

Hydro Lab

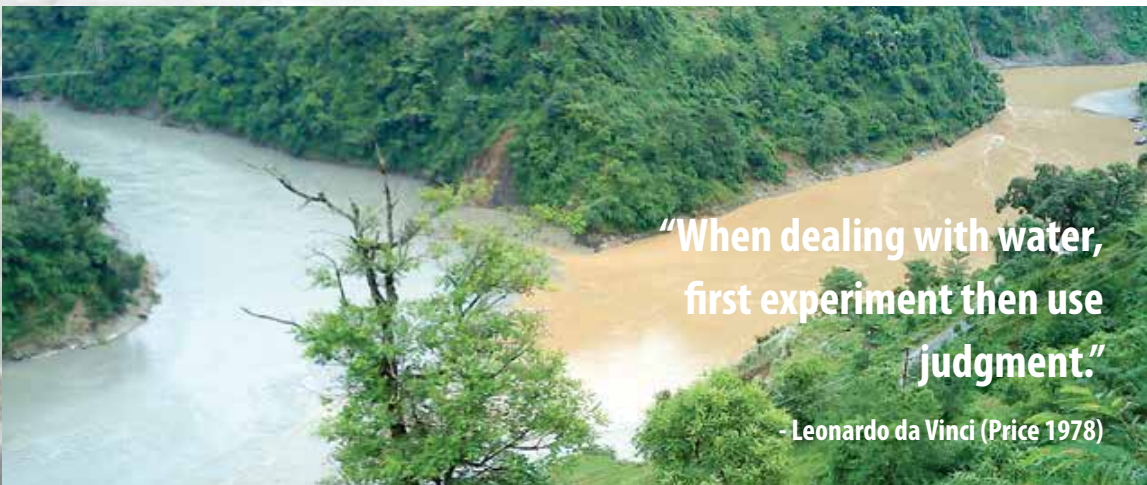
in cooperation with NTNU, Norway

1. BACKGROUND

Harnessing Himalayan Rivers is challenging with respect to complex hydraulics and sediment transport. Since theoretical analysis cannot precisely represent the hydraulic behaviour of steep rivers, physical hydraulic modelling is one of the reliable tools for dealing with such rivers. The need for developing well-equipped hydraulic laboratory became evident in mid-eighties in order to cope with the pertinent problems in developing water resource projects in Himalayan Rivers. Hydro Lab initially started its activities as River Research Laboratory in the premises of Institute of Engineering, Tribhuvan University (TU), Kathmandu back in 1988 with joint co-operation between Norwegian University of Technology (NTH by then) and Institute of Engineering (IoE), Tribhuvan University to carry out a physical hydraulic model study of the headworks of 12 MW Jhimruk Hydropower Project in Nepal. Professor Dagfinn K. Lysne and Dr. Haakon Stole from Norwegian University of Science and Technology (NTNU) were instrumental in materializing the concept of establishing such hydraulic laboratory in Nepal. Following this, model study of the headworks of Khimti 1 Hydropower Project was carried out from 1995 to 1997 at the River Research Laboratory with technical support from NTNU. In 1998 Hydro Lab Pvt. Ltd., an independent laboratory with permanent facilities was established by People, Energy and Environment Development Association (PEEDA) by replacing the existing River Research Laboratory. Financial support to Hydro Lab for basic infrastructure development was provided by the Norwegian Agency for Development Cooperation (NORAD) and technical and scientific support was provided by NTNU. The International Centre for Hydropower (ICH), Trondheim, Norway coordinated this programme on behalf of NORAD. Following this,

a 5 years second phase of cooperation agreement was signed with the Royal Norwegian Embassy in Kathmandu in 2006 for supporting the Research and Development Programme at Hydro Lab with the technical and scientific support from NTNU.

The objective of Hydro Lab is to assist in the achievement of national development goals by providing an effective base for research and development, training and consulting services in the field of water resources development in Nepal and in the region. This is the only organisation of this kind in Nepal, which is capable of performing physical hydraulic model studies for water resources development projects as well as sediment studies and associated research. Since its establishment in 1998, Hydro Lab has gradually expanded its activities including sediment sampling and laboratory analyses, flow measurement, prototype turbine efficiency testing, settling basin performance tests, reservoir sedimentation study, hydraulic design and design review of the headworks. Further to the expansion of activities, Hydro Lab has established geotechnical laboratory and started to provide geotechnical and geological testing and investigation services. Apart from physical hydraulic model study, service of numerical modelling has also been added. Knowledge sharing through training/workshops and providing research opportunity to MSc and PhD students from different universities from Nepal and abroad is also one of the important activities of Hydro Lab. Establishment of cooperation and creation of global network with national and international professional as well as academic institutions with similar research interest is an ongoing process of Hydro Lab and has got internationally qualified and experienced human resources.



**“When dealing with water,
first experiment then use
judgment.”**

- Leonardo da Vinci (Price 1978)

2. OWNERSHIP

The present ownership structure of the Company is as presented in the following table.

SN.	Shareholders	Share %
1	People, Energy and Environment Development Association (PEEDA) (a NGO working on energy and environment)	50.08
2	Institute of Engineering (IoE), Tribhuvan University (an academic institution)	16.64
3	Nepal Electricity Authority (NEA) (a public utility corporation 100% owned by the Government of Nepal)	16.64
4	Butwal Power Company Limited (BPC) (a public limited company)	16.64
	TOTAL	100

Note: Hydro Lab has got institutional shareholding only and the shareholders have agreed not to take dividend from the Company and hence is a non-dividend distributing Company.

3. BOARD OF DIRECTORS

The Board of Directors of the Company consists of the following persons representing from the respective shareholding organisations.



Mr. Govinda Prasad Devkota
Chairperson
Chairperson, PEEDA



Mr. Shiva Ram Pradhan
Director
Immediate Past Chairperson,
PEEDA



Mr. Gaurav Dahal
Director
Vice Chairperson,
PEEDA



Prof. Dr. Sushil B. Bajracharya
Director
Dean, Institute of Engineering,
Tribhuvan University



Mr. Nasib Man Pradhan
Director
Director, Nepal Electricity
Authority (NEA)



Mr. Pratik MS Pradhan
Director
Vice President, Business
Development & Projects, BPC



Dr. Meg B. Bishwakarma
Board Secretary
General Manager
Hydro Lab



4. MISSION AND VISION

The mission and vision statements of the Company are given below. This outlines activities which will enable the attainment of the Vision of Hydro Lab in pursuit of fulfilling its Mission.

4.1 Mission Statement

The mission of Hydro Lab is:

To be a professional, sustainable and an ethical research organisation, promoting innovative techniques for water resources development.

4.2 Vision Statement

Hydro Lab will be a contributor to a sustainable development of the water resources projects in Nepal as well as other parts of the world.

In pursuit of the above mission, the Company seeks to achieve its vision by:

1. Promoting technical expertise in the field of water resources and sedimentation through research, field work, laboratory work and analysis;
2. Working together with its clients and partners to achieve mutual goals;
3. Implementing efficient and innovative design of water resources related projects for their cost effectiveness.

4.3 Values Statement

The following are the values, which Hydro Lab seeks to adhere in the pursuit of the Company's mission and vision.

Integrity

We seek to be truthful and transparent. We will act honestly in handling goods and money, respect others and show responsibility in fulfilling our duties. We will abide by our agreements even if they hurt us economically.

Fairness

We strive to treat fairly our staff, our clients, our suppliers and the communities in which we operate. We do not try to get the most out of a negotiation or transaction at the expense of others.

Professional Competence

We desire to excel in our work and to improve our competence. We expect to achieve demonstrable results. We achieve our greatest success by working together as a team. We respect new ideas and innovation no matter who brings them up.

Alliances

We strive to achieve innovative, responsive and productive partnerships with institutions or organisations having common area of professional interest.

Concern for the Women, Disadvantaged and Poor

We give attention to women, poor, the vulnerable and oppressed.

5. OUR FACILITIES

5.1 Hydraulic Laboratory

Our hydraulic laboratory is equipped with space, facilities, instrumentation and equipment required for physical hydraulic model studies. This includes:



- ⦿ Total available area 5,387 m²;
- ⦿ Roofed model test area 2,300 m² comprising 5 individual trussed sheds
- ⦿ Underground reservoir of capacity 220,000 litres
- ⦿ Pumps with approximately 350 lps discharge capacity (can be upgraded as necessary)
- ⦿ Well-equipped mechanical and carpentry workshop for the fabrication of experimental facilities
- ⦿ Velocity Meters (Acoustic Doppler Current Profiler (ADCP), Acoustic Doppler Velocity Meter (ADV) and Micro Propeller type)

- ⦿ Water level recorder
- ⦿ CAD design system
- ⦿ Numerical modelling
- ⦿ Standby generators for power backup;

5.2 Sediment Laboratory

Our sediment laboratory is equipped with the instrumentation and equipment required for sediment sampling and laboratory analyses. This includes:

- ⦿ Hand held samplers
- ⦿ Depth integrating samplers
- ⦿ Vacuum pump filtering system with several manifolds



“Physical model study can maximize economic benefit of water development projects by recommending efficient operation schedule by reducing the risk of design failure and increasing its performance.”

- ⇒ Electronic balances
- ⇒ Muffle furnace & drying ovens
- ⇒ Visual Accumulation (VA) Tube for particle size distribution analyses of sand fraction
- ⇒ LS 13 320 Laser diffraction particle size analyser (Beckman Coulter's product)
- ⇒ Stereoscopic microscope for mineral content analysis



5.3 Geotechnical Laboratory and tunnel support design

Our geotechnical laboratory is equipped with the instrumentation and equipment required for the characterization of rocks and the analysis for tunnel, slopes, dam foundation and other infra-structure projects. Major equipment and software include:



- ⇒ Compression device and accessories for rock core specimen testing for Uniaxial Compressive Strength (UCS), Elasticity Modulus and Poisson's Ratio.
- ⇒ Core trimmer and cut-off machine for rock core samples.
- ⇒ Point load testing equipment
- ⇒ RS2 (Phase 2) software for stability analysis and support design for tunnel and underground cavern.

- ⇒ Current meters and conductivity meters for flow measurement
- ⇒ Online sediment concentration measurement equipment
- ⇒ Equipment for turbine relative efficiency measurement
- ⇒ Differential Global Positioning System (DGPS) equipment for reservoir bathymetric survey
- ⇒ Equipment set for Hydro Fracture and Hydraulic Jacking tests (purchase in progress as of April 2018)

5.4 Field Measurement Equipment

Hydro Lab is well equipped with following equipment and accessories for field instrumentation and measurement. Major equipment includes:

- ⇒ Equipment for land surveying
- ⇒ Ultrasonic Flow Meter
- ⇒ Equipment set for prototype turbine efficiency measurement by thermodynamic method
- ⇒ Acoustic Doppler Current Profiler (ADCP) for velocity and flow measurement



6. OUR SERVICES

6.1 Physical hydraulic model studies

The utmost importance of physical hydraulic scale model is accepted and recognized because of the fact that empirical formulae and computer simulations are inadequate for a reliable hydraulic design of hydraulic structures. As every river is different from the other in terms of hydraulic behaviour and sediment transport, model study becomes essential to ensure the sustainability and reliability of designed headworks in a proposed location. Physical hydraulic modelling is important for the following reasons:



- To determine the optimum design of hydraulic structures.
- To provide possibilities for hydrodynamic experimental research on problems that cannot be solved through theoretical or numerical analysis.
- To provide visualisation of hydraulic phenomena associated with any water resources projects to management, decision makers, managers,



developers, investors and those concerned.

- To provide facilities and opportunities for training in applied hydraulics for hydraulic design and experimental research.
- In brief, to avoid failure in performance of hydraulic structures that may lead to significant losses of revenue due to losses in power generation and increased costs of maintenance.

Hydro Lab is proud to be the only research organisation in Nepal having capacity, expertise and experience for conducting physical hydraulic model studies in the following areas:

- River works and water conveyance system
- Weirs, levees and dams
- Intake and settling basins
- Spillway and energy dissipation systems
- Reservoir flushing and other sediment management options for its sustainability;

6.2 Numerical modelling

Continuous rise in computing power and advancement in computation hydraulics have enabled numerical modelling as complementary tools for physical hydraulic models to study far field hydraulic and sedimentation phenomena. Currently, we provide numerical modelling services in the area of river morphology and reservoir sedimentation studies. Sedimentation studies are crucial for the sustainable development of reservoir projects in Nepal - which lies in one of the regions producing highest sediment in the world. Hydro Lab has also initiated collaboration with Deltares (former Delft Hydraulics) in the areas of Numerical modelling and river studies.

6.3 Design review

Apart from conducting the physical hydraulic model study and numerical modelling of the headworks of water resources projects, Hydro Lab provides services on hydraulic design review of the headworks as per the request received from the Clients. This service includes;

- Hydraulic design review of the overall components of headworks
- Hydraulic design review of head to tail of hydropower projects



6.4 Field testing and measurements

Field testing and data collection is another important service that Hydro Lab has been providing. Acquisition of reliable data from field is essential for planning, designing, building and operating any water resources project. Keeping this fact in mind, Hydro Lab provides the following services under this category;

- Performance testing of the prototype settling basins and other hydraulic structures
- Efficiency measurement of prototype turbines by thermodynamic method
- Sediment measurement in hydropower plants
- Establishment and monitoring of flow and sediment gauging stations
- Suspended sediment sampling in rivers
- Flow and velocity measurements (reservoirs, rivers, channels and pipelines)
- Bathymetric survey of reservoirs and lakes

6.5 Laboratory analyses of sediments

- The laboratory analyses of sediments include the following activities mostly targeting to the development of hydropower projects.
- Concentration analysis
- Particle size distribution analysis
- Mineral content analysis
- Organic matter content analysis



“Physical model study can save millions!”

7. EDUCATION, TRAINING AND RESEARCH

Know-how transfer through education, training and joint research is one of the important objectives of Hydro Lab. This objective is fulfilled by performing the following activities:

- Organising international, regional and national level seminar/workshop/training programs individually as well as together with other institutions such as IoE, ICH, NHA, IPPAN, NNAA etc.;
- Conducting internal research in the field of hydraulic and sediment engineering;
- Developing measurement technology and instrumentation;
- Offering guest lectures to MSc and PhD candidates from IoE, KU and other universities in the area of Hydro Lab's research and development;
- Providing opportunities for internships, project works and theses works for Bachelors', Masters' and PhD candidates from national and international universities
- Sharing knowledge through model demonstration to educational institutions, project developers, designers, public, politicians, and other stakeholders of water resources projects.



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“M.Sc. And PhD students from and outside Nepal have successfully completed their theses in cooperation with Hydro Lab.”

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“Hydro Lab offers tailor made training programme in sediment engineering including field sampling and laboratory analyses”.

IoE: Institute of Engineering, **ICH:** International Centre for Hydropower, **NHA:** Nepal Hydropower Association, **IPPAN:** Independent Power Producers' Association Nepal, **NNAA:** Nepal Norway Alumni Association, **DPRI:** Disaster Prevention Research Institute, **KU:** Kathmandu University

8. NETWORKING AND INTERNATIONAL CO-OPERATION

Hydro Lab believes in collaboration and cooperation among organisation/institutions having common area of interests in order to enhance knowledge, carry out joint researches and increase competence to serve the present need and future demand. Therefore, Hydro Lab has an active cooperation with but not limited to the following institutions:

- Asian Institute of Technology (AIT), Thailand
- Chigasaki Research Institute of J-Power, Japan
- Department of Civil and Environmental Engineering, Faculty of Engineering, Universitas Gadjah Mada (CEE-UGM), Indonesia
- Department of Geology and Mineral Resources Engineering (IGB), Norway
- Deltares, The Netherlands
- Disaster Prevention Research Institute (DPRI), Kyoto University, Japan
- Hydropower companies/consultants in Nepal and abroad
- International Centre for Hydropower (ICH), Norway
- Institute of Engineering, Tribhuvan University, Nepal
- Kathmandu University, Nepal
- Nanjing Hydraulic Research Institute (NHRI), China
- Nepal Hydropower Association (NHA)
- Nepal Norway Alumni Association (NNAA)
- Norplan AS, Norway
- Norwegian Geotechnical Institute Pty. Ltd. (NGI Perth)
- Norwegian University of Science and Technology (NTNU), Norway
- Sediment Systems AS, Norway

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“The hydraulic/sediment interaction is so complex that the older Einstein is said to have warned his son strongly of the difficulties in dealing with sediment transport process” - Vollmers (1989)



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“Several graduating engineering students, professionals both local and expatriates, and representatives from government and non-government bodies have visited the Lab for observation of physical model testings.”



9. OUR CLIENTS

Hydro Lab's present and potential clients include;

- ⊖ Hydropower developers; national and international
- ⊖ Government agencies; national and international
- ⊖ Hydropower Plant owners and operators
- ⊖ Banks and international funding agencies
- ⊖ Embassies and International bodies
- ⊖ Consultants; national and international

Hydro Lab's international Clients include;

- ⊖ Asian Development Bank (ADB)
- ⊖ Daelim Kyeryong Joint Venture, Korea
- ⊖ Department of Energy, Bhutan
- ⊖ Department of Hydromet Services, Bhutan
- ⊖ Druk Green Power Corporation (DGPC), Bhutan
- ⊖ Electric Power Development Co. Ltd. (J-POWER), Japan
- ⊖ Fichtner GmbH, Germany
- ⊖ GMR, India
- ⊖ International Centre for Hydropower (ICH), Norway
- ⊖ International Finance Corporation (IFC)
- ⊖ Kreditanstalt für Wiederaufbau (KfW), Germany
- ⊖ Malana Power Company Ltd., India
- ⊖ MWH Global Inc., USA
- ⊖ Norconsult, Norway
- ⊖ Norplan, Norway
- ⊖ Norwegian Agency for Development Cooperation (NORAD)
- ⊖ Satluj Jalavidhyut Nigam, India
- ⊖ SN Power, Norway
- ⊖ The World Bank (WB)
- ⊖ Tractebel Engineering, S. A., France
- ⊖ Troms Kraft, Norway



10. MAJOR SERVICES PERFORMED UNTIL 2017

10.1 Physical Hydraulic Model Studies

Hydro Lab has conducted physical hydraulic model studies of the headworks of the following projects.

S. N.	Project Name	Client	Project location
1	Jhimruk RoR HPP (12 MW)	Butwal Power company Limited (BPC), Nepal	Mid-Western Nepal
2	Khimti I RoR HPP (60 MW)	Himal Power Limited, Nepal	Eastern Nepal
3	Melamchi Drinking Water Project	NORPLAN AS, Norway for Melamchi Water Supply Board, Nepal	Central Nepal
4	Jhimruk RoR HPP - Additional settling basin (12 MW)	Butwal Power Company, Nepal	Mid-Western Nepal
5	Upper Tamakoshi PRoR HPP (456 MW)	NORCONSULT, Norway for Nepal Electricity Authority	Eastern Nepal
6	Devighat RoR HPP (14.4 MW)	Nepal Electricity Authority, Nepal	Central Nepal
7	Upper Mai RoR HPP (9.98 MW)	East Nepal Endeavour Pvt. Ltd./Mai Valley Hydropower P. Ltd., Nepal	Eastern Nepal
8	Nyadi RoR HPP (30 MW)	Nyadi Hydropower Limited, Nepal	Western Nepal
9	Mai RoR HPP (22 MW)	Sanima Mai Hydropower (P) Ltd., Nepal	Eastern Nepal
10	Kabeli 'A' PRoR HPP (37.7 MW)	Kabeli Energy Limited, Nepal	Eastern Nepal
11	Kali Gandaki 'A' PRoR HPP (144 MW)	Nepal Electricity Authority, Nepal	Western Nepal
12	Upper Seti Reservoir HPP (140 MW)	Electric Power Co. Ltd., Japan (JPower) for Nepal Electricity Authority	Western Nepal
13	Lower Manang Marsyangdi RoR HPP (141 MW)	Butwal Power Company Limited, Nepal	Western Nepal
14	Mristi Khola RoR HPP (42 MW)	Robust Energy P. Ltd., Nepal	Western Nepal
15	Upper Trishuli – 1 RoR HPP (216 MW)	Daelim Kyeryong Joint Venture, Korea	Central Nepal
16	Budhi Gandaki Reservoir HPP (1,200 MW)	Tractebel Engineering S. A., France / Jade Consult Pvt. Ltd., Nepal	Central Nepal
17	Solu Khola (Dudhkoshi) RoR HPP (86 MW)	Hydro Venture P. Limited, Nepal	Eastern Nepal
18	Likhu-1 RoR HPP (77 MW)	Pan Himalaya Energy Pvt. Ltd., Nepal	Eastern Nepal
19	Khimti - 2 RoR HPP (48.8 MW)	People's Hydro Cooperative Limited, Nepal	Eastern Nepal
20	Super Dordi RoR HPP – Kha (54 MW)	Peoples Hydropower Company Pvt. Ltd., Nepal	Central Nepal

10.2 Headworks Design Review

Design of headworks is a major challenging task in harnessing water resources from steep sediment loaded rivers. Therefore, apart from the physical and numerical modelling of headworks to meet performance standards, Hydro Lab holds the capacity and expertise for reviewing the planned design and operation of headworks to make them more effective in terms of hydraulics and sediment handling.

RoR HPP: Run-Of-River Hydropower Project, **PRoR HPP:** Peaking Run-Of-River Hydropower Project

10.3 Sediment Samplings and Laboratory Analyses

Hydro Lab has successfully carried out the field sediment sampling followed by laboratory analyses of about 100 different hydropower projects in Nepal. Moreover, Hydro Lab has also conducted laboratory analyses of suspended sediment samples collected by several other companies from different projects within and outside Nepal. The sediment sampling in the field includes point sampling by handheld sampler and depth integrated sampling with depth integrating samplers. Laboratory analyses of sediment include; concentration, particle sizes, mineral content and organic matters content tests. Moreover, Hydro Lab has also cooperated with Sediment Systems AS, Norway for the development of Sediment Monitoring and Operation Tool for Hydro projects (SMOOTH).

10.4 Reservoir Sedimentation Survey and Sustainability Study

Storage capacity depletion in lakes and reservoirs takes place due to sedimentation. It is therefore

important to conduct regular survey of the deposit and study various options to make lakes/reservoirs sustainable for long term utilisation of its capacity. Hydro Lab holds the capacity and expertise for conducting reservoir sedimentation survey by using Differential Global Positioning System (DGPS). It is also capable for evaluating reservoir's lifetime and conducting studies for possible ways of sediment flushing out from reservoirs. In cooperation with NTNU, Hydro Lab has conducted Reservoir Sedimentation Survey in different reservoirs of Nepal since 2003. The details of Reservoir Sedimentation Survey carried out by Hydro Lab are presented below:



S. N.	Projects	Client	Measurement performed in
1.	Kulekhani reservoir sedimentation survey	NTNU	November 2003
2.	Kulekhani reservoir sedimentation survey	NTNU	October and November 2004
3.	Kulekhani reservoir sedimentation survey	NTNU	November 2009
4.	Kulekhani reservoir sedimentation survey	NTNU	November 2010
5.	Kali Gandaki - A HEP reservoir sedimentation survey	NEA	December 2010
6.	Middle Marsyangdi HPP reservoir sedimentation survey	NTNU	December 2010
7.	Middle Marsyangdi HPP; bathymetric survey and velocity measurement at 40 sections of the reservoir	NEA	April and December 2013

10.5 Major Trainings/Workshops Conducted

One of the objectives of Hydro Lab is to offer training and education to the professionals involved in the field of water resources engineering and create awareness among the concerned authorities and stakeholders. The following major international workshops/seminars have been conducted by Hydro Lab in cooperation with the International Centre for Hydropower (ICH), Norway in Kathmandu, Nepal. Professionals from Bhutan, Brazil, Guatemala, India, Kenya, Nepal, Norway, Pakistan, Sri Lanka and Vietnam have taken part on the workshops/trainings. These workshops/seminars have been extremely useful in sharing effective ways of handling sediments, design of headworks in steep

sediment loaded rivers and sediment sensitive operations of hydropower systems. In addition, one workshop at Chhukha Hydropower Plant, Bhutan has also been conducted jointly with ICH, Hydro Lab and Druk Green Power Corporation (DGPC), Bhutan. These programmes have been appreciated by the participants and Hydro Lab has received requests from several international participants for similar workshops in the future as well. Furthermore, Hydro Lab has also conducted international workshop in collaboration with Nepal Hydropower Association (NHA) and Disaster Prevention Research Institute (DPRI) - Kyoto University, Japan.



S. N.	Topics of training/workshop	Dates conducted	Location	Co-organiser
1.	Sediment measurements for successful Hydropower development	11-22 November 2004	Kathmandu, Nepal	ICH, Norway
2.	Headworks design in steep sediment loaded rivers	14-20 November 2005		
3.	Sediment sensitive operations in hydropower systems	11-20 February 2008		
4.	Sediment workshop	14-21 November 2010		
5.	Headworks design workshop	22-28 September 2013	Kathmandu/ Pokhara, Nepal	
6.	Reservoir Sedimentation and its Sustainability: Bathymetric Survey of Reservoirs by DGPS	24-26 September 2014	Chhukha and Tala Hydropower Plants, Bhutan	ICH, Norway and DGPC, Bhutan
7.	Sediment Sensitive Operations of Hydropower Systems	05-11 April 2016	Kathmandu/ Bandipur, Nepal	ICH, Norway
8.	Multimodal Sediment Disaster	29 October – 01 November 2017	Kathmandu, Nepal	NHA, Nepal and DPRI-Kyoto University, Japan

Apart from the above listed workshops/trainings, Hydro Lab has organised several short workshops/seminars and talk programmes together with Nepal Hydropower Association, Nepal Norway Alumni Association, Independent Power Producers Association, Institute of Engineering, etc. It has also provided trainings to Bhutanese and Tanzanian participants on flow measurement, sediment sampling & laboratory analyses on several occasions. Hydro Lab also provided equipment and training for Sediment Lab establishment in Department of Energy and Chhukha Hydropower Plant in Bhutan and Nathpa Jhakri Hydropower Plant in India.

10.6 Turbine Efficiency Measurement

Turbine efficiency measurement is done basically for two purposes. Efficiency measurement of new turbines is done to ensure that the equipment supplier has met

the guaranteed efficiency and for old turbines it is done to know the present status and figure out the improvement potential in terms of generation. Hydro Lab has the expertise, equipment and experience to conduct prototype turbine efficiency measurement by thermodynamic method. Till date, Hydro Lab has measured the efficiency of 43 Turbine Runners of different power plants within and outside the Country. Following is the list of power plants where Hydro Lab has conducted efficiency measurement.



S. N.	Project	Client	Location	No. of turbines measured	Measurement dates
1	12 MW Jhimruk Hydropower Plant	Butwal Power Company Ltd., Nepal	Mid-Western Nepal, Pyuthan District	2 Turbines	August 2003
2	60 MW Khimti I Hydropower Plant	Himal Power Limited, Nepal	Central Nepal, Dolkha District	4 Turbines	May and October 2004
3	5.1 MW Andhi Khola Hydropower Plant	Butwal Power Company Ltd., Nepal	Western Nepal, Syangja District	2 Turbines	June 2004
4	336 MW Chhukha Hydropower Plant	Druk Green Power Corporation Limited, Bhutan	Chhukha, Bhutan	3 Turbines	April 2006
5	86 MW Malana Hydropower Plant	Malana Power Company Limited, India	Himanchal state, India	4 Turbines	March 2007
6	336 MW Chhukha Hydropower Plant	Druk Green Power Corporation Limited, Bhutan	Chhukha, Bhutan	1 Turbine	May 2007
7	60 MW Khimti I Hydropower Plant	Himal Power Limited, Nepal	Central Nepal, Dolkha District	2 Turbines	June 2007
8	12 MW Jhimruk Hydropower Plant	Butwal Power Company Ltd., Nepal	Mid-Western Nepal, Pyuthan District	3 Turbines	July 2007
9	4 MW Khudi Hydropower Plant	Khudi Hydropower Limited, Nepal	Western Nepal, Lamjung District	2 Turbines	April 2008
10	60 MW Khimti I Hydropower Plant	Himal Power Limited, Nepal	Central Nepal, Dolkha District	5 Turbines	June/October 2010
11	336 MW Chhukha Hydropower Plant	Druk Green Power Corporation Limited, Bhutan	Chhukha, Bhutan	1 Turbine	November 2010
12	60 MW Khimti I Hydropower Plant	Himal Power Limited, Nepal	Central Nepal, Dolkha District	6 Turbines	June/October 2012
13	60 MW Khimti I Hydropower Plant	Himal Power Limited, Nepal	Central Nepal, Dolkha District	3 Turbines	July/October 2013
14	60 MW Khimti I Hydropower Plant	Himal Power Limited, Nepal	Central Nepal, Dolkha District	1 Turbine / 1 Turbine	August / October 2015
15	144 MW Kali Gandaki 'A' HEP	Nepal Electricity Authority	Western Nepal, Syangja District	3 Turbines	April/May 2017

10.7 Sediment Monitoring in Hydropower Plants

Sediment monitoring in Run-of-River hydropower plant is essential to document the sediment load that passes through the turbine and also to know the level of concentration to the incoming flow to the power plant. Sediment can be monitored manually or automatically. Hydro Lab has got experience and expertise to conduct sediment measurement in any hydropower plant built on sediment laden river. Hydro Lab in cooperation with NTNU and Sediment Systems, Norway provided sediment monitoring and laboratory establishment services to Nathpa Jhakri Hydropower

Plant (1500 MW) in India through GE Hydro, Norway. Similarly, it has been providing such services in some of the Nepalese power plants as well.

10.8 Projects Carried-out Beyond Regular Activities

- Technical Audit of disaster prevention project for Kulekhani Hydropower Plant
- Study on Sediment Management in Run-of-River Hydropower Projects of Nepal awarded by Water and Energy Commission Secretariat

11. RESEARCH AND DEVELOPMENT

Research and development (R&D) in hydraulics and sediment is an ongoing and never ending activity at Hydro Lab. The identified activities for research and development activities include cost effective sediment handling in run-of-river hydropower plants, alternative ways of sediment handling, online sediment monitoring, creation of headworks database and improvement in headworks design, reservoir sediment management, etc. The findings from the research are disseminated to the professionals by organising workshops/seminars, delivering lectures and arranging demonstrations in the laboratory. The research and development activities at Hydro Lab have been funded by Ministry of Foreign Affairs (MFA), Norway through the Royal Norwegian Embassy in Kathmandu, which was completed at the end of November 2015.

Generating fund for research and development always becomes a challenge for the Company. Hydro Lab alone does not have capacity to raise funding for such activities and therefore, it is crucial to obtain funding either from the Government of Nepal or from other donor agencies to continue the R & D programmes.

11.1 Energize Nepal Programme

A consolidated Nepal Energy program called "Energize Nepal" was formulated in the partnership of Kathmandu University (KU), Hydro Lab Pvt. Ltd., SINTEF Energi AS, Norwegian University of Science and Technology (NTNU) for the development of

energy sector in Nepal. Capacity enhancement on hydropower and other renewable energy development is one of the main components of this programme. Thus, to support the renewable energy development in Nepal and in the region, the Norwegian Ministry of Foreign Affairs (MFA) awarded a grant for this programme for Five years starting from July 2016.

11.2 Collaborative research with Chigasaki Research Institute

The cooperation between Chigasaki Research Institute (CRI) of J-Power, Japan and Hydro Lab was rendered aiming to conduct joint research and development program in the field of hydraulic and environment related to sediment transport issues in connection with hydropower projects. The cooperation agreement was effective from the beginning of 2017 and will remain for 4 years' period. Research activities within this cooperation is focused on the study of massive riverbed deformation caused by large scale flood and sediment disaster.

11.3 Partnership with NTNU on SEDIPASS Research Programme

Hydro Lab is working together with Norwegian University of Science and Technology (NTNU) in a joint research programme on sustainable design and operation of hydropower plants exposed to high sediment yield (SEDIPASS).


12. ACADEMIC INVOLVEMENT

Knowledge sharing through academic involvement is another important approach of Hydro Lab. Under this, Hydro Lab has been continuously providing opportunities for internships, thesis or project works for BE, MSc and PhD candidates from different universities. In addition, Hydro Lab has also been involved in the Masters in Hydropower Engineering course running at the Institute of Engineering (IoE), Tribhuvan University. Following are some of the examples of Hydro Lab's involvement in academic field as well. Hydro Lab has assisted BE, MSc and PhD students for thesis/internship/project works from,


- Asian Institute of Technology, Thailand
- Institute of Engineering, Tribhuvan University, Nepal
- Jacobs University Bremen, Germany
- Jawaharlal Nehru Technological University, India
- Karlsruhe Institute of Technology, Germany
- Kathmandu University, Nepal
- Kyoto University, Japan
- Motilal Nehru National Institute of Technology, India
- Norwegian University of Science and Technology, Norway
- Ostfalia, University of Applied Science, Germany
- VIA University College, Denmark


13. PERSONNEL

Brief personal detail of key staff of the Company is given below:

Dr. Meg B. Bishwakarma General Manager		
Qualifications	<ul style="list-style-type: none"> ➤ PhD (Dr. Ing.) from the Norwegian University of Science and Technology (NTNU), Trondheim, Norway (2008) ➤ MSc in Hydropower Development from the Norwegian University of Science and Technology (NTNU), Trondheim, Norway (1998) 	
Key Experience	<p>Above Twenty Five years of experience in planning, design, construction supervision, contract management/administration and the environmental mitigation and monitoring of hydro projects. Last 13 years of work involves hydraulic design, physical hydraulic modelling, intensive research on sediment measurement and cost effective sediment handling including 5 years part time teaching at the Norwegian University of Science and Technology (NTNU).</p>	

Prof. Dr. Haakon Støle Scientific Advisor (part time)		
Qualifications	<ul style="list-style-type: none"> ➤ PhD (Dr. Ing.), Norwegian Institute of Technology, Norway, 1993. ➤ MSc (siv. ing.), Norwegian Institute of Technology, Norway, 1984. 	
Key Experience	<p>More than Thirty years of experience in sediment sampling and sediment studies, hydraulic model studies, headworks design for water diversion structures and sediment exclusion, harbour and coastal engineering, lecturing, training and technology transfer, software development for hydraulic calculations and development of technology for sediment flushing.</p>	

Dr. Gyanendra Lal Shrestha DGM/Head of Research (part time)		
Qualifications	<ul style="list-style-type: none"> ➤ Ph D (Dr. Ing.) from the Norwegian University of Science and Technology (NTNU), Trondheim, Norway (2006) ➤ M Sc. Engineering in Geotechnical (foundation) Engineering, The University of Birmingham, UK (1994) 	
Key Experience	<p>Over 25 years experience in site investigation, geotechnical design parameter recommendation, bearing capacity and settlement calculation using geotechnical software. Tunnel stability analysis and support design using empirical, analytical and numerical modelling. Site selection, design, construction supervision, trouble shooting, management and quality control of civil/tunnel/hydropower projects.</p>	

Mr. Yogesh Khadka Laboratory Manager		
Qualifications	<ul style="list-style-type: none"> ➤ Executive Masters in Business Administration (EMBA), Purbanchal University, Nepal 	
Key Experience	<p>More than Twenty-Three years of experience in physical hydraulic model planning, construction supervision, testing and field measurements related to the model study which also includes 15 years' experience on turbine efficiency measurements of hydropower plants, reservoir sedimentation survey, laboratory analyses and overall management of the laboratory including cost estimates, proposals and agreements. Responsible on maintaining quality management system ISO 9001:2015 as a Management Representative since 2013.</p>	

Dr. Umesh Singh

Senior Research Engineer



Qualifications	<ul style="list-style-type: none"> ➤ PhD in River Science (Joint Degree) from University of Trento, Italy and Queen Mary University of London, United Kingdom (2016) ➤ MSc in Water Science and Engineering from UNESCO-IHE Institute for Water Education, the Netherlands (2012)
Key Experience	More than Six years of experience in fluvial geomorphology and sediment related research (fundamental and applied). More than Five years of professional experience in hydropower sector in Nepal including feasibility studies and research. Experiences in physical experiments and state-of-the-art numerical modelling.

Mr. Sanat K. Karmacharya

Project Engineer



Qualifications	<ul style="list-style-type: none"> ➤ PhD on going ➤ MSc in Water Resource Engineering from the IoE, TU, Nepal
Key Experience	More than Seven years of experience in physical planning, construction, testing and reporting. Detailed feasibility design, cost estimation and reporting of micro hydro-projects in rural areas of Nepal for 2 and ½ years structural design of buildings and truss structures for 6 months valuation of fixed assets for financial institutions for 4 years. Assistant lecturer for water resources subjects.

Mr. Kunjan Lal Pradhan

Project Engineer



Qualifications	<ul style="list-style-type: none"> ➤ MSc in Water Engineering and Management from AIT, Thailand ➤ MSc in Euro Hydro-Informatics and Management (dual degree exchange student programme, Universite de Nice Sophia Antipolis, Nice, France)
Key Experience	5 years of experience on managing Waste water treatment plant which also involves on managing health & safety at workplace and also responsible as a team leader for emergency response. About Six months experience on feasibility study of Hydropower Projects, hydrological analysis in computer based model, design and cost estimation.

Mr. Ojaswi Sharma

Project Engineer (Geotechnical)



Qualifications	<ul style="list-style-type: none"> ➤ MSc in Geotechnical Engineering from the Institute of Engineering, Tribhuvan University, Nepal
Key Experience	About 3 years experience on design, estimate, construction and supervision of Rcc and Prefab structure

Mr. Ishwar Joshi
Project Engineer



Qualifications	⇒ MSc in Water Conservancy and Hydropower Engineering, Hohai University, China
Key Experience	About 2 years experience as a lecturer on Applied Mechanics and Dynamics

Mr. Jeevan Kumar Ban
Project Engineer



Qualifications	⇒ MSc in Civil and Environmental Engineering, Kongju National University, Cheonan, Korea
Key Experience	More than 2 years as a research scholar, about 1 year experience as a lecturer on Fluid Mechanics & Engineering Hydrology and about 3 years experience on rural energy (RE) system development

Mr. Shreedeepy Shrestha
Project Engineer



Qualifications	⇒ MSc in Water Science and Engineering, UNESCO-IHE Institute for Water Education, Delft, The Netherlands
Key Experience	About two years of experience in the preparation of BoQ, preparation of contract document, project scheduling etc. of Hydropower Project and about five years of experience in designing of road and railway line

Ms. Nirmala Lama
Technical officer



Qualifications	<ul style="list-style-type: none"> ⇒ Bachelor's Degree in Civil Engineering from Pokhara University, Nepal ⇒ Bachelor's Degree in Arts from Tri-chandra College, Tribhuvan University
Key Experience	More than Ten years of experience in hydraulic laboratory involving in the physical hydraulic model construction, testing, laboratory infrastructure development, sediment analysis and report preparation. Has also one year experience on detail survey, design and estimate and construction supervision of green roads in Nepal.

Ms. Debika Aryal
Finance/Admin Officer



Qualifications	⇒ Masters in Business Studies (MBS), Tribhuvan University, Nepal
Key Experience	More than Eight years of experience in accounting and Finance section in different organizations. In addition, Two years of teaching experience in school.



Further Information

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