STUDY OF PROPAGATION CONDITIONS IN COASTAL AREAS OF TAMIL NADU

FINAL REPORT

Submitted to Department of Information Technology
Government of India

By

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Acknowledgements

This final report is submitted as a result of the study of propagation conditions in amateur radio communications in the coastal districts in Tamil Nadu State over a period of 12 months by NIAR.

We thank the Department of Information Technology, Government of India for taking up useful R&D project in our country for the first time, the successful results of which can only encourage all the user groups like district administrations, NGOs, amateur radio operators etc. The study is to further promote the use of amateur radio technology for Disaster mitigation/ management and also to empower disadvantaged sections of the population in rural areas specifically the fishermen.

Our thanks are due to Chairman and members of the PRSG while monitoring the progress of the project contributed many valuable suggestions as well as for their encouragement and advice. We received invaluable support and suggestions from district collectors, people and also from various NGOs particularly the Helpage India, Cuddalore. Inputs received from the International Ham experts from various countries during the Hamfest-2006 and 2007 were useful during the course of the study.

We would like to express our appreciation for the co-operation extended to us by the officials of WPC wing, Department of Telecommunications, Government of India for giving necessary permissions for using amateur radio stations in the state of Tamil Nadu. We would also like to thank Government of Tamil Nadu for their help in organising meetings and travel in coastal areas for collection of data and information for the study report.

We also take this opportunity to thank all the team of volunteer Hams, who have conducted the study disregarding any personal inconvenience that they would have had to face.

NIAR expresses its gratitude the Government of India, Department of Information Technology, for readily agreeing to the proposal for funding the project and supporting it wholeheartedly.

S.Ram Mohan, VU2MYH
& Study team

Executive summary

The coastal areas of the country have been frequently affected by disasters like Floods, Cyclones, Tsunami etc causing immense loss of life and property in the region. it has been realised that communication, either within or between agencies working in disaster management, is essential for their effectiveness to provide effective rescue and relief.

Hams and Amateur Radio communication systems are considered ideal to serve such a purpose, as they can be quickly deployed in a disaster site and can support mobility. In the planning of any communication link, field surveys are necessary in order to sample and establish the true practical propagation characteristics obtainable over a particular path at a given instance.

The study of propagation conditions in amateur radio communications in coastal areas was initiated to identify frequencies in amateur radio communications for coastal areas and also to indicate suitable locations for operating amateur radio stations with a purpose to respond to human suffering caused by disasters.

The data obtained from a 12-month period on behavior of the radio signal from the point of transmission to the receiving point on high frequency as well as very high frequency (VHF) and ultra high frequency (UHF) - line of sight communication in amateur radio frequencies, carried out in coastal areas of Tamil Nadu, have been statistically analyzed in this study. This would have available propagation data that enable us to demonstrate that amateur radio communication will meet both the feasibility and performance objectives.

The report is the summary of signal strength reports from log sheet data of the two-way amateur radio communication contacts made by the Ham volunteers in the coastal areas on their own work. It is hoped that the report will help the policy makers and decision makers to encourage promotion of amateur radio activity and also as a tool for alternate channel of communication for people living in coastal areas vulnerable to natural disasters.

The Log book maintained as a prerequisite for operating an amateur radio station, has inbuilt components of much wider details with respect to frequencies being used by hams in conducting propagation condition tests, details of operators and date, time of operation, power output, station contacted, location and reports exchanged are recorded. These will include the clear procedure of the operations.

The parameters such as the transmitter power, frequency, type of signal modulation, type of aerial, and the sites of the transmitter and receiver are taken into consideration. Propagation conditions often vary considerably from month to month, and the monthly variability can change significantly from year to year.

These statistics of signal variability, are required for predicting the reliability of amateur radio communications. In this context it is important to know, the signal level exceeded for large percentages of time or location, in the determination of signal quality from a desired amateur radio station or of that particular area; and the signal level from amateur radio stations that are heard for small percentages of time, to determine signal loss or with significance of potential interference.

The experiments were conducted under the existing Indian Wireless Telegraphs (Amateur Service) rules issued by Dept. of Telecom (WPC Wing) on amateur radio operation which require a log book and the equipment register maintained by the ham volunteers, who are licenced amateur radio operators working on this project.

The results from Ship to shore VHF communication from a given transmitter would typically travel over paths of 60 km or less is achieved, in order to ensure a satisfactory communication, while signals from a VHF repeater station would travel from far greater distances. However, there are occasions when radio-meteorological conditions occur whereby signals can travel to far greater distances than normal with sufficient signal strength to achieve long distance communication. The purpose of conducting propagation measurements on long distance propagation paths is, also to acquire knowledge of the likelihood of such reports. While the HF communication provided long distance communication day/night from amateur radio stations from coast to coast during this period. Limited success was achieved in the use of UHF frequency bands /HAMSAT during the period of study.

In the planning of any communication link, field surveys are necessary in order to sample and establish the true practical propagation characteristics obtainable over a particular path at a given instance. High frequency transmission where ionospheric paths are considered, surveys need not be very extensive in a large number of instances, as these can be supplemented by a vast amount of statistical information, which is already available. For VHF transmission propagated over tropospheric paths, relatively long-duration field surveys are necessary because of the inadequate knowledge of the essential properties of the propagation medium combined with the lack of relevant statistical information. The study has brought out the need for establishing more VHF repeater stations and HF communication stations on permanent basis in the coast.

In developed countries, due to the existence of large number of radio amateurs that are spread over different locations as a permanent feature, these countries could use Amateur Radio resource more extensively than in India. Our country therefore needs to look at this prospect not only for disaster management but as part of other development process and plans. An extensive measurement campaign is thus necessary to extend knowledge of the propagation characteristics in this region. This report presents the results of radio signal characteristics and propagation measurements carried out in the coastal areas of Tamil Nadu.

F**oreword**

It is well known that in developed countries like USA, Australia, Britain, Japan, France and elsewhere, there exist large number of Radio Hams spread over different locations within their countries as a permanent feature. In comparison the Ham activity in India has been very limited. The real fillip to the Ham movement in India was given by the Late Shri Rajiv Gandhi VU2RG in the past and now Thiru Dayanidhi Maran, VU2DMK who, being Hams themselves recognized the potential of this scientific activity and gave full support to its development.

The need for promoting amateur radio technologies as alternate means of communication for the benefit of community in distress was highlighted and suitable recommendations were made by various institutions including the Planning Commission, Ministry of Home Affairs, NHRC, The President of India, The Central Vigilance Commissioner and several others in the recent years.

Since then the radio hams in India in general, and NIAR in particular, have rendered yeoman service in times of natural calamities, like the floods in Andhra Pradesh, Super Cyclone in Orissa, Gujarat earthquake, Indian Ocean Tsunami of Dec 2004 only to name a few.

Out of the experience of the 2004- Tsunami relief communications, the idea of empowering the Hams across the coastal belt was born to provide earliest warnings of any future eventualities, so that more effective help could be rendered to the people in the danger zone. This, first of all requires knowledge of the most suitable conditions that would facilitate effective radio amateur communication within the region at any time of the day in all seasons of the year and the most important factor being propagation conditions prevailing in the region, it was natural that a study be conducted. Accordingly proposal for this R&D project was put up to study the propagation conditions in Tamilnadu State as a first step that has historically the most prone to the ‘Disasters from the Sea’

The proposal highlighted the need for the study, the project objectives, the technical specifications of the equipment that would be deployed, an outline of the methodology to be used, besides highlighting the past achievements of NIAR in the field of disaster mitigation.

The recommendations/suggestions made in this report are implemented, the TN and the country would stand to benefit. I thank the Department of Information Technology under MCIT for encouraging this study and supporting NIAR as implementing agency.

S.Suri
Chairman, NIAR

1. INTRODUCTION

1.1 BACKGROUND

a) Process by which a radio signal is conveyed from a transmitting antenna to a receiving antenna is referred to as Propagation. The major factors that govern the propagation of radio signals are changes in Sunspot activity, Ionospheric conditions and varying whether conditions during day and night.

b) Amateur Radio communication utilizes HF, VHF and UHF frequency bands. Better Line-Of-Sight (straight-line) communication can be generally be achieved at moderately long range in VHF/UHF frequencies with high gain antenna at transmitting and receiving ends on identical polarization. In HF band however it is the selection of frequency in any band that is the major determining factor since these frequencies are most affected by the propagation conditions prevailing at any time of the day.

c) Since HF band is ideal for long range communication, the proposal was put up to conduct propagation studies for HF/VHF/UHF during day and night covering all weather conditions for a period of 12 months. This would result in determining the most suitable frequencies for Amateur Radio communication round the clock. Additionally for the VHF/UHF particularly, the height and gain of the antenna required to get best communication at maximum ranges also could be determined.

d) With the latest advancement in the technology, base station and hand held equipment provide HF/VHF/UHF communication facilities in single equipment on single power source. This is an advantage for stations in remote areas to hear weather warnings broadcasted on other frequencies. Moreover the low earth-orbiting amateur radio satellites in polar orbit have uplink frequencies on UHF and downlink frequencies on VHF, only equipment for dual band operation with UHF/VHF facility in single equipment is considered ideal for such communication. The area of footprint covered by HAMSAT and other amateur radio satellites on UHF/VHF frequencies could provide an additional source of communications in sea.

e) The transmitting stations can also be amateur radio beacon to operate on a particular frequency and the receiving station may note the reception quality of the signal received. The report of signal reception could be taken on different timings of the day to analyze the propagation conditions.

2. PROJECT OBJECTIVES

The Report seeks to identify the frequency spectrum in amateur radio communication favorable
for communications along the coastal areas. Where appropriate it refers/defers discussion to separate reports that provide greater detail on the technology or platform discussed. Through this statistical analysis the user groups will be better informed on the coverage of amateur radio communications along the coast and the use of these systems for disaster management.

- To determine suitable frequencies for Amateur Radio wireless communication in sea coast.
- Provide Alternate Channels of Communication for communities in sea coast.
- To determine suitable locations for installation of amateur radio communication equipment.
- Human Resource Development.
- Knowledge and Information Exchange.
- Effective use in Disaster Mitigation/ Management.

3.1 Methodology

The parameters such as the transmitter power, frequency, type of signal modulation, type of aerial, and the sites of the transmitter and receiver are taken into consideration. Propagation conditions often vary considerably from month to month, and the monthly variability can change significantly from year to year.

These statistics of signal variability, are required for predicting the reliability of amateur radio communication. In this context it is important to know, for example, the signal level exceeded for large percentages of time or location, for example in the determination of quality signal from a desired amateur radio station or of that particular area; and the signal level from amateur radio stations that are heard for small percentages of time, to determine signal loss or with significance of potential interference.

Communications range is determined by the quality of the signal available at the receiver. Quality measures of a communications link include the amount of distortion and interference (particularly from transmissions travelling by multiple paths to the receiver) but arguably the most significant determinant of range the received signal strength in relation to local noise (Signal to Noise Ratio – SNR). Ultimately the range achieved in amateur radio communications is determined by the ability to achieve signal quality at the receiver sufficient to sustain the required communications quality.

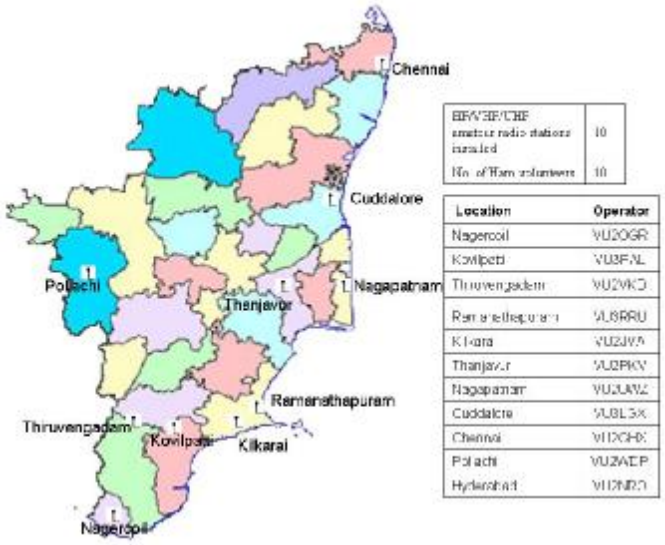
The operating range of line of sight communications is determined from the achieved signal at the receiving station after due consideration of signal attenuation, path loss with respect to topography and complex terrain.

The transmitting and receiving stations were strategically located along the coastal areas of Tamil Nadu cover the coastline of 1076 Kms. The propagation link is essentially a land path. Table I gives details of the parameters of the experiment while Fig. 1 shows a section of the map of Tamil Nadu indicating the positions of the transmitter and receiver. The climate of Tamil Nadu is tropical in nature with little variation in summer and winter temperatures. While April-June is the hottest summer period with the temperature rising up to the 40ºC mark, November-February is the coolest winter period with temperature hovering around 20ºC, Tamil Nadu gets all its rains from the North-east Monsoons between October and December. During summers (April- June), the coastal regions of Tamil Nadu become uncomfortably warm and humid, but cool sea breezes in the afternoon make nights cool.

Table –I
Parameters of Measurement

Frequency	HF: 3.5 MHz 7 MHz 14 MHz VHF:145.200 MHz UHF: 435.00 MHz
Tx. Antenna height	10 M
Rx. Antenna height	10 M
Tx output power	HF 100 Watts VHF 50 Watts UHF 10 Watts

Fig.1 – Location of Amateur Radio stations in Tamil Nadu



It was decided to cover the entire coastline by :

a) Identifying volunteer Hams from Tamilnadu who would be willing to man Amateur radio base stations.

b) Awareness on the objectives of the project, Imparting training/orientation to various Hams, Fishermen communities, Local Administration, NGOs, Schools and Colleges in Tamilnadu both to take part in the project and as a Ham human resource that would be available in future.

c) Selecting sites for 10 base stations to be set up in Tamilnadu some off coast some on coast.

d) Procuring Amateur Radio equipment in HF/VHF/UHF bands along with suitable antennas.

e) Equipping the stations with appropriate Amateur radio equipment and conducting communication studies with shore using vhf sets in ships.

All the active Hams in Tamilnadu and in nearby locations would be alerted so that they could expect contacts to and with the proposed Stations. The selected Hams in the coastal areas of Tamil Nadu were provided the necessary amateur radio communication equipment for HF/VHF/UHF frequency bands along with accessories and also to maintain complete log book record for data collection as per the requirements of the Project. The collected data would be analysed in three groups, i.e. for between **Shore to Shore** locations, between **Shore to Inland** and between **Ship to Shore** which will be in VHF band. For the first two groups the data would be analysed as tabulated below.

The data received between March 2006 and February 2007 has been statistically analyzed in this report.

HF radio contacts during (Day and Night)	
Day 0600-1800 Hrs.	Night 1800-0600 Hrs.
a) No. of contacts made during each month with Hams in coast b) **Signal strengths recorded with Hams in each location along coastal areas for each month during day and night.**	

Since there is little difference between day and night conditions of VHF 'line-of sight' communication day/night division would be dispensed with. Ship to Shore data would also be analysed similarly. UHF data wherever available, will be analysed in the same manner except there is no repeater in this case.

The summery of the above will indicate to what extent the objectives have been achieved and also suggest what further action, if any should be taken.

3.2 SELECTION OF SITES & FORMATION OF TEAMS

Ten locations were identified for establishing 10 Ham Stations and teams of volunteers selected as tabulated below in Table-II.

Table-II : List of Amateur Radio stations

S.No	Location	Call Sign	Name
1	Chennai	VU2GHX	Mr.G.Madhavan
2	Pollachi	VU2WDP	Mr.S. Vijayan
3	Nagarcoil	VU2OGR VU2OGQ	Mr. Y. Sunder Singh Mr. N.A.Subramania Raja
4	Nagapatnam	VU2UWZ	Mr.S. Madhu Mohanan
5	Ramanathapuram	VU3RRU	Mr.R. Mandra Selvan
6	Kilakarai	VU2JVA	Mr. V. Asokan
7	Cuddalore	VU3LGX	Mr. K.Leela Krishna
8	Thanjavur	VU2PKV	Mr.V. Palaniappan
9	Thiruvengadam	VU2VKD	Mr.V.Kandasamy
10	Kovilpatti	VU3PAL	Mr. G.Rajagopalan

The locations are equally divided between Shore and Inland.

Additional volunteers/members of NIAR staff moved to the coast stations to conduct specific studies. Thus more than 10 stations in the coast at times during specific study.

3.3 PROCUREMENT & INSTALLATION OF EQUIPMENT

The following Ham Communication equipment was procured and installed at the selected location with the type and height of antenna as indicated in table-III below:

Table-III : List of amateur radio equipment

Sl.No.	Item Description	Quantity
1	HF/VHF/UHF Transceiver	3
2	13.8 V, 20 A	4
3	HF wide band antenna	10
4	VHF/UHF Transceiver	10
5	VHF/UHF Yagi antenna	10
6	VHF 3dBSlim Jim Antenna	5
7	VHF 6 dB gain Antenna	2
8	HF/VHF/UHF Antenna Analyzer	1

In addition to the above NIAR has provided its HF and VHF communication equipment, HF&VHF antennas, accessories, spares and test instruments towards its contribution for successful implementation of the project.

4. Analysis of the Amateur Radio communication log.

The analysis of the log sheet data submitted by volunteer hams are independent, identically distributed, random variables with measurable statistics, in the strata of situations, locations and times. We report on comparisons from over 20,862 successful two-way radio communication contacts covering HF & VHF frequency bands during the project duration.

4.1 HF Communication

For frequencies generally in the High Frequency (HF) band an ionised portion of the atmosphere known as the 'ionosphere' can refract the waves back to Earth. The angular deviation induced by the ionosphere depends on the frequency of the wave and the degree of ionisation (which has short term changes atop of diurnal, seasonal and '11 year sunspot cycle' variations). The ranges achieved depend on the geometry involved (i.e. the apparent height of the ionosphere and the angle of the ray being refracted).

Skywave communications have been practiced extensively in amateur radio communications. A threat to skywave communications is the speculation of the overdue occurrence of a period of no sunspot activity such as the Maunder Minimum and earlier Spoorer Minimum. The occurrences of these periods are subject to scientific debate as well as the effects they will have on long-range communications. However, the possibility of a lack of sunspot activity presents the interesting possibility of the disappearance of the ionosphere for practical long-range communications purposes.

Amateur radio stations at each of the test locations contacted with each other at different period times of the day during March 2006 to February, 2007. The amateur radio station could contact other station on HF frequencies without interference or noise. Several contacts were made with the same station in different seasons to learn the changes in the signal strength pattern. The signal strength reports are collected with other ham volunteers using the equipment provided under the project. A folded dipole - a wide band HF antenna, covering all the frequency bands and an Inverted V antenna are used for their simple design, construction and installation, which are also most commonly used by Hams and other wireless communication users.

The log book data submitted by each of the stations were entered in the computer, great care was taken in terms of identification of each station i.e. callsign, date and time of each contact and signal reports sent and received.

The signal strength measurements of the entire database of amateur radio log has been computed to show the signal strength values of daily radio contacts of day and night for number of days of the measuring period. The signal reports exchanged by transmitting and receiving stations were identical for maximum number of contacts.

S-meter and signal strength measurement

The S-meter is an instrument present on the amateur radio communication receivers that measures the strength of the signal that is being received, and uses a special unit: the S-point. S-points are used by amateur radio operators to exchange RST reports, a "five and nine" report exchanged is an excellent signal.

S-points go from S1 to S9 and each S-point is defined as a 6 dB change in signal strength. This means that each time the voltage is halved (-6 dB) the signal strength decreases by one point. S9 is already a very strong signal, but to describe larger signals steps of 10 dB are used instead of 6 dB, like "S9+20" meaning 20 dB above S9.

Table-IV : co-relation of S Meter reading and perceived strength

S Meter reading	Received voltage	Perceived Strength
S9+60dB	50 millivolts	Acutely strong
S9+50dB	16 millivolts	Acutely strong
S9+40dB	5 millivolts	Extremely strong
S9+30dB	1.6 millivolts	Extremely strong
S9+20dB	500 microvolts	Extremely strong
S9+10dB	160 microvolts	Extremely strong
S9	50 microvolts	Very strong
S8	25 microvolts	Strong signals
S7	12 microvolts	Moderately strong
S6	6 microvolts	Good signals
S5	3 microvolts	Fairly good signals
S4	1.5 microvolts	Fair signals
S3	0.8 microvolts	Weak signals
S2	0.4 microvolts	Very weak signals
S1	0.2 microvolts	Barely usable signals

There are two references values for frequencies below 30 MHz, S9 is defined as a voltage of 50 uV over 50 Ohms at the receiver antenna connector; for frequencies above 30 MHz, S9 is defined as a voltage of 5 uV over 50 Ohms at the receiver antenna connector.

Overview of radio contacts by coastal stations

Over 5473 contacts successful two-way radio contacts were made with amateur radio stations on 3.5 Mhz, 7 Mhz, 14 Mhz, & 21 Mhz frequency bands by coastal stations in Chennai, Nagapattinam, Tanjavur, Pollachi, Kovilpatti, Cuddalore and Kilakari.

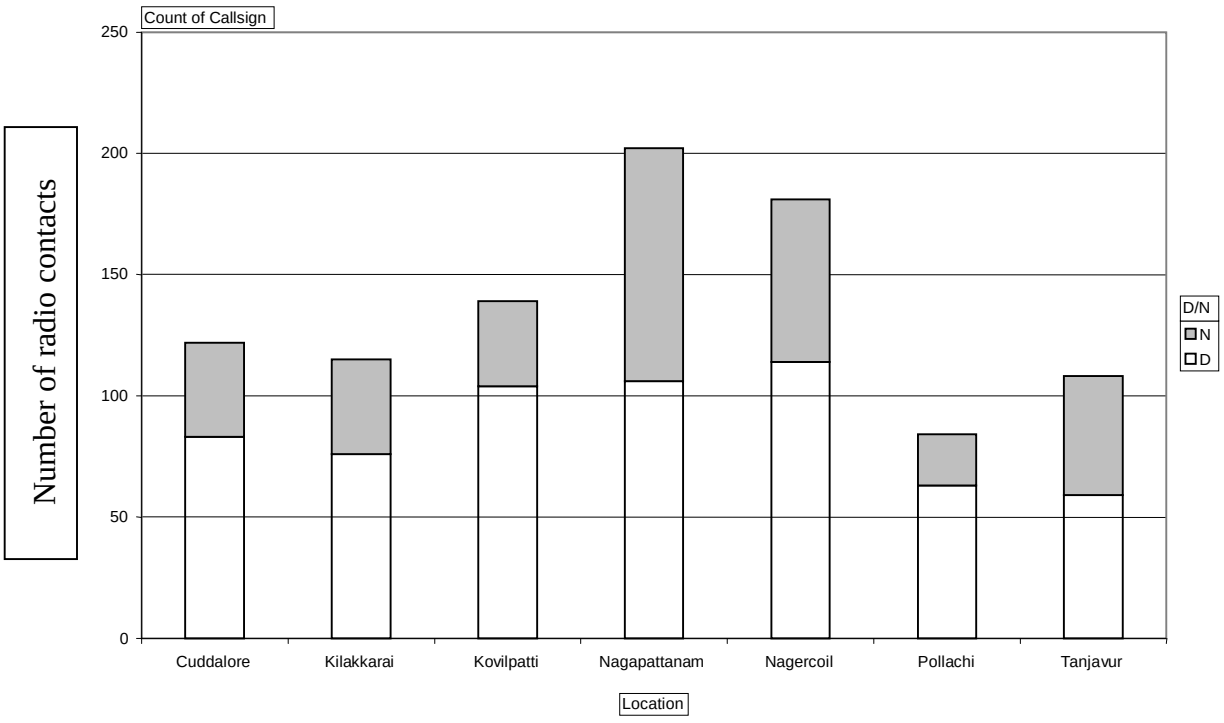
Table-V : Total number of Day and Night contacts made on HF frequency bands from each location

Location	Day	Night
Nagapattanam	477	532
Chennai	827	388
Pollachi	912	313
Cuddalore	217	202
Kilakarai	193	172
Kovilpatti	387	164
Tanjavur	160	148
Nagarcoil	214	167

Table V above gives the details of number of day and night contacts made at each of the station. In addition to ham contacts made with above stations, large numbers of contacts were also made with other Hams at locations in Tamil Nadu, Andhra Pradesh and Kerala.

A typical study of amateur radio log data for 7 MHz frequency band from Chennai to Cuddalore, Kilakarai, Nagapatnam, Nagarcoil, Pollachi is given below is illustrated in Fig – 2. It details number of contacts made during day and night with Hams in coastal areas during the period of 12 months from Chennai to Hams in coastal areas. A Total of 951 (605 during the day and 346 during night) radio contacts were recorded between the above said amateur radio stations

Fig-2: Number of contacts made at each of the 7 locations during day and night.



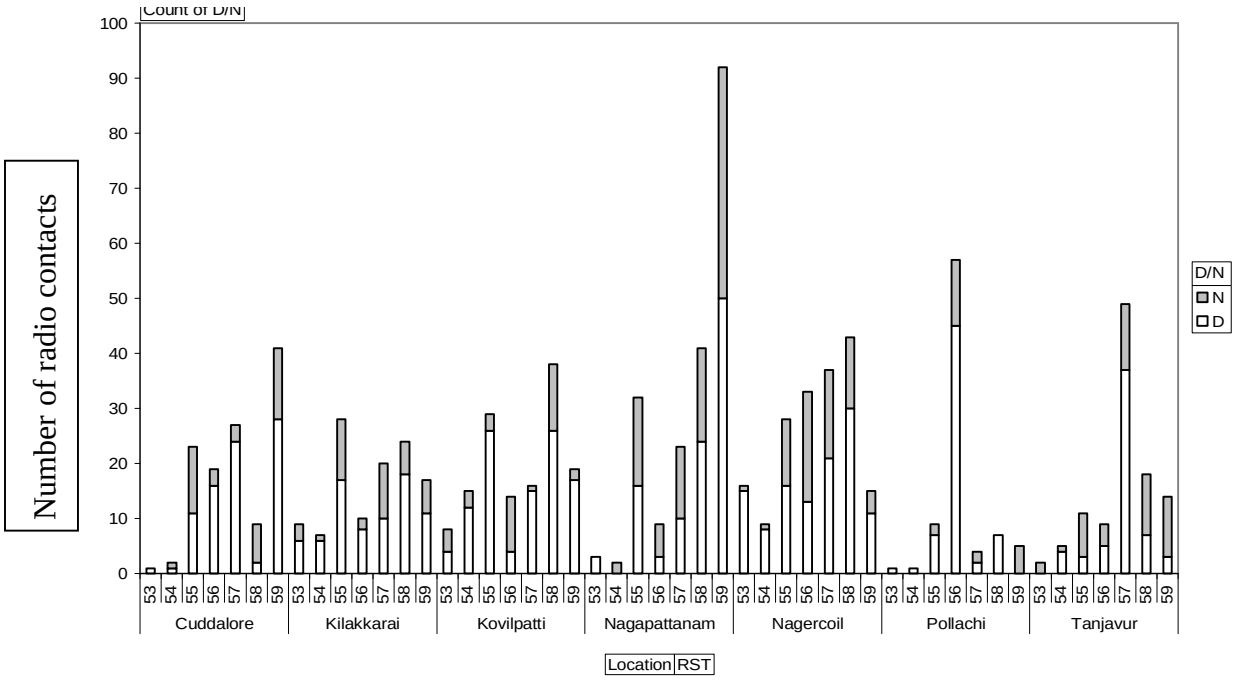
Overall signal strength distribution

Table -VI shows the signal strength distribution for the database of measurements, over a 12-month period between March 2006 and February 2007. The signal strength measurements were recorded at different time duration of day and night, 46% of the total contacts were recorded in the time duration between 06:00 AM to 12:00 Noon, 17% of contacts were recorded in the time duration 12:00 Noon to 06:00 PM, and 36% of contacts were recorded in the time duration between 06:00 PM to 12:00 Midnight.

Table-VI : Signal strength measurement recorded during day and Night

S-point	Day	Night
53	30	10
54	32	9
55	96	64
56	94	57
57	119	57
58	114	66
59	120	83

Fig-3 Signal strength measurements recorded at receiving stations during 12 month period



The fig-3 shows the value of signal strength measurement recorded at the receiving station during this period. The signal strength value S-point at 9 corresponding to very strong signal is recorded with the highest number of samples at 21% of the entire data base of measurement.

The distribution of signal strength measurements corresponding to weak signal is recorded at 4%, fair signal recorded at 4%, Good and strong signal recorded at 92%. These are clear indications of high reliability of successful two-way communication on occasional occurrences of weak signal report.

Monthly signal strength readings at each station

For a more detailed analysis of the measured signal strength values, signal strength parameters recorded at each location for the corresponding month are noted. These are shown in Fig 4-10. As shown in the figures, the month of July and August recorded highest number of contacts corresponding to the signal strength due to the heightened activity due conduct of awareness programs, demonstration of amateur radio communications, lecture programs and interaction with the fishermen community, more frequent contacts were made during different times of day contributing to high values. Hams in coastal areas participated in each of these programs.

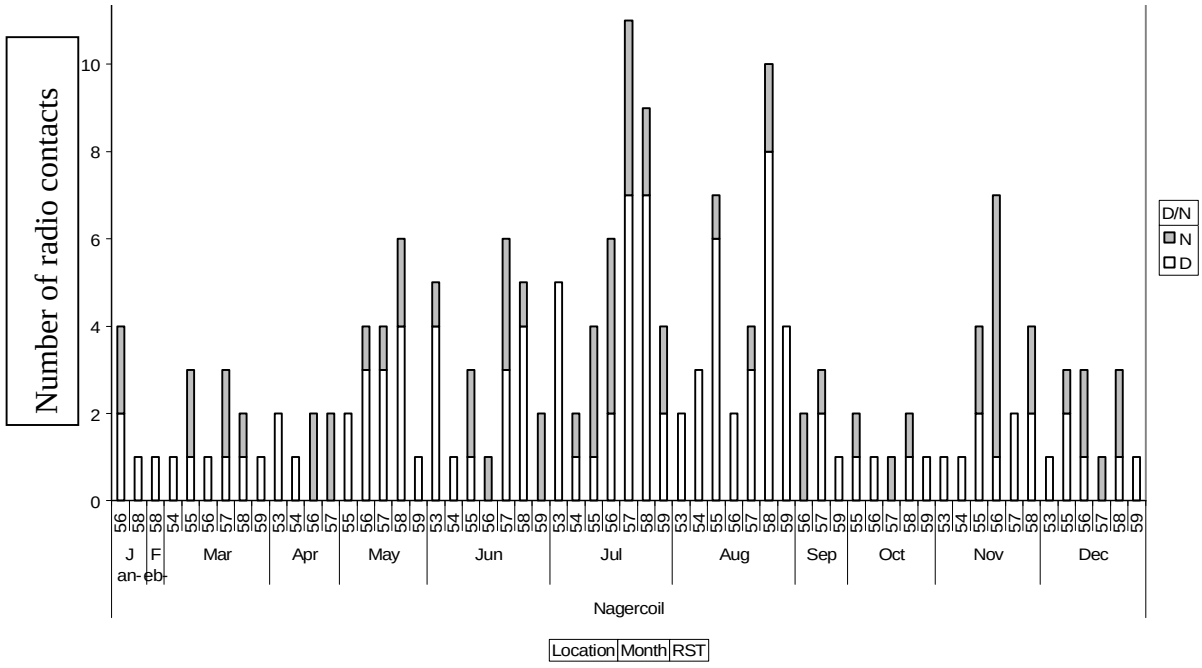


Fig-4: Signal strength measurements recorded at Nagercoil.

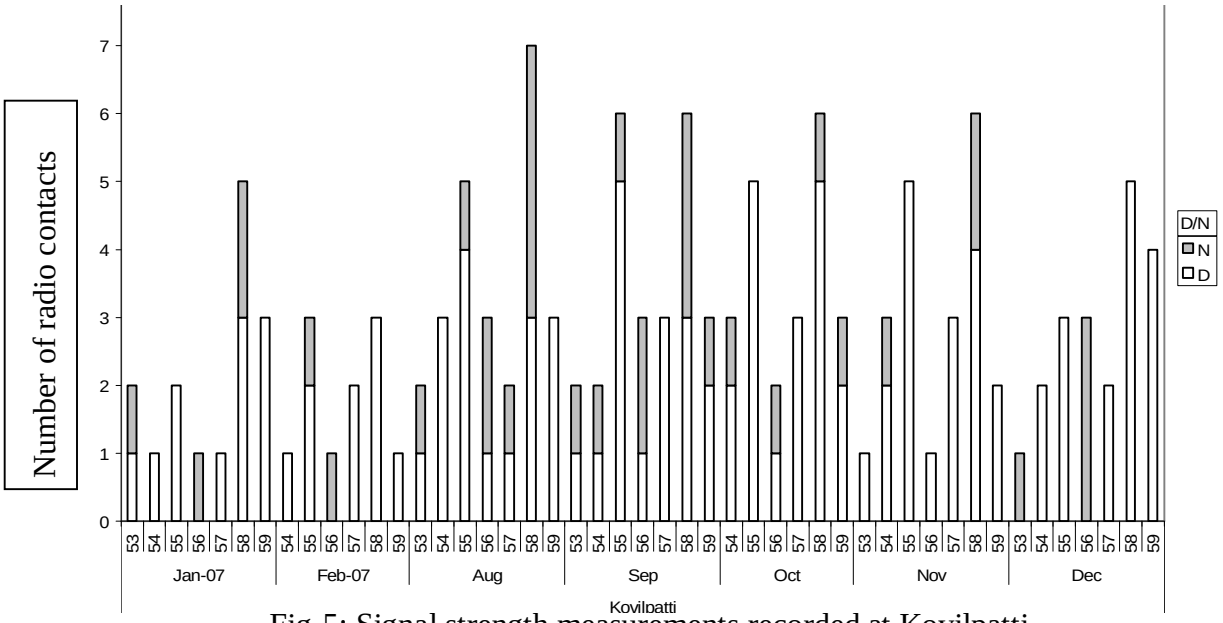


Fig-5: Signal strength measurements recorded at Kovilpatti.

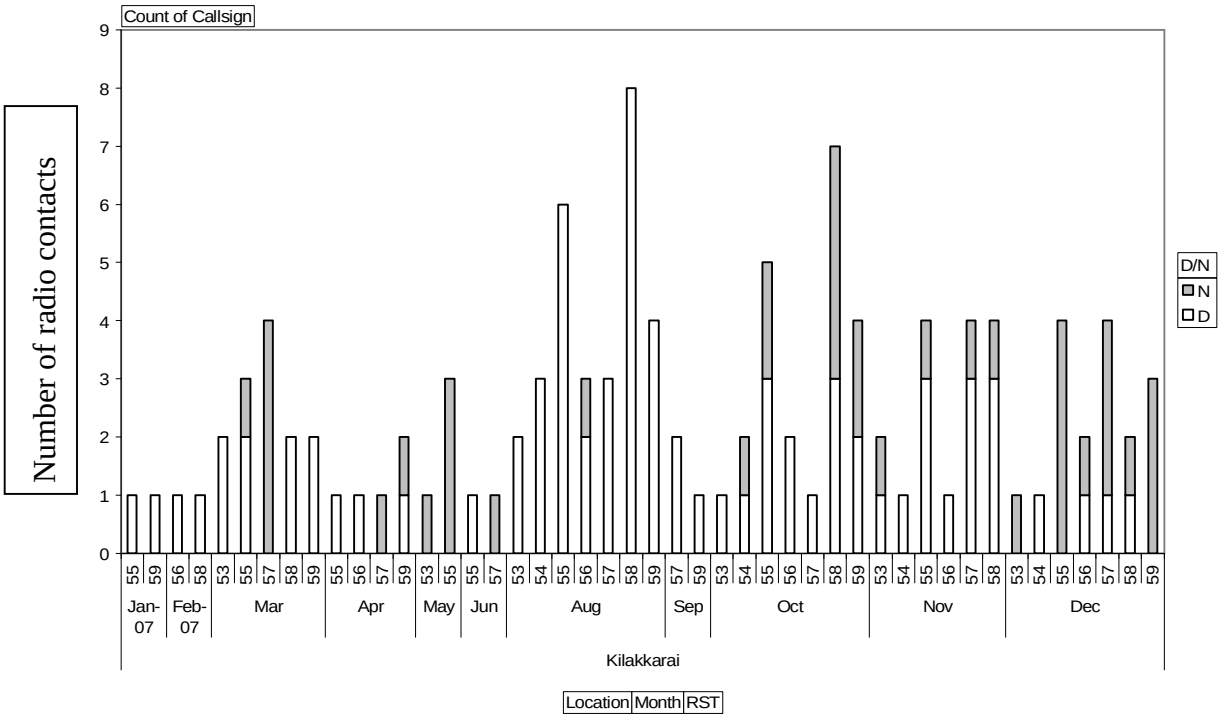


Fig-6: Signal strength measurements recorded at Kilakarai.

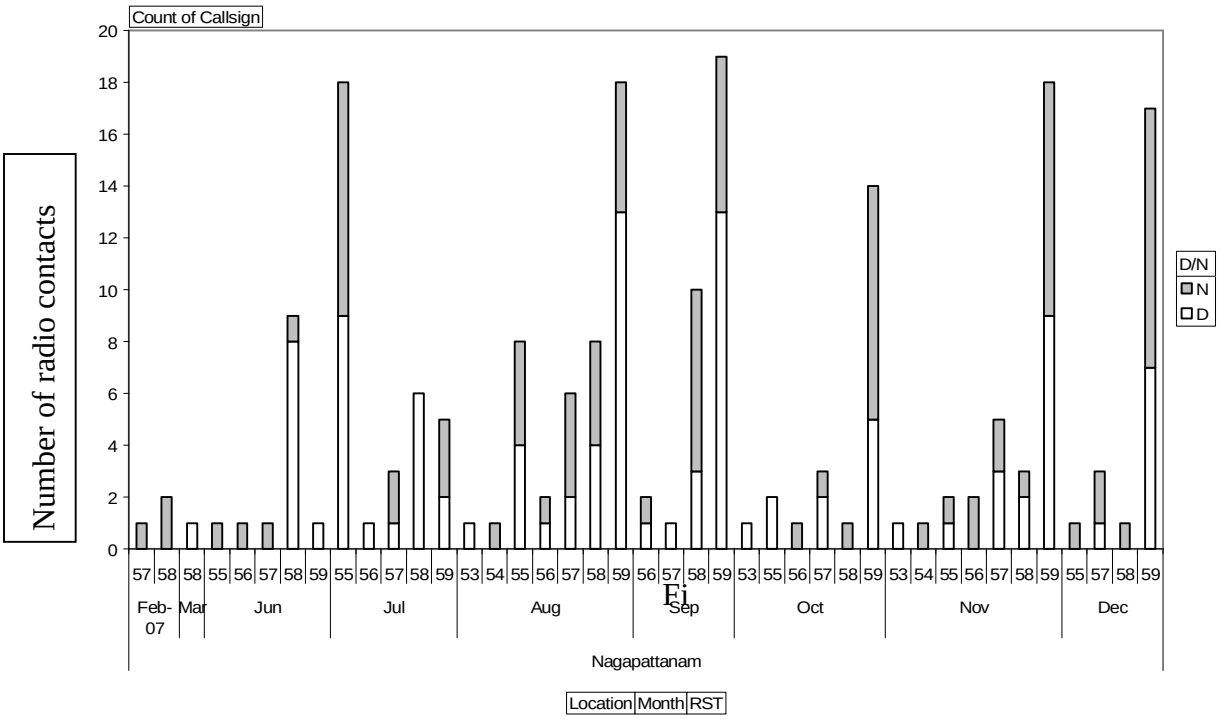


Fig-7: Signal strength measurements recorded at Nagapattinam.

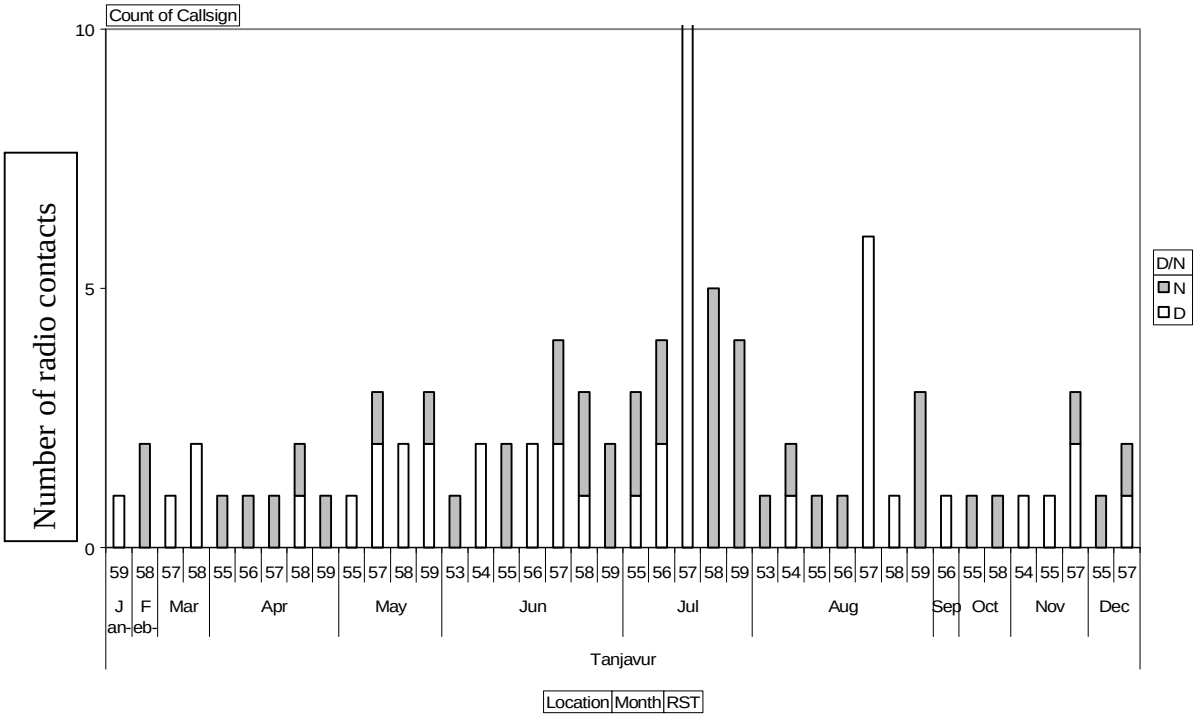


Fig-8: Signal strength measurements recorded at Tanjavur.

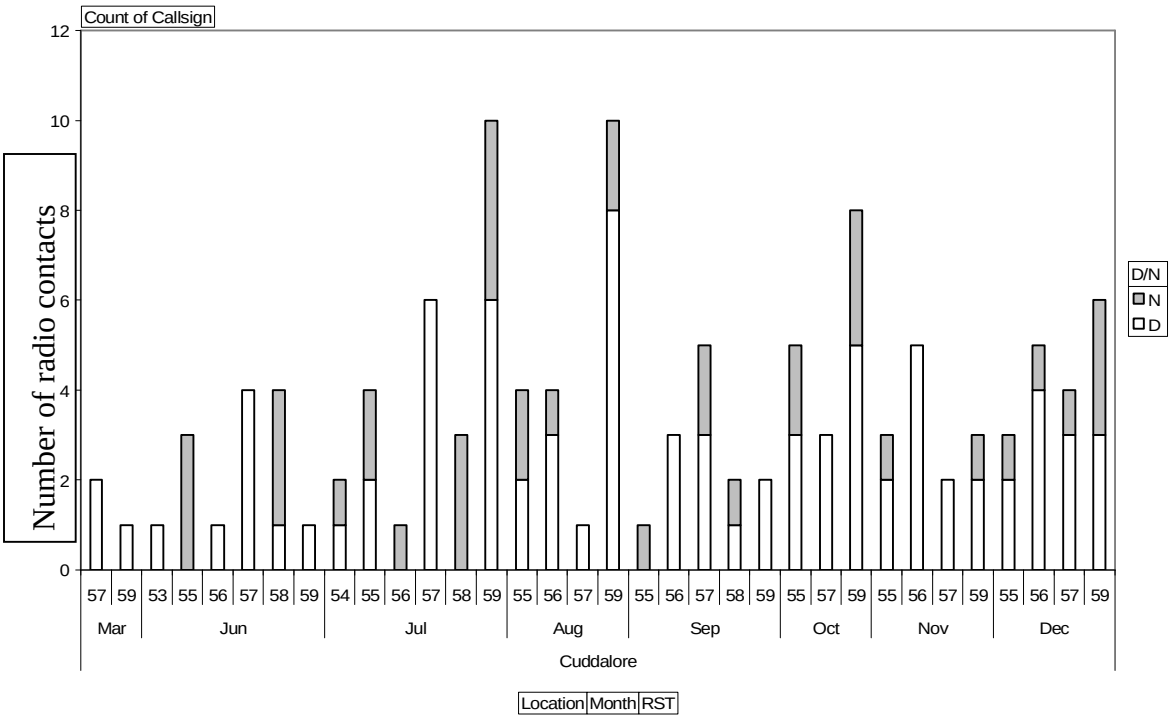


Fig-9: Signal strength measurements recorded at Cuddalore.

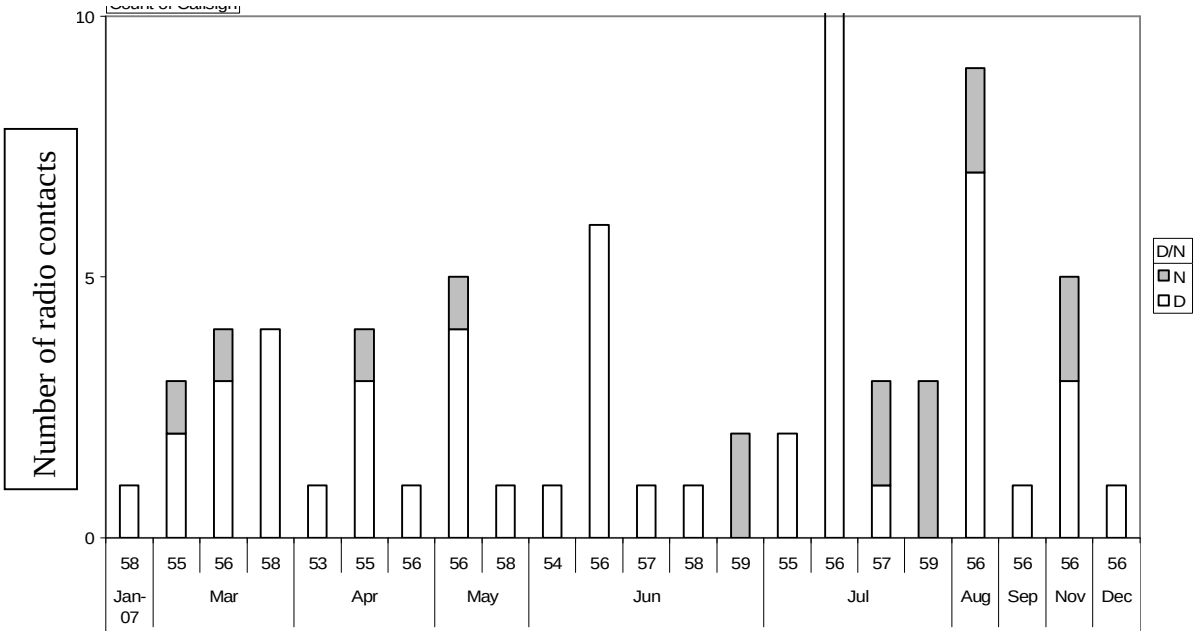


Fig-10: Signal strength measurements recorded at Pollachi.

Daily signal strength record

To study the variations in the signal strength pattern, signal strength readings of each day received are shown in figs.(11-17). These typical months of July, August, October, November are selected for recording high and low variations recorded in the months of high activity.

Fig-11 **Daily record of signal strength measurement**

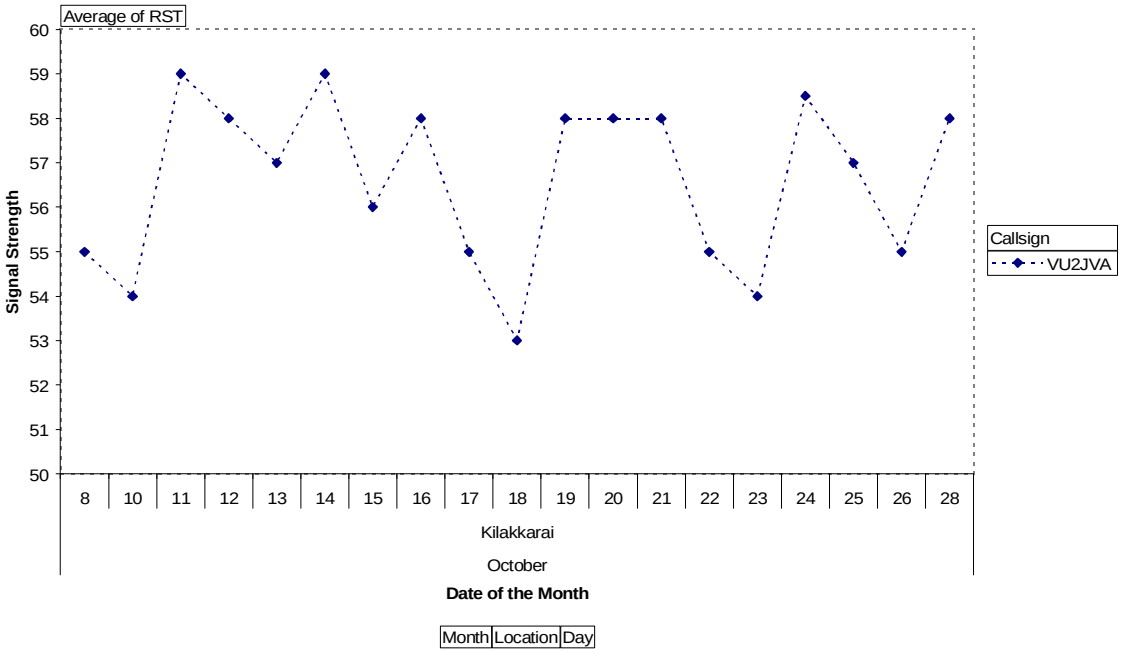


Fig-12: **Daily record of signal strength measurement**

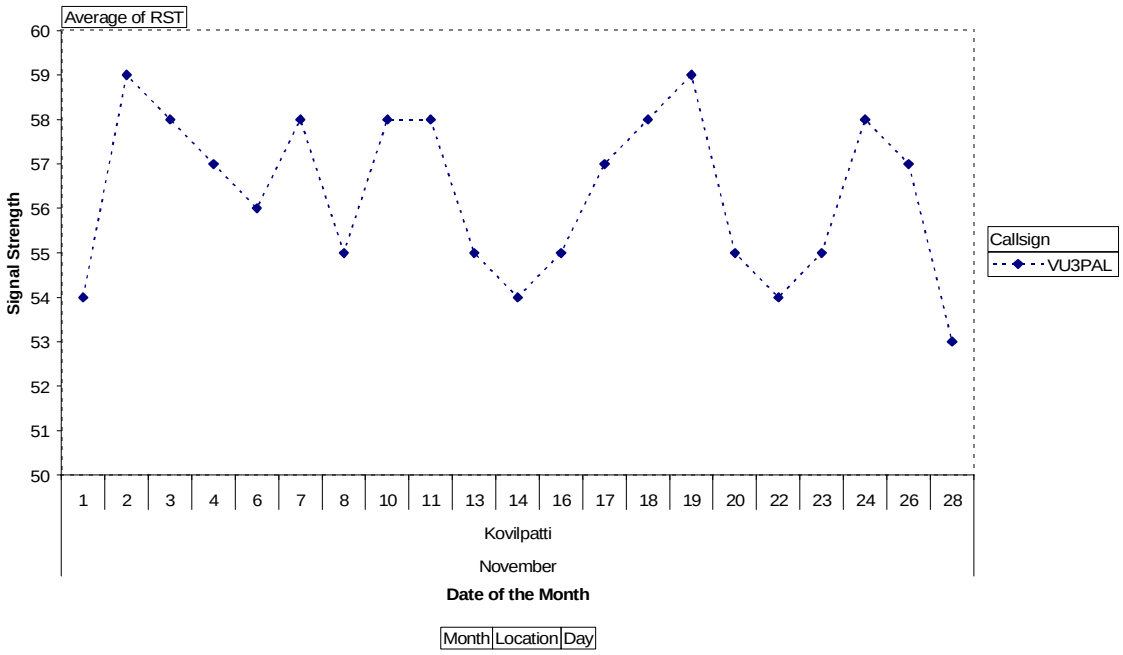


Fig-13: **Daily record of signal strength measurement**

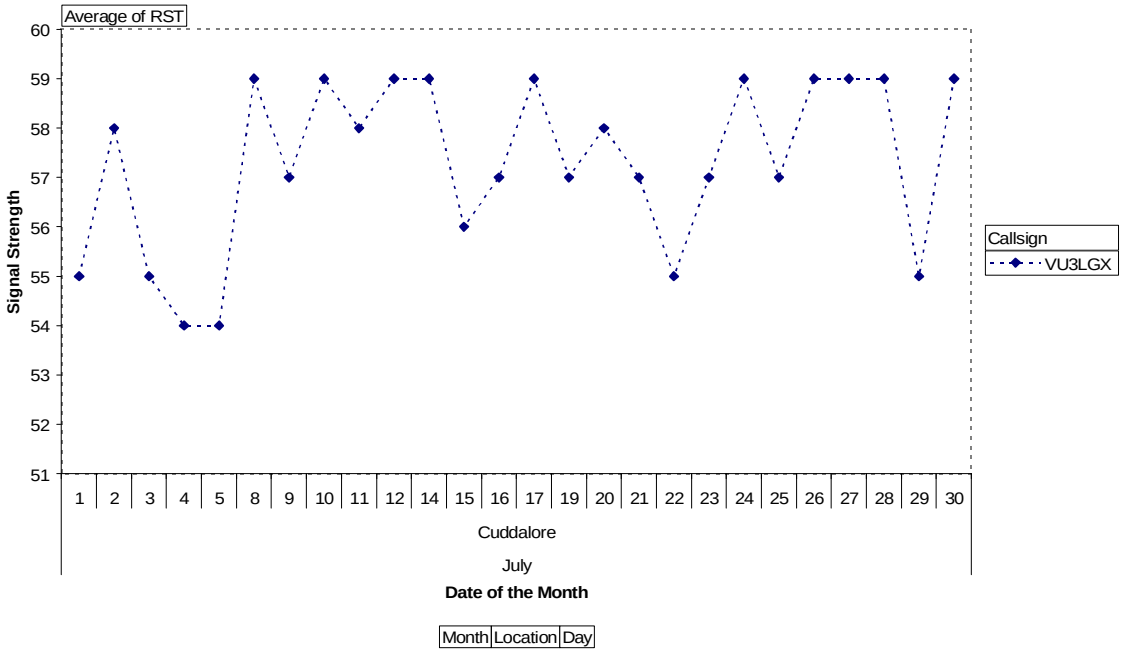


Fig-14: **Daily record of signal strength measurement**

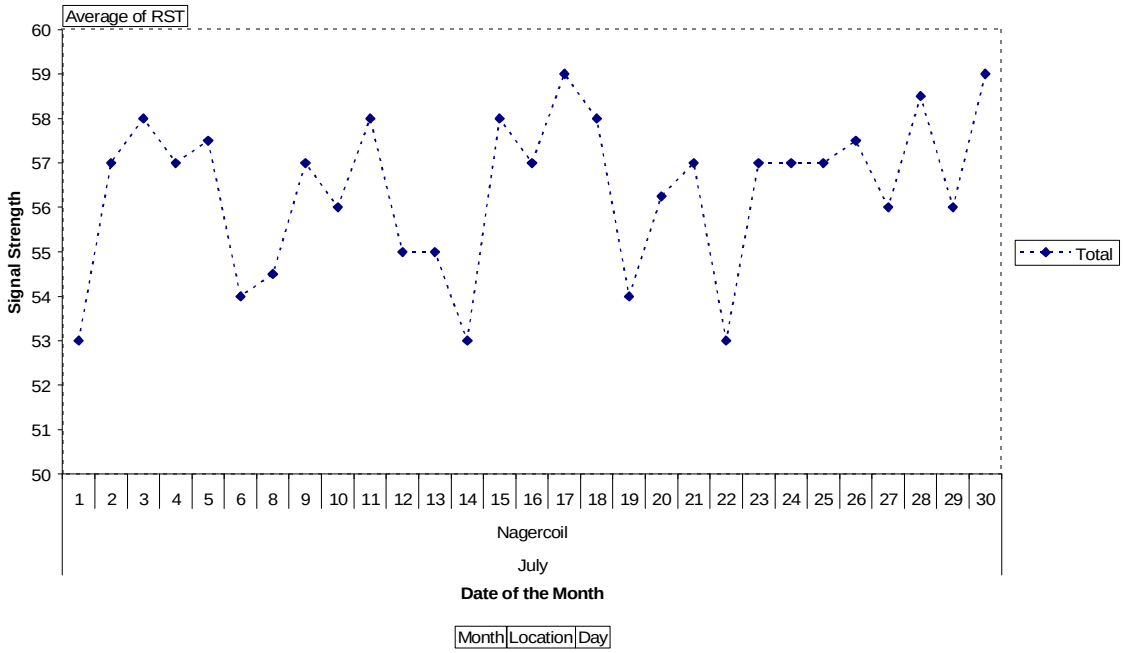


Fig-15: **Daily record of signal strength measurement**

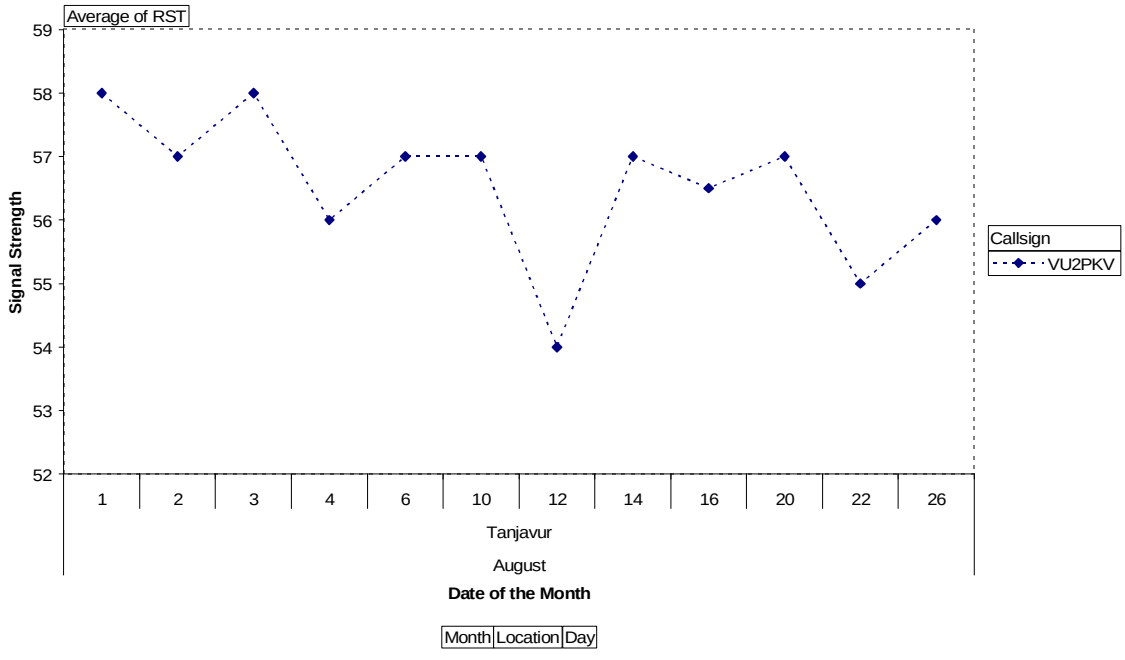


Fig-16: **Daily record of signal strength measurement**

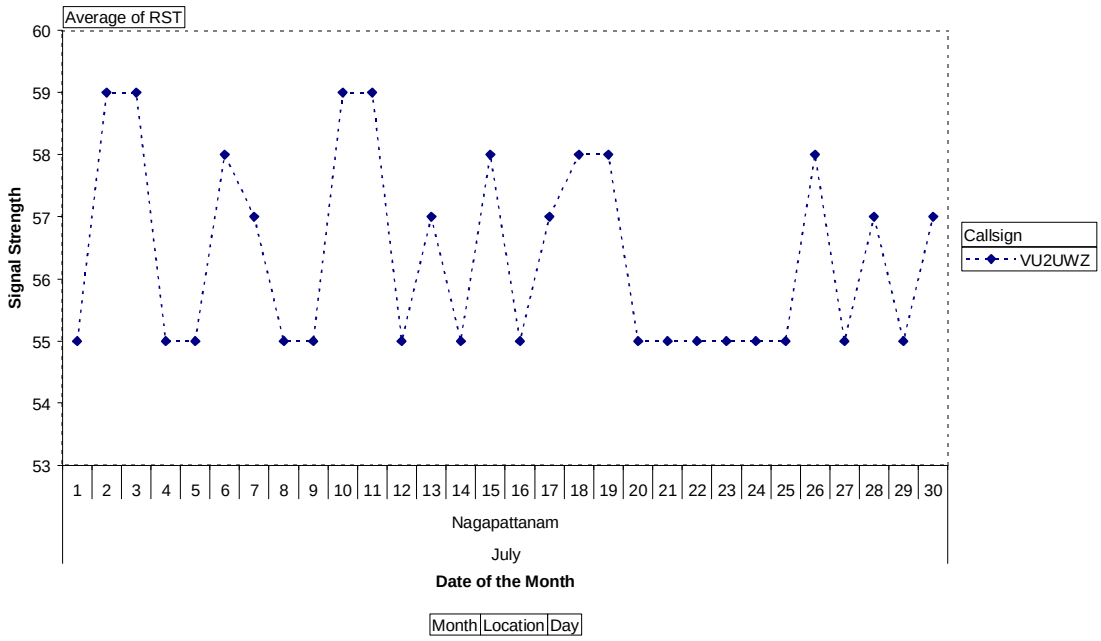
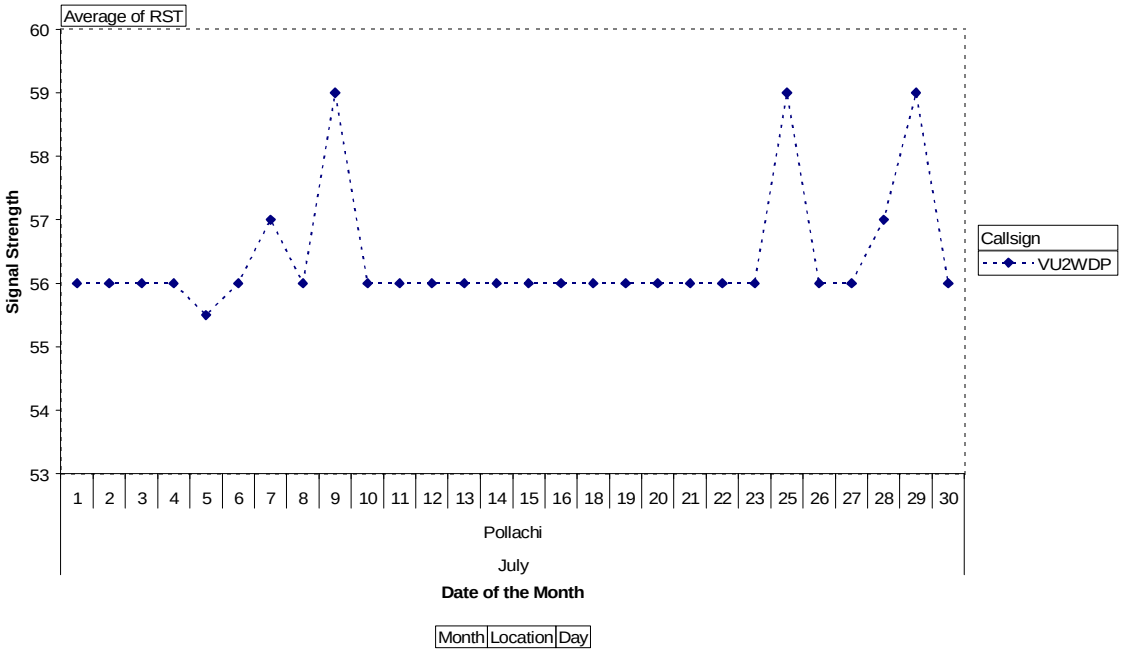


Fig-17: **Daily record of signal strength measurement**



The results of the observations made on the statistical analysis of the HF communication log sheet data indicate reliable HF communication with minimal occurrences of weak signal strength. It may also be considered that during the current path of the solar cycle 23, when the sun spot activity is at maunder minimum and other path loss in the radio communication test circuit between transmitter and receiver. is It is be learnt from the statistical data provided from the amateur radio log sheet data that reliable communication on 7Mhz amateur radio frequency band is favorable during all seasons, day and night. However, during the hours between the Midnight to sunrise 3.5 MHz provided most favorable results. Several contacts were recorded and several successful two-way radio contacts achieved during the time periods of 01:00 Hrs to 05:00 Hrs on 3.5MHz frequency from the Ham station at Nagapatnam. It is desirable to use Day and Night frequencies for uninterrupted communication in coastal areas to Tamil Nadu.

The log reports indicate that propagation of radio signal on higher bands exceed 1000 kms by operating on frequencies above 7 Mhz during the day. Large number long distance contacts were made at different periods of time with other Hams on 14Mhz frequency band, the log report of Nagapattinam has recorded a successful contact with an amateur radio station in USA during this period.

4.2 VHF Communication:

Amateur Radio VHF communication frequencies range from 144 MHz – 146 MHz. VHF radio signals are considered to travel in a line-of-sight (also called direct wave) mode with minimal problems from skip and noise. Line-of-sight propagation means that the range of the radio link is limited by the radio horizon, being the point at which the curvature of the earth blocks the signal between the transmitting and receiving antennas.
In general, VHF High-Band systems experience better coverage range and building penetration. The increased penetration at VHF frequencies allows amateur radio stations the ability to achieve in-building coverage with fewer repeater towers and less output power.

On rare occasions, VHF signals may propagate in a mode called “ducting.” This occurs when a temperature inversion provides atmospheric conditions such that the radio signal becomes trapped between layers in the atmosphere. The radio waves travel in the “duct” and may propagate for long distances.

The repeater station has an associated coverage footprint that helps in extending the range of communicates with fixed and portable radios in the area. Hams communicate from their Hand Held radios or base station equipment at their homes with others as long as they remain within the coverage footprint of their repeater station.

This mode of operation can be advantageous communication during emergency situations (e.g. Flood, Cyclone, Tsunami etc), when mobile stations travel to the scene of a disaster recovery effort.

The amateur radio stations at Ramanadhapuram, Kovilpatti, Pollachi, Thiruvengadam, Nagarcoil made several successful contacts using the repeater station located at Kodaikanal, Yercaud, Rajapalayam and repeaters in Sri Lanka with an effective area of coverage beyond 250 Kms. Successful contacts were made with Hams in southern districts of Tamil Nadu and Northern Kerala make successful contact using kodaikanal repeater station.

The VHF distances between the amateur radio stations at different locations coastal areas in this study being more than 100 kms, existing repeater stations were used to ascertain the range of VHF communications.

The VHF communication stations located at Cuddalore, Nagapattinam and Thanjavur did not report any successful two-way communication contacts between them or with other Hams due to non-availability of repeaters in their range. Field experiments were therefore conducted along the coastline to identify locations and area of coverage of VHF signal in these locations.

An experimental repeater station was step up at an elevated point in Kodayar in the district of Tirunelveli to achieve long range communication in the southern districts of Kanyakumari, Tirunelveli, Tuticorin, Ramanathapuram. This repeater was also accessed by Hams in the southern region of Kerala State providing a vide coverage area of over 200 kms radius several hundreds of radio contacts were recorded during the days of operation. This repeater station was accessed and used during ship to shore communication experiment at Kanyakumari.

The point-to-point communication was achieved between stations of Kilakarai - Ramathapuram, Kovilpatti – Thiruvengadam on VHF band. ¼ wave VHF antenna installed at each of the location at a height of 30 feet.

The VHF communication stations at Chennai, Cuddalore, Nagapattinam, Thanjavur were located at distances beyond 100 Kms over land and did not report any direct contact with each other anytime during the year.

The VHF communication between Chennai, Pollachi, Ramanathapuran, Nagarcoil, Thiruvengadam, Kilakarai were predominantly by using the repeater stations located at Kodaikanal, Yercaud and Rajapalayam. The log sheet data from Ramanathapuram and Thiruvengadam reported access to repeater stations located in Srilanka during the summer months of April-June, several contacts were recorded during day and night using this repeater. Table VII gives the details of repeater stations.

The table VII given below gives the repeater stations accessed by Hams in Tamil Nadu.

Table-VII: Repeater stations accessed by Hams during the study

Sl.No	Repeater location	Rx. Freq	Tx.Freq
1.	Kodaikanal	145.750 MHz 145.150 MHz	145.150 MHz 145.750 MHz (Since January 2007)
2.	Yercaud	145.850 MHz	145.250 MHz
3.	Rajapalayam	145.600 MHz	145.000 MHz
4.	Kollam (Kerala)	145.350 MHz	144.750 MHz
5.	Yatiyantota, (Sri Lanka)	145.625 MHz	145.025 MHz
6.	Nuwara Eliya, (Sri Lanka)	145.650 MHz	145.065 MHz

Ramanathapuram

The station recorded over 4941 VHF communication contacts during the project duration out of which over 3371 (1758 day and 1978 Night) contacts were made using repeater Kodaikanal, Yercaud and repeaters in Srilanka. The repeaters were accessed daily and large numbers of contacts were reported with strong to very strong signal strength.

The radio contacts made with other Hams using Kodaikanal repeater station cover the districts of Dindigul, Madurai, Sivaganga, Virudunagar, Tuticorin, Tirunelveli, Kanyakumari, Coimbatore and Theni.

Table - VIII : Summary of repeater communication at Ramanathapuram

Repeaters accessed	**Day**	**Night**
Kodaikanal	1567	1747
Yercaud	172	176
Yatiyantota, Nuwara Eliya	14	55

Repeated radio contacts with Hams as far as Bangalore and Chennai were recorded on using repeater station at Yercaud. The distance of Yercaud repeater site to Ramanathapuram station is over 285 Kms.

69 radio contacts during day and night were recorded using repeater stations in Sri Lanka predominantly during the summer months of April, May and June. Daily contacts with Srilankan Hams were recorded in the log during this period.

1210 point-to-point contacts during day and night were recorded during the period of 12 months and regular contacts were made Hams in Salaigaramam, Tuticorin, Palayamkottai, Kodaikanal with coverage of over a radius of over 100 Kms, 99% of the contacts made recorded very strong to strong signal strength report and good to fair signal strength report with different stations in month of June, September, November and January,

Farthest communication in excess of 200 Kms recorded strong signal strength with a Ham station twice, from Thiruchengode in Namakkal district in November, 2006 and again in February, 2007. On one occasion direct contact with Chennai was recorded during night in March, 2007.

Pollachi

Two-way VHF communication contacts 1480 were recorded, 83% of the contacts were made using Kodaikanal and Coimbatore repeater station almost daily during day and night. The radio contacts were recorded on regularly with Hams in Thiruvengadam, Kovilpatti and Ramanathapuram. The point-to-point contacts were recorded with Coimbatore (45 Kms) and Palakkad, Kerala (30 Kms).

Table - IX : Summary of Repeater communication at Pollachi

Repeaters accessed	**Day**	**Night**
Kodaikanal	521	562
Coimbatore	101	50

Signal strength reports recorded were strong to very strong signal strength for maximum contacts made, Fair & Good signal strength was recorded for 8 contacts in March, April, May, August and September, Weak signal strength was reported only for 3 contacts for one day in March and on two days in September.

Thiruvengadam

Over 3710 VHF communication contacts were made accessing 6 repeater stations (including one from Sri Lanka and one from neighboring state of Kerala), 232 Point-to-point communication contacts were recorded with stations from Rajapalayam (45 Kms), Manamadhurai (80 Kms), Tuticorin (75 Kms), Paramakudi (70 Kms), Kodaikanal (100 Kms). About 0.4% of the contacts recorded signal strengths ranging from fair to poor on different dates during the year, remaining contacts recorded very fair to very strong signal strengths.

Table - X : Summary of Repeater communication at Thiruvengadam

Repeater	**Day**	**Night**
Kodaikanal	1450	1299
Rajapalayam	283	72
Yercaud	157	90
Kollam	46	69
Yatiyankota (Srilanka)	4	8

The station also made Point-to-Point contacts during ship to shore VHF communication trails near Tuticorin and recorded very strong signal strength measurements.

Kovilpatti

During the 12 months over 5258 (1588, daytime and 3670 Nighttime) contacts were recorded on VHF communication almost daily at different periods of time. A maximum number of 4929 radio contacts using the Kodaikanal repeater station out of which over 1433 during day and 3496 during night were recorded. Very strong signal strength report was recorded for all the contacts made from this station.

Point to point radio contacts were also recorded very strong signal strength reports for contacts with stations from Rajapalayam(55 Kms), Tuticorin (45 Kms), Thiruvengadam(25 Kms), Palayamkottai (50 Kms) in all months. One contact with Ham stations at Ramanathapuram (90 Kms), Madurai (85 Kms), Kodaikanal (115 Kms) was recorded in the month of December.

Table – XI : Summary of Repeater communication at Kovilpatti

Repeater stations worked	Day	Night
Kodaikanal	1433	3496
Rajapalayam	127	25

4.3 VHF mobile communication

Nagarcoil - Ramnathapuram

To ascertain point-to-point VHF propagation communication was checked from base to mobile station. A slim-jim antenna was installed at a height of 40 feet above the ground at Base station in Nagarcoil, successful contacts made with the base station on 'simplex' mode from the mobile station were recorded in the month of July. The area of coverage for point-to-point communication was achieved within the radius of 50 kms, without distortion in the signal or fading along the coast with respect to base station. Farthest station reported with the fading signal was reported from Palayamkottai (at distance of 70 Kms).

The contacts with the base station at Nagarcoil also reported successful contact for point-to-point communication upto Kuzhithurai along the coast. Signal fading was recorded at certain specific locations of Kolachal, Palur and Enayam.

Nagapattinam – Thirukkadayur

Field trial was conducted with a fixed station at Nagapattinam using a ¼ wave ground plane omni directional antenna installed at a height of 25 feet and a 5/8 wave whip antenna installed on a mobile vehicle was installed to ascertain signal strength reports for point-to-point communication.

Very strong to strong signal strength was recorded between Nagapattinam and T.R. Pattanam. Fair to weak signal strength was recorded thereafter at T.R.Pattanam, Karaikal and Tarangambadi. The signal strength improved from weak to fair signal from Tarangambadi to Tirukkadayur

Cuddalore - Nagapattinam

The amateur radio stations at Cuddalore and Nagapattinam which are at a distance of nearly 120 Kms did not report of any direct communication during the period.

Field trial was conducted by setting up a VHF station with a 6dB gain antenna installed at 55ft height at Thirukkadayar (35 Kms from Nagapattinam and 85 Kms from Cuddalore). Successful point-to-point communication was reported between Cuddalore and Thirukkadayar. A report of fair signal was recorded. The station at Thirukkadayar also reported accessing the VHF repeater station at Kodaikanal and fair signal strength report was recorded for a contact made with a Ham station from Madurai.

Cuddalore - Chidambaram

The signal strength report of this field trial indicate that successful VHF communication with very strong signal strength was recorded between Cuddalore and Puthuchandram, thereafter varying signal strength from fair to weak signal strength was recorded from Puthuchandram upto Chidambaram for achieving coverage area of 40 Kms. Local Ham volunteers joined the project team to conduct the field trials.

Thirukkadayur - Chidambaram

A field trial on mobile communication was conducted to ascertain VHF communication range between fixed station at Thirukkadayur and mobile station towards Chidambaram, very strong signal strength was recorded from Tirukkadayur to Kollidam bridge and varying signal strength from fair to weak signal strength was recorded thereafter upto Chidambaram for achieving a distance for 45 Kms.

Sippipari

In month of December, A VHF communication station was setup top of a hill in Sippipari village between Tiruvengadam and Kovilpatti for a field communication study. Hand-Held hand VHF transceiver with 2 watt outpower was used for Point-to-point communication. Direct contact was established with Hams in Nagacoil, Kodaikanal,

Muthur, and Thiuchengode. Several contacts were made using Thiruchengode repeater station. Local Hams in the area also participated in the field trial along with the members of project group.

4.4 UHF Communication

A field trial was conducted between a fixed station at Nagapattinam and a with mobile fixed with UHF equipment and antenna towards Valankanni, strong signal strength measurements recorded upto Parali and weak signal at Velanganni the distance between the locations is about 12 Kms.

4.5 VHF communication from Coast to Sea

Nagapattinam

A fishing vessel was used to conduct field trial to study propagation from coast-sea at Nagapattinam during June and November. A directional antenna, 6dB gain antenna installed on the vessel at a height of 15 feet above sea level. The base station antenna on the coast was at the height of 50 feet above the ground. The vessel was fixed with the Garmin Navigator GPS for checking the accuracy of distance covered as well as direction in motion. Signal reports were exchanged at regular intervals by giving the longitude and latitude. By plotting the co-ordinates on the map the area of coverage recorded 42 Kms and 45 Kms on the path from coast to sea.

Cuddalore

The fishing vessel was fixed with a 6dBgain antenna and 5/8 wave installed at a height of 15 feet above level during June and November. The antenna height at the base station was at the height of 30 feet above the ground. The successful contacts achieved propagation of radio signal to a distance of 38 Kms and 44 Kms from coast to sea.

Kanyakumari

The field trials at this location were conducted in the month of October on HF and VHF frequency bands. The vessel was fixed with a whip antenna for HF communication and 6dB gain antenna for VHF communication, Yagi antenna. The VHF communication equipment was connected to the automatic position reporting digital interface module which is also connected to the GPS receiver. The information was transmitted as data packets through digital interface module programmed to transmit GPS information every 60 seconds. Uninterrupted point to point communication was achieved upto a distance of 56 Kms at receiving station in Kanyakumari, members of the PRSG also visited the station while the data communication was being received. Regualar voice communication

with this station was conducted on a different frequency in VHF band as well as using repeater station at Kodayar.

The experimental station also worked on HF with the other stations in Tamil Nadu along the coast. The station was monitored making contacts with Hams as far as Hyderabad on 7MHz HF frequency band. The members of PRSG were present at Nagarcoil station while vessel was communicating on HF band, very strong strength report was recorded.

Poompuhar

VHF communication trails were conducted from coast to sea in the month of March, 2007 at Poompuhar, Tuticorin, and Eruvadi. 6dB gain omni directional antenna was installed on top of the vessel at a height of 15 feet from the surface and communication link was tested with the receiving station installed identical equipment configuration having antenna at a height of 36 feet. The information on current location of the vessel with longitude and latitude was communicated to the receiving station at regular intervals of time until the reported signal strength decreased from very strong to weak signal. The range of amateur radio communication was calculated by plotting the longitude and latitude positions on the map, the results indicate 52 Kms at Poompuhar, 65 Kms at Tuticorin and 62 Kms range with very strong signal strength measurement was recorded.

A typical Plotting of vessel course using longitude and latitude coordinates based on GPS information exchanged during a field trail conducted at the coast of Nagapattinam in the month of June is shown below:

Fig-18: Plotting of vessel course using GPS information to measure range of VHF communication.

5. Awareness programs and Interaction with local bodies

The ham volunteers conducted demonstration and lecture programs explaining the usefulness of the amateur radio communication technologies to students, disaster management experts, NGOs as well as interacted with officials in the local administration.

National Engineering College, Kovilpatti.

Polytechnic College, Kovilpatti.

Mohamed Sathak Polytechnic College, Kilakarai.

Nagapattanam Polytechnic College, Nagapattanam.

National Workshop on Disaster Preparedness in Agriculture in Thanjavore.

Helpage India, Nagapattinam.

Helpage India, Vedaranyam.

Nachimuttu Polytechnic College, Pollachi.

SSM College of Engineering, Komarapalayam.

DRDA, Cuddalore

District Amateur Radio Centre, Ramanathapuram

Awareness and Interaction with NGOs and fishermen community leaders and societies was conducted at following locations:

Cuddalore

Nagapattinam

Ramanathapuran

Tuticorin

Nagarcoil

Poompuhar

The interactions with the vulnerable communities living at different locations in the coastal areas indicate the lack of awareness on existence of communication tools which can provide life saving information in their times of need. Awareness campaigns have to be a continuous process, if any technology is to be introduced including amateur radio for social good and also economic development. The successful test results of amateur radio communications can provide communities with direct channels of communication in these locations along the coast areas to ensure accurate information can be provided with adequate early warning. Amateur radio, citizen band radio and public telephone networks only empower people to enable them to self support in the event of calamities/catastrophes. Amateur radio can play a major role not only as a disaster management tool but also as a instrument for improving the quality of life of people with extensive technology support and skills it gives to people.

6. Conclusion and Recommendations

The High Frequency (HF) band has traditionally been used for long distance radio communication because of reflecting properties of the ionosphere. The ionosphere is a natural resource that is always present, but its dynamics and variability makes it difficult and unstable propagation medium. Knowledge of ionosphere behavior and trained operators have been absolutely necessary in order to communicate efficiently. Practical observations and theoretical knowledge assist amateur radio operators to achieve reliable and efficient long distance communication.

Inspite of the development of other techniques for long distance communications such as satellite communication, mobile phone communications and Internet, amateur radio operators in particular still have strong interest in HF communications because of its reliability of communication and its effective use in times of Natural calamities like Cyclones, floods, Earthquake, Tsunami etc. Efficient use of this data and natural resource of amateur radio communication can provide better understanding for utilization of this resource.

The study shows that the desired frequencies for amateur radio communication in coastal areas for disaster management are 7.035 Mhz for communication during day and 3.565 Mhz during night for HF communication and 145.200 MHz on VHF for point-to-point communication are suitable among in India. The above frequencies are suggested taking into consideration the activity of Hams on the said frequency band, use of frequencies for various radio nets.

The Global Amateur Radio communications conference has also made similar recommendations as centre of activity per band as follows:

40M	7.060 MHz	80M	3.760 MHz	15M	21.360 Mhz
17M	18.160 MHz	20M	14.300 MHz		

Based on the experience during the above experiment, the following recommendations are made

1. Establish amateur radio VHF repeater stations along the coastal areas of the country.

2. Establishing Permanent Amateur Radio Stations in the coastal areas particularly at Chennai, Cuddalore, Nagapattinam, Tuticorin, Nagercoil, Ramanathapuram with HF/VHF communications alongwith VHF repeater stations.

3. There is an urgent need for dissemination of information about the relevance of Amateur Radio to Fishermen community through seminars, Exhibitions, Mock exercises, community meetings by Amateur Radio groups.

4. Establish amateur radio VHF base stations at Schools/Colleges/Public institutions /Community Based Organisations and NGOs for every 10 Kms along the coast.

5. Youth in coastal areas particularly fishermen community be encouraged to train in amateur radio disaster response Course.

6. Preparation of amateur radio emergency communications Handbook & study material including Video/CD of Amateur Station Operator Certificate examination syllabus.

7. Create a database of propagation conditions in amateur radio communications in entire country especially for all coastal areas of the country.

8. Amateur Radio beacon stations need to be established in the country particularly coastal areas to provide round the clock monitoring of HF propagation conditions.

9. A detailed investigation on utilization of Automatic Position Reporting systems (APRS) for forwarding position and weather reports from vessels at sea need to be carried out.

10. A detailed investigation of the contribution that Echolink, Winlink can make to Amateur radio communications along the coastal areas. The proposed Repeater stations should utilize the technical resources in amateur radio communications like Echolink, Winlink etc. for Improvements in sea safety.

After wide public consultation among Indian and foreign amateur radio communication experts at Hamfest 2006 & 2007 and on noteworthy suggestions / recommendations by various institutions including The President of India, the Planning Commission, Ministry of Home Affairs, NHRC, The Central Vigilance Commissioner and several others in the recent years the following recommendations are also made:

11. Considering the modern communication practices Morse code test may be eliminated as a prerequisite for access to frequencies below 30MHz.

12. Foundation licence may be introduced and arrangements made to permit holders of other licence classes to operate on a greater range of frequency bands including WRC approved recommendation to extended amateur radio frequency band in 7MHz (i.e. from 7.000 MHz to 7.2000 MHz)

13. Amateur Station Operator Certificate examination/licensing process in India need to be simplified and promotional/development projects in Amateur Radio to be supported by Government.

14. Allowing Amateurs to connect radio equipment to the public telecommunications network and/or internet for disaster management.

Although the points focused above are perhaps not generally considered as mainline Amateur activities, all use Amateur Radio facilities to provide a community service. In this way, it is my hope that it will attract an interest in Amateur Radio from groups for whom its resources can provide valuable assistance in their primary objectives.