SIGNIFICANCE OF SEDIMENT ANALYSIS IN HYDROPOWER DEVELOPMENT OF NEPAL
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MAJOR RIVER BASINS OF NEPAL

Based on river discharge and their sources, Nepalese rivers are broadly classified as follows:

a) First Grade Rivers: Originate from glacier on ice capped mountains above snowline (about 5000m altitude)
   - Perennial and carry sufficient flows throughout the year. Karnali, Gandaki and Koshi
b) Second Grade Rivers: Originate from Mahabharat hills below snowline
   - They also do not dry up in low flow period as they meet spring and shallow underground water tables.
   - Mechi, Kankai, Kamala, Bagmati and Mahakali
c) Third Grade Rivers: Originate from Siwaliks hills as well as from Terai plain.
   - Contain either very less water in winter or no surface flow in dry period.
   - Tilawa at Parsa, Manusmara at Sarlahi, Sunsari at Sunsari etc.
There are 6,000 rivers including rivulets and tributaries totaling about 45,000 km in length.

- Occupy 2.27% of the world water resources (5% of total surface area of country).
- Availability of more than 9,000 m$^3$ of water per capita which is far more than internationally recognized norms of 1,750 m$^3$ per capita.
- Perennial nature of Nepali rivers and the steep gradient of the country's topography provide ideal conditions for the development of some of the world's largest hydroelectric projects in Nepal.
Theoretical hydropower potential is estimated 83,290 MW (Dr. Hari Man Shrestha in 1966).
Technically and economically viable hydropower potential 42,133 MW.
Current hydropower generation 680 MW (approx.).
Only about 40% of Nepal’s population has access to electricity through the grid and off grid system.
Most of the power plants in Nepal are ROR type with energy available in excess of the in-country demand during the monsoon season and deficit during the dry season.

<table>
<thead>
<tr>
<th>Energy Gap (2011 Figures)</th>
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<tbody>
<tr>
<td>Annual Peak Demand</td>
<td>946.10 MW</td>
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<tr>
<td>Dry Season Generation</td>
<td>450 MW</td>
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<tr>
<td><strong>Deficit (Gap)</strong></td>
<td><strong>500 MW</strong></td>
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**Causes of Sedimentation in Nepal**

- a) Stream bank erosion
- b) Gully erosion
- c) Sheet and rill erosion
- d) Splash erosion
e) Catastrophic GLOFs.  f) Massive deforestation


g) Overgrazing  h) Unscientific cultivation

i) Haphazard development activities

IMPACTS OF SEDIMENTATION ON STORAGE PROJECTS

- Loss of storage capacity of reservoir.
- Damage of hydraulic, electro-mechanical parts.
- Increase flood level and severe bank erosion.

Figure: Reservoir capacity and deposition variation of Kulekhani reservoir
ECONOMIC ANALYSIS OF RESERVOIR SEDIMENTATION

- For hydropower silting, the annual cost of replacement is estimated to be 13.6 billion $/year in global scale (ICOLD).
- Annual loss of storage of irrigation reservoir (5 billion $/year)
- The cost of downstream damages, losses of power supply, maintenance cost of turbine wear etc. (5-10% of cost of hydropower plants),
- Total annual lost linked with sedimentation problems is about 21 billion $ and deserves great care.
- Comparing with annual overall cost and benefits of dams, the annual cost of reservoir sedimentation (in terms of replacement cost) is thus about 37% of the overall cost which is not insignificant. However, much less than 37% is currently spent on sedimentation mitigation measures and the problems are therefore postponed to future generations in many countries and Nepal is not the exception.

IMPACTS OF SEDIMENTATION ON RUN-OFF-RIVER PROJECTS

- High degree of erosion/cavitation damage is caused to hydraulic structures (under sluices, spillway etc.) and hydro-mechanical equipments.
- Reduce the machine efficiency and ultimately life of turbine.
- Large revenue loss and high maintenance cost.

![Efficiency measurements at Jhimruk Hydro power plant](image-url)
INFLUENCE OF MINERALOGICAL COMPOSITION ON EROSION RATE

- Mineralogical composition of sediments and shape of particles have significant effect on erosion rate.
- Hard materials (quartz, feldspar) cause severe abrasion of hydro-mechanical and electro-mechanical elements.
- Eastern basins have higher erosion rate compared to western basin due to higher quartz content.

PRESENT STATE OF SEDIMENT MEASUREMENT IN NEPAL

- Department of Hydrology and Meteorology (DHM) is a government agency responsible for all the hydrologic and meteorological monitoring activities including sediment in Nepal.
- About 25 sediment sampling stations (only 20 stations are in operation) located mostly in the middle mountain region in the major rivers of Nepal.
- The first flow gauging station in Nepal was established on January 1st, 1961 in the Asara Ghat of Karnali River.
- Sampling of the suspended sediment was started in the same gauging station in 1964 by DHM.
- Besides DHM, NEA, BPC, Hydrolab Pvt. Ltd, and HPL are also involved in several aspects of sediment studies.
- The quality control of the data gathered is inadequate and the data products are insufficient to match user’s demand on quality information on river sediment and transport of matter.
CONCLUSION

- No doubt, Nepal is one of the richest countries in the world on inland water resources. But we should not forget the bitter fact that Himalayan rivers are also the giant source of sediment loads.
- Sustainable development of hydropower is quite incomplete without proper sediment analysis and management system.
- Hydro power engineers must be 'sediment conscious' during investigations, design, operation and maintenance. More research and development is needed into the causes and mitigation of sediment erosion impacts.
- Sediment in river is considered as hurdle for development of hydropower in Nepal. On the other hand its economic value is never thought of. The mineral analysis of sediment samples indicates the possibility of its use for industrial purpose. So the burden can be converted to byproducts if properly utilized.

REFERENCES

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THANK YOU!