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Poland (Republic of)

**ANALYSIS OF THE DIGITAL ELEVATION MAP (DEM) PARAMETRIZATION
 ON THE RECOMMENDATION ITU-R P.1546-5
 PROPAGATION MODEL RESULTS**

1 Introduction

As Recommendation ITU-R P.1546-5 does not provide any information concerning accuracy of the digital elevation map (DEM) and taking into account the important role of DEM during the process of calculation of the electric field strength over an area we conducted a detail study to scrutinise the DEM parametrization dependence on computed values. For our study the GUGIK NMPT DEM was used. This digital map was created by Polish Head Office of Geodesy and Cartography and has got a bare spatial resolution 0.5 or 1 m with average error height equals 0.2 m.

2 The electric field strength distribution calculations

All propagation computation in our case study were conduct with Recommendation ITU-R P.1546-5 for the frequency 216.928 MHz (T-DAB 11A) for two low power DAB+ broadcast stations. The parameters of the stations are presented in Table 1 below. The stations were located in the city of Wroclaw, Poland.

TABLE 1

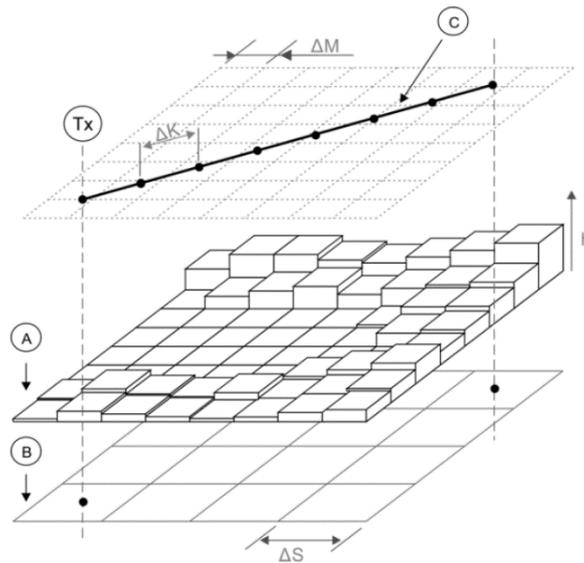
Parameters of the broadcasting stations

Station	Antenna height [m]	Antenna location height [m]	ERP [dBW]	Coordinates	
1	20	116	23,98	51°06'55,19''N	17°06'48,68''E
2	16,6	111	23,98	51°07'37,10''N	17°00'32,97''E

The area of calculation was limited to a 10 km radius. All results are presented in a rectangular grid with a spatial resolution (ΔS) equal to 1". During our analysis the electric field strength simulation based on Recommendation ITU-R P.1546-5 incorporated various DEM parameters a) terrain profile sampling step (ΔK) and b) horizontal resolution of DEM (ΔM). In the Figure 1 the visualization of the above parameters is presented. It is worth to mention that spatial resolution of results and spatial resolution of DEM are treated separately. ΔM and ΔK values have an impact on receiver location height, h_1 , and TCA, which are designated by the Recommendation ITU-R P.1546-5 implementation.

FIGURE 1

Dependence between map layer (A), results layer (B), and terrain profile sampling step (C)



All propagation analyses were conducted for parameters as shown below:

- terrain profile sampling step (ΔK) = { 5 m, 10 m, 20 m, 40 m, 80 m, 160 m, 320 m }
- horizontal resolution of DEM (ΔM) = { 0.2", 0.6", 1", 3" }

As the results were represented by the same rectangular grid ($\Delta S = 1''$) all of them were compared one to another. The most detailed configuration {0.2"/5m} was treated as the reference. Thus, the root mean square error (RMSE) was calculated based on above data. Three scenarios were scrutinized:

- a) Station 1 with reception height at 10 m
- b) Station 1 with reception height at 1.5 m
- c) Station 2 with reception height at 10 m

In the Figures 2-4 outcomes are presented.

FIGURE 2
RMSE for case a).

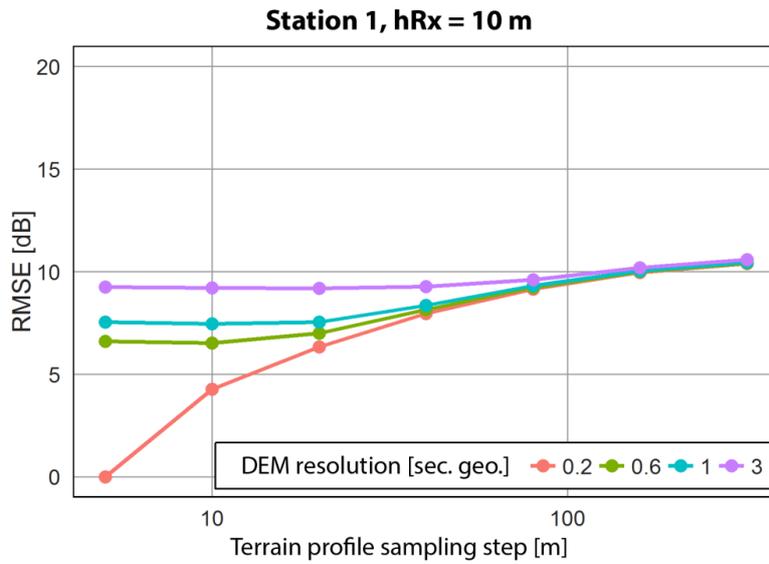


FIGURE 3
RMSE for case b)

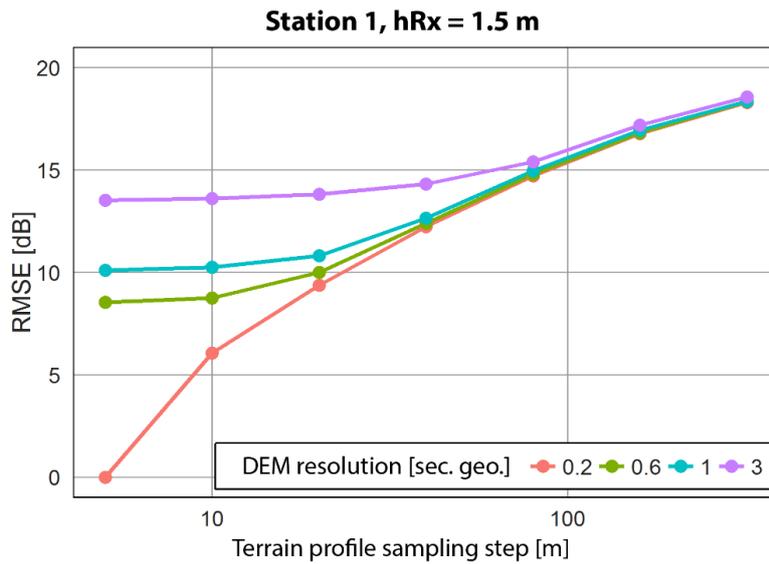
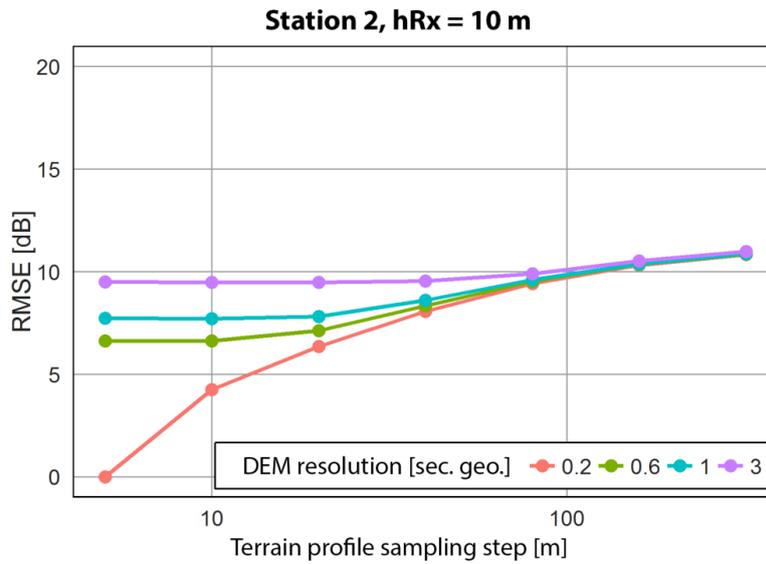
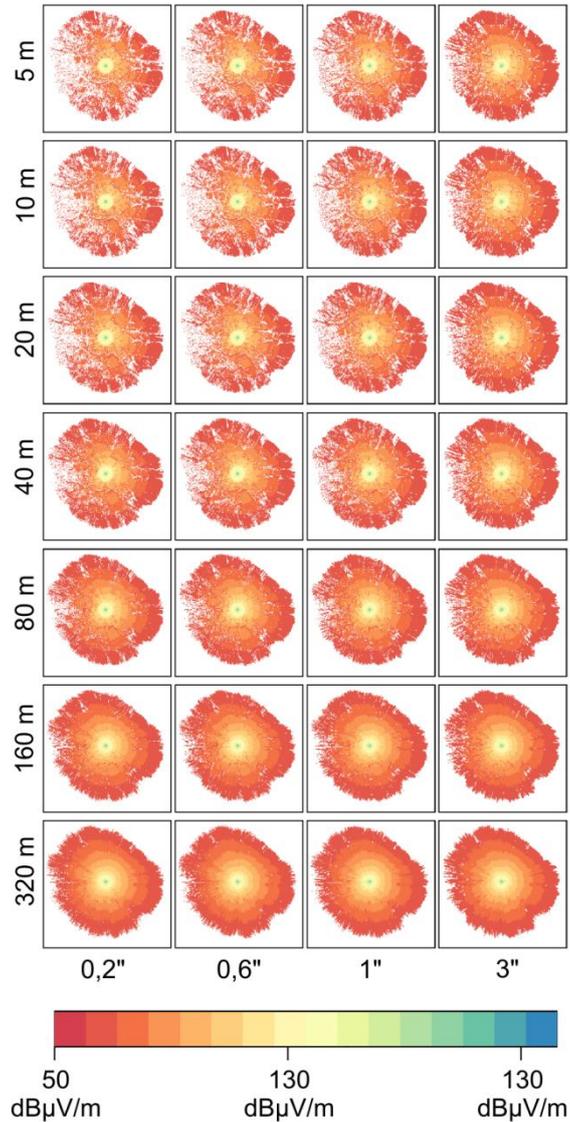


FIGURE 4
RMSE for case c)



The above results show a strong correlation between DEM parametrization and final outcomes of the Recommendation ITU-R P.1546-5 models. Each time when the spatial resolution of the digital map is lower and profile sampling step is higher the RMSE is rising. For instance, the coverage of station 1 for DAB+ mobile reception/95% location for parameter {3"/320 m} is about 50% higher than for {0.2"/5m}. The coverage visualization matrix is presented in Figure 5.

FIGURE 5
The coverage matrix plot (Station 1)



3 Final remarks

Our case study was conducted for a suburban/urban environment for low power DAB+ stations. Thus, we incorporated a very high accuracy digital elevation model for a simulation process. As we proofed in paragraph 2, both electric field strength distribution and station coverage are correlated to the DEM parametrization. Those parameters are not accurately described in Recommendation ITU-R P.1546-5, but have an important role in the calculations. Our study shows the limitation of using very accurate DEM in case of urban areas and will be in future further analyzed and compared with measurement results.