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Reaction of Internet Users to the Seismic Hazard

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ABSTRACT

A prototype of a generalized portrait of the activity of the Internet community for three major earthquakes that occurred in different regions of the Earth: Mexico, Japan and Afghanistan is discussed. The activity of the Internet community is a reaction to the second alarm system. A model of the reaction of Internet community activity to earthquake precursors is proposed. To diagnose "informational" harbingers of seismic danger, sets of query words semantically related to geophysical harbingers were used. The search for the repeatability of keywords was carried out using Internet search engines. The geographical binding of requests was taken into account. No effects of Internet community activity were detected in earthquake-prone regions. The analysis of information precursors of earthquakes was carried out according to the calculated spectra and amplitude diagrams of variations in the repeatability of the query words. Before the earthquakes in the earthquake-prone region, there was increased activity of the Internet community with statistically significant harbinger signals. The presented results are useful for use in artificial intelligence technologies.

Keywords: *Earthquake, Precursors, Information, Internet, Society, Activity*

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INTRODUCTION

The first signaling system in humans and animals manifests itself in reflexes that arise from signals that are perceived by the senses. Only humans have the second signaling system which allows reflexes from the first signaling system to be expressed in words.

For representatives of fauna, the response of the first signaling system to changes in the state of geophysical fields may be characterized by descriptions of biological earthquake precursors (Fedorov, 2012; Fedorov, 2013). Similar effects for carriers of the second signaling system are presented, for example, in (Sidorin, 1992; Tertyshnikov, 1996; Tertyshnikov, 2000). Potentially a human can be a biosensor of seismogenic perturbations of geophysical fields and can also express it in words influencing the society around him.

In modern conditions, the behavior of the representatives of society is manifested in the means of technical communication, especially under natural or imposed threats. Society, as an anthropogenic element of the natural environment, is a bio-indicator of environmental changes through behavior and activity as psychomotor acts (actions), communication, and information search, including the Internet.

The prospect of studying the response of Internet users to seismic hazards was confirmed when diagnosing information precursors for the Mexican earthquake of 1.02.2019 (Tertyshnikov, 1996). Development of these studies requires estimates of a "generalized portrait" of informational earthquake precursors using artificial intelligence technologies.

The concept of environment includes both natural environment and its anthropogenic surroundings. The society as an element of anthropogenic surroundings strongly affects the environment state and is a biological indicator of its variations. Geophysical-field disturbances in a seismically active region with a seismotectonic anomaly affect the activity in the behavior of bioindicators – primary transformers of geophysical disturbances **(Figure 1)**.

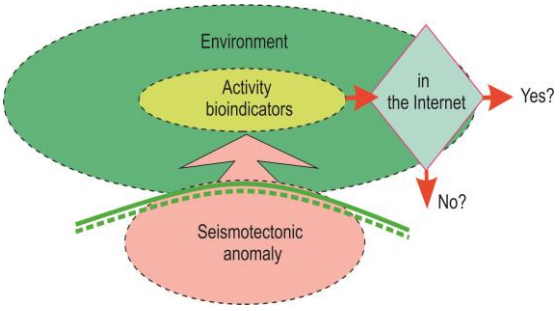


Figure 1. Scheme Experiment on seismic-hazard diagnostics.

Statement of the experiment problem

Internet users are supposed to be the primary transducers of seismogenic disturbances of geophysical fields in an earthquake-prone region (Tertyshnikov, 1996; Tertyshnikov, 2013). Their behavior includes description and discussion, including the Internet, of their observations and sensations, search for their explanation, and comparison with reactions of other people. Activity in the form of psychomotor acts is aimed at communication and search for satisfaction of internal needs, which may not be realized.

Internet community can enhance the appearance of weak signals-sensations from individual users through empathy and criticism, increasing their number and repetition of discussed words, which before earthquakes are semantically connected with seismogenic changes of geophysical fields state. Such a change in Internet-society activity can be represented by the simplest simulation model of a "box" with input and output data, controlling influences according to GOST R ISO/IEC 12207-99 **(Figure 2)**.

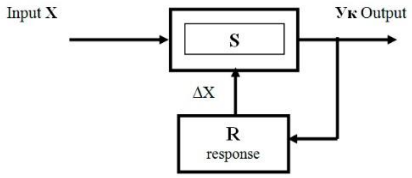


Figure 2. Scheme of the response of the Internet community: X is the input information flow, Y is the output result, S is the transfer function, and R is the feedback function.

In the model, the flow of information about the state of the environment passes through the participants of the Internet community. They react to the state of the natural environment, and changes in the state of geophysical fields through the function R, which is related to the information flow at the output. In the simplest case the coefficient R is usually in the interval]0...1]. Transfer function S can represent the safety function or the response of the Internet society to the incoming information: $0 < S < 1$, which is typical for the weak sensitivity of bioindicators.

With instantaneous feedback $\Delta X=RY$, and the new value $Y_к=S(X+\Delta X)=S(X+RY)=XS/(1–RS)$. The coefficient $S/(1–RS)$ determines the adjustability of the activity. Measurement of activity ($Y_к > Y$?) due to feedback allows us to estimate the existence of information earthquake precursors.

MATERIALS AND METHODS

Resources for screening Internet community activity are provided by search engine operators in the area of electronic information, such as Yandex™, Google™, Bing™ and other organizations providing space for IT, content aggregators (e.g. Digg™, Reddit™), content recommendation systems (e.g. StumbleUpon™, Pinterest™), etc. Linguistic search and information analysis software has been created for processing texts and complex queries in Internet search engines. Information-analytical systems and hardware-software complexes for information search and processing have been developed (Tertyshnikov, 2007; Tertyshnikov, 2020; Tertyshnikov, 2023).

What to look for? We need an ontological model of the process/phenomenon, reflecting ideas about earthquake preparation processes and allowing us to form a local thesaurus, which is needed to find information precursors of earthquakes. One of the nuances of local thesaurus formation is the logical-linguistic and semantic peculiarities of communication in Internet society. For example, members of the Internet community, instead of "hydrogeological precursors," will rather focus on the simplified term "water," etc.

After analyzing the list of earthquake precursors - the ontological model of manifestation of the earthquake preparation process for the local thesaurus was proposed to use the following keyword queries in Russian: «avariya», «voda», «vozdukh», «zdorovye» *et al*. and their analogs in English: Air, Crash, Health, Radioactivity, Water.

The composition of the local thesaurus can be adjusted according to the example of the analysis of selected terms before 21 strong earthquakes in different regions of the world. The analysis was carried out visually on the search-engine-generated temporal graphs of the recurrence of query words before and after the specified strong earthquakes. The best result was obtained for the term "water" according to the following criteria: "yes"=15 events, "rather yes"=2, "rather no"=1, "no"=0, "no data"=3. The other terms showed "yes" repeatability one-third less than "water". The term "radioactivity" showed up in about 35% of the cases with large gaps in the data. For Muslim countries, the repeatability of the term "health" before the earthquake was higher.

The completeness of the information collection on the frequency of the selected query words was negatively affected by holidays. Each earthquake-prone region showed its peculiarities in the frequency of occurrence of query words.

With the selected local thesaurus, a generalized portrait of the response of the behavior of the Internet community to seismic hazard was assessed.

The analyzed time interval for estimating the recurrence of query words was limited to 3 weeks before and after strong earthquakes. The background activity of word-query recurrence for the analyzed region was taken into account in order not to take national features of information flow variations for and earthquake precursors.

The results of keyword recurrence found by the search engines were generated in tables and graphs, and the geographical reference of the results was taken into account. To identify weak seismogenic signals within natural noise, a fast Fourier transform was used in a 16-day sliding window over a series of observations. In the calculated amplitudograms assigned to the right boundary of the sliding window, we diagnosed "signal" periods claiming to identify short-term earthquake precursors.

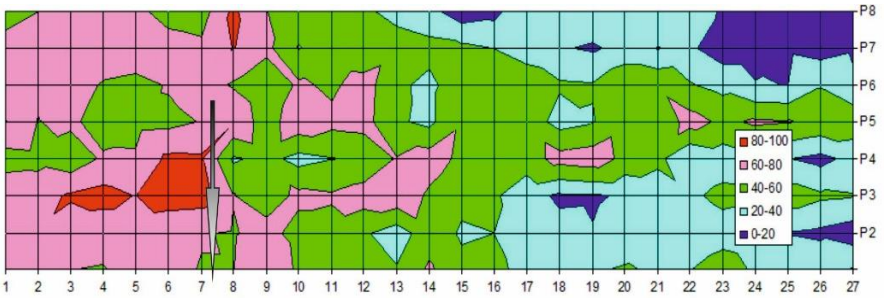
A generalized portrait of the seismogenic behavior of the Internet community

A prototype of the generalized portrait of the amplitudeogram as the average sum of three amplitudeograms according to the recurrence of "information precursors" is shown in **Figure 3**.

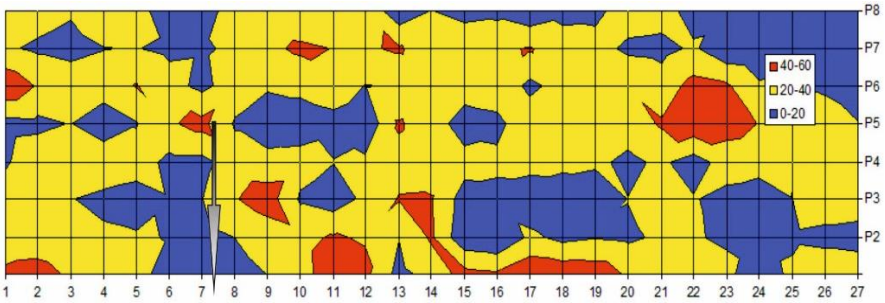
Earthquake characteristics: Mexican 1.02.2019 (16:14:12.2 UTC, 14.86 N; 92.20 W, Mw=6.6 (Chiapas, Mexico)), H=67.9 km; near Hokkaido 4.11.2018 (19:26:3.7 UT, 44.50 N, 145.65 E, H=24 km, M=6.2 (5.8 according to other estimates, somewhat earlier there was an earthquake with M=5.0 at 18:54:23.3, 23.48 N, 143.33 E, H=10 km (Volcano Islands, Japan region)); Afghan 02.02.2019 (H=211 km, 12:04:32.5, 36.44 N, 70.77 E, M= 5.8 (6,2 according to other estimates). Earthquakes have occurred in calm magnetic conditions (Tertyshnikov & Syroeshkin, 2014).

Figure 3a shows the relative (in %) estimates of the mathematical expectation for the generalized amplitudeogram in the range of the minimax interval of each of the calculated

periods. **Figure 3b** shows the relative (in %) estimates of the unbiased standard deviation for the estimates of **Figure 3a**.



a)



b)

Figure 3. Relative (in %) estimates of the first two moments of the calculated periods in the range of the minimax interval for three earthquakes: a) estimates of the mathematical expectation; b) estimates of the unbiased standard deviation. Arrow - day with an earthquake.

On the generalized amplitudeogram, three sections are distinguished: with an elevated amplitude level before the generalized earthquake, then almost a week with an average level, and then with a reduced level. For the estimates of the mathematical expectation of amplitudes for a period of 3 days, the elevated values before the generalized earthquake appear. At the same time, the estimates of the standard deviation are average, which indirectly indicates the existence of informational earthquake precursors.

For three days and one day before the generalized earthquake, statistically significant bursts of amplitude exceeding the boundaries of the 95% confidence interval by Student's criterion are manifested for the period of 3 days. For the period of 4 days, they are manifested the day before the generalized earthquake.

RESULTS AND DISCUSSION

The obtained generalized portraits indicate that the functioning of human mental organization responds to the threat of an earthquake and manifests itself through the second signaling system.

The use of spectral analysis is due to a large level of natural variations of the words of the local thesaurus in the analyzed Internet information flows.

Confirmation of the identified effects may be the results in (Yudin, 2018) for the average daily data on the inhibition of the Monitor-E spacecraft before strong earthquakes.

If the activity of Internet society can be used for diagnostics of informational precursors of earthquakes, it is necessary to conduct further research on regional ontological models of unstable states of the environment, development of basic models and technologies of search in information flows of query words or phrases, characterizing subject of the search. Analysis of the activity of regional and local social networks can refine the obtained results of seismic hazard diagnostics in earthquake-prone regions.

The presented results are useful for use in artificial intelligence technologies.

CONCLUSION

With the help of Internet search engines using a set of query words semantically related to earthquake preparation processes, we revealed the reaction of the Internet society to seismic hazard - "informational" earthquake precursors, representing the reaction of the second signal system to earthquake threat.

Internet-society activity increases before strong earthquakes.

A prototype of a generalized portrait of information precursors of three strong earthquakes, which occurred in different regions of the Earth: Mexico, Japan, and Afghanistan with different religious mentalities, has been obtained.

The results of monitoring variations in the activity of the Internet community can be used to monitor seismic hazards.

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