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Radio Direction Finding (RDF) - Geomagnetic Monitoring Study of the Himalaya Area in Search of Pre-Seismic Electromagnetic Signals

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Abstract

The study proposes to present data on the broadband electromagnetic monitoring (SELF-VLF band, 0-32000 Hz) able to work 24h7, within the electromagnetic monitoring network with RDF (Radio Direction Finding) technology. The area monitored for the experimentation is the Himalayan one, historically hit by strong and devastating earthquakes. The study collected 2991 groups of radio-anomalies, related to the crustal diagnosis and to non-destructive earthquakes. It is the first network of this type able to work on a wide bandwidth (ELF-VLF band, 0-32000 Hz) specially designed to study the so-called "Seismic Electromagnetic Precursors" (SEPs) and the "Seismic Geomagnetic Precursors" "(SGPs). This monitoring system, based on RDF technology, has been active since 2017. In questo studio viene proposta una nuova chiave di lettura dei candidate precursori sismici, sperimentabili e verificabili anche in altre parti del mondo. The areas remotely monitored by the experimental station of Rome and Pisa, in Italy, thousands of kilometers away show a convergence of the data and, in particular, the frequency bands that appear before the earthquakes of magnitude equal to or greater than 4.5 of the Richter scale, about 72 hours before the main shock. The direction of the electromagnetic signal of the future epicentral area is intercepted by the RDF system. This is the first study for the analysis of EM precursors worldwide.

Keywords: RDF system, Earthquake prediction, SELF-VLF, Himalayan area, seismic precursor, EM pre-earthquake signals.

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Ethical: This study follows all ethical practices during writing.

Contents

1. Introduction

The devastating earthquake in Bhuj, on January 26, 2001, highlighted the high risk of earthquakes in the Indian region of Gujarat (India). Recent studies [1] have shown that we can expect strong and destructive earthquakes in the Indian area and the one facing the Himalayan arc. An analysis of historical earthquakes suggests that many important earthquakes should have already occurred in this region, but that recent low activity has focused attention away from the Himalayan arc, citing scholars to underestimate the high risk of this area. The projections of previous earthquakes suggest that only one of the Himalayan earthquakes that could occur soon, could cause about 200,000 victims [1]. The monitoring carried out by the Radio Emissions Project showed that there are electromagnetic signals recorded before the strong earthquakes occurred on a global scale [2]; [3]; [4]; [5]; [6] and that such signals could be of predictive importance in a context of seismic prediction. This study, which began April 5, 2018, and ended December 31, 2018 was not only an opportunity to test the monitoring system developed by Daniele and Gabriele Cataldi, but also to keep the Himalayan area under close control, where it has been waiting for some time a strong and destructive earthquake.

2. Instrumental Used

2.1. The RDF Station in Lariano (Rome, Italy)

The RDF station (Radio Direction Finding) considered in this study is that of Lariano (Rome, Italy, Lat: 41.729535N, Long: 12.840968E), equipped with two 1 meter of the diameter Loop antennas containing 50 turns each Figure 1 aligned with each other orthogonally and with respect to the geographic poles.

It is managed by Dr. Daniele Cataldi and is equipped with a prototype radio receiver designed and built by Dr. Gabriele Cataldi that is able to detect changes in the electromagnetic field in the band VLF (0.3-32 kHz) 24H7.

3. The Study

On April 5, 2018, the electromagnetic monitoring of the Himalayan area began between the borders of China, Tibet, Nepal, Bhutan, India, as shown in Figure 2-3.

This electromagnetic monitoring was made possible thanks to the RDF - Radio Direction Finding station of the electromagnetic detection system of the Radio Emissions Project in Lariano, Rome, Italy.

3.1. The Monitored Area

The monitoring area is between 5.645 km and 7373 km from the Lariano RDF station (Rome, Italy), as shown in Figure 4.

This distance, considering the reception characteristics of the RDF station itself, is not underestimated with respect to the total coverage of the station (with a radius of 20,000 km), reaching about 1/3 of the maximum coverage (in this case the experimentation took place in 2017) [2] as shown in Figure 4.

In this case, the electromagnetic monitored signals fall below the turquoise azimuth, tending to green, as evidenced by the colorimetric map of the RDF system of Lariano (RM) Figure 5.

This azimuth is found in correspondence with the Himalayan arc, in precise East position with respect to the Italian geographical position where the RDF monitoring station is located. This geographical area is extremely large as shown in Figure 5:

- Perimeter: over 4,600 km.
- Area: 909.444.439.316 km^2.

The monitoring system therefore had to keep under continuous electromagnetic control all the emissions from this large area, considering also the vicinity of the ring of fire, which is only a few thousand kilometers and which is a very broad natural emission transmitter continuous electromagnetic and strong intensity.

The signals coming from this large area have often generated intense electromagnetic modulations, such as to cover the weak emissions coming from the Himalayan arc.

This is therefore one of the important data that should not be underestimated, which was nevertheless considered in this study and which represented a "limit" of the RDF system, in detecting further signals from the area under continuous monitoring.

4. The Data

4.1. The Signals

The signals recorded by the RDF - Radio Direction Finding system, developed by the Radio Emissions Project, concerned pulsatile or continuous increases at the turquoise azimuth (tending to green), these signals appeared very frequently, saturating, for most of the appearances, the entire electromagnetic band taken into consideration (32 kHz bandwidth), as shown in Figure 6.

Sporadic signals have instead appeared limited to certain frequencies, whose emission characteristics we will analyze later.

The study addressed by the Radio Emissions Project by means of the RDF station in Lariano, Rome, Italy, highlighted some interesting features of radioanomalies recorded during the study, a study focused on the search for signals with characteristics of seismic predictivity in the Himalayan area.

The signals considered were only those polarized with Himalayan azimuth, eliminating all the increases and electromagnetic peaks coming from other geographic areas of the terrestrial globe.

The first interesting data are the number of anomalies (having the same azimuth of the monitored area), which appeared during the weeks and months in which this study lasted. The Figure 7, concerning the number of radio-anomalies highlighted between April 2018 and December 2018 (9 months), indicates that there has been a marked increase in the number of signals recorded around the end of August 2018, with 297 groups of signals (9.93%) out of a total of 2991 groups of radio-anomalies recorded and analyzed, after which we find a large number of radio-anomalies between 22 May and 9 July 2018, with a total of 910 (30.42%) radio anomalies with the Himalayan area as an azimuthal characteristic.

A third increase in the number of radio-anomalies, however, appeared around April 20, 2018, with a total of 226 cases recorded (7.56%) as shown in Figure 7.

The variation in the number of such radio-anomalies, if we consider their electromagnetic frequency, shows very important details: Almost all the signals had a full-band emission (0-32000 Hz), with 2387 radio-anomalies (79.81 %). Small percentages of signals instead concern the frequencies included between: 5700-7600; 9500-11400; 13300-15200 (20.19%).

This shows us that almost 80% of emissions are able to cover the entire geomagnetic fund monitored, because they possess important physical characteristics, such as their intensity compared to the remaining natural geomagnetic bottom Figure 8.

This figure is certainly due to the enormous energy accumulated in the Himalayan area, where there are sources of radio emissions coming, as already mentioned, from the nearby "belt of fire", where, as you know, the energy in accumulation at the crustal level it is notable compared to other areas of the globe. This energy can generate full-band electromagnetic emissions, able to reach long distances.

The electromagnetic behavior of the recorded radio-anomalies indicates that the signals emitted in the direction of the Himalayas are extremely wide in frequency and have a variable duration, from a few minutes to many hours.

This is explainable because in this direction, we find continuous crustal emissions, the area known as the "fire circle", an area in which mechanical stress is practically continuous, finding ourselves on thousands of fault surfaces containing great energy of accumulation. The RDF system therefore receives, continuously, emissions from this area, being prospectively in the same azimuth position of the Himalayan area.

Such a bandwidth of the signals could be determined, in fact, by overmodulation of hundreds of active faults, which saturate the local electromagnetic band, which the radio receiver used in this study and developed by the Radio Emissions Project, is able to perceive and amplify, making them intelligible by the computerized system.

In this context, however, the system recorded a huge number of signals from a distance of no less than 5,600 km.

If we then go to see the time when these radio-anomalies are recorded by the RDF monitoring system, then we find the following data:

- Two main peaks of grouping of the number of radio-anomalies, was recorded between 06:08 UTC and 07:40 UTC (272 cases - 9.9%);
- A second peak was recorded again, between 09:12 UTC and 10:45 UTC (270 cases - 9.03%).
- A third grouping is instead visible between 13:49 UTC and 16:53 UTC (436 cases - 14.58%).
- A fourth grouping of anomalies is instead visible between 00:00 UTC and about 01:32 UTC (192 registered cases - 6.42%).

Also in this case, as highlighted in previous studies [7] the recording or not of radio anomalies depends on solar activity and solar illumination with respect to the recording time. The ionospheric variations provide a more or less suitable substrate with respect to the propagation of the signals coming from the Himalayan area. The majority of the radio-anomalies in this case study is highlighted precisely in the daytime, that is solar lighting, with respect to the position of the monitoring station as shown in Figure 9.

During the experimentation it was noted that out of a total of 2992 recorded cases, the behavior of the average frequency variation of the recorded radio anomalies increased drastically during the year Figure 10.

In this case, the electromagnetic emissions are almost all broadband, as already mentioned and as can be seen in Figure 8 and Figure 11.

The change in this frequency showed a marked increase compared to the signals recorded during the first weeks of monitoring.

On this increase in frequency it is not possible today to provide a univocal explanation. On this increase process solar activity could have interacted, with the approach to the solar minimum and the release of energy from the large Pacific Active Faults.

In fact, studies show that during the solar minimums (during which we are in the course of such monitoring), the energy accumulated by the planetary system is released, generating a greater number of natural catastrophic phenomena and not least the accumulation and the release of crustal energy [8].

Obviously this is only a hypothesis and not a confirmed data, further studies will be needed to understand and understand the reason for these variations, compared to the data already obtained.

4.2. Seismic Data

The seismic data relating to the Himalayan area recorded during the study show a total of 47 earthquakes with magnitude M2.5 + of the Richter scale Figure 12. These earthquakes were considered in their appearance characteristics, compared to the time period in which the radio-anomalies occurred.

The graphs from Graph 1 to 9 show an evident and important data, that relating to the electromagnetic frequency and the occurrence of the earthquake. This report indicates that in the course of strong and lasting increases there are more earthquakes, compared to the period of time in which electromagnetic emissions are few.

As regards such electromagnetic emissions, the greatest number of earthquakes seems to appear when there have been emissions with turquoise azimuth, having extended (full-band) electromagnetic frequency. This data would underline that when there is a huge flow of energy that releases itself, emitting strong and lasting electromagnetic emissions, an earthquake is most likely to be expected.

The index of the electromagnetic frequency of the radio-anomalies also says that when the signals have a lower frequency or their appearance is intermittent and not lasting in time, the earthquakes have a lower magnitude, even if the number of such earthquakes is greater, compared to the periods in which the emissions are long, lasting and extended to full band, saturating the electromagnetic frequency monitored by the RDF system developed by the Radio Emissions Project.

5. Conclusions

The total number of radio-anomalies recorded during the study is 2991, each of which correlated with Himalayan azimuth. This number is associated with electromagnetic increments having different frequency as shown in Figure 11 and duration. The data contained in this study were extrapolated from the monitoring system developed by Daniele and Gabriele Cataldi, who independently detected the electromagnetic emissions, providing indications on their azimuthal origin (frequency polarization), in relation to the entire extension of the Earth's surface and therefore taking into consideration the geographical areas of the terrestrial globe, from where such signals seem to come.

The study of radio anomalies also allowed to show how there is a relationship between the seismic magnitude of the events recorded in the study period, and the quantity of radio-anomalies that appeared in the same temporal context Figure 13.

It is clear that the increase in the number of radio-anomalies recorded in a certain period raises the seismic magnitude of telluric events recorded in the Himalayan area. This suggests that the greatest number of electromagnetic emissions can refer to a higher energy in accumulation, which then frees itself in the form of greater seismic magnitude.

These data also say that we find ourselves within a system of laws governed by thermodynamics. The first principle of thermodynamics, also called, by extension: "law of conservation of energy", is a fundamental assumption of the theory of thermodynamics; it represents a formulation of the principle of conservation of energy and states that: "Energy internal of an isolated thermodynamic system is constant". A thermodynamic universe, consisting of the system and its environment, is an isolated system. Energy is neither created nor destroyed, but is transformed from one form to another: energy can be transferred through heat and labor exchanges.

In the case of our study, the evidence of these statements is evident because the reference system that is energy in storage, seems to constantly change from one form to another, i.e. from mechanical energy, potential energy, electromagnetic energy and kinetic energy, to then return to the "zero principle" or to a thermodynamic equilibrium.

This mechanism takes place continuously, and the emissions received by the RDF monitoring system indicate precisely such mechanisms. The greater the intensity and duration in minutes or hours, the greater the seismic magnitude observed.

Summarizing the discoveries made during the nine months of monitoring, it was possible to establish the following:

1. The greater the number of radio-anomalies and the greater the seismic magnitude of telluric events that occur in a given area indicated by the RDF system.
2. The lower the number of radio-anomalies and the lower the seismic magnitude that can be expected from the telluric events in a given area indicated by the RDF system.
3. The radio emissions detected by the RDF system of the Radio Emissions Project have indicated precisely the geographical areas where earthquakes have occurred, with an error in azimuth (in degrees) that is greater for the most distant earthquakes and lower for those close to the monitoring station (in this case we speak of signal phase shift).
4. Radio emissions with longer duration and amplitude, or simultaneous appearance on different frequencies of the band plumbed by the detection system have indicated more intense earthquakes than those preceded by less durable and less extensive increases in frequency that have always preceded earthquakes of lower magnitude.
5. Normally, the electromagnetic increments highlighted by the monitoring system preceded strong seismic events even for several days. On average, this time difference reaches 20 hours.

The important evidence of these data indicates how it is necessary to continue experimenting with this monitoring technique on a global scale.

The indications provided by the RDF system developed by the Radio Emissions Project confirm the working hypotheses advanced since 2017, when this monitoring technique was used for the first time.

The ionospheric and solar interactions, according to what can be ascertained from the monitoring data, are correlated with the seismic phenomena on a global scale.

This interaction has already been known for some time, through the observations and studies of the Radio Emissions Project.

Again, this interaction was confirmed. The scientific evidence of pre-seismic electromagnetic emissions, coming from the area under monitoring, suggests that these phenomena are local and therefore generated precisely, as already mentioned, by crustal phenomena able to accumulate sufficient energy to determine earthquakes. intense.

It is also clear that such emissions are deployed from precise areas whose azimuthal position does not differ very much in degrees from the azimuthal angle indicated by the monitoring system.

This tells us therefore that this system is able to accurately indicate the areas of the planet where such signals come, suggesting in advance the area in which an earthquake will occur.

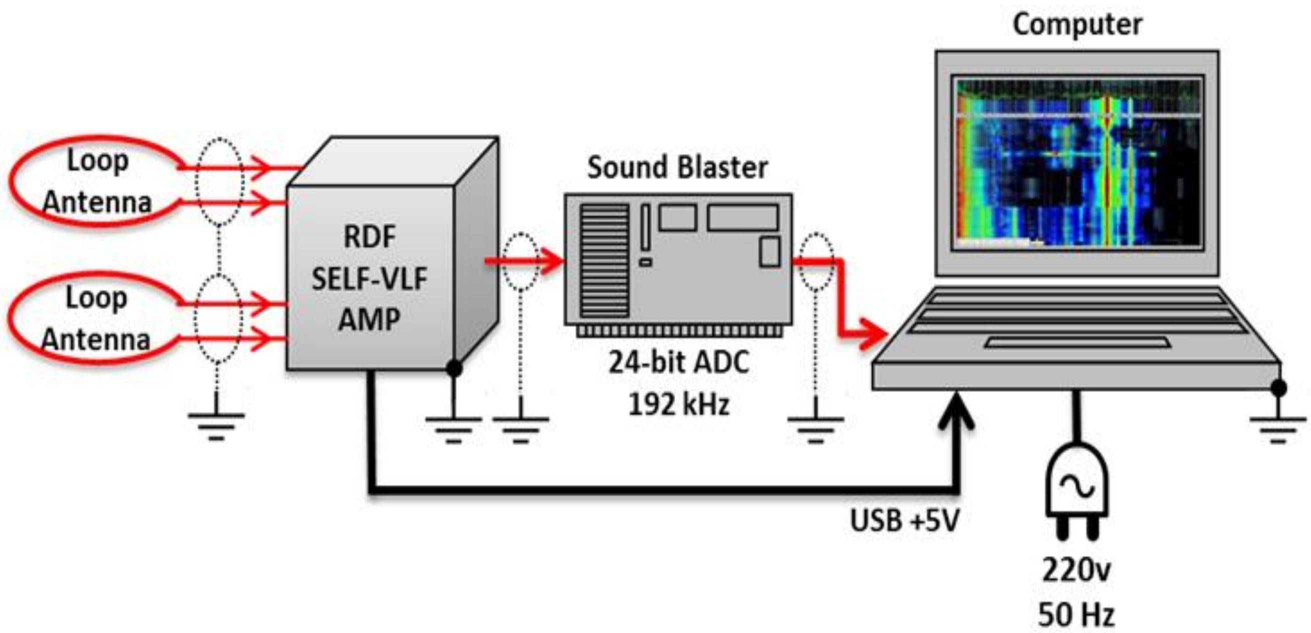


Figure-1. Schematization of the RDF Radio Direction Finding receiving and amplification system located in Lariano, Rome, Italy; developed by the Radio Emissions Project, and used for this study. It consists of two Loop antennas, a radio amplifier (receiver), connected to the PC's microphone socket, via the Sound Blaster.
Source: Radio Emissions Project, Rome-Italy.

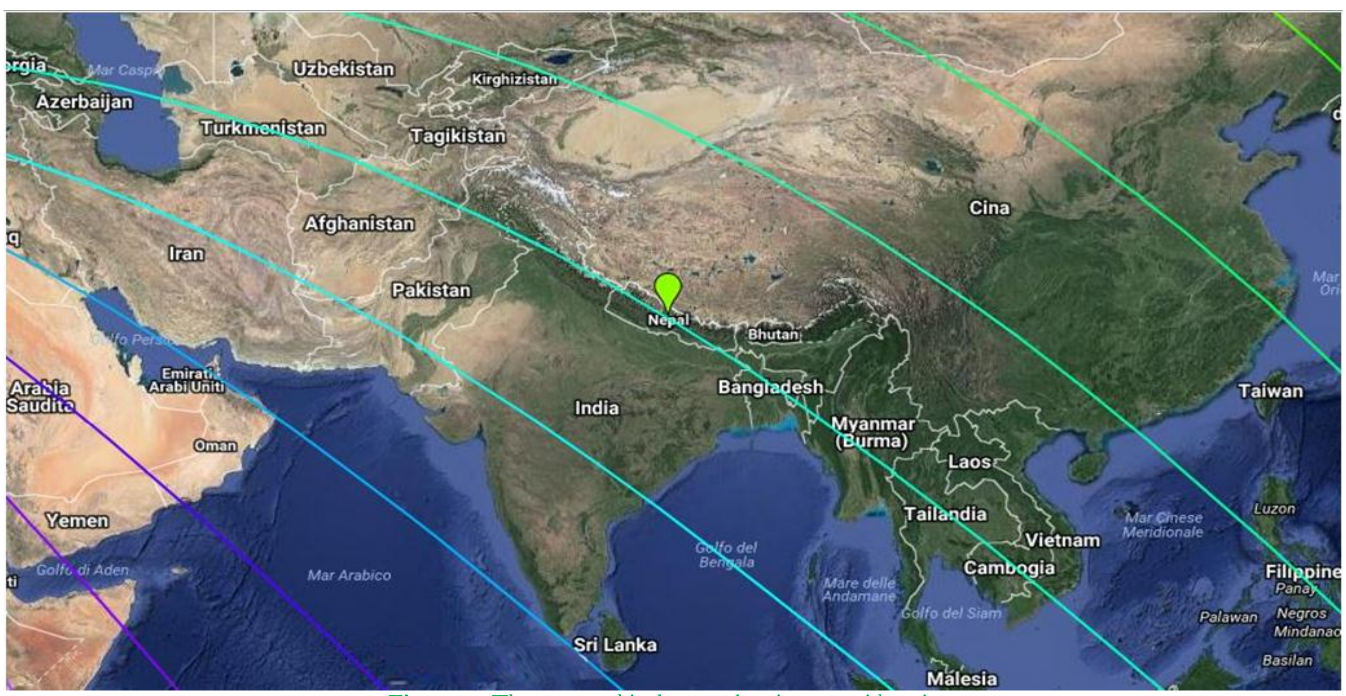


Figure-2. The geographical area taken into consideration.
Source: Google Map.

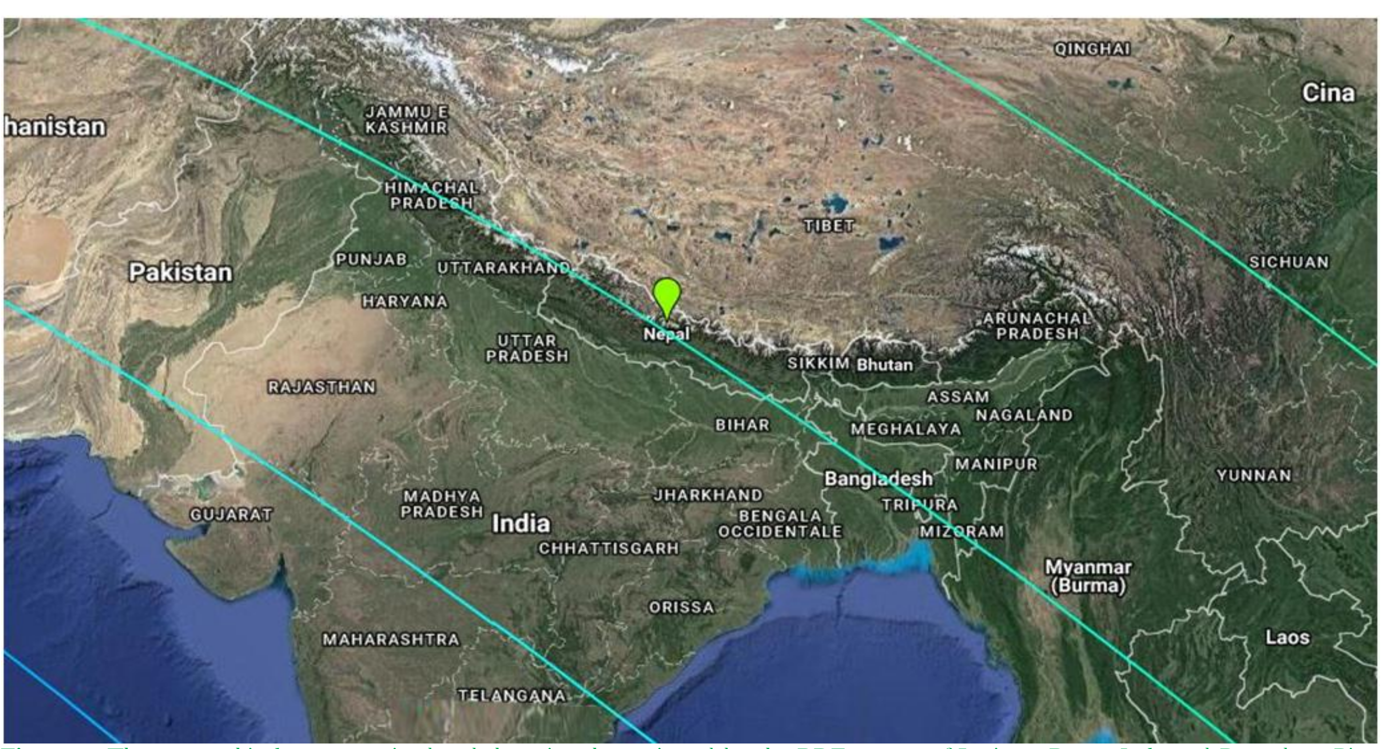


Figure-3. The geographical area examined and the azimuth monitored by the RDF system of Lariano, Rome, Italy and Pontedera, Pisa, Italy.
Source: Google Map.

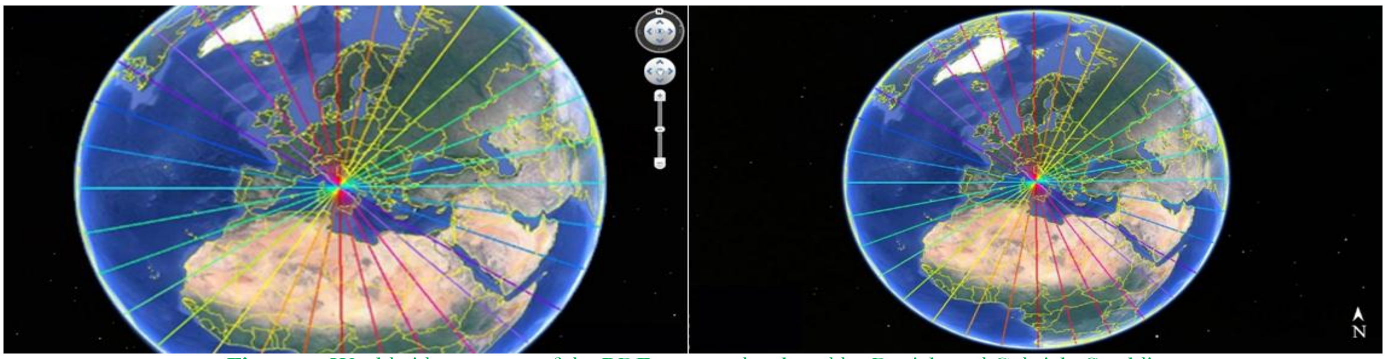


Figure-4. Worldwide coverage of the RDF system, developed by Daniele and Gabriele Cataldi.

Source: Google Earth.

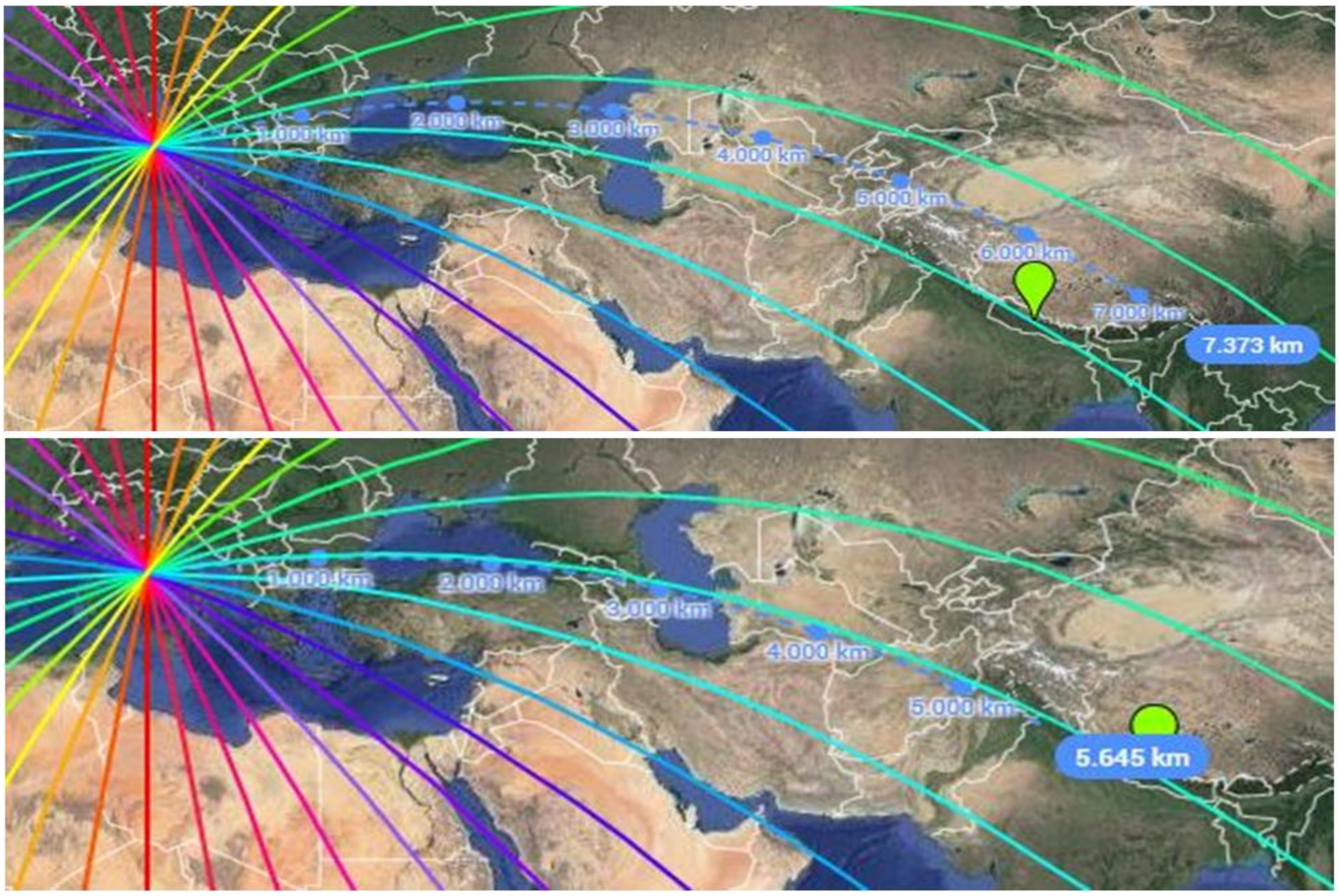


Figure-5. Distance between the RDF station of Lariano, Rome, Italy and the Himalayan area subject to monitoring.

Source: © Google Maps.

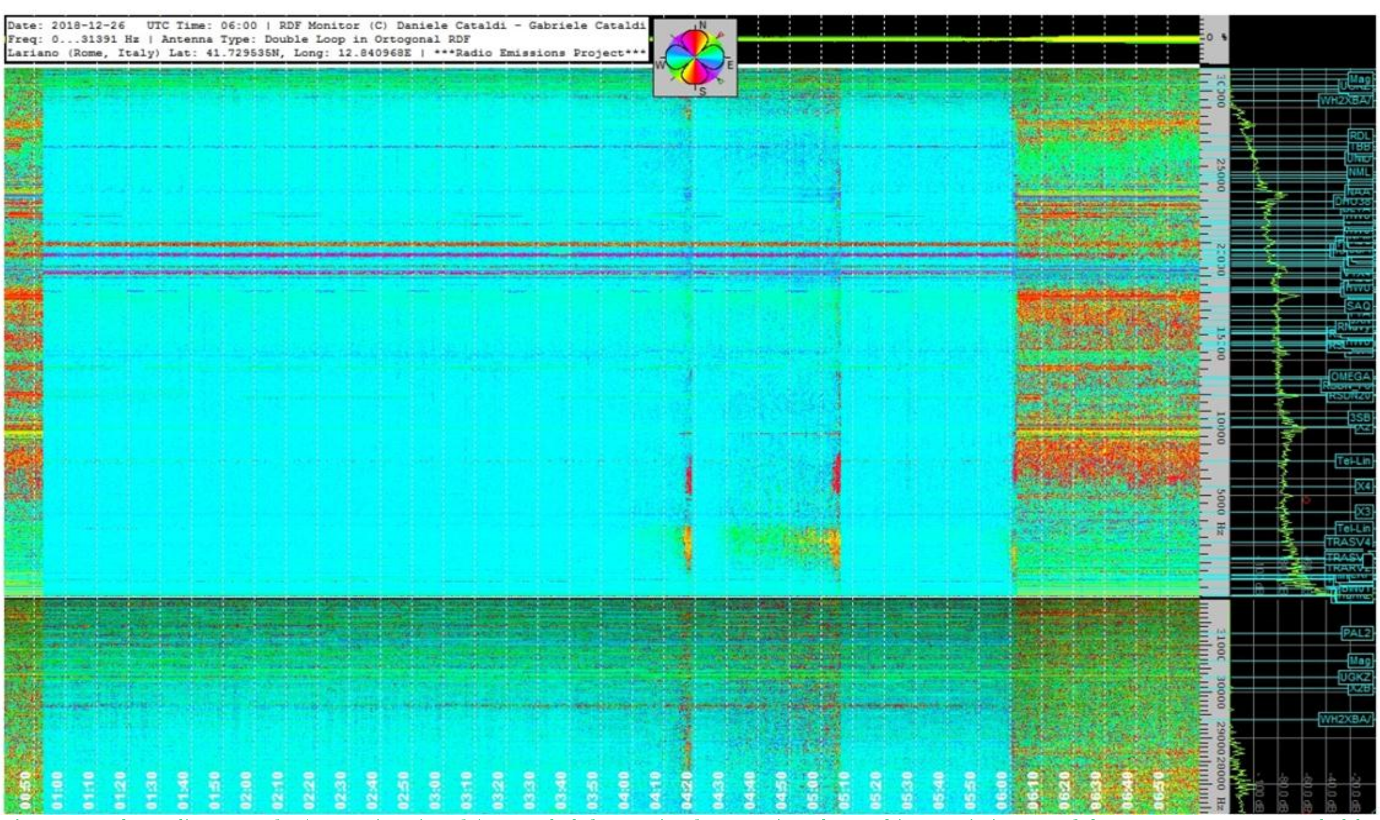


Figure-6. The radio-anomaly (turquoise signals) recorded from Himalayan azimuth. In this case it is one of the spectrograms recorded by the RDF station in Lariano, Rome, Italy.

Source: Radio Emissions Project, Rome-Italy.

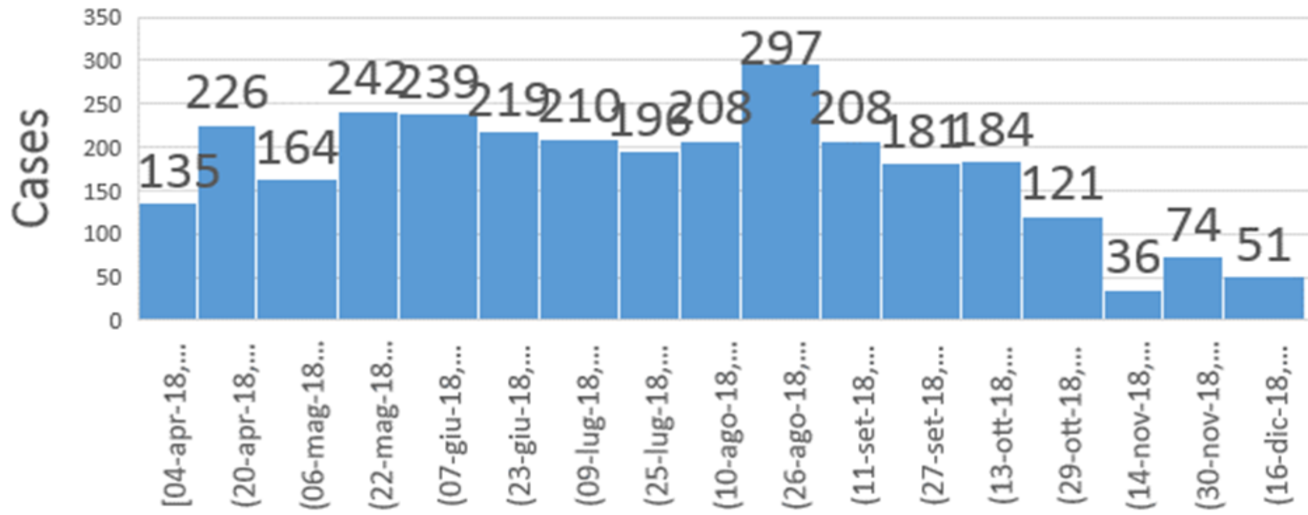


Figure-7. Relationship between the number of electromagnetic anomalies that appeared during the monitored period of the study.
Source: Radio Emissions Project, Rome-Italy.

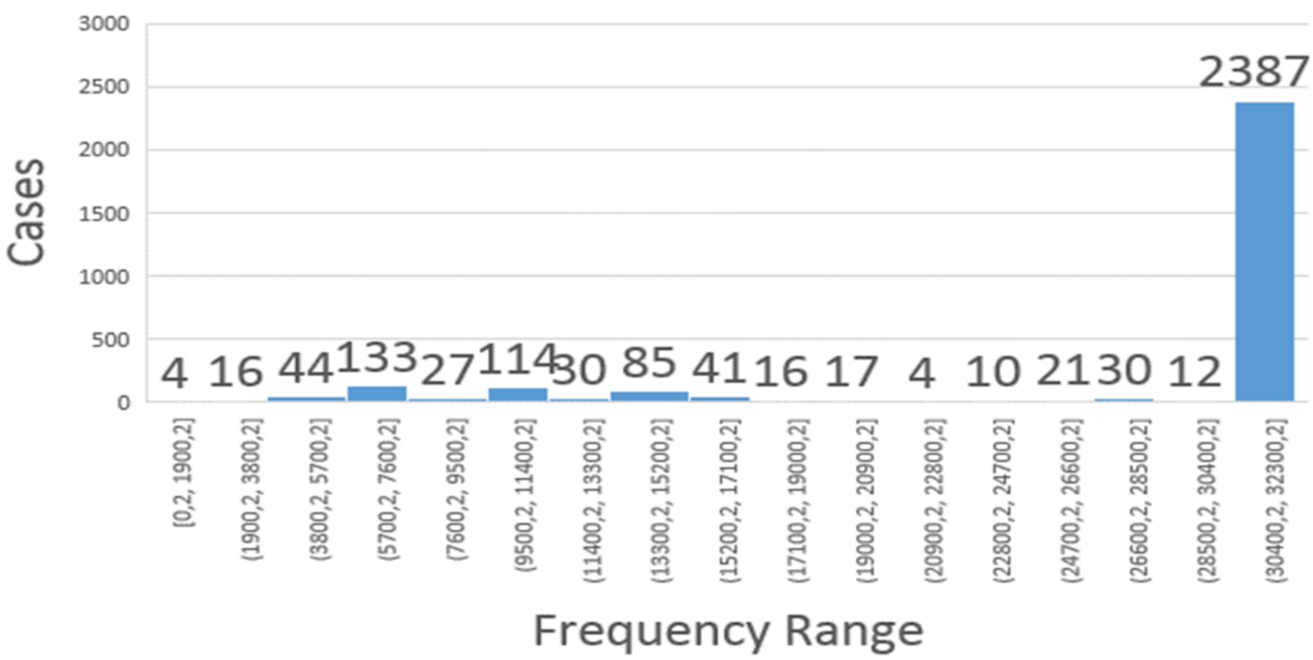


Figure-8. Relationship between electromagnetic frequency of the radio-anomalies appeared and their number in the period in which this study continued.
Source: Radio Emissions Project, Rome-Italy.

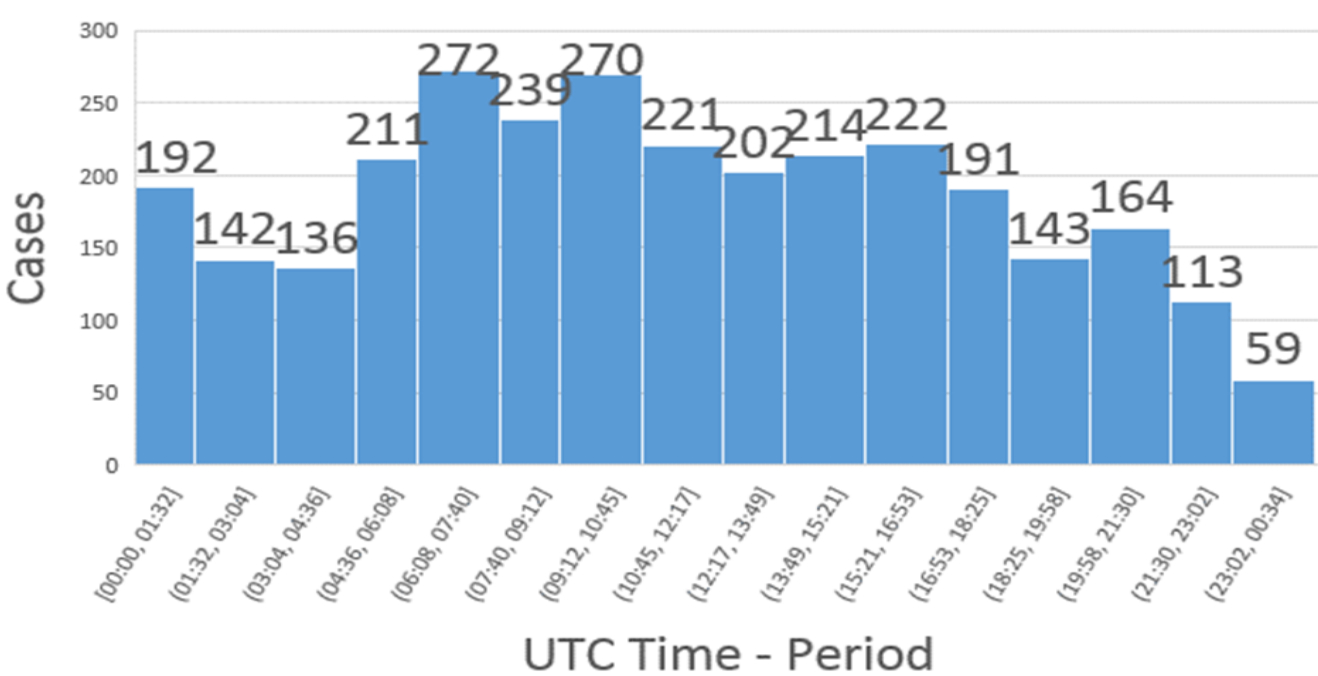


Figure-9. Number of radio-anomalies and their distribution in the UTC temporal context.
Source: Radio Emissions Project, Rome-Italy.

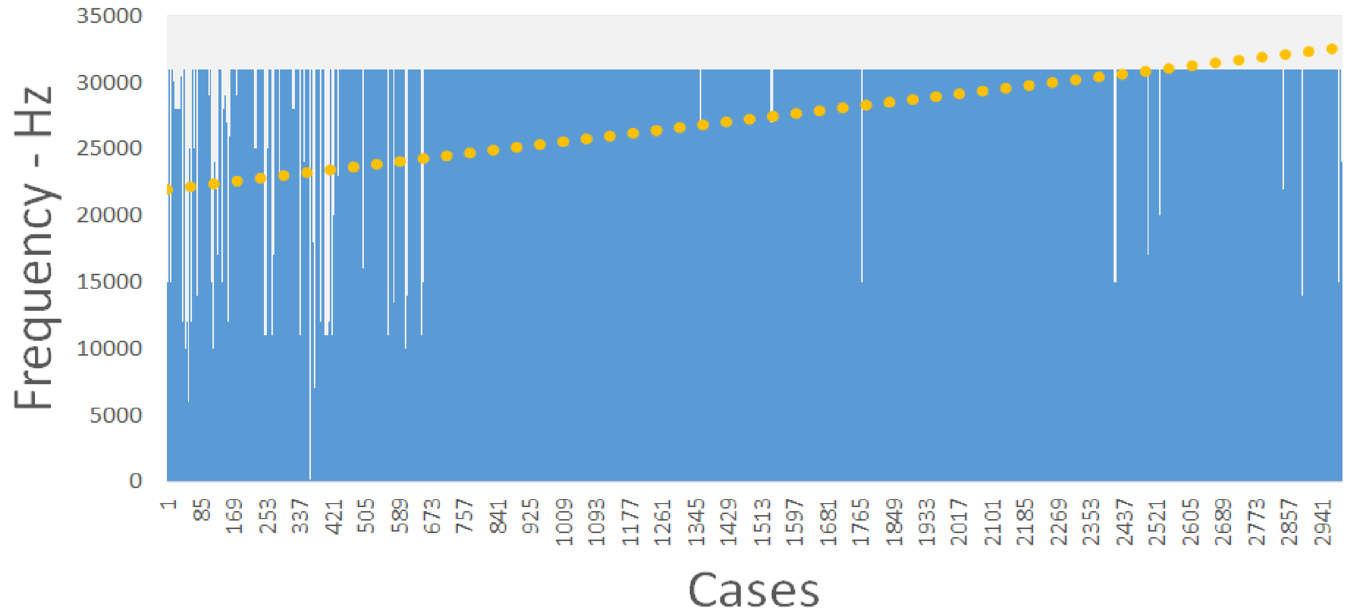


Figure-10. Distribution of radio-anomalies and their electromagnetic frequency. As can be seen, most of these include the whole electromagnetic band considered.
Source: Radio Emissions Project, Rome-Italy.

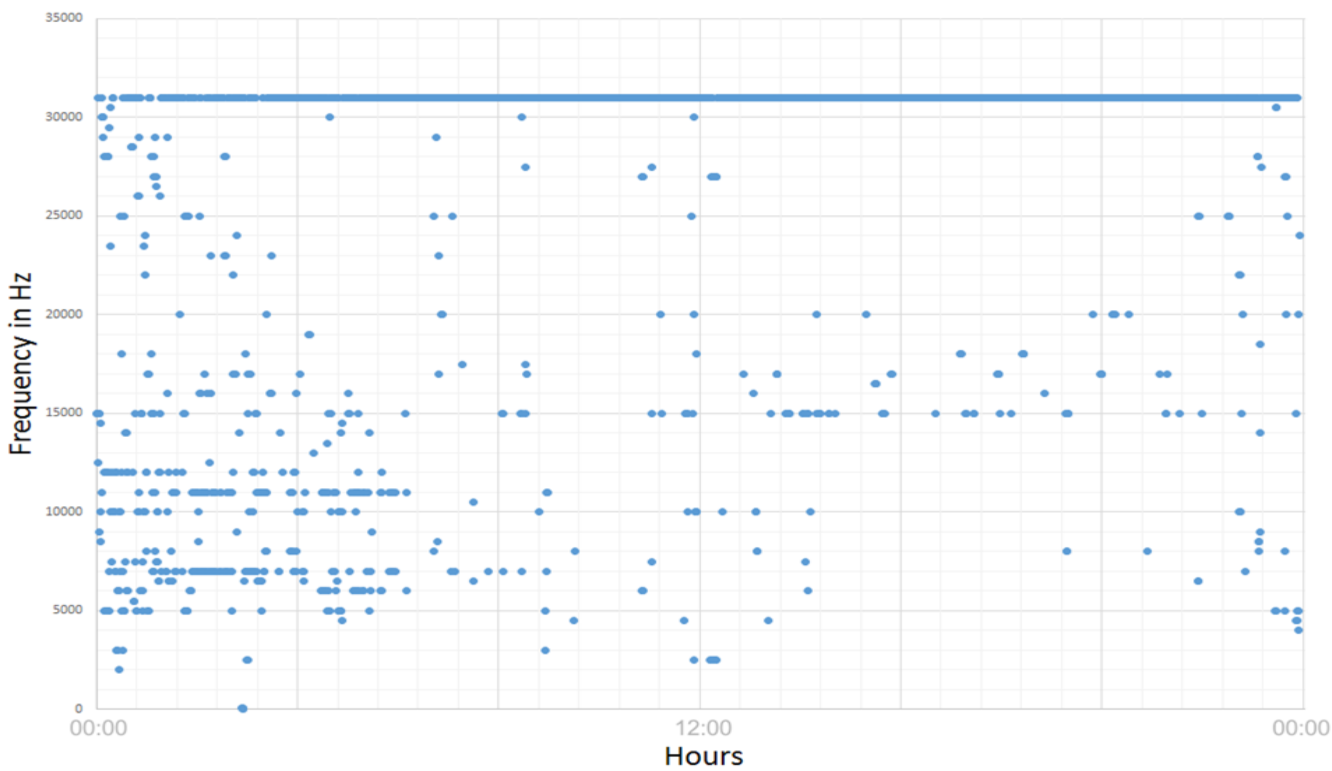


Figure-11. Distribution of radio-frequency anomalies. As it is visible the largest percentage is the one with a send width of 32000 Hz.
Source: Radio Emissions Project, Rome-Italy.

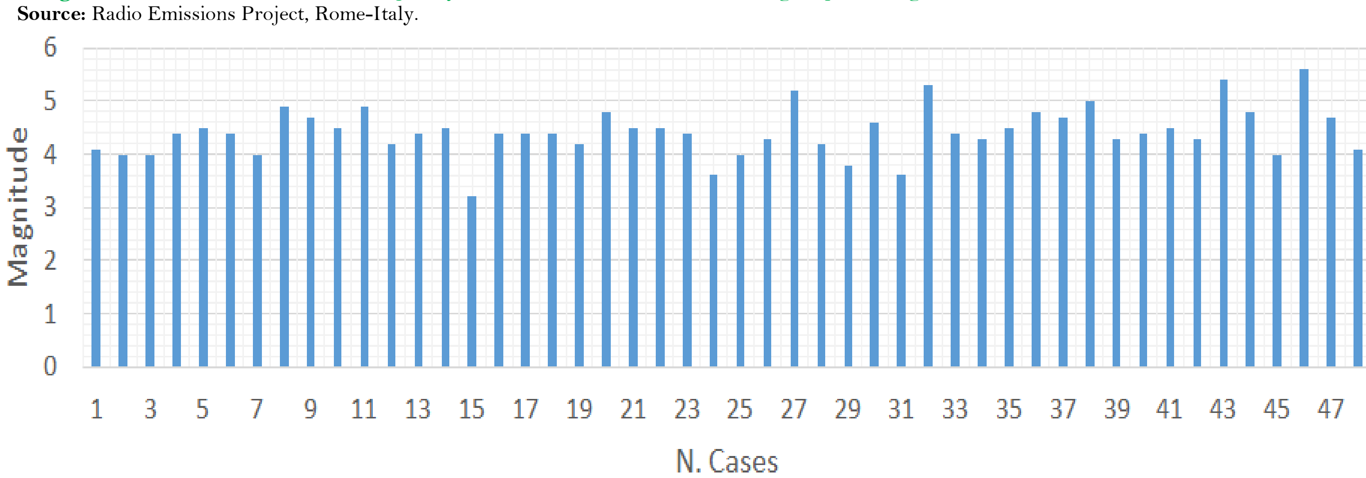


Figure-12. Distribution of the number of earthquakes, which appeared in the Himalayan area examined by the study and their magnitude.
Source: USGS

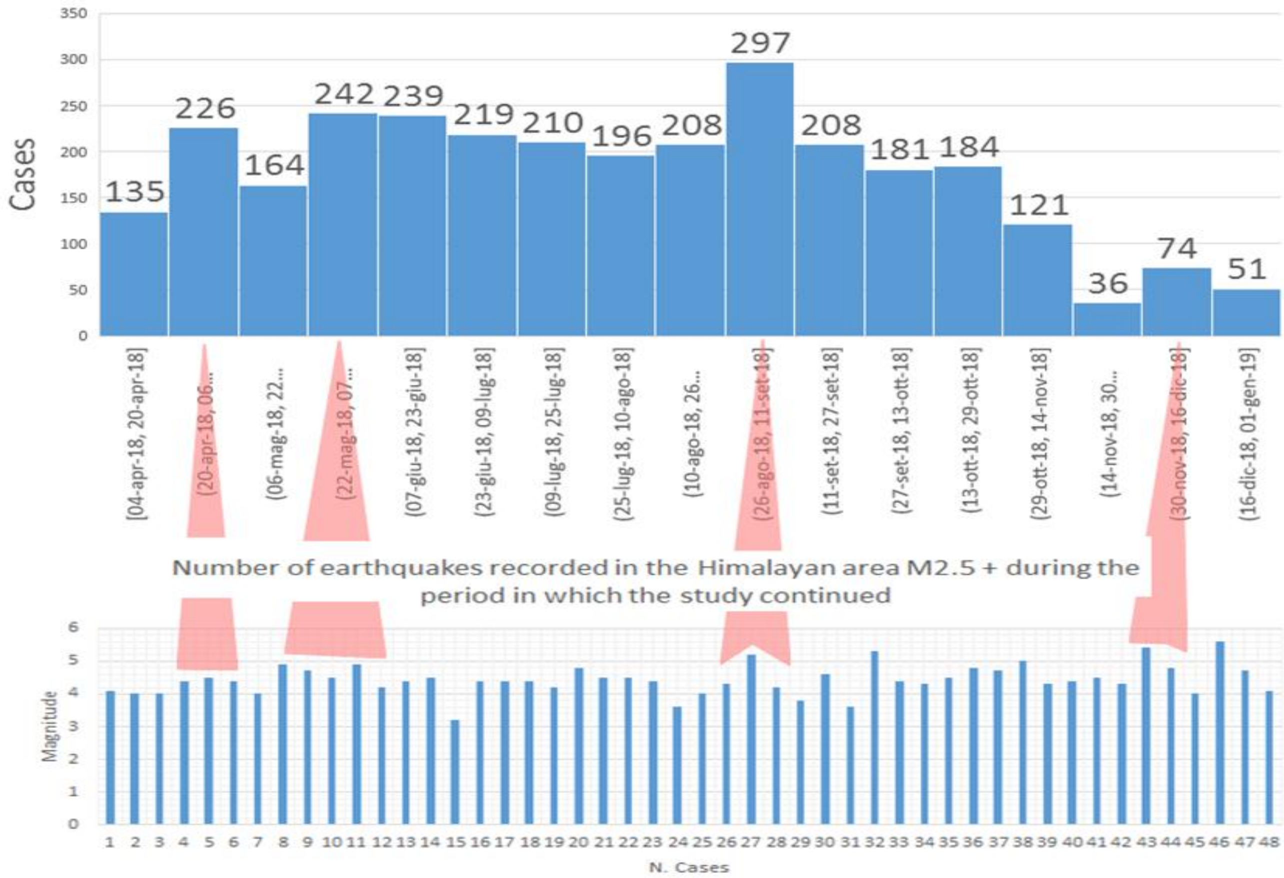
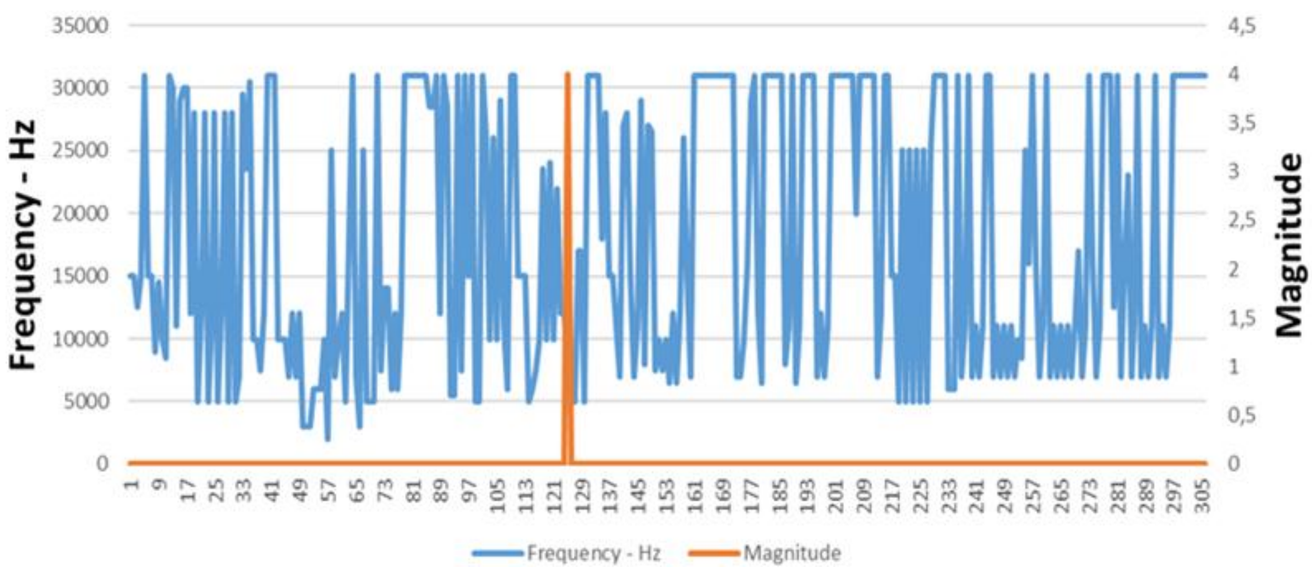


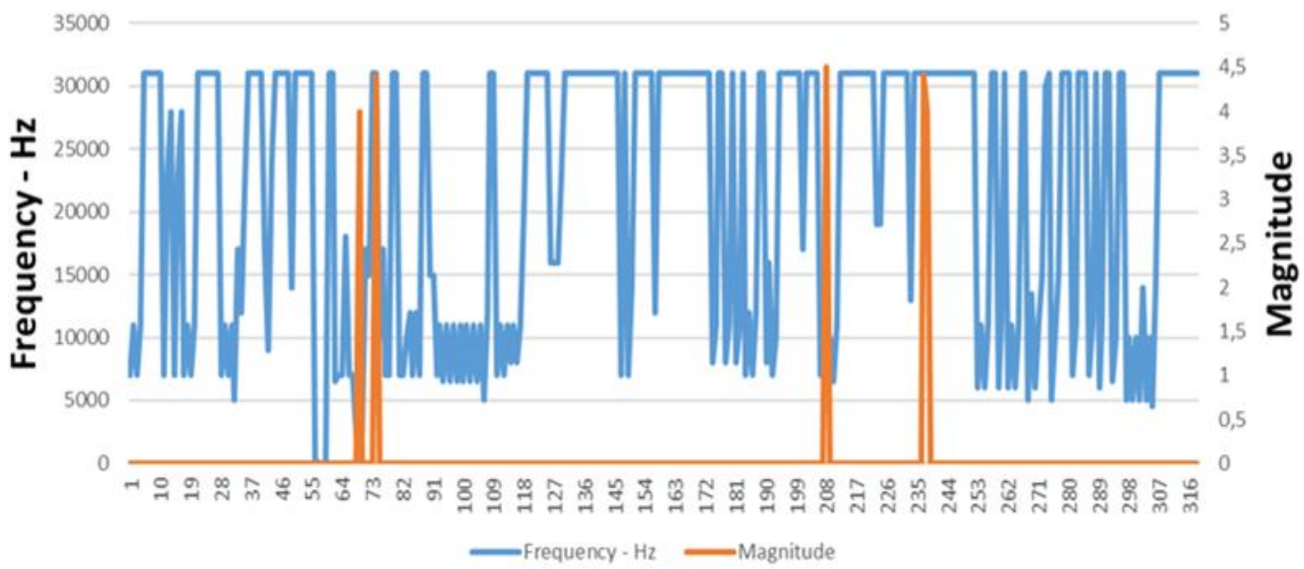
Figure-13. Relationship between the number of radio-anomalies appeared during the study (by the Radio Emissions Project) and the number of earthquakes appeared in the same period, with magnitude M 2.5+ (by USGS).

Source: USGS and Radio Emissions Project, Rome-Italy.



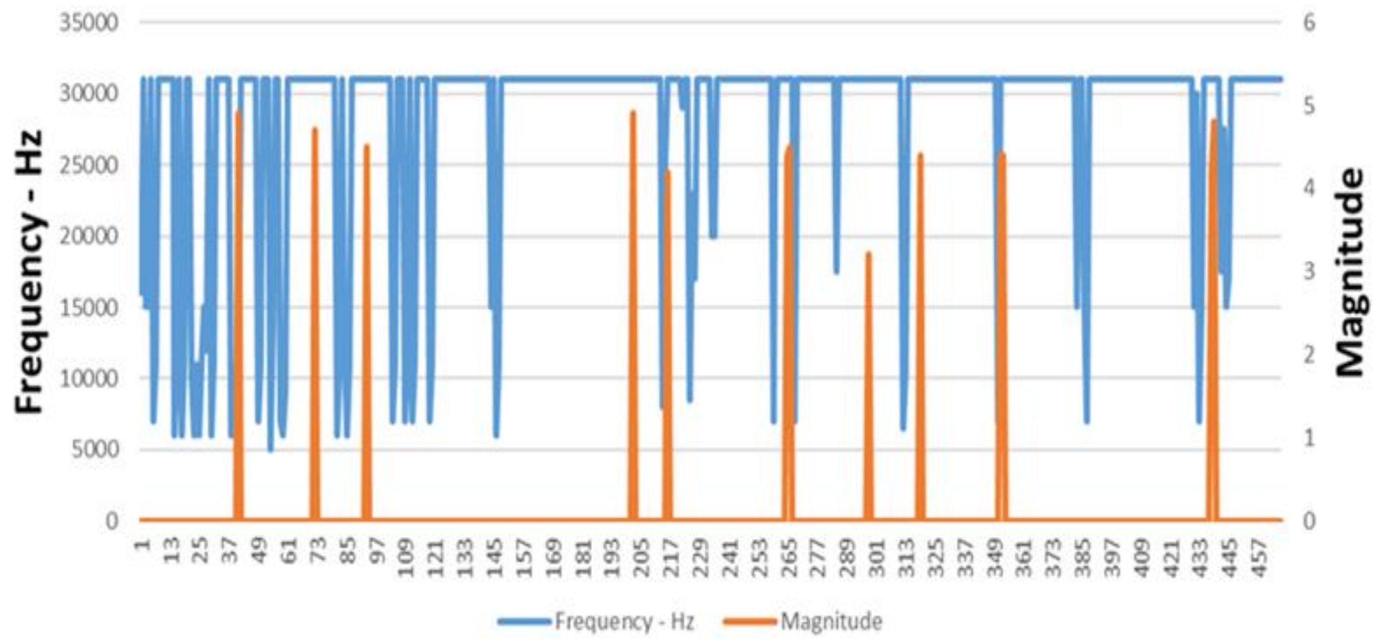
Graph-1. Relationship between the frequency variation of the recorded electromagnetic signals and the seismic magnitude of the events occurring in the Himalayan area - April 2018.

Source: Radio Emissions Project, Rome-Italy and USGS.

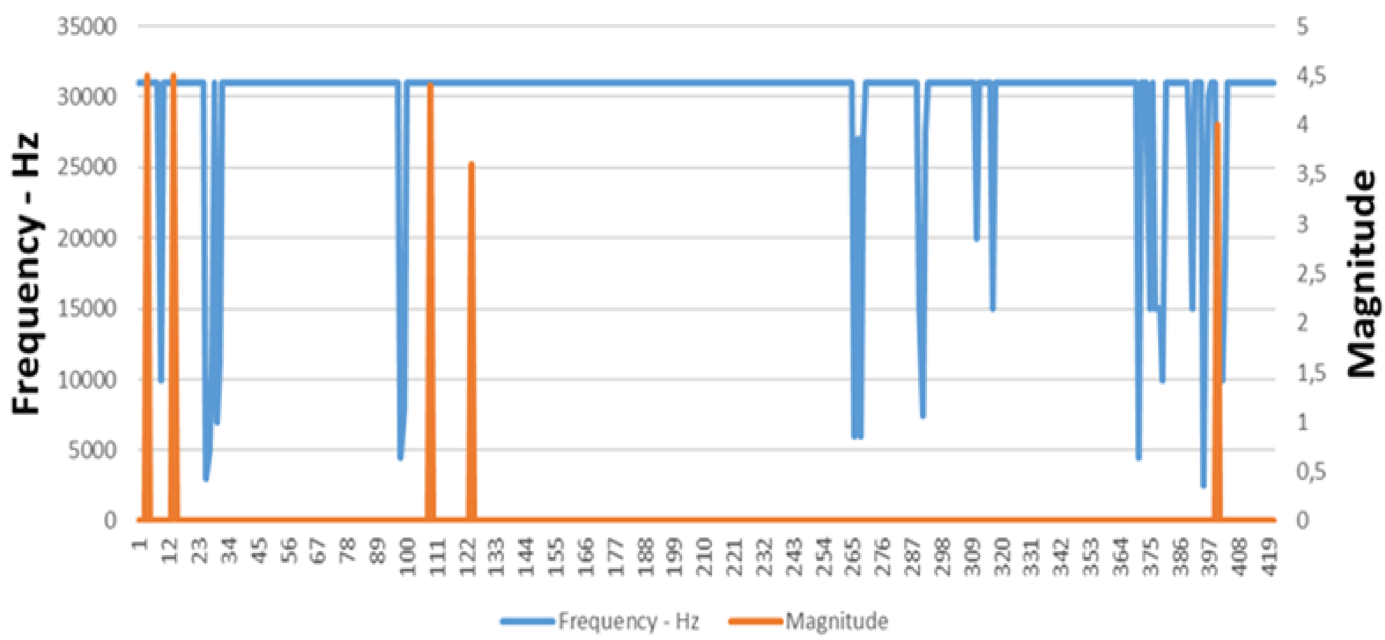


Graph-2. Relationship between the frequency variation of the recorded electromagnetic signals and the seismic magnitude of the events occurring in the Himalayan area - May 2018.

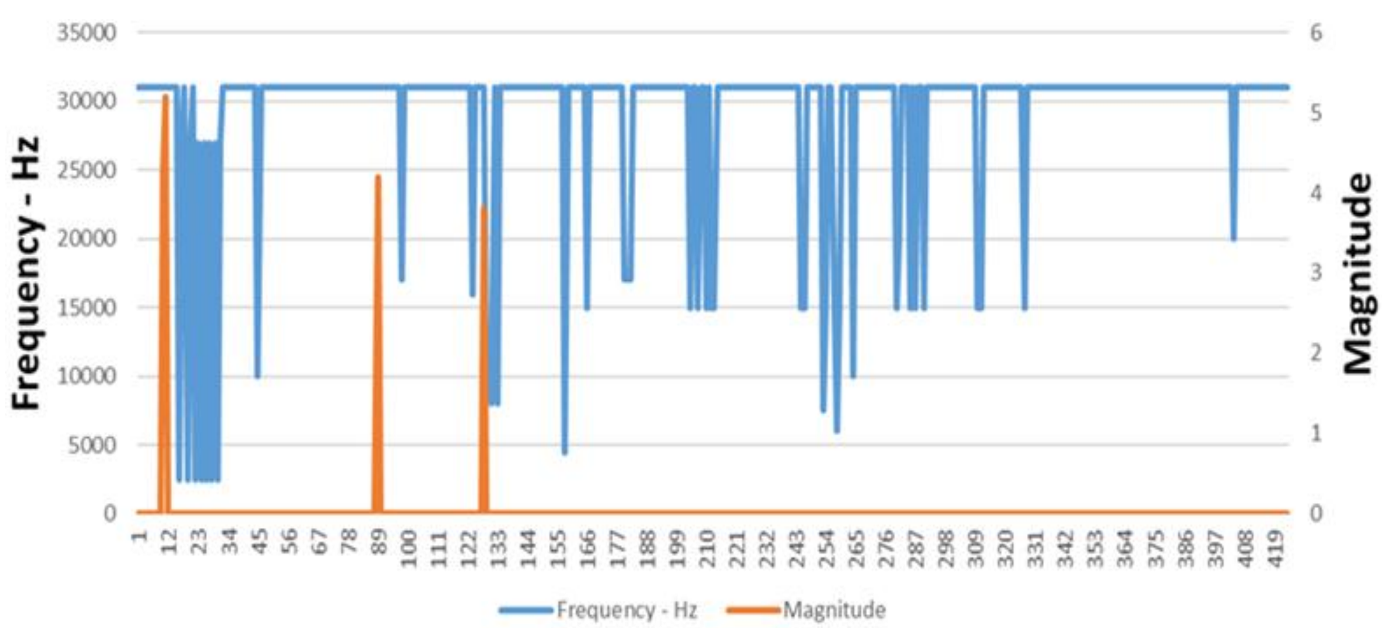
Source: Radio Emissions Project, Rome-Italy and USGS.



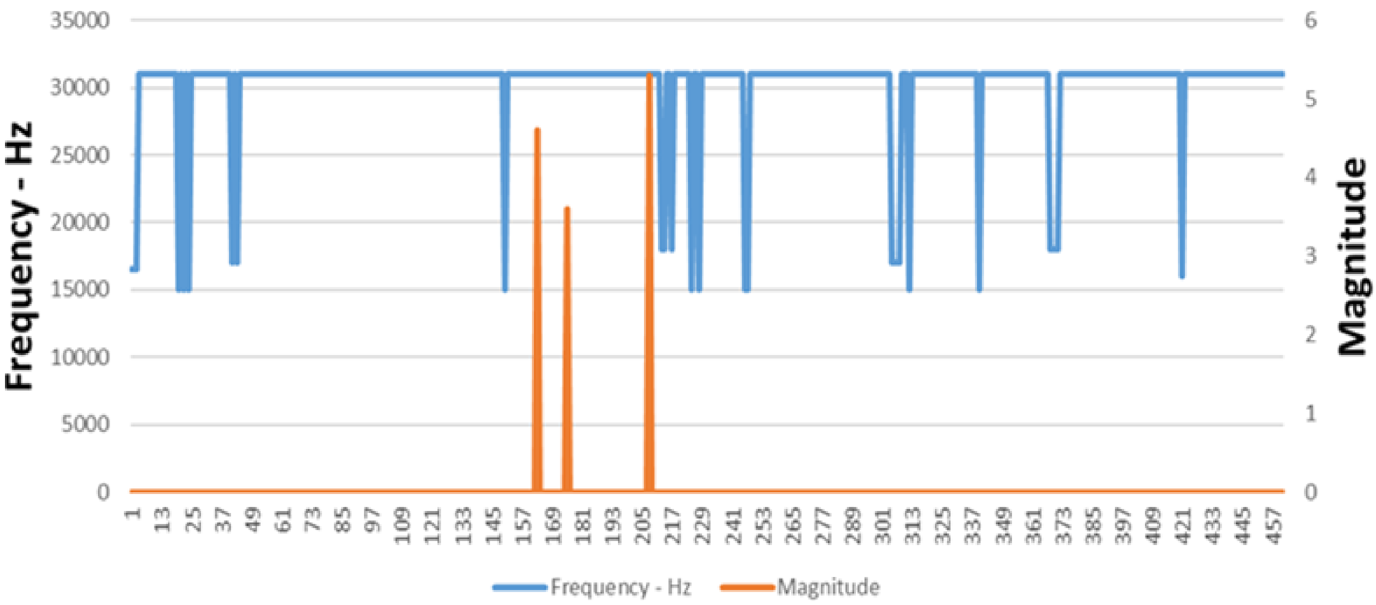
Graph-3. Relationship between the frequency variation of the recorded electromagnetic signals and the seismic magnitude of the events occurring in the Himalayan area - June 2018.
Source: Radio Emissions Project, Rome-Italy and USGS.



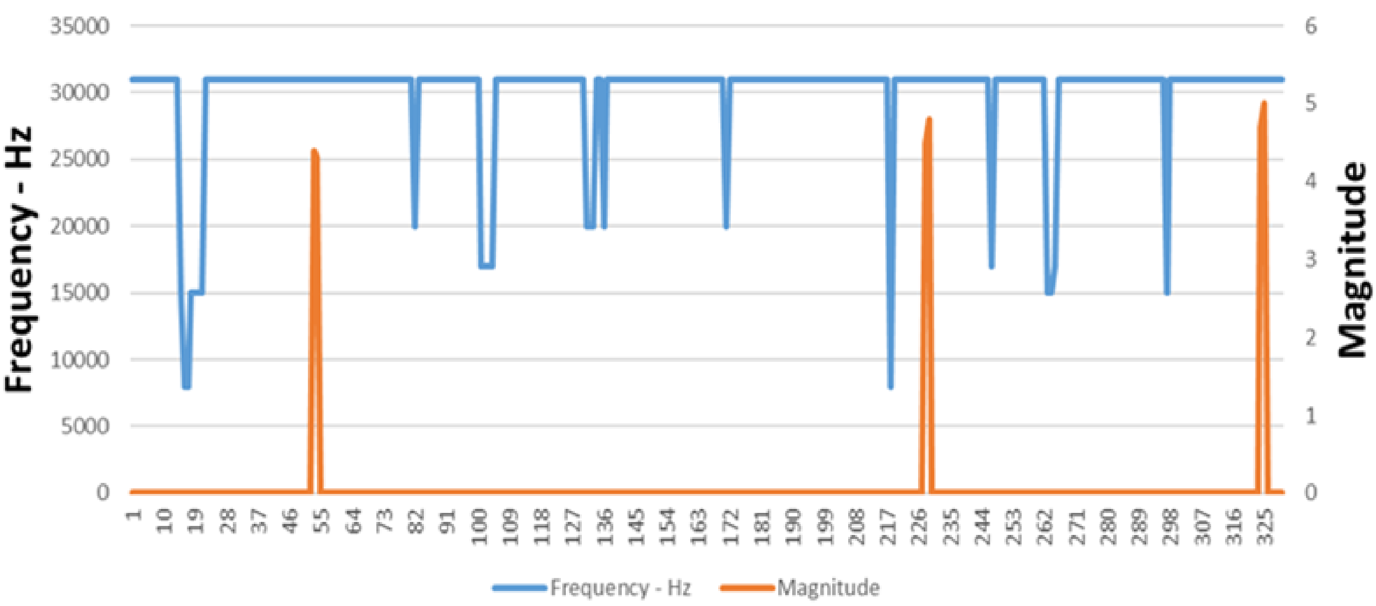
Graph-4. Relationship between the frequency variation of the recorded electromagnetic signals and the seismic magnitude of the events occurring in the Himalayan area - July 2018.
Source: Radio Emissions Project, Rome-Italy and USGS.



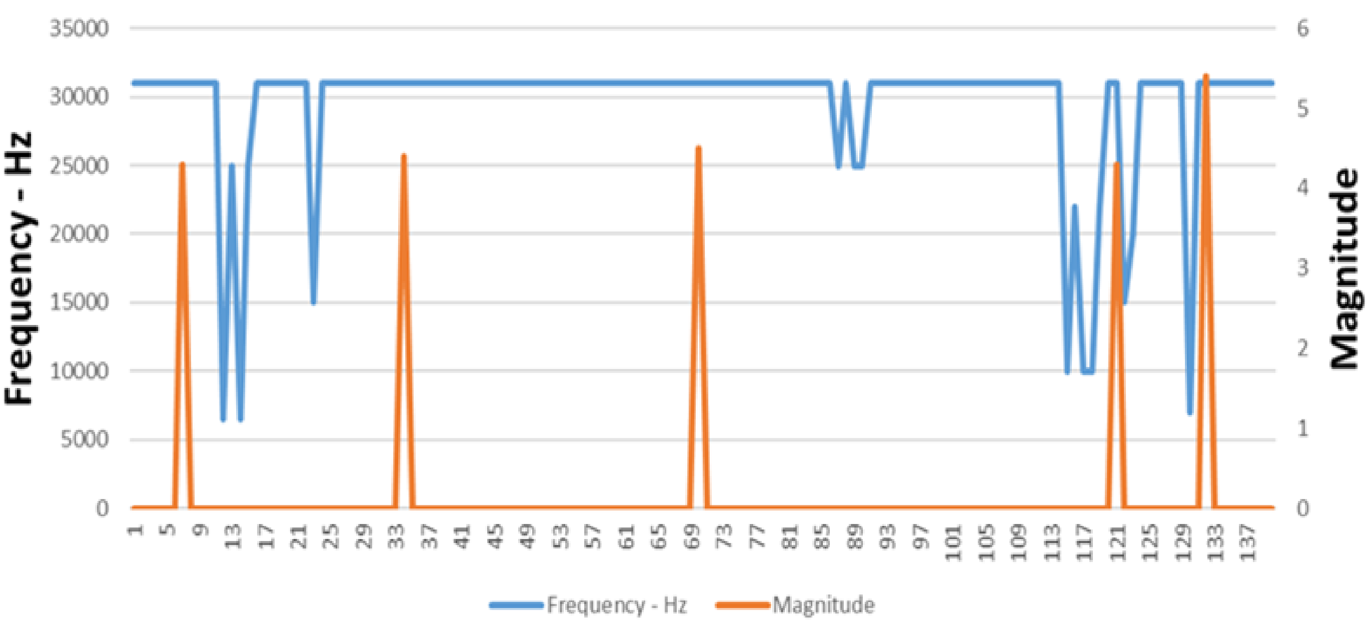
Graph-5. Relationship between the frequency variation of the recorded electromagnetic signals and the seismic magnitude of the events occurring in the Himalayan area - August 2018.
Source: Radio Emissions Project, Rome-Italy and USGS.



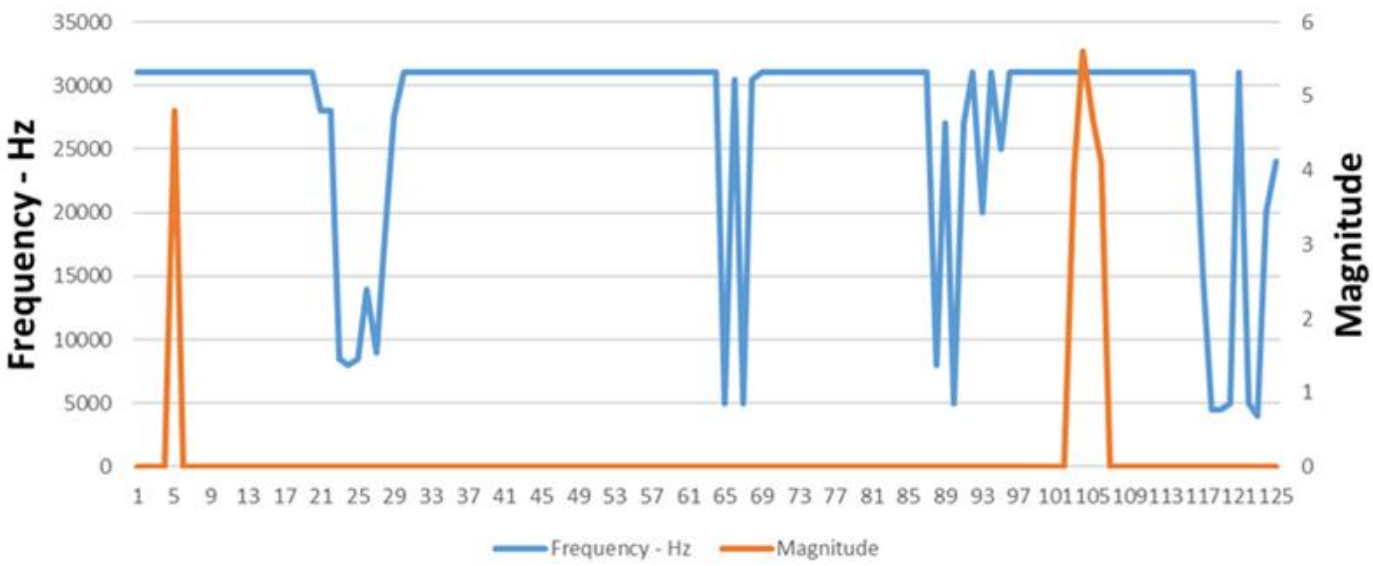
Graph-6. Relationship between the frequency variation of the recorded electromagnetic signals and the seismic magnitude of the events occurring in the Himalayan area - September 2018.
Source: Radio Emissions Project, Rome-Italy and USGS.



Graph-7. Relationship between the frequency variation of the recorded electromagnetic signals and the seismic magnitude of the events occurring in the Himalayan area - October 2018.
Source: Radio Emissions Project, Rome-Italy and USGS.



Graph-8. Relationship between the frequency variation of the recorded electromagnetic signals and the seismic magnitude of the events occurring in the Himalayan area - November 2018.
Source: Radio Emissions Project, Rome-Italy and USGS.



Graph-9. Relationship between the frequency variation of the recorded electromagnetic signals and the seismic magnitude of the events occurring in the Himalayan area - December 2018.
Source: Radio Emissions Project, Rome-Italy and USGS.

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