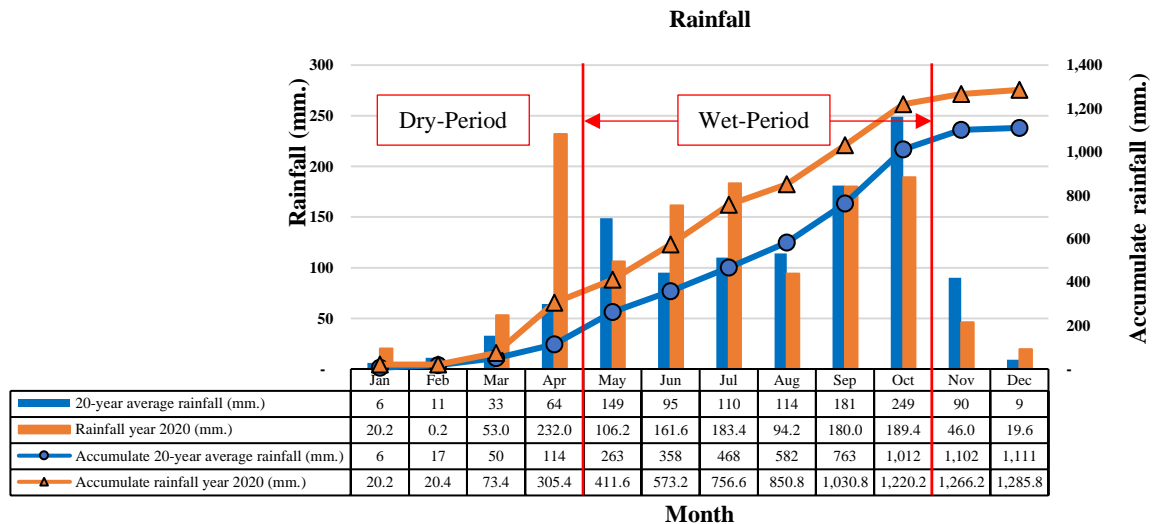


Figure 7 Comparison of monthly rainfall between 20-year average and year 2020

Source: National Hydroinformatics Data Center (2020)

3.2 Streamflow

The annual streamflow in 2020 was about 491.47 MCM (396.35 mm.) or 30.83% of annual rainfall. The amount of streamflow during Wet-Period (May - October) and Dry-Period (November - April) was about 384.24 MCM (309.87 mm.) or 78.18% and 107.23 MCM (86.48 mm.) or 21.82% of annual streamflow, respectively. Monthly streamflow was highest in October (196.76 MCM) lowest in February (10.15 MCM). (Figure 8)

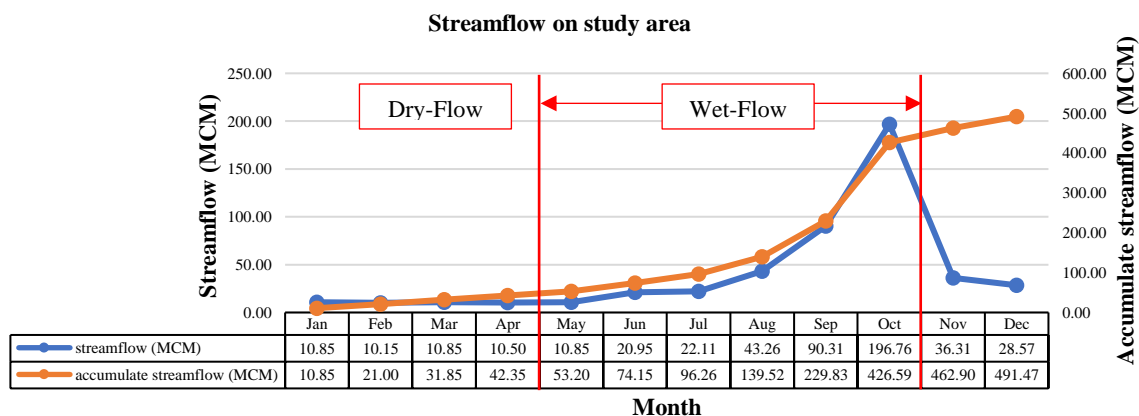


Figure 8 Monthly streamflow and cumulative value of the study area (2020)

The average amount of streamflow per study area was 396,347 m³/km² and the annual rainfall was 1,240 mm. This area was 99% natural forests (Tropical rain forest and Dry evergreen forest). When compared with Mae Taeng watershed which similar size and represent Northern watershed, the average streamflow per area was 313,486 m³/km², the annual rainfall was 1,978 mm. This area consisted of 85% natural forests, accounting for 82% and 18% of streamflow was during Wet-Period and Dry-Period, respectively. The large northern watersheds were able to provide 81% and 19% of streamflow, respectively (Klinkhachorn, 1990), while Choen watershed, Represent Northeast watershed, the average streamflow per area was 315,660 m³/km², the annual rainfall was 727 mm. This area consisted of 68% natural forests, accounting for 81% and 19% of streamflow was during Wet-Period and Dry-Period, respectively and Khlong Yan watershed, Represent Southern watershed, the average streamflow per area was 1,128,775 m³/km², the annual rainfall was 1,135 mm. This area consisted of 69% natural forests, accounting for 70% and 30% of streamflow was during Wet-Period and Dry-Period, respectively (Kongritti, 1997) so it showed that the watershed that was hill evergreen forest can provide average streamflow per area up to 1,350,000 m³/km² and 70% and 30% of streamflow during Wet-Period and Dry-Period, respectively (Chankao et al., 1982). The potential of study area has streamflow at a lower than the natural hill evergreen forest (Khlong Yan Watershed) but still better than the other 2 watershed because the during Dry-Period has streamflow greater proportion. (Table 1)

Table 1 Comparison the potential of streamflow contribution of some watershed and Kaeng Krachan National Park

Watershed	Area (sq.km.)	Forest area (%)	Annual rainfall (mm.)	Streamflow				Total Flow	Streamflow/Rainfall (%)	Streamflow/Area (m ³ /sq.km.)
				Wet-Period (MCM)	Dry-Period (MCM)	Wet-Period (%)	Dry-Period (%)			
Mae Taeng	1,978	85.32	1,055.1	508.47	111.61	82	18	620.08	29.71	313,486
Choen	727	68.31	1,196.8	185.88	43.60	81	19	229.48	26.37	315,660
Khlong Yan	1,135	69.29	1,855.4	896.81	384.35	70	30	1,281.16	60.84	1,128,775
Study Area	1,240	99.00	1,285.8	384.24	107.23	78	22	491.47	30.83	396,347

Source: Kongritti (1997)

3.3 Assessment of the status

Indices and criteria used to assess the hydrological status

(1) Percentage of streamflow to rainfall. The index shows the watershed potential for streamflow. Good watersheds have a higher proportion of streamflow than deteriorated watersheds.

(2) The proportion of streamflow that flows during Wet-Dry Period. A good watershed must have a proportion of streamflow in Wet-Period not much higher than in Dry-Period. In the degraded watershed, this proportion will be more different.

(3) Flow regime, The watershed where the ecosystem is not disturbed. The mainstream usually has flow regime all year round. The degraded and disturbed watersheds do not have water flow in the mainstream flow regime all year round. (Table 2)

Table 2 Criteria for assessing the hydrological status of each index

Status	Score	Volume		Flow Regime (Month)
		% Of streamflow/rainfall	Wet : Dry Flow proportion	
Balance	4	>40	50-60/40-50	12
Warning	3	31-40	60-70/30-40	10-11
Risk	2	20-30	70-80/20-30	8-9
Critical	1	<20	>80/<20	<8

Source: Boonyawat (2010)

The study found that the study area had a balanced hydrological status. The amount of streamflow to rainfall was 31%, the proportion of Wet : Dry Flow was 78 : 22 and has flow regime all year round which located in the deepest and highest of the Phetchaburi Watershed. Therefore, such area appropriate for streamflow to downstream and has storage dams and diversion dams affecting to the water management in this area. (Table 3)

Table 3 Assessment of Hydrological Status of Phetchaburi Watershed and Study Area

Area	sq.km.	Streamflow/Rainfall			Score	Wet Flow	Dry Flow	Score	Flow Regime (Mouth)	Average score	Status
		Streamflow (mm.)	Rainfall (mm.)	%							
Study Area	1,240	396.35	1,285.80	30.83	4	78.18	21.82	2	12	3.33	Balance
Upper Phetchaburi Watershed	2,915	215.15	811.67	26.51	2	71.80	28.20	2	12	2.67	Warning
All area Phetchaburi Watershed	6,254	428.97	1,111.00	38.65	3	81.55	18.45	1	12	2.67	Warning

Source: National Hydroinformatics Data Center (2020)

4. Conclusion

From the study of the Potential of Headwater Kaeng Krachan National Park on Streamflow Distribution to Upper Phetchaburi River above Kaeng Krachan Reservoir concluded that area provided annual streamflow 30.83% of the annual rainfall, the proportion of streamflow during Wet : Dry Period was 78 : 22 so the potential is low when compared to other watershed that require streamflow to rainfall more than 60%, the proportion of streamflow during Wet : Dry Period to be in the range of 60 : 40 and hydrological status is balance because the amount of rainfall that occurs as streamflow has a good proportion (31 – 40%), ratio of streamflow during Wet-Period is high effected from area was 99% natural forests (Tropical rain forest and Dry evergreen forest) by the nature type of which forest will produce a relatively high streamflow. The rain that falls will be completely retained in the soil and runoff in large quantities and area with high rainfall in the area every year and proportion of streamflow during Dry-Period is low because of condition of the area is rain shadow area but a complete natural forest, soil can hold water well and allow water to sub surface runoff from soil in Dry-Period. Therefore, there is streamflow flow regime all year round.

5. Acknowledgements

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