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Representative Catalogue of the Neva Floods. Construction Principles

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Abstract: The Neva floods should be studied as a phenomenon, the origin and characteristics of which are the result of direct and indirect manifestations of natural factors that differ significantly in their spatiotemporal scales. The problem should be approached interdisciplinary. In the process of studying historical the Neva floods scientific principles were formulated for constructing a representative flood catalogue, which has not yet been created, which creates additional difficulties in studying the evolution of the hydrodynamic system that includes Ladoga Lake, the Neva and the Gulf of Finland: a comprehensive methodological approach to solving the problem; unconditional priority of primary sources; refusal to "correct" historical series *post factum*; cataloguing typos and discrepancies in versions for the entire period of observations; development and implementation into practice of a unified program for assessing the representativeness of series; search for new information on water level observations.

Keywords: Neva floods, representative catalogue, historical series of floods, evolution of natural processes on secular intervals, database of the Neva floods of 18th century.

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1. Introduction

The current year, 2024, is very important in the history of St. Petersburg in terms of the floods that have occurred there. The city was founded at the mouth of the Neva, an obviously unsafe place, and Peter I faced the problem of flooding just three months after the founding. Among floods of varying levels of danger, it is customary to single out catastrophic ones. In the history of the Neva floods, catastrophic events are those of 1777, 1824, and 1924. It is noteworthy that the assessment of destructiveness in the 18th and 20th–21st centuries is different: in the first half of the 18th century there were no embankments, and floods with non-catastrophic maximum marks by modern standards could have led to fatal consequences. A number of publications in 2010 proved the legitimacy of including the floods of 1721, 1726, and 1752 in the list of catastrophic ones. A three-hundred-year series of catastrophic floods is emerging, occurring with a period of approximately 100 years: 1721, 1726, 1824, and 1924. Hence, we can consider the current year 2024 as a tragic anniversary of all catastrophic Neva floods [*Bogdanov et al.*, 2009a,b; 2012; *Malova et al.*, 2021; *Malova*, 2008].

Information about floods is of fundamental scientific and great practical interest. When studying the evolution of the hydrodynamic system, including Ladoga Lake, the Neva, and the Gulf of Finland, when studying secular changes in the region, and when refining the flood protection strategy in St. Petersburg and adjacent territories.

Today, the problem of systematization of information about historical Neva floods seems extremely urgent. The fact is that the construction of prognostic models, planning

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of hydrotechnical, engineering, social and cultural activities are difficult without analyzing information about floods. The difficulty is that the official catalogs available to researchers, unfortunately, are full of distortions [*Malova*, 2022b; *Rumyantzev et al.*, 2024].

The situation is also complicated by the non-representativeness of the initial series of floods, which is critical given the extension of flood height measurement systems to all previous times. The non-representativeness is also because there have been several ordinaries (points where the level measurement took place) within St. Petersburg throughout the history of flood studies: on the Moika River, on the Neva near the Academy of Arts, near the Academy of Sciences, near the Main Admiralty, inside the Main Admiralty Canal, near the Peter and Paul Fortress, and near the supports of many St. Petersburg bridges. There are known cases when the same flood was measured from different ordinaries, and then the confusion in the height values went into the catalogs [*Malova*, 2022b].

What is the relevance of systematizing information about historical floods of the Neva? Three hundred years is a long period, we are talking about the evolution of natural processes at secular intervals and about instrumental support for observing the changes that occur. Three centuries of changes are significant for a single city.

2. Materials and methods

One of the reasons for the presence of distortions in official lists and catalogues presenting information on the heights of the Neva floods is the cloning of erroneous information, which turns a complex and confusing data system into the absence of any system at all.

The main obvious shortcomings of modern lists of the Neva floods can be summarized as follows:

1. the extension of flood height measurement systems (either from the Mining Institute's ordinar or from the beginning of the Baltic height system) to all previous times and the assignment of a single accuracy (±1 cm) to flood heights measured with different accuracy;
2. lack of information on the stability of the Kronstadt sea gauge;
3. the presence of a huge number of typos and distortions of information about the Neva floods, the maximum of which occurred in the years after the flood of 1924;
4. In addition, we must take into account the methodological and metrological imperfections of the established practice of forming centuries-old series of instrumental natural measurements [*Bogdanov et al.*, 2009a,b; 2012; *Malova*, 2008].

Let us clarify the flood of September 23, 1924. During the research it was revealed that it was during this period that a number of floods by I.G. Leitman over the period 1721–1729, a number by E. I. Shreter over the period 1749–1777 were completely destroyed and distorted. During this same period several more legends related to the Neva floods appeared. For example, the existence of the mythical Petropavlovsk tide gauge was "substantiated". Academician V. L. Kraft was accused of distorting the height of the catastrophic flood of 1777 [*Bogdanov et al.*, 2009b; 2012].

What happened in 1924? Why were the consequences of the flood so terrifying? Here we recall the monk of the Valamo Monastery Iuvian. On Valamo island there was a meteorological station and a water level measuring post, where regular observations had been conducted since 1861. Iuvian analyzed the data, compared them with the current meteorological situation. He concluded that the level in the Neva depends on the level of Lake Ladoga. The summer of 1924 was very rainy, the level of the lake was extremely high. In mid-September Iuvian sent a letter to Academician Sovetov and warned about the upcoming flood. But at that time, the opinion of a cleric meant little. The flood happened, the damage was enormous [*Bogdanov et al.*, 2009b].

3. Results and discussion

Work on systematization of information on historical floods of the Neva continues. A database of the Neva floods of the 18th century has been created in the St. Petersburg branch of the Institute of Oceanology. The database is open access. The main objective

of its creation is to provide information support for research related to the restoration of distorted series (or individual historical Neva floods) [*Malova*, 2022a,b].

From the point of view of the analysis of the subject area, the database provides systematization of data on floods, gives a comprehensive idea of each specific episode from a qualitative and quantitative point of view, and allows searching for information on:

- date (in different chronology systems),
- the height of water rise relative to different ordinaries,
- to the author of the flood description (if any),
- a link to a bibliographic source (published or archival).

In terms of functionality, the use of the database allows visually assessing the distorted series of historical Neva floods and verifying information about them.

The database covers historical floods of the Neva for the period 1703–1799. All events archived in currently existing catalogues, as well as in archival sources examined during the study, all events were analyzed [*Malova*, 2022a]. The database is publicly available on the website of the St. Petersburg branch of the Shirshov Institute of Oceanology, RAS [*Malova*, 2020].

The proposed database is not a full-fledged representative catalogue of the Neva floods. Its purpose is to systematize information about the Neva floods of the 18th century. The creation of a representative catalogue that would cover all events from the foundation of St. Petersburg to the present day is a matter for the future. The principles of constructing such a catalogue, tested on the materials of sea level observations at the Kronstadt tide gauge, can be reduced to the following:

I. an integrated methodological approach to solving the problem,
II. unconditional priority of primary sources,
III. refusal to "correct" time series and information *post factum*,
IV. cataloguing typos and discrepancies in versions over the entire period of observation,
V. publication of all surviving versions and materials without exception,
VI. development and implementation into practice of a unified program for assessing the homogeneity, long-term accuracy and representativeness of secular series,
VII. search for new information on water level observations.

However, it is necessary to take into account that the available materials and information:

1. fragmentary, incomplete and contradictory,
2. contain an abundance of emotional characteristics,
3. are obtained from observations at various points, sometimes several kilometers apart,
4. are represented by measurements in various non-uniform reference systems changing in time and space,
5. were assigned at different stages to different systems of counting heights (from a single ordinary level, in various geodetic coordinate systems, etc.),
6. are distorted by various kinds of "amendments" and "corrections", in particular, due to the "correction" of primary materials,
7. are deformed by extrapolating later or even modern Baltic height systems tens and hundreds of years ago.

The search for information on the Neva floods, their analysis and verification must certainly be continued from a modern scientific standpoint. Currently the proposed electronic database, which includes information on the Neva floods of the 18th century, can be considered a fundamentally new stage in the formation of a fundamental representative catalog of the Neva floods.

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