Public Archives and other Sources for Surveying of Dumpsites and Polluting Enterprises before 1950

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Abstract: *In Denmark, the local environmental authorities have had an obligation to survey areas for soil contamination since the early 1980s. Through the years, detecting and locating old dumpsites and gathering historical information on them have been very dependent on old aerial photographs. As a result, the environmental authorities only have little knowledge of dumpsites operating before the mid-1950s. This study describes the utility of various historical sources for surveying of old dumpsites in the former Ballerup-Maaløv Municipality near Copenhagen. The minute books of the Council and the Health Commission in the municipality were used. In order to locate two dumpsites mentioned in the minute books and gather information on them, the following additional sources were used: Old census papers, index cards from tax assessments of real property, income tax returns, writings from local history societies on the former villages, recorded memories told by senior citizens and jubilee publications from homeowners' associations together with old cadastral maps, old topographical maps, and old aerial photographs plus a comparison of terrain heights in a topographical military map from 1900 and the Danish Elevation Model from 2005-2007. The minute books of the Council and the Health Commission contain information on 31 dumpsites and 15 possible dumpsites of very different characteristics. Only a few of the dumpsites were already known by the local environmental authorities. In addition, the minute books and the index cards for properties contain much information which can be used for surveying of other activities in the past that may have caused soil contamination e.g. former industrial enterprises.*

Keywords: *Dumpsite, soil contamination, surveying, health commission, minute book, elevation model, Ballerup-Maaløv Municipality, Denmark.*

1. Introduction

In Denmark, the local environmental authorities have an obligation to survey areas for soil contamination in accordance with the Danish Soil Contamination Act (Jordforureningsloven 2013). The survey of areas for soil contamination caused by activities in the past e.g. dumpsites and industrial enterprises has been performed since 1982. The act defines areas of priority for public action to avoid the damaging effect of soil contamination. This includes surveying. The act concerns areas where there is soil contamination which may have a harmful effect on groundwater within an area with special drinking water interest or a catchment area for a public water supply plant or may have a harmful effect on people in an area containing housing, child care centers or public playing fields. The act has recently been changed, and now it includes areas with soil contamination which may have a harmful effect on surface water and international nature protection areas. Generally, contamination of groundwater is given the highest priority in extensively urbanized areas (Danske Regioner 2010).

Areas with an increased background concentration of immobile contaminants, usually polycyclic aromatic hydrocarbons (PAH's) and heavy metals, are classified by the local environmental authorities as "lightly contaminated" without warranting an individual registration of each property (Miljøstyrelsen 2007). These areas are typically urban areas in 1945 (Danske Regioner 2010).

In recent years, a number of soil contamination cases carried out by the local environmental authorities have surfaced because old abandoned dumpsites unexpectedly and accidentally were found in developed areas (Michaelsen 1987-2003).

In the 1980s and early 1990s, the old dumpsites received a great deal of attention from the former Danish counties (abolished in 2007), and many counties expected that all significant dumpsites in environmental terms were surveyed (Miljøstyrelsen 2000b). The author estimates that the counties' efforts mainly resulted in knowledge of large and newer dumpsites, while primarily small, older dumpsites remained undetected. This is due to the methods used for detecting and locating the dumpsites.

The counties' knowledge was based on reports from the municipalities in the early 1980s. Experience shows that these reports do not include all old dumpsites (Københavns Amtskommune 1986; Københavns Amt 1997; Holt 2012a; Holt 2012b). The reports mainly contain information on dumpsites with a file in the municipal record system or dumpsites the staff could remember. The reports were made when the Danish Ministry of the Environment in 1980 asked the counties to register old dumpsites in order to investigate the effects on the environment from any deposited or buried chemical waste (Københavns Amtskommune 1986). The primary purpose of the municipal reports was therefore to obtain information on old dumpsites where there was either knowledge of or a possibility of deposited chemical waste. This has probably led to a greater focus on large dumpsites, since it was widely believed that the possibility of deposition of chemical waste on these sites was very high.

Several counties and municipalities have since carried out a more systematic detection and location of the old dumpsites, mainly based on examinations of old aerial photographs. The reason for these efforts was primarily due to the landfill gas explosion in a house in 1991 next to an old dumpsite in Skellingsted in Denmark, and to assess the risk of landfill gas explosion hazards (Københavns Amt 1997). However, old aerial photographs have shortcomings in relation to the detection and location of old dumpsites in Denmark, especially in urban areas.

Dumpsites operating until the late 1920s were used in a period where no aerial photographs were taken. Dumpsites operating from the early 1930s to the early 1950s were used in a period where aerial photographs were only taken in a few selected years and have a poorer picture quality compared to aerial photographs taken during and after 1954. It can be difficult to get aerial photographs of operating dumpsites and aerial photographs where the deposit appears clearly relating to the early 1930s to the early 1950s. In addition, the small dumpsites and the traces of them are almost impossible to spot on aerial photographs from this period if one is not aware of their existence and geographical location in advance.

Large dumpsites in operation and traces after them are easier to spot on aerial photographs due to their size. In addition, the deposition on large dumpsites

often has been going on for several years. The deposition, or part of it, has in many cases happened later than on many small dumpsites. This makes it often possible to obtain aerial photographs of large dumpsites from different years and aerial photographs from years where the picture quality is good.

It is not easy to identify abandoned dumpsites on old aerial photographs, when the dumpsites are located within urban areas. Thus, it is more difficult to see traces of former dumpsite activity in gardens, industrial areas, developed areas and sealed areas than in agricultural fields without crops and green areas covered with grass. It is also more difficult to identify dumpsites on old aerial photographs, where the deposit occurs in a waterhole, small lake, bog, hollow or flat ground instead of a gravel or clay pit.

As a result of the methods used in detecting and locating the old dumpsites, the environmental authorities only have little knowledge of dumpsites operating before the mid-1950s.

One could argue that the large dumpsites, which have primarily been operating after the mid-1950's, pose a higher risk to human health and the environment, because they contain more chemicals and younger waste and therefore pollute more. However, site investigations carried out in Denmark include many dumpsites without chemical waste and several older dumpsites and the results show that the investigated dumpsites within this category pose a risk to human health in areas with sensitive land use. In several of the dumpsites, the risk is due to, for example, high concentrations of polycyclic aromatic hydrocarbons (PAH's) and heavy metals in the waste. Because of low mobility and low biodegradability, PAH's and heavy metals remain in the waste (Bote 2013). The site investigations also show that a number of the dumpsites pose a risk to groundwater.

Waste from gasworks, the production of fertilizer, tanning etc. can be the source of high concentrations of specific substances, but ordinary household waste is also a source of heavy metals, inorganic compounds and environmentally harmful organic substances including PAH's in fill and leachate (Bote 2013). Furthermore, household waste and other types of waste with a high content of organic matter are the source of landfill gas production. Even in older dumpsites, high concentrations of methane and carbon dioxide can be detected and the landfill gas can be a potential threat for buildings etc. on the dumpsite (Bote 2013). Some of the older dumpsites that have not been detected yet may therefore represent a significant overlooked risk to human health and the environment, especially dumpsites with municipal waste or with household waste and other kinds of waste from a homeowners' association or a village.

When the local environmental authorities do not know about the dumpsites, they cannot act on the environmental risks, and when the local environmental authorities become aware of the dumpsites during ongoing construction and maintenance work, conditions for acting are difficult. The surveying of the dumpsites provides a number of environmental benefits. Some examples are mentioned in the following.

On dumpsite areas with sensitive land use (dwellings, allotments, holiday cottages, child care centers, schools, public playing fields and green areas), the local environmental authorities inform the property owners and the users about the health risks and give advice on behavior that reduces the risks, where the soil contamination has exceeded the values when no risks are expected; the Danish quality criteria for soil (Miljøstyrelsen 2000a; Miljøstyrelsen 2010). On dumpsite areas with very sensitive land use, the local environmental authorities carry out remediation, where the soil contamination has exceeded the values, when the exposure should be cut off; the Danish cut-off criteria for soil contamination (Miljøstyrelsen 2000a; Miljøstyrelsen 2010), and where landfill gas poses a fire and explosion hazard.

Environmental considerations can be included in planning of construction and maintenance works from the very beginning. This allows more time for engineering studies on the dumpsite as well as more time for the local environmental authorities to assess conditions for the work. Property owners, developers and builders avoid work stops and exceeding of schedules and financial budgets.

The local environmental authorities avoid the cases where old dumpsites are unexpectedly and randomly found in housing areas. Such cases are resource intensive, partly because the soil contamination, even at small dumpsites, usually comprises several

properties and people and partly because the cases often get attention from journalists and politicians and typically must be solved under considerable time pressure (Michaelsen 1987-2003).

Another issue is the gathering of historical information on the individual old dumpsites in connection with surveying and investigating areas with soil contamination. The reports from the municipalities contain generally only little information on the individual dumpsites. The information has to be gathered from many different sources, which often are difficult to use. However, the time and money that normally is spent on gathering historical information result in considerable limitations in the collection of data, and that valuable information on the individual dumpsites is not gathered and included in the work.

Some historical sources are not structured by properties but by geographical areas, e.g. minute books of the health commission and the council in the former municipalities, the health regulations of the former municipalities, jubilee publications published by homeowners' associations, books and articles published by local history societies and recorded memories told by senior citizens. Usually, these historical sources are not examined because the work of finding information on a single dumpsite is cumbersome and expensive in time and money. It has a big influence on the survey and the investigations of the old dumpsites that these sources not are included, partly for the validity of the historical information on each dumpsite, partly for dumpsites, which are overlooked. This also counts for other activities in the past that may have caused soil contamination.

2. Problem and Methods

The questions for this study were:

Can detecting and locating old dumpsites in the area of Ballerup-Maaløv Municipality in Denmark and gathering historical information on the individual dumpsites be organized differently and done better?

What types of old dumpsites have not been detected yet in Ballerup-Maaløv Municipality and how many are there of the different types?

The study has focused on the utility of the aforementioned minute books and writings on local history for detecting and locating old dumpsites and gathering historical information on them. It has also included other historical sources, among them old municipal records from tax levy on income and real property.

In addition, the study has used a different approach in the detection phase compared to the approach used hitherto by the local environmental authorities for old dumpsites and other activities in the past that may have caused soil contamination. In the method used hitherto, information on potential soil contamination sites in the geographical detection area has been gathered separately for each site. In the study, there are both gathered information on the individual dumpsites and on the utilisation, handling and transport of waste and the municipal waste management throughout the detection area in a historical perspective.

To take advantage of the historical sources in the most suitable way, the study has gathered information on dumpsites in a geographical area which consists of a municipality before the local government reform in 1970. Ballerup-Maaløv Municipality was chosen as a test area. This is a former rural municipality, which after World War II developed into a suburban municipality of Copenhagen. Information on dumpsites was primarily gathered from about 1900 to the mid-1950s when aerial photographs have most shortcomings. All written sources were found in the Ballerup Town Archive (Ballerup Stadsarkiv 2009-2010).

In the study, an examination was made of the minute books of the Health Commission and the Council in the municipality. The minute books have been keystones in the gathering of information on old dumpsites.

Subsequently, two of the dumpsites mentioned in the minute books were selected and was made to locate the dumpsites geographically and delimit the waste layer's area and thickness as well as an effort to gather information on the operation period and the waste composition. The minute books do not answer these questions. This work included an examination of old census papers, old index cards from tax assessments of real property, old income tax

returns, writings from local history societies on the former villages, recorded memories told by senior citizens and jubilee publications from homeowners' associations together with an examination of old cadastral maps, old topographical maps and old aerial photographs plus a comparison of terrain heights in a topographical military map from 1900 and DK-DEM/Terrain, part of the Danish Elevation Model from 2005-2007.

In another example, the information from the minute books was elaborated by examination of old writings from Ballerup Homeowners' Association that covered Ballerup Town. This included letters, minute book, jubilee publication and a newspaper clipping collection.

In the examination of the historical sources, there was also gathered impression of their utility to give information on other activities in the past that may have caused soil contamination.

3. Experience from Ballerup-Maaløv Municipality

3.1 The Minute Books of the Health Commission

An examination was made of the minute books of the Health Commission of Ballerup-Maaløv Municipality from 1893-1948 and 1950-1972 (Sundhedskommissionen 1861-1972). The Health Commission oversaw the health situation in the municipality. The work was mainly based on the local health regulations laid down by the council in the municipality, who also elected the members of the health commission (Betænkning 1970). In most of the rural areas in Denmark, there was no health commission or the health commission was not active up to about 1900 (Engberg 1999). The health commission was repealed when the Danish Parliament passed the Danish Environmental Protection Act in 1973.

The minute books contain much information on dumpsites and the utilisation, handling and transport of waste and the Health Commission's policy on dumpsites and waste. They include in all approximately 345 pages and contain minutes for every meeting of the Health Commission. The minutes show which cases the Health Commission discussed and what decision the Health Commission made in the individual cases. The text of the facts, issue and decision in the cases was written by hand in cursive writing. In the minute book from 1893-1948 passages with poor formulations and a careless handwriting are often found. This and the older Danish language and handwriting at that time makes it difficult to understand the passages. Information on dumpsites and waste is scattered, random and there is no index. One must read all pages in every minute book to find relevant information.

There is information on dumpsites and waste on specific sites in cases of complaints from citizens regarding nuisances, reports from the police and the council department in the municipality on contravention of the municipality's health regulations, the Health Commission's orders to landowners, the Health Commission's requests for assistance from the police, and applications of permission to use household waste. However, not all cases, which the Health Commission dealt with are documented in the minute books (Michaelsen 2012). Generally, the minute books contain limited exact information on the individual dumpsites.

For a number of sites on farms and market gardens, the texts do not directly mention a dumpsite. However, based on the historical information gathered, it is a possibility that there has been a dumpsite.

Information on existing dumpsites and possible dumpsites cannot be given a defined geographical location immediately. Before 1950, most of the dumpsites are associated with a name and position of a farmer, a gardener and/or a name on a farm, a market garden. The other dumpsites are associated with a name of a homeowners' association or with a village pond and the name of a neighbouring street. After 1950, the dumpsites are primarily associated with the cadastral number in the Danish cadastral register for the property, where the dumpsite was located. There is no indication of where the dumpsite was located on the property.

The minute books also contain information about the introduction of compulsory collection of household waste in urban areas and the changes in the municipality's health regulations and in the Health Commission's general policy in relation to dumpsites and the utilisation, handling and transport of waste.

In total, the minute books of the Health Commission contain much historical information on dumpsites and waste that can provide valuable information on the individual dumpsites beyond the minute books exact information on them. The minute books also contain information on other types of pollution e.g. from industrial enterprises.

3.2 The Minute Books of the Council

An examination was made of the minute books of the Council of Ballerup-Maaløv Municipality from 1908-1913 and 1925-1952 (Sognerådet 1908-1952). In this period, the municipality had the status of a rural municipality. In 1952, Ballerup-Maaløv Municipality gained a new government system similar to a municipality with a market town (Dansk Center for Byhistorie 2013).

The minute books contain minutes of every meeting of the Council. Decisions made by the President of the Council between the meetings are not recorded in the minute books. One of the Council's fields of responsibility was waste management.

In total, the minute books include 2795 pages. Texts were written by hand in cursive writing. The language is concise and precise. The texts are therefore hardly affected by the older Danish language used at the time when the minute books were written. The handwriting is neat. There are also many headlines that make it easier to find text which may contain relevant information. This makes the handwriting simpler to read than the handwriting in the minute books of the Health Commission. Information on dumpsites and waste is scattered, random and one must read all pages in every minute book to find relevant information as is also the case with the minute books of the Health Commission. The total amount of information on dumpsites and waste is almost the same.

The examination of the minute books of the Council is time-consuming because of the many handwritten pages and the many different types of cases the Council considered. On the other hand, the examination gives an essential supplement to the information on dumpsites and waste in the minute books of the Health Commission and many details and a great insight into the urban development and the development of industry and agriculture in the municipality. This can be used in detecting and locating the old dumpsites and gathering historical information on them.

There is information on dumpsites and waste on specific sites in cases of the municipality's buying and leasing land for waste disposal, implementation of actions and operation conditions for the municipal dumpsites, filling of village ponds, reports from the police on contravention of the municipality's health regulations, and complaints from citizens regarding nuisances and the Health Commission's decisions. Generally, the minute books contain limited exact information on the individual dumpsites just as the minute books of the Health Commission.

The minute books contain information on the Council's decisions to buy land or enter into a contract with a private landowner for lease of land for a dumpsite. However, for several of the dumpsites there is no information in the minute books which can confirm that the land was bought or agreement of the lease of land was achieved and the dumpsite came into operation.

There is no direct mention in the texts that there is a dumpsite for a number of sites on farms. However, based on the historical information gathered, it is a possibility that there has been a dumpsite.

Like the minute books of the Health Commission, information on existing dumpsites and possible dumpsites cannot be given a defined geographical location immediately. About half of the dumpsites are associated with a name and position of a farmer and/or a name on a farm. The other dumpsites are associated with a name of a company or with a village pond and the name of the village or a neighbouring street. Cadastral number for the property is only listed for a few sites. There is no indication of where the dumpsite was located on the property.

The minute books of the Council contain additional information on the waste collection and the changes in the municipality's health regulations in relation to dumpsites and the utilisation, handling and transport of waste. They also contain information on steps taken in the extermination of rats in relation to dumpsites and waste.

Furthermore, the minute books contain information on specific industrial enterprises. Until the late

1930s, the minute books contain little information on them. In the 1930s, the Council began to give permission to establish industrial enterprises. Permission was given to both large and small enterprises in existing and new buildings. In the 1940s, the Council began to allocate land areas where industrial enterprises could be established. The Council also allocated a land area for artisans.

3.3 Index Cards for Properties from 1932-1952

The Ballerup Town Archive holds old index cards, which have been used by the council department in Ballerup-Maaløv Municipality for the period about 1932-1952 to record information on each property in the municipality for tax levy on real property. The information comes from tax assessments of real property, which were carried out at approximately 5-year intervals or when there were significant changes on the property. An examination was made of all index cards for properties in the area of Ballerup By (town), Ballerup Sogn (parish) in the Danish cadastral register. This corresponds to half of the total number of index cards. The index cards were also used to provide information on two dumpsites.

The index cards were filled in by hand in cursive writing. The letters and numbers are small and sometimes difficult to read. Extraction of information from the index cards is very time-consuming. On the other hand, the index cards contain much useful information to detect and locate old dumpsites and other activities in the past that may have caused soil contamination.

The index cards contain information on e.g. the property's cadastral number/numbers, the property's use and area in acres, parceling and extension of the property and the date, the landowners name and position and the date for change in ownership. Often there will be information on the property's name.

The index cards are therefore suitable for the geographical location of names of people, farms, market gardens and companies mentioned in connection with specific dumpsites in the minute books of the Health Commission and the Council and in writings on local history. By using the index cards, the names can be associated with the cadastral number/numbers belonging to the person, farm, market garden or company at the time when the dumpsite was operating. Primarily, the use includes dumpsites operating in the index cards data period.

The information in the index cards can also help to illuminate changes on the individual properties such as change in ownership, change in land use and parceling or extension. This can provide information on the dumpsite.

When the information in the index cards about the individual properties are linked with old cadastral maps on the website on the Internet for the Danish Geodata Agency, it is possible to obtain a more detailed picture (spatial and in time) of the property's area and the parceling and/or extension of the property than from the index cards and the cadastral maps separately. For some properties, the picture may also include subsequent residential housing and enterprises. This provides better conditions for reading old topographical maps, old aerial photographs and writings on local history in studies of specific dumpsites.

The index cards' facts about properties' use are copious. This provides information on the different types of enterprises about 1932-1952 that potentially may have disposed their waste (or a part of the waste) of to some of the nearby dumpsites. It also makes the index cards suitable for detecting and locating other activities in this period that may have caused soil contamination. Table 1 shows examples of activities, listed in the index cards under the heading "Property type and use", which may be a source of soil contamination.

***Table 1**. Examples of activities listed in the index cards for the individual properties in the municipality about 1932-52 under the heading "Property type and use", which may be a source of soil contamination.*

factory	workshop - master builder	grocery	orchard
tannery	workshop - master painter	gas station	mink farm
dairy	workshop - master cabinetmaker	garage	
brickyard	workshop - turner	haulage contractor	
printing house	workshop - master smith	laundry	
wallpaper printing	storage yard - timber yard	telephone exchange	
bindery	storage yard - master builder	cable house - phone brigade	
	storage yard - roads authority	transformer	
	storage building	transformer substation	

3.4 Tax Census Papers from 1905-1923

The Ballerup Town Archive holds an annual census paper for each property in Ballerup - Maaløv Municipality from 1905 to 1923 created for tax levy. An examination was made of all census papers from 1905, 1910, 1915 and 1920 for properties in the area of Skovlunde By (Town), Ballerup Sogn (Parish) in the Danish cadastral register. They were also used to provide information on two dumpsites.

The census paper contains information on the property's cadastral number/numbers, the landowner's name and position as well as name, position and date of birth of people who lived on the property. The landowners have filled in the census papers. This has been done by hand in a readable cursive writing. Like the index cards from tax assessments of real property, the tax census papers are suitable for the geographical location of dumpsites mentioned in the historical sources by a person's name and his position. The use primarily includes dumpsites operating in the census papers data period. The information in the census papers can also help to illuminate changes on the individual properties, which can provide information on the dumpsite.

The tax census papers are not suitable for detecting other activities in the past that may have caused soil contamination.

3.5 Writings on the History of Ballerup Town

In the Ballerup Town Archive, under the topic Ballerup Homeowners' Association, an examination was made of writings with historical information on the handling of waste in Ballerup Town and the dumpsites for the town's waste. Since 1900, Ballerup Town has been the largest town in the municipality. In the 1920s-1930s, Ballerup Homeowners' Association was very active in solving the town's problems in a number of areas including disposal of waste.

The writings include 12 letters to and from Ballerup Homeowners' Association in 1924-1938, which contain much information on the disposal of household waste from the members of the Ballerup Homeowners' Association as well as the dumpsites where the waste was deposited. The letters from the homeowners' association (half of the letters) were written by hand in cursive writing in the older Danish language and handwriting at that time. The text is written in a formal and polite style. This often makes the text difficult to understand.

The writings also include the minute book of Ballerup Homeowners' Association from 1926-1953, written by hand in cursive writing in the older Danish language and handwriting at that time (Ballerup Grundejerforening 1926-1953). There are few headlines, which makes it difficult to estimate where the text may contain relevant information and where the text can be skipped. There are only relevant data in the first part of the minute book. Nevertheless, the data elaborates the information in the letters.

Furthermore, the writings includes the 50-years jubilee publication of Ballerup Homeowners' Association (Ballerup Grundejerforening 1944), which contains information on the disposal of household waste from Ballerup Town based on the letters and

the minute book. The jubilee publication also contains information on the disposal of household waste from the town at a later time.

In addition, a newspaper clipping collection from 1924-1950 produced by a citizen in Ballerup Town was found (Avisudklipsamling 1924-1950). It contains selected newspaper articles both from local newspapers and national newspapers on various matters in Ballerup Town and its environs. Among them are articles on the disposal of household waste from Ballerup Town and on nuisances and complaints from citizens due to the supply and utilisation of household waste in agriculture and market gardening. This information supplements the information in the letters, the minute book and the jubilee publication. The newspaper clipping collection contains also a few newspaper articles on the pollution from a large chemical factory.

3.6 Writings on the History of Aagesdal and Kavsbjerggaard

Information was gathered on two dumpsites mentioned in the Health Commission's minute books namely the dumpsite on Aagesdal farm and the dumpsite on Kavsbjerggaard farm mentioned a few times in the late 1930s and early 1940s. An effort was made to locate the farm land and the dumpsite on the farm land geographically and delimit the waste layer's area and thickness as well as to gather information on the dumpsite's operation period and the waste composition.

The analysis was based on the historical information on the utilisation, handling and transport of waste, dumpsites, urban development and development of industry, agriculture and business in the municipality from the examination of the previous sources. Moreover, the analysis used historical information gathered on the supply and utilisation of household waste in agriculture and market gardening in the municipality and around Copenhagen (Betænkning 1938; Carlsson and Carlsson 1996; Gøgsig 1994; Eriksen 1996; Hilden 1973; Jørgensen 2000 and 2001; Larsen 2000; Thomsen 1983).

In addition, specific historical information was gathered about the two dumpsites, among others from the index cards for properties and the tax census papers plus old cadastral maps from the Danish Geodata Agency.

A search in the Ballerup Town Archive was performed to identify writings on the history of the two farms and the subsequent holiday cottages and single-family houses built on the farm land. A direct search for the dumpsites themselves will not be successful.

The search identified two books on the history of the former villages published by Ballerup History Society and two articles in the society's journal, a book of memories told by senior citizens, a festschrift published by the town archive and five jubilee publications published by homeowners' associations (Bitsch and Hansen 1992; Grundejerforeningen Egebjerglund-Syd 1986; Grundejerforeningen Egebjerglund-Syd 1996; Hassing 1986; Jensen 1988; Jensen 1990; Jensen 1998; Johannsen and Jensen 1973; Rugaard 1964; Thomsen 1983; Thomsen and Johansson et al. 1998).

The writings on local history contain much information that is useful to the geographical location of the dumpsite on Aagesdal's land, to delimit the waste layer's area and to provide information on the dumpsite's operation period and the waste composition. The writings on local history also contain much information that is useful to illuminate developments in the waste production and disposal of waste in the subsequent holiday cottages and single-family houses on the farm land.

The writings on local history provide important information on the dumpsite at Aagesdal, which is not obtainable through the other used sources. In addition, the data gives a much better interpretation of the old topographical maps, the old aerial photographs and the Danish Elevation Model of the present terrain, mentioned in sections 3.8 and 3.9.

The writings on local history contain no information on the dumpsite on Kavsbjerggaard farm. There is information on Kavsbjerggaard and the subsequent holiday cottages and single-family houses on the farm land. This information supplements the information from the other used sources. However, the amount of information is significantly less than for Aagesdal.

3.7 Old Income Tax Returns

Old income tax returns in the Ballerup Town Archive were also used for information on the dumpsite on Kavsbjerggaard. The historical information gathered indicates that in Ballerup-Maaløv Municipality there is a link between farms with many pigs and the occurrence of a dumpsite with household waste on the farms in the period when the dumpsite on Kavsbjerggaard was operating (Carlsson and Carlsson 1996; Gøgsig 1994; Hilden 1973; Jørgensen 2000 and 2001; Thomsen 1983). Income tax returns from 1944 and the following years contain a form where owners and users of agricultural properties gave information on livestock herd and number of the different farm animals (Hansen 2009). The income tax returns may therefore provide information on development in livestock herd and the number of pigs on each farm. This can be used to identify farms where there is a possibility of a dumpsite with household waste and to illustrate the development of the dumpsite.

3.8 Old Topographical Maps and Old Aerial Photographs

To locate and delimit possible areas for the dumpsite activity on Aagesdal's and Kavsbjerggaard's land, a survey was made in a geographic information system (GIS) of waterholes and wet areas, which are reduced or have disappeared on the farm land and nearby the subsequent holiday cottages and single-family houses on the farm land. The survey was carried out on the basis of old topographical maps, which include a topographical military map on the scale of 1:10.000 from 1900. These kinds of maps are known as the Fortification Maps around Copenhagen. The maps also include a topographical map on the scale of 1:20.000 (Ordnance map) from the same time and the subsequent topographical maps on the scale of 1:20.000 (Ordnance maps) and the later topographical maps on the scale of 1:25.000 (4-cm maps). Subsequently, the survey was carried out on the basis of old aerial photographs with support from the historical information gathered. There were aerial photographs, taken as a vertical photograph, from 1944, 1945, 1954 and different years during the 1960s and up to date ortophotographs. The most of the maps and aerial photographs were used in a digital geo-referenced version.

The aerial photographs were also used to identify areas that may indicate dumpsite waste and traces of the former dumpsite activity. Aerial photographs from the writings on local history, taken as an oblique photograph, where the farm buildings and part of the farm land can be seen, were used as well. The interpretation of the aerial photographs was made with support from the historical information gathered. Two private photographs from 1937 of the dumpsite on Aagesdal in recorded memories told by a senior citizen were used to delimit the area, where the waste can be seen on the photographs.

3.9 The Danish Elevation Model

In order to get information on the contemporary geographical extent and thickness of the waste layer on the dumpsite on Aagesdal farm and on Kavsbjerggaard farm, a comparison was made of terrain heights in the landscape today and before the dumpsites were operating. The comparison also included the dumpsite for the subsequent holiday cottages and single-family houses on Aagesdal's land detected by the old aerial photographs.

The comparison started with the farm land. The Danish Elevation Model DK-DEM from the Danish Geodata Agency was used. It is a high resolution digital elevation model for Denmark produced by airborne laser scanning in 2005-2007. From the model, DK-DEM/Terrain was used. Here all objects above ground surface such as trees, houses, bales of straw, cars, etc. are removed, so that it is high points at the ground surface that are analysed. Also, DK-DEM/Contours was used, which consists of automatically generated contour lines with an equidistance of 0.5 m based on DK-DEM/Terrain. The GIS, DK-DEM/Terrain and DK-DEM/Contours were juxtaposed to the contour lines in a digital geo-referenced version of a Fortification Map. The map is based on field survey in 1900 on the scale of 1:10.000 and has contour lines with an equidistance of 1.25 meters. The reading of difference in terrain height and assessment of thickness of fill and dumpsite waste was made manually with support from the historical information gathered. Figure 1 shows the comparison south of the former farm buildings on Aagesdal.

The comparison could be used to estimate whether there has been a filling in a specific area and to estimate the fill's thickness. However, the estimate of the fill's thickness was associated with some uncertainty and with restrictions in areas of the former waterholes, due to lack of information on the waterhole's depth. DK-DEM/Terrain could also supply

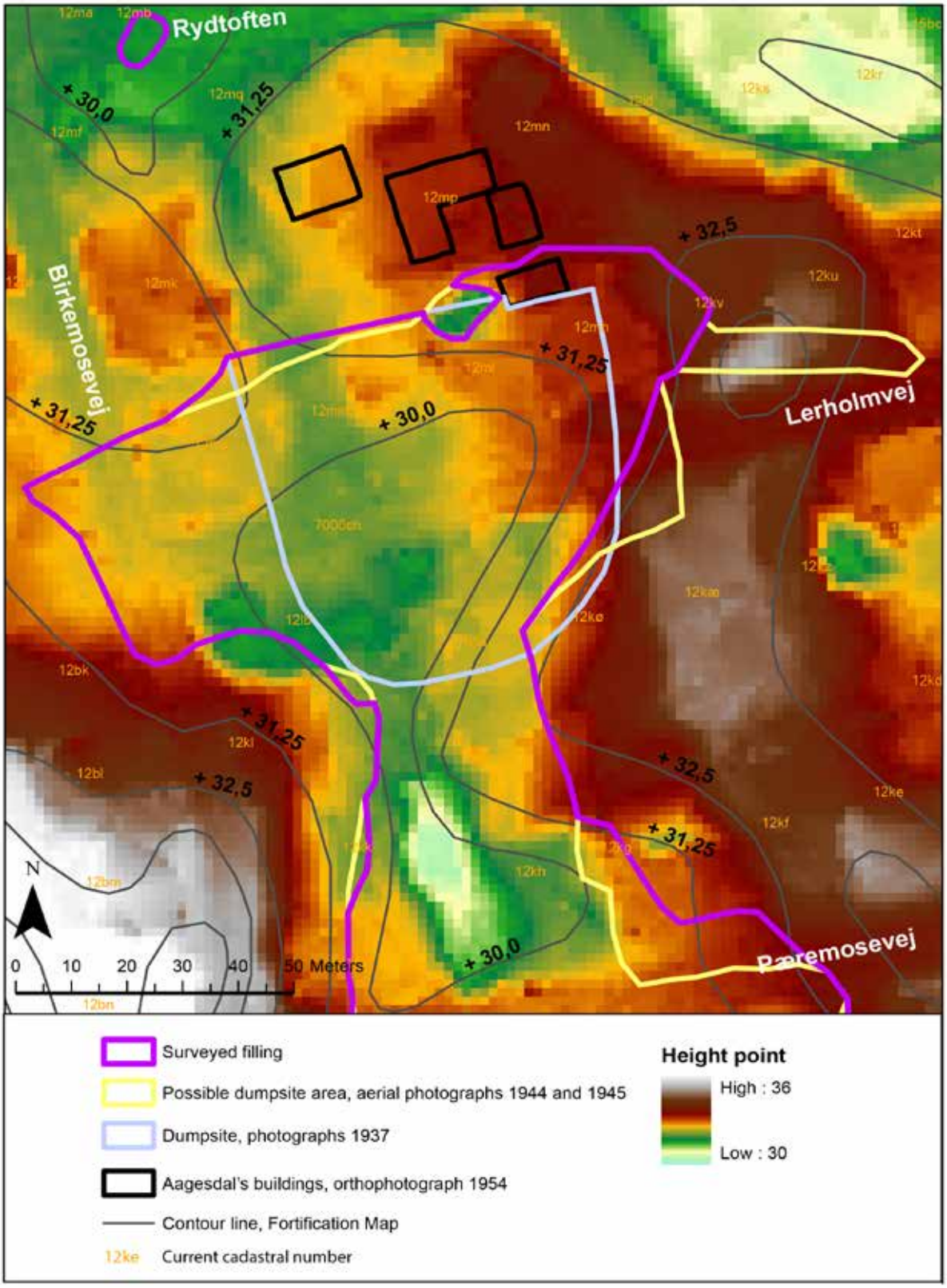

***Figure 1**. A section of DK-DEM/Terrain south of the former buildings on Aagesdal with contour lines from the Fortification Map, areas with a possibility of dumpsite waste and areas where filling was surveyed by comparison of terrain heights in DK-DEM/Terrain and the Fortification Map.*

information from the old topographical maps and the old aerial photographs on the waterholes and clarify uncertainties about filling in the waterholes. If the individual waterhole was not filled up, the waterhole recess appeared in a different color in DK-DEM/Terrain. However, the estimate of filling and fill thickness was difficult and time consuming.

Generally, the Fortification Maps give a better representation of the terrain than the topographical maps on the scale of 1:20.000 (Ordnance maps) from the same time and later. However, the Fortification Map for Aagesdal's land was not placed exactly geographically in the GIS, partly because of error in the survey of Aagesdal's land when the Fortification Map was produced, partly because of a general uncertainty in geo-reference of the old topographical maps as the method is based on linking in points in the middle of the roads on the old and the newest topographical map. The real geographical location of the waterholes and wet areas and probably also the contour lines on the fortification map was estimated to be approximately 5 meters further east and 2.5 meters further north (Michaelsen 2012).

It was disruptive to the reading of heights in DK-DEM/Terrain and to the estimate of filling and fill thickness that the contour lines on the Fortification Map (which were drawn up as a layer in the GIS) were not placed precisely geographically, and the displacement needed to be kept in the head instead of a recorded line on the computer screen. This can easily cause an error in the reading of heights in DK-DEM/Terrain if one does not pay attention to the contour lines real geographical location all the time. It was also disruptive to the reading of heights in DK-DEM/Terrain that there have been fillings on the many plots of land for single-family houses on Aagesdal's and Kavsbjerggaard's former land in connection with the plots' use. The fillings have made the present terrain surface irregular and this made it difficult to get an overview of where there are fillings and fill thickness. In addition, this made it impossible to distinguish between dumpsite waste or soil and other kinds of fill that later have been deposited on the plots during their use and therefore it was not possible to delimit the contemporary geographical extent and thickness of the dumpsite waste layer.

Because of these weaknesses, the comparison focused on areas where dumpsite waste may occur according to the old aerial photographs and the writings on local history and on waterholes and wet areas, which disappears or are reduced according to the topographical maps and the aerial photographs. Outside these areas, the comparison was only a screening to identify possible areas with big fill thickness. Such areas were not found. The comparison is not suitable for a detection of old dumpsites. It is only to be used in selected areas where the historical sources indicate a possibility of dumpsite waste.

On the Island of Zealand outside the Copenhagen area, where the Fortification Maps do not exist, a comparison of terrain heights in DK-DEM/Terrain and the topographical maps on the scale of 1:20.000 from the same time and later are not suitable for estimation of differences in terrain height. The maps have contour lines with an equidistance of 2.5 meters or twice the equidistance of 1.25 meters on the Fortification Maps. This results in a high uncertainty in reading the heights in DK-DEM/Terrain and estimates of filling and fill thickness.

When DK-DEM/Terrain, old topographical maps and old aerial photographs for the land of Aagesdal and Kavsbjerggaard were compared in the GIS, it was observed that the contour lines of the topographical map on the scale of 1:20.000, based on field survey in 1899-1900, and the topographical map on the scale of 1:20.000, corrected in 1930, from the Danish Geodata Agency's nationwide digital and geo-referenced map series, are not at the same geographical location. The contour lines on the map from 1899-1900 are located east-northeast of the same contour lines on the map from 1930. At Aagesdal's land, the distance varies from 8 to 21 meters. In many places, the distance is in the interval from 17 to 21 meters (Michaelsen 2012). This was also observed at Kavsbjerggaard's land.

The difference is not due to changes in terrain heights as both maps are based on the field survey in 1899-1900. Possible reasons may be differences in delineation of the contour lines when the maps were produced, printing of the paper maps, physical impact on the paper maps from use before digitization, and geo-reference of the maps.

It was also observed that waterholes in Aagesdal's land are not at the same geographical location on the two maps. Waterholes on the map from 1899-1900

are located east-northeast of the same waterholes on the map from 1930 (Michaelsen 2012). The direction is the same as for the contour lines, but the distance is not the same, it is less - approximately 8 meters. See Figure 2.

When using a paper or a digital geo-referenced version of the Fortification Maps and the various old topographical maps on the scale of 1:20.000 to locate old dumpsites and to delimit the waste layer's geographical extent and thickness, it is important to

***Figure 2**. Comparison of waterholes around the former Aagesdal farm in the topographical map on the scale of 1:20.000 (Ordnance map) based on field survey in 1899-1900 and the topographical map on the scale of 1:20.000 (Ordnance map) corrected in 1930, from the Danish Geodata Agency's nationwide digital map series.*

note that the maps do not have the same high exactness as DK-DEM/Terrain in the representation of terrain heights and geographical location and extent of elements in the terrain. This also includes the old topographical maps on the scale of 1:25.000 (4-cm maps). There is a significant uncertainty when the maps are compared with DK-DEM/Terrain and when the maps are used to delimit a dumpsite's geographical extent on existing properties of which many are plots of land for single-family houses.

4. Detected Dumpsites in Ballerup-Maaløv Municipality

4.1 The Minute Books of the Health Commission

The minute books of the Health Commission of Ballerup-Maaløv Municipality contain information on 23 dumpsites and seven possible dumpsites of very different characteristics. They cover the filling of a village pond, use of household waste in agriculture and market gardening, illegal deposits of waste and waste disposal sites for homeowners' associations and urban settlements in the municipality.

For a number of sites on farms and market gardens, the texts do not directly mention a dumpsite. However, based on the historical information gathered, it is a possibility that there has been a dumpsite. See Table 2.

Four of the dumpsites were already known by the local environmental authorities (the local environmental authorities have knowledge of 12 dumpsites in the municipality (Region Hovedstaden 2010)).

4.2 The Minute Books of the Council

The minute books of the Council of Ballerup-Maaløv Municipality contain information on eight dumpsites and eight possible dumpsites of very different characteristics as in the minute books of the Health Commission. They cover the filling of village ponds, use of household waste in agriculture and waste disposal sites for urban settlements established by the Council.

The minute books contain information on the Council's decisions to buy land or enter into a contract with a private landowner for lease of land for a dumpsite. For several of the sites there is no information in the minute books which can confirm that the dumpsite came into operation. For some of the sites on farms, there is no direct mention of a dumpsite. However, based on the historical information gathered, it is a possibility that there has been a dumpsite. See Table 2.

Table 2. *Dumpsites in the minute books of the Health Commission and the Council. Their type, numbers and years they are mentioned.*

Type of dumpsite	Numbers Health Com.	Numbers Council	Time-period
Filled village pond	1	2	1908-1912
Dumpsite on a farm	9	2	1930-1946
Possibility of a dumpsite on a farm	4	4	1956-1960
Dumpsite on a market garden	5		1939-1946
Possibility of a dumpsite on a market garden	3		
Dumpsite of a homeowners' association	2		1937-1939
Municipal dumpsite		4	1925-1944
Municipal dumpsite - no confirm of operation		4	
Municipal dumpsite - large	1		1957-1971
Illegal deposit	4		1957-1967
Other dumpsite	1		1957
Dumpsites total	23	8	
Possible dumpsites total	7	8	

One of the dumpsites was already known by the local environmental authorities. Three of the dumpsites are among the dumpsites mentioned in the minute books of the Health Commission. Although the minute books of the Council covers the same type of dumpsites as the minute books of the Health Commission, but with different fields of responsibility, very few dumpsites are mentioned in both minute books.

4.3 Written Materials from Ballerup Homeowners' Association

The historical sources from Ballerup Homeowners' Association contain information on two dumpsites mentioned in 1924-1933, where household waste from the association was deposited. Concerning another site mentioned in 1929-1930, it is a possibility that there has been a dumpsite receiving household waste from the association and municipal buildings. Two of the dumpsites are mentioned in the minute books of the Council. None of the dumpsites were known by the local environmental authorities.

4.4 The Dumpsites on Aagesdal and at Pæremosen

The examination of the various historical sources has resulted in the following conclusions about the dumpsite on Aagesdal farm and the dumpsite at Pæremosen.

The dumpsite on Aagesdal farm was operating from 1936 to 1940 and possibly until spring 1941. The dumpsite consists of household waste and waste from restaurants that were collected by the farmer, who also had a refuse collecting company operating in Copenhagen. The waste was used as feed for the many pigs on the farm. The pigs rooted in the waste and ate what the they could find on the dumpsite. After 1941, a part of the waste was sold to market gardens as fertilizer.

In addition, a dumpsite was detected and located just south of the farm land. The dumpsite started operating in the mid-1950s and shut down in 1966. The fill may contain building materials from the demolition of the holiday cottages and soil, stumps and cuttings of trees and of bushes from the establishment of year-round houses on the former farm land. The fill may also contain household waste from the houses until the compulsory collection of household waste was introduced in 1962.

Figure 3 shows the existing single-family houses on Aagesdal's former land and the recreational green area immediately south of it. The figure depicts the area where the dumpsite on Aagesdal can be seen on photographs taken in 1937 and the areas where a possibility of dumpsite waste is indicated on the aerial photographs and in the writings on local history. The figure also depicts the areas where filling was surveyed by the comparison of terrain heights on the Fortification Map and DK-DEM/Terrain in the selected areas. The figure shows, that filling is surveyed in almost the whole area, where dumpsite waste is possible.

On Aagesdals land, the biggest fill thickness occurs in a former low area in terrain with a little waterhole, which lay immediately south of the buildings on Aagesdal, before filling with household waste started. Here, the fill thickness can be up to 2.5 meters above the former ground surface around the waterhole. To this must be added the fill in the waterhole. This thickness cannot be estimated by the comparison due to lack of information on the waterhole's depth. In the comparison, it was not possible to distinguish between dumpsite waste or soil and other kinds of fill from the later use on the former farm land. This made it not possible to delimit the geographical extent and the vertical extent of the dumpsite waste today. The total amount of fill in the area where the dumpsite can be seen on photographs taken in 1937 and is estimated to be approximately 8000 m^3. A production of landfill gas would be possible from the household waste in the waterhole.

Just south of the farm land in the area of the dumpsite, the biggest fill thickness occurs in the filled part of the two waterholes called Pæremosen. Here, the fill thickness is a minimum 1.3-2.0 meters above the former ground surface around the waterholes. The total amount of fill in the dumpsite area is estimated to be approximately 11000 m^3. In the fill in the waterholes, a production of landfill gas would be possible depending on the organic matter in the fill.

Figure 3. *A section of orthophotograph DDOby 2009 with the single-family houses on Aagesdal's former land and the recreational green area south of the former farm land together with the areas where filling was surveyed by comparison of terrain heights in DK-DEM/Terrain and the Fortification Map in the selected areas and where the historical sources indicates a possibility of dumpsite waste.*

5. Discussion

The historical sources used in the study are all useful for detecting and locating old dumpsites in Ballerup-Maaløv Municipality and gathering historical information on them. The sources complement each other well. Generally, it takes many hours to use the sources. However, the time spent is a good investment because one can gain much useful information in return.

The minute books of the Health Commission and the Council of Ballerup-Maaløv Municipality contain, in all, information on 31 dumpsites and 15 possible dumpsites, mainly from the 1930-1940s and of very different characteristics. Few were already known from the earlier efforts to detect and locate old dumpsites. For the Ballerup-Maaløv-area is was based on reports from the municipality, primarily of dumpsites with a file in the municipal record system, and the former county's examination of old aerial photographs in selected areas from 1945 and onwards (Københavns Amtskommune 1986; Geoteknisk Institut 1994; N&R Consult A/S 1991).

The minute books generally contain little factual information on the individual dumpsites. The used minute books, health regulations, tax index cards for properties, writings on local history, letters and newspaper clippings contain, taken together, a great deal of historical information on the utilisation, handling and transport of waste, dumpsites and conflicts of interest about waste and dumpsites in Ballerup-Maaløv Municipality plus the Health Commission's and the Council's policy on waste and dumpsites. The sources contain also much historical information on the urban development and the development of industry, agriculture and business in the municipality. This can provide valuable information on the individual dumpsites and improve the detection of the dumpsites.

In the historical sources, information on dumpsites most often has to be found in the form of indirect information. Therefore, it is important to be able to decode the information in the historical sources. The more historical sources one reads, the better one gets to decode the information. By reading various historical sources and compiling their information, as in this study, knowledge on the history of the entire municipality including waste and dumpsites can be established. This provides a synergy effect in the yield of information. Thus, a better understanding and interpretation of the individual historical sources is achieved, which both affects the dumpsites one detect and the information one gathers on each dumpsite in the individual historical sources. It also makes it possible to supplement the specific factual information on each dumpsite in the sources with information from other dumpsites and handling of waste in the municipality. This can for example give information on the dumpsite's size, waste composition and operation period. Together this contributes to a better detection and location of the old dumpsites and a better gathering of historical information on them from the historical sources. Furthermore, the knowledge on the history of the entire municipality can provide input to methods for detecting and locating dumpsites that are not mentioned in the minute books.

The historical information on the individual dumpsite, which can be obtained from the history of the entire municipality and specific information from the old tax documents and the writings on the history of the area where the dumpsite was located, provides a much better gathering of information on the dumpsite than the traditional sources. Moreover it provides a much better gathering of information from the traditional sources. One obtains a more correct interpretation of the old topographical maps and old aerial photographs. One obtains a better delimitation of possible properties the dumpsite comprises today and where it is necessary to look through the present municipality's files involving the properties (environmental, construction of buildings, fire, parceling and planning files). In addition, one obtains a better selection of useful information from the records. Furthermore, it is possible to ask the relevant questions in interviews with landowners and senior citizens and to obtain a better interpretation of the responses, which provides more information.

The minute books of the Health Commission and the Council and the index cards from tax assessments of real property appear to contain much information that can be used to detect and locate other activities in the past that may have caused soil contamination and to gather historical information on them e.g. former industrial enterprises.

As the survey is based on gathering information from many sources, most benefit will be provided when reading the historical sources and selection of data is made by the same person or by few persons who work closely together. Preferably, the survey should be carried out as a tightly focused project. It can also be expected that some of the sources often must be reexamined, because facts often are seen in a different perspective, when more knowledge on the history of the local area and the entire municipality is gained.

The minute books, index cards, and private letters were written by hand in cursive writing. In the majority of the material, an older Danish cursive writing and an older Danish language were used. However, the older text's readability varies, as stated in the description of the individual sources. In some of the sources there are passages, where the handwriting is careless and/or there are poor formulations or the handwriting is small. Here can the older handwriting be difficult to read, especially for the reader who does not have experience of writing by hand in cursive.

Use of the same types of written historical sources for other municipalities in Denmark require that they have been archived and not subsequently lost and are readily available. The Ballerup Town Archive has been a well-managed municipal town archive for many years, where many records of the Council and the council departments in Ballerup-Maaløv Municipality are stored together with other records and writings on local history in the municipality. All the sources used in the study from the town archive are archived in a readily available manner. This is necessarily not the situation for other municipalities. On the other hand, there might be other useful sources that do not exist for Ballerup-Maaløv Municipality.

The detection and location of the old dumpsites in Ballerup-Maaløv Municipality and the gathering of historical information on them can be improved e.g. by mapping the urban development and by gathering information on the development in the waste production (waste composition and quantity of waste), the handling of waste and the waste collection in the areas with dwellings and holiday cottages.

Ballerup-Maaløv Municipality has much in common with the other municipalities around Copenhagen from about 1900 to the mid-1950s regarding dumpsites and waste. The picture may be different in other parts of the country, depending on the nature and the urban development and the development of industry, agriculture and business in the municipality. Outside the Copenhagen area, many of the dumpsites were probably located around the market towns. A different picture of dumpsites and waste may lead to a need to perform the method in a slightly different way, for example by beginning the analyses before 1900.

It is too early to assess whether the surveying of the old dumpsites before the mid-1950s with the used method is well worth the effort compared to the knowledge obtained. More methodological experience is needed and more historical information on the old dumpsites before the mid-1950s is needed, partly from Ballerup-Maaløv Municipality and partly from other municipalities before the local government reform in 1970.

6. Conclusion

The minute books of the Health Commission and the Council of Ballerup-Maaløv Municipality contain information on a large number of dumpsites of very different characteristics, which were not discovered by the methods used by the local environmental authorities earlier efforts to detect and locate old dumpsites.

The minute books, health regulations, tax index cards for properties, writings on local history, letters and newspaper clippings contain, taken together, much historical information on the utilisation, handling and transport of waste, dumpsites and urban development and the development of industry, agriculture and business in the municipality.

This information provides a better understanding and interpretation of the individual historical sources. It also makes it possible to supplement the specific factual information on each dumpsite in the historical sources with information from other dumpsites and handling of waste in the municipality. Furthermore, the information can provide input to methods for detecting and locating dumpsites that are not mentioned in the minute books.

The historical information on the individual dumpsite, which can be obtained from the history of the entire municipality, the old tax documents and the

writings on the history of the area where the dumpsite was located, provides much better information on the dumpsite than the traditional sources like old topographical maps, old aerial photographs, the present municipality's files and interviews with landowners.

Finally, the minute books of the Health Commission and the Council and the index cards from tax assessments of real property contain much information that can be used in detecting and locating other activities in the past that may have caused soil contamination and in gathering historical information on them e.g. former industrial enterprises.

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