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HOW TO DEAL WITH RADIO ASTRONOMY INTERFERENCE

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ABSTRACT

Radio sources are very weak, as they can travel through large distances. Radio sources also have photons with low energies compared to others electromagnetic waves (EM). Microwave photons have a little more energy than radio waves, infrared photons have still more, then visible, ultraviolet, X-rays, and the most energetic electromagnetic wave is gamma-rays. Radio astronomy studies are restricted due to radio frequency interference (RFI) produced by people. If this disturbance is not minimized, it poses critical problems for astrophysical studies. The purpose of this paper is to profile RFI maps in Peninsular Malaysia with a minimum mapping technique for RFI interference. Decision-making processes using GIS (Geographical Information System) for the selection requires gathering information for a variety of parameters. These factors affecting the selection process are also taken into account. In this study, various factors or parameters are involved, such as the availability of telecommunications transmission (including radio and television), rainfall, water lines and human activity. This mapping step must be followed by RFI site testing in order to identify areas of low RFI. This study will benefit radio astronomy research, especially regarding the RFI profile.

Key words: Radio Astronomy, Radio Frequency Interference (RFI), and RFI mapping technique: GIS.

1. SPECTRUM MANAGEMENT

Almost 100 are satellites launched per year, there are always new gadgets and the applications of electronic equipment is growing exponentially. If we can control or reduce electromagnetic smog, this would help. However, this is impossible because money is a priority to the world today.

What can be done by members of the astronomy union is to provide education and awareness on the importance of astronomy studies to the world. As we know, only 2% of the sub 50 GHz radio frequencies are allocated to radio astronomy research and activity. The rest of the spectrum has been allocated for other purposes, such as telecommunication, radio and TV transmission, and many more, which sometimes interfere with radio astronomical observations. However, we are appreciative to the international union for sparing the hydrogen lines (HI) frequency for radio astronomy study and that this remains protected for astronomers to further study this spectrum and the Universe (Abidin et al., 2009, 2010, 2013).

2. SITE SELECTION

The chosen site for a radio astronomy observatory is very important in order to find a site with a low level of RFI (Abidin et al., 2010). The aim of this project is to produce a predicted map illustrating the profile of RFI in peninsular Malaysia using GIS techniques. This may also benefit the selection of the best possible candidate for radio astronomical observation sites. The study was implemented in Peninsula of Malaysia, which is expected to be suitable for an astronomical observatory site with appropriate climate properties and weather conditions. Eleven factors were considered, split into two categories; geographical factors and anthropogenic factors. The geographical factors which have been taken into account are:

1. Slope of the hill
2. Rainfall
3. River

The anthropogenic factors, which also means human made RFI, are the biggest contributors of interference sources. They are:

1. Population density
2. Road network
3. Land use (e.g: commercial, plantation, industry

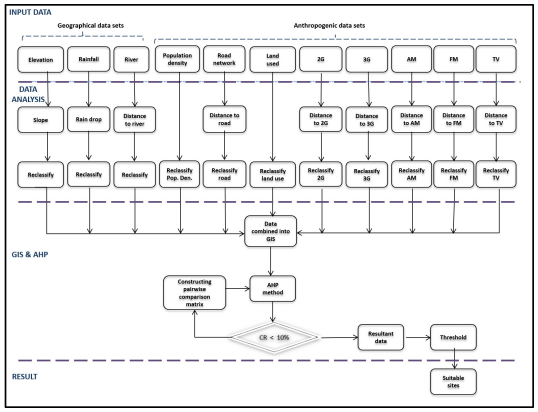

Figure 1. The process of MCDA integrated with GIS.

etc.)

4. Second-generation of mobile communication (2G)
5. Third-generation of mobile communication (3G)
6. Amplitude modulation (AM) radio
7. Frequency modulation (FM) radio
8. Television (TV) transmitters

2.1. GIS

There are many way to mitigate an RFI. In this paper we would like to propose that astronomers use RFI mapping techniques using GIS. A GIS is a decision aiding tool that can be applied in many ways to many problems. We can list some potential applications, such as: transportation, political activities, water resources, the environment, security and public lighting. GIS is an automatic system that merges data from various sources. It collects, organizes, stores, manages, analyzes and visualizes localized geographically information.

2.2. Multi-Criteria Decision Analysis (MCDA)

Multi-criteria decision analysis (MCDA) is a popular and useful technique that explicitly considers multiple criteria in decision-making environments. If one needs to make a choice which deals with multiple conflicting criteria, one has to consider factors that may influence or affect the final result. One also needs to evaluate the influence of various activities and then the corresponding attributes or indicators are identified to fulfil a given objective. The indicators are often defined based on scores achieved, ranks and weighting. This method is capable of supporting decision makers facing such problems.

In this study, the MCDA technique is the best, well known structured approach to be used. As a result, the regions over peninsular Malaysia will be ranked from the lowest RFI (the best site) to the highest RFI (the most inappropriate place to consider for the location of radio telescope).

The next step is RFI mapping, in which we will produce a final RFI map.

3. RFI MAPPING TECHNIQUE

Finally, after the RFI observations for all parameters were done, a set of accurate threshold values of the factors were determined. All of these value were then used in RFI profiling to produce the RFI map of peninsular Malaysia. It was then compared with the predicted map produced earlier. The process of mapping was performed once again using MCDA techniques intergrated with GIS to form layers for each parameter and then combined together to obtain the actual RFI map. The AHP approach was also used in this stage to gain the weightings of the parameter.

This technique helps to find and monitor spectral occupancy, and to identify and recognize the most intense sources of interference, particularly from terrestrial transmitters.

Eleven factors are identified to determined the effects of radio signals, and have been used to create a reference map. However only four factors were observed to obtain real values.

4. CONCLUSIONS

It is very important to select a site with very low RFI in radio astronomy observations (Umar et al., 2013). This study was implemented in Peninsular of Malaysia, which is convenient for astronomical site observatory facilities with its appropriate climate properties and weather conditions. Eleven factors (slope, rainfall, river, population density, road networks, land use, 2G or second-generation wireless telephone technology, third-generation (3G) wireless technology, amplitude modulation (AM), frequency modulation (FM) and television (TV) transmitters) were identified and split into two categories; anthropogenic factors and geographical factors. The site selection study is the most crucial part for decision makers to propose where to build an astronomical observatory, especially in radio astronomy, with a maximum efficiency.

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