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Svein Erik Stave

Documents

Water consumption in Food Processing and the Service Industries in Norway

Statistics Norway/Division for Environmental Statistics

Abstract

The general purpose of this project has been to estimate water consumption in Food Processing (NACE 15) and the Service Industries (NACE 50-93) by exploitation of the administrative/business registers of public water suppliers (municipalities and private water supply plants). The aim of the project was to fill gaps in the Norwegian water accounts and to improve Norway's ability to report water consumption figures in the Eurostat/OECD Joint Questionnaire on Inland Waters (JQ). A primary motivation for initiating the project was to explore whether the expanding system of invoicing individual costumers, including industrial establishments, on basis of real amounts supplied (measured by water meters), could be used for statistical purposes.

The methodological concept has been to develop water consumption coefficients (i.e. water consumption by number of employees) for the different industries of interest, on basis of the water consumption data from the administrative registers. The coefficients have then been combined with structural statistics on employees and economic turnover to inflate to national figures.

A total of 9 registers, from 8 municipalities and 1 private water supply plant, were collected, containing annual water consumption data for about 17,000 individual costumers. To increase the total sample further, 3 additional data sources were used: 1) a register on water discharges by industrial companies registered in the database of the Pollution Control Authority, 2) a register containing industrial establishments supplied by their own sources, operated by the Food Safety Authority, and 3) reports on the environmental performance of some of the largest industrial enterprises in Norway.

Out of a total sample of about 22,000 individual records, only 4,000 were industrial establishments. After a thoroughly revision, with focus on identification of organisational numbers that could be used to relate auxiliary data (employees and economic turnover) to the water consumption data, the final sample contained 803 establishments in addition to a few enterprises representing an unspecified number of establishments. The final sample covered 34 per cent of the total economic turnover in NACE 15, but only 0.5 per cent of the total number of employees in NACE 50-93.

The sample establishments were divided into 27 water consumption groups according to their water consumption behaviour, and according to if their water consumption was primarily driven by the number of employees and clients (students, costumers, patients, etc.) or by their production activities. The Food Processing Industry (NACE 15) was divided into 7 groups, while the Service Industries were divided into 20 groups, of which water consumption in 15 groups were primarily driven by the number of employees/clients, and in the remaining 5 groups by production activities.

The results show that the water consumption coefficients for the 7 groups in the Food Processing Industry range from 125 m^3/million NOK (manufacture of meat products and cooking oil) to 476 m^3/million NOK (manufacture of fish products). The coefficients for the 15 "employee/client-driven" groups in the Service Industries range from 23 m^3/employee (office related business and administration) to 284 m^3/employee (accommodation and serving of food and beverages), while the coefficients for the 5 "production-driven" groups range from 176 m^3/million NOK (hairdressers) to 1,051 m^3/million NOK (laundries).

On basis of the 27 water consumption coefficients, the total annual water consumption in the Food Processing Industry has been estimated to 32 million m^3, and to 105 million m^3 in the Service Industries. The results for the Food Processing Industry show good compliance with other comparable sources, indicating that the coefficient methodology can be a reliable approach. The results for the Service Industries are also promising when comparing to other information on water supply in Norway, in particular when considering the small sample that has been available for these industries.

In conclusion, the project has shown that the coefficient method based on public water supplier's administrative registers can be a rational and good tool in developing Norway's water statistics.

Sammendrag på norsk

Hovedformålet med dette prosjektet har vært å beregne vannforbruket i næringsmiddelindustrien (NACE 15) og i de tjenesteytende næringer (NACE 50-93) ved å utnytte kunderegistrene til offentlige vannverk. Prosjektet vil bidra til å videreutvikle Statistisk sentralbyrås vannressursregnskap for Norge, samt forbedre Norges evne til å rapportere vannstatistikk til OECD og Eurostat. Bakgrunnen for prosjektet var å undersøke om vannverkenes økende bruk av vannmålere som grunnlag for fakturering av enkeltkunder, inkludert næringsbedrifter, vil kunne utnyttes til statistikkformål.

Metodikken har gått ut på å lage faktorer for vannforbruk per ansatte eller per million kroner i omsetning ved kombinere opplysninger om vannforbruk i kunderegistrene med opplysninger om ansatte og omsetning for de samme bedriftene i Bedrifts- og fortaksregisteret (BoF). Utvalget kan deretter blåses opp til vannforbruk på nasjonalt nivå for ulike næringsgrupper ved å multiplisere faktoren for en bestemt næringsgruppe med totalt antall ansatte/omsetning for alle landets bedrifter i samme næringsgruppe.

Totalt 9 kunderegistre ble innhentet fra offentlige vannleverandører som fakturerer på bakgrunn av målte vannmengder, 8 registre fra kommuner og 1 register fra et større privat vannverk. I tillegg ble det hentet inn opplysninger fra 2 andre administrative vannforsyningsregistre samt miljørapporter fra noen av de største næringsmiddelforetakene i landet. Totalt inneholdt disse registrene 22 000 registreringer, hvorav om lag 4 000 var næringsbedrifter. Etter en grundig gjennomgang av registrene, med hovedvekt på å finne kjennetegn ved bedriftene som kunne kobles mot opplysningene i BoF, ble det endelige utvalget redusert til 803 bedrifter i tillegg til noen få foretak som representerte et uspesifisert antall bedrifter. Det endelige utvalget for NACE 15 representerte 34 prosent av den totale omsetningen for næringslivsbedrifter i Norge, mens utvalget for de tjenesteytende næringene kun representerte 0,5 prosent av antall totalt antall ansatte i disse næringene.

Bedriftene i utvalget ble inndelt i 27 vannforbruksgrupper ut i fra fellestrekk ved vannforbruket hos de ulike bedriftene, og ut i fra om vannforbruket var bestemt av antall ansatte og klienter (skoleelever, pasienter, kunder, gjester, osv.) eller av produksjonsaktivitetene i bedriftene. Næringsmiddelindustrien ble delt inn i 7 grupper, mens de tjenesteytende næringen ble delt inn i 20 grupper, hvorav vannforbruket i 15 grupper var primært drevet av ansatte/klienter og vannforbruket i de resterende 5 av produksjonsaktiviteter.

Resultatene viser at vannforbruket for de 7 næringsmiddelgruppene lå mellom 125 m^3/million kroner omsatt (produksjon av kjøttprodukter og matolje) og 476 m^3/million kroner (produksjon av fiskeprodukter). Faktorene for de 15 "ansatt-/klientgruppene" i de tjenesteytende næringene varierte fra 23 m^3/ansatt (kontorbasert foretningsdrift og administrasjon) til 284 m^3/ansatt (overnatting og servering), mens faktorene for de resterende 5 "produksjonsgruppene" i de tjenesteytende næringene varierte fra 176 m^3/million kroner (frisørsalonger) til 1 051 m^3/million kroner (vaskerier).

På grunnlag av de beregnede vannforbruksfaktorene er det totale årlige vannforbruket i næringsmiddelindustrien beregnet til 32 millioner m^3, og det årlige forbruket i de tjenesteytende næringen til 105 millioner m^3. Resultatene for næringsmiddelindustrien samsvarer godt med resultater fra andre sammenlignbare kilder, blant annet Statistisk sentralbyrås undersøkelse over vannforbruket i industrien som er basert på en annen metodikk en i undersøkelsen som presenteres i denne rapporten. Resultatene for de tjenesteytende næringene anses også som gode, spesielt med tanke på de begrensede utvalget som har vært tilgjengelig for disse næringene, og står i et sannsynlig forhold til opplysninger om blant annet totale offentlige vannleveranser i Norge.

Den generelle konklusjonen fra prosjektet er at en faktormetode basert på opplysninger fra vannverks kunderegistre virker godt egnet til statistikkproduksjon. Med tanke på den stadig økende bruken av vannmålere som grunnlag for fakturering vil den metoden være et rasjonelt og godt verktøy for produksjon og videreutvikling av vannstatistikken i Norge.

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Preface

This document contains the results from the project *Water consumption in Food, Beverages and Tobacco Manufacturing and the Service Industries*, initiated in 2005 according to agreement No. ESTAT 71301.2005.001-2005.014 between Eurostat and Statistics Norway. The project is part of Statistics Norway's development of the National Water Accounts for Norway. Total amounts of water consumption given in the document represent the year 2004, while the water consumption coefficients represent the period 2003-2005 due to different status of update in the various administrative registers that have been used as data sources for the coefficients.

The document is written by the project leader; Svein Erik Stave, at the Division for Environmental Statistics. Kari. B. Mellem and Håkon Skullerud have contributed in data collection and processing. Grete Smerud and Kjersti Pauline Vartdal, at the Division for Business Register, have contributed in the work of connecting water consumption data to auxiliary and structural statistics in Statistics Norway's Business Register (BoF).

Statistics Norway would like to thank Eurostat for supporting the development of the Water Accounts for Norway by the contribution of financial funds for this project.

Oslo, 29. May 2006

1. Introduction

1.1 Background

Availability of water at the national level has been considered a minor problem in Norway, although regional and local scarcity has occurred for periods. The primary focus of water management has, thus, been on ensuring water quality rather than on quantifying water availability and use. Consequently, Norway's reporting to the OECD/Eurostat's Joint Questionnaire (JQ) on Inland Waters has been very limited with respect to water resources and water supply and use. In addition, significant uncertainty has been attributed to many of the reported figures.

However, quantification of water resources and use is increasingly being recognised as a fundamental building block within the present national and international management regime of Integrated Water Management. At the same time, public water supply services are increasingly being adapted to market principles. For instance, the municipalities are imposed by law to run their water supply services by the sell-at-cost principle, which has led to an increasing use of water meters in both households and industrial establishments.

In this project we have made use of the increasing number of business registers operated by public water suppliers that invoice their costumers by real amounts of water supplied. Together with other available data on real water amounts supplied to different establishments, the business registers have been used to develop coefficients for the industries of interest in this project, by comparing water consumption data with the number of employees or economic turnover.

The project was initiated to contribute in the ongoing development of water accounts for Norway at the national level. In addition, it was designed to provide basic input data to the Norwegian National Account Matrix with Environmental Accounts (NAMEA), as well as to put Norway in a better position to report on the JQ on Inland Waters.

Earlier estimates of water consumption in Food, Beverages and Tobacco Manufacturing (NACE 15-16) and the Service Industries (NACE 50-93) have been based purely on reports from the water supply plants to the National Register of Water Works (VReg), which is managed by the National Institute of Public Health (FHI). These reports contain the total amounts of water supplied by the plants, as well as the total amounts divided by: 1) leakage, and amounts supplied to 2) households, 3) food related industries, and 4) other industry. The division of the supply by the above four categories is, however, mainly based on crude estimates by the operators of the plants and are considered to be relatively uncertain. In addition, the share of water consumed by the Service Industries alone is not reported to the register, and has previously only been estimated as a remainder share of the total amount supplied by the plants.

1.2 Objectives

The overall objective of this project has been to:

Contribute to the establishment of water accounts in Norway at the national level, by quantifying the consumption of water from public water supply in the Food and Beverages and Tobacco Manufacturing (NACE 15-16) and the Service Industries (NACE 50-93), with focus on the data availability and how various data sources can be combined to provide better reporting to the OECD/Eurostat -Joint Questionnaire on Inland Waters:

More specifically, the following expected results were stated in the detailed work programme of the application and the agreement:

1. *Norway should be able to report figures for NACE 50 - 93 in OECD/Eurostat - JQ tables 3.1 and 3.2 for water use by public water supply. (Possibly tables 2.1 and 2.2 (water abstraction by source) for NACE 50 - 93 as well, depending on how successful the use of business registers in this project will be.)*
2. *Water consumption coefficients for NACE 15 and 16 will be compared with results from Statistics Norway's surveys on water consumption in the manufacturing industries (1999 and 2003), and will give us valuable information for evaluating the quality of the results from these surveys.*
3. *The new coefficients will be compared with some existing coefficients for the service sector, such as normal water consumption for patients in hospitals per year etc. Depending on the findings after this comparison, this may result in updates of coefficients used in Norway.*
4. *A new set of coefficients for water consumption for NACE 50 - 93 will enable Norway to calculate time series for water consumption in the Service Industries.*

In addition, the following sub-objectives and project outputs were mentioned in the detailed work programme of the application/agreement:

- *The water consumption coefficients will be developed for different categories of enterprises. The categories will be divided according to the homogeneity of water consumption among the enterprises and to an appropriate NACE division required for different purposes, i.e. to incorporate the results in the development of a NAMEA for water* [requires NACE division at a 2-digit level]
- *The results will be compared with results from international statistics*
- *The results from the project will be documented and published in a final report, which will also include a description of the methodology used as well as the methodological experiences gained. In addition the results will be published via Statistics Norway's website*

1.3 Definitions

Food Processing and the Service Industries

Food Processing and *the Service Industries* comprise NACE division 15 and divisions 50 up to and including 93, respectively. Thus, *manufacturing of beverages* (NACE 15.9) is included in the term *Food Processing* as used in this project.

The initial title of the project also included NACE division 16, *Tobacco Manufacturing*, and divisions 95 and 99, *Private Households with Employed Persons* and *Extra-Territorial Organizations and Bodies*. These divisions have, however, been excluded from the project for the following reasons:

- NACE 16 and 95-99 are not included in the definitions of *Food Processing Industries* and *Other Activities* in JQ tables 2.1-3.2 (see table 1.2)
- NACE 16 comprises only a total of 10 establishments in Norway, and this industry is well covered by the survey on water consumption in the manufacturing industries (see: Undelstvedt 2006)
- NACE 95 is difficult, and not desired, to separate from household water consumption
- NACE 99 comprises only 7 registered "establishments" in Statistics Norway's Business Register (BoF), and is thus neglect able in this project.

The different NACE divisions (2-digits), groups (3-digits) and classes (4-digits) referred to in this report are defined in table 1.1. Definitions and applications of categories at different levels are based on the fact that different industries within the same divisions use water for different purposes, and that

the use is driven by different factors. E.g., while the consumption of water in NACE 55; *Hotels and restaurants*, in general is driven by the number of guests and employees, the consumption in the parts of the industry that serve food and/or drinks is primarily driven by the economic activity. The applications of the different categories defined in table 1.1 are further described in the coming sections of the report.

Table 1.1 NACE categories referred to in the document

NACE	Description
15	Manufacture of food products and beverages
15.1	Production, processing and preserving of meat and meat products
15.2	Processing and preserving of fish and fish products
15.3	Processing and preserving of fruit and vegetables
15.4	Manufacture of vegetable and animal oil and fats
15.5	Manufacture of dairy products
15.6	Manufacture of grain mill products, starches and starch products
15.7	Manufacture of prepared animal feeds
15.8	Manufacture of other food products
15.9	Manufacture of beverages
16	Manufacture of tobacco products
50	Sale, maintenance and repair of motor vehicles and motorcycles, retail sale of automotive fuel
50.2	Maintenance and repair of motor vehicles
50.4	Sale, maintenance and repair of motorcycles and related parts and accessories
50.5	Retail sale of automotive fuel
51	Wholesale trade and commission trade, except of motor vehicles and motorcycles
52	Retail trade, except of motor vehicles and motorcycles, Repair of personal and household goods
55	Hotels and restaurants
55.11	Hotels and motels, with restaurant
55.3	Restaurants
55.4	Bars
55.5	Canteens and catering
60	Land transport, transport via pipelines
61	Water transport
62	Air transport
63	Supporting and auxiliary transport activities, activities of travel agencies
64	Post and telecommunications
65	Financial intermediation, except insurance and pension funding
66	Insurance and pension funding, except compulsory social security
67	Activities auxiliary to financial intermediation
70	Real estate activities
71	Renting of machinery and equipment without operator and of personal and household goods
71.1	Renting of automobiles
71.2	Renting of other transport equipment
71.31	Renting of agricultural machinery and equipment
71.32	Renting of construction and civil engineering machinery and equipment
72	Computers and related activities
73	Research and development
74	Other business activities
75	Public administration and defense, compulsory social security
75.22	Defense activities
80	Education
85	Health and social work
90	Sewage and refuse disposal, sanitation and similar activities
91	Activities of membership organizations n.e.c.
92	Recreational, cultural and sporting activities
92.33	Fair and amusement park activities
92.61	Operation of sports arenas and stadiums
93	Other service activities
93.01	Washing and dry-cleaning of textile and fur products
93.02	Hairdressing and other beauty treatment
95	Activities of households with employed persons
99	Extra-territorial organizations and bodies

Reporting units in the JQ tables 2.1, 2.2, 3.1 and 3.2

With reference to the objectives of this project, the following tables in the OECD/Eurostat JQ on Inland Waters contain the units to be reported by the results of the project. The units are shaded in the table below:

Table 1.2 The JQ tables 2.1, 2.2, 3.1 and 3.2 with the units to reported as a result of the project

Table 2.1 Annual fresh water abstraction by source. 2004

Fresh surface water (14)	**NACE**	**mio m³**
Total gross abstraction (19)		
of which: (a)		
* Public water supply (23)	(41)	
* Agriculture, forestry, fishing	(01-05)	
of which: Irrigation (27)		
* Manufacturing industry	(15-37)	
of which: industry-cooling (28)		
* Production of electricity (cooling) (28)	(40.1)	
* Other activities (b)	(50-93)	
* Households		
Fresh ground water (15)	**NACE**	**mio m³**
Total gross abstraction (19)		
of which: (a)		
* Public water supply (23)	(41)	
* Agriculture, forestry, fishing	(01-05)	
of which: Irrigation (27)		
* Manufacturing industry	(15-37)	
of which: industry-cooling (28)		
* Production of electricity (cooling) (28)	(40.1)	
* Other activities (b)	(50-93)	
* Households		
Total surface and ground water	**NACE**	**mio m³**
Total gross abstraction (19)		
of which: (a)		
* Public water supply (23)	(41)	
* Agriculture, forestry, fishing	(01-05)	
of which: Irrigation (27)		
* Manufacturing industry	(15-37)	
of which: industry-cooling (28)		
* Production of electricity (cooling) (28)	(401)	
* Other activities (b)	(50-93)	
* Households		
* Returned water (before use or without use) (29)		
Net abstraction (20)		

Table 3.1 Water use by supply category. 2004

Public water supply (23).	**NACE**	**mio m³**
Population connected to public water supply (%)		
TOTAL		
of which used by:		
* Agriculture, forestry, fishing	(01-05)	
* All industrial activities	(10-45)	
-Total manufacturing industries	(15-37)	
of which for cooling purposes		
-Production and distribution of electricity	(40.1)	
of which for cooling purposes		
* Domestic sector		
-households		
-other activities	(50-93)	
Self supply (24)	**NACE**	**mio m³**
TOTAL		
of which used by:		
* Agriculture, forestry, fishing	(01-05)	
of which for : Irrigation purposes (27)		
* All industrial activities	(10-45)	
-Total manufacturing industries	(15-37)	
of which for cooling purposes		
-Production and distribution of electricity	(40.1)	
of which for cooling purposes		
* Domestic sector		
-households		
-other activities	(50-93)	
Other supply (25)	**NACE**	**mio m³**
TOTAL		
of which used to:		
* Agriculture, forestry, fishing	(01-05)	
of which for : Irrigation purposes (27)		
Losses during transport (32) TOTAL		
Evaporation losses		
Leakage		

Table 2.2 Other sources of water. 2004

Non fresh water sources (16)	**NACE**	**mio m³**
(Marine and brackish water)		
Total gross abstraction (a) (19)		
* Agriculture, forestry, fishing	(01-05)	
of which: Irrigation (27)		
* Manufacturing industry	(15-37)	
of which: industry-cooling (28)		
* Production of electricity (cooling) (28)	(40.1)	
* Other activities (b)	(50-93)	
Desalinated water (17)	**NACE**	**mio m³**
Total		
* Public water supply (23)	(41)	
* Other activities (b)	(50-93)	
Reused water (31)	**NACE**	**mio m³**
Total		
* Agriculture, forestry, fishing	(01-05)	
of which: Irrigation (27)		
* Manufacturing industry	(15-37)	
of which: industry-cooling (28)		
* Production of electricity (cooling) (28)	(40.1)	
* Other activities (b)	(50-93)	
Imports of water (33)		
Total		

Table 3.2 Water use by industrial activities. 2004

Public water supply (23)	**NACE**	**mio m³**
Total manufacturing industry	(15-37)	
of which used by:		
- food processing industry	(15)	
- basic metals	(27)	
- transport equipment	(35)	
- textiles	(17-19)	
- paper and paper products	(21)	
- chemicals, refined petroleum, etc.	(23-24)	
- other manufacturing industry n.e.c.		
Mining and quarrying	(10-14)	
Construction	(45)	
Self supply (24)	**NACE**	**mio m³**
Total manufacturing industry	(15-37)	
of which used by:		
- food processing industry	(15)	
- basic metals	(27)	
- transport equipment	(35)	
- textiles	(17-19)	
- paper and paper products	(21)	
- chemicals, refined petroleum, etc.	(23-24)	
- other manufacturing industry n.e.c.		
Mining and quarrying	(10-14)	
Construction	(45)	

Industrial water consumption

"Industrial water consumption" is an ambiguous term. In particular, the definition of industrial water consumption versus household water consumption is a matter for discussion, of which the main questions are:

1. Should water consumption by employees for household-like sanitation purposes be accounted for as industrial use?
2. Should household-like water consumption by non-employees, such as costumers, students, patients, etc, be accounted for as industrial use?

The core question is, thus, whether the definition of industrial water consumption should be based on the *activity* of consumption (regardless of where it is performed) or the *location* of consumption.

In a water management perspective the most suitable definition in most cases is based on activity, as both consumption and pollution that require special concern compared to household-like water use, is primarily related to production of goods and services. Methodologically also, a distinction based on activity would in many cases be easier to handle, as municipalities and water supply plants operate with an unclear distinction between water supplied to, e.g., offices and water supplied to households, while water supplied to manufacturing industries is more clearly recorded.

In a statistical perspective, however, the most common definition of industrial water consumption is based on the location of consumption. Thus, the statistical input data are the amounts of water supplied to the establishments of a particular NACE category, regardless of the purpose for which the water is used within the establishment.

Industrial water consumption is defined on basis of the location of consumption in this study. However, the methodological coefficient approach taken makes it possible to distinguish between the amounts of water used:

1. For *production* purposes (water used in products/services or in the production process)
2. By *employees* for household-like sanitation purposes
3. By "*clients*" (patients, students, costumers, etc.) for household like sanitation purposes

Public water supply

Public water supply comprises all water supply plants that supply water via a public water pipeline system. The plants and pipeline systems can be owned by municipalities (municipal or inter-municipal plants), privately owned, or owned by the state (there is only one state owned water supply plant in Norway).

Self-supply plants

Self-supply plants comprise individual plants that are established to supply water to a particular individual industrial establishment, such as a manufacturing industry plant, a camping site, or a school, and which in general are owned by the supplied institutions. This latter distinction can be used to define whether a water supply plant that supplies a limited cluster of houses, cabins, etc., should be defined as public or self-supply.

Establishment

The term "establishment", refers to a local kind-of-activity unit. An establishment can in general be identified by its specific geographical location, and it can, by the same criterion, be separated from a "company" or an "enterprise", of which the establishment can be a part.

2 Methodology

2.1 Data collection and sources

2.1.1 Data collection

The initial idea of this project was to explore whether the increasing use of water meters in public water supply could provide applicable data for producing statistics on water consumption in different industries. It was assumed that data would be available through collection of business registers from municipalities and private water supply plants that were invoicing their individual costumers on basis of measured amounts of supplied water.

Requests for registers were sent to 20 municipalities, on basis of information in the national register of public water supply plants (VReg) about the number of water meters used in the municipality and the share of water supplied to the Food Processing Industry and other non-household use. It was found that 40 municipalities invoiced more than 90 per cent of their total water supply by the use of water meters. However, only 50 per cent of these municipalities supplied significant shares of the water to the Food Processing Industry or to non-households. In addition, two private water supply plants were requested to provide their business registers on basis of information on private water supply plants obtained from the National Institute of Public Health (FHI).

Collection of the business registers proved, however, to be more difficult than anticipated in advance. Firstly, many municipalities were reluctant to give away costumer information. Even though Statistics Norway may collect such registers by law, it is often less time consuming to make agreements based on mutual benefits rather than to demand data. Agreements were made with the majority of the municipalities, but a second obstacle was experienced when it proved impossible for the municipalities to generate reports from their computer systems without technical support from external consultant company that had developed the systems. In the end we managed to make an agreement with the company that they provided a description to the municipalities on how reports could be generated from the systems.

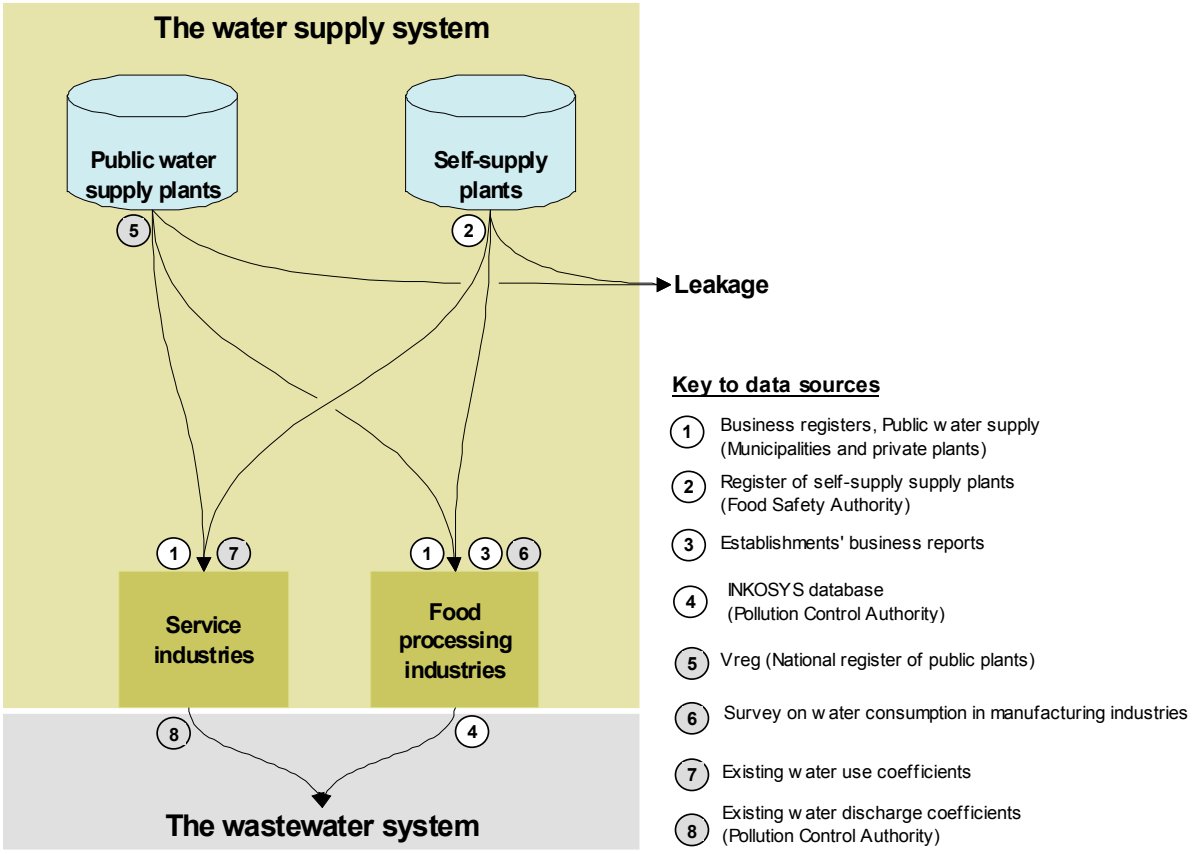
The final result was that we were able to collect the registers from 8 municipalities and 1 private plant. These registers contained about 17,000 costumers in total. Since we initially were hoping to collect data from more municipalities, we started to look for additional sources of data that could increase the total sample. 3 additional sources of data applicable for our purpose of developing water consumption coefficients were found: 1) The register of self-supply plants operated by the Food Safety Authority, 2) The INKOSYS database operated by the Pollution Control Authority, and 3) Business reports from establishments/enterprises.

In addition a set of data collected in the Survey on water consumption in the manufacturing industries was available for our purpose. This set has, however, only been used for comparisons with the results from the present study.

2.1.2 Water consumption data

It should be restated that the water amounts used to develop coefficients in the present project are total amounts of fresh water consumed by the establishments, regardless of source. The total amounts calculated from the coefficients are later calibrated to public water supply based on data on total supply of water from different water supply sources at the national level. The different data sources applied in the project is described below. Figure 2.1 positions the different sources according to the flow of water in a general water resources utilisation system. The White circles in the figure represent data sources used in the development of water consumption coefficients, while grey circles represent data sources used for comparisons and verification of the results calculated from the coefficients.

Figure 2.1 System measuring points of the water consumption data applied in the project



1. Business registers from public water supply
As already mentioned, a total of 9 business registers from 8 municipalities and one private water supply plant were collected. The registers contained 17,000 individual costumers, of which less than 50 per cent were initially identified as industrial units (non-households).

2. The register of self-supply plants
The Food Safety Authority is responsible for approval and control of water supplied to food related purposes, including drinking water, in Norway. The Authority keeps a register of all plants supplying water to these purposes, including self-supply plants. It was found that the sub-register of self-supply plants could be used in this project due to the fact that the majority of these plants supply only their registered owners, which in most cases are food processing establishments, social institutions or camping sites. The register contains a total of 3,800 plants.

3. Establishment's business reports
To increase the sample further, business reports from some of the largest enterprises were collected. Although only 5 such reports were collected, these enterprises cover a large number of local establishments spread all over the country, and which hold market shares up to 90 per cent of the total in their respective industrial sectors.

4. The INKOSYS database
The INKOSYS database is operated by the Pollution Control Authority (SFT) and contains data on discharge of wastewater from industry establishments. Only 68 establishments in NACE 15 were registered in the database, and only one establishment in NACE 50. As with the collected business reports, however, many of the establishments recorded in INKOSYS are among the larges and most important in their respective industrial sectors.

5. The national register of public water supply plants (VReg)
The national register of public water supply plants (VReg) is operated by the National Institute of Public Health, and contains all public water supply plants that supply more than 50 people or 20 households. The register contains about 1,700 plants, which supply about 4 million people (more than 80 per cent of the national population). Among the data in the register that have been used in this project, are the total amount of supplied water from the plants divided by: 1) food related industry, 2) households, 3) other industrial activities, 4) other use and 5) leakage from the pipeline system. The information has mainly been used to compare the results of the project against total amounts of supplied water reported from the public water plants.

6. Statistics Norway's survey on water consumption in the manufacturing industries
Statistics Norway conducts a questionnaire survey on water consumption in all manufacturing industries, including NACE 15 and 16. The sample coverage in these two industries were 10 per cent of the total establishments in the country, but which employed about 50 per cent of the total labour stock and were responsible for 50 per cent of the total economic turnover in the industries. The survey was conducted last time in 2004 with data for 2003. The data and the results of the survey have only been used for comparisons in this project. For further details on the survey, see: Undelstvedt 2006.

7. and 8. Existing coefficients on water consumption and wastewater discharges
Finally, existing coefficients on water consumption for different activities, such as hotel stays, school attendance, hospital stays, employment activities, etc, were collected. For this purpose, coefficients for wastewater discharges for different activities were also employed. The coefficients have been used for direct and indirect comparisons of the results from this project.

2.1.3 Auxiliary data and structural statistics
The auxiliary data and the structural statistics used in the development of coefficients and in inflation of the sample in this project have been obtained from Statistics Norway's Business Register (BoF). The register contains, among other things, the number of employees and the economic turnover of all enterprises in Norway at five-digit NACE level. Thus, the number of employees and the economic turnover of the establishments of which we have collected water consumption data should be found in BoF, provided that we were able to identify the establishments by a common identification variable. Furthermore, the population (total number of establishments and employees and the total economic turnover) of the sample groups applied in the project could be generated from BoF.

2.2 The coefficient approach

2.2.1 Identification of sample establishments
The establishments recorded in the different data sources on water consumption collected in this project did not contain any clear identification variable that could easily be linked to the establishments in BoF. Thus, a substantial amount of work was carried out be to be able to relate the establishments of the initial sample with the same establishments in BoF.

A pre-developed computerized identification programme was obtained from the Division of Business Register in Statistics Norway, and the programme was further developed and modified to suit the needs of this project. The programme is developed to recognize the phonetic characteristics of the establishment's names in combination with other information in the different registers, such as addresses and geographical location (municipalities). In addition, a substantial number of the establishments in the final samples have been identified through telephone directories, the Internet and through manual searches in BoF.

Out of the initial 22,000 records/costumers in the collected water consumption registers, only about 4,000 records were identified as establishments. After several revisions of this intermediate sample

throughout the project, the final sample contained only 803 establishments and enterprises (representing an additional but unspecified number of establishments) in NACE 15 and 50-93.

The revision process was mainly divided in two steps: The first prior to the attachment of auxiliary data and the second on basis of the calculated coefficients of each individual establishment after the auxiliary data had been attached to the establishments. Prior to the attachment of auxiliary data, revision constituted mainly verification of names and NACE relationships, e.g. many establishments were registered by several NACE codes in BoF, and establishments that could not be related clearly (with respect to water consumption activity) to only one of the NACE-based groups applied in this project were deleted from the sample.

2.2.2 Attachment of auxiliary data

When establishments in the sample had been identified by the procedures described above, attachment of auxiliary data in BoF was quite straightforward by the use of the common identification variable (organisational number). The auxiliary data used in this project are number of employees and economic turnover, which have been attached to different groups of establishments according to whether water consumption is driven by production activities or by the number of employees/employees and "clients" (guests, patients, students, etc.). Auxiliary statistics on the number of clients have not been used directly in this project, but have been incorporated in the coefficients of water consumption per employee in the relevant industries.

The sample of establishments was further revised on basis of a control of the calculated coefficients for every single establishment. The main focus of this control was to detect whether correct auxiliary data had been attached, i.e. that data was representing the right organizational level of enterprises. Furthermore, the individual coefficients were used to classify the establishments into water consumption groups according to differences in average coefficients for establishments of different NACE categories.

2.2.3 Classification of water consumption groups

Table 2.1 shows the classification of water consumption groups used in this project. The classification is based on the homogeneity of water consumption among the different establishments, which again is partly based on assumptions and knowledge gathered from different sources and partly on the initial calculation of coefficients for the individual establishments in the sample. The main consideration in the classification was whether the establishment's water consumption was driven primarily by production activities or by the number of employees/clients.

Table 2.1 Definition of the water consumption groups

Consumption group No.	Group description	NACE coverage
Food processing industry		
1	Manufacture of meat products and cooking oil	15.1,15.4
2	Manufacture of fish products	15.2
3	Manufacture of fruit, vegetables and grain mill products	15.3, 15.6
4	Manufacture of dairy products	15.5
5	Manufacture of animal feeds	15.7
6	Manufacture of dry general food products	15.8
7	Manufacture of beverages	15.9
8	Manufacturing of tobacco	16
Service Industries		
9	Wholesale and retail sale	50.1, 50.3, 51, 52, 71
10	Maintenance end repair of motor vehicles	50.2, 50.4, 50.5
11	Accommodation and serving of food and beverages	55
12	Transport	60-62
13	Business and cultural activities	63-67, 70, 91,92.1-92.31, 92.4-92.60, 92.7, 93.03, 93.05
14	Military camps and activities	75.22
15	Office business and administration	72-75.21, 75.23-75.3
16	Education	80
17	Hospital activities	85.11
18	Medical practice	85.12-85.2
19	Social work within institutions	85.31
20	Kindergartens	85.321
21	Social work outside institutions	85.322-85.329
22	Maintenance of water and sanitation systems	90
23	Operation of entertainment facilities	92.32-92.34
24	Operation of sports arenas and activities	92.61-92.62, 92.72
25	Laundries	93.01
26	Hairdressers	93.02
27	Fitness centres	93.04

2.2.4 Inflation of the samples

Two methods of establishing the inflation coefficients were considered: 1) to use the average of the individual coefficients for each establishment within the different consumption groups, or 2) to divide the total water consumption of all establishments on the total number of employees/economic turnover for each consumption group. The latter method was preferred for mainly two reasons:

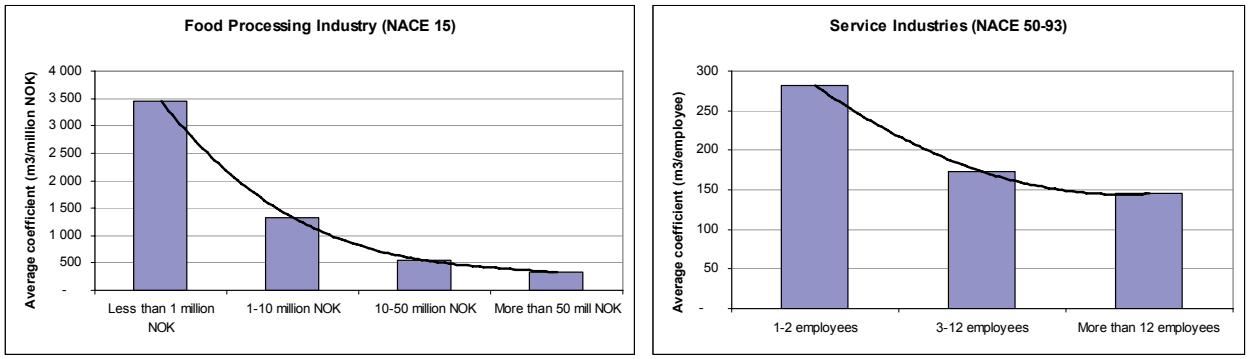
1. The smaller establishments tended to have significantly higher coefficients than the larger establishments (see figure 2.2), and some of the small establishments had very large coefficients without being extreme enough to be deleted from the sample. Since the final sample contained a relatively large share of such establishments, giving them weight 1, as would have been the case with the first method, would give too large coefficients compared to the relatively small number of employees and share of economic turnover they represent.

2. Some of the individual records in the sample were enterprises, which represented a large number of establishments by the total figure recorded for the enterprise as a whole. These registrations were generally considered to be more reliable than the records for smaller establishments. Enterprises and other larger establishments should therefore be given higher weights than the small establishments.

The inflation coefficients were, thus, established by dividing the total water consumption within each water consumption group on the total number of employees/economic turnover (million NOK), thereby indirectly weighting the establishments/enterprises according to their size. The established coefficients were then multiplied by the total (national) number of employees/economic turnover of each water consumption group to inflate the samples to national figures.

In future calculations, when larger samples will be available, it should be considered to incorporate the differences in water consumption between small and larger establishments into the equation of sample inflation, e.g. by using two separate inflation coefficients: one (small) constant coefficient representing the minimum water consumption by any establishment, and one (large) dependent coefficient representing the water consumption per employee/million NOK.

Figure 2.2 Difference in average coefficients between establishments of different size. NACE 15 and 50-93, with polynomic trend-lines



2.3 Sources of uncertainty

2.3.1 Main sources of uncertainty

Given the characteristics of the sample employed in this project, there are several sources of errors and uncertainty attributed to the data and their use. The main sources are presented below:

1. Small samples

The final sample contained only 1.5 per cent of the total population of employees in NACE 15 and 50-93. However, the sample of NACE 15 establishments represented 34 per cent of the total economic turnover in the Food Processing Industry and 6 per cent of the total number of establishments. The total sample of NACE 50-93 establishments covered in average only 0.5 per cent of the total number of employees in the Service Industries, with a coverage range of 0.03 to 1.87 per cent between the different groups. Table 2.2 summarises the coverage of the samples compared to the total populations of each water consumption group. Figures are given for the selected auxiliary variables for each group only.

Table 2.2 Coverage of the samples applied in the project compared to the total population of establishments and employees/economic turnover

Consumption group	No. of establishments, Sample	No. of establishments, Population	Economic turnover (mill. NOK), Sample	Economic turnover (mill. NOK), Population	No. of employees, Sample	No. of employees, Population	Coverage, No. of establishments, Per cent	Coverage, Selected auxiliary variable, Per cent
1	36		19 081 933	41 263 176				46,24
2	42		3 215 261	21 328 703				15,07
3	7		724 652	5 796 722				12,50
4	22		14 407 677	16 690 460				86,32
5	11		2 352 181	9 680 048				24,30
6	21		585 211	15 999 768				3,66
7	8		1 866 980	14 494 005				12,88
Total NACE 15	147	2 544	42 233 895	125 252 882			5,78	33,72
9	114				1 728	300 865		0,57
10	17				132	34 367		0,38
11	230				1 031	79 737		1,29
12	73				329	96 430		0,34
13	65				961	207 816		0,46
14	3				85	6 628		1,28
15	34				1 212	313 465		0,39
16	14				429	184 267		0,23
17	8				1 374	181 887		0,76
18	28				83	58 212		0,14
19	6				243	13 027		1,87
20	21				209	16 618		1,26
21	6				144	75 386		0,19
22	3				3	6 630		0,05
23	5		40 257	2 184 259				1,84
24	21		75 644	nd		nd		nd
25	2		2 933	1 513 291				0,19
26	5		4 704	4 802 675				0,10
27	1		547	1 639 577				0,03
Total NACE 50-93	656	296 700			8 125	1 599 636	0,22	0,51

To increase the smallest samples, it was considered to merge some of the groups. However, as water consumption showed to differ considerably between different groups, it was decided to keep the water consumption groups as described in table 2.1. Another argument for keeping the initial groups was that it made it easier to compare the water consumption of the different groups with other available information, and thereby be able to assess the probability and the quality of the coefficients more directly than could have been done by merging groups with different water consumption patterns.

2. No control of the coverage of the sample
A general disadvantage by employing register data is that you cannot statistically control the coverage of the sample in advance. Combined with the small sample collected in this project, this could possess a major problem. General assessments of the sample have, however, revealed that the coverage is not too biased with respect to small and large enterprises and geographical location.

3. Data from different sources
Different registers commonly contain different figures on the same variables due to differences in, such as, definitions and general reporting culture. In addition, the sources used in this project reflect measures at different points in the water resources utilisation systems (see figure 2.1). Comparisons between the different sources employed show, however, that they comply relatively well with each other. This observation is also based on the fact that some of the applied establishments have been recorded in more than one of the data sources and have, thus, been possible to compare directly against each other.

4. Bias of the inflation method
As already mentioned, the selected method of inflation gives weight to the different establishments according to their size, with reference to the auxiliary data used. This could be a source of underestimation of water consumption in some groups.

5. Establishments with supply from more than one source
Lastly, there is a possibility that some of the establishments in the sample are supplied by other sources in addition to the one recorded in the collected registers. This should to a large degree be detected by the revision of extreme coefficient values for the potential establishments. In addition, the problem is considered to be minor on basis of information from other sources, i.e. the survey on water consumption in manufacturing industries.

2.3.2 Particularly uncertain water consumption groups
The following water consumption groups are regarded as particularly uncertain for reasons given below:

Group 13 (Business and cultural activities)
This group contains real estate activities (NACE 70), including letting of property such as office complexes etc. Although revision has focused on the problem, it is probable that water consumption could be overestimated for this group because water consumption of renters could be registered on the owners of the properties, who again are defined as establishments of group 13.

Group 14 (Military camps and activities)
This group includes military camps etc. (NACE 75.22), with a large and variable number of soldiers, recruits, and members of the civil defense using the camps. Many of the larger military camps in Norway do, however, use their own sources of water supply and can to a certain degree be defined out of this project. We do, however, not have a good overview of the situation in this NACE class. The small sample of this group used in the present project contains one camp with very large water consumption, representing a "typical" military camp, while the other "establishments" in the sample represent military administration units.

Group 22 (Maintenance of water and sanitation systems)
Water consumption in this group, which contains maintenance of water pipes and the sewerage system, is not well known. Water consumption related to such activities is difficult to attribute to the industry as water used for flushing water and wastewater pipeline systems etc. are commonly taken from sources at the sites of activity, not owned by establishments in this group. The coefficient given in this report does represent water supplied directly to establishments of the group.

Group 23 (Operation of entertainment facilities)
This group contains amusement parks and other entertainment facilities, which presumably vary considerably with respect to water consumption. The sample reflects this, but is too small to give a good coverage of the different facilities included in this group, i.e. water amusement parks.

Group 24 (Operation of sports arenas and activities)
This group contains sport arenas etc, including public swimming pools. No structural data was available for this group, and it had therefore to be excluded from the project. A coefficient has, however, been developed on basis of the records in the collected data sources, but this coefficient is, however, highly uncertain both with respect to water amount as well as to the relationship with the selected auxiliary variable. A separate method of estimation is probably required for this category.

In addition, the different groups are exposed to the general uncertainties mentioned in the previous paragraph 2.3.1, of which the small sample of some groups is the most significant problem. However, these groups have, as mentioned earlier, not been merged as the water consumption is assumed to be varying considerably between the groups.

3. Results

3.1 Water consumption by economic turnover and number of employees

3.1.1 Coefficients by water consumption group

Table 3.1 presents the results of the coefficient method as applied in this project. The table also shows what auxiliary variables that have been employed for the different water consumption groups. Water consumption in NACE 15 (group 1-7) has been related to economic turnover. The same has the majority of groups and classes in NACE 92 and 93, while water consumption in the remaining Service Industries have been related to the number of employees, including clients for some of the groups.

Table 3.1 The developed water consumption coefficients

Consumption group	Group description	Applied coefficient	
		m^3/million NOK	m^3/employee
1	Manufacture of meat products and cooking oil	125	
2	Manufacture of fish products	476	
3	Manufacture of fruit, vegetables and grain mill products	449	
4	Manufacture of dairy products	314	
5	Manufacture of animal feeds	154	
6	Manufacture of dry general food products	170	
7	Manufacture of beverages	317	
9	Wholesale and retail sale		27
10	Maintenance end repair of motor vehicles		117
11	Accommodation and serving of food and beverages		284
12	Transport		43
13	Business and cultural activities		64
14	Military camps and activities		224
15	Office business and administration		23
16	Education		95
17	Hospital activities		51
18	Medical practice		104
19	Social work within institutions		61
20	Kindergartens		57
21	Social work outside institutions		40
22	Maintenance of water and sanitation systems		265
23	Operation of entertainment facilities	884	
24	Operation of sports arenas and activities	652	
25	Laundries	1 051	
26	Hairdressers	176	
27	Fitness centres	344	

3.1.2 Comparisons with coefficients calculated from data collected in the Manufacturing Industries Survey for NACE 15

For the purpose of comparison, the set of data collected in the survey on water consumption in the manufacturing industries (Manufacturing Industries Survey) has been used to develop coefficients by the same method as in the present project. The sample used in the survey is statistically selected, and could thus be used to indicate the quality of the sample used in the present project. The total coverage of the two different samples, with respect to economic turnover, is 34 and 47 per cent for the sample used in the present project and in the Manufacturing Industries Survey, respectively.

Table 3.2 shows the coefficients calculated from the two different data sets. The coefficients are in relatively good compliance with each other considering the many uncertainties related to the samples used in the project described in this report. The main exception from this observation is the coefficient for group 3 (manufacturing of fruit, vegetables and grain mill products), which is 100 per cent larger in the results calculated from the Manufacturing Industries Survey data compared to the results calculated from the data set used in the present project. The main cause of this large difference is that the Manufacturing Industries Survey data contain one large enterprise in NACE 15.3 that consumes a

very large amount of water, but which activities probably should have been divided between several NACE categories. An indication of the validity of this assumption is the fact that a local establishment of this enterprise is registered in NACE 15.6 in the sample used in the present project.

Table 3.2 Comparison of the coefficients developed in the present study with coefficients developed from the data collected in the Manufacturing Industries Survey

Consumption group	Group description	m^3/mill NOK, This study	m^3/mill NOK, Industry survey data	Difference in per cent
1	Manufacture of meat products and cooking oil	125	153	-22
2	Manufacture of fish products	476	598	-26
3	Manufacture of fruit, vegetables and grain mill products	449	893	-99
4	Manufacture of dairy products	314	259	18
5	Manufacture of animal feeds	154	144	6
6	Manufacture of dry general food products	170	135	20
7	Manufacture of beverages	317	340	-7

3.2 Total water consumption

3.2.1 Total water consumption by consumption group

Table 3.3 shows the total consumption of water in the different consumption groups, calculated from the coefficients in table 3.1 combined with structural statistics for 2004. Total water consumption in the Food Processing Industry is estimated to be 32 million m^3, while the total consumption in the Service Industries is estimated to be 105 million m^3. Not surprisingly, fish processing consumed the largest amount of water in the Food Processing Industry, while accommodation establishments and restaurants were the largest consumers in the Service Industries.

Table 3.3 Total water consumption in Food Processing and the Service Industries by water consumption groups. 2004

Consumption group	Group description	Water consumption (million m^3)
1	Manufacture of meat products and cooking oil	5,18
2	Manufacture of fish products	10,14
3	Manufacture of fruit, vegetables and grain mill products	2,60
4	Manufacture of dairy products	5,24
5	Manufacture of animal feeds	1,49
6	Manufacture of dry general food products	2,71
7	Manufacture of beverages	4,60
Total NACE 15		**31,96**
9	Wholesale and retail sale	7,99
10	Maintenance end repair of motor vehicles	4,02
11	Accommodation and serving of food and beverages	22,62
12	Transport	4,14
13	Business and cultural activities	13,31
14	Military camps and activities	1,49
15	Office business and administration	7,33
16	Education	17,56
17	Hospital activities	9,31
18	Medical practice	6,07
19	Social work within institutions	0,79
20	Kindergartens	0,95
21	Social work outside institutions	3,03
22	Maintenance of water and sanitation systems	1,76
23	Operation of entertainment facilities	1,93
24	Operation of sports arenas and activities	no data
25	Laundries	1,59
26	Hairdressers	0,85
27	Fitness centres	0,56
Total NACE 50-93		**105,31**

3.2.2 Comparisons with the results from the Manufacturing Industries Survey

The final results from the Manufacturing Industries Survey show (using the method described by Undelstvedt 2006), that a total of 35 million m^3 of fresh water was consumed in the Food Processing Industry (NACE 15) in 2003. Given the many sources of uncertainty attributed to the data described in section 2.1.2, this figure is somewhat surprisingly close to the 32 million m^3 calculated by the coefficient method in this project. This may indicate that the coefficient method based on data from the existing registers used in this project is a promising approach, although this statement needs further analyses.

A calculation of total amounts based on the coefficients calculated from the Manufacturing Industries Survey data (table 3.2) gives 37 million m^3 as result. Although this is 5 million m^3 more than the result calculated in the present project, the result is still within an acceptable range of comparison.

Comparisons with the data set from the Manufacturing Industries Survey for 1999 show large differences in both total amounts and in coefficients developed on basis of the data set. However, more thoroughly investigations of the 1999-dataset have revealed considerable inconsistencies related to misunderstandings of the use of measurements units in the questionnaire, and is thus not considered to be reliable for comparisons. The results from the present study have contributed to verify this problem.

3.2.3 Comparisons with other national sources of information

Table 3.4 summarises existing coefficients and total amounts of water supply used by various national water management institutions, and that can be used to compare the results of this project. Starting with the amounts of water supplied from public and self-supply sources, it can be seen that the reported amounts of public water supplied to the Food Processing Industry is significantly larger than the results from both this study as well as from the study on water consumption in the manufacturing industries (Undelstvedt 2006). The category reported to VReg is, however, defined in the reporting form as "food related industry" and is regarded by the operator of the register as highly uncertain. A possibility is that activities reported as "food related" should have been reported as other industrial activities, which could explain why this latter category is lower in table 3.4 compared to the results from the present project. In addition, the separation of Households and Service Industries is probably unclear in the amounts reported in VReg.

Other comparisons have been made on basis of existing coefficients of water consumption for different activities. Calculation of water consumption in hotel and restaurants, kindergartens and schools on basis of the existing coefficients given in table 3.4, shows relatively good consistency with the coefficients developed in this project. In general, the existing coefficients are somewhat lower than the coefficients employed in this project for the mentioned groups. This is, however, difficult to state exactly, as many assumptions have been made, i.e. on the number of pupils per teacher, hotel guests per employee, to be able to compare the coefficients.

Table 3.4 gives also an idea of the amount of public water supplied to Food Processing and the Service Industries compared to the amount supplied from self-supply sources. About 1.5 million m^3 of self-supplied water is used by the Food Processing Industry according to the Register of self-supply sources. The remaining 6.5 million m^3 is primarily supplied to social institutions, hotels and camping sites, included in the Service Industries. Given that the remaining part of water consumed in NACE 15 and 50-93 comes from public sources, the coefficients developed in this project should represent public water quite closely.

To be strictly correct, however, about 5 per cent of the total consumed water should be subtracted from NACE 15 given that the information on leakages given in table 3.4 (34 per cent of the total abstracted water from public water supply plants) also apply to self-supply sources. According to the same information, 6 per cent should be subtracted from the total amount in NACE 50-93.

Table 3.4 Summary of reported figures for abstraction of freshwater from public and self-supply sources and existing coefficients used in Norway. 2003/2004/2005

Amount of water reported to be abstracted from public and self-supply sources

Type of water supply	Amount (mill m^3)	Year	Data source
Public water supply	808	2003	National Institute of Public Health
of which to "food related" industry	89	2003	National Institute of Public Health
of which to other indutstrial activities	65	2003	National Institute of Public Health
of which to other use	73	2003	National Institute of Public Health
of which leakage	275	2003	National Institute of Public Health
Self-supply sources, Food processing, institutions and camping sites	8	2005	The Food Safety Authority
Total	816	2003/2005	

Existing coefficients of water consumption

Activity	Coefficient	Unit	Data source
Employee, "White colour" work	25	litres/day	The Food Safety Authority
Employee, "Blue colour" work	75	litres/day	The Food Safety Authority
Child in kindergarten	30	litres/day	The Food Safety Authority
School pupil/Student (average)	20	litres/day	The Food Safety Authority
Hotel, High standard with swimming pool	500	litres/guest day	The Food Safety Authority
Hotel, Normal standard	275	litres/guest day	The Food Safety Authority
Tourist motel, camping site (average)	80	litres/guest day	The Food Safety Authority
Cafeteria	50	litres/guest	The Food Safety Authority
Household activities	150-210	litres/pers/day	National Institute of Public Health
Employee at instututions/service industry	0.3 * Household activity coefficient		The Pollution Control Authority (SFT)
School pupil/Student	0.2 * Household activity coefficient		The Pollution Control Authority (SFT)
Patients/people in institutions	1.1 * Household activity coefficient		The Pollution Control Authority (SFT)
Hotel guests	1.1 * Household activity coefficient		The Pollution Control Authority (SFT)

3.2.4 Comparisons with international statistics

Comparisons of the results from this project with international statistics have proved difficult, as both categorisations of coefficients as well as methodologies and the industrial structure, differs between countries. The only figures that could be used for comparison, although quite indirectly and inexactly, were found in the works on NAMEA for water in Sweden and Denmark. In addition, New Zealand has developed similar approaches to economic water accounting, but these figures have not possible to compare with the results from this project due to the use of a different kind of auxiliary variable in the New Zealand approach (Ford et al. 2001).

The Swedish NAMEA report (Brånvall et al. 1999) gives only a figure of 800 m^3 per million SEK for water consumption in the Food Processing Industry (NACE 15 and 16) as a whole. In the present project, the equivalent figure is 249 m^3 per million NOK. This large difference is difficult to explain from available information, and can neither be explained by currency differences nor the 5 years time span between the years that the coefficients represent.

The Danish NAMEA report (Olesen 2003) gives figures for water intensity measured as m^3 consumed per million DKK (1995-prices) in 2001 for the following Service Industries:

Wholesale and retail trade; hotels and restaurants	46
Transport, storage and communication	21
Financial intermediation, business activities	8
Public and personal services	125

As the Danish coefficients are based on economic figures, and not on employment as in the present project, it is not possible to compare all figures. However, comparable figures for the two first groups (*Wholesale and retail trade; hotels and restaurants* and *Transport, storage and communication*) calculated on basis of the data applied in the present project gives significantly higher coefficients, 78 and 91 m^3 per million NOK, respectively. Even though the coefficients are not directly comparable, the coefficients given in the Danish report are generally lower than the ones developed in this project.

4. Conclusions

4.1 Summary of findings

With reference to the stated objectives in section 1.2, the main findings of this project are summarised below.

On the overall objective:
Several existing registers contain data on water consumption for individual establishments. This project has shown that these registers can be used for development of water statistics. The business registers of public water suppliers, do, however, have a far greater potential as data sources than what is possible to utilise at present. The main present constraint to release the potential of the registers is the possibility to identify establishments on basis of a variable common in the water consumption registers and in Statistics Norway's Business Register (BoF).

The combination of data sources collected in this project has provided valuable new information to the establishment of total water accounts in Norway. The project has produced promising figures for the Food Processing Industry and the Service Industries, and has improved Norway's basis for reporting to the Eurostat/OECD Joint Questionnaire on Inland Waters (JQ). In addition, data sources collected for comparison purposes have proved to be valuable in comparisons and calibrations of other water statistics.

Specific objective 1:
On basis of the results from this project, the following figures for 2004 may be reported in the JQ tables 3.1 and 3.2:

JQ table 3.1 Water use by supply category

Public water supply, Other activities (NACE 50-93)	98.5 mio m^3
Self-supply, Other activities (NACE 50-03)	6.5 mio m^3

JQ table 3.2 Water use by industrial activities

Public water supply, Food Processing Industry (NACE 15)	30.5 mio m^3
Self-supply, Food Processing Industry (NACE 15)	1.5 mio m^3

In addition, the following figure can be reported in table 2.1 by using the total leakage from public water supply plants reported in the National register of public water supply plants (34 per cent) to define the difference between abstracted and used amount of water. The leakage is added to the total amount of public water supply given in JQ table 3.1 above, but not to the minor amount of self-supplied water due to no information on leakages in self-supply plants.

JQ table 2.1 Annual freshwater abstraction by source

Total surface and ground water, Other activities (NACE 50-93)	150.5 mio m^3

Specific objective 2:
The results calculated by the water consumption coefficient method used in this project for the Food Processing Industry is in line with the results estimated by another method (see: Undelstvedt 2006) in Statistics Norway's Survey on water consumption in the manufacturing industries: 32 million m^3 versus 35 million m^3, respectively. This could indicate that both the method used in the present study as well as in the Manufacturing industries survey give good results. This assumption should, however, be further assessed.

Specific objective 3:
Comparisons with existing coefficients used by different water management institutions in Norway for school pupils/students, patients in hospitals, people in institutions, and "blue" and "white colour" work, show that the existing coefficients are generally lower than the ones developed in this project. As the coefficients are not directly comparable, this observation needs also to be further assessed.

Specific objective 4:
The developed water consumption coefficients can be used for calculating time-series for water consumption in the Service Industries by the application of time-series of the structural statistics (number of employees/economic turnover). A premise is, however, that the coefficients do not change significantly over the time period in question, and that the length of the time-series is limited by this premise.

On the sub-objectives:
The water consumption coefficients have been developed for 27 groups of industries within the Food Processing Industry and the Service Industries, according to the characteristics of the water consumption patterns of the industrial establishments within the different groups. This categorisation meets a set of different requirements for further applications of the coefficients, i.e. conversion to categories required for developing a NAMEA for water.

It has proven difficult to compare the results of this project with international statistics, as both categorisations of coefficients as well as methodologies and the industrial structure differs between countries. The only comparable figures were found in the work on NAMEA for water in Sweden and Denmark. The Swedish coefficient for the Food Processing Industry is significantly higher than the one developed in this project, 800 m^3/million SEK against 249 m^3/million NOK, respectively. The Danish coefficients for the Service Industries are harder to compare due to differences in classification, but are generally lower than the ones developed in this project.

4.2 General conclusion

In spite of the relatively small sample of establishments that was obtainable for this project, and the many sources of uncertainty attributed to the sample, the results are considered to be promising with respect to further development and use of the methodology. This conclusion is further supported by the rapid increase in the use of water meters as basis for invoicing. This will provide better data availability on the individual level in the future. The promising results of the project, with respect to being in line with comparable sources of statistics, should, however, be made subject to further analyses of uncertainty.

The use of existing registers is in line with the general policy of Statistic Norway, and is to be preferred in comparison with questionnaire surveys, given that the registers are of the required quality. The quality and the availability of the registers may, however, be partly influenced by Statistics Norway's involvement in development of registers. Such involvement should be promoted, and could be of significant benefit in the future employment of registers from public water supply for statistical purposes.

4.3 Recommendations and further work

On basis of the general conclusions above, it is recommended to further develop the coefficient method based on data in the administrative/business registers of public water suppliers. For the time being, however, the Survey on water consumption in the manufacturing industries does probably provide a better basis for estimating water consumption in the Food Processing Industry in comparison with the use of administrative registers. For the Service Industries, however, the use of registers is to be preferred in comparison with questionnaire surveys due to the large size of this industrial sector.

Water consumption in the Food Processing Industry should, however, continue to be estimated on basis of the administrative registers collected for the purpose of estimations for the Service Industries. This will give a good opportunity to follow the development of quality in the registers.

At the same time, Statistics Norway should try to influence the structures and development of administrative/business registers in the public water supply sector, and to make arrangements for convenient generation and transfer of reports/data for statistical purposes.

On basis of the results and the data collected in this project, further analyses of the material should also be conducted to reveal additional quality aspects and sources of uncertainty attributed to the material. Furthermore, data collected for comparison of the results in this study should be used to compare and to calibrate other water statistics and the water accounts.

More specifically related to the uncertainties and gaps still to be filled with respect to water consumption in the Service Industries, it is recommended to find alternative methods to estimate water consumption in some important groups. Initially, priority should be given to public swimming pools, water amusement parks, and military camps.

When larger samples of data will be available in the future, with the increased use of water meters, it should be considered to incorporate the detected differences in water consumption between small and larger establishments into the equation of sample inflation. This can, for instance, be done by using two separate inflation factors: one (small) constant factor, representing the minimum water consumption by any establishment, and one (large) dependent factor representing the water consumption per employee/million NOK. This procedure has been described by Skullerud and Stave (2002) in a former Eurostat financed project on waste statistics (contract No. 200071200004), which was based on a similar methodology.

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