Health Impact Assessment of Hydropower Dams: Experiences from Nepal

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Ecological Regions
Nepal

Legend: Elevation of the region (m)
Mountain (> 40000m)
Hill (1000 – 4000 m)
Tarai (60 – 1000 m)
A. Human Health

• Health is a state of complete **physical, mental** and **social well-being** and not merely an absence of **disease or infirmity** (WHO 1947)

**Concepts and components**

• Primary health care: Alma Ata declaration (1978) - the World Health Assembly established a goal “Health for all”

  • Equitable distribution
  • Community participation
  • Intersectional coordination
  • Appropriate technology
1. Interaction among Agent, Host and Environment

2. Health Determinants
   - Physical environment
   - Lifestyles
   - Social environment
   - Access to and quality of services

3. Major routes of agents entry
   - Water
   - Air
   - Food
B. Hydropower Dam

• Development infrastructure – raising quality of life

• Large dam – reservoir capacity of at least 1 million cubic meters, and maximum flood discharge of 2,000 cubic meters per second
Possible impacts

Hydropower Dam

Land Use Change

- Agriculture
- Forest
- Pasture
- Built-ups

Livelihood systems

- Resources-based production pattern, irrigation, recreation, etc

PUBLIC HEALTH

- Drinking water sanitation
- Energy
- Nutrition

Factors

- Population growth & migration
- Employment growth
- Infrastructure
- Government policies
- Productivity
C. Health Impact Assessment (HIA)

1. Baseline impact indicators (cross cutting)
   – Impact catchment area – site + downward area
   – Direct health - diseases
   – Indirect health (determinants)

2. Sample base (size)
   – Standard sample size formula
Health baseline Indicators

I. Diseases - number and types

- Cholera
- Typhoid
- River blindness (Onchocerciasis)
- Bilharzias (Schistosomiasis)
- Malaria
- Lymphatic Filariasis
- Japanese encephalitis
- Dengue
- ARI/COPD
- TB
- Diabetes
- STD/HIV
II. Health Determinants (Causality of impact)

• Air quality
• Noise – number and types of vehicles
• Sanitary condition – toilet, sewerage
• Waste disposals
• Source of drinking water
• Black fly (*Simulium damnosium*)
• Mosquitoes -
• Swampy areas
• Irrigation canals
Health baseline Indicators (contd.)

III. Hydrological effects
• Water quality (physical, biological - benthic macro-invertebrates and chemical indicators)
• Water availability for drinking and irrigation
• Stream flow
• Temperature
• Rainfall & Humidity

IV. Geomorphic effects
• Submerged land – area
• Habitats – number and types
• Erosion - area
• Sedimentation/siltation - volume
• Flooding in the downstream - frequency
• Water level in streams
V. Cultural and socioeconomic impacts

- Demographic – sex, age, migration, education, employment, marriage, ethnicity, etc.
- Displacement of settlements
- Land uses (arable, vegetation, water bodies, pasture, built-ups, etc)
- Cultivation practices – slash and burn farming, shifting, contour farming, cropping pattern
- Landholding size
- Tourism
Purpose is to identify:

- Positive effects - to be enhanced
- Negative ones – to be mitigated

Possible impacts:

- Positive on people: electricity, irrigation water (productivity increase), entertainment, job creation, etc
- Negative (on health and environment):
  - loss of vegetations
  - change in riverine flows
  - Displacement of settlements
  - loss of cultural values
  - inundating of agricultural land and siltation
  - drought and severe reduction of flow downstream
Sampling technique

• Sampling Methods
  ▪ Stratified sampling – social and economic groups, as well as spatial (distance) – household survey

• Survey tools
  ▪ structured questionnaire tools and questions to be asked- *where* (sites), *when* (time), *whom* (communities) and *how* much - magnitude of impacts (both quality and quantity)
  ▪ Observation – checklist/protocol
  ▪ Focus Group Discussion – qualitative information
  ▪ Mapping tools - GIS, RS and GPS, toposheet with large scale (≈10,000 map scale)
# Identification of magnitude of health impacts

<table>
<thead>
<tr>
<th>Categories/ specific influences on health</th>
<th>Project operation activity</th>
<th>Predicted health impacts</th>
<th>Risk of health impacts</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Negative</td>
<td>Positive</td>
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Data Analysis

• Health status
  - incidence /prevalence of diseases, mortality, morbidity, nutrition
  - water quality, air quality and noise

• Demographic
  - Births, deaths, migration/mobility, marriage, occupations, fertility

• Agricultural production
  - Productivity, food security/surplus, cropping patterns,

• Environmental conditions
  - Soil erosion, landslides, siltation, floods, draught, land use change, Meteorological parameter change (GIS mapping)
How to check the Design Logic in a Logical Framework

A + B = C
A without B does not equal C

Results Hierarchy

Impact
C: Children recover from malnutrition

Outcome
A: Children consume blended food in intended quantity

Risks and Assumptions

B: Disease affecting nutritional status is effectively controlled

UNFP (2011)
### D. Hydropower Situation of Nepal

#### I. Status

<table>
<thead>
<tr>
<th>Description</th>
<th>Hydropower</th>
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<tr>
<td>Internal demand</td>
<td>1190 MW</td>
</tr>
<tr>
<td>Production</td>
<td>690 MW</td>
</tr>
<tr>
<td>Deficient</td>
<td>500 MW</td>
</tr>
<tr>
<td>Production capacity</td>
<td>83,000 MW</td>
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<tr>
<td>Technical feasibility</td>
<td>41,000 MW</td>
</tr>
<tr>
<td>Total rivers</td>
<td>6000</td>
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</tbody>
</table>
Existing Capacity of Hydropowers

- Total No of Hydropower: 57
- Major Hydropower: 16
- Small Hydropower: 9
- Isolated: 32
- Minimum Capacity: 32 Kw
- Maximum Capacity: 144000 Kw
- Total Capacity: 549201 Kw

Capacity of Hydroelectricity (in Kw)
- Below 1000
- 1001 - 36000
- 36001 - 69000
- Above 69000

Source: District Development Profile of Nepal, 2004
Despite huge hydropower potential only about 40% of Nepal's population has access to electricity.
Most of the power plants in Nepal are run-of-river type.
Merely 1% energy need in the country fulfilled by electricity.
Hydropower Situation of Nepal (contd.)

• More than 500 hydropower projects of different capacity
• Hydropower started in 1911, but increased rapidly since 1970
• Hydropower policy of 1992
  • Emphasizes the need for a minimum flow of 10% of the minimum monthly average discharge or a flow equal to the discharge to the downstream flow.
Distribution of Existing Hydroelectricity

Existing Hydroelectricity
- Major Hydro Projects
- Small Hydro Projects
- Existing (Isolated)

Physiographic divisions
- Mountain
- Hill
- Tarai
- Boundary

Source:
Quartz content from mineral analysis and erosion rate

ER = 10-35 mg/kg, Quartz contents ≥75%
I. Hydro Dam Case

Kali Gandaki A - Western Hill

- The feasibility study carried out in 1979 – completed in 2002.
- Run off river type - Daily pondage type scheme

- Installed capacity: 144 MW
- Annual energy output: 842 GWh
- Using a net head of 115m
Impacts of A Kali Gandaki A Hydropower Dam

• **Resettlement and Rehabilitation** program for affected Bote (Fishermen) families
• implementation of **Community Support Program** like micro-credit revolving fund program with an earmarked budget of NRs 2,900,000.
• Protection of Setiben Sheela, a **holy stone** religious site
• Construction of **cremation sheds** and renovation of temples.
• Implementation of **skill development** training program.
• **Earning** nearly six times greater than the previous cash income.
• Downstream Bote fisherman to harvest affected, causing adverse impact on their income and livelihood.
• Quality of life enhanced, more houses now have **toilets and separate cowsheds**.
II. Hydro Dam Case – Middle Marsyangdi Dam

• Second largest Hydro Electric Dam
• Duration of Services 1999-2007
• A run off river type in the mid-hills
• Installed capacity: 76 MW with head 120 m
• The average annual energy output amounts to 470 GWh of which 280 GWh are firm energy.
• Flooding and GLOFS
Middle Marsyangdi Dam (contd.)

- Flooding including Glacier Lake outburst floods (GLOF) and sediment loads

- Health accessibility increased
III Kulekhani Hydro Dam

MAP OF MAKAWANPUR

REduction in Reservoir Capacity due to Sedimentation

Mean Daily rainfall

Source: District Forest Department, MAH Projects

Report by: Mahanecon Corp, B.P. Makawanpur
Kulekhani Hydro Power Dam (contd.)

- Completed in late 1980s
- The first and only reservoir based hydropower plan in the country.

• A strong cloudburst of July 1993 seriously hit the plant as its penstock pipes were swept away and seriously reduced water holding capacity of the reservoir due to sediment deposit.
The 45,000 residents of the Kulekhani watershed was affected.

65 mm/hour. In the catchment area of the Kulekhani Dam, a 540 mm / 24 hour period bringing down five million cubic metres of silt and boulders into the reservoir.

The rain dumped in one night a sediment load several times larger than the estimate made by Kulekhani’s designers for the entire lifespan of the dam.

64 people and 274 animals died. The disruption of water sources and irrigation canal system has resulted in problem of water scarcity for drinking and irrigation.
Indication of potentially health impacts

- Nutrition deficiency due to change in production pattern or food habit due to displacement or loss of land
- Environment & ecology of the localities
- Loss of social harmony – psychological/mental diseases in increasing trend
- BCC related disease – diabetes, smoking, drug abuse
- Livelihood
- challenges of the health system

<table>
<thead>
<tr>
<th>Disease</th>
<th>Hydropower</th>
</tr>
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<tbody>
<tr>
<td>STD and HIV</td>
<td>+</td>
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<tr>
<td>Hepatitis B and C</td>
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<tr>
<td>Water borne disease</td>
<td>+</td>
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<tr>
<td>Tuberculosis</td>
<td></td>
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<tr>
<td>Respiratory infections</td>
<td></td>
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<tr>
<td>Malaria</td>
<td>+</td>
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<tr>
<td>Leishmaniasis</td>
<td></td>
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<tr>
<td>Dengue fiver</td>
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<tr>
<td>Filariasis</td>
<td>+</td>
</tr>
<tr>
<td>Japanese encephalitis</td>
<td>+</td>
</tr>
<tr>
<td>Childhood disease</td>
<td></td>
</tr>
<tr>
<td>Occupational falls</td>
<td>+</td>
</tr>
</tbody>
</table>

+ Potentially increase risk of disease
E. Concluding Remarks

• Research gaps in hydro dam health impacts -
  – 6% of HIA literature focussed on developing countries; remaining 94% in developed countries - a major discrepancy
  – 10/90 gap in health research

• Baseline data in Nepal – EIA comprises some of the health related data, but no baseline data focusing on health impacts exists

• Should be essential for government’s health policy measures and programmes
Thank you so much