Hydropower is a renewable energy that is widely-used worldwide and a reliable source of electrical power. In the Philippines, hydrologic resources are abundant and proven to be a viable clean energy source. Philippines has a goal to improve fuel mix used for industrial and domestic electrical consumption for renewable energy.
The potential annual power generation of a hydro power project is proportional to the head and flow of water. The requirements for a hydro-electric power plant are flow, head and runoff.

Flow is defined as the quantity of water moving through a specified point per unit of time.
**Runoff** is the rainfall that actually does enter the stream as either surface or subsurface flow.

**Head** is the difference in elevation between two water levels, it is the vertical distance of the water falls. Higher heads require less water to produce a given amount of power.
OBJECTIVES

The study was aimed to use remote sensing data particularly Synthetic Aperture Radar (SAR) and Geographic Information System (GIS) technologies to assess the hydro-energy resource potential of Ilocos Norte river basin. Moreover, the study was aimed to delineate river reaches, simulated flow, detect suitable head locations and identify potential locations for possible establishment of hydro-energy power plants.
METHODOLOGY

Dataset used in the study

- Synthetic Aperture Radar (SAR)
  - Location: Ilocos Norte
  - Area: 308478.097412 ha
  - Resolution: 10-meters
  - Acquisition Year: 2012
METHODOLOGY

Soil and Water Assessment Tool (SWAT) is a river basin, or watershed, scale model developed to predict the effect of land management practices on water, sediment and agricultural chemical yields in large complex watersheds with varying soils, land use and management conditions over long periods of time.
Head Determination Algorithm
-program developed by University of the Philippines – Diliman REMap Hydro team to extract heads from delineated river cells by defining the minimum head threshold and horizontal distance between the virtual intake and powerhouse.
METHODOLOGY

Power Calculation and Classification

• Flow/Discharge values from SWAT Simulation
• Head features derived from Head Determination Algorithm
### Simulated River Flow using SWAT

<table>
<thead>
<tr>
<th>Flow</th>
<th>Reach</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum Flow</td>
<td>0.00148 m³/s 83</td>
</tr>
<tr>
<td>Maximum Flow</td>
<td>0.9706 m³/s 110</td>
</tr>
</tbody>
</table>
## RESULTS

### Power Distribution

**100 m Preferred Penstock length**

<table>
<thead>
<tr>
<th>Power Distribution</th>
<th>Count</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pico</td>
<td>47</td>
<td>1.81%</td>
</tr>
<tr>
<td>Micro</td>
<td>2471</td>
<td>95.30%</td>
</tr>
<tr>
<td>Mini</td>
<td>75</td>
<td>2.89%</td>
</tr>
</tbody>
</table>

- **Minimum Simulated Power**: 2.32 kw
- **Maximum Simulated Power**: 180.09 kw
# RESULTS

## Power Distribution

**500 m Preferred Penstock length**

<table>
<thead>
<tr>
<th>Power Distribution</th>
<th>Count</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pico</td>
<td>180</td>
<td>0.94%</td>
</tr>
<tr>
<td>Micro</td>
<td>16779</td>
<td>87.38%</td>
</tr>
<tr>
<td>Mini</td>
<td>2244</td>
<td>11.69%</td>
</tr>
</tbody>
</table>

Minimum Simulated Power: 2.42 kw

Maximum Simulated Power: 576.18 kw
RESULTS

Power Distribution

1000 m Preferred Penstock length

<table>
<thead>
<tr>
<th>Power Distribution</th>
<th>Count</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pico</td>
<td>205</td>
<td>0.67%</td>
</tr>
<tr>
<td>Micro</td>
<td>21571</td>
<td>70.44%</td>
</tr>
<tr>
<td>Mini</td>
<td>8847</td>
<td>28.89%</td>
</tr>
</tbody>
</table>

Minimum Simulated Power: 2.237 kw
Maximum Simulated Power: 581.61 kw
The study was able to assess the hydro-energy resource potential of the Ilocos Norte river basin using SAR dataset and GIS technologies. Possible locations for the intake bay, penstock and powerhouse was also identified. Lengths of penstocks and head distance was integrated from the attribute of the shapefiles produced. The study was able to establish a model identifying locations for strong river flow with a suitable head in the river basin of the province of La Union. The identified sites was supported by the computed potential hydro-power and was labelled according to their classification.
The attribute table of the final feature contains the information for the highest modelled power generation capacity and can be used as a reference as to where a hydro-power plant could be built.
Site suitability assessment of the areas identified to have a potential hydro-energy resource for the establishment of hydro-power facilities must be further studied. Social and environmental impacts on the area where the potential hydro-generation sites must be taken into consideration. Impact of the identified location in possible establishment of irrigation systems for the benefit of local farmers should also be studied.
HYDRO ENERGY RESOURCE ASSESSMENT OF ILOCOS NORTE RIVER BASIN, PHILIPPINES

Presentor: Engr. Jholeeh Charls T. Madalipay
Co-authors: Richard Dean P. Yadao, Psalm David Pastor, Rodel T. Utrera, Nathaniel R. Alibuyog

PHIL-LIDAR 2: NATIONWIDE DETAILED RESOURCE ASSESSMENT USING LIDAR SURVEYS AND OTHER REMOTELY SENSED DATA
MARIANO MARCOS STATE UNIVERSITY, CITY OF BATAC, PHILIPPINES