

August 27, 2024
Warsaw

dr hab. Artur Magnuszewski, prof. ucz.
Hydrology Department
Faculty of Geography and Regional Studies
University of Warsaw
Krakowskie Przedmieście 30
00-927 Warszawa

Review of the Doctoral Dissertation

" The occurrence and causes of floods in Polish lands from the 11th to 18th centuries"

Babak Ghazi

Research novelty

Ph. D. candidate Mr Babak Ghazi decided to investigate the historical floods in Poland covering period 11-18 th centuries. Understanding the pattern of historical floods is important not only from the point of view of studies on Anthropocene but also has a practical application for modern hydrology showing the regions with the highest flood risk. The period of studies is long and covers different climate fluctuations which is interesting for manifested climate change and hydrological cycle response. Floods are one of the factors controlling the setting of human settlement, location of the cities and economic development of the regions. Expected impact of global warming due to a climate change on the frequency and magnitude of floods is a subject of growing concern. Many disastrous floods have occurred in the past so to understand future floods we need to have the information on historical floods. Additionally regarding extreme floods as natural phenomena, it is necessary to include their frequency to data series over a long time span. First instrumental measurements of water stages have started in Poland during the 18th century and systematic

observations were established during the 19th century. So instrumental records are not long enough to give representative information for calculating magnitude of floods with the large return periods of catastrophic events. Information about floods in the pre-instrumental period obtained from historical documents are very important for so-called historical hydrology. Information about historical floods started to be collected during the end of the 18th century. Recently there is a number of publications describing historical catastrophic floods in the single countries and in Europe. There was even a research project SPHERE (Systematic, Palaeoflood and Historical data for the improvEment of flood Risk Estimation), funded by the European Commission.

Looking on specified research task I find the proposed subject of the dissertation important, for modern and historical hydrology and worth to be studied.

The applied methods and results

Ph.D. thesis written by Mr Babak Ghazi is based on a series of three published and one under review monothematic papers. These are:

1. Ghazi B., Przybylak R., Oliński P., Bogdańska K., Pospieszyńska A., 2023, The frequency, intensity, and origin of floods in Poland in the 11th–15th centuries based on documentary evidence. *Journal of Hydrology*, 623 (2023) 129778, (<https://doi.org/10.1016/j.jhydrol.2023.129778>)
2. Ghazi B., Przybylak R., Oliński P., Bogdańska K., Chorążyczewski W., Pospieszyńska A., 2023, An assessment of flood occurrences in Poland in the 16th century. *Journal of Hydrology*, 50 (2023) 101597, (<https://doi.org/10.1016/j.ejrh.2023.101597>)
3. Ghazi B., Przybylak R., Oliński P., Targowski M., Filipiak J., Pospieszyńska A., 2024, A comprehensive study of floods in Poland in the 17th–18th centuries, *Journal of Hydrology*, 53 (2024) 101796, (<https://doi.org/10.1016/j.ejrh.2024.101796>)
4. Ghazi B., Przybylak R., Oliński P., Pospieszyńska A., Flood occurrences and characteristics in Poland in the last millennium. Submitted to *Scientific Reports* (2045-2322)

These papers were published in the *Journal of Hydrology* and *Journal of Hydrology: Regional Studies* both printed by Elsevier. These journals belong to the group of high rank scientific magazines having the impact factor higher than 4.

Study of the historical floods in Poland was conducted using the three large catchments: Baltic Coast rivers, Oder River, and Vistula River. The regional differentiation was analyzed in six historical regions: Baltic Coast and Pomerania, Greater Poland, Masovia, Masuria-Podlasie, Lesser Poland, Silesia. This approach is justified by the fact of many changes in the borders of Poland. Additionally use of river catchments boundaries makes possible to compare historical floods with contemporary.

Gathering information on historical floods was performed using archive documents. The importance and credibility of the source was differentiated using following scale: 1 – weak, if the information is derived from secondary literature rather than the original source; 2 – moderate, if the information is written in centuries after the flood occurrence, and 3 – high, if the information is written in a source in the same period that the flood event occurred and provides precise information.

One of the steps in preparation of the data base was classification of flood intensity and genesis done separately by project members, who included climatologists, historians, and a hydrologist to overcome possible biases. This procedure is not explained in the published papers and in dissertation text. It should be written who were the experts, and what was the protocol of their judgements.

In the selection of the historical floods and their origin the two most widely used and reliable classifications (Barriendos & Coeur, 2004; Brázdil et al., 2006) were applied. One approach would be also useful but was not used, namely classification of EU Flood directive for preparation of preliminary maps of assessment of flood risk (Wstępna ocena ryzyka powodziowego - WORP).

Result of the historical data query was creation of four data bases covering following periods: the 11th–15th centuries, 16th century, and 17th–18th centuries and one updated and complete version for the 11th–18th centuries. It is worth to notice that in a literature only a few studies in Europe have covered the medieval period, and Ph.D dissertation research is filling that gap.

In the 3-rd paper it was undertaken an attempt of comprehensive comparison of flood frequency in the two rivers Vistula and Oder in Poland compared with the Danube, Dyje, Morava, Vltava, Elbe, Inn, Main, and Norrström rivers.

Data bases being part of the dissertation have a very important practical value. The inventory of historical floods in Poland can be used in other comparative studies in the search for a large scale catastrophic floods. I believe this data base is one of the most important results of the research done in doctoral dissertation. Data about large scale catastrophic floods are very important for design of civil engineering works because very often they form an out-layer from the existing set of observations. In the classical civil engineering the observations of large catastrophic floods were used as a reference level for design flood dikes, bridges and reservoirs.

Results of the investigation of flood occurrences in Poland in 1001–1800 are showing that 1,252 floods were registered in Poland. This number is compared with 428 floods in the 19th–20th centuries, based on contemporary literature sources. Ph.D. candidate is aware of the fact that the oldest sources are emphasizing the importance of the extreme catastrophic floods. The number of records on historical floods from later periods is growing as a result of the increase of settlement exposure to flood risk. Calculating statistics showing the trend in the whole period is questionable due to lack of data homogeneity. Last century data represent period of instrumental measurements while data from previous centuries are descriptive.

Interesting is finding about regional differentiation of extreme floods occurrence. It has been shown that in Poland in years 1001–1800 the Silesia region experienced the greatest number of floods (533%). The number of floods in other regions was, in descending order: Baltic Coast and Pomerania (289%) Lesser Poland (212%) Greater Poland (109, 9%) Masovia (53%), and Masuria-Podlasie (11%). Presented picture shows both natural processes influence on flood occurrence but also number of historical sources which are very abundant in Silesia region. Silesia region as a place of location of early coal mining and iron industry had a well-organized natural disasters reporting system. An example of level of details available from Prussia archives are shown in work: Czaja S.W., 2011, *Powodzie w dorzeczu górnej Odry*. Uniwersytet Śląski. Katowice. I would recommend Ph.D. Candidate to get familiar with that work. It shows on maps the range of historical floods on upper Oder and its tributaries.

It is also a pity that Ph.D. candidate did not used the work by Dobrowolski A, Mierkiewicz M, Ostrowski J, Sasim M (2010) *Regiony polski najbardziej zagrożone powodzią katastrofalnymi*. In: Magnuszewski A (red) *Hydrologia w ochronie i kształtowaniu środowiska*. Monografie Komitetu Inżynierii Środowiska PAN, vol 69. pp 55–69. That publication was using both hydrological and proxy historical data from a post war period. Generally the region of Sudety mountains was shown to be the most frequently affected by flooding.

Ph.D. Candidate summarizes the findings with a statement that in Poland it can be observed an increase in the frequency of floods since the end of the Little Ice Age. He wrote that due to the high frequency of floods seen in the first 40 years of the 20th century, the trend's sign turned to negative. In the discussion of the results one aspect was not raised, namely the growing volume of artificial reservoirs. Post war period until late 70. was a time of completing many large reservoirs build mostly in the upper Vistula river catchment at Carpathian mountains tributaries.

Important is finding that in the last 30 years of the 20th century, there was a change in flood trends and more floods have been observed. The trend of recent decades has shifted to positive.

That tendency is summarized in the sentence: "Thus, this tendency is in line with the changes seen in the majority of the world's regions". That general statement better to support by reference sources.

Ph.D. Candidate is aware that the oldest information sources on extreme floods have very limited use for explaining the flood origin in meteorological conditions. Data are mostly descriptive and contain information on level and spatial range of inundation. For a hydrological calculations they have limited use but are very valuable for historical analysis. For example The extreme floods of 1813 in the Vistula and Oder catchments had a negative effect for movement of forces during the Napoleon campaign.

Interesting is the statistics showing that rain was the main cause of floods for the study area. This category was perhaps mixed with snow melt floods. Inventory shows that floods could occur in any of the seasons from 63% in autumn, 58% in summer, 48% in spring, to 44% in winter. In newer data it was found the most common causes of floods were torrential rains in spring (28%) and summer (20%) and long-lasting rains in winter (24%) and autumn (23%).

The geographical distribution of floods was shown at figure 12 of the dissertation. Map shows that the spatial density of flood occurrences in Poland was greatest in three south-western and south-eastern Poland, as well as in the middle of northern Poland (of which, especially the area of the Lower Vistula river). One remark should be added to that picture. Lower Vistula River especially in the delta area was a subject of many snow-melt and ice jams floods. In the 19 th century to solve that problem a system of flood dikes was build and a artificial cut-off opened near Świbno to easy the flow of flood waters and ice floes.

Very interesting is the statistics showing the cities with highest number of historical floods this finding deserve further investigation and could be used in the process of flood risk maps update which is a periodic procedure. Some differentiation should be made between small mountain catchments and large lowland rivers, where ice jam floods play significant role.

Conclusion

Looking on the novelty of the dissertation subject and its practical usefulness I can say that this work meets the requirements of the Ph.D. thesis. Mr. Babak Ghazi has shown that he can formulate the scientific problem, find the archive data and analyze them critically. The final

statements are based on analysis of the data with the use of statistical methods. One of very valuable outcomes of the dissertation is the set of four data bases which are open for public use.

Taking that in to consideration I am convinced that Doctoral Dissertation by Mr. Babak Ghazi which I had a chance to review fulfills all conditions expressed in Ustawa „Prawo o szkolnictwie wyższym i nauce” z dnia 20 lipca 2018 r. z późniejszymi zmianami, określone w art. 187 Ustawy (Dz.U.2018; poz. 1668)”. I will request to let Mr. Babak Ghazi defend his dissertation at public. Taking in to consideration scientific level of the research and practical applicability I would like to apply for the distinction of the Doctoral Dissertation.

A handwritten signature in blue ink, appearing to read 'Magurski', is written on the page.