Types of watermills on Polish rivers – assumptions in the CeBaDoM database

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ABSTRACT

The article presents assumptions and research problems related to organization and dissemination as a part of the OZwRCIN project of the Central Database of Mills in Poland (CeBaDoM) implemented as a part of the Operational Program Digital Poland of the European Union. The database is open to all users and its aim is to popularize the vanishing cultural heritage. It includes a number of information: about the type of mill, its purpose, location and periods of operation. The article describes the main types of water mills, sources of information about them, as well as the composition of the structure of signature assigned to individual objects.

Keywords: water mills, molinology, historical database, digitizing, science dissemination, cultural heritage, dLibra

1. INTRODUCTION

Molinology, or according to the author of the concept, Joao Miguel dos Santos Simões, the study of mills and other mechanical devices which use the energy of moving water or wind, or the strength of animal or human muscle to power machines for purposes such as hammering, grinding, pumping, sawing, pressing or fulling (van Berge Henegouwen, 2018), is a discipline
formed in the second half of the twentieth century. The first molinological symposium took place in Portugal in 1965. From that time, the meetings of scientists and milling enthusiasts are held regularly every three to five years, while on 15th September 1970 an International Molinological Society (The International Molinological Society, TIMS) was established. A significant feature of TIMS is the broad, interdisciplinary context of research possibilities on broadly understood milling sciences: from social sciences, through history (eg. Lucas, 2011), archaeology (eg. Leveau, 1996), ethnology (eg. Rzepkowski, 2015), physical geography (eg. Downward, Skinner, 2005; Brykała, 2005; Walter, Merritts, 2008; Fajer, 2018), up to broadly understood technical sciences (eg. Reynolds, 2002; Müller et al., 2010).

Among the main goals set by molinologists themselves, is the effective work on reconstruction and dissemination of knowledge about mills, both still preserved and already non-existing in landscape. For this reason, attempts have been made since the 1970s, in order to create databases of mills in selected countries or regions (eg. Podwińska, 1970; Dembińska, 1973; Aoki et al., 1982; Holt, 1988; Langdon, 1991; Kreiner, 1996). Digital information development in recent years has allowed to expand significantly the publication portfolio of sources on mills. It also made possible the creation of either generally available or restricted access databases on old mills (Rahmacher, 2018).

1. 1. Point and field of CeBaDoM

In the course of the ongoing research concerning the reconstruction of network of mills in Poland, various regional scientific studies containing catalogs of objects, also often maps showing their deployment, have been performed (e.g. Podgórska, 2004; Brykała et al., 2015; Kubicki, 2019). Most often, though, these works have been limited to a specific time frame or area. There is also noted a substantial lack of a comprehensive approach to the location-time issue in the reconstruction of the network of all mills that ever existed in the present and former territory of Poland.

An opportunity to change it comes with a widely open, generally accessible digital platform in which information about the mills will gradually be supplemented with the use of all possible sources. Similar studies, in reconstructing the shape of cultural landscape on the designated area based on historical sources, have been conducted already (eg. Li et al., 2018; Słowiński et al., 2019). In this article, the project of creation the Central Database of Mills in Poland CeBaDoM will be presented, with structure of the signature of object explained. It depends, among others, on the type of mill, which is why this will be discussed based on the example of different types of water mills found on Polish territory.

1. 2. Sources of knowledge about mill network in Poland

A. Archival sources

Only a small part of documentary resources originating from the Medieval times, released by state or church authorities, have survived to our times (Fig. 1). It is, however an exceptionally valuable source containing the first recorded mentions of mills. Such objects were often recalled in documents as the most important source of income for the owner. Among various written sources that survived to our times, the inventories of districts (Polish starostwa) are the most valuable (performed between 15th and 18th centuries).
Figure 1. An example of archival source with list of water mills from 15th century (Source: Central Archives of Historical Records in Warsaw, Collection: Crown Treasury Archive, signature: Od. 56 G-11, p. 53v-54r).
B. Cartographic sources

One of the basic sources of information about locations of water mills are large-scale maps (Fig. 2) – the most helpful are those made since the 18th century. Such maps may be divided into the following categories: topographic maps, hydrographic maps, border maps and city or village plans.

Figure 2. An example of cartographical source with location of water mills from 19th century (Source: Central Archives of Historical Records in Warsaw, Collection: Cartographic Collection, signature: 73-6).

C. Scientific publications

The results of up-to-date studies have been extensively used. The literature covering various issues related to water mills contains over 400 items. Most often, these are historical studies discussing particular regions or towns. The references to listed publications in the database allow to verify the information and enable further in-depth studies.

D. Field inventory

During the implementation of earlier research projects an inventory focused on the individual mills in the field was performed. Collected photographic material is often the last visual record of objects in decay (Fig. 3).
E. Oral history

When performing that fieldwork, there were situations in which people remembering the old mills were contacted, as well as the millers themselves. The information gathered from them made an important supplement to written sources.

2. EXPERIMENTAL

2. 1. Types of watermills on Polish rivers

The beginnings of water milling in Poland dates back to the end of the 11th or the beginning of the 12th century (Dembinska, 1973), however, only beginning of the 13th century brings a noticeable development of this type of activity, and gradual development in the following centuries is observed, when the number of water mills on Polish territory constantly grew, consequently forming a vast network of watermills. Many objects of this type functioned until the second half of the 20th century.

Due to the way the mills are located on a watercourse, we can divide them into stationary, and floating mills. The first ones are located mostly on the river banks or mill stream, or on stilts in the riverbed, while the other ones on the river itself, fixed on boats or other types of floating platforms, most often in the place where the strong water current existed. A specific
type of mills were the pendant mills (mills on scales), whose construction, as E. Kowalczyk-Heymann's recalls in her article, was probably based on the principle of double sided lever (Kowalczyk-Heymann, 2015).

Considering the construction of mill wheel, the main driving unit for water mill, the earliest constructions that appeared on Polish lands most probably were equipped with vertical stream shot water wheel. It meant, that blades of water wheel whose axle is suspended above the water surface would be set in motion from the bottom through the river current, causing the mechanism to turn in the opposite direction.

Such construction had both, advantages and disadvantages. On one hand, it did not need additional works resulting in accumulation of water, on the other hand, the efficiency of operation of such a mill was largely dependent on actual water level in the watercourse. It often happened that such mills had a downtimes in functioning due to a low water level.

A specific type of stream shot water wheel mill was the aforementioned floating mill, first recorded in Rome in 537 AD (Gräf, 2006). It began to spread in Poland in the late 13th century, and they were built on such rivers where it was impossible to carry out complex hydrotechnical works (Brykała, Prarat, 2018), and on watercourses affected in wintertime only by a moderate strenght ice floe, which wouldn't cause any major damage to the construction of the object. Its wheels could be assembled in a variety of ways; the most often built between rigidly joined floating elements (of which one was small house – młynica, the other, a stabilizing element), but there were also solutions of fixing the wheels on one or both sides of the boat, just like in a steamship. Despite relatively low efficiency of such mills (which was a general disadvantage of stream shot water wheels) the advantage of floating mill was the fact of its ability to operate regardless of water level, as well as the ability to move it to another place if necessary.

Mills with backshot or overshot waterwheels, where the water would hit near the top of the wheel and turn it either back towards the head race or in the opposite direction were constructed in Poland as far as in the 13th century, however the earliest ones would be raised only under specific field condition - wherever it met the naturally adequate water accumulation allowing the movent of the mechanism. This type of mill provided much higher efficiency than the other, however, if profitability of its construction was not dictated by environmental considerations, a specific regulation of a watercourse was necessary.

Water turbines in their design resembling largely ship propellers, use almost all the energy of the water flowing through them. In the Polish territory they began to spread on a large scale along with the turn of the 19th and 20th centuries, the earliest were installed in the Prussian and Russian partitions, while in a somewhat technologically backward Austro-hungarian partition, these appeared relatively late. The advantage of this type of engine is its high efficiency, much higher than in mills equipped with ordinary water wheels. The higher efficiency of the wheel also meant that it could move, for example, more sets of millstones.

When discussing the types of water wheels used in Polish mills, it should be mentioned that they were not only powering the milling equipment and not necessarily appeared in single mill objects. Because, generally, the problem was caused by the power transmission, each device had its own wheel, and it could be, apart from the grain mills, used to propel for example:

- fulling mechanisms,
- sawmills,
- ironworks,
- oil mills,
- paper mills,


- tanneries,
- powder and gypsum mills.

Summing up the above review, outlining only the matter, we may understand the complex functionality of water mills, including not only the engineering issues, but its social dimension and elementary needs being satisfied (Adamczewski, 2001). All of these components caused that objects of this type had a special place not only in the landscape, but also also in the cultural space and conscience of local communities.

2. 2. Project of CeBaDoM database as a part of Open Resources in Digital Repository of Scientific Institutes

The project of Central Database of Mills in Poland (CeBaDoM) was commenced on 1st August 2018 and is now implemented by a team of scientists from the Polish Academy of Sciences, Institute of Geography and Spatial Organization, Department of Environmental Resources and Geohazards.

Fact sheet materials about individual objects have been collected over the last 20 years of field research and archival queries conducted within 3 scientific projects financed from public sources in Poland and Germany. Digital Repository of Scientific Institutes (RCIN) available at the website: http://rcin.org.pl/ is to be a platform on which texts, graphic materials (maps, photos, technical documentation) and data sheets documenting each mill, will successively be placed. It is a platform on which full-text resources created by 17 Polish scientific institutes are available. What’s important, the source files of the uploaded research results and publications will be a subject of professional and continuous digital archiving.

Attempts have been made on Polish land to catalog mill facilities. However, the study was published in the form of an atlas divided into several volumes. Certain markings on the map informed exclusively about the location of a given mill and the time frame of its operation (Podwińska, 1970). Also the territorial scope in which the research was carried out, was limited. The structure of CeBaDoM metadata provides the inclusion and exposure of such information as: type of facility (all types of mills will be taken into account, from those powered by water, through windmills, horse mills or motor mills), the number of mill wheels (in case of water mills), geographical coordinates or detailed location in a given administrative unit, both old and modern.

A dLibra software, belonging to DinGO package, will be used when placing objects on the web database. It is a program allowing to share documents from public and academic libraries, private and corporate collections or non-governmental institutions. An intuitive and friendly interface of the application helps to update easily metadata of the object, select the required content and helps to plan the publication and set the accessibility time for specific data, designated for a wide audience.

2. 2. 1. Main difficulties in research

The main research problem prior to publishing information about the specific object is the variety of sources that should be reviewed - starting from the written sources, through cartographic and iconographic ones (landscape paintings, photography), concerning the mill objects in various degrees of preservation. As the mill had its own place not only in local economy, being also a part of the society and local folklore, we should not underestimate the
so-called oral history. Although such records can be strictly subjective, they can provide valuable research material after the process of proper criticism.

It is worth mentioning here, that physical state of document and its legibility are not without significance in certain written sources. In many cases, these are manuscripts from individual collections or branches of regional state archives, Central Archives of Historical Records in Warsaw, as well as archives in Vienna or Berlin. Very often the possibility to extract any detailed information depends on the nature of the introduction letter, the quality of writing material and the degree of deterioration of such document over the years. Although this is not a novelty for any historian, it is a challenge to prepare the most accurate detailed interactive map and provide the maximum information on a given topic. This is a very serious barrier in certain cases.

The old toponyms are a separate difficulty, too. Parts of towns and settlements in the course of history could either lose or change its original names, or else, might be absorbed by larger settlements - become districts or others administrative units of larger cities. A representative example in such case is Warsaw, of which, several today's districts used to be only neighboring villages. It is not uncommon i.e., that two or more towns with the same name are present in the same administrative unit. As a good exemplification of such case we may recall the mill located in the past royal properties (ekonomia), in Brwilno near Płock. It is difficult to determine today, which of the three current towns of the same name are concerned (we have Brwilno in the commune of Stara Biała, Brwilno in the commune of Nowy Duninów or Brwilno Dolne, formerly called Brwilno Niskie).

2. 3. Structure of the object’s signature in CeBaDoM

The right order of data processed requires an appropriate numbering of objects. The difficulty lies in the assumption that the signature (identification number) assigned to given object should not only identify and position it in the database, but in a clear and systematized way inform the user at least about location and type of mill, before one gets the full description of such object – existing as a metadata record.

![Figure 4. The diagram showing following elements of CeBaDoM object’s signature.](image)

The starting point for methodology of creating the proposed signature for CeBaDoM database was solution suggested by the previously cited, Joao Miguel dos Santos Simões, who proposed a special inventory card and similar reference numbers for objects in Portugal (dos Santos Simões, 1977). By using his method, design of the signature structure of the mill (Fig. 4) for created database was conceived, in which:

- GREEN colour marks the section with information in which modern country the objects is located in. Two-letter digit codes would be most suitable here, as per the ISO 3166 Alpha-2 standardization.
- BLUE colour marks the segment describing the contemporary administrative unit in which the object is located in. Designers agreed in limitation to primary units (i.e. voivodships for Poland, oblasts for Ukraine, etc.), in order to facilitate the search and reach the maximum transparency.

Regarding the numbering of individual units, the proposed numbering rule is: from the northwest to the east, moving systematically towards the south (numbering order for Poland is shown in Figure 5).

![Figure 5. Numeration of Polish voievodships used in CeBaDoM object’s signature.](image)

- DARK PINK colour reflects the information about the type of object in the form of three-letter abbreviation. Initially, it was decided to distinguish the following types, depending on the type of drive:

1. WIM – windmills
2. WAM – water mills
3. MPM – muscle-propelled mills
   - MOM – motor mills
   - MIX – mixed
   - OTH – other
As far as the information on the given mill is being available, additional subtype information may be included, after a dash, with a small Latin alphabet letter (Table 1).

**Table 1.** The method of signing different subtypes of mills in the CeBaDoM database Signature

<table>
<thead>
<tr>
<th></th>
<th>Windmills (WIM)</th>
<th>Watermills (WAM)</th>
<th>Muscle – Propelled Mills (MPM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>Post mill</td>
<td>Stationary mill</td>
<td>Animal - propelled</td>
</tr>
<tr>
<td>b</td>
<td>Paltrok</td>
<td>Floating mill</td>
<td>Human - propelled</td>
</tr>
<tr>
<td>c</td>
<td>Smock mill</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>d</td>
<td>Wind turbine</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>e</td>
<td>Other</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

- ORANGE coloured section in the diagram relates to information about whether the object is a single or group object.

It was established that the signs showing these features will be a “dot” - for single objects, and “colon” for group objects.

- the last section, marked with PURPLE colour, is an individual, five-digit object number assigned in the order in which the records are entered into the database, starting from 00001, etc.

**Figure 6.** Example of signature of horse muscle-propelled mill from Mazovian Voivodship.

From the above mentioned example (Fig. 6) we can read that it is a mill driven with the animal muscle power, found in Poland in today's Mazovian Voivodship, individual mill number: 00058 (it is fifty eighth inventoried object). The signature will be preceded by an acronym in the database - CeBaDoM.

The major problem occurring during the development of above mentioned model was caused by the multiplicity of information contained in description, resulting in rejection of some of these parameters in the process of construction of signature, and the inclusion of information that the type of drive might have changed over the time - for example: as a result of modernization or transition to another type, without complicating the record content.
unnecessarily. The proposed signature scheme allows modification of three letter description of the mill drive while other data remains unchanged, and furthermore, that each mill may have different markings assigned to various drives, without the need of additional record concerning the same object.

Such approach makes possible identification of the same object, altering only some of its features over the time. So, if the mill from that above example has changed at some point its drive, into i.e. motor one, then, according to the rules, we would change only the middle signature part, as illustrated below (Fig. 7).

![Signature of this same object like on the Fig. 6, in which the description of propulsion was changed.](image)

3. CONCLUSION

The CeBaDoM database is to be a basic source of information about the mills operating in the area of modern and old Poland. The assumption is to cover tens of thousands records regarding the various types of objects. Giving each mill an unique signature will systematize the knowledge and expand the database as far as possible and include any new information regarding the object.

The project is an opportunity to create an interdisciplinary platform connecting not only scientists but all those interested in local culture heritage. It can also be a reliable source of information when choosing a location for future constructions, i.e. of small, modern hydro power plants based on renewable energy source (e.g. Müller, Kauppert, 2002).

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The results presented here contribute to the Central Database of Mills in Poland CeBaDoM. It is available on the platform [http://rcin.org.pl/] as a part of the project entitled Open Scientific Sources in the Digital Repository of Scientific Institutes (OZwRCIN) – financed with the European Union funds and the Polish state budget within the Operational Programme: Digital Poland 2.3.1. Digital sharing of the information from the public sector from the administrative and scientific sources, Grant No. POPC.02.03.01-00-0029/17.
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