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RESEARCH ARTICLES

How to deal with sparse macroseismic data: Reflections on earthquake records and recollections in the Eastern Baltic Shield

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ABSTRACT

This study discusses the scope of historical earthquake analysis in low-seismicity regions. Examples of non-damaging earthquake reports are given from the Eastern Baltic (Fennoscandian) Shield in north-eastern Europe from the 16th to the 19th centuries. The information available for past earthquakes in the region is typically sparse and cannot be increased through a careful search of the archives. This study applies recommended rigorous methodologies of historical seismology developed using ample data to these sparse reports from the Eastern Baltic Shield. Attention is paid to the context of the reporting, the identity and role of the authors, the circumstances of the reporting, and the opportunity to verify the available information by collating the sources. We evaluate the reliability of oral earthquake recollections and develop criteria for cases when a historical earthquake is attested to by a single source. We propose parametric earthquake scenarios as a way to deal with sparse macroseismic reports and as an improvement to existing databases.

1. Introduction

Seismologists' interest in historical earthquakes was renewed worldwide in the early 1980s. The mandatory seismic hazard and risk assessments for critical constructions, such as nuclear power plants, were a major reason for the need for seismicity catalogs that cover both the pre-instrumental and instrumental eras. Until that time, parametric earthquake catalogs based on macroseismic information had largely been compiled from previously published seismological compilations. The aim had been to obtain the requisite parametric lines in the catalog, rather than the qualification of the sources used. The focus shifted to the sources when historians joined seismological research. The outcome of this cooperation between historians and seismologists is two-fold: the uncovering of previously unknown written documentary records in different archives and libraries, and the development of rigorous methods of source analysis. Regions of high seismicity and with long traditions of documentation have a large accumulation of written source materials, so it is reasonable that they tend to influence methodological considerations. Guidoboni and Stucchi [1993], for example, considered seismological compilation related to the «Latin» culture. Guidoboni and Ferrari [2000] investigated factors, such as building techniques and population density, that influenced the effects of damaging earthquakes in Italy over the centuries. Guidoboni and Ebel [2009] provided detailed techniques for historical seismology and drew extensively upon examples from the Mediterranean region.

This study focuses on low-seismicity regions where earthquakes seldom have social or economic impact. Reports of non-damaging earthquakes (maximum intensities below 7) are drawn from the Eastern Baltic (Fennoscandian) Shield (Figure 1), and particularly from the 16th to the 19th centuries. This region is sparsely populated and is divided by state borders, language, religion, and traditions, all of which pose obstacles in the study of historical earthquakes. Moreover, a thorough search of archives and libraries is not likely to bring to light previously unknown ample documentation on past earthquakes. A history of macroseismology in the region appears in Mäntyniemi et al. [2004] and Tatevossian [2004]. Occasionally, earthquakes in the region were investigated elsewhere [e.g., Perrey 1845], but the main descriptive catalogs were compiled locally. Most earthquake information is currently available in parametric catalogs [e.g., Båth 1956, Kondorskaya and Shebalin 1977, 1982, Ahjos and Uski 1992], whereas investigations of individual earthquakes have been less numerous and conducted in one nation only, and are sometimes many decades old. One of the few newer studies was provided by Nikonov [2004]. When various parametric solutions conflict with each other, or when the only solution available appears

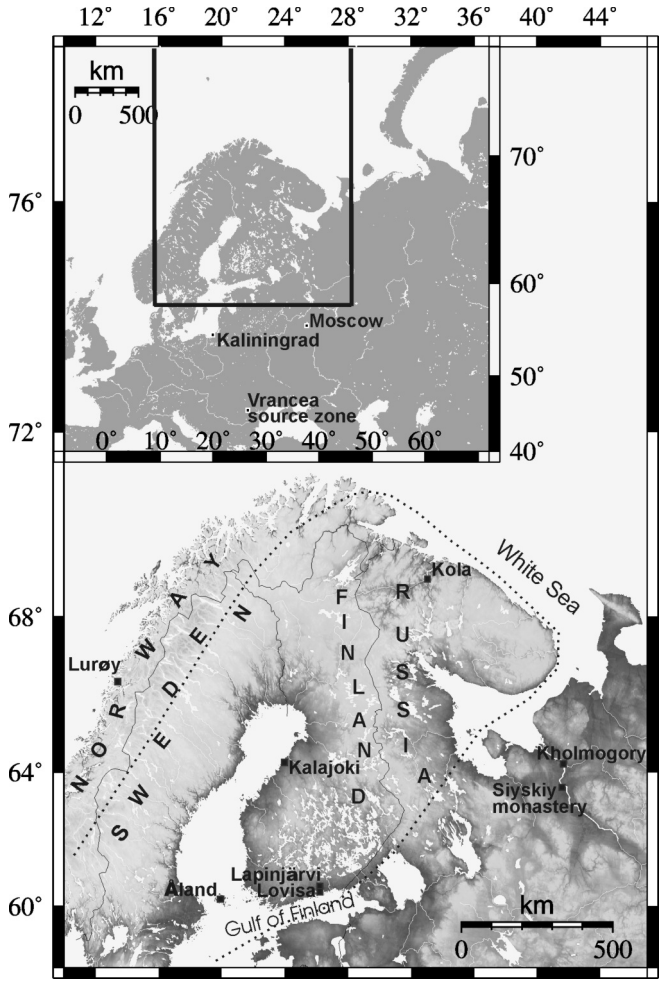

Figure 1. Locations mentioned in the main text. Dotted line, approximation of the Baltic (Fennoscandian) Shield; black lines, current state borders; capital letters, countries.

not to be satisfactory, it may be difficult to find any information about the inference of the parameters or the sources used. The renewed interest in the original sources aims at better control of what is available, at displaying these data and the effects of earthquakes according to modern standards, and, ultimately, at a more consistent way of obtaining parameters from written documentary sources. Before attempting to obtain any parameters it is necessary to investigate the features of the data.

This study investigates recommended historical methods and their application to sparse macroseismic data. Attention focuses on the context of reporting and the authors, the use of coeval sources and oral accounts, the primary sources themselves, and the identification of indicators of reliability, when a historical earthquake is attested by a single source and when a source relies on reminiscence.

2. The context of the reporting

Small earthquakes are essentially natural phenomena that cause no natural disasters. Reports related to these cases rarely refer to damage assessment, casualties, and costs. The basic motivation of those who write such reports is to inform contemporaries about the occurrence, and an important part of the message is sometimes that the earthquake caused no damage. This applies, for example, to the formal reporting of a local district officer to the regional governor of western Finland in 1883 [Vaasa Provincial Archives, Provincial Administration in Vaasa, letters 1883, Eab:18].

The identity of the author of such reports may be difficult to trace, although the number of possible candidates in small remote places during times of prevalent illiteracy was limited. For instance, the compilation of Russian chronicles was highly diversified and included contributions from people who remained anonymous, and especially from monasteries. Later, letters in newspapers were often supplied with little more than a pseudonym. Ample reporting was edited to an unknown extent, which can result in the loss of the information about the initial observers. Muir Wood [1988] provided a rare identification of an author: he attributed the description of the Lurøy, Norway, earthquake of August 31, 1819, in the newspaper Åbo Tidningar [January 15, 1820] to ornithologist and doctor Lars Johan Prytz (1789-1823), who was traveling in the affected area at the time of the occurrence (cf. Example 4 in Section 5). One benefit of the systematic macroseismic surveys introduced in the late 1800s was the improved identification of the respondents. The early questionnaires were designed for location rather than an assessment of intensity, but they did provide the name of the reporter.

The descriptions reflect different levels of comprehension of the phenomenon. A fundamental problem is to decide whether they are actually related to a real earthquake. The description «In the same year [6599/1091], Vsevolod was hunting close to Vyshegorod, and had just cast a net when a horrible snake fell from the heavens frightening all the people. At the same time, the earth struck and many felt it» is included in the Lavrentevskiy chronicle (edited by Kloss in 1997). The cryptic remarks gradually gave way to a more rational understanding of the phenomenon, but a variety of reactions and attitudes remained typical for long afterwards. Some documents from the 1600s reflect a fear of earthquakes as omens of misfortune and gratitude to God for sparing people from bad consequences. A superstitious post-earthquake rumor floated around Western Finland in 1883 [Norra Posten newspaper, April 12, 1883], although contemporary newspaper reports remained matter-of-fact. Some took a persistent earthquake swarm in Lapinjärvi, southern Finland in 1951-1952 to be military activity, whereas the elderly tended to think in religious terms. On the 50th anniversary of the occurrences, a man who was a schoolboy at that time told how the earthquakes were exciting and made the locality stand out from the quiet countryside [Helsingin Sanomat newspaper, April 17 2002].

In many instances, the observation served well as a piece of news. In the latter half of the 1800s, many newspapers regularly published columns of letters from the countryside, sometimes even if nothing particularly newsworthy had taken place, so ground shaking provided something out of the ordinary to report. Such letters sometimes reflect astonishment about the rarity of the phenomenon. Some reporters even went to great lengths to stress that the observation came from trustworthy people.

Given the rarity and transience of earthquakes in a low-seismicity region, the perception of the phenomenon may not be evident. The available reports record different degrees of certainty as to the origin of the observation. Even relatively large recent events have been attributed to human activity. Examples include the earthquake of October 25, 1976, in the Gulf of Finland, and the earthquakes of September 21, 2004, in Kaliningrad. Their magnitudes were estimated at M_S 4.3 ±0.5 [Kondorskaya and Shebalin 1982] and M_W 5.0 and 5.2 [Gregersen et al. 2007], respectively. More frequent microearthquakes, weather-related phenomena – especially cryoseisms [Lacroix 1980] – and earthquake sounds and thunder have been confused with each other.

3. On the importance of being contemporary

The basic task of historians is to use the original document instead of a copy of an original or a copy of a copy. The preference of original documentation contemporary with an event under study is also an important guideline in historical seismology. A large set of data may allow researchers to separate the effects of earthquakes that occurred close together in time [e.g., Albini and Rodríguez de la Torre 2001].

In a region investigated, the available source may have been written down years after the occurrence. A description of a church partially damaged due to an earthquake in 1626 appears in a manuscript of 1663 [Cajanus 1663]. An observation made in southern Finland after the great Lisbon earthquake of November 1, 1755, was published in a newspaper seven years later (Figure 2).

Brief remarks about earthquakes that appear in longer historical accounts from a given locality constitute original documents. This is a variant of the basic context of earthquake reporting (Section 2): authors recorded recollections in writing next to more general matters. Typically, little is known about the procedure: How did the author obtain the information? Were interviews conducted?

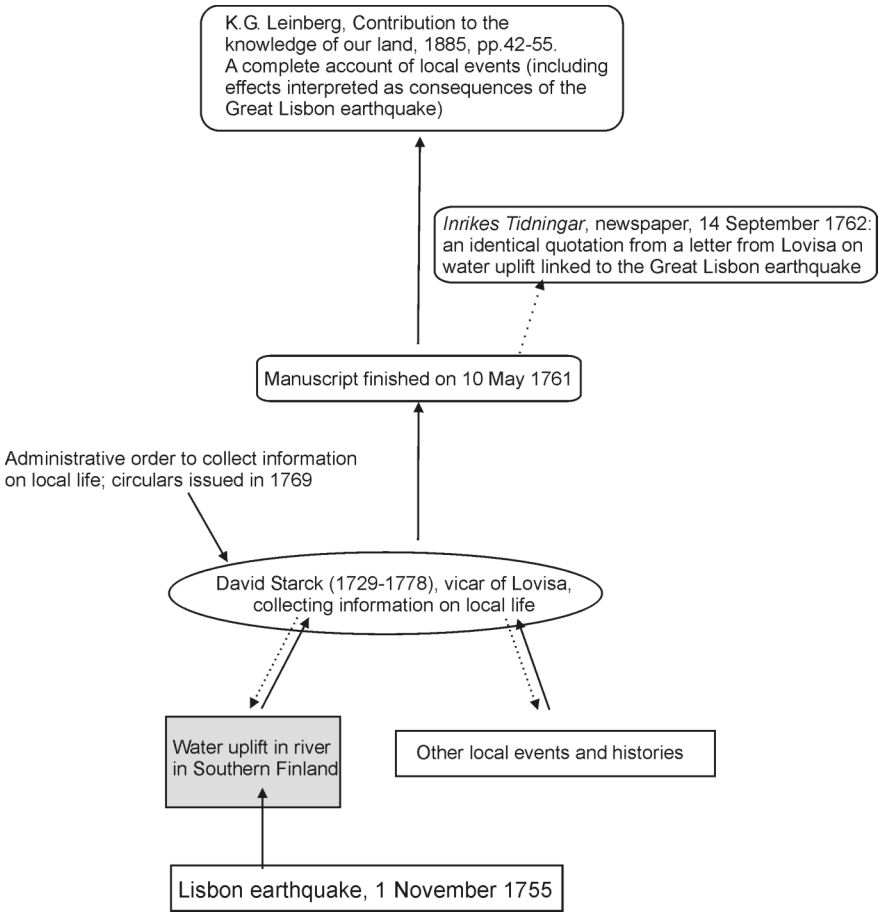

Figure 2. Flow chart of how an unusual river phenomenon in southern Finland that claimed to be an effect of the great Lisbon Earthquake of November 1, 1755, entered written records. The author, David Starck, was a local vicar who recorded recollections of the phenomenon in writing along with more general matters. The description appeared in a newspaper seven years after the event, and then in a book over 120 years after the event.

How many people contributed to the earthquake recollection? Remarks about earthquakes might have been based on notes of a literate individual, but may also have survived in an oral form. Oral accounts are plausible, because nobody was under an obligation to report earthquakes until much later, and although ordinary people lacked the skills and means to write, they were nevertheless subject to the natural environment, including the climate, the flora and fauna. Presumably, such individuals were good observers, although poor recorders of ground shaking. This raises the question about the reliability of reminiscences.

Gold [1980] investigated the behavior of people who experience natural disasters, and stated that, «Extreme events tend to act as a fixed point in experience, obliterating memories of earlier occurrences and acting as a standard against which later ones will be compared, although the poignancy of the recollection will fade if the extreme event happens only very rarely» [p. 206]. In contrast, lesser earthquakes appear to awaken recollections of earlier occurrences. When an earthquake occurred in northern Sweden and Finland on November 5, 1898, many reporters remembered the previous event on June 23, 1882 [Mäntyniemi 2008]. The older event served as a standard against which to compare the new one: this time, ground shaking was less intense than it had been 16 years earlier. If the time interval between successive earthquakes is long, few people will remain who remember the previous event. Kalajoki in western Finland was one of the places where observers felt the earthquake of June 23, 1882. According to its oldest inhabitants, an earlier earthquake was felt there in August, 1818 [Uusi Suometar newspaper, July 1, 1882]. This recollection most likely refers to August 31, 1819, when ground shaking occurred in Kalajoki [Åbo Tidningar newspaper, January 15, 1820].

Earthquake observations are rare in a low-seismicity region, which reduces the probability that an eyewitness will confuse one occurrence with another. On the 75th anniversary of the central Finland earthquake of November 16, 1931, a local newspaper reporter interviewed a man who was newborn at the time of the event, and who had learned about it later from his mother [Laukaa-Konnevesi newspaper, November 23, 2006]. An earthquake without devastating consequences is not traumatic, and people share an eager tendency to relate their memories rather than to hold them in silence. Recollections of earlier earthquakes and comparisons of their intensities have been discovered in other regions as well [Tatevossian et al. 2003]. According to Schacter [2001, p. 31], incidents that are discussed and pondered immediately afterwards are, at least partially, protected from transience. Earthquake occurrences may fall into the category of memorable experiences, but human memory has its limitations. People tend to remember the time of year and day, or to link the event to another occasion, rather than to a date. In northern countries, the contrast between summer and winter is stark, which serves memory well. Some observers of an earthquake that occurred on a dark November night in 1898 mentioned that the previous earthquake in the area occurred 16 years previously on a sunny summer morning [Mäntyniemi 2008]. After the earthquake of June 30, 1882, in Åland, the older people related this a previous occurrence that had been felt there in winter about 60 years previously [Åbo Posten newspaper, July 11, 1882]. They were probably remembering the strong earthquake of January 30, 1823. It is not unusual for recollections to include a rounded rather than a precise number of years. The time of day is a credible indicator of a genuine observation because it is related to the whereabouts of the individual at the time, but in a way, this is too inherent a part of the observation to give cause for alteration. Accuracy is typically limited to the separation between morning, afternoon, and night. A report from the Gulf of Kandalaksh in the White Sea noted the time of occurrence as «1 o'clock in the daytime, year 7050 (1542)» [Panasenko 1977]. The combination of the precise time of day and the year is exceptional, although it may actually be erroneous, because no other sources have been found for this earthquake.

The human mind can also err unconsciously in many ways. According to Schacter [2001], the suggestibility of memory refers to the tendency of an individual to incorporate information from external sources, such as other people, written materials, or the media, into personal recollections. Misattribution involves assigning a memory to the wrong source, such as remembering that a neighbor told a story which was actually published in a newspaper. Such malfunctions of memory can yield erratic earthquake recollections. Details may be distorted or the entire recollection may fade over time.

4. To collate or not to collate

Historians apply a number of principles to the challenging task of source comparison [e.g., Howell and Prevenier 2001, pp. 70-71]. Among these principles is a preference for the eyewitnesses and experts who created the sources with the most "authority". Eyewitnesses are, in general, preferred, especially in circumstances when the ordinary observer deals with details that are known to many contemporaries. A single source obviously precludes collating, but the principle of *authoritativeness* is also recommended in such cases [Guidoboni and Ebel 2009, p. 227].

If the author of a single source is known, we might be able to infer from biographical knowledge how well the author should have observed what he or she reported. Such "authority" may also have mixed standards. Around 1663, Johannes Andreae Cajanus (1626-1703) wrote a manuscript

that includes a remark about a church damaged during an earthquake in 1626 in present-day Finland. Cajanus was the vicar of the parish in question, and historians appreciate his manuscript for the ethnographic information it contains. However, since Cajanus was born in 1626, his knowledge of the earthquake is second-hand. The only eyewitness testimony he provided in his contemporary correspondence was the effects on the church as seen nearly four decades after the earthquake.

One should not reject a source just because the identity of the author is missing. In monasteries, for instance, the author generally received no credit for his achievements. The wording of a recollection may contain clues of an eyewitness testimony. Baeck [1747] recollects that «– around the year 1737, autumn time, one afternoon, when I was alone at the Korsholm district office in Vaasa (…), attending to my duties, I noticed that the building shook so strongly that both the windows and walls rattled (…)» [Renqvist 1930, p. 11]. In this case, the identity of the author is known, although even if it was not known, the definitions of the time and place give reason to presume that this was a genuine recollection, because they are well within the limits of a person's ability to remember years later. A more accurate timing of an earthquake recollection would imply that it was based on written notes, which are sometimes consulted when a new earthquake occurs.

Among the principles applied by historians, there is a preference for the source that appears to accord best with common sense, if disagreement between sources cannot be resolved otherwise. A source related to a past earthquake is first of all judged against seismological sense (i.e. whether a natural phenomenon occurred and whether information about its origin time, strength, and place of observation can be determined). References to local conditions, such as building types, contribute to the overall impression. Seismological sense also includes what is known about the earthquake phenomenon and its effects. In many instances, eyewitness reports indicate that two shocks occurred after a very short time interval, or that a roar sounded just before the tremor began; these phenomena are interpreted as the arrival of different seismic waves. New interpretations of old earthquake reports might be warranted, as the understanding of earthquakes can be improved. References to unknown phenomena, such as earthquake-related lights, might have made old texts look unreliable to previous readers. However, the reader should not impose too much seismological knowledge on a brief felt report. Moreover, re-examination of the seismicity record further back in time can lead to the discovery of previously unknown incidents. The area indicated in an old report, for example, might be well known for its frequent earthquake activity, but the instrumental catalog may also indicate that the area is seismically quiescent. Seismological sense should also serve to detect potentially false reports. For instance, reports may have been written for amusement, such as an April Fool's Day hoax [Ekenäs Notisblad newspaper, April 1, 1887].

Sources are associated with the same earthquake based on the origin time, which can lead to a complicated puzzle of different notations and understandings of time. If the available sources are deemed to belong to the same earthquake, collating is possible in principle, although it might not actually eliminate any problems. The sources might carry equal weight in terms of "authority", or they might be of mixed quality, so that only parts of their reports are seismically sound or can provide usable information. The sources may also be of entirely different types: the recollection of an individual is related to one site, but a general description can provide an idea of the total area of perceptibility. Seldom is a source considered indisputably the best. An essential prerequisite for meaningful collation is that the contents of the sources overlap. In many cases, only a few details are available, and they can be neither confirmed nor contradicted by collating.

5. Examples of earthquake reports

There are four examples of historical earthquake reports given below; they appear in their original languages in the Appendix.

Example 1: *Moskovskiy letopisniy svod kontsa XV veka* (Moscow annual code of the end of the 15th century, edited by Kloss in 2004) records the following:

«In the same autumn [1446], on the first day of October when the Grand Duke was set free in Kurmysh, at six o'clock in the evening, Moscow was shaken; the Kremlin, the entire town and the churches also shook. Not all of the people who were sleeping felt it, but many who felt it were in grief and afraid for their lives. In the morning, with tears, they told all this to the people who were not awakened.»

Comments 1: Reasoning by analogy, this report might relate to the strong intermediate-depth earthquakes in Vrancea, Romania, that were felt with more or less the same intensity in Moscow throughout the centuries [Tatevossian and Albini 2010]. As long as the fundamental circumstances that produced the similarities remain unchanged, the analogy works. A seismogenic source zone changes on a geological timescale, while the building stock in Moscow changes on a human timescale, but in a direction that enhances the observations felt.

Example 2: *Kholmogorskaya letopis'. Dvinskiy Letopisets* (Dvina Chronicle, compiled in Kholmogory; Polnoye Sobraniye Russkikh Letopisey, 33, 1977, p. 172) includes the following remark:

«1627. A terrible quake. While governing this voevoda in Dvina, a terrible quake occurred in [the year] 135, May, day

20, during All Saints week at five o'clock before Monday. Because of our sins, the wrath of God shook the earth; and many people saw this quake, but some were sleeping, and God saved the people from the quake.»

Comments 2: The description is attributed to the Siyskiy monastery along the River Dvina (Figure 1). The year 135 is 7135 (the thousands were omitted in the Dvina Chronicle); the year 7135 according to the Byzantine calendar is 1627 according to the Gregorian calendar. No other remark with exactly the same dating exists. This is a brief remark typical of the region. For intensity assessment, it is worth noting that not all of the people were awakened.

Example 3: A newspaper report in *Tidningar utgifne af et Sällskap i Åbo* on September 30, 1777, p. 143 (place names mentioned are shown in Figure 3):

«Extracted from a letter from the commune of Malax in the province of Ostrobothnia

Earthquakes are unusual in Ostrobothnia, if not totally unknown; but last Easter eve there was a strong shaking, such that people in several places were frightened. It was felt in Brahestad, Ny-Carleby, Vörå, Lill-Stor-Kyrö and Vasa, such that chairs and dishes shook in people's houses. Here in Malax, only a strong roar was heard at the same time. It is not known whether this rare occurrence has been noticed over a broader area.»

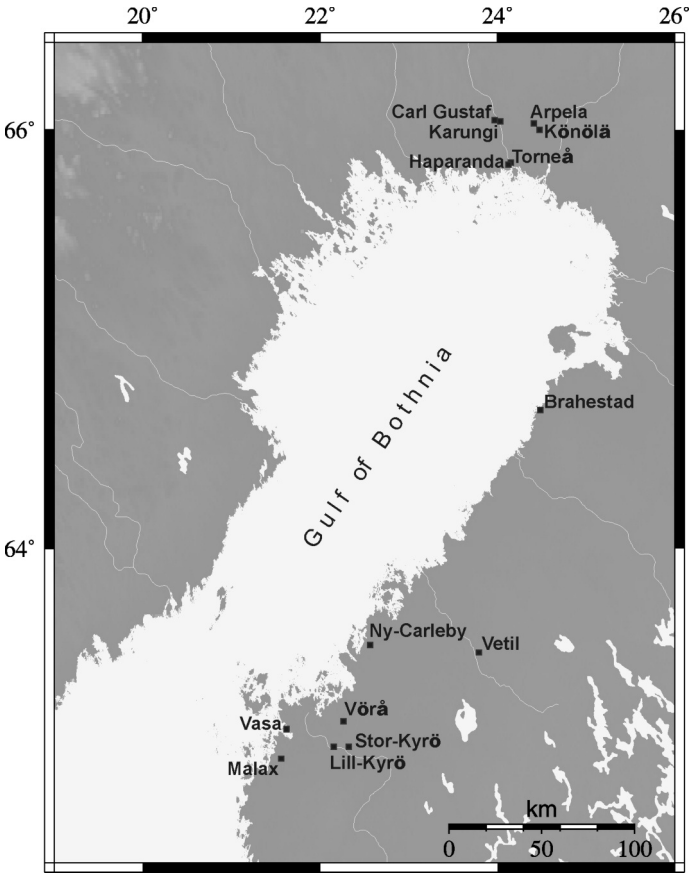

Figure 3. Locations related to the earthquake reports of 1777 (Example 3 in Section 5) and 1819 (Example 4 in Section 5). The cluster of places in the north comes from Example 4.

Comments 3: This is a very concise report. The radius of perceptibility depends heavily on the northernmost place mentioned; Brahestad. Actually, two other sources related to Vetil exist [Renqvist 1930, p. 19]; indeed all sources agree on the date, but collation does not solve the reliability of Brahestad, or whether the shaking was felt over a broader area. The pattern of observations felt might be unpredictable along a shoreline.

Example 4: A part of a newspaper report in *Åbo Tidningar* on January 15, 1820 (p. 2) (place names mentioned are shown in Figure 3):

«(…) The other earthquake that occurred in the Nordic countries last year happened on the 31st of August between three and four o'clock p.m. and was felt over a broader area. (…) Within the borders of Finland it was without doubt felt in many of its northern areas, but reliable information about this has been obtained only from the town of Torneå and the commune of Kalajoki. In the vicinity of Torneå, no roar was heard, but houses and buildings experienced a wavelike shaking, such that loose pieces of furniture and dishes were moving for half a minute, like during heavy thunder. Also, the air, which had been under a quite clear sky, later became rather misty, with air like smoke from a nearby forest fire, although the weather was a continuous southern wind that blew from the sea. This shaking was not felt in nearby Torneå or any further to the north than 30 km, until Karungi or the church of Carl Gustaf, but was stronger in the vicinity of Arpela and Könölä than near Torneå and Haparanda, of which it has also been concluded for this limited area, that the direction was from the southwest to the northeast (…)»

Comments 4: Many reports are available on the earthquake of August 31, 1819, but this is the only data on Torneå. At that time, earthquake reports often carefully described the weather conditions. It is not unusual to conclude that shaking was stronger in one place than another without providing too many helpful classification criteria for any assessment of intensity.

6. Discussion

In the region of interest, a search of macroseismic sources and critical textual analysis might yield only a few usable bits of information on a past earthquake. No philosophical reflections on historical background, linguistic analyses, or psychological preferences can improve the sources. The consensus of competent readers (i.e., specialists) appears to be the fundamental criterion in interpreting also sparse historical earthquake reports.

The fragmentary reports are the basis for assessing macroseismic intensity and compiling parametric catalogs of

historical earthquakes, with these catalogs often motivated by a seismic hazard assessment. It follows from the low magnitudes of earthquakes in the area that a narrow range of intensities is typically available. Rather few classification criteria are associated with these intensities, and the statistical definitions of 'very few', 'few' and 'many' are problematic with sparse reports. It might appear that if a seismologist refuses to make any assessment of intensity because the available information is too brief, no decision will be made. In a way, however, this might appear to suggest that any interpretation is equally reasonable, which is seldom the case. Even the short account of Example 2 in Section 5 mentions that not all of the people were awakened; moreover, it implies that no significant damage occurred. Assessing intensity in the credible range from 4 to 6 is a quantification of historical seismicity in the area.

We propose parametric earthquake scenarios as a way to link sparse macroseismic reports to their earthquake phenomena. Essentially, any historical earthquake presented in parametric form is an earthquake scenario constructed to conform to the available data. This also applies to cases when only a few sources are at hand. The parameters follow from a decision to accept the available information either completely or in part. If Example 3 in Section 5 is accepted as such, we can define the area of perceptibility, infer the epicenter, and compute the magnitude. However, this scenario is based on the assumption that an absence of recorded observations from a broader area is negative information, which might be far from correct. Another scenario, if one assumes that Brahestad is erroneous, is a small local earthquake. The analyst should be aware of hidden assumptions behind a parametric solution.

Quantifying uncertainty on the basis of sparse sources is difficult – especially if only a single source is available – but one possible approach is to construct different scenarios using the available bits of information and to attach an explanatory comment to each of them (the assumption on which the parametric solution relies). In a way, this is to suggest that sparse written texts and parametric data are so incompatible that transforming the former into the latter type without a comment line is meaningless. Modern data-storing facilities make this easy. Documentation prevents other researchers from having to repeat the same work all over again. This is a way to improve existing databases. For instance, Tatevossian et al. [2011] presented scenarios for the cross-border area between present-day Finland and Russia. Current parametric catalogs include two earthquakes there in 1626, close together in time, and rather close in space, which can be considered a two-earthquake scenario. A few sources exist for both sides of the border, but the different calendars and understandings of time complicate any decision as to whether they are related to the same earthquake. The region investigated is a platform shield that is characterized by low attenuation. Quite moderate earthquakes might be felt over long distances there (over 400 km), which was also shown by the Kaliningrad earthquakes of 2004 [Gregersen et al. 2007]. Therefore distance is not a usable criterion either. After making certain assumptions about the dating, one can draft a new parametric solution for a one-earthquake scenario. Thus different scenarios provide a way to quantify the seismicity for seismic hazard assessment.

7. Conclusions

The rigorous methods recommended for the analysis of historical earthquake documents need to be modified for the isolated and sparse reports of non-damaging earthquakes that are available in the region investigated. The challenge of source comparison is often avoided, because only a single source might exist for a given historical earthquake, or it may not actually eliminate any problems. The basic task of using the original document instead of a copy can be adapted to using the first documentary record that appeared in writing years after the earthquake.

Identifying the author of a single source is still meaningful; eyewitness testimonies are considered more reliable than second-hand reports. If the report is not contemporary, the local authors are, in general, more reliable than distant ones. The definition of time and place might indicate whether a genuine earthquake recollection is reported, because human memory has its limitations.

We propose the using of scenarios as the way to link sparse macroseismic reports to their natural phenomena. Each earthquake scenario usually relies on one or more assumptions that should be documented. Working with scenarios solves the problem of association of uncertainty to earthquake parameters.

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Appendix. Examples of earthquake reports from Section 5, in their original languages

Example 1. Source: *Moskovskiy letopisniy svod kontsa XV veka* (Moscow annual code of the end of the 15th century, edited by Kloss in 2004)

«А тое же осени октября 1, в кои день отпущен князь великы с Курмыша, в 6 часов нощи тоа потрясеся град Москва, кремль и посад весь, и храмы поколебашася. Людям же спящим в то время и не слышаша вси, мнози же не спяще и слышавше то во мнози скорби беша, и живота отчаявшеся, на утри же со многими слезами не слышащим сия исповедаху.»

Example 2. Source: *Kholmogorskaya letopis'. Dvinskiy Letopisets* (Polnoye Sobraniye Russkikh Letopisey, 33, p. 172)

«1627 г. О страшном трусе. При сем воеводе был на Двине страшной трус. В 135 году маия 20 день в неделю Всех святых, к понедельнику в 5 часу ночи грех ради наших гневом божиим потрясеся земля, и мнози от людей истрясение земли видеша, а инии людие в то время спали. И от того труса людей бог помиловал.»

Example 3. Source: *Tidningar utgifne af et Sällskap i Åbo*, September 30, 1777, p. 143.

«Utdrag af Bref ifrån Malax Sockn i Österbotten

Jordbäfningar i Österbotn äro owanlige, om ej aldeles ohörde; men sist förledne Påskafton war en stark skakning, så at folcket på flere ställen blef förskräckt. I Brahestad, Ny-Carleby, Vörå, Lill-Stor-Kyrö, och Wasa har den warit så kjänbar, at stolar och kärlili i husen darlat. Här i Malax hördes allenast, samma tid, ett starkt dån. Om denne sällsynta händelsen längre i kring förmärkts, är än obekant.»

Example 4. Source: *Åbo Tidningar*, January 15, 1820, p. 2

«(…) Det andra inom sistledne år uti Norden inträffade jordskalfwet skedde den 31 Augusti klockan mellan 3 och 4 e.m., och war af widsträcktare omfattning. (…) Inom Finlands gränsor har det utan twifwel blifwit kändt på flera af de nordliga trakter, men pålitliga uppgifter derom äro afgifna endast ifrån Torneå Stad och Kalajoki Socken. I negden af Torneå har intet dån blifwit hördt, men Huß och Byggnader försattes uti en wåglik skakning, så att lösa Meubler och Käril under ½ minuts tid warit i rörelse, liksom wid ett hårdt åskslag. Luften har ock sedermera under alldeles molnfri himmel warit ganska dimmig, med luft såsom af rök ifrån en närbelägen skogseld, ehuru wädret under fortfarande sydlig wind blåste ifrån hafwet. Denna skakning har man wid Torneå ej känt längre åt norr, än 3 mil derifrån till Karungi eller Carl Gustafs Kyrka; men åt sidan i Arpela och Könölä hvar har den warit häftigare än wid Torneå och Haaparanda, hwaraf man äfwen för denna inskränktare ort gjort den slutsats, att de sträckning warit ifrån sydwest åt nordost. (…)»