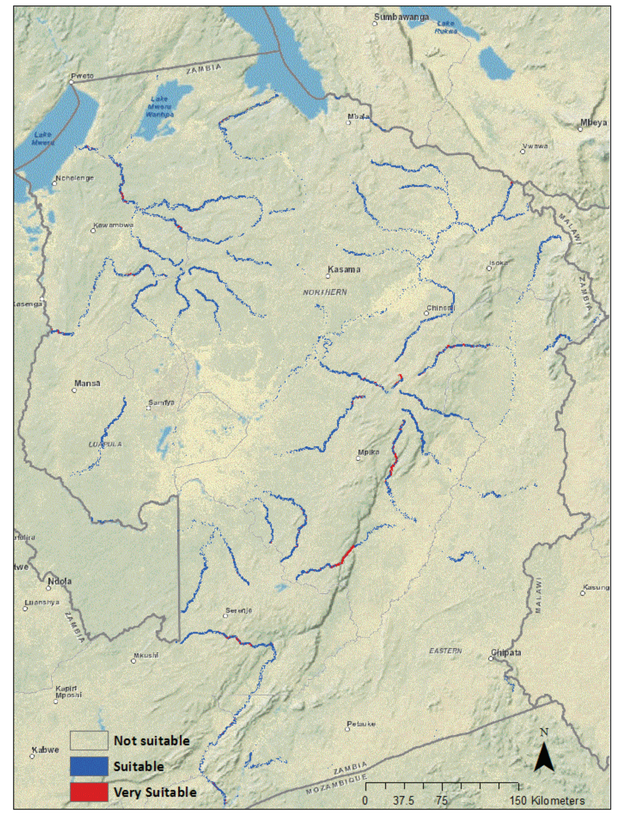
Mini-hydro power siting: a suitability study of hydropower in Northern Zambia

Project Description

The project investigates if there are suitable places to build mini-hydro power plants in Northern Zambia. There are two basic reasons why this question is a relevant one for Zambia. The first reason is that Zambia suffers from chronic power outages and enjoys one of the lowest rates of access and consumption of electricity in the world. Local authorities in 2008 reported that only 22% of the population had access to electricity (49% of the urban population and only 3% in rural areas) with a per capita consumption of 600 kWh per year. Just as terms of comparison China has a per capita consumption of 2,600 kWh and Switzerland around 8,000 kWh. The second reason is that Zambia has a tremendous endowment of water resources that can be used to significantly increase the electric power capacity of the country.

This project has decided to focus on a particular region of Zambia: North/ North-East region. There are two practical reasons guiding this choice. The first one is that the region has significant hydro potential. This reason which we postulated as a hypothesis in our project is substantiated by our project's findings. The second reason is that the region is far away from the major sources of electric power. The result is that the Northern region has one of the lowest electricity consumption rates in the country and suffers from chronic under-supply of electricity.

Mini-hydro Siting



Methodology

The analysis was conducted by essentially creating rater data with the key variables for mini-hydro projects. The most important variable is of course hydro power potential. The basic formula for hydro power capacity is the product of energy efficiency of the turbine (η) times the flow of water (expressed as m3/s) times the head (height difference). Therefore, in our analysis the focus should be on major rivers (flow) and on areas with high slope inclination (major height difference). The next most important factor is proximity to the electrical grid. Connecting a remote mini-hydro power plant to a distant grid absorbs many financial and planning resources. Land cover is a relevant factor, but less important compared to the previous two. As long as the mini-hydro (which by definition is run-off-the-river) is not built in a dense forest then there should not be major operational difficulties for construction works. Finally, in Zambia where population density is minimal and economic activity still anchored to farming, proximity to population density is less important and proximity to the grid becomes even more important as the majority of Zambia's customers for electricity are public facilities and manufacturing businesses.

Summary of Results

According to our analysis there are in Northern Zambia, **6,723 Squared Kilometers of suitable areas for mini-hydro projects.** We define "suitable areas" as areas with *on average* a slope inclination of more than 1.5% a distance from utility lines which is less than 100 kilometers, proximity to areas with more than 500 inhabitants per square kilometer with either woody or pasture land cover. We also found **333 Squared Kilometers of very suitable areas for mini-hydro projects.** We define "very suitable" areas as areas with *on average* a slope inclination of more than 8.6% and the remaining parameters the same as for the suitable areas. Both areas are within a radius of one kilometer from the river streams.

Cartographer: Ferrante Benvenuti *Project Date:* 5/8/2012 *Data Sources:* USGS HydroSHEDS (2000), Zambia Utility lines USAID GIST (1997), Global Population Database (2005), land cover GEM GLC (2000) *Projection Coordinate System:*