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# Potential Micro-hydropower Assessment in Mun River Basin, Thailand

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**ABSTRACT:**

*In Thailand, fossil and coal fuel energies are normally used for electrical generation and the tendency of used fossil and coal fuel energy is continuously increasing. There are about 1300 – 1500 mm rainfall and 1467 reservoirs in Mun river basin, which covers 71,071 square kilometers in lower northeastern of Thailand. Then, micro-hydropower is of interest as a renewable energy form of mankind for providing electricity for rural community. The purpose of this paper is to assess the potential micro-hydropower sites of more than 50 kW but not over than 10 MW. Reservoir type is considered for potential micro-hydropower assessment. The discharge in reservoir and the head in dam are considered to generate electricity. The main objective of the reservoir is not affected from the electrical production. Also, a large flooding is not occurs from this installation. The result revealed that there are 24 reservoirs in irrigation projects where both discharge and head are suitable for electricity generation. However, stream flow during dry season is very low therefore electricity can be produced in rainy season. The maximum power load is $3.15 \times 10^6$ kW in a year and installed generator is 6000 kW. If the electricity is produced, it will be used by these 24 irrigation projects. Then, stakeholders will able to earn this benefit. The potential micro-hydropower sites from this research should be continuously evaluated for the feasibility study to build and operate the micro-hydropower plant.*

**Conference Topic: Renewable Energy**

**Keywords: Micro-hydropower, Reservoir Type, Mun River Basin**

## 1. INTRODUCTION:

In Thailand, fossil and coal fuel energies are normally used for electrical generation and the tendency of used fossil and coal fuel energy is continuously increasing. About 145,214 million watts per hour were used in 2009 while only 90,413.99 million watts per hour were used in 1999. It is then necessary to provide more electricity in the near future. To solve this situation, renewable energies such as solar, wind, biomass, hydropower, geothermal etc are of interest. The energy from water or hydropower has been proved as economical and clean for electricity generation. It is one of the oldest energy forms of mankind and of the best solutions for providing electricity for rural community, hence improving the quality of life. Also, there are many dams and irrigation projects in Thailand. Then, this study aims at assessing the potential micro-hydropower sites of more than 50 kW but not over than 10 MW. A cast study is Mun River Basin.

The Mun River Basin is in lower northeastern of Thailand and covers 71,071 square kilometers. Mun River rises in the Khao Yai National Park of the Sankambeng range, near Nakhon Ratchasima province. It then flows east through the Khorat Plateau in southern northeastern (Buriram, Surin and Sisaket provinces) for 750 km (466 miles) until it joins the Mekong at Khong Chiam in Ubon Ratchathani province. There are 31 sub-basins and there is 1,300 – 1,500 mm for rainfall.

## 2. METHODOLOGY:

To produce alternative energy to be used for powering local communities with a surplus of renewable hydropower energy to potentially sell on the grid, a micro-hydropower plant project is concerned. A mass of water flows in a stream with a certain fall to the turbine into electric energy at the lower end of the scheme and electricity is then occurred. There are normally the two types of electrical scheme, run-of-the-river scheme and reservoir scheme. For the run-of-the-river, water flow in river is diverted to the intake via a pressure pipe or an open canal when the water in the river is sufficient for designed discharge. Thereafter, it is conveyed to the turbine via a penstock to generate electricity. It does not need its own large reservoir which is the advantage of the run-of-the-river scheme. This scheme is not suitable for flat area because the differential elevation of topography or head is also an important parameter to determine the capacity of electrical generation. The higher the head, the higher the power output. On the other hand, the reservoir type, water in reservoir is released to channel and via turbine into electric energy. The water in the reservoirs was used to estimate the load of electricity before releasing for these irrigation's purposes. A designed head can be determined from both the characteristic and the water level of reservoir. The advantage of the reservoir scheme is that the main purposes of reservoir, such as irrigation, flood control, ecological flow, water supply and recreation, are not affected by electricity production. Also, there is not a new reservoir or a new dam. This scheme was concerned for this study because there are 1,467 reservoirs in Mun River Basin.

Since the power output of the micro-hydropower scheme is proportional to the flow and to the head, both the discharge and the characteristic of reservoir are important data. The discharge is the quantity of water falling in gallons per minute, cubic feet per second, or liters per second. The daily discharge of reservoir was considered to determine a designed discharge based on the method of Flow Duration Curve or FDC. On the other hand, the vertical distance that water falls is the definition of head. It is a function of the characteristics of the channel or pipe through which it flows. To determine head, it is necessary to understand the definition of both gross head ($H_{gross}$) and net head ($H_{net}$). The gross head is the vertical distance between the top of the penstock that conveys the water under pressure and the point where the water discharges from the turbine. The net head is the difference between the gross head and the losses due to friction and turbulence in piping. These losses are included major and minor head loss. (Tarek et al. 2007 and Vaill 2000) For this study, topographic maps with the scale of 1:50000 and 1:4000, surveying and reservoir characteristics are considered to determine designed head. Since there are normally two main channels in a reservoir included Right Main Channel (RMC) and Left Main Channel (LMC), the discharge and head from both RMC and LMC were used for the estimation of power. When both designed discharge and head were already defined, power output was computed. The calculation is presented as follows.

### 2.1 Flow Duration Curve (FDC):

The relationship between the normalized stream flow and the percent exceed is called Flow Duration Curve or FDC. Stream flow was normalized in order to divide it by the median discharge of the non-zero flow days. This ensures that the log of the normalized stream flow crosses the axis at the median stream of the non-zero flow days. (Asquith et al., 1997; Best et al., 2003; Clement, 1987; Soenksen et al., 1999)

There are 28 runoff stations in the Mun River Basin. These runoff stations are operated by the Royal Irrigation Department. Figures 1 to 4 are the examples of FDC at runoff stations.

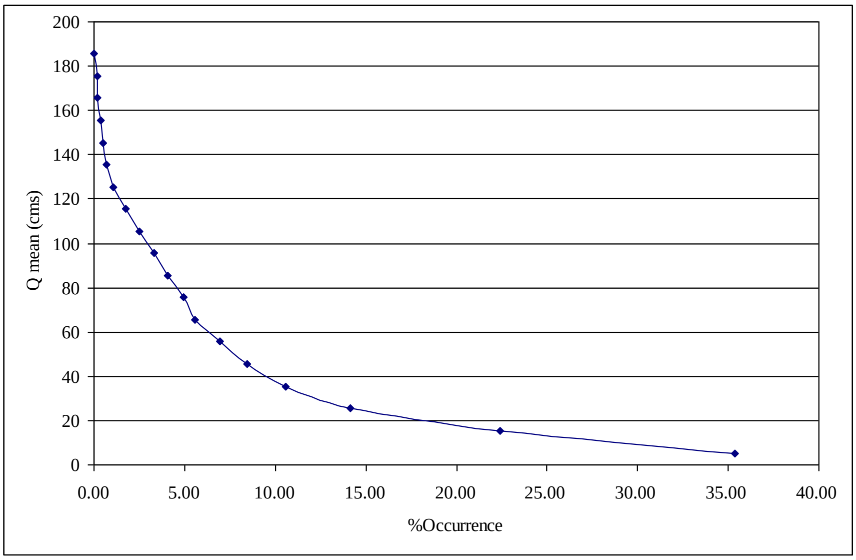


**Fig.1 Flow Duration Curve at Nakhon Ratchasima province (M2A)**

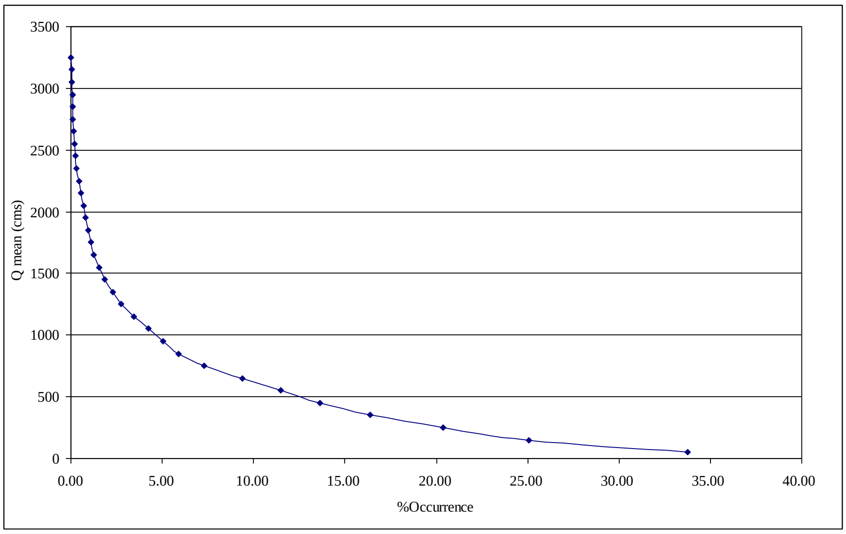


**Fig.2 Flow Duration Curve at Sisaket province (M5)**

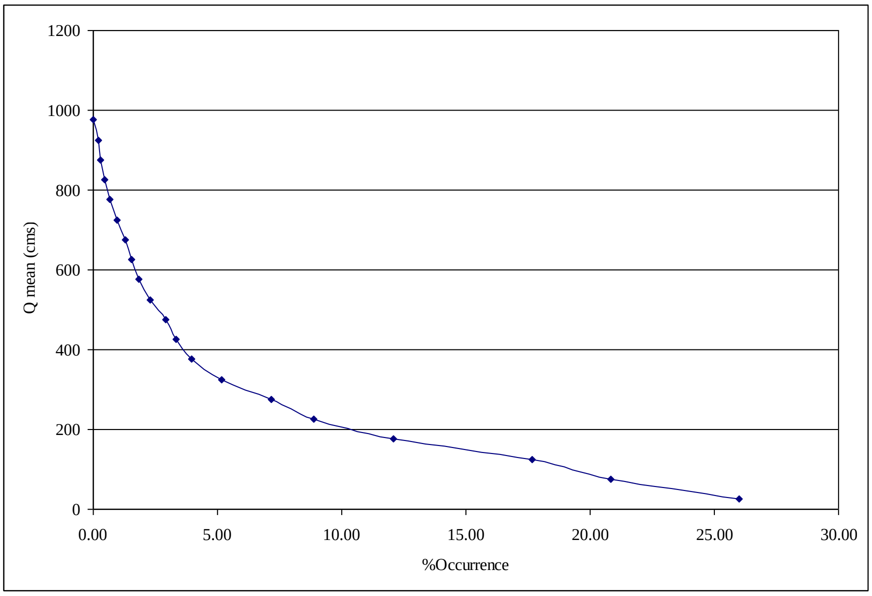


**Fig.3 Flow Duration Curve at Buriram province (M6A)**

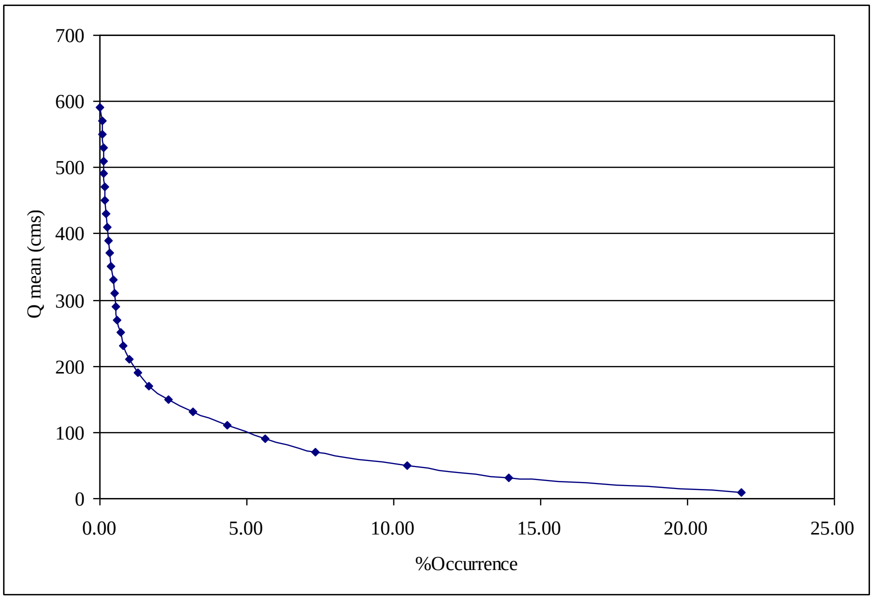


**Fig.4 Flow Duration Curve at Surin province (M26)**

## 2.2 Electric power output:

Electric power output can be computed using both designed discharge and head. The power generated is presented as follows (Tarek et al. 2007 and Vaill 2000).

$$P = \frac{\eta\gamma Q H_{net}}{1000} \qquad (1)$$

$$H_{net} = H_{gross} - H_{loss} \qquad (2)$$

$$H_{loss} = H_{major} + H_{minor} \qquad (3)$$

$$H_{major} = \frac{f \times L_p \times 0.08Q^2}{d^5} \qquad (4)$$

$$H_{minor} = \frac{kv^2}{2g} \qquad (5)$$

where

| | |
|---|---|
| $P$ | is electric power output in kW, |
| $\eta$ | is station efficiency, |
| $\gamma$ | is specific weight of water in N/ $m^3$, |
| $Q$ | is design flow in $m^3/s$ , |
| $H_{net}$ | is net head of water in m , |
| $H_{gross}$ | is gross head of water in m, |
| $H_{loss}$ | is head loss in system in m, |
| $H_{major}$ | is major head loss in m, |

$H_{minor}$ is minor head loss in m,
$f$ is friction coefficient,
$d$ is a diameter in m,
$v$ is velocity in m/s and
k is minor loss coefficient.

## 3. RESULT:

There are 24 projects, suitable for generating the electricity as presented in Figure 5. They are Subpradu Reservoir, Bannsaytho 9 South Weir, Kaophong Weir, Nongthanonkrang Reservoir, Huytakuy Weir, Lumjunghan Reservoir, Taju Reservoir, Huyjarakeymak Reservoir, Huytalad Reservoir, Huysavay Reservoir, Lumpateay Reservoir, Phayanak Reservoir, Huyta Reservoir, Lumchaikai Reservoir, Huykanun Reservoir, Bann Nonkingkai Reservoir, Huysara Reservoir, Lumtakong Dam, Munbon Dam, Lumnangrong Reservoir, Lumpraymas Dam, Huina Weir, Rasisalai Weir, and Lumcha Reservoir. The maximum installed capacity of 6000 kW is in Lumpraymas Dam while the minimum installed capacity of 50 kW is in Subpradu reservoir (see Table 1). Moreover, the maximum power load of 3.150 kW/yr is in Lumpraymas Dam while the minimum power load of 0.0192 kW/yr is in Huyjarakeymak Reservoir. The maximum cost of 318.38 million Baht to build hydropower system is in Lumpraymas Dam while the minimum cost of 4.69 million Baht is in Subpradu reservoir. The lengths of electric line from power house to main power transformer were defined as shown in Table 1. The range length of electric line is between 0.252 km and 2 km. However, the power load in a year, the electrical system cost and the length of electric line cannot be calculated in many projects because there is no data of daily discharge. Then, it is necessary to measure the daily discharge in the step of detail design. Figures 6 and 7 present the location of power house at Lumnangrong Reservoir. On the other hand, the power house of other 23 projects were designed as same as the Lumnangrong Reservoir.

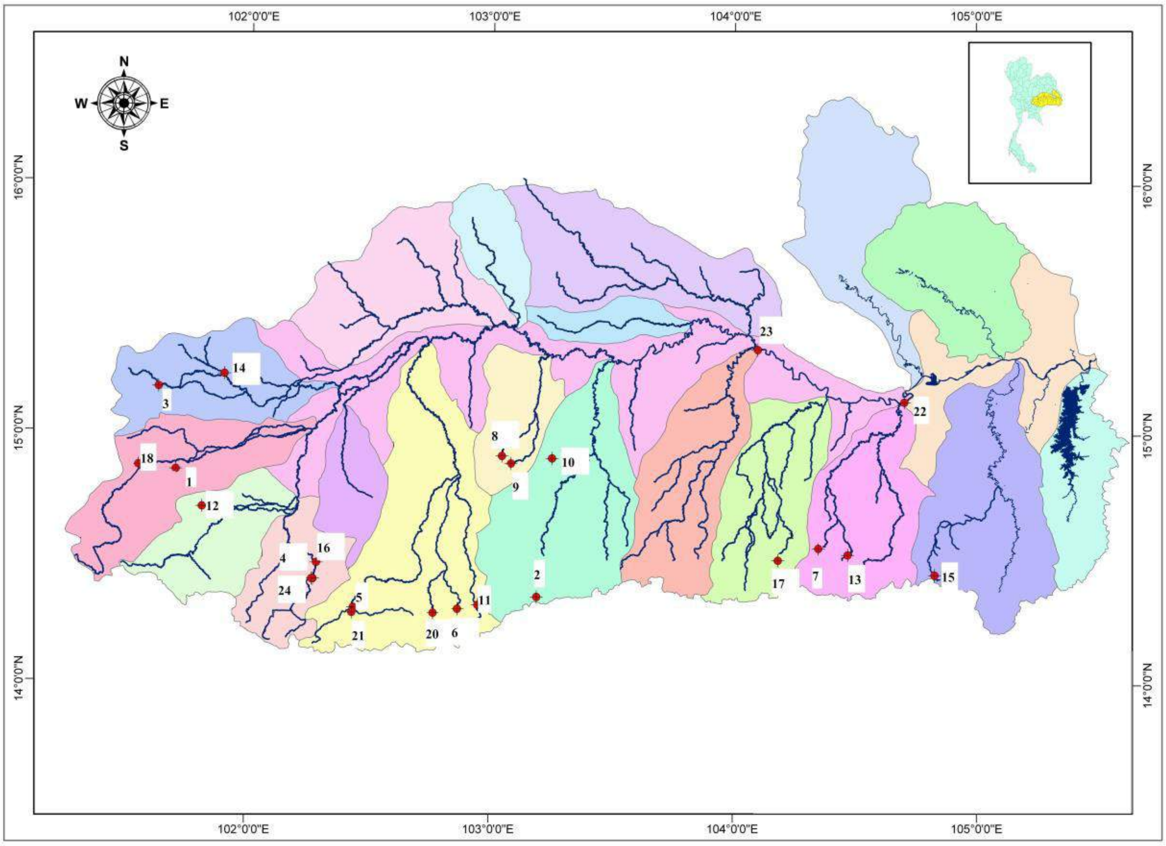


**Fig.5 Positions of hydropower at Mun River Basin**


**Fig.6 The location of power house at Lumnangrong Reservoir presented by topographic map**


**Fig.7 The location of power house at Lumnangrong Reservoir presented by aerial photograph**

**Table 1 Hydropower sites**

| No | Project | Powerhouse (UTM, WGS84) | | Installed Capacity (kW) | Power Load (MW/year) | Hydropower Cost (Mill Baht) | Electric Line (km) |
|---|---|---|---|---|---|---|---|
| | | E | N | | | | |
| 1 | Subpradu Reservoir | 145040 | 1643500 | 50 | 28 | 4.69 | 0.252 |
| 2 | Bannsaytho 9 South Weir | 305025 | 1587211 | 51 | - | - | - |
| 3 | Kaophong Weir | 137748 | 1679980 | 63 | - | - | - |
| 4 | Nongthanonkrang Reservoir | 205866 | 1595552 | 80 | - | - | - |
| 5 | Huytakuy Weir | 223710 | 1582861 | 80 | - | - | - |
| 6 | Lumjunghan Reservoir | 269875 | 1581963 | 80 | 26.9 | 6.62 | 0.5 |
| 7 | Taju Reservoir | 429936 | 1608458 | 100 | 41.9 | 6.67 | 0.5 |
| 8 | Huyjarakeymak Reservoir | 289827 | 1649634 | 100 | 19.2 | 10.35 | 0.5 |
| 9 | Huytalad Reservoir | 293799 | 1646308 | 100 | 57.5 | 10.35 | 0.5 |
| 10 | Huysavay Reservoir | 311985 | 1648563 | 100 | 34.5 | 10.35 | 0.5 |
| 11 | Lumpateay Reservoir | 278884 | 1583727 | 125 | 24.8 | 9.08 | 0.5 |
| 12 | Phayanak Reservoir | 156844 | 1627219 | 162 | - | - | - |
| 13 | Huyta Reservoir | 442935 | 1605580 | 250 | 107 | 16.09 | 0.5 |
| 14 | Lumchaikai Reservoir | 166790 | 1686206 | 300 | 58.4 | 17.93 | 1 |
| 15 | Huykanun Reservoir | 481447 | 1596594 | 300 | 59.1 | 18.51 | 0.5 |
| 16 | Bann Nonkingkai Reservoir | 207419 | 1602731 | 531 | - | - | 0.5 |
| 17 | Huysara Reservoir | 411999 | 1603182 | 750 | 155 | 46.55 | 1 |
| 18 | Lumtakong Dam | 129894 | 1645146 | 6000 | 3,150 | 318.38 | 2 |
| 19 | Munbon Dam | 192499 | 1601226 | 300 | - | 29.32 | 2 |
| 20 | Lumnangrong Reservoir | 259065 | 1580220 | 200 | 29.2 | 11.61 | 0.5 |
| 21 | Lumpraymas Dam | 223370 | 1580592 | 500 | - | 46.56 | 2 |
| 22 | Huina Weir | 468082 | 1673211 | 1000 | - | 89.73 | 2 |
| 23 | Rasisalai Weir | 403235 | 1696501 | 1500 | - | 132.73 | 2 |
| 24 | Lumcha Reservoir | 205342 | 1595559 | 1800 | - | 158.65 | 2 |

Note: 1 USD equals to about 33 baht.

## 4. CONCLUSION:

As above result, it can be concluded that the Mun River Basin has potential to produce micro-hydropower using the reservoir type. The total power output is about 3,792 MW per year and the total construction cost is more than 944 million Bbaht. Both the designed discharge and the designed head are important parameters. The designed head for each site is normally fitted by their structures. It is less than 10 m. Since stream flow during dry season is very low, thus electricity can be mainly produced in rainy season. If the electricity is produced, it will be consumed by the 24 irrigation projects and the stakeholders will able to earn this benefit. The potential micro-hydropower sites from this research should be continuously evaluated for the feasibility study to build and operate the micro-hydropower plant. This research is a pilot study to determine the potential site of micro hydropower projects based on the reservoir type.


## 5. ACKNOWLEDGEMENTS:

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