Project financed by *SCOR Foundation for Science*

Centre Sismologique
Euro-Méditerranéen

2ND ACTIVITY REPORT OF THE EMSC

FOR

SCOR FOUNDATION FOR SCIENCE

Rémy Bossu on behalf of the EMSC team

April 2022

CONTENTS

I. ABSTRACT

The 2nd year of the sponsorship convention signed with the *SCOR Foundation for Science* has seen significant advances and progress in line with the initial objectives, even surpassing them in some areas. In terms of public visibility, apart for the websites for which traffic remains stable, the other components of the LastQuake system (Twitter quakebot and apps) have seen a 2 to 4 fold increase in usage since the start of the project. The renovation of our digital tools has continued apace; following the release in November 2020 of our new website for mobile devices, a new and more ambitious Twitter quakebot has been released in January 2022. This is a very capable quakebot and contains some innovations such as the automatic invitation of eyewitnesses to report their experience through the LastQuake system. It not only provides rapid information but also tests the use of teachable moments to increase awareness and preparedness. A performance monitoring tool that reports all interactions with each publish tweet has also been deployed to better target future improvements.

The refactoring of the seismic data processing tools has made several significant steps, one of them being the integration of a new up-to-date location algorithm. This new version imposes a new data model and database structure and so will only replace the current system when all of the required changes are completely finalized and tested.

In the meantime, a new version of the website for desktops is being developed and should be online at the end of the summer. The user interface of the future version 3 of the LastQuake app is being finalized and we can also hope to make it available by the end of the year.

Finally, the field of citizen seismology which is the core of this project and which the EMSC has been pioneering for years, is now fully recognized by the seismological community as a powerful approach which brings benefits to operational seismology and which still has a lot more to offer. The final year of this project should further demonstrate this.

II. TEAM

As of April 1st 2022, following 2 recruitments early 2022, the EMSC team comprises the following members:

- Rémy Bossu, seismologist and team leader
- Jean-Marc Cheny, IT
- Marina Corradini, communication officer
- Laure Fallou, sociologist
- Simon Isartel, geophysicist and data analysis
- Matthieu Landès, seismologist
- Julien Roch, seismologist
- Frédéric Roussel, IT
- Robert Steed, data science and software developments
- Guillaume Ucciani, seismologist

III. EVOLUTIONS OF KEY PERFORMANCE INDICATORS AND PROJECT VISIBILITY

Several key performance indicators (KPI) have been identified in the project, they are not the only way to evaluate its evolution but they do characterize its public visibility and crowdsourcing efficiency. Although one should note that some of these KPI (e.g. number of collected felt reports or the number of LastQuake app users) are influenced by recent earthquake activity (which has been rather low over the last few months), their evolution since the initiation of the project are positive (Table 1)

	Project start	2022
@LastQuake Twitter followers	110k	210k
@LastQuake Twitter views	64.4M	157M
Monthly website visits	1.5M	1.5M
LastQuake App users	440k	889k
LastQuake app Views (Android)	28.7M	121.4M
LastQuake app Views (ios)	702k	3.2M
Number of Felt Reports	125k	334k
Median felt report collection time	12.5 min	9.6 min
App rating (Ios/Android)	4.7/4.7	4.7/4.6

TABLE 1 : EVOLUTION OF KPI SINCE THE START OF THE PROJECT. THE DECREASE IN ANDROID APP RATING IS MARGINAL WITH A CURRENT RATING OF 4.622. UNFORTUNATELY, TRAFFIC MEASUREMENTS USE DIFFERENT METRICS ON IOS AND ANDROID AND THEY ARE NOT EASILY COMPARABLE.

In terms of use of the different platforms, it is remarkable that while the visibility of Twitter and the apps has increased by a factor of 2.5 and more than 4 respectively, no change was observed for the websites. This illustrates that social media and apps are by far the preferred means used by the public to access rapid earthquake information. In addition, the rapidity of crowdsourcing felt reports has shown an improvement of 25%. In conclusion, the improvements to the services that has been carried out since the beginning of the sponsorship from SCOR *Foundation for Science* have improved their reach and efficiency.

Concerning the visibility of this collaboration within the academic community, two of our recent articles (Kouskouna et al., Martin et al. 2021) acknowledged the support from the SCOR *Foundation for Science*. The articles illustrate the benefits of LastQuake services in 2 countries (India and Greece) and for 2 complementary aspects: earthquake impact and human reactions to earthquakes. The article concerning Greece illustrated how rapid crowdsourcing complements instrumental seismic data and improves our description of earthquakes and their effects; while in India, LastQuake data was exploited to analyze public reaction at the time of a predicted earthquake, a prediction which logically proved wrong!

Finally, we gave a number of interviews especially following the Petrinja (Croatia) earthquake of late December 2020 but also with interviewers from Canada, and the communication team of *the SCOR Foundation for Science* shot a video in our premises.

Martin, S. S., Bossu, R., Steed, R., Landès, M., Srinagesh, D., Srinivas, D., & Hough, S. E. (2021). When Punjab Cried Wolf: How a Rumor Triggered an "Earthquake" in India. Seismological Society of America, 92(6), 3887-3898.

Kouskouna, V., Ganas, A., Kleanthi, M., Kassaras, I., Sakellariou, N., Sakkas, G., ... & Bossu, R. (2021). Evaluation of macroseismic intensity, strong ground motion pattern and fault model of the 19 July 2019 Mw5. 1 earthquake west of Athens. Journal of Seismology, 25(3), 747-769.

Dnevnik:	Stay away from earthquake prediction!
Corriere della Sera	Terremoti, prevederli non è facile
Canadian Geographic	Geotracking technology becomes ever more sophisticated
HINA	Why does EMSC websites collapse?
N1 HRV	If someone claims he can predict earthquakes...

IV. ACHIEVEMENTS IN YEAR 2

The main tangible achievement of the year 2 has been the full renovation of our Twitter quakebot @LastQuake. @Lastquake offers real time information about felt earthquakes and their effects. Since its inception in 2012, it has gradually evolved but there were some limitations that required a new development from scratch.

We had 4 main objectives:

1. To adapt the number of published tweets and the time window of publication to the importance of the earthquake
2. To take advantage of the teachable moments created by small magnitude felt earthquakes to improve awareness and preparedness
3. To integrate new services and notably the CsLoc service for fast seismic location (~1min)
4. To better monitor the actual use of the quakebot by the public

Figure 1 represents a schematic view of the quakebot operations.

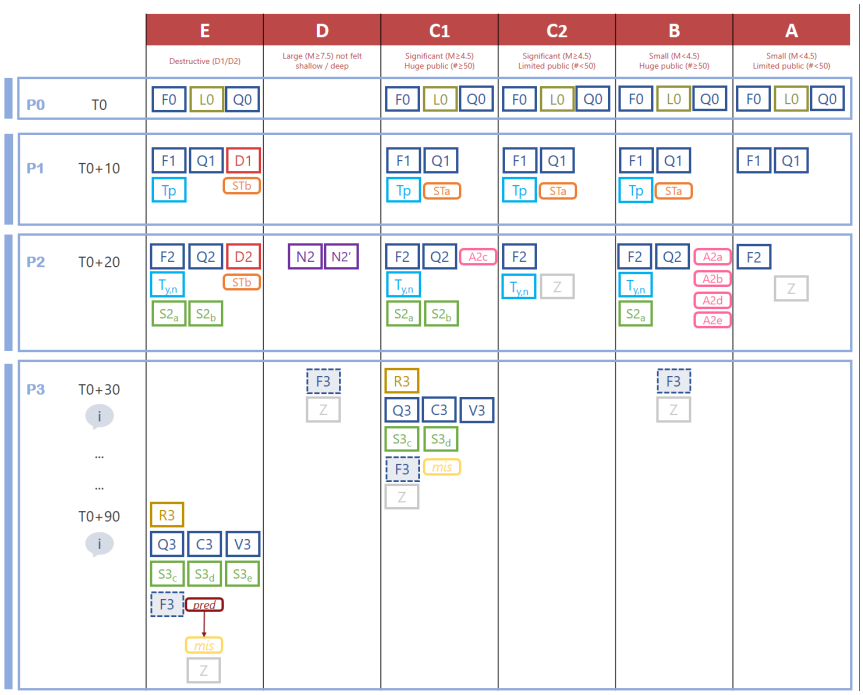

FIGURE 1 : SCHEMATIC VIEW OF THE DIFFERENT TWEETS PUBLISHED BY THE @LASTQUAKE TWITTER QUAKEBOT AS A FUNCTION OF THE CATEGORY OF EARTHQUAKE (COLUMNS) AND TIME. EACH TWEET HAS A LABEL, THE LETTER REPRESENTING THE TYPE OF INFORMATION IT CONTAINS (E.G., F1 IS A TWEET INFORMING AN EARTHQUAKE HAS BEEN FELT IN THE PERIOD 1).

@LastQuake also contains a new feature consisting of an automatic answer to people publishing tweets containing the keyword earthquake in the local language and from the region where an earthquake has just been felt, this automatic tweet inviting them to share their observations (felt experience, pictures) with the EMSC. It is an experiment for further improving crowdsourcing performance.

1. ADAPTATION TO THE IMPORTANCE OF THE EARTHQUAKE

In the previous version of the @LastQuake quakebot, new tweets were published up to 90 min after an earthquake occurrence regardless its magnitude. This strategy showed its limits during active aftershock sequences when numerous earthquakes occurred close in space and time. In such situation, tweets related to different events became intertwined generating possible confusion and perhaps more fundamentally, it pushed tweets related to the mainshock far down in the timeline making them difficult to find.

In order to deal with this issue, we defined several categories of earthquakes based on their expected impact (damaging, non-damaging), recorded magnitude and the amount of collected felt reports which are used as a proxy for the desire for information from our audience. So a small magnitude non-damaging earthquake for which only a handful of felt reports are available will only be the topic of a couple of tweets within 15 min of its occurrence. A damaging earthquake will be the subject of more tweets, over a longer period of times and include new type of tweets such as historical seismicity, a list of recent deadly events but also education (safety tips, misinformation warnings…) and finally at the end of its publication period a series of "wrap-up" tweets synthetizing all the information available.

2. TEACHABLE MOMENTS

Felt earthquakes open a "teachable moment" among eyewitnesses, i.e. a time window when they are psychologically receptive to new information and in this case, earthquake safety information. Awareness and preparedness campaigns should not only focus on the content of the messages but rather, for the sake of their efficiency, on their timeliness and target periods when receptivity is at its maximum. Experience shows indeed that timeliness can be key (Figure 2).

FIGURE 2: EFFICIENCY OF PREVENTION AND RISK AWARENESS MESSAGES DEPENDS IN A SIGNIFICANT PART OF THEIR TIMELINESS

In practice, teachable moments are detected by crowdsourced detections and a large and rapid collection of felt reports (Figure 3). In such a case, and for non-damaging earthquakes only, we automatically publish educational tweets e.g. explaining the difference between magnitude and intensity, or explaining that earthquake prediction does not currently exist. The tweets reference internal and external resources. Several tweets are available for the same topic and they are sequentially published in successive moments making each of them different from the previous one.

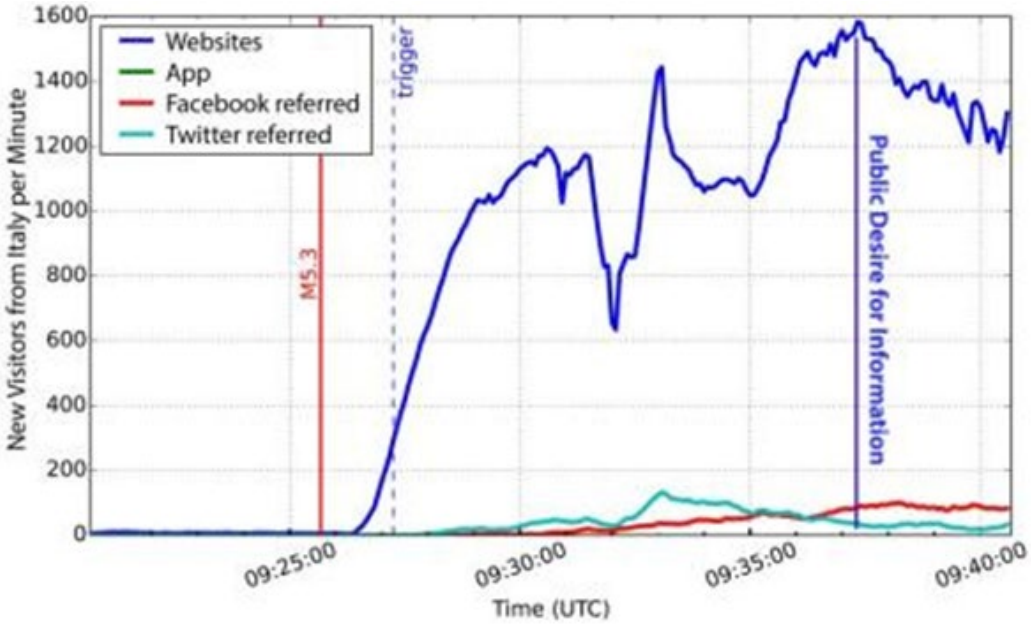

FIGURE 3 : EXAMPLE OF TIME EVOLUTION OF TRAFFIC ON EMSC WEBSITE FOLLOWING A FELT EARTHQUAKE. THE SURGE REFLECTS INFORMATION SEEKING BEHAVIORS FROM EYEWITNESSES. ITS AMPLITUDE CAN BE SEEN AS A PROXY FOR THE PUBLIC DESIRE FOR INFORMATION AND IT MARKS THE OPENING OF A TEACHABLE MOMENT.

3. INTEGRATION OF NEW CSLOC SERVICE

CsLoc is the combined analysis of crowdsourced and seismic data for fast (~1 min) and reliable seismic location of felt earthquakes (Figure 4). For cases with enough data is available, it also computes a magnitude sometime after the location is found. In practice, this means that, contrary to what has been happening until now, we can confirm the existence and location of a felt earthquake without knowing its magnitude. This has led to new tweets and we have had to define how this data will be published in the future version of LastQuake app.

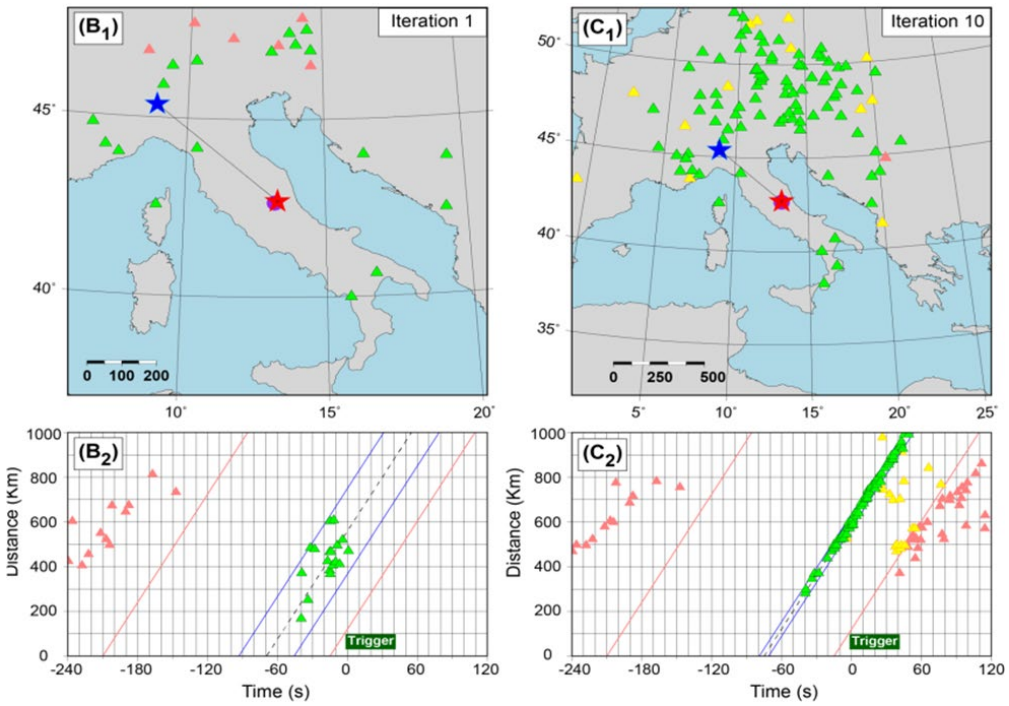

FIGURE 4 : CSLOC EXPLOITS THE LOCATION OF THE CROWDSOURCED DETECTION (BLUE STAR) TO IDENTIFY SEISMIC STATIONS (TRIANGLES) WHICH HAVE LIKELY RECORDED THE SHAKING. DATA ARE RETRIEVED, OUTLIERS EXCLUDED (BELOW) AND A SEISMIC LOCATION (RED STAR) PERFORMED. IT IS AN ITERATIVE PROCESS WHICH STOPS WHEN THE LOCATION REACHES PREDEFINED QUALITY CRITERIA.

4. MONITORING @LASTQUAKE PERFORMANCES

The development of @LastQuake is empirical and based on 10 years of operation and evaluating its efficiency is not straightforward. In order to help with this task, a detailed monitoring system using the Twitter API (Application Programming Interface) has been created to collect the public reaction (like, reply, views...) for each of the published tweets (Figure 4). It will be used to identify the tweets generating public reaction and the ones which do not. This tool will be essential for the future evolution of this tool.

You are here : EMSC > Member > Twitter Flux Reporting — Our sponsors: SCOR — Donate — About EMSC

Twitter Flux Reporting

Link to Metrics and Graphics on Twitter

Year : 2022

Period : Last 10 days | Last 20 days | Last 30 days | Last 50 days | Last 60 days

Categories	Descriptions	Event Percentages (326 events)
Destructive	Destructive (with D1/D2 from EQIA)	0%
Significant with Huge Public	Significant (M>=4.5) with Huge Public (#>=50 at 16 min from T0)	5.8%
Small with Huge Public	Small (M<4.5) with Huge Public (#>=50 at 16 min from T0)	13.8%
Large Not Felt	Large (M>=7.5) not felt shallow/deep	0%
Significant with Limited Public	Significant (M>=4.5) with Limited Public (#<50 at 16 min from T0)	23.9%
Small with Limited Public	Small (M<4.5) with Limited Public (#<50 at 16 min from T0)	54.9%
Orphan Noids	Not associated Noid or associated Noid at later time	1.5%
Other	uncategorized events	0%

Tweet Names	Descriptions	Event Percentages (326 events)	LIKES	RETWEETS	REPLIES	QUOTES	LINK CLICKS	PROFILE CLICKS	IMPRESSIONS	ENGAGEMENT RATE
F0	Crowdsourced Detection	30.7%	17841	16000	1391	4176	13088	17021	4864229	0.01429147353
L0_EQN	Noide confirmed by EQN	4.6%	70	14	17	1	74	108	93180	0.003047864349
L0	Noide (Loc but no Mag) confirmed by CSLoc	25.5%	704	190	97	25	967	1134	415546	0.007500974621
LM0	Noide (Loc + Mag) confirmed by CSLoc	6.7%	195	135	22	37	281	273	100557	0.009377765844
QN0	Not-associated Felt Reports	17.2%	2141	1142	145	366	0	1710	772289	0.00712686572
F1	Confirmed Earthquake with preliminary info	30.4%	4193	2682	168	576	0	4659	1932596	0.006353112601
Q1	Early Felt Reports Map at P1	6.7%	517	577	30	120	640	561	329801	0.007413561511
ST1A	Safety Tips for non-destrutive events at P1	4%	307	230	15	6	0	187	147207	0.005060900637
ST1B	Safety Tips for destrutive events at P1	0%								0
D1	Destructive earthquakes at P1 (triggered from EQIA)	0%								0
TPENDING	Tsunami risk under evaluation	2.5%	129	56	8	7	0	79	36741	0.007593696415
N2	Large, not felt, shallow (z<300) at P2	0%								0

FIGURE 5 : INTERFACE OF THE LASTQUAKE TWITTER QUAKEBOT PERFORMANCE ANALYSIS TOOL. ONE CAN CHECK THE PROPORTION OF THE DIFFERENT TWEETS PUBLISHED IN A GIVEN PERIOD OF TIME AND THE DIFFERENT MODE OF PUBLIC ENGAGEMENT FOR EACH OF THEM.

V. ONGOING ACTIVITIES

There are many ongoing activities which have not yet produced visible results but which remains fundamentals for the future. There are obviously IT improvements, from upgrading the different operating systems to network improvements. We have moved to Python 3 the majority of our software which were developed in Python 2. This includes notably all the crowdsourced detections (detection of felt earthquakes through the online footprints from eyewitnesses), and the impact assessment tool. We have been also upgrading the GMT tools extensively used to automatically generate maps from versions 3 and 4 to version 6.

We have continued our efforts to upgrade the system processing the seismic data. This venerable system includes many legacies that we need to get rid of and the requirement to implement a modified database scheme, data model and format has meant that the new system is being developed in parallel to the operational one and will only replace it only once totally finalized and validated. Still significant progresses have been made, an up-to-date location algorithm has been implemented and a new data grouping strategy defined.

After the new website for mobile devices and the new @LastQuake Twitter quakebot, we are now developing the new desktop website. Also preparation for the LastQuake app v.3 has been completed which will integrate websocket technology in order to ensure real time updates without any action on the user's side and a brand new user interface is being finalized. New versions of the app and of the website for desktop will complete the renovation of our communication tools.

VI. BEYOND INITIAL OBJECTIVES

There are 2 beyond-the-state-of-the-art initiatives which, if successful could further contribute to LastQuake's success. We are currently experimenting the development of the first quakebot for WhatsApp and, if successful, will test the possibility of crowdsourcing eyewitnesses' observations from this messaging app. The advantages are obvious, this would dramatically increase the audience of the LastQuake system and solve the problems of app user retention. The second initiative is to test artificial intelligence approaches to processing crowdsourced data in order to rapidly identify damaging from not damaging earthquake. Rather than simply taking into account the text of the actual felt reports, these approaches also identify time and geographical patterns of the collection itself. We will have a better view on the potential of these 2 initiatives before the end of our convention with the *SCOR Foundation for Science*.

VII. CONCLUSION

The sponsorship convention between the EMSC and the *SCOR Foundation for Science* initiated 2 years ago has been particularly efficient and has already achieved significant results in term of improvements of services' performances and visibility.

Still a significant part of the work carried out is related to the refactoring of the seismic data processing which will only be visible once achieved probably early 2023. In addition, a new version of the LastQuake smartphone app with a brand new ergonomic and a new version of the website for desktops will be in line in the coming year.