

SIGNAL COVERAGE MAPPING OF LOCAL RADIOS

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KEYWORDS

Coverage mapping, Transmission station, Radio Mobile, Signal strength

ABSTRACT

FM radio transmission is greatly affected by geography. Nepal faces particular problems in relation to variations in signal reach because of its varying topography. Radio signal coverage mapping indicates service areas of radio communication transmitting stations. The objectives of this study are to map the signal coverage of local radios (Kavre district) and to assess parameters affecting FM signal strength. The primary data were GPS coordinates of FM transmission stations and bearing of antenna. The secondary data regarding frequency of station, transmitter model, transmitter power, antenna model, and height of antenna from ground level were collected from respective FM stations. For elevation data freely available SRTMv3 was used. Combined Cartesian coverage maps for each FM stations were prepared using Radio Mobile software that showed varying signal strength of station in dB μ V/m. The accuracy of the maps through field validation was observed to be 85%. Assessment of parameters affecting FM signal strength concluded that increase in antenna elevation, gain of antenna and power of transmitter increases the signal coverage.

1 INTRODUCTION

Coverage maps are designed to indicate service areas of transmitting stations within which the user can expect to obtain good reception using standard equipment under normal operating conditions. Typically these may be produced for radio or television station, for mobile telephones networks and for satellite networks. Radio signal coverage map shows the field signal intensity of broadcast radio signals by the FM transmission components taking into account topography, frequency, antenna and its height above ground.

FM radio transmission is greatly affected by geography. Nepal faces particular problems in relation to variations in signal reach because of

its varying topography. FM radio stations being the most prevalent form of mass communication in Nepal, it is necessary to ensure the reach of radio signals to every household. Considering this, radio signal coverage mapping was carried out in Nepal in 2006-2007 AD for the first time by Equal Access Nepal. On the basis of data provided by Ministry of Information and Communications (updated till 2073/10/20 B.S), there are 700 FM stations in Nepal.

2 OBJECTIVE

The objectives of this study are to map the signal coverage of local radios and to assess parameters affecting FM signal strength.

The growing FM stations everyday have increased the demand of signal coverage maps as they are extremely useful for them. These maps can assist the radio broadcasters to analyze their current signal reach and also in planning for new radio station, providing assistance in document submission process to government or related media organization.

3 STUDY AREA

This project deals with the signal coverage mapping of local radios of Kavrepalanchok district. It includes mapping of six stations namely:

1. Grace FM 107.6 MHz
2. Madhyapurva FM 104 MHz
3. Namobuddha FM 106.7 MHz
4. Prime FM 104.5 MHz
5. Radio ABC 89.8 MHz
6. Radio Shepherd 88.4 MHz

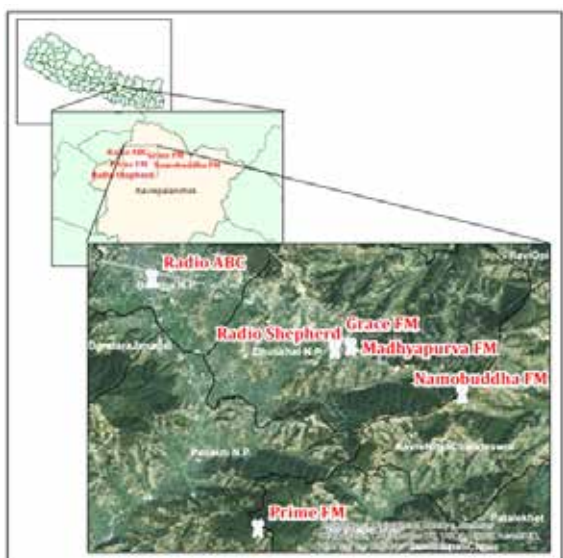


Figure 1: Study area

4 METHODOLOGY

4.1 Data Collection

The primary data for the study includes GPS coordinates of transmitting tower and bearing of antenna. A technical datasheet was prepared to collect the secondary data from each FM station. It includes radio station details (station name, frequency), radio transmitter details (transmitter power, model), and antenna details (antenna height, model). Along with these, antenna

gain was obtained from **manufacturer's specification list**. For elevation data, SRTMv3 (*version 3*) of accuracy 90m was downloaded from USGS website.

4.2 Mapping

Radio Mobile computer program, a free software written and maintained by Roger Coudé, is used for this study to map the coverage of FM stations. It is a radio propagation simulation program which operates over the frequency range of 20MHz to 20GHz. It uses Longley-Rice Propagation Model and follows the radio signal mapping recommendations made by International Telecommunications Union – Radio Communications (ITU-R). The Longley-Rice model, which is based on electromagnetic theory and on statistical analyses of both terrain features and radio measurements, predicts the median attenuation of a radio signal as a function of distance and the variability of the signal in time and in space (Longley and Rice, 1968). All radio coverage is based on probability theory. Radio coverage is affected by weather and atmospheric conditions on a continual basis (Henderson B. J., 2011). Study of atmospheric effect on these signal coverage is beyond the scope of this project.

For mapping signal coverage, primary and secondary data were given as input in the software. Two units namely FM station whose coverage is to be prepared and Mobile, the receiver were defined. The path to the SRTM data was defined to extract the elevation map for the area of interest taking the location of transmitting tower as the centre. The colored elevation map extracted was changed to grayscale so that the coverage plot when overlaid can show the colors defining signal levels clearly. After this, pixel resolution for the output map was defined to align with the resolution of elevation data used. Combined Cartesian coverage plots were generated one at a time for all stations that uses an X-Y rectangular method of calculating coverage. Apart from the plots, a kml layer showing the coverage is also generated which can be visualized in Google Earth. The prepared coverage plots were mapped in a GIS environment by georeferencing and transforming to WGS 1984 Universal Transverse Mercator Zone 45N.

4.3 Validation of Coverage Maps

Value	Interpretation
4	Perfectly clear, no station-specific noise
3	Noticeable noise a minority of the time
2	Consistent noise, but still understandable
1	Hard to understand
0	No Signal

Table 1: Evaluation table for validation at field

In order to check the accuracy of the coverage maps of FM stations, field validation was carried out with respect to map information. Multiple ring buffers at distance of 2 km were created each using location of transmitting tower as a centre point. At every circle, some accessible places were selected and visited to evaluate signal quality by using a mobile phone. The coordinates of selected places were also obtained using GPS and then plotted in the coverage map. The evaluation of radio signal was done by analyzing its quality as shown in table 1.

4.4 Assessment of Parameters Affecting FM Signal Strength

An assessment of the parameters that affect the strength or power of the radio signals was performed. For FM stations the signal strength is determined by height of antenna location, antenna gain and power of transmitter.

5 RESULT AND DISCUSSION

5.1 Radio Signal Coverage Map of Radio Stations

Combined Cartesian coverage maps for each FM stations are produced from the software. The coverage is shown using multiple colours referred to as "rainbow" where varying colours represent various signal levels in dB μ V/m. The coverage area displayed in red colour indicates highest signal strength (near the transmitting tower) and that displayed in blue color indicates least signal strength. The arrow in the maps shows antenna direction of transmitting tower. Coverage maps for each FM stations are shown in figure 5.

5.2 Result of Validation

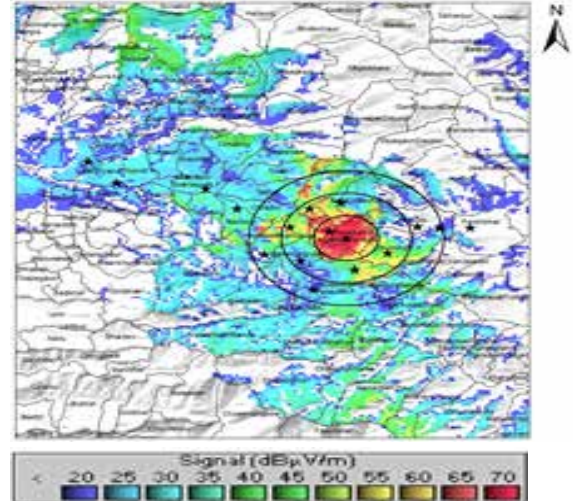


Figure 2: GPS location of selected points overlaid on coverage map for field validation.

The field validation of the coverage maps was carried out for two FM stations namely Grace FM and Radio ABC. The interpretation made in field based on evaluation table for each point was visually compared with the signal strength shown in maps. Based on our samples, the overall accuracy of coverage map was observed to be 85%.

5.3 Assessment Result

5.3.1 Height of Antenna Location

Among 7 FM stations, Radio ABC has the least height, so in spite of having the highest transmitter power i.e., 500 watt, the coverage of this FM is the least.

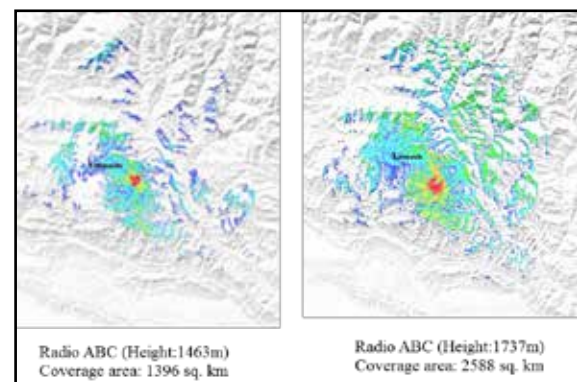


Figure 3: Comparison of antenna elevation

As shown in the figure 3, with the increase in height of transmitter station, the signal coverage also increases.

5.3.2 Antenna Gain

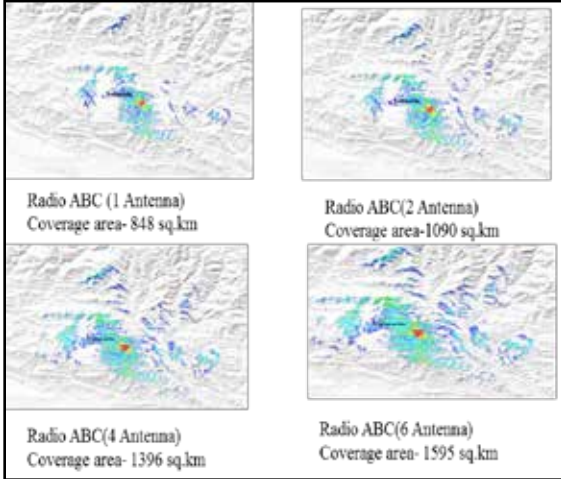
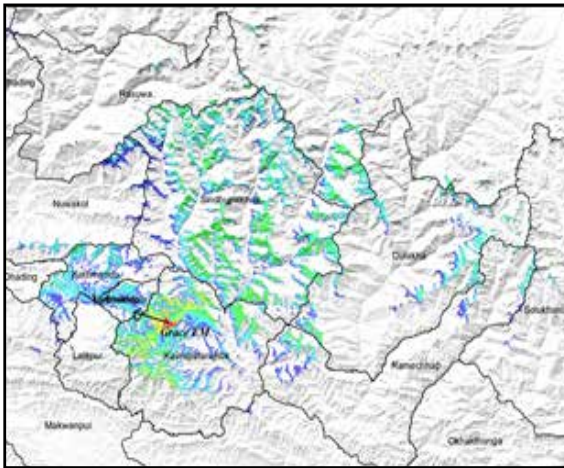
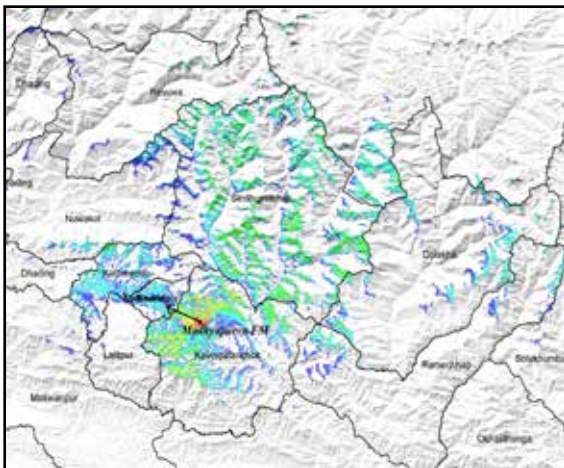


Figure 4: Comparison of antenna gain

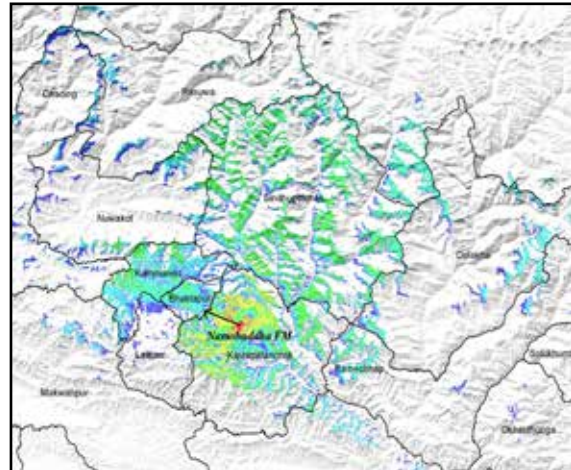
Grace FM



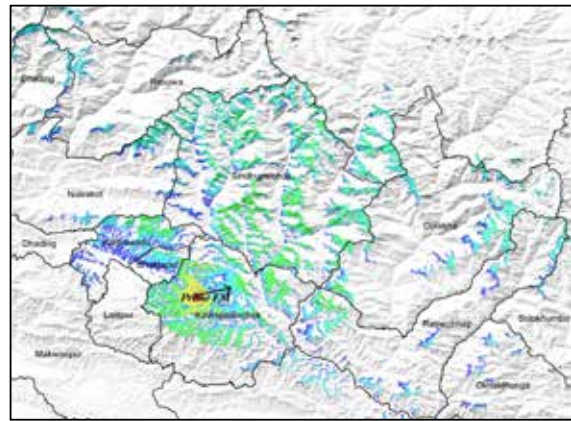
Madhyapurva FM



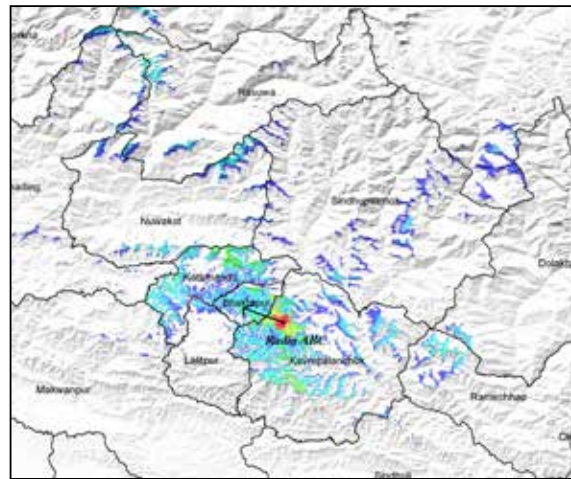
Namobuddha FM



Prime FM



Radio ABC



Radio Shepherd

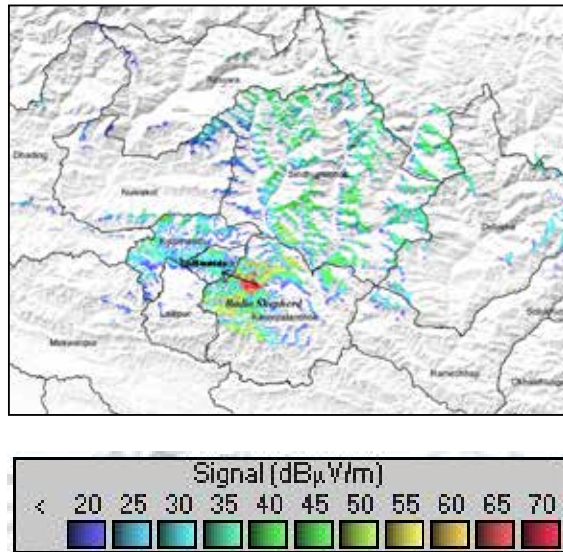


Figure 5: Coverage maps

Figure 4 shows that signal coverage area increases with the increase in antenna gain (considering other parameters constant). Increase in antenna gain increases signal transmission distance. However, as the antenna gain is increased, the signals get focused to one particular direction and therefore multiple antennas are required to set up to spread the signals in all directions.

Based on the output maps, Radio Shepherd, having transmitter power 50 watt, has coverage similar to other radio stations with 100 watt. This is because it has 6 antennas which results in more gain, unlike other stations which have 4 antennas. This also shows gain of transmission antenna is one of the major factors in determining the transmission capacity of the radio station.

5.3.3 Power of transmitter

The power of the transmitter is generally used to explain the broadcasting capacity of the radio station. The higher the power, higher is the signal strength. As shown in figure 6, keeping other parameters constant, coverage area increases with the increase in transmitter power.

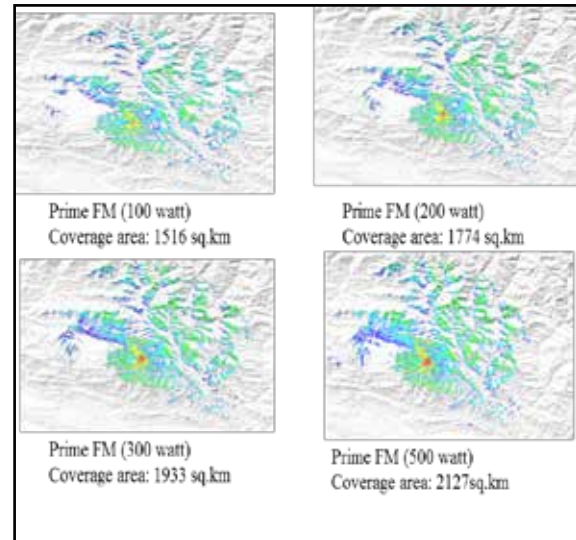


Figure 6: Comparison of transmitter power

6 Conclusion

The radio signal coverage mapping was done successfully with Radio Mobile software with the accuracy of 85% obtained through field verification. This shows that the software 'Radio Mobile' is applicable in our context. From above mentioned assessment, increasing the height of transmitter is found to be an effective way of increasing the coverage area of a particular FM station. So, it is better to set up transmission antenna at the highest point available in the locality. If possible, the antenna should be constructed at the top of a nearby hill or a high building. Also, increasing the power of transmitter in coordination with number of antenna can be another means to have maximum coverage. Such coverage maps help the radio broadcasters to take decisions regarding their need to increase signal reach and ensure sustainability.

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