The strategy for establishing one or more radio-quiet reserves in Western Australia

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Summary

The Western Australian Government in association with the ATNF has developed strategies to set aside protected areas for conservation and observational scientific uses, including the establishment of one or more radio-quiet reserves. Several potential areas have already been identified for detailed study and over the next year or so, further areas are expected to be identified. To assist in quantifying the quality of possible sites, high sensitivity measurements of the spectrum are currently being planned for the next two years. To assist in this program, preliminary estimates of the desired electromagnetic ambient noise level across a significant proportion of the spectrum have been made.

1. General strategy and implications

Following the early interest of the Western Australian State Government in the Square Kilometre Array (SKA), investigation of areas within the Gascoyne - Mid West region of the State have shown that there are a number of sites which could be established and set aside by the State for compatible conservation and observational scientific uses, including their designation and protection as radio-quiet reserves (See Fig. 1). One or more such sites could be proposed for the central site of the SKA in 2005, when a decision is expected to be made by the International SKA Steering Committee.

Fig.1: Western Australia showing the search area (550 x 250 km) in the Gascoyne - Mid West region for the compatible conservation and radio - quiet reserves.

The region is characterised by large leasehold properties, each being about 50 x 40 km in area. Except for grazing the region has very little other economic activity, although there are some areas which have active mines (mainly gold). There are several optic-fibre links and gas pipelines through the region, thus providing communication and power for significant undertakings. Communications to the station homesteads is via VHF and UHF fixed links. However, the very low population densities ensure that most radio communications is restricted to just three or four bands, leaving significant useable spectrum with a very low electromagnetic em ambient noise-level. Fig. 3 shows the location of the radio communication transmitting services for a 400 x 400-km area centred near Waldburg homestead. (The more dense regions to the north are at the town of Paraburdoo, and to the south-east at several gold mining centres).

It is fortuitous that the WA State and Commonwealth Governments are funding, over a six-year period, an extensive purchase of leases, which are considered marginal for grazing, and which would be suitable for expanding the WA Government Conservation Reserve System. The scheme has about two years to run. The WA Department of Minerals and Energy is currently evaluating a number of such leases for mineral and/or petroleum prospectivity. For designation of a radio-quiet reserve, the prospectivity must be low before the Government will legislate prohibiting incompatible economic activities in the nominated areas and surrounding "buffer zones". It is expected that legislation covering all essential aspects will take three years once the sites are agreed.

In addition to the intensive interactions between the ATNF and the WA Government departments and instrumentalities over the past two and one-half years, briefings are regularly given to the Commonwealth Department of Industry Science and Resources and the Australian Communications Authority (ACA) which is responsible for frequency coordination and allocation. Because of the increasing pressure on sections of the radio spectrum, particularly for mobile communication services (land- and satellite-based), the ACA has requested that in establishing radio-quiet reserves, maximum attention be given to implementing a strategy of "self-protection" (e.g. remoteness, receiver robustness and effective interference mitigation techniques). Protection of the reserve also needs to be agreed through appropriate frequency-coordination methods (yet to be considered).

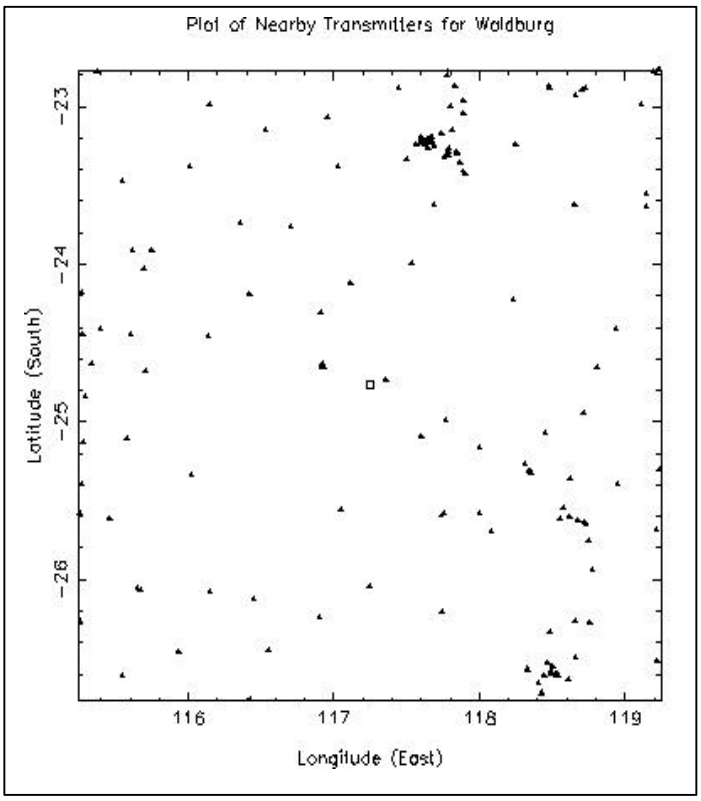

Fig.3: Location of licensed transmitters across a 400 x 400 km area centred near Waldburg homestead (courtesy J. Sarkissian)

At this stage, the designation of appropriate areas as potential radio-quiet reserves has been based on a review of the density of transmit-licenses over an extensive area as deduced from the ACA database. The next stage will include an extensive testing program of radio communication activity and the em ambient noise level. Planning for this program is well under way, and is described in more detail in Sec.3.

2. Some em requirements for a radio-quiet reserve

For the purpose of implementing a radio-quiet reserve, it is appropriate to divide the spectrum into four categories:

- ***The spectrum allocated to radio astronomy.*** The amount of spectrum is relatively small and is inadequate for detailed investigations of the universe.

- ***The spectrum allocated and used for radio communication purposes in the general area of the proposed radio-quiet reserve***. In the remote areas of WA being considered, the services provided are mainly low data-rate links to the homesteads and mining companies. CB radio is also extensively used on the stations. The "backbone" for remote services typically uses high data rate links above 1.7 GHz. Transmitters carrying low data rates are normally off unless activated. Nearby transmitting systems can be "absorbed" within the facility and national optic-fibre networks, thus reducing the spectrum in use.

- ***The spectrum, which is not used in the general area for communication purposes.*** It is this spectrum which is of greatest interest in defining the "quality" of the reserve. Intrinsically, the quality of a reserve can be quantified by the proportion of spectrum, which has an em ambient noise level below a given value. In practice, other "external" factors will play a significant part, for example:

  - The effectiveness of interference mitigation techniques;

  - The degree of cooperation with licensing authorities and service providers, and the effectiveness of any related legislation.

- ***The spectrum which is allocated to satellite down-links and the impact of services on the quality of the reserve.*** This aspect is very complex since the levels will be dependent on the satellite beam shape and the willingness and/or ability of the service provider to switch off those emissions, which are not providing necessary communications in the vicinity of the radio-quiet reserve.

To compare the quality of potential radio-quiet reserves, detailed measurements are necessary. As input into the equipment specifications, it is necessary to set a benchmark for the em ambient noise level. In the absence of any more recent studies, the ITU Recommendation (ITU, RA 769-1) for the protection of spectrum allocated to radio astronomy, is considered appropriate. In particular, the reference for spectral-line observations is applicable, since the bandwidths are not dissimilar to those used in communications systems. There is also a degree of immunity offered by an array (compared to the single antenna case used in the Recommendation), so that typical reference levels can be reduced by around 10 dB at 100 MHz, 20 dB at 1 GHz and 30 dB at 10 GHz. (For a facility with a compact "central core", the reduction may be only 3, 6 and 10 dB respectively for this part of the array).

3. The planned em measurement program in WA

The Western Australian Government is funding a comprehensive em measurement program with technical input from the ATNF. The first two stages will concentrate on the reception of land-based communication signals and the third will cover satellite down-links. Stage 1 will be a trial program to determine low frequency (~150 MHz) emissions from typical gold mine activity, and measurements on a remote station across three frequency ranges (148 - 222, 400 - 600 and 1350 - 1600 MHz). Antennas to be used will be a 10 dB Yagi, 15-dB horn, and 20-dB horn for the three bands respectively. An LNA will be connected directly to the antenna, with a spectrum analyser used as a receiving system. Stage 1 will be completed about March 2001.

In Stage 2, detailed measurements will be carried out at a number of sites with extended frequency coverage. However, to achieve the desired effective sensitivity, the spectrum analyser will be replaced by an Interference Monitoring System (IMS) currently under construction by Mal Smith (ANTF Parkes Observatory). The IMS will have 1024 channels with alternative channel bandwidths of 62.5 and 15.6 kHz (total bandwidth of 64 and 16 MHz). The basic integration time will be set at 5 sec. It is expected that Stage 2 will commence in July 2001.

Preliminary discussions have been held with NFRA (Albert-Jan Boonstra) about the adoption of standard output data formats developed for RFI monitoring activities at European observatories. The adoption of a common standard should enable a comparison of the quality of sites being proposed for the SKA to be readily made on an international scale.

4. Conclusions

The study in Western Australia has shown that there are large areas, which could provide the dual role of legislated compatible land use for conservation, such as undisturbed habitats for wild life, environmental studies, and other scientific observations including radio astronomy. Legal processes will be implemented to provide adequate protection for the areas, including those necessary to establish radio-quiet reserves. Such legislation and agreements will be in place prior to 2005 when a decision about the choice of a site for the SKA is expected to be made at international level.

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