MODEL STRUCTURE OF RODENTS (MSOR) FOR EARTHQUAKE ALERTS-A SURVEY BASED STUDY

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ABSTRACT

Natural disasters are that category of disaster which are beyond human control, it leads to massive damage and chaos once occurred. Amongst all, Earthquake is probably the most destructive. Before Earthquake befall, there are two strong waves engendered. The initial Primary-wave, forewarning about the rupture of rocks beneath the soil, acts as an alert signal, whereas, times later a more powerful and devastating Secondary-wave is generated from the epi-center, causing eradication of anything along its way. Besides so many tools for Earthquake prediction, there are some precursors which also occur before its transpiring. These renowned precursors help in predicting the Earthquake. In the list of precursors, Unusual Behavior pattern of certain animals is considered to be a reliable and inexpensive one for less developed countries. This paper focuses on providing a solution to the less developed countries for predicting Earthquake by observing the change in behavior of animals. Of all different animal species which shows a drastic change in their behavior, rodents are taken in to consideration in this research, as their senses are far subtler than others. A model solution based on the installation of datacenters in different Earthquake-prone areas is proposed for less developed countries. The datacenters focus on, changes in the behavior of rodents before the Earthquake using the facilities of Information and Communications Technology.

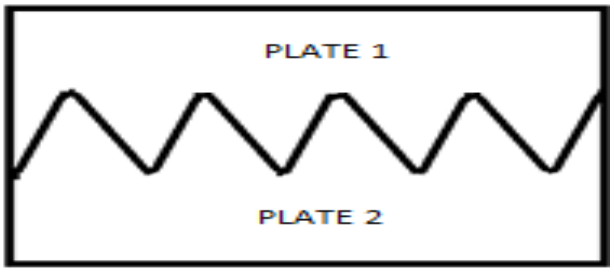
Keywords: Model Structure of Rodents (MSoR); Natural Disasters; Earthquake; Animal Behavior (AnB); Information Communications Technology (ICT)

Introduction

Disaster is something that affect person's life in one way or another, the only thing anyone experiences after encountering a disaster is loss and misfortune. Disasters are mainly categorized in to two; Manmade Disasters and Natural Disasters.

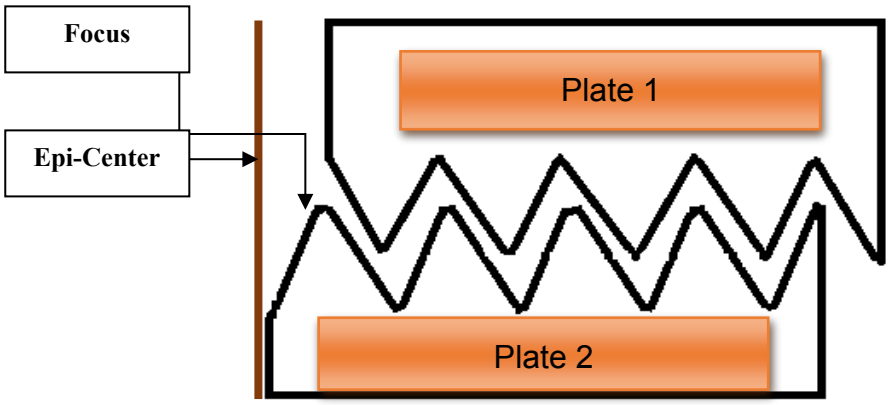
Manmade Disasters—these are those which occurred due to intentional or un-intentional act of mankind. Disasters like terrorism, use of noxious material and recession etc. falls under this umbrella. On the other hand, Natural Disasters-- These disasters are beyond the confines of mankind. It is very hard to determine when and where the disaster under this umbrella will occur. There are numerous natural disasters, but the mother of all is Earthquake, as, Earthquakes can easily transmute into many other catastrophes like Tsunami, Volcanic Eruption and Avalanches (Personal, Archive, Khan & Khan, 2008).

Figure1: Earth plates in contact



Earthquake took place when the plates (tectonic plates) starts sliding under the Earth's surface. Initially a less devastating Primary-Wave is released due to the crusading of plates. This wave acts as an alert, giving sign of apprehension to the concerned ones. Times later a more powerful and devastating Secondary-wave is generated from the fragmented rocks, causing obliteration of anything along its way. The point where the plates slide is known as Focus, whereas, the point directly above the focus on the ground is known as Epicenter (Tiwari & Tiwari, 2011).

Figure 2: Earth plates rubbing each other



The intensity of an Earthquake is measured on Richter scale. Earthquake with magnitude below 6 is considered to be less devastating then the one greater than 6 on the Richter scale (United States Geological Survey, 2013).

For Earthquake prediction there are multiple tools available but none proved to be one hundred percent successful yet. Besides the available tools there are numerous indications which arose before the Earthquake, known as precursors. The precursors are considerably a cheaper solution than using the expensive and delicate tools, they help a lot for less developed countries in prediction. There are multiple precursors available by focusing on which Earthquake can be predicted, few of them include:

Ground Tilting, Humidity Changes, Change in animal behavior, Electric currents, Magnetic field radiations (Kirschvink, 2000).

CHANGE IN ANIMAL BEHAVIOR (Anb) BEFORE EARTHQUAKE

Although there are so many precursors available which helps in prediction, but amongst them, change in animal behavior is something that is cheap and more reliable. Animals have a special sense of observing things; there sensory organs are very sensitive which helps them to perceive any impending danger. Not only they observe via their organs but they can act on the other raised precursors as well. Rodents, Birds, fish, mammals, and reptiles vary in their behavior with respect to the intensity of the earthquake.

There are so many animals that changes their behavior, as soon as they sense any danger. The sensory mechanism of animals is far more complex and enhanced than humans. There are around 58 animal species that changes their behavior as soon as they sense any impending danger, thus alerting their communities for safety (Harnett, 2012).

From the list of animals which has shown drastic changes in their behavior some of them are: dogs, as they start barking and howling, Cats start crying and hiding for hours, Deep water fish comes to the surface of water, Snakes and Rodents come out from their burrows during their hibernation season, Rodents like mice and rats start behaving as they drunk or having convulsions, they started jumping, vertical leaping or sometimes show crouch like gestures, toads stop mating as soon as they sense any impending danger like Earthquake.

Animals show unique changes in their behavior which becomes a pattern for observation. These patterns include:

Restlessness—Many farm and domestic animals show this behavior before Earthquake.

Trembling—Body of animals started shuddering.

Shaking off—Animals started quivering off a lot.

No appetite—Animals lose their appetite.

Stuck—Animals wedged to the owner.

Aggressive—mostly in wild animals, they become belligerent.

Frightened—Animals seems frightened from something.
(Yamauchi, Uchiyama, Ohtani, Ohta, 2014).

Chemical, Acoustic and electromagnetic signals are another type of Animal signals helping in recognition of impending catastrophes like Earthquake. Animals are capable of recognizing such types of signals which are uncertain and un-notified by the delicate instruments and measuring techniques (Hussain, Asif, 2012). Unfortunately, humans do not understand their meaningful vocal modulations, as they usually communicate on the frequency bands which are beyond the audible range of

humans. Different animals have different sensory organs which helps them to communicate if they feel any danger. Animals start alarming about the danger by changing their behaviors which is mostly neglected by humans (Liso, 2014).

Amongst the different animal species, Rodents (rats and mice) are focused in this research, as; they are amongst the intelligent and most sociable animals that excel at leaning and understanding concepts very easily. They live in communities and after perceiving any signals through their unique sensing mechanism they alert other communities ("Hidden Lives of Rats and Mice | Features | PETA", 2016).

There are multiple species of rodents which are being separated from each other based on their Anatomy. Zoologically the rodents are categorized into three different groups:

1) The Sciuromorpha, or squirrel like rodents include: the various species of squirrel, chipmunk, marmot, wood chuck (or ground hog), prairie dog, gopher (or pocket gopher), pocket mouse, kangaroo rat, and beaver.

2) The Myomorpha, or mouse like rodents include: a great variety of mouse and rat species, as well as species of hamster, lemming of hamster, lemming, vole, muskrat gerbil, dormouse, and jerboa. This is the largest rodent group.

3) The Hystricomorpha, or porcupine like rodents include: the porcupine, capybara, nutria, agouti, cavy (including the domestic guinea pig), mara, and chinchilla, as well as many species whose common names include the term *rat* (e.g., the South American bush rat) ("Rodent: Types of Rodents", 2000).

Rats and Mice are amongst those rodents which can be globally found. There are around eleven (11) species of rodents which participate in the share of human's food whether it is in the field or stored at homes ("Studies on Rats and Mice as a Reservoir of Zoonotic Parasites", 2009).

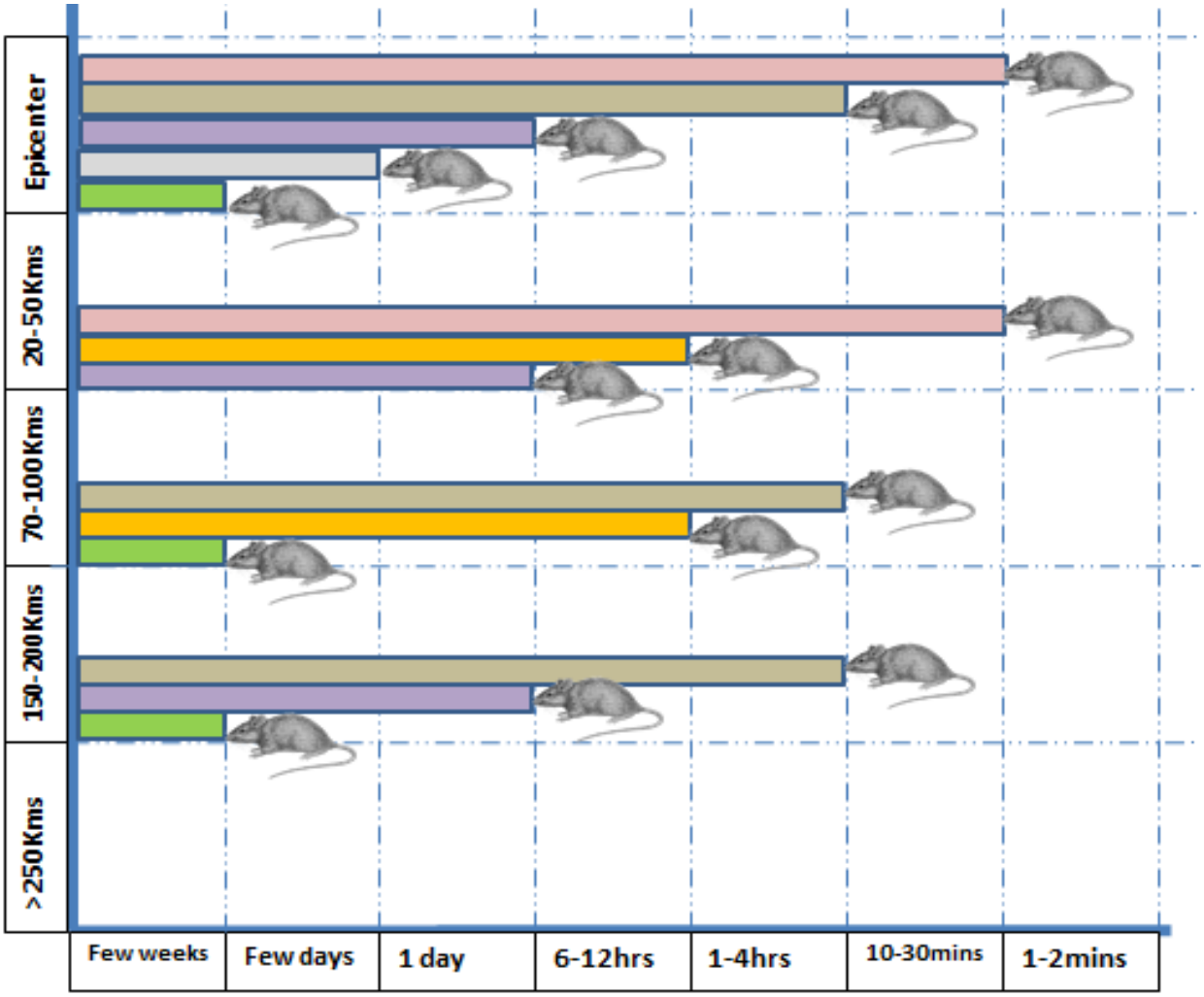
Behavioral Changes In Rodents Prior To The Quake

It has been experimentally proven that Rats and Mice are smart and most sociable faunae in animal kingdom. Because of their sociable nature they prefer to live in communities in burrows, as they can store and hibernate easily. The structure of a burrow system is related to the social relationship of rats that dig and maintain it. Many families live together within the same burrow. If the social structure of a group breaks down, the rats are no longer able to maintain a complex burrow system and it falls into disrepair. Cavity is a part of burrow which consists of several small and large chambers in which seven (7) to eleven (11) rats can be accommodated at a single time ("Wild Norway Rat Behavior", 2004).

Rats and Mice has a very complex system of communication, they communicate by touch, smell and through Ultra high frequencies. Their frequency range for hearing is beyond the audible range of humans. Due to the seismic electrical signals rats and mice has a drastic change in their behavior weeks to days before the occurrence of an earthquake. Before an earthquake befalls, it has been empirically proven that ionic and electrical signals are released due to the rupture of rocks. Thus, to evaluate the change in behavior of mice an experiment is performed in which mice were kept in a cage with wet conductive tissue at its base. The behavior of rats and mice started changing as the initial voltage between 0.1v to 50v is applied, the behavior started changing from normal to nervousness. They try to avoid the field and when the voltage is increased they started biting the cage, running and trembling (Bhargava, Katiyar, Sharma & Pradhan, 2009).

The intake of food by rats and mice is also increased days before the Earthquake and it reached to its peak on the day of Earthquake. The stress level of mice and rats also increased before the Earthquake. It is assumed that they might experience physiological changes as they are having an increase in stress level (Chen, Hu, Zheng, Zhang, Kong, Yang & Yue, 2010). As the rats and mice stays underground, the probability is higher for them to detect Earthquake easily and earlier than other animals (see figure 3).

Figure 3: Graph showing the change in behavior of mice and rats few days to weeks before the earthquake ("abnorm_anim_behav_earthquakes_WilliamTong," 1988)



Proposed Model Based On The Analysis Of Sensing Earthquake By Rats And Mice

Rats and Mice are amongst the known animals for showing unusual behavior days to weeks before the quake. Befalling of an Earthquake is unpredictable. There are numerous Earthquakes which strike and bring catastrophes to all over the country in every quarter of the year.

The proposed model helps in predicting the Earthquake based on unusual behavior of animals, especially Rats and Mice, as they are amongst those animals which can be easily found and observed.

The different species of Rats and Mice which can be easily found include:

Lesser Bandicoot (bandicota bengalensis): can be easily found in Foothills and coastal plains.

Indian Gerbil (tatera indica): can be easily found in throughout the nations except in sand dunes and Rocky Mountains.

Soft Furred Field Rat: can be found in rocky and mountain area.

House Mouse (mus musculus): The house mouse is very common and can easily be found in houses.

Short tailed mole rat: It has been found in various regions where the soil is damp and light.

Norway rat (Rattus norvegicus): Norway rats can easily found in port and dock areas.

Desert Jird (Meriones Hurricane): It is found in the sand dune areas and sea coasts.

Libyan Jird: They can be found in mountain and rocky areas.

Indian or Crested Porcupine (Hystrix Indica): They are mostly found in Rocky and sandy soils.

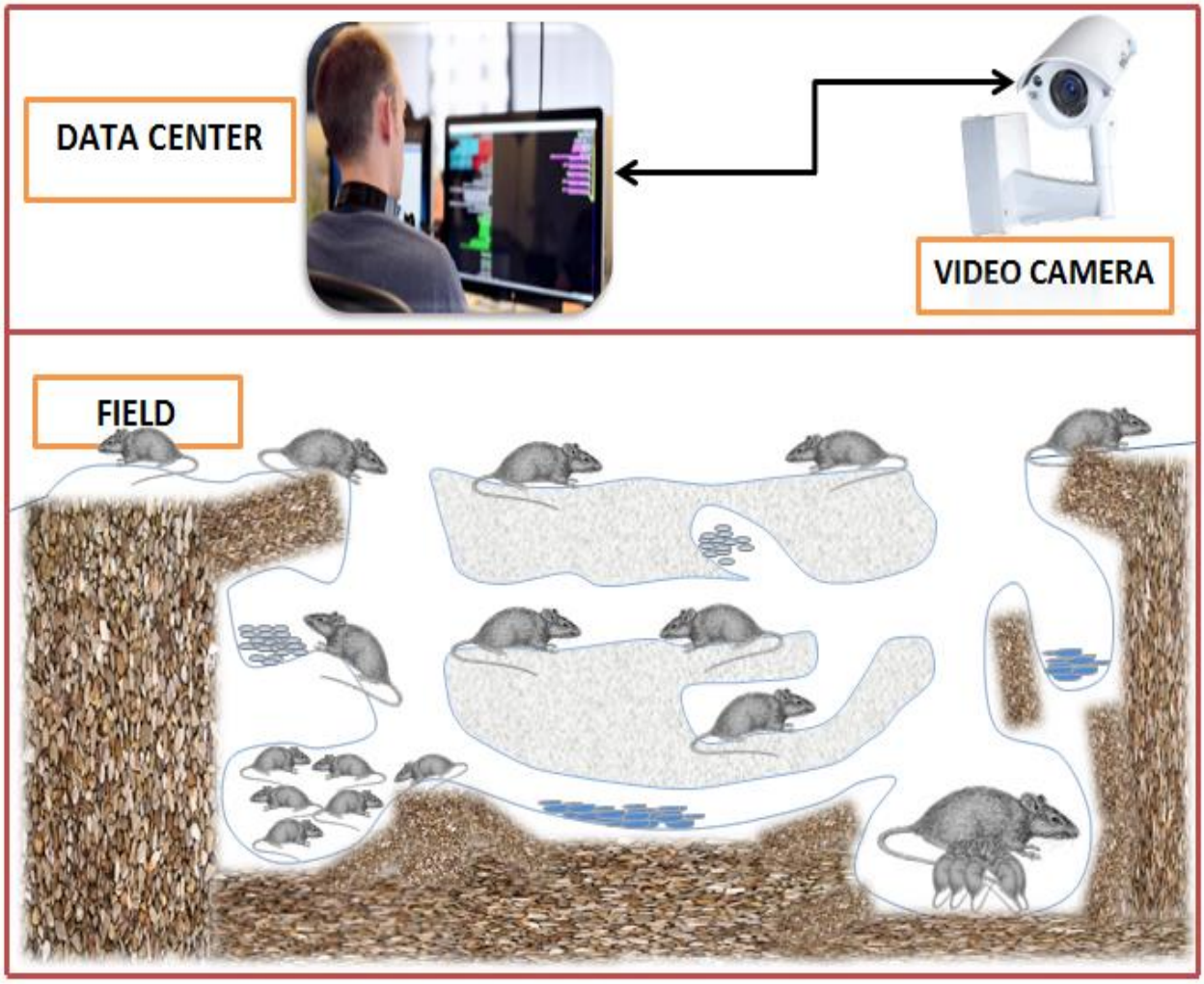
The Murree Vole (Hyperacrius Wynnei): They are available in Himalayan and can also be found in open grassy slopes ("Types of Mice and Rats | Identify Mouse & Rat Problems and Mice," 2016).

The Hearing range of Rats and Mice are better than humans. The audible range of a Human is from 20Hz- 20 KHz whereas Rats and Mice communicate at a frequency of 200 Hz to 80 or 90 kHz. Due to the ultrasonic hearing capabilities of Rats and Mice along with their sensitive sensory organs they have a high probability for determining the impending Earthquake (Bautista, 2008).

Based on their distribution and availability across nations, a model based on the changes in behavior of mice for predicting the Earthquake for less developed countries is proposed in this research. The model includes the placement of datacenters in various areas of a country for Earthquake prediction.

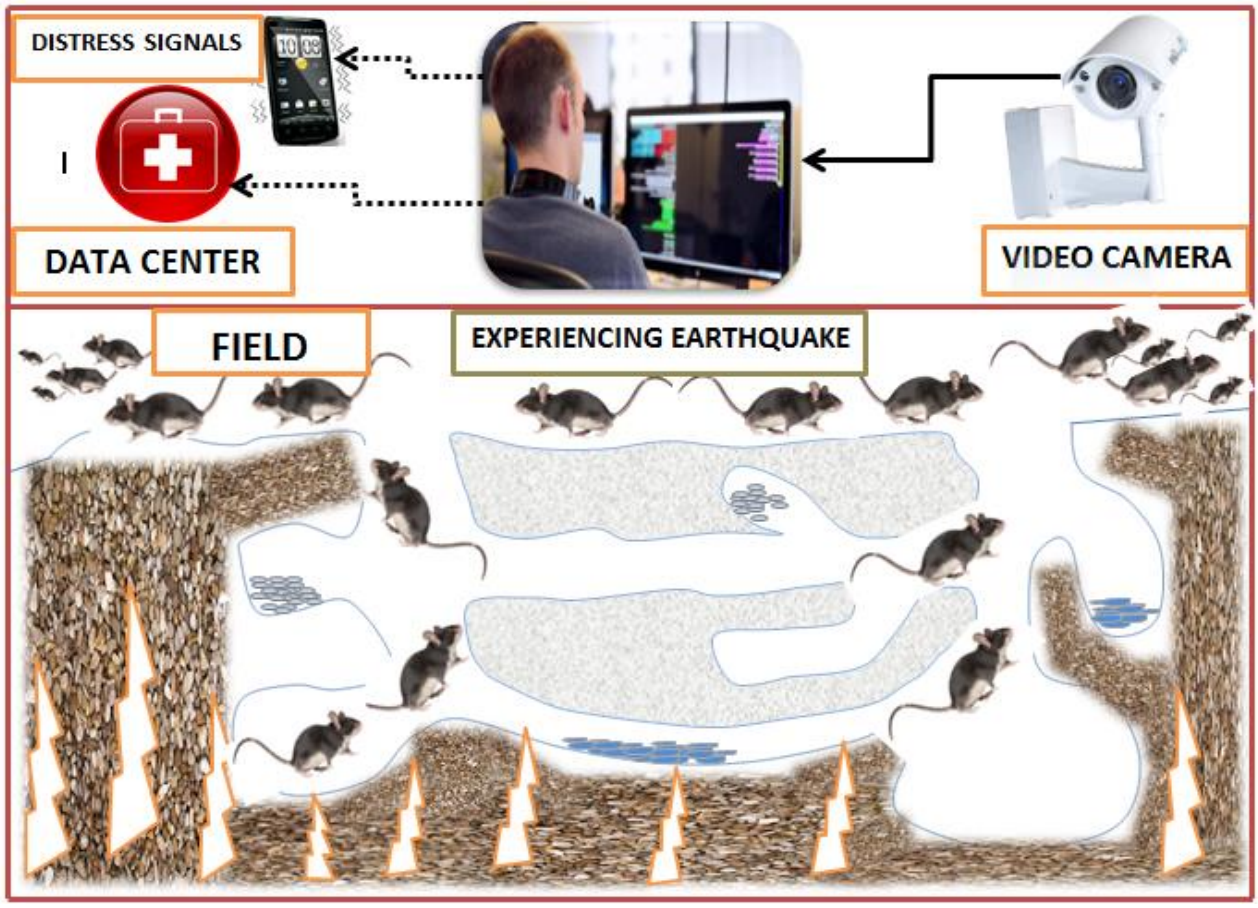
The suggested model includes a data center (see figure 4), which has multiple colonies of Mice (for reference only one colony is illustrated in the model). Usually the mice remain calm and perform their daily activities in the datacenter. These colonies are being continuously monitored by a camera, and every single activity is being recorded (shown in figure 4). For the precision and accuracy of results, the data centers must be installed in earthquake zones.

Figure 4: Mouse Colonies observed in a datacenter before Earthquake



As soon as the mice in datacenters senses any preliminary Primary wave from the ruptured rocks, they started behaving peculiarly. This peculiar behavior is observed & recorded and by using ICT an alert is sent to the registered community of that area for taking preventive measures. The alert send to them is in the form of short messaging service and an alarm signal is send as a push notification on the smart phones. There will be three different level of alerts; the first alert will be a warning signal

which is sent when there is a noticeable change in the behavior of mice. The second alert will be more serious than the first one, alerting to be ready as the earthquake can befall any time. The third alert will be a final alert stating to leave the place as soon as possible. The alerts will be circulated according to the severity of levels.



Usage of mobile phones is increasing day by day and now a day almost every person has a mobile phone. As the technology advances, basic mobile phones have been replaced with smartphones, now a day almost every nine out of ten person uses smart phones. The number of smartphone users have reached to a limit of 2.08 billion in 2016 and it is exponentially increasing ("2 Billion Consumers Worldwide to Get Smart(phones) by 2016 - eMarketer," 2014).

The best method for receiving an Earthquake alert signal is on mobile phone. It could be a Short Messaging Service (SMS) or an alert of an alarm as a push notification on Smart phones.

Reason for suggesting this model

- Availability of Rodent Species
- Since Rats and Mice are found underground, therefore their ability of sensing Earthquake is higher than others.
- The Model is Economically feasible
- Can easily be implemented in both Urban and Rural areas of less developed countries

Conclusion

Earthquake is identified as the mother of all Disasters, it has a devastating effect on lives. There are many precursors that can be focused for Earthquake prediction, but amongst these portents unusual animal behavior is at the top. It is economical and is in the list of reliable portents. Animal behaviors have been taken into consideration since 373 BC and it is considered to be the most reliable approach for predicting Earthquake for less developed countries. The research focuses on the behavior of Mice and Rats, as they are considered to be the most intelligent and the most observable animals.

The research provides a solution for predicting Earthquake for less developed countries. A model solution is proposed in this research which involves the placement of data centers in various regions of a country. The data center works on observing the behavior of these animals. A distress signal is disseminated as soon as the datacenters encountered any unusual behavior of Rats and Mice. The alert signal can be in the form of Short Messaging Service (SMS) or it can be a simple alert on the smart phone device. Once the alert is received, registered users can proactively take necessary precautionary measures for prevention. Although SMS and Smart phone alerts effectively helps in knowledge sharing but can sometimes create an exasperating situation for users, as during the Earthquake if any signal tower stops responding, there will be no source for broadcasting the knowledge and the ones wedged in the debris have no chance to escape, thus the situation becomes difficult and ends up in a more chaotic manner.

The research plays an important role for predicting Earthquake in less developed countries, as it is based on observing unusual behavior of animals. The observations can be used to setup a threshold, which can act as a policy used nationwide for setting up a marker for Earthquake alerts. The datacenters can use those markers for disseminating the alert signals on the registered devices, thus making the system respond proactively for Earthquake prediction.

References

Personal, M., Archive, R., Khan, H., & Khan, A. (2008). Mpra, (11052)

Tiwari, R., & Tiwari, S. (2011). Animals: A natural messenger for disasters . *Journal of Natural Products*, *4*, 3–4

United States Geological Survey. (2013). The Severity of an Earthquake. Retrieved from http://pubs.usgs.gov/gip/earthq4/severitygip.html

Kirschvink, J. L. (2000). Earthquake prediction by animals: Evolution and sensory perception. *Bulletin of the Seismological Society of America*, *90*(2), 312–323. http://doi.org/10.1785/0119980114

Harnett, C. (2012). To what extent can animals aid earthquake prediction? The 1975 Haicheng Earthquake.

Yamauchi, H., Uchiyama, H., Ohtani, N., & Ohta, M. (2014). Unusual animal behavior preceding the 2011 earthquake off the pacific coast of Tohoku, Japan: A way to predict the approach of large earthquakes. *Animals*, *4*(2), 131–145. http://doi.org/10.3390/ani4020131

Hussain, M. S., & Asif, S. M. (2012). Signals, animal response and earthquake. *Journal of Theoretical and Applied Information Technology*, *39*(2), 218–224.

Liso, G. De. (2014). Unusual Animal Behaviour before Earthquakes and Multiple Parameter Monitoring in Western Piedmont. *Earth Sciences*, *3*(1), 14. http://doi.org/10.11648/j.earth.20140301.13

Hidden Lives of Rats and Mice | Features | PETA. (2016). Retrieved from http://www.peta.org/features/hidden-lives-rats-mice/

Rodent: Types of Rodents. Retrieved from http://www.infoplease.com/encyclopedia/science/rodent-types-rodents.html

Studies on Rats and Mice as a Reservoir of Zoonotic Parasites. Retrieved from http://prr.hec.gov.pk/thesis/242s.pdf

Wild Norway Rat Behavior. Retrieved from
http://www.ratbehavior.org/WildRats.htm

Bhargava, N., Katiyar, V. K., Sharma, M. L., & Pradhan, P. (2009). Earthquake prediction through animal behavior: A review. *Indian J. Biomech*, 7–8.

Chen, L.-L., Hu, X., Zheng, J., Zhang, H.-H., Kong, W., Yang, W.-H., … Yue, L. (2010). Increases in energy intake, insulin resistance and stress in rats before Wenchuan earthquake far from the epicenter. *Experimental Biology and Medicine (Maywood, N.J.)*, *235*(10), 1216–23.

abnorm_anim_behav_earthquakes_WilliamTong. (1988)

Types of Mice and Rats | Identify Mouse & Rat Problems and Mice. (2016). Retrieved from
http://www.victorpest.com/advice/rodent-library

Bautista, M. A. (2008). *Ultrastructural Analysis of Excitatory and Inhibitory Synapses within the Medial Nucleus of the Trapezoid Body of Normal Hearing and Congenitally Deaf Mice* (Doctoral dissertation, Wright State University).

2 Billion Consumers Worldwide to Get Smart(phones) by 2016 - eMarketer. (2014). Retrieved from
http://www.emarketer.com/Article/2-Billion-Consumers-Worldwide-Smartphones-by-2016/1011694