

Radio Astronomy in Turkey: Site selection studies for radio quiet zones

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Site selection studies for a 40 m single-dish Radio Telescope in Turkey were started as a State Planning Organization Project by "Turkey's National Radio Astronomy Observatory Site Selection Committee". The project began on 04 May 2007 and was completed on 31 December 2008. Within this project, meteorological and atmospheric atlases, topographical & earthquake analysis, and Radio Frequency (RF) spectrum measurements were compiled for the whole of Turkey, and then used to analyze and compare potential stations. In this paper, the analysis of spectral measurements, determination of the radio quiet zone and atmospheric, meteorological and topographic studies of new measurement stations are given. This project was executed in cooperation with the Agency of Information & Communication Technologies (BTK), General Directorate of State Meteorology Affairs (DMGM), General Directorate of TÜBİTAK - Space, General Directorate of Disaster Affairs, General Directorate of Mineral Research & Exploration (MTA), General Command of the Map, and Erciyes University of Turkey. The National Radio Astronomy site selection studies have been completed in cooperation with all of these institutions for the first time.

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*Speaker.

1. National Radio Astronomy Observatory

One of the important activities in the technology foresight project of Turkey for 'vision 2023' is the establishment of a national radio astronomy observatory to have a 30-40 m dish antenna. Educational studies have started in Erciyes University for this purpose. A 13 m radio telescope with a 22 m diameter radome and two 5 m radio antennas have been built.

2. Previous Attempts

2.1 Between 1990-1995

The efforts to build a radio telescope in Turkey started first between 1990-1995, with a 2 m radio telescope project, which was nationally funded by TÜBİTAK Marmara Research Center (MRC). The design considerations were jointly for radio astronomical observations and for remote sensing image reception. This telescope was built to work between 85-115 GHz for CO observations of the Milky Way.

2.2 Between 2000-2005

Radio Astronomy is considered to be one of the main research areas in several astronomy and physics departments. Among them, Erciyes University, in Kayseri, which has built two 5 m antennas and a 13 m antenna with a radome: educational radio astronomy was started.

3. Current Situation and Site Selection Studies

Two State Planning Organization (DPT) projects were carried out to establish a national radio astronomy observatory. Site selection studies started in 2008. Analysis has been made in two parts under the headings atmospheric-meteorological, and radio quiet zone. The first steps in the procedure are:

- determination and calculation of required meteorological and atmospheric parameters for the radio observatory [4], [5],
- the historical development of the algorithms used in the analysis,
- creation of the required database for the analysis,
- provide information about analysis methods and tools,
- spatial and temporal review of the meteorological and atmospheric parameters
- preparation of a common selection environment.

In the second step, the procedures:

- examination of radio interference effects for a Radio Astronomy Observatory,
- determination of the methods to be used in the spectral measurements [3],
- analysis of measurement instruments,
- evaluation of measurement results

Table 1: Coordinates and elevations for measurement locations

CITY	PLACE	Y_{DD}	X_{DD}	Z_M
Antalya	Elmalı-Korkuteli	36,9947	30,1556	1142
Antalya	Akçay Ahatlı Köyü	36,6058	30,2950	1118
Antalya	Bozova	37,2353	30,1556	868
Burdur	Yeşilova	37,5689	29,8383	1169
Karaman	Merkez	37,1869	33,2192	1030
Karaman	Yazılı	37,1375	33,0936	1065
Karaman	Akçaşehir	37,4039	33,4936	1108

4. Measurements and Interpretations

We first identified the Burdur, Antalya and Karaman regions for electromagnetic spectrum measurements, as displayed in Figure 1. The Antalya and Burdur regions were both selected to provide atmospheric and meteorological parameters from high mountain zones and for being close to TÜBİTAK National Observatory. Karaman is the region with the lowest seismic risk, taking into account the earthquake zone activity of Turkey. Some examples of the prevailing electromagnetic spectrum are given in Figures 3 - 5 for seven locations identified in these three provinces. Coordinates and elevation information taken with GPS are given in Table 1. Frequency measurements for the range of 0 to 270 degrees polarizations were taken for the horizontal and vertical polarizations using the HL-50 log-periodic antenna [6]. Horizontal and vertical polarizations are provided with park mounting by polarization apparatus that is fitted to a special mast (raising mechanism). Measurements are made over the frequency ranges (span) and bandwidths (RBW) given in Figures 2-6. Reference levels were taken as -22 dBm. Measurements were performed over the spectrum ranges 10 MHz - 1 GHz, 1 - 2 GHz, 2 - 3 GHz, and so on up to 30 GHz with the Omni and HL-50 log-periodic antennas. Identified signal peaks from the frequency scans were examined by increasing the frequency resolution and attempts then made to identify the sources of these transmissions. Interference effects observed during these measurements and their peak frequencies (GSM, TV broadcast, radar, etc.) are captured on the figures. Frequency measurements for the range of 0 to 270 degrees polarizations were taken for the horizontal and vertical polarizations and the HL-50 log-periodic antenna is used [6]. Horizontal and vertical polarizations are provided with park mounting by polarization apparatus that is fitted to a special mast (uprising mechanism). Measurements are made in the frequency range (span) and the bandwidth (RBW) given in Figures 2-6. References were taken as -22 dBm. Identified peaks during the frequency scanning were examined by diminish to frequency ranges and were tried to find these transmission sources. Interference effects determined during these measurements and frequency peaks (GSM, TV broadcast, radar, etc.) were captured on the figures.

References

- [1] J. Cohen, T. Spoelstra, R. Ambrosini, W. van Driel, *CRAF Handbook of Radio Astronomy*, Third Edition, 2005
- [2] Recommendation *ITU-R RA.769-2*, Protection criteria used for radio astronomical measurement, 1992-1995-2003.
- [3] R. Ambrosini, RFI selection criteria for new radio telescopes, *17th International Wroclaw Symposium and Exhibition On Electromagnetic Compatibility*, Wroclaw, June 29-July 1 2004.
- [4] J. E. Simon et al., *Atmospheric Conditions at a Site for Submillimeter Wavelength Astronomy*, NRAO.
- [5] M. A. McHenry, K. Steadman, *Spectrum Occupancy Measurements Location 5 of 6*, NRAO, October 10-11 2004, Revision 3.
- [6] C. Munoz-Tunon et al., *Instrument and Tools for Site Testing, GW3-ESO-Site Evaluation*, February 2006.

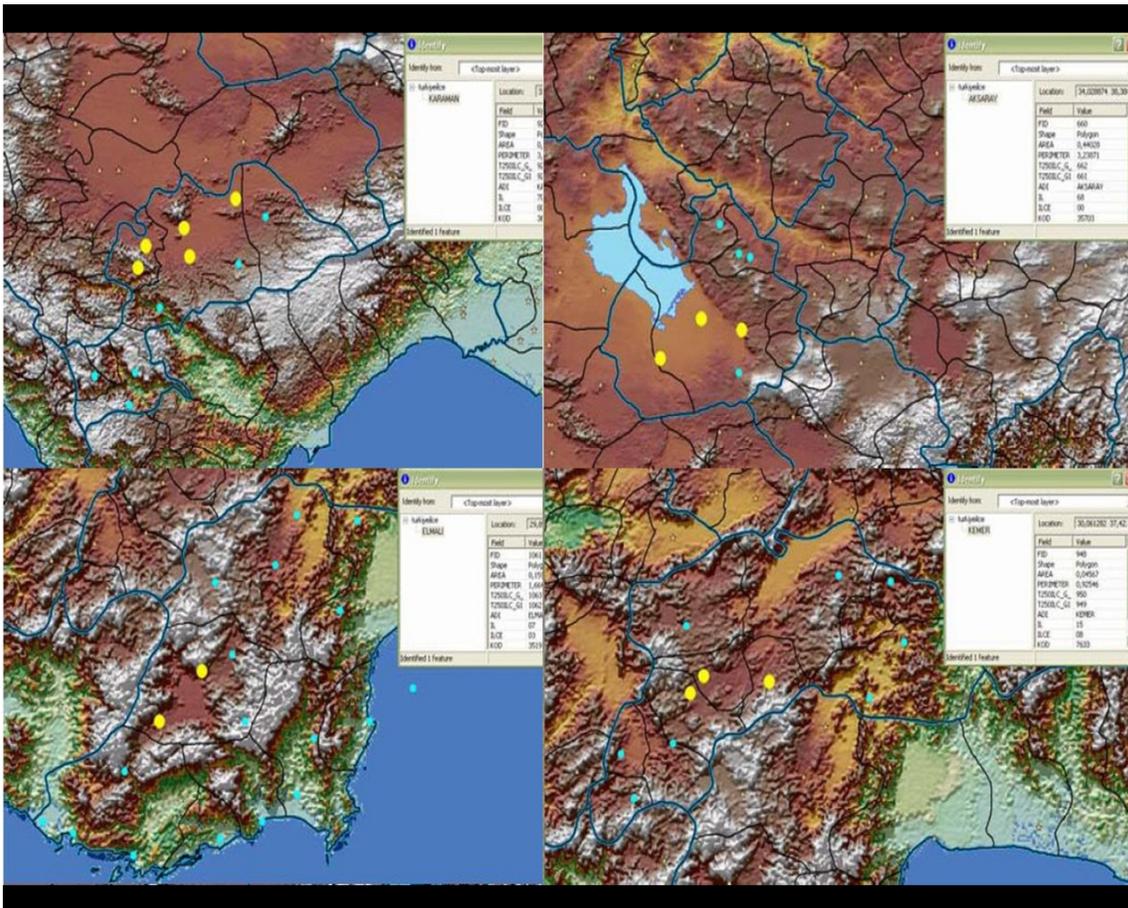


Figure 1: Measurement centers (big open circles) for possible radio quiet zones.

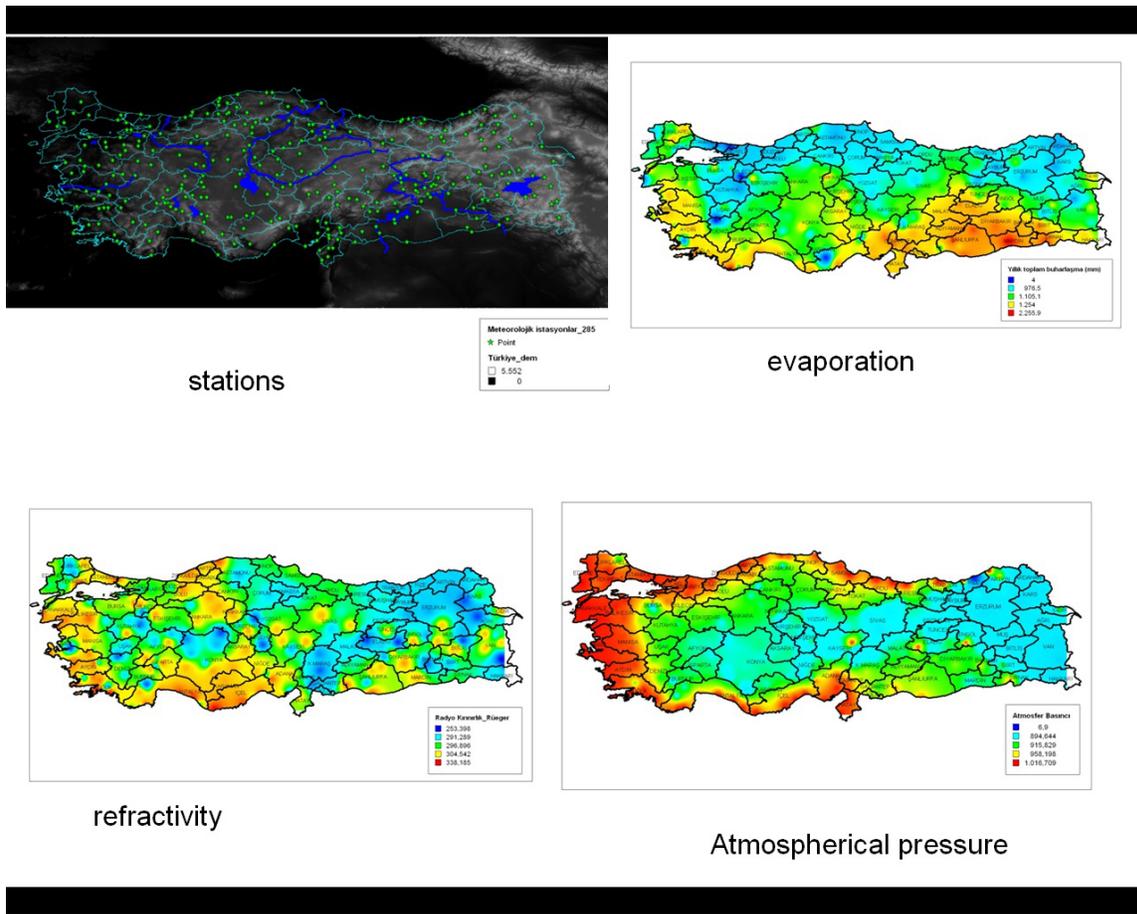
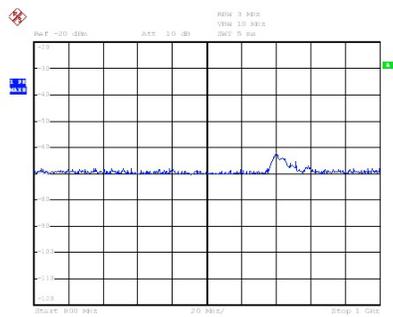


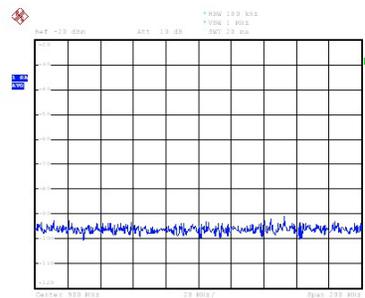
Figure 2: Measurement stations (top left), maps for evaporation (top right), radio refractivity (bottom left), and atmospherical pressure (bottom right).

Measurement samples: below 1GHz



Date: 6.AUG.2008 11:10:02

For 90° polarization
800MHz - 1GHz



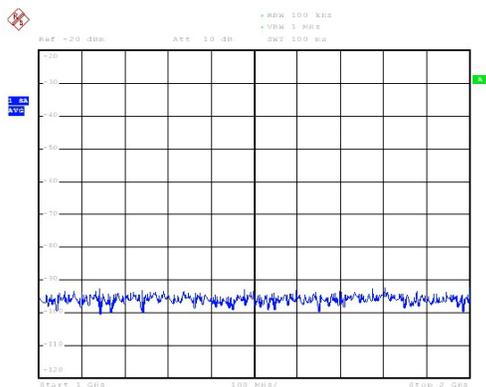
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For 180° polarization
800MHz - 1GHz

Site: KARAMAN - Yazılı

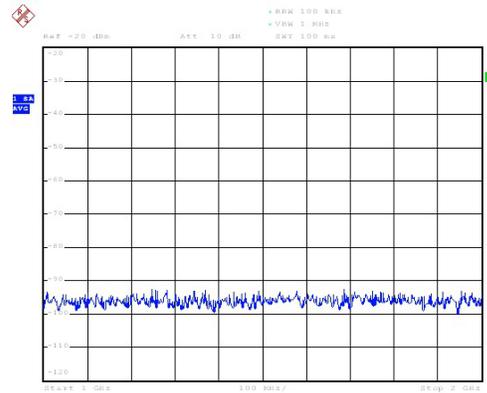
Figure 3: RFI Polarization Measurement samples (below 1GHz) for the candidate Karaman-Yazılı region.

Measurement samples: between 1GHz - 30GHz



Date: 6.AUG.2008 13:04:25

90° polarization
1-2GHz



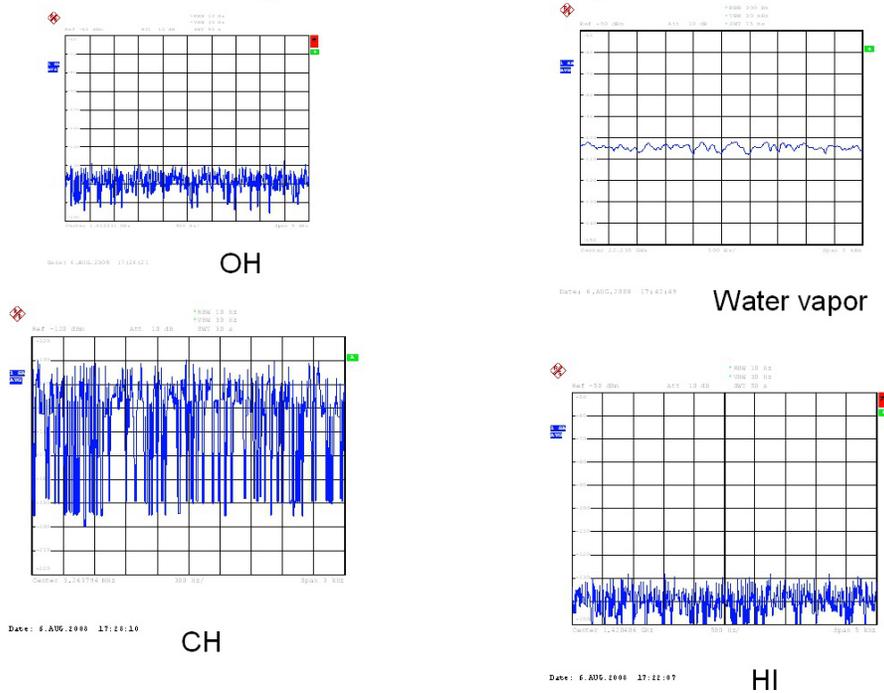
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45° polarization
1-2GHz

Site: KARAMAN - Yazılı

Figure 4: Measurement samples (between 1-30GHz) for the candidate Karaman-Yazılı region.

Special frequencies



Site: KARAMAN - Yazılı

Figure 5: Measurements for OH, Water Vapor, CH and HI [1], [2] for the candidate Karaman-Yazılı region.