Ertha Technologies Inc.

Ertha Tech Inc.

Advanced Earthquake Early Warning System

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Mission Statement

The AEEWS team, endeavour to implement the Advance Earthquake Early Warning System to maximise mitigation and response opportunities to minimise and eliminate consequential casualties of earthquakes by establishing a robust and collaborative global advanced early warning monitoring, analysis and reporting network, contributing simultaneously to developing physical asset protection strategies embracing all sectors of society beneficial to governance, commerce and the individual

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Project Proposal Briefing

Setting-up and Implementation of a
Multi-parameter Advanced Early Earthquake Warning System (AEEWS) for South Asia-Pilot Nepal

Objective: Demonstration of a Nepal and a South Asia wide AEEWS capable of detecting up to 15 days in advance of a potential seismic event (M5+) with provision up to 4 days advance early warning (99 % confidence) of impending earthquakes (EQ) of M7 with pinpoint epicenter location (+/- 25 KM) at any specific geographical location in the Nepal region within 3 years project period.

Context: Asia has suffered a number of catastrophic earthquakes in recent years causing massive loss of life and assets. One fundamental cause for this significant loss, amongst others, is the critical lack of any advance warning of an impending earthquake. Earthquakes strike suddenly, and with no warning.

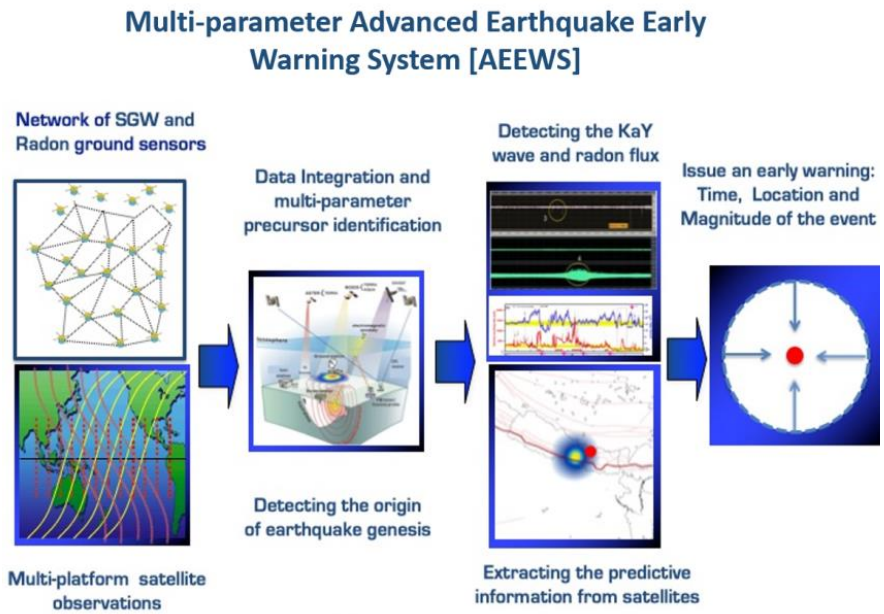
Within the recent decades, various statistical, scientific, and technological research (such as ground EM observations, radon gas monitoring, satellite atmospheric patterns, and ionospheric GPS monitoring, etc) has been undertaken through-out the world to establish any methodology or a system to predict earthquakes with any degree of accuracy for its locations, size or event time. None of these have evolved or been adopted as usable for front line mitigation strategies, to date. Ertha Tech AEEWS is the system that eliminates all such limitations.

AEEWS is based on a state-of-the-art method of integrating and monitoring specific seismic wave propagation, radon survey, and satellite observations to determine the most relevant combined signals that provide the most reliable forecast solution. AEEWS methodology integrates ground seismic, radon and use of multi-sensor satellites from NASA and other sources.

The AEEW System will demonstrate its operational EQ event and aftershock forecast capability in Nepal as pilot. Centering on Nepal seismicity provides the opportunity to extend AEEWS capabilities to surrounding EQ prone countries (India, Bhutan, Myanmar, Pakistan etc) as a larger regional AEEWS network. (add aftershock)

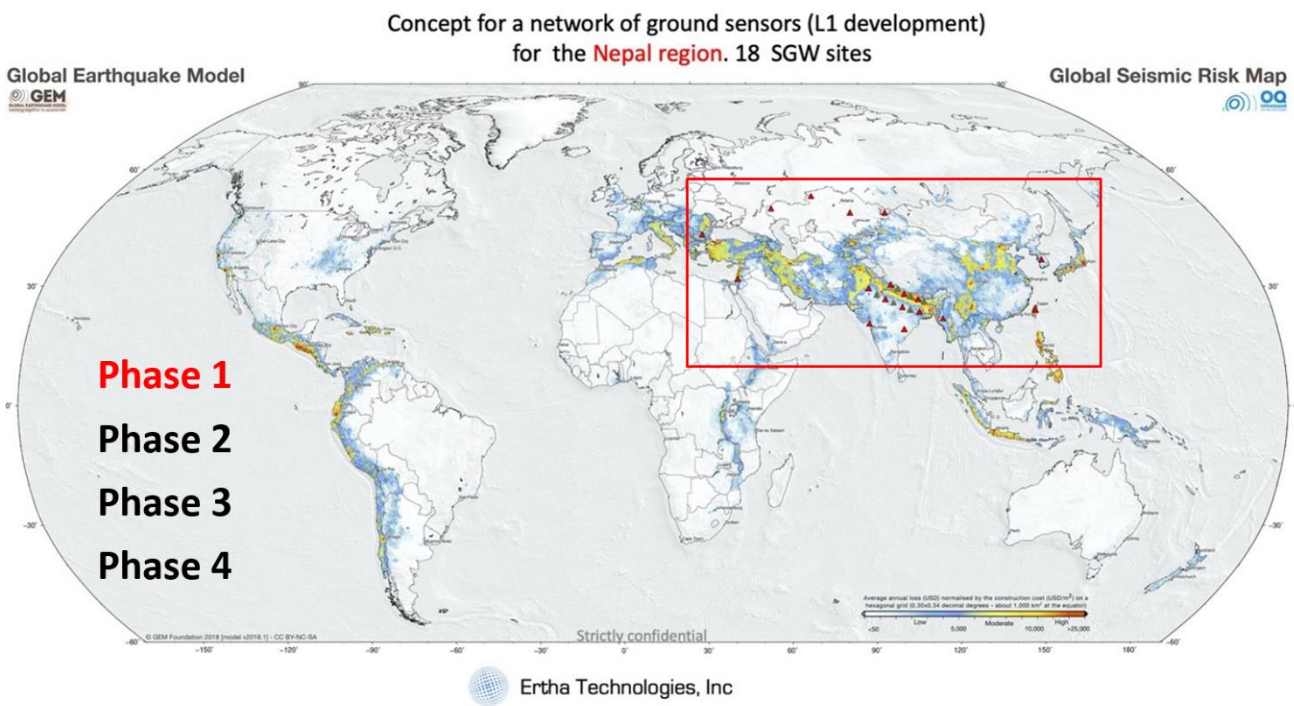
Design

The project will set-up and implement a multi-parameter sensor methodology, on the One-Network concept, integrating ground and Satellite observation in one coordinated system capable of producing AEEWS.



Key Technical Components of One-Network System

1. Ground Seismic Gravity Wave sensors installation (inside and outside of Nepal)
2. Ground Gas monitoring sensor installation (inside and outside of Nepal)
3. Satellite data observation core
4. Data processing analytics



Implementation Framework: Ertha Tech (Virginia-US) will execute the project in planning and coordination with partner institutions and states and will be the programmatic, technical, financial, and administrative manager of the pilot demonstration.

A Nepal Regional project office/ data center will be setup to coordinate specific data gathering from Nepal, as well as undertaking initial data analysis, and capacity building.. A 24/7 operations based sensor data analysis hub will be set-up in in Bulgaria for all ground based sensors (SGW, Radon, Weather), data with real-time data collation and analysis capability from 18 geographic site locations in Asia. A similar 24/7 operations based satellite data analysis hub will be set-up in the US for all real-time collection and analysis of satellite based data for various EQ precursors and parameters, and integration of sensor based data analytics for issuance of a secured AEEWS forecast. A Formal project liaison presence in other project partner countries will be maintained in support of project implementation. Specific AEEWS Asia program and business development activity for Nepal and partners countries will be set-up as to support AEEWS Asia-wide expansion and coverage.

The framework as above will also serve as an operational planning tool in implementation of an envisioned global AEEWS coverage, capable of providing precise advanced warning to over 95% of earthquake prone geographical locations of the world.

Time Frame: Three years.
Total Cost: ~ USD 33.00 Million

Financing Schedule:

1. Signing and Mobilization: ~USD 6.60 M (20 % of the total project cost)
2. At End of Sixth Month: ~USD 9.90 M (30% of the total project cost).
3. At Beginning of Year 2: ~ USD 8.25 M (25% of the total project cost).
4. At beginning of year 3: ~ USD 8.25 M (25% of the total project cost).

Primary Benefits of an Advanced Earthquake Early Warning System

The most 'cost effective' benefit will derive from the use of the advanced warning and aftershock warnings to prepare society to follow strategic instructions with the following targets:

- The primary target is to remove persons from risk environments to minimize the loss of life during any earthquake
- The second target is to ensure domestic possessions and commercial goods protection generating improved mitigation of asset loss
- The ultimate target is to develop resilience and continuity, establishing a robust society to earthquakes

AEEWS Benefits Brief

Benefits of the Advanced Earthquake Early Warning System

Introduction
After 20 years development, the Ertha Tech Team have 'packaged' a methodology of tracking the potential earthquake emergence during its preceding weeks, generating reliable advanced warnings, by monitoring the multiple individual regional ground and satellite anomaly precursors. The AEEWS is a combination of observation, monitoring, and analysis of several independent precursors. New ground-breaking analysis of gravitational-seismic processes reveals the precise earthquake hypocenter energy release location.

The AEEWS in the preceding weeks, first identifies the areas of potential seismic activity, culminating in the new game changer of Advanced Earthquake Early Warning System's ability to confirm "time location size" providing confirmed hours of advanced warning for lower magnitude to days for higher magnitudes, importantly with an accurate epicentral location, its magnitude and the narrow time window of the event occurrence.

AEEWS provides a core benefit of potentially eliminating the traditional 30km radius blind zone which even the most sophisticated existing p-wave early warning systems can not address, thus enabling a robust proactive phased response strategy to be instigated across the whole of a vulnerable society within the preceding hours and days, offering the potential development of numerous seismic event mitigation opportunities, unable to be considered before, saving billions of dollars and thousands of casualties.

Primary Benefits of the Advanced Earthquake Early Warning System:
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- The second target is to enable domestic possessions and commercial goods protection generating improved mitigation of asset loss
- The ultimate target is to develop resilience and continuity within communities and commerce, establishing a robust society to earthquakes

UN DRR strategies have demonstrated prevention and preparedness have proven to be the best practice and early warning has been prioritized within the 2015 Sendai Framework for Action and within the SDGs 2030 target. The unpredictability of earthquakes can now potentially be eliminated by the AEEWS.

Categories of benefits

Traditionally early warning falls into four categories of benefit:

1. health & safety (i.e. death and injury mitigation).
2. psychological preparedness. (removing the surprise element)
3. activation of emergency plans and situational assessment. (crisis management)
4. organisational and site-specific actions to reduce impacts and aid response and recovery. (minimising crisis deficits)

However, we can now introduce the 5th, 6th and 7th categories that will benefit in the use of the hours and days of the advanced earthquake early warning system:

5. Asset preparedness and mitigation of loss, going beyond the traditional auto mechanisms, evolving into implementing physical counter measures in the home, office, retail and industry.
6. Pre event modelling will maximise best use of the advance time to model the more precise consequences enabling the creation of intelligent pre event response strategies.
7. AEEWS also generates an aftershock 'Watchguard' ability providing minutes of prior warning of aftershocks, benefiting Emergency response teams, aid agencies and the disorientated.

AEEWS enhanced Insurance opportunities:

- Reducing risk deficits to insurers for both lives and assets, developing market footprint and consequently reducing the Insurance Protection Gap.
- Implementation of parametric insurance products pioneering advanced asset protection, improving business continuity, shortening recovery time, reducing GDP economic losses, contributing to reducing the Risk Protection Gap and facilitating improved potential benefits of Parametric Sovereign CAT Bonds

Project Target Benefits include:

1. Triggering NDMAs to activate pre-event preparedness strategies including proactive mobilisation of emergency response and security services plus relief agencies.
2. Minimizing casualties using the advanced warning for coordinated societal response through government media and public address broadcasts, prioritising the vulnerable.
3. Reducing urban and rural domestic and livelihood losses, enabling potential for crucial industry and commerce to mobilise relocation from potential epicentral zones.

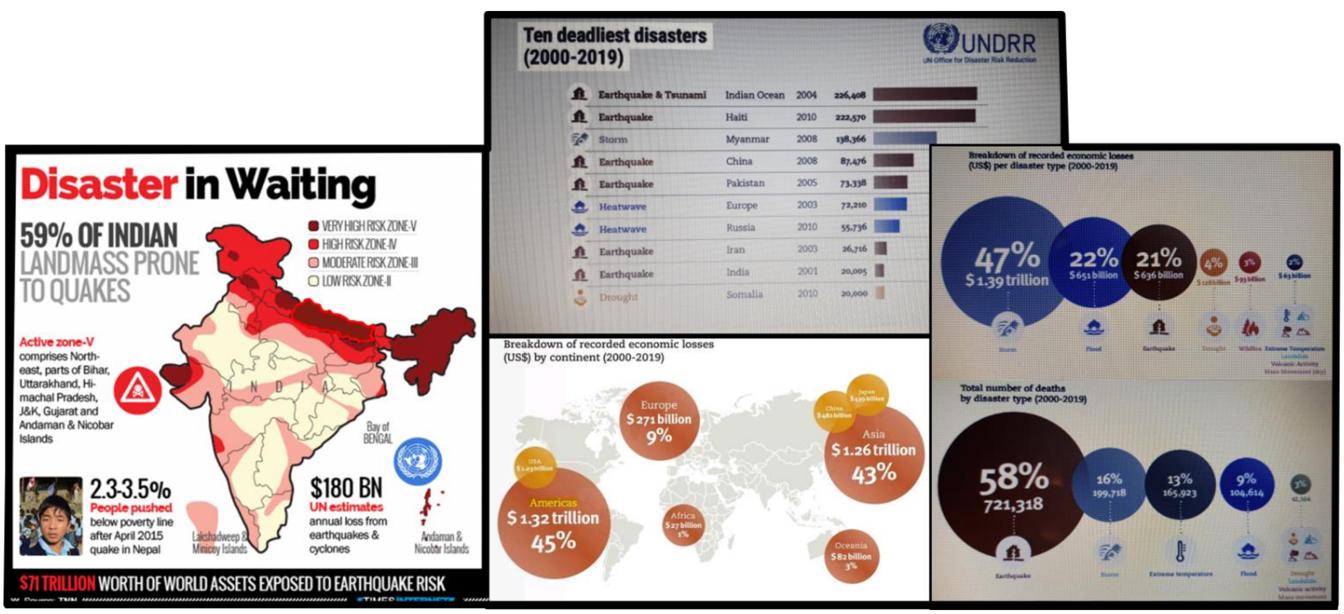
4. Instigating proactive crisis management within critical infrastructure and utility services, enhancing their event resilience minimizing disruption to service continuity.
5. Mobilising advanced protection of cultural and heritage infrastructure, artifacts, antiquities and national art and library facilities.

In summary

The AEEWS now potentially transforms Earthquake Mitigation and Preparedness, by combining the various precursor observation methods, as per the science Abstract, which generate up to 15 days growing awareness of impending seismic activity, with the SGW wave which confirms the triggering of the physical earthquake rupture hours to days in advance.

By using the generated hours/ days of advanced warning, numerous new opportunities of mitigation procedures will both minimise casualties and also enable protection of commercial, state and private assets, overall saving billions of dollars and thousands of lives.

Furthermore, potentially encouraging the reduction of the ‘protection gap’ through expanded access to Insurance. The AEEWS offers a whole new landscape within personal and economic resilience as a true Game Changer within Earthquake preparedness and mitigation previously unachievable.



AEEWS Science Briefing

Towards advancing the short-term earthquake early-warnings

Introduction

In the mid of 90s, the deterministic conception based on physical precursors was reconsidered with the introduction of the fast-developing theory of fractals and chaos [Bak et al., 1988]. The physical approach to earthquake prediction is based on Scholz et al. [1972], where the seismic cycle frame's earthquake preparation process is considered. Another important concept for short-term earthquake prediction is the earthquake preparation zone introduced by Dobrovolsky et al. [1979].

It was established that all anomalous variations of different parameters presented are observed within the earthquake preparation zone, which is correlated with the magnitude of an impending earthquake. The limited success of earthquake prediction research is primarily associated with the retrospective study of instrumental and macroseismic data and theoretical concepts. Failures of predictive studies are caused by insufficient instrumentation within the network of geophysical and other observations, insufficient depth and incomplete processing of current data, lack of knowledge about the beginning of the earthquake genesis, and the triggering process of each earthquake.

Current State of Scientific Knowledge

The influence of lithospheric processes on geophysical fields has been studied over the last 30 years and led to the creation of lithosphere-atmosphere-ionosphere-magnetosphere coupling (LAIC) understanding about pre-earthquake processes. However, despite the progress, the initial force behind the short-term pre-earthquake processes was still unknown.

To fill this gap, we further developed the initial Kozyrev's idea about the Earth's synchronicity and the Moon's tectonics. Under the influence of the gravitational fields of the Sun and the Moon on the Earth's crust (and the rotation of the Earth, the precession of the Moon and the vibration of solid crustal blocks on the Moon, creating the synchronicity of the tectonics of the Earth and the Moon, described by astrophysicist N.A. Kozyrev) the first stage indicating that next major earthquake is initiated- the low-frequency resonance of the Earth's crust blocks.

The resonance of the Earth's crust is associated with the release of underground gases (radon, methane, CO_2, etc.) a rise in temperature in the atmosphere, and an increase in electron density in the ionosphere. Thus, the connection between the lithosphere, the atmosphere and the ionosphere, is initiated. Satellite thermal observations in the 8-12-micron wavelength range show anomalous signs above the epicentral zones. Seismo-gravity wave (SGW), geogas (radon) observations meteorological and satellite monitoring are proposed as the integrated approach to short-term forecasting on a global scale that will provide the hours of the reliable advance forecast as part of Advanced earthquake early warning system (AEEWS).

Concept Rationale

Recent failures of short-term predictive studies suggest that it is unlikely that only one physical method can provide successful and reliable short-term forecasting on a global scale. This is most likely due to the complex local geology, tectonics and the notion that strong earthquakes are the result of a long, large-scale process, at different stages of which different parts of the fault network are involved. However, the simultaneous use of carefully validated measurements as a common methodology with known underlying mechanisms are the solution that could provide the necessary information from multiple observation stations, both on earth and from space, to identify reliable precursors.
The advantage of the AEEWS is to enable multiple and already validated physical measurements to be fused into one network providing operational data analytics of ground and satellite data.

Method of Seismo-gravitational waves: Experimental observations of SGW show that a network of sensors offers new data about a future earthquake. Since the front of the SGW converges back to the hypocenter of the earthquake, the wider the network of stations are located regionally or globally, the earlier the parameters of the future earthquake will be determined.

The Sensors threshold screens out the anomalies cause by smaller magnitude earthquakes to enable the higher amplitude of resonance recorded peaks for the larger quake's to be identified and tracked, generating the ability to observe the SGW direction, distance travelled to its convergence , interpret its magnitude and then calculate the time of the return resonance to its point of origin, the hypocenter, providing the critical parameters of magnitude, location and time of the future earthquake

Through the network of sensors, the wave is repeatedly confirmed and measured at each station as each wave returns to the hypocenter, consequently these measurements' reliability is close to 99%.
The first operational testing based on SGW observation was performed in 2012. Short-term forecasting of earthquakes was carried out generating hours/tens of hours of warning before the start of the earthquake, based on monitoring the KaY-wave. The Russian Emergencies Ministry coordinated the tests. During the tests, 20 earthquakes were predicted including in the Mediterranean Sea, the Middle East, Russia, Chile, without a single false alarm.

Method of satellite thermal radiation anomalies: Recent advances in satellite technology have helped expand the scientific understanding of atmospheric precursors' nature and their relationship to transient thermal anomalies. It was found that heat fluxes over the areas of the earthquake development are the most likely result of air ionization caused by geogases (radon) and the subsequent condensation of water vapor on newly formed ions. Latent heat (LH) is released as a result of this process and leads to the formation of local thermal radiation anomalies (TRA) [Ouzounov et al., 2007]. The TRA method's initial operating testing was performed during the period of June 2014, to March 2015 over Japan. We continuously performed advanced alerts for Japan for major events with ≥ M 5.5. Each alert contained four parameters: (a) location, including latitude and longitude coordinates; (b) estimated earthquake magnitude ± 0.5; (c) a time interval, usually within 30 days; and (d) a confidence level of 0.5 to 1.0. Each forecast was transmitted in real-time and published on the Internet. During the testing period of 310 days, 22 alarms were issued. There were no false alarms. All earthquakes with a magnitude of 5.5+ were warned in advance, except for one, which we did not warn due to a computer failure [Ouzounov et al., 2018].

Method of Radon monitoring: During the last ten years, precursory radon anomalies have been used for earthquake forecasting in Italy, Taiwan and the USA [Fu et al., 2005,2011]. Anomalous radon variations occurred from a few days upto a few months before the earthquake and are likely to be associated with the seismo -gravitational process, which is leading to dilatancy and micro fracturing stages of the earthquake development. Significant changes in soil Rn were observed at multiple stations originating from a stress accumulation and were recorded two weeks before the major earthquakes in Taiwan, Italy, the USA, Greece and Turkey. Simultaneous variations of radon anomalies at different stations show precursory anomalies that can help identify an impending seismic event zone with high confidence. Furthermore, the increasing gamma counting rate periods may also be related to induced stress changes, which may be related to the impending earthquake swarms, a large earthquake, or both. Hence, the radon measurements provide a useful tool that could be integrated with other short-term observation methods.

Discussion

The most massive earthquake in Japan for the last 70 years occurred near Sendai on March 11, 2011. SGW observations were able to indicate in advance for the 2011 Japanese EQ. On April 24 and May 12, 2015, M7.8 and M7.3 occurred in Nepal and brought major devastation for the region. Both SGW and Satellite observations, being independent of each other, were able to alert in advance for the 2015 M7.3 Nepal earthquake of May 12. The two methods (SGW and TRA) were able to provide an advance warnings during the test period, again independently of each other, for following notifiable earthquakes: M8.2 Okhotsk Sea 01.26.2013; M7.1 Mexico 09.19.2017; M7.6 Honduras of 01.18.2018; M6.8 Turkey of 01.24.2020 M7.0 Dodecane Island of 10.30.2020 , etc. This information was shared in advance with a very select audience, and was not formally made available within the public domain.

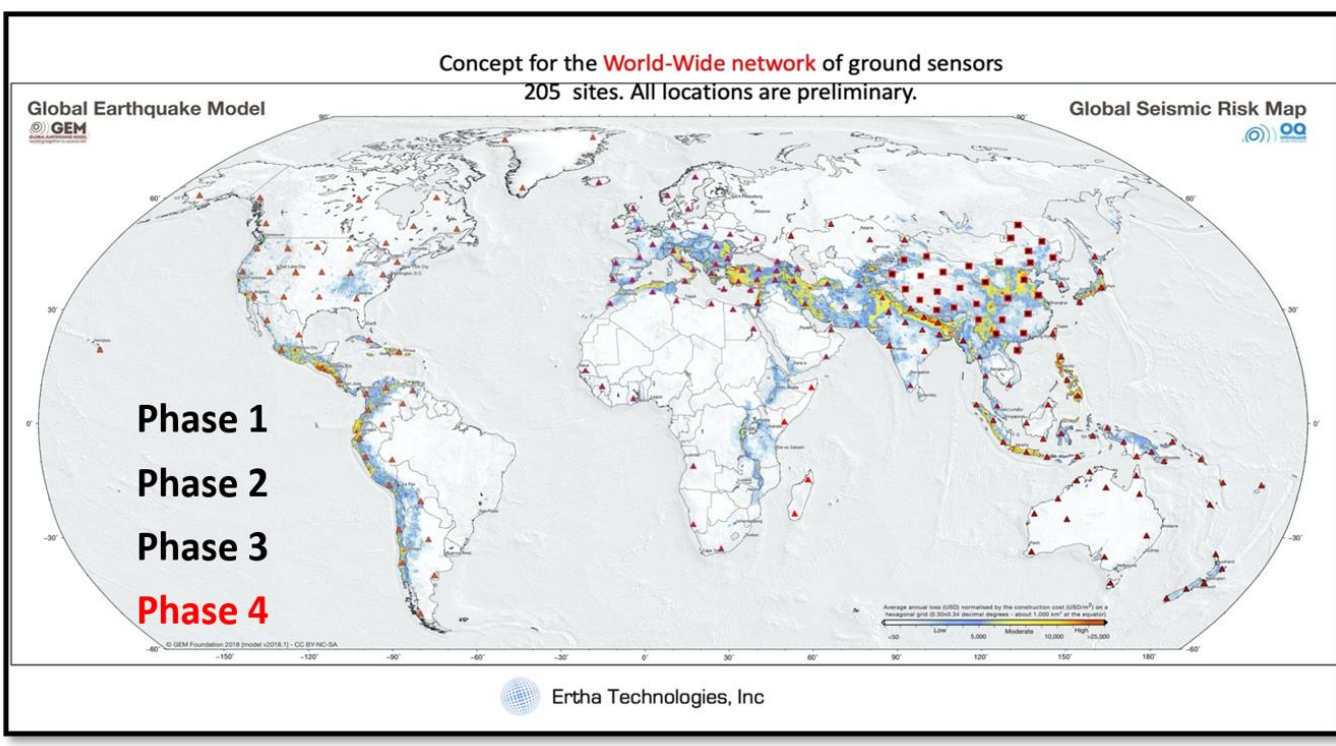
These results suggest that many pre-seismic anomalies are true precursors of the earthquake and demonstrate that extensive, multidisciplinary, and real-time monitoring are essential for an advanced earthquake alarm system.

AEEWS is a multi-layer system consisting of different physical methods with the ultimate goal of providing an optimized solution. The main concept behind the integration was to follow the entire genesis of the earthquake observed with different non-correlated physical systems until the moment of final seismic rupture initiation. Such a goal was only possible because of applied novelties.

The SGW observation follows the infrasonic waves propagation associated with resonance of a specific signature, only because of the sensor custom design, which filters out all other seismic waves generated by other earthquakes. This selectivity level provides the additional capabilities to recognize volcanoes and EQ aftershocks signals and their reliable separation by time and magnitude. We have found striking similarities between the low-frequency wave warnings patterns and satellite signals detected before earthquakes and volcanic eruptions during the validation stage. The difference in the anomaly's signature shape allows one to reliably separate anomalies alerting for earthquakes and those alerting for volcanic eruptions

Our radon monitoring is based on the latest sensor technology associated with gamma spectrometers, which provide us additional sensitivities compared to the classical type of radon observations. The satellite analysis was designed on the physical principle guided by the LAIC model, which allowed for additional sensitivities towards TRA detection. We can detect TRA signals, usually undetectable by similar alternative methods, because those signals were often hidden into the background noise. Integration was only possible because AEEWS is based on Scalable architecture, performing well on a regional level up to a comprehensive global network and by supporting numerous diverse and heterogeneous sensor types from ground and space observations.

Final:
Together by combining the various methods which generate up to a 15 day growing awareness of impending seismic activity, with the SGW wave which confirms the triggering of the physical earthquake rupture, Ertha provides a perfect game changing advanced earthquake early warning system previously unachievable.



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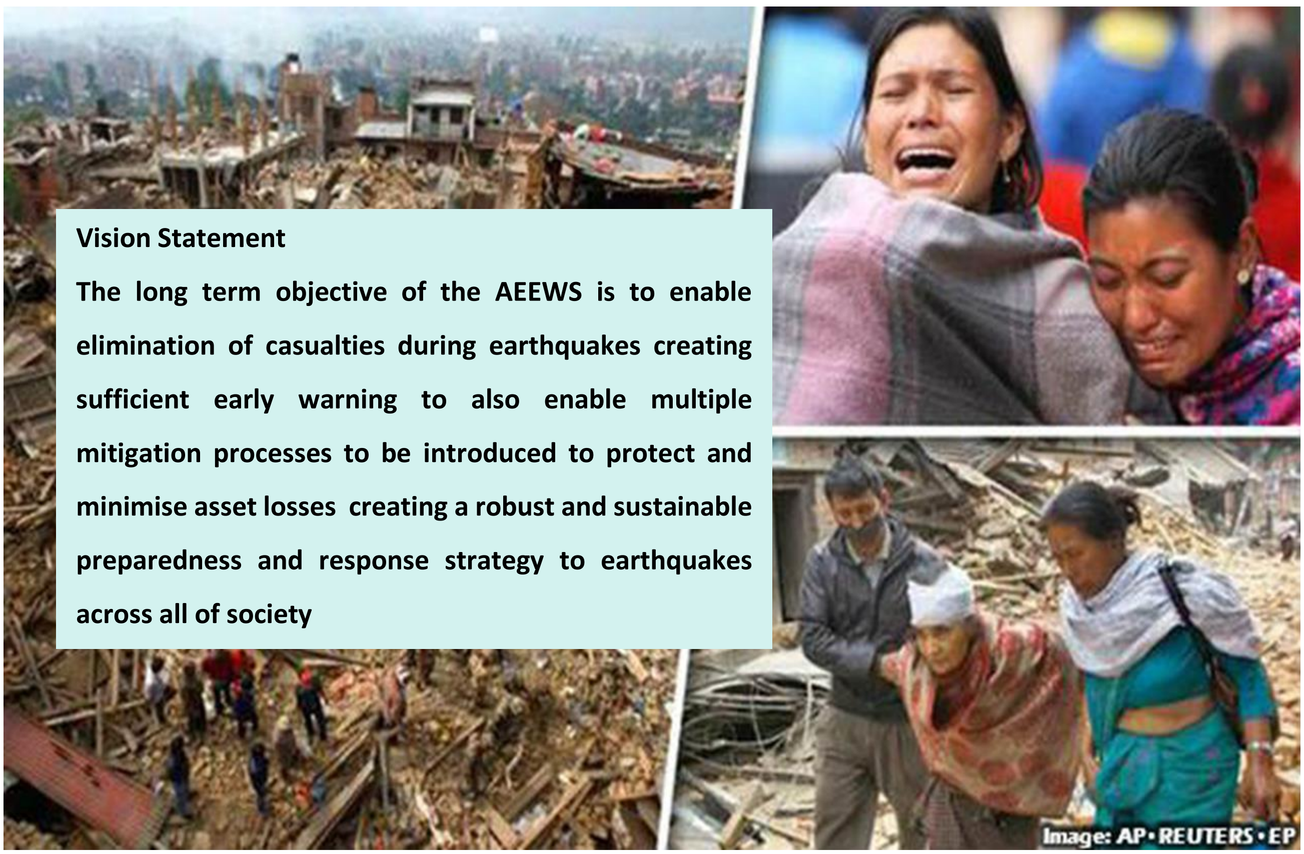

Vision Statement

The long term objective of the AEEWS is to enable elimination of casualties during earthquakes creating sufficient early warning to also enable multiple mitigation processes to be introduced to protect and minimise asset losses creating a robust and sustainable preparedness and response strategy to earthquakes across all of society

Briefing Documents

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