Developing a Resettlement Plan for the People Displaced by Budi Gandaki Hydroelectric Project

Er. Khimlal Gautam, Susheel Dangol,
e-mail: gautamkhimlal@gmail.com, susheeldangol@gmail.com

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Abstract
Natural disasters, armed conflicts, mega-development projects, etc cause displacement of people from their native location beyond or within the national territories. Reservoir based hydropower development projects cause internal displacement of people; resettlement of whom forms an integral part of the project. Large scale hydropower projects featuring dam construction causes massive inundation resulting in displacement of population either economically or both economically and physically. Successful execution of these projects necessities resettlement plan. One of the major parts of resettlement plan is relocation of the Internally Displaced People (IDP)s which requires rigorous method for selection of suitable location involving several criteria. This paper discusses about the relocation plan of BGHEP. A multi-criteria approach is implemented through the application of Analytical Hierarchy Process for selection of suitable sites for relocation of the IDPs. Site suitability analysis involves several criteria namely slope, land cover, geology, aspect, etc. The influence of each of these criteria on site selection is determined using AHP. Along with the spatial criteria, the analysis considers policy, legislations, good practice guidelines implemented for site selection in similar hydropower projects. The analysis indicates that there is sufficient suitable site for relocation of IDPs within each Village Development Committee.

1. INTRODUCTION

Resettlement is a process to rebuilt all the infrastructure in another site. "Resettlement refers both to physical displacement (relocation or loss of shelter) and to economic displacement (loss of assets or access to assets that leads to loss of income sources or other means of livelihood as a result of project-related land acquisition and/or restrictions on land use" (IFC, 2012). Involuntary resettlement occurs when affected persons or communities do not have the right to decline land acquisition that result in physical or economic displacement. In every development project, relocation of settlement for displaced people commonly known as Internally Displaced People (IDP) is very challenging issue all over the world. IDP are those who have not crossed an international border, but have remained in their home country and are forced to flee their home due to number of reasons like armed conflict, mega-development project, and natural disaster. According to Internal Displacement Monitoring Center (2015) 38 million people are displaced by the conflict of January 2015, and 22 million people newly displaced by disaster of 2013 a among which 19.1% is only from Asia. According to IDMC, up to 50,000 people are internally displaced due to armed conflict which does not include people displaced by violence in the central Terai. Similarly, monsoon flooding in August 2014 displaced families acounting around 21,196 families.

Besides conflict and disaster, development project is also another big reason for internal displacement of the people. Among the development projects Hydroelectricity Development Project are one of the major causes for internal displacement of the people, particularly, in context of Nepal. The successful execution of such development project depends on the

proper resettlement of the internally displaced people. In this, research Budhi Gandaki Hydroelectric Project (BGHEP) has been taken as case where approximately 50,000 people wre internally displaced due to the reservoir prepared for BGHEP. According to Tang,*et.al*, (2013), hiring relocation lands, building new communities, developing local infrastructure, mitigating geological hazards, compensations, and improving displaced people's skills for sustainable development are some of the aspects to be considered during resettlement. Determining factors for the success of relocation planning is determined by access to land, social support networks, employment, business, credit and market opportunities and the selecting of the sites for relocation that match closely with the previous site in terms of environmental, social, cultural, and economic characteristics (ADB, 1998).

In hydropower development, resettlement of people displaced by the reservoir, dam and others construction is crucial and important issue. Land lost in the surface due to the reservoir inundation and the adjustment of land-use policy resulted land-use changes and its impact on the human carrying capacity of the land, and the land availability for resettlement needs to be addressed while designing resettlement plan. Relocation not only includes resettlement and rehabilitation of the physically and economically displaced people, but also the relocation of the affected Schools and Collages, Public and Private Institutions, Temples / Shrines and the Cremation sites. Local people have the social and cultural attachment with the place and thus may be reluctant and resistant to the relocation to new places. Present issue of resistance from the people of Sindhupalchok district who were displaced due to recent devastating earthquake is a good example of the social and cultural attachment with their native place. Thus, different aspects need to be considered during relocation and rehabilitation.

Among many different hydroelectric Project, Budhi Gandaki Hydroelectric Project (BGHEP) is one of the project with national priority proposed by the Government of Nepal. The project is a reservoir type hydroelectric project which is going to be developed with installed capacity of 1000/ 1200MW. The project is expected to cater energy requirements of the major cities and industrial hubs in the Central and Western Development Region of Nepal. Currently, Detailed Project Report (DPR) of the project is being developed. Being a reservoir type project, the reservoir will submerge settlement areas affecting about 50,000 people. Till date, Kulekhani hydropower project (1977-82) is the only reservoir based project which induced displacement of people at a larger scale. 3000 individuals were displaced from 450 households which is still very less in comparison to the displacement that would be caused due to BGHEP (Benerjee, 2005)**.** Thus, resettlement of the affected people through different means will be required while executing the project and leading to successful completion. There are different mega projects in Nepal that are being delayed due to the lack of suitable resettlement plan. In this context, regarding the successful completion of the project also, the main issue to be considered is the resettlement and rehabilitation of the physically and economically displaced people and relocation of the affected Schools and Collages, Public and Private Institutions, Temples / Shrines and the Cremation sites. As the project in the phase of developing DPR, it is right time to develop an appropriate resettlement plan. Therefore, this study aims to develop resettlement plan such that the affected people can be relocated in the vicinity of the reservoir of the project.

2. STUDY AREA

Proposed BGHEP is a reservoir based project located about 2 km upstream of Budhi Gandaki – Trishuli confluence on Budhi Gandaki River. When developed with the proposed Full

Supply Level (FSL) at 540 MASL, the project reservoir will require approximately 66 km long linear stripe of land area totalling 6637 hectare along the valley of Budhi Gandaki in the district of Gorkha and Dhading at the cross-junction of Central and Western Development Region of Nepal (Figure 1).

In this research , 27 VDC from both district Gorkha (14 VDC) and Dhading (13VDC) are taken as a study area. The VDC are Baseri, Budhathum, Mulpani, Salyantar, Aginchok Salyankot, Marpak, Tripureswor, Jyamrung, Chainpur, Khari, Maidi, and Salang of Dhading District and Thumi (Partial), Aarurbang, Aaruchanuate, Aarupokhari, Tandrang, Dhawa, Asrang, Borlang, Bunkot, Namjung, Fujel, Darbhung, Bhumlichok and Ghyalchok, of Gorkha district. The total study area is 579.22 sq.km. including the reservoir area.

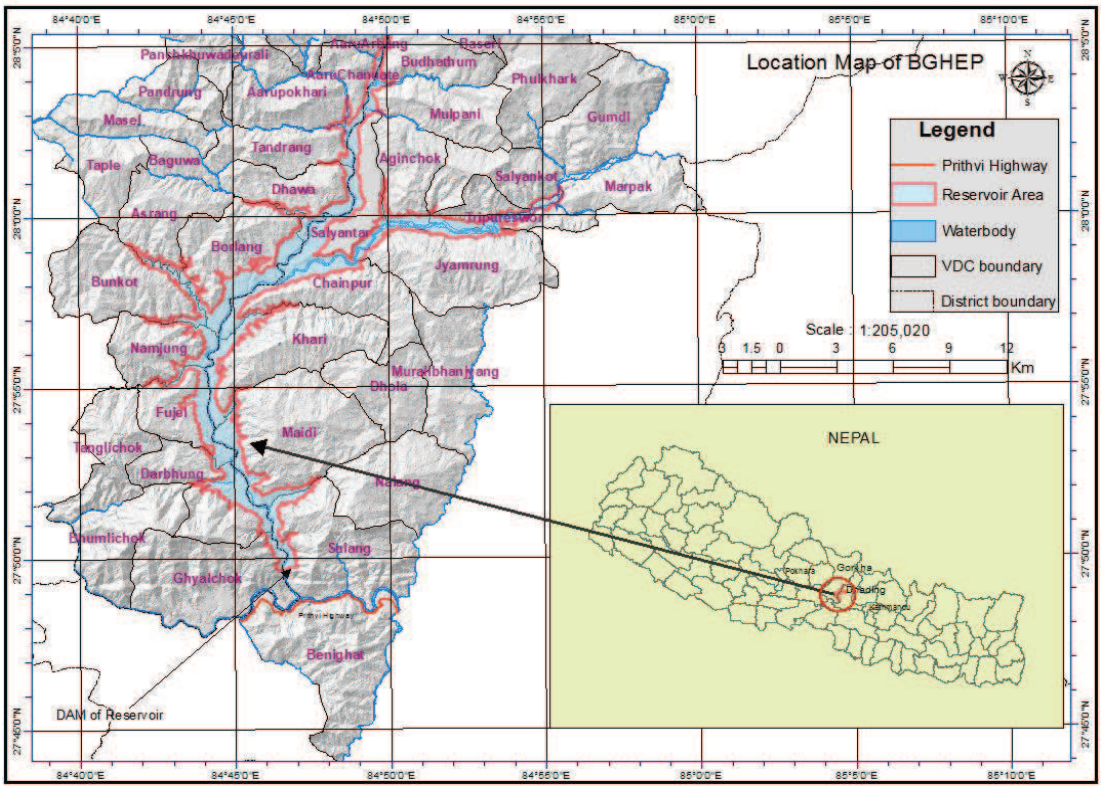

Figure 1: Study area.

3. MATERIALS AND METHODS

Different primary and secondary source of data are collected for the research. The secondary data include different maps acting as factors for the analysis. The primary data includes socio-economic data collected by field visit.

3.1 Data

- Ortho-photo of reservoir area with dam from BGHEP
- Existing topographical data with contour and land cover of study from survey department.
- Socio economic data from Central Bureau of Statistic (CBS) of Nepal
- Geological map from Department of Mine and geology of Nepal.

3.2 Factors

Five factors or criteria are taken in consideration for this research to develop the resettlement plan. Different weight given for different criteria are shown in Annex A.

3.2.1. Slope

Slope is one of the important factor for determining the pattern in resettlement area for basic living conditions. Flat area is recommend for the construction of infrastructure. Area with steep slope may result in high probability of geological hazards. After the big earth quake in Nepal on April 25, the Government of Nepal declared that the area higher than 30 degree slope is not acceptable for the housing purpose without taking prior permission from the Department of Mines and Geology (GON, 2015). In this research the area more than 30 degree slope is selected as not suitable area for resettlement and given the weight 0.

3.2.2. Land Cover

Availability of abundant land resources suitable for residential development and cropping are the living security for migrants (Sheng *et al*. 2009). Thus, in every type of spatial analysis for resettlement, assessment of land use/ land cover is the basic criteria of assessment. In resettlement planning, there exist a principle that land resources of the new resettlement area should have better conditions over areas that the migrants move out from (Yimin *et al.* 2011). Built-up, water body, sand deposits and wetland are not suitable and cannot be recommended for settlement (Ibrahim *et al*. 2015). Moreover hazardous area also cannot be recommended for the resettlement purpose. Thus, built-up, water body, drainage, sand deposits and wetland are considered as outliers in selection of suitable resettlement site

3.2.3. Geology

Since Nepal is highly vulnerable to earth quake and other natural disaster as the Indian plate and Eurasian plate is continuously slipping one over other, analysis of lithology of the area is most important part as well. The Budi Gandaki hydropower reservoir and its surrounding area lies mainly on Main Boundary Thrust (MBT). People cannot be settled where there exist fault and thrust because these area are prone to natural disasters like earthquake. Thus, these kinds of area are excluded in the selection of resettlement sites.

3.2.4. Elevation

Elevation in the study area varies from 260 meter to 3000 meter from mean sea level. This links with the livelihood of the displaced people. In high altitude it may be difficult to find suitable land for agriculture which is necessary to support the displaced people with their livelihood. Thus, area with high altitude is given less weight and plane area is given high weight.

3.2.5. Aspect

Aspect means the direction of land pattern in hilly area. If we consider about the construction of building, it is better to face the building either in East or in South direction because of the sun light. Since sun rise from east and sets in the west, most of day time, there is sufficient amount of light in East and South direction. In North faced land, there is very poor light and always cold. Hence, the South and East aspect are given high weight and North and West aspect are given less weight.

3.3 Method

Primary data was collected from socio-economic survey of the affected people of the project site and spatial data as the secondary source was collected from different source. On the basis of different factors considered for the resettlement purpose, multi-criteria analysis was conducted in GIS platform. Suitability of the resettlement site are dependent on the land use/land cover, slope, elevation (contours), geology and Aspect. Land use/land cover information of inundation and its vicinity were extracted from Topographical map sheet of Nepal 1996, and Ortho image taken for BGHEP 2012.

3.3.1 Analytical Hierarchy Process (AHP) and calculating the suitability index

Analytical Hierarchy Process(AHP) was used for allocating the weightage of each subjective parameter. Expert knowledge was used for the calculation of weightage of subjective parameters and value of subclass of each criteria. In pair wise comparison matrix, two factors were measured at a time as per the importance related to the stated objective. Reciprocal matrix of all the factors were prepared which was normalized. Then normalized pair wise comparison matrix was prepared from which principle eigen value was calculated.

Since the matrix is symmetrical, the lower triangle of the matrix was calculated. The matrix M is reciprocal matrix which means $M_{qp} = M_{pq-1}$. All the diagonal elements of this matrix is 1. A normalized comparison matrix was obtained by dividing each element of the matrix by the sum of its column. The average of each row of the normalized matrix gives the priority vector of each factor. The ratio scales are derived from the principal Eigen vectors which is the actual weight of that criteria, and the consistency index is derived from the principal Eigen value.

Given below is the pair wise comparison matrix and relative importance weights of the evaluation criteria for each factor. Which are used in this research.

Reciprocal Matrix for pair wise comparison Matrix					
	Slope	Elevation	Aspect	Geology	Land Cover
Slope	1.000	5	3	7	1
Elevation	0.200	1	0.2	0.33	0.2
Aspect	0.333	5	1	1	0.33
Geology	0.143	3	1	1	0.33
Land Cover	1.000	5	3	3	1
Sum	2.676	19	8.2	12.33	2.87

Normalized Relative Weight (Normalized pairwise comparison Matrix)						**Principle Eigen Vector**
	Slope	Elevation	Aspect	Geology	Land Cover	(which is the weightage of each parameter)
Slope	0.374	0.263	0.366	0.568	0.349	0.384
Elevation	0.075	0.053	0.024	0.027	0.070	0.050
Aspect	0.125	0.263	0.122	0.081	0.116	0.141
Geology	0.053	0.158	0.122	0.081	0.116	0.106
Land	0.374	0.263	0.366	0.243	0.349	0.319

Cover						
Sum	1.000	1	1	1	1	1.000

Principal Eigen Value (λ) = 5.3514, Consistency Index(CI) = 0.089, Consistency Ratio (CR) = 0.079< 0.1 , which is consistent.

3.3.2. Multi Criteria Analysis (MCA)

MCA is the process to reduce complex problems into simple and fine ranking of the best scenario on the base of multiple factors from which best option can be selected (Yassine and Adel, 2011). It includes factor criteria and constraint criteria and every criteria are expressed as map layer. In this research also MCA was performed for the suitability analysis of resettlement sites. Five spatial subjective criteria as discussed in section 3.2 were taken into consideration for resettlement site selection. Some of restrictive factors such as existing settlement area, hazardous area and buffer of drainage, thrust and fault were carried off from the result of subjective criteria and the final resettlement site were purposed for the IDPs (Figure 2). The raster calculator tool was used to perform the weightage overlay analysis using the result of AHP from the expert knowledge and prepare the suitability map of resettlement sites for the IDPs (Figure 3) .

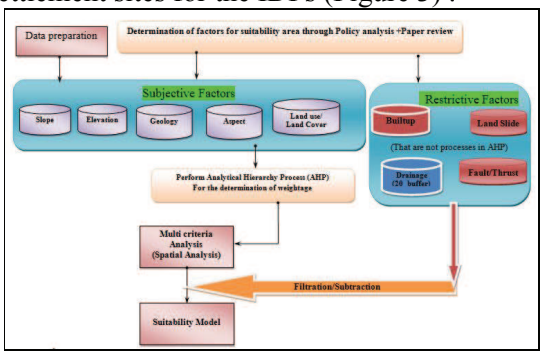

Figure 2: Work flow diagram for Multi Criteria Analysis for suitability of resettlement sites.

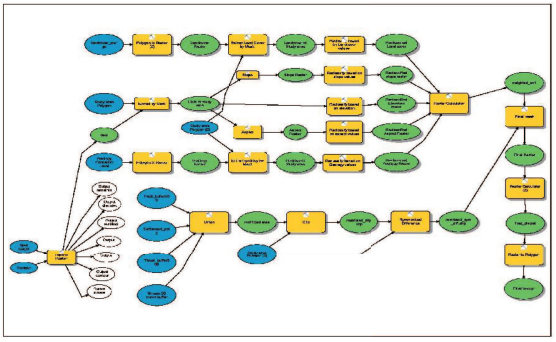

Figure 3: Model of geographic information

4. RESULT AND DISCUSSION

Suitability parameters (Geological formation, Slope, Land cover, Aspect and elevation) were evaluated against each other and some restrictive factor (buffer of drainage, fault, Thrust and existing settlement area) which were deducted directly from the result. It can be observed that from the pair wise comparison and computation of principle eigen vector, slope governs 38.4% influences, land cover governs 31.9%, aspect governs 14.1%, lithology (geology) governs 10.6%, and elevation influences 5 %. Here, expert gave more importance for the slope than other since the area is the hilly area. The overall weighted overlay of the suitability factors shows that within the study area of vicinity of reservoir 150.90 square kilometres of the area is shown as suitable resettlement sites for IDPs. Out of the 150.90 square kilometre, 117.26 square kilometre is slightly suitable area, 30.2 square kilometre is suitable and remaining 3.44 square kilometre area is highly suitable area for resettlement plan (Figure 4). For the final result, it was neglected the small polygon having area of less than 1000 square meter.

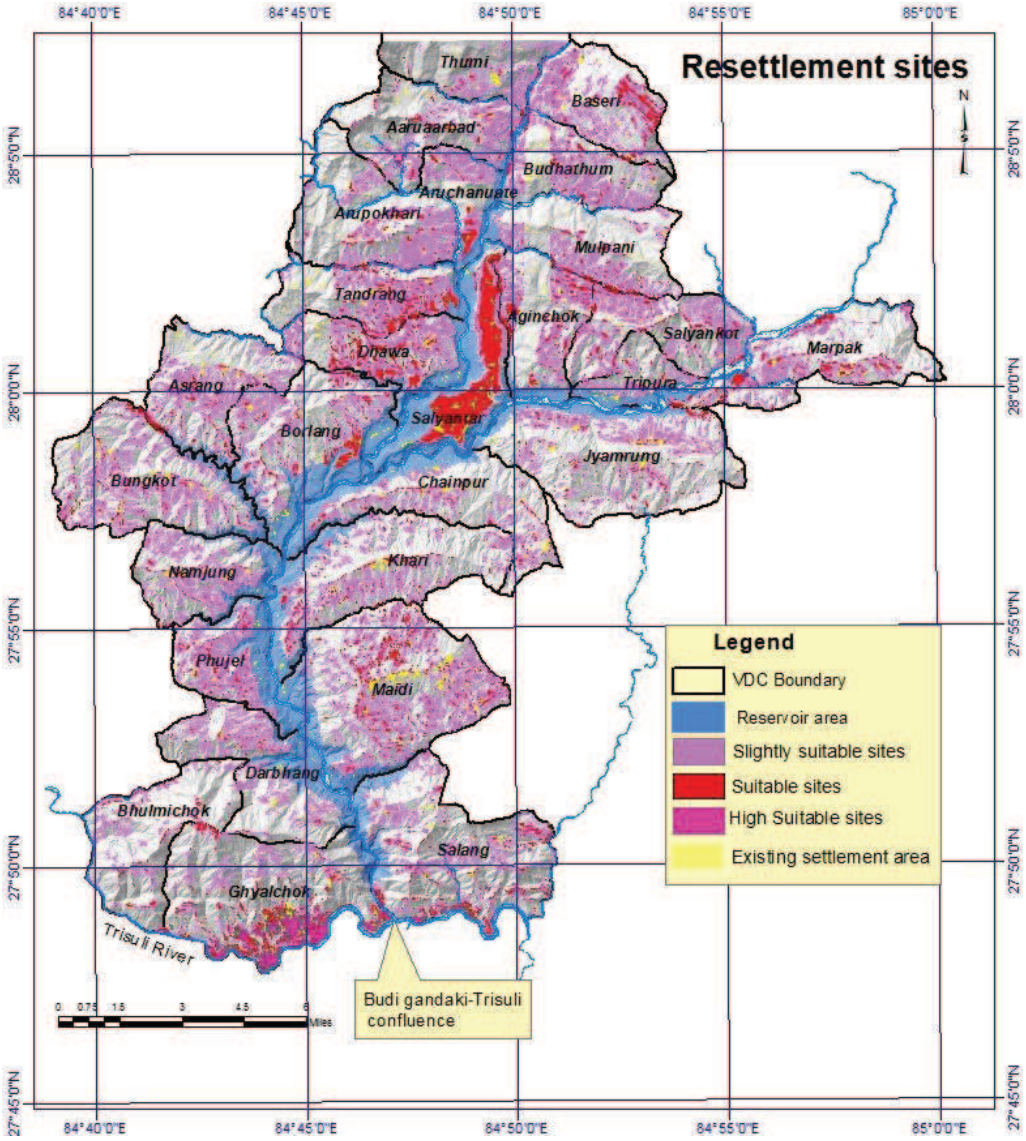

Figure 4: Map showing suitable sites for resettlement..

5. CONCLUSION

Overlay of resettlement polygon with the slope rating map shows that most of the polygon lie in high slope (20-30^0). Hence, for such area, land development program should be conducted for the better improvement of such resettlement site which will also support in increasing geological stability and combating natural hazard. In this study, accesibility to the resettlement sites and other public facility was not considered since the area is the proposed site for relocation and these kind of facilities are to be developed simultaneously.

During the socio-economic survey more than 90% of the people who participated in the survey showed the willingness to live within vicinity of the reservoir. Thus, in order to resettle the people, it is important to consider the common interest of IDPs. Studies have shown that

those projects in which public interest were addressed have been successfully completed in time but in those projects where decisions are made against affected people's voices have faced several socio-political problems and therefore could not complete in time.

According to the Environment protection Regulation (EPR) of Nepal, partially inundated area by the reservoir are only considerd as the project impacted area. Thus, 27 such VDC are only considered for this study. Further, relocating people displaced by the project outside these VDCs enlarges the geographical scope of the project vis a vis project cost. This may also dislocate socio cultural and kith and kin relationship. Therefore to minimize the geographical and economical scope of the project, relocation sites need to be within the geographical boundaries of the PVDCs and the analysis was done accordingly. The research and its output can be of great use for the decision makers to resolve the resettlement issue of the BGHEP and the methodology can also be replicated to other development projects as well.

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CONTACTS

Mr. Khimlal Gautam
Survey Department, Minbhawan Kathmandu
Nepal
Tel. +9779851037556
Email: gautamkhimlal@gmail.com

Annex A: Weightage value for different criteria

Slope (In	Area (Sq.	Rating	Description
< 10^0	175.8218	9	Extreme Suitable
10--20	163.9498	7	High suitable
20-30	123.5332	5	Suitable
>30	49.8446	0	Not Suitable

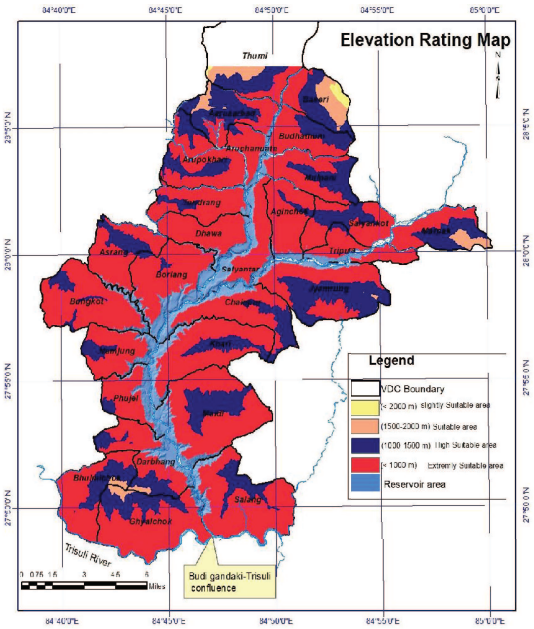
Land cover	Area (km2)	Rating	Description
Agriculture	273.8	7	High suitable
Forest	156.95	5	Slightly suitable
Grassland	8.80	9	Extremely suitable
Shrubland	66.18	7	High suitable
Bare area	0.12	8	Highly Suitable
Water body	4.83	0	Not suitable
Cliff		0	Not suitable

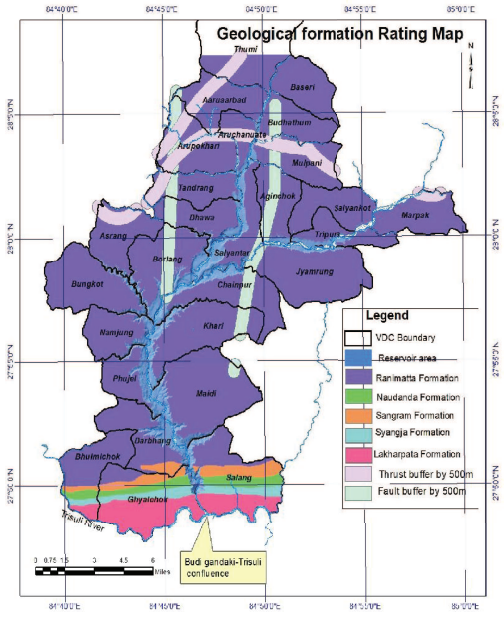
Aspect	Value	Suitability
North	5	Slightly suitable
North-east	6	Suitable
East	8	Highly suitable
South-East	7	High suitable
South	8.5	Highly suitable
South-Wast	6	
West	5	Slightly suitable
North-West	5.5	Slightly suitable
Flat	9	Extremely suitable

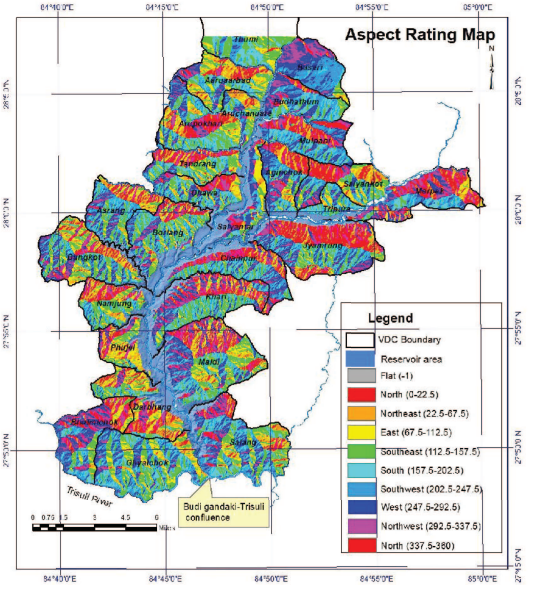
Geological Formation	Value	Description of lithology
Lakharpata Formation	7	Grey shales with intercalation of
Naudanda Formation	6.5	White massive quartzites and shales
Ranimatta Formation	9	Phylites, Quartzites, Metasandstone and
Sangram Formation	6	Green shales, limestones and quartzite
Syangja Formation	5	White pale orange pinkish or purplish calcareous quartzite's and quartzitic limestone's intercalated with dark grey purple and green shales strongly ripply marked quartzite at the base

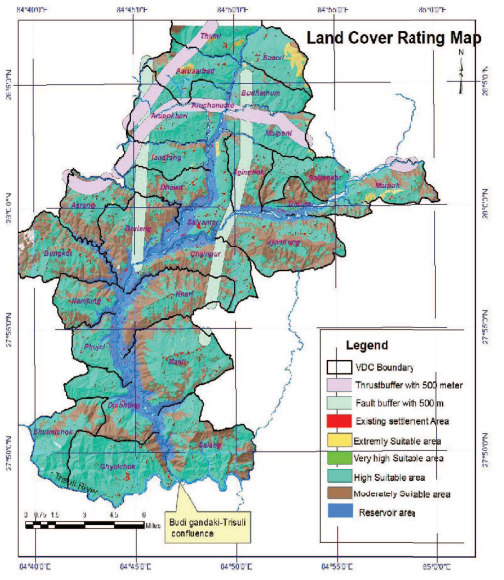
Elevation range	Value	Occupied Area (Sq.Km.)
< 1000 m	9	369.82
1000-1500	8	127.73
1500-2000	6	14.03
2000-2500	5	1.56

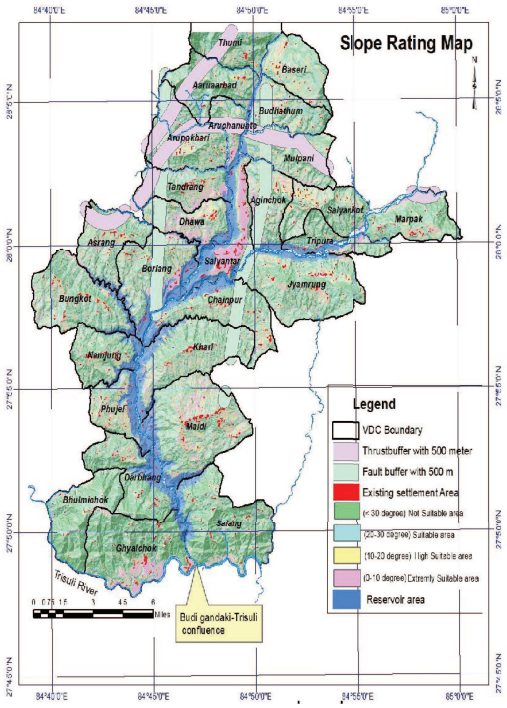
Annex 2: Rating maps for different criteria.

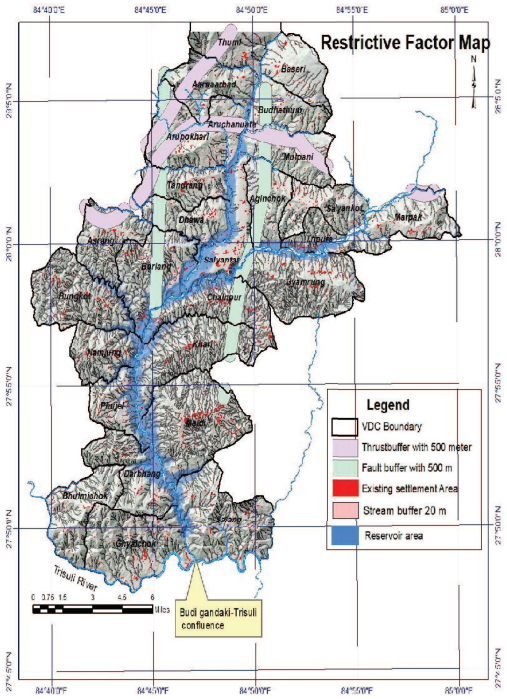









Slope Rating Map
Legend
VDC Boundary
Thrustbuffer with 500 meter
Fault buffer with 500 m
Existing settlement Area
(< 30 degree) Not Suitable area
(20-30 degree) Suitable area
(10-20 degree) High Suitable area
(0-10 degree) Extremly Suitable area
Reservoir area
Budi gandaki-Trisuli confluence
Trisuli River


Restrictive Factor Map
Legend
VDC Boundary
Thrustbuffer with 500 meter
Fault buffer with 500 m
Existing settlement Area
Stream buffer 20 m
Reservoir area
Budi gandaki-Trisuli confluence
Trisuli River