Historical Seismology in Switzerland: Reflections on Issues and Insights

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ABSTRACT

Historical seismology cannot rely on instrumental measurement alone; investigation depends mainly on the evaluation of historical sources. Improving the quality of historical data underlying *macroseismic* and *seismological* parameters has been proposed as a *desideratum*. As a consequence, the investigation and interpretation of historical documents have been encouraged during the last two decades, and seismologists and historians have worked together. Attempts at combining reconstruction of physical processes with the discursive perceptions of a disaster need an interdisciplinary approach. Current discussions in cultural science have heightened the sensitivity of historians, leading them to seek and elaborate new models and to establish contact with scientific disciplines. The revision of the new unified Earthquake Catalog of Switzerland and neighbouring regions (ECOS) during 2000–2002 has to be settled within this context. The objective of the revision was basic research on historical, macroseismic and seismological levels. This paper focuses mainly on methodological approaches, relating to historical and macroseismic purposes, adopted during this project.

KEY WORDS

Historical seismology, historical methods, macroseismology, Switzerland

I. INTRODUCTION

Historical seismology is the study of earthquakes of the past, directed towards a scientific utilisation that is concentrated on the estimation of seismic danger, as well as on the identification of active faults. Today, recordings of ground

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motion as a function of time, or *seismograms*, recorded by *seismometers*, provide the basic data that seismologists use to study elastic waves as they spread throughout the planet. However, it is commonly known and fully accepted that the time range of reliable instrumental data is far too short when assessing seismic hazard. Though instrumental observations go back to the end of the last century, reliable instrumental data have been available for a few decades only. Historical earthquake data therefore represent a wealth of potential information on long-term seismicity, which in its turn contributes to understanding tectonics and assessing seismic risk.

The study of historical events attempts a reliable reconstruction of the events of the past with the aim of creating a survey of earthquakes in history in order to determine the risks and hazards of a particular area. This involves the research and interpretation of historical documents using approaches that have been established in the literature, but have to be refined as the work progresses. Systematic questions about written sources and also archaeological sites and pictorial records have generated great interest within the seismological community.[1]

The fast-growing preoccupation with the study of risk has not left historians indifferent, for a number of reasons. The most important, especially regarding natural disasters, is based on the inescapable recurring aspect of catastrophes, e.g. floods or earthquakes. However, historians' contributions to the study of

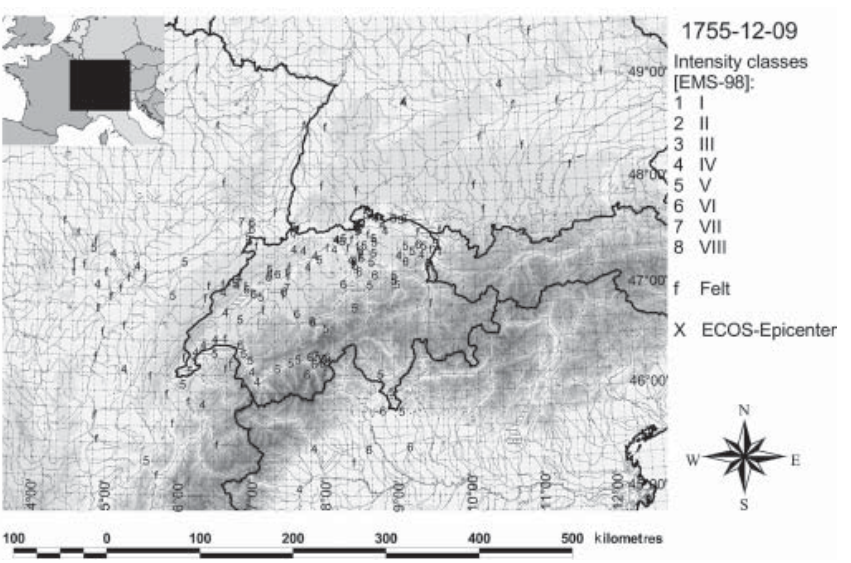

FIGURE 1. Macroseismic field of the 9 December 1755 event in the Valais (Switzerland). Each number stands for the intensity at the respective location. The event caused damage in the Valais area, and it was felt all over Switzerland and neighbouring regions. (Figure is taken from Gisler et al. 2003b.)

risks are not limited to filling catalogues of events; but also contribute to the study of social, cultural and economic aspects before, during and after catastrophes. Current discussions in historiography have heightened the sensitivity of historians, leading them to seek and elaborate new models and to establish contact with scientific disciplines.[2]

Works undertaken in the last two decades in the particular domain of seismic risks show that awareness of this topic has widened the historians' focus.[3] In conjunction with the development of environmental history, the interest of historians in the field of historical seismology has increased. Rather than the bare compilation of effects, their interests lie in questions of mentalities or of matters of political and social behaviour regarding those who suffered in earthquakes. Nevertheless, the work with historical records for purposes of study of earthquakes is mainly driven by the need for reliable data in order to process them by means of macroseismic interpretations. The demands of seismologists are first of all a reliable dataset; the work of a historian would then be to provide historical data with the aim of establishing macroseismic fields, isoseismic maps, earthquake catalogues and so on (Figures 1 and 2). Historians and seismologists have to deal with theories and methods on this topic.

date	time	status	type	lat.	long.	Mw	Io	Ix	place name
8 Oct 1336	–	reliable	not classified	47.5	7.6	3.9	5	-	Reinach, Basel
18 Oct 1356	5p.m.	reliable	foreshock	47.55	7.6	6.2	7.5	8	Basel
18 Oct 1356	9p.m.	reliable	main event	47.47	7.6	6.9	9	9	Basel/BS
5 May 1357	–	questionable	not classified	47.67	9.18	3.9	5	-	Konstanz
8 May 1357	5p.m.	questionable	not classified	47.67	9.18	3.9	5	5	Konstanz
14 May 1357	–	reliable	aftershock	48.17	7.5	5.5	7	7	Strassburg/F
24 Jun 1363	–	reliable	not classified	47.8	7.1	5.5	7	7	Thann, Haut-Rhin/F
11 May 1364	–	reliable	not classified	47.8	7.1	4.3	5.5	-	Thann, Haut-Rhin/F
21 Sep 1365	–	reliable	not classified	45.43	10.98	4	5.5	5.5	Verona
1 Feb 1369	–	reliable	not classified	45.58	8.22	5.1	7.5	-	Carpignano, Novara/I
1 Jun 1372	–	reliable	not classified	47.83	7.15	5.5	7	7	Mühlhausen/F
8 Sep 1372	–	reliable	not classified	47.47	7.6	4.3	5.5	-	Aesch, Basel
– 1375	–	reliable	not classified	46.82	8.22	3.9	5	5	Schweiz
22 Apr 1394	11a.m.	reliable	not classified	47.37	8.54	4.7	5	5	Zürich/ZH
26 Nov 1396	–	reliable	not classified	45.58	9.27	4.8	7.5	7.5	Monza

FIGURE 2. Excerpt from ECOS (Earthquake Catalog of Switzerland). © Swiss Seismological Service, ETH Zurich.

This paper is thus concentrated on questions of how knowledge of earthquakes in history is to be gathered and interpreted so as to obtain a reliable database for seismology. By presenting some reflections made when participating at the revision of the *Earthquake Catalog of Switzerland* (ECOS) I will argue for a consistent reliance on historical methods that will satisfy both historiographic as well as seismic purposes. I will first give some hints on some studies concerning historical seismology in Europe and will then offer some ideas on the investigation and interpretation of historical records regarding seismological aspects.[4] This includes a discussion of interpretation patterns for macroseismology.

II. HISTORICAL SEISMOLOGY: A SHORT SURVEY

Research into natural disasters has a long historical tradition and is not a sole issue of the twentieth century. Furthermore, as the establishment of academic disciplines is rather young, the interest in natural phenomena was for a long time not bound to specific disciplines but was a multi-level approach of so called *polymaths*.

Earthquake descriptions have existed since the fifteenth century.[5] But even in the annals and chronicles of the Middle Ages, copies of older manuscripts are to be found. Scholars with a great interest in nature and its phenomena gathered information about known earthquakes for a certain reason, as for example learning more about natural phenomena or the natural order of the world. Such studies – usually designed as chronological catalogues – were mainly produced after a major earthquake, written according to the scientific understanding of the respective time. The first known catalogue of earthquakes in Europe is by the Florentine *Giannozzo Manetti*, written immediately after the great earthquake of Central Italy in 1456.[6] The oldest known catalogues for Switzerland are the ones by Lycostenes 1557[7] and Rasch 1591[8], followed by Bertrand's important studies and catalogues after the large earthquakes in Lisbon (November 1755) and in the Valais region (December 1755)[9], as well as Volger's catalogue, produced after the major Valais event of 1855[10]. These historical earthquake catalogues are interesting evidence of a literary and scientific culture; they constitute a sort of inheritance from seismological traditions and are of great interest for the history of culture and science as well as for historical seismology. Their principal limitation in all their different forms lies in the fact that they offer a rather confused picture, in spite of the seeming accuracy of the vast data they offer.[11]

For a long time these catalogues provided the basic information for most of the historical earthquake catalogues currently in use. It is only very recently that the seismologists' community has agreed that these earthquake chronicles do not fulfil modern requirements anymore, either from a seismological[12] or a historical position,[13] as these early earthquake catalogues generally concentrated on providing information on as many events as possible, without any critical

verification of the respective sources. Current interdisciplinary research groups, bringing together seismologists, historians, archeologists and philologists have hence focused on overcoming the shortcomings of traditional catalogues. Their aims have been the upgrading of already existing catalogues, case studies on important quakes, as well as the study of new sources with the intention of finding more detailed information on earthquakes and on as yet unknown quakes. The emphasis has been on returning to reliable sources, setting wrong earthquake parameters to rights and detecting 'fake quakes'.[14] False data were mainly the result of mixing, extrapolating or splitting single events.[15]

It was in the late 1970s that studies in historical seismology began to draw on several specialist disciplines to investigate most of the factors contributing to an identification, assessment and analysis of earthquake data.[16] In France, the geologist and seismologist *Jean Vogt* proposed investigation of the history of earthquakes based on reliable historical and historiographical methods. He emphasised the need to investigate contemporary records instead of traditional earthquake catalogues which originate chiefly from the nineteenth and early twentieth centuries. In an introductory article to the French earthquake catalogue of 1979, he postulated a critical analysis of the traditional earthquake catalogues and a thoroughly methodological approach to issues regarding dating and localising earthquakes.[17]

Another very important contribution in this field is the British study of *Ambraseys* and *Melville* of 1982 on the history of Persian earthquakes.[18] The authors, a seismo-engineer and an orientalist, provided their work as a starting point for the development of a method of multidisciplinary study. Their concern reflected first of all on the problems one encounters when working with historical documents that are not consistent for different regions and over different time periods. The result is a study of the historical seismicity of Iran over thirteen centuries, showing a long-term tectonic pattern which is different from that deduced from short-term observations.

As methodological debates were mainly based on the quality and reliability of earthquake chronicles, in 1984 the Belgian historian *Alexandre* set a turning point by suggesting that conventional catalogues not based on historical–critical analyses be set aside. He instead proposed recompiling earthquake catalogues from a thorough research of contemporary documents in archives and libraries, with their evaluation based on the rules of historical criticism.[19] However – as has been pointed out by *Ambraseys et al.* among others – there is a risk that compilers who are ignorant of earlier earthquake compliations simply restate ignored earthquakes.[20] Others suggested that results achieved by previous researchers should be taken into account by means of careful handling and critical interpretation of data sets supporting their seismological interpretations.[21] Furthermore source criticism as the sole textual interpretation is certainly not satisfying, as it does not grasp the complete coherence of a document and the information contained therein.

In the 1990s more and more interdisciplinary projects brought seismologists together with historians, archaeologists and philologists. A monographic publication by the historian *Guidoboni* and others, dealing with ancient earthquakes and those of the early Middle Ages up to the tenth century in the Mediterranean area proved for the first time the fact that a surprising amount of information is also available on earthquakes during the less well-documented Middle Ages for the Mediterranean region. Moreover, the value of this collection lies in its methodological premises, dealing with historiographic methods supplied by methodological discussions after the *cultural turn*.[22]

Collaboration with historians has since been seen as a multidisciplinary approach, not only at the level of collecting data but also when it comes to interpretation.[23] Research groups in Europe have set themselves the task of doing more than merely providing a chronological list of quakes denoted only by epicentre and parameters; they now seek to provide an overall picture of the events, including property damage and the particular historical and geographical context.[24] These interests were directed basically by methodological discussions.

The result of re-investigating and analysing historical documents has been the publication of a large number of national[25] and European[26] earthquake catalogues and (case) studies, available in published form, as CD-ROMs or on the Internet.[27] These earthquake collections are assembled from different eras, generated within different cultural frameworks and represent an informative package of statistical significance. This of course poses problems, considering the chronological and geographical span of investigation. The results are of different quality, not all of them fulfilling the requirements of homogeneity concerning methodology and provided sources.[28]

The publication of the Catalogue of Strong Italian Earthquakes in 2000 marks a turning point in earthquake investigation, and not only for Italy.[29] This catalogue provides seismological parameters and in addition offers a structured series of commentaries on particular aspects of each quake, as well as a compendium of information on the specific features, demographic data and construction. Moreover it is concerned with social contexts of the respective events. That is not an optional research luxury – as *Guidoboni*, one of the editors underlines – but something that serves to throw light on the filters through which historical data pass before becoming part of a usable written source.[30] And what is more, an analysis of these contexts provides the parameters for understanding descriptive data. The emphasis is on questions such as whether over long periods disastrous seismic effects were recurrent and related to natural seismicity or whether there were appreciable variations depending on changes in living conditions.

In Switzerland, a first earthquake catalogue from a modern standpoint was established in 1975.[31] Earthquake parameters were then built on macroseismic data obtained from the critical evaluation of the main known earthquake

chronicles and catalogues and from printed yearly reports of the Swiss Seismological commission, established in 1878. The integration of the instrumental catalogue started after 1975. Before that, earthquake parameters were based essentially on macroseismic data, with few additions from international bulletins. Earthquake parameters were then assigned ad hoc by comparing different authors; parameter uncertainties were also roughly estimated.[32]

III. HISTORICAL SEISMOLOGY IN SWITZERLAND

To proceed further with the evaluation of seismic hazard for Switzerland, a substantial revision of the macroseismic database and of the Swiss earthquake catalogue was required. The project *ECOS* (Earthquake Catalog of Switzerland), starting in 2000, was carried out by an interdisciplinary working group of historians, seismologists and database experts. The intension was to compile a complete inventory of intensity fields for earthquakes that were supposed to have caused damage in Switzerland and neighbouring regions, and to derive a unified earthquake catalogue with uniform source parameters. The existing catalogue spans now a time period of more than 1000 years, as the first known event is dated 849; with a more uncertain event in A.D. 250 in *Augusta Raurica* (Augst/CH). Reliable instrumental information had been available only since 1975, so the bulk of the catalogue is derived from macroseismic input. Paleoseismological evidence is still very preliminary.

Three levels of investigation were conducted, by continuously applying the same research method for each level: a historical, a macroseismic and a seismological level. In what follows, the focus will be on the historical and macroseismological part of the project.

Procedure

For revising the historical earthquakes a three-step procedure was adopted.[33]

In a first step, all known earthquake chronicles and catalogues were consulted critically. As has been stated above, such earthquake compilations are usually based on a heterogeneous dataset. In order to understand better how texts mentioning the same earthquake, depend on each other, it has been recommended in the literature to establish *genealogical trees* (Figure 3).[34] This achievement is significant for two reasons. On the one hand genealogical trees can show how earthquake catalogues or compilations[35] are accumulative in the sense that data from one are adopted by the next, mostly with no critical verification.[36] Errors in transmission can consequently be uncovered and henceforth prevented (e.g. the conversion of information both narrative and quantitative, after several copying steps).[37] Moreover, tracing back to the roots sometimes enables one to find contemporary sources in archives, and this may be

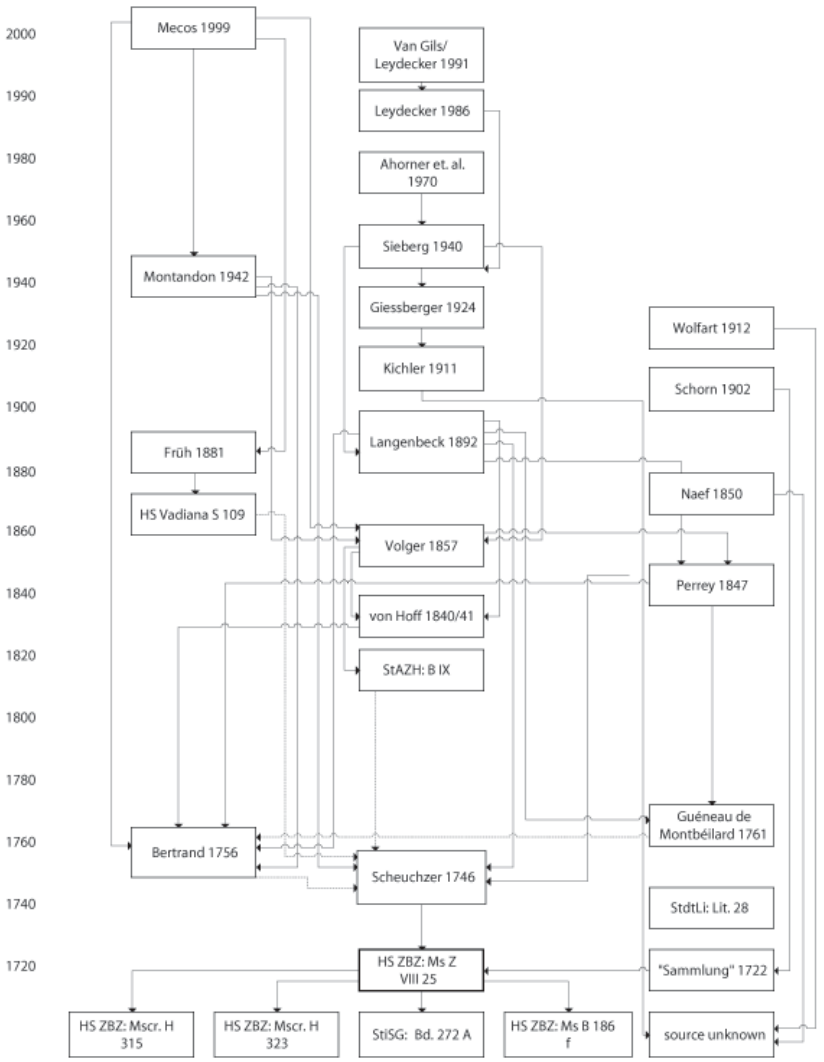

FIGURE 3. *Genealogical tree* of the 20 December 1720 event in the Region of Lake Constance (Switzerland). The tree shows the dependency of the compilations starting in present time and going back to contemporary sources of the event. If you follow the lines, you get an idea on who cited whom and what problems occurred when someone made an error. (Figure is taken from Fah et al. 2003.)
—— source quoted; ..... source unquoted but verified.

easier and faster than an unsystematic archival investigation. This leads to the second step, where indications of historical sources mentioned in the compilations were investigated. All documents brought to light were examined carefully and compared to the compilations in order to achieve representations of events. This required of course that the authors of earthquake compilations had mentioned their sources. Within this sequence, new or supplementary sources of all types were investigated in archives or libraries – step three. They were evaluated by means of a formalistic procedure based on historical methods, which will be discussed below. They were complemented by scientific sources, as for example macroseismic questionnaires or seismological reports, dating from the late nineteenth and twentieth centuries. The objective was basic research in order to fill gaps regarding the picture of certain events and also identification of previously unknown quakes.

Successful investigation of earthquake records depends on the organisation of archives and libraries as well as on the availability of working tools, for example, guides and inventories. The Records Offices of the Swiss Cantons store both community and parish archives; they are of outstanding importance concerning the investigation of historical earthquakes. They contain source types such as contemporary historiographic texts, correspondence and protocols, but also official documents that were written with political, economical or legal intentions. Of another type are private documents such as leaflets, letters, diaries, memoirs, autobiographies and sermons, which are most fruitful regarding earthquakes. Yet numerous documents are still located in the archives of communities, where the chance of finding prolific records is rather small, due to their generally unsystematic organisation. This is also true for parish archives and archives in monasteries, which store a lot of material (mostly annals and chronicles, in addition to letters and correspondence) but are in general poorly organised.

The Earthquake Database

The earthquake database is very heterogeneous; information exists in both official and private records. Geographic distribution of the sources is very unequal. Municipal zones had a significantly more prolific writing tradition than rural areas; places with convents have an older writing tradition than others (identified events in Switzerland before the year one thousand are based chiefly upon sources from monasteries, i.e. so-called *annals*). The result is that the quality and quantity of written records vary for different regions.

From documents produced in urban centres, we learn of severe earthquakes that hit a wider region and not only the centre itself. In any case, such information has to be treated with restraint. The authors of such texts quite often did not differentiate between observing the events themselves or learning about it from

others. This is quite often the case with annals. The events in the annals of the early and high Middle Ages are characterised by very short descriptions such as 'an earthquake happened on the day of …'. Insofar as no indication of place or intensity is given, the localisation and the assessment of intensities are then not possible. Moreover, it may not be concluded that if no information on a place is available, nothing happened. This appears banal, yet in intensity determination such short-circuiting is often observed.

In 1117, with the large earthquake in the region of Verona, the first descriptions of damage appear.[38] Only at the end of the thirteenth century do certain annals pass over to longer descriptions, as for example the *Annales Colmarienses* for an event in 1295 in the region of *Churwalden* (CH).[39]

In the fourteenth century the first town chronicles appeared and the authors, sensitised by a series of natural disasters in the middle of this century, recorded descriptions of natural phenomena like the *earthquake of 1348* (Austria) or the famous *event of October 1356 at Basel* (Switzerland). The oldest known diary for Switzerland with natural observations was begun in 1399 for the region of Basel. Besides indications about weather and astronomy it also mentions two earthquakes. In the middle of the fifteenth century there is an information gap, most likely due to political circumstances in Europe at this time.

It is only with the sixteenth and seventeenth centuries that earthquake reports increased. We find for this period observations on earthquakes in many different kinds of records, as for example historiographic texts, correspondence, protocols and calculation books, but also private documents such as leaflets, letters, diaries, memoirs, autobiographies and sermons etc. But even the major events in this time span, as for example those in 1584 and 1601, show gaps in the reports.[40] After the famous *'Lisbon' earthquake* in 1755 and with the growing interest in natural science, the density of earthquake information grew rapidly.[41] The nineteenth century then brought an alteration in the production of newspapers, with the result that information about earthquakes became overwhelming, although the quality varied. At the end of this century the Swiss Seismological Commission was established, so that research was then launched on a modern scientific level. Data collected was then based on both narrative as well as quantitative information. However, it is only in the last few decades that seismological research has concentrated on instrumental data. Macroseismic investigation is still important, so that methodological discussion is not brought to an end.

Interpretation

By far the largest and most important group of sources concerning medieval and modern history is the group of written records completed by archaeological and/or iconographic sources; though it has been averred from the professional side that the interpretation of iconographic sources becomes meaningful only in

connection with written documents.[42] Working on historical earthquakes means working with *texts* and not with earthquakes as natural phenomena. Analysing texts that describe earthquakes hence requires textual and philological methods. Vice versa, when analysing data provided by historical sources, one should know something about seismic phenomena. Furthermore it must be recognised that research methods are usually biased by the expected results. The investigation of historical earthquakes is therefore influenced by the fact that the result will be a parameterised database.[43]

Macroseismic analysis depends mainly on the accuracy of the respective observation of the intensity of an event. This includes first of all notes on damage to buildings, but also subjective perceptions. Thus the focus is on quantitative and numerical terms. All the more then, an analysis of the text genre that is the individual style of a written record as well as the use of terms had to be taken into consideration, supplemented by reflections on the cultural background, basically influencing the conditions of production of the respective documents as well as their function.

Terms and Language

Medieval and humanistic sources often followed a rhetorical tradition that abets the unnecessary proliferation of epithets. The use of the term *terraemotus magnus* for example, to be found in records of the early and high Middle Ages, did not allow us to make statements about the intensity of an event: it may simply be that the respective author had a special bias for the popular epithet *magnus*. Or the author pursued a moralising intention of the text by choosing special epithets in order to emphasise the dimension of God, who sent the earthquake.

Literary clichés, as for example *metaphors* or *topoi*, were likely to be used in older texts. It was the purpose of the author to give a certain image of nature when mentioning an earthquake. For this reason an arsenal of pictorial arrangements connected to his time had been used, so as to present a certain orientation. The use of the term *hora vespertina* – a numerical topos – is an example that reminds of a parallel structure with the biblical Good Friday event. Likewise is the mention of the duration of 40 days; it is reminiscent of the numerical topos of Lent or diluvium.[44] Knowledge of the literary archetype was thus important; otherwise an incorporation of the information was not possible.

Topoi were also used in scripts of individual statements, as for example sermons. Components in sermons emphasise the Christian life and the certainty of its end, the fears of an untimely death, worries about the hereafter, concerns about raging epidemics etc.

In the medieval way of thinking, the earthquake recalled biblical pictures of the Apocalypse, which would be announced by a series of natural catastrophes.[45] The meaning of a divine omen that announced the end of the world, the amazement, the fear and an increased attitude of penance reflected a culture that

incorporated the extraordinary and destructive event into the quantity of divine punishments that one had to meet with humility. Earthquakes as a sign of divine rage became part of the description of an actual event. *Hammerl* pointed this out years ago by underlining that 'in the medieval way of thinking an earthquake provoked biblical pictures of apocalypse that should be heralded by series of natural catastrophes'.[46]

Likewise the term *pater noster* was used quite often to give the duration of one or several shocks of an event. Yet – how long did a pater noster last? We then depended on more accurate information even though the duration of an event is mostly a subjective impression rather than an objective value.

It becomes obvious that religious terms were commonly used, but did not necessarily give an authentic picture. It was important to distinguish between unemotional descriptions and subjective impressions that were connected to the given circumstances. Moreover it was a question of dealing with uncertainties. A large range of interpretation challenged the set of possible readings and interpretations as a whole. It was all the more important that reservations and empty spaces were not concealed, but unveiled in each individual case.

Production and Function of Documents

We had to deal with a long historical span of a society which produced a great heterogeneity of documents. Perceptions, beliefs and consciousness are mainly influenced by the respective mentalities and paradigms. Mentalities are traces of systems that affect the actions, the feelings and the opinions of people in societies.[47] Exceptional situations, for example, natural catastrophes, may expose mentalities. We consequently needed to be aware why and how the documents were produced and to whom they were addressed. For a long time in history, the perception of earthquakes was dominated by the belief that catastrophes were sent by God in order to warn or punish humankind. As a result, earthquakes have sometimes been ignored, a fact that is reflected in the situation of historical documents.[48] We had to assume that not all earthquakes found their way into written records and we would never be able to learn about them. Small but also large events were forgotten soon after, and were cancelled from the cultural memory. This oblivion may also be responsible for the neglect of many smaller events. For this reason, an extensive reconstruction of an earthquake was sometimes difficult. On the other hand, many sources on earthquakes were produced several centuries later, possibly due to a *seismophily* of the region. It was obviously difficult to make sure whether these later records were based on contemporary sources or not. The problems with the 18 October 1356 Basel event, for example, are mainly with just this question.[49]

When interpreting sources, the function of these different kinds of documents had to be taken into consideration. Chronicles, for example, had a historiographic function, i.e. the writing of the history of a certain community

and era. This was always connected to the question of identity of the respective community, and the writing of the text was influenced thereby. On the other hand, letters and diaries were of private use and the chance of finding more authentic statements was presumed. It had then to be taken into account that the function of a source type was not the same over time. Early newspapers of the eighteenth and early nineteenth centuries demanded high quality information, while the mass media of the later nineteenth and the twentieth centuries were much more concerned with quantity than quality.[50] For that reason, such information was handled with restraint.

It was therefore most important to deal with a multitude of different sources. The distinction had to be made between statements of a singular meaning from others of a rather generic sort and conventional nature. While personal documentation provided information from one perspective in a very individual way only, official records or generalising sources gave a more general impression and an overview of the event. Both types of information were important; it was best when both were at hand, so that they could be compared to each other. This was particularly important when assessing macroseismic intensities. We had to be aware that when information on damage was given by one record only, generalisation to the whole area was hardly possible. The uncertainty of intensity assessment had then to be made obvious.

IV. MACROSEISMIC INTENSITY ASSESSMENTS

Macroseismic intensity is a measurement, or rather a classification of the strength of shaking of an earthquake at a particular place, based on the observations made of the different effects. An intensity scale provides a series of idealised descriptions of an earthquake's effects, starting with the very weakest (the shaking is imperceptible) up to the very strongest (everything is totally destroyed). Information on observations during an earthquake is broken down into four groups: human beings, objects, buildings and the natural environment. These four levels are scaled by means of numerical values. Several scales are in use in order to assign intensities, currently the so-called *European macroseismic scale (EMS 98)* established in 1998 (see Figure 4).[51] While other scales were designed for use in the field, the EMS 98 scale mentions the problem of the application of the historical data. An intensity of effects scale allows a particular degree of intensity to be attributed to the seismic effects observed in the various localities struck by an earthquake and it relates to a series of qualitative factors that reflect specific seismic effects. The resulting intensity map gives a comprehensive picture of the pattern of effects of an earthquake (see Figure 1).

Assessing strategies for intensity assignment are far from being standardised and there is an element of subjectivity in the assignment. The conversion of terms

EMS intensity	Definition	Description of typical observed effects
I	Not felt	Not felt.
II	Scarcely felt	Felt only by very few individual people at rest in houses.
III	Weak	Felt indoors by a few people. People at rest feel a swaying or light trembling.
IV	Largely observed	Felt indoors by many people, outdoors by very few. A few people are awakened. Windows, doors and dishes rattle.
V	Strong	Felt indoors by most, outdoors by few. Many sleeping people awake. A few are frightened. Buildings tremble throughout. Hanging objects swing considerably. Small objects are shifted. Doors and windows swing open or shut.
VI	Slightly damaging	Many people are frightened and run outdoors. Some objects fall. Many houses suffer slight non-structural damage like hair-line cracks and fall of small pieces of plaster.
VII	Damaging	Most people are frightened and run outdoors. Furniture is shifted and objects fall from shelves in large numbers. Many well built ordinary buildings suffer moderate damage: small cracks in walls, fall of plaster, parts of chimneys fall down; older buildings may show large cracks in walls and failure of fill-in walls.
VIII	Heavily damaging	Many people find it difficult to stand. Many houses have large cracks in walls. A few well built ordinary buildings show serious failure of walls, while weak older structures may collapse.
IX	Destructive	General panic. Many weak constructions collapse. Even well built ordinary buildings show very heavy damage: serious failure of walls and partial structural failure.
X	Very destructive	Many ordinary well built buildings collapse.
XI	Devastating	Most ordinary well built buildings collapse, even some with good earthquake resistant design are destroyed.
XII	Completely devastating	Almost all buildings are destroyed.

FIGURE 4. The short form of the *European Macroseismic Scale 98*, abstracted from the Core Part, is intended to give a very simplified and generalised view of the EM 98 Scale. (Figure is taken from Grünthal 1998.)

and their implementation in another discipline was rather difficult. It was a question of a particularly critical and cautious procedure.[52] Considering a broad spectrum, the establishment of a certain level of conformity was needed. The assignment of a range of intensity by giving a minimum and a maximum possible value provided evidence of information gaps and uncertainties concerning

historical interpretation. In any case, it had to be made obvious that the basis of such numerical values was always a narrative description.

When reading macroseismic fields and earthquake catalogues (Figure 2) it was and still is important to be aware that intensity assessment is *descriptive* in the manner of a prose account rather than an analytical tool like instrumental measurement. Given information in historical records is not just a stated fact that may be determined at once. A text may not be read from a contemporary point of view but with knowledge of the structure, the context and the cultural matters of the particular era. What sounds common for the historians' ears had to be communicated to seismologists. The results of processing historical insights into numerical values were sometimes accepted blindly, because numbers and tables suggest reliability and accuracy that actually do not exist and that historical sources would actually never admit. When information is fixed as numerical data the method by which it has been established, or rather the awareness of what is 'behind the intensity map',[53] is easily forgotten. *Leydecker* pointed this out years ago: 'Zahlen, Tabellen erwecken ein Gefühl der Seriosität und des Vertrauens. Verborgen sind die Zweifel des Bearbeiters z.B. bei der Zuweisung des Intensitätswertes oder bei der Festlegung des Epizentrums, trotz der Angabe von Vertrauensgrenzen.' ['Numbers, tables sustain an idea of seriousness and confidence. The doubts of the examiner are concealed, for example, when assigning intensity values or establishing epicentres, in spite of the statement of the limits of confidence.'][54] If historical sources are taken at face value and turned into chronological lists of data and assessments, misunderstandings and simplistic conclusions will inevitably result. It was necessary to consider carefully the meaning and limitations of the sources, for even when the scale was used with great care and respect for the original texts, a certain amount of arbitrariness was always involved. *Guidoboni* highlighted this fact concerning texts from the tenth century and earlier: 'Since the data on ancient earthquakes up to the tenth century come from a strictly limited number of documentary sources, there is a risk that, if they are isolated from their underlying problems and divorced from their original intention, they will be reduced to no more than "simplistic" data, of a kind more akin to anecdote and curiosity than to historical and scientific comment.'[55] This is certainly also true for more recent data.

V. CONCLUSIONS

As reliable instrumental data has been available for a few decades only, it is generally accepted that research on earthquakes in history has to focus on the evaluation of historical sources. In order to reach a high quality level of data, and since the seismologists agree that earthquake catalogues based on early earthquake chronicles do not fulfil modern seismological and historical requirements,

endeavours in the field of historical seismology have been undertaken. With an increasing interest in the field of natural disasters by historians, interdisciplinary investigation teams have conducted new projects by revising former catalogues and establishing new ones. It is commonly acknowledged nowadays that it is the work of historians to prepare the historical data using tools and resources elaborated in methodological discussions of the last two decades, including the investigation of written records, their historical and sometimes even macroseismic interpretation.

In this paper, some reflections on problems of a chiefly methodological nature have been presented, by discussing some issues encountered when revising the new Earthquake Catalog of Switzerland (ECOS) in the years 2000–2002. The main focus was the debate on how information about earthquakes in history was gathered and interpreted so as to obtain a reliable database for macroseismology. The study of historical events means first of all interpreting texts, not computing numerical values. Thus the analysis of texts describing earthquakes requires historical and philological methods. A consistent reliance on historical methods has been presented, including some reflections about historical research, historiographical aspects, and consideration on the development of texts, including questions on cultural matters.

Still, when the data are fixed as numerical data, it is easily forgotten how they have been established. When we read an earthquake catalogue we learn about intensity, a set of magnitudes, the presumed location and so forth, but we never learn how these data have been set up. Looking at a catalogue does not show the diversity and the heterogeneity of the documents used for the purpose of setting the data. A catalogue usually spans more than a thousand years, and there is a wide range concerning quality and quantity in the documents underlying the data. Furthermore, by interpreting a catalogue we do not learn anything of the methods that have been applied to interpret the records. But first and most important is the fact that a catalogue never shows the uncertainty that accompanies the interpreting of historical records and the assessing of macroseismic data.

When presenting results, one should also refer to gaps or *desiderata* concerning the investigation in archives and the interpretation of the documents. Missing information or uncertainties should be revealed. This was and still is rarely pursued. It is the undertaking of the historians' community, interested in the field of natural disasters, to carry out efforts in communicating these concerns.

NOTES

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[1] See e.g. Kozak and Musson 1997; Guidoboni and Stucchi 1993, 202–3.
[2] Berlioz and Quenet 2000, 19–37.
[3] Helly 2000, 90.
[4] For an overview of projects in historical seismology on an international level see the forthcoming publication of the workshop 'Investigating the records of past earthquakes'; to be published in the *Annals of Geophysics*, in autumn 2003.
[5] See among others: for Italy, Bonito 1691; Baratta 1901; for France, Guéneau de Montbéliard 1761; Perrey 1847; for Germany, Langenbeck 1892; Sieberg 1940; for Austria Schorn 1902; catalogues with general outlines, Seyfart 1756; von Hoff 1840/41; Mallet 1852–4. See also the list of major earthquake catalogues for Italy since the 15th century in Guidoboni 2000, 659–62; an overview of French catalogues is given by Massard-Guilbaud 2002, 11–2 and Quenet 2002, 3–9.
[6] Guidoboni 2000, 636.
[7] Lycosthenes 1557.
[8] Rasch 1591.
[9] Bertrand 1756, 1766; see also Albini et al. 1989; Gisler et al. 2003b.
[10] Volger 1857; see also Candreia 1905, Montandon 1942.
[11] Guidoboni 1994, 17–20.
[12] Stucchi 1993.
[13] Alexandre 1994.
[14] See, for example, the lists of fake quakes at http://www.sisfrance.net and http://histserver.ethz.ch.
[15] Alexandre 1994, 431.
[16] An exception is an early article by Ambraseys 1971; where he discusses problems concerning the unreliableness of earthquake chronicles of the nineteenth and early twentieth centuries.
[17] Vogt 1979; Alexandre 1990; Stucchi et al. 1991; Guidoboni and Stucchi 1993; Alexandre 1994; Ambraseys et al. 1994.
[18] Ambraseys and Melville 1982, 2–3; see also Ambraseys et al. 1994.
[19] Alexandre 1984; see also Alexandre 1990, 1994.
[20] Ambraseys et al. 1994, xii.
[21] Albini et al. 1996; Guidoboni and Stucchi 1993.
[22] Guidoboni 1994; the catalogue of 1994 is a new enlarged and revised version of Guidoboni ed. 1989; critiques of the sample of epigraphs in Waldherr 1997, 12.
[23] Guidoboni 1994, 12–13.
[24] Boschi 2000, 613.
[25] Among others see Gutdeutsch et al. 1987; Guidoboni 1989; van Gils and Leydecker 1991; Eisinger et al. 1992; Ambraseys et al. 1994; Boschi et al. 1997; Lambert and Levret-Albaret 1996; Hammerl and Lenhardt 1997.
[26] Stucchi 1998.
[27] Bureau de Recherches Géologiques et Minières 2002 (URL: http://www.sisfrance.net/sommaire.asp); Istituto Nazionale di Geofisica e Vulcanologia (INGV) 2002 (URL: http://emidius.mi.ingv.it/DOM/consultazione.html); Swiss Seismological Service 2002 (URL: http://histserver.ethz.ch/).
[28] Alexandre 1996.
[29] Boschi et al. ed. 2000.
[30] Guidoboni 2000, 626–7.

[31] Basler and Hoffman and Schweizerischer Erdbebendienst 1977; Sägesser and Mayer-Rosa 1978.
[32] Fäh et al. 2003.
[33] Guidoboni and Stucchi 1993; Guidoboni 2000, 623.
[34] Eisinger et al. 1992, 38–9; Guidoboni and Stucchi 1993.
[35] Concerning the use of this term see Albini et al. 1996, 1055.
[36] Alexandre 1984, 222; Ambraseys 1994, xii; Gisler et al. 2003a.
[37] Albini et al. 1996, 1056.
[38] Guidoboni 1984; von Hülsen 1993.
[39] http://histserver.ethz.ch.
[40] http://histserver.ethz.ch; Schwarz-Zanetti 2003.
[41] Albini et al. 1996; Alexandre 1996; Gisler et al. 2003b.
[42] Von Hülsen 1993, 230.
[43] However, not all information assembled from historical records is to be parameterised. The information provided in the catalogue on Mediterranean earthquakes is only given in a descriptive manner; a statistical analysis has not been undertaken; Guidoboni 1994, 101.
[44] Von Hülsen 1993, 228–9; Rohr 2001, 21.
[45] Hammerl and Lenhardt 1997, 17–9, 179.
[46] Hammerl 1991, 184.
[47] Van Dülmen 2000, 32.
[48] Borst 1981, 532.
[49] Meyer 1990.
[50] Musson 1986.
[51] Grünthal 1998.
[52] Concerning the problems involved in dealing with macroseismic data from historical documents: see among others Musson 1998, 79–91.
[53] Stucchi et al. 1991.
[54] Leydecker 1986, 7.
[55] Guidoboni 1994, 10.

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