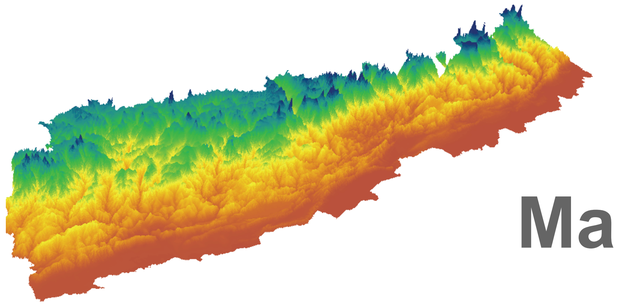
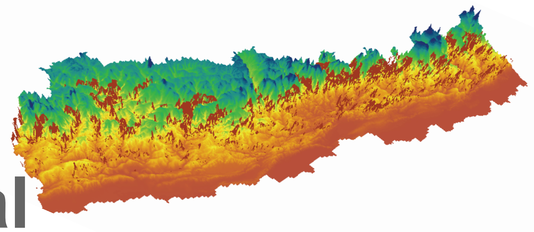


Power to the People

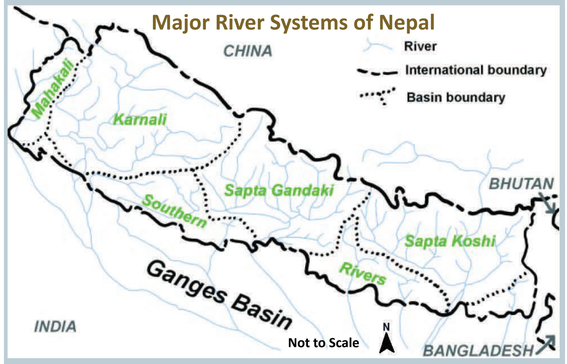
Mapping Hydropower Suitability in Nepal



Hydropower in Nepal

Table 1: Major River Basins of Nepal and their Hydropower Potential

Basin	Amount flow (in billions of m^3)	Catchment Area (in km^2)	Theoretical Potential (in MW)
Sapta Koshi	33	28 140	22 350
Sapta Gandaki	50	31 600	20 650
Karnali	42	41 890	32 010
Mahakali	7	5 410	4 160
Southern Rivers	42	40 141	4 110
Total	174	147 181	83 280



This project aims to map the areas in Nepal suitable for the construction of hydropower plants. It encompasses power plants of all sizes (from the micro-hydro plants that generate a few hundred Kilowatts to mega plants generating several thousand Megawatts) and of different basic designs (run-of-the river and dams). It will identify the most important variables for the construction of a hydropower plant, map them, and analyze the aggregate to ascertain what regions are the most suitable for the construction of such power plants.

Nepal has an estimated theoretical hydropower potential of 83,000 Megawatts (and economically feasible potential of 40,000 Megawatts), of which only 600 Megawatts have been developed. Its demand for energy due to urban growth has far outstripped the supply, and it faces daily power-cuts for up to sixteen hours every Winter. Only 40 percent of the Nepali population has access to electricity.

Even though Nepal has the world's second-largest per –capita hydropower potential, less than one percent of that potential has been realized

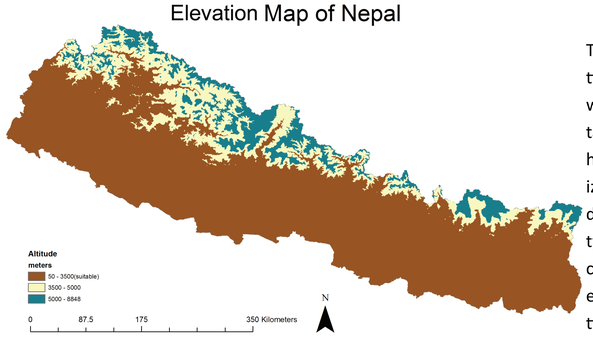
Despite its hydropower potential, Nepal has less than five percent of its energy needs met by electricity. Nepal is mostly a rural agricultural country, and that is reflected in it's energy pattern — over sixty percent of energy comes from burning wood, twenty percent from animal and agricultural waste, and about ten percent from imported fossil fuel. With growing urbanization, the dependency on electricity has been growing tremendously, and is bound to grow for the foreseeable future. Nepal needs a lot more hydropower plants to meet its demands.

Nepal's steep mountains and the rivers flowing through them give it its advantage for hydroelectricity generation. Therefore, for this analysis, the slope of the land near a river was given the greatest weightage in the suitability calculations. However, hydroelectric power plants are not constructed above 4000m above sea level, rarely above 3000m, because of high construction, maintenance and environmental costs. That lead to an elimination of a significant area, since a large portion of Northern Nepal is at a high altitude in addition to being quite steep. Land between 3500m to 4000m was given lower priority over land at lower altitude for the same reason.

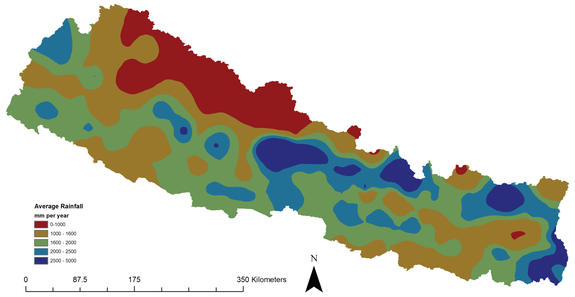
To make the analysis more realistic, buffers were created around rivers at 1km, 5km, 10km and 20km, with closer buffers being weighted heavier. Tunnels up to several kilometers long have been constructed in Nepal for hydropower generation.

Nepal has two kinds of hydropower stations based on how they operate: run-of-the-river stations, and those with dams. Hydropower stations with dams generate more electricity, and can store water during the monsoon for the dry season, but are not environmentally friendly and usually involve displacing nearby human settlements. Run-of-the-river stations run on rainwater and water from glaciers, and have no dams. They do not store water, so produce little or no electricity during the dry season, but are environmentally friendly and do not require human displacement. In both type of stations, rain plays an important part in replenishing the water, and allowing for greater production of electricity. Therefore, places that received greater rainfall are considered more valuable over drier regions.

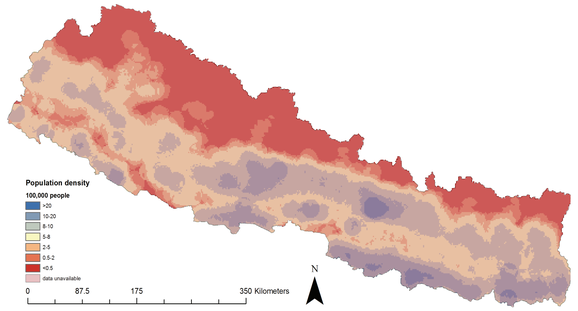
Elevation Map of Nepal



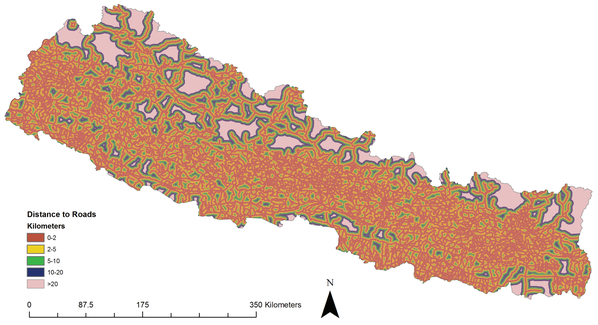
Annual Mean Precipitation in Nepal



Population Density of Nepal



Distance to nearby Roads: Nepal



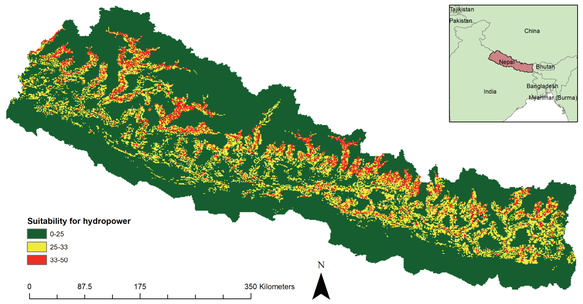
The environmental and population aspects of the power plants were also considered. The distance between power plants and human settlements was maximized and areas with low human density were given greater priority. Moreover, regions that were close to, or parts of, protected areas (such as watershed conservation areas, national parks or reserves) were considered to be less suitable than other regions.

Hydropower stations tend to have a significant construction footprint, so a hydropower's distance from nearby road would have a significant impact on how it affects its surroundings. A hydropower station built far from nearby roads and/or near human settlements or natural environments was assumed to have more significant adverse socioeconomic and environmental impact than that constructed nearby to an existing road network. A power plant's proximity to an existing road network was included as a factor for consideration, and so was the proximity to electrical transmission lines.

Soil types of different regions were also factored into the modeling. The soil-type of a given location influences the kind of construction and civil work that needs to done, which directly corresponds to the costs (both environmental and economic) of a project, and thus the suitability of a given project. Areas with more suitable soil were given more points as compared with areas that had less suitable soil for the construction of power plants.

Conclusion

Suitability Analysis for Hydropower in Nepal



As is clear from the final map above, Nepal has incredible unrealized potential in hydropower. There are clusters of high -density regions very suitable for hydroelectric plants in the Eastern, Central, Mid-Western, and Far Western Regions. While the red regions at the southern part of the country are a surprise, since they would be in mid-hills or the southern plains, they represent areas with very high gradient of altitude, and would be useful for micro-hydro projects, and make up for the lack of relative abundance of clusters of regions of high suitability regions as in the northern and western parts.

Nepal's hydropower assets are concentrated in four clusters: East, Center, Mid-West, and Far West, and they potentially hold the key to Nepal's growth.

Considering the internal growth in demand and its total potential, it becomes obvious that Nepal is well-poised to become an exporter of hydroelectricity, were the facilities properly developed. It must also be noted that the far eastern and the far western parts are especially suited for electricity exports, with greater hydropower potential, and their proximity to both India and China, who have both a growing appetite for energy. Therefore, if the government made policies with the clustering of energy-clustering in mind, it could make big economic gains through the internal utilization, and sale of hydroelectricity.

DATA SOURCES:

Hydropower in Nepal — Chart and Map: http://lib.icimod.org/record/10707/files/5951.pdf , Shaligram Pokharel, Nanyang Technological University, Singapore, 2007

Soil Classifications Data:

- http://tinyurl.com/d2agr7o
- http://nesoil.com/plymouth/classification.htm
- http://nagaland.nic.in/functionaries/department/agri/soil/survey.htm

Last modified 2004

Maps: *www.icimod.org* , "International Centre for Integrated Mountain Development (ICIMOD)", 2010

Map produced by Shirish Pokharel

December 17, 2012

Projection: WGS_1984