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Quality systems and statistical auditing. A pragmatic approach to statistical quality management

Willem de Vries and Richard van Brakel

This article [1] is about quality management at Statistics Netherlands (SN), and about statistical auditing in particular. Statistics Netherlands adopted an overall quality programme in 1996: 'CBS 2000'. One of the objectives of this business plan is to introduce quality systems in all statistical departments. A standardised model for such a system will be finalised by the end of 1998. Provisional guidelines for quality systems were issued in 1997. Simultaneously, a system of 'statistical auditing' was set up to check how quality management in statistical departments is functioning, and how the quality of statistical products and procedures may be improved.

Introduction

As providers of essential information for public debate, and for decision making at various levels of society, national statistical offices (NSI's) have to take the quality of their products and services very seriously. This has always been so, and quality issues have been around as long as NSI's have existed. However, particularly since the performance of NSI's, and indeed of government services in general, have come under closer scrutiny in many countries, quality management has lately become a focal point for many NSI's. Obviously, there are many sides to the 'quality' of official statistics. To mention some of the most important aspects: official statistics must be

- relevant
- timely and
- accurate,

but they should also be

- produced cost-effectively, and
- without too much of a burden for data providers.

Each of these major quality aspects of official statistics requires its own quality management approach.

Quality systems

National statistical institutes (NSI's) appear to adopt various approaches to quality management. Some NSI's have opted for a system of Total Quality Management (TQM), others aim at certification along the lines of the ISO-9000 system.
In 1996, Statistics Netherlands (SN) adopted a kind of comprehensive quality programme of its own, laid down in the form of a 'business plan' for the next decade [2]. Apart from some general background information about this business plan, this article in particular highlights two specific components of this overall quality programme. On the one hand it is about the *quality guidelines* we are introducing. On the other it is about a system of what we have named '*statistical auditing*'. The focus of statistical auditing in this sense is on the quality of the *statistical production process.* This implies that it relates *primarily* to the quality elements 'timely', 'accurate', 'produced in a cost-effective manner' and 'without too much of a burden for data providers'. 'Relevance', though an important part of the quality guidelines, is usually not covered *in depth* by the statistical audits. There are other mechanisma to measure user satisfaction with the SN work programme in general and with individual sets of statistics in particular. These too are set out in the business plan.
We certainly do not to have 'invented' statistical auditing at Statistics Netherlands. In fact, the approach we have taken was partly inspired by similar activities that have been going on at Statistics Canada for a number of years [3].

What is quality?

Essentially, quality is a *subjective* measure of the properties of a product or service. Quality assessments by users of products and services depend to a large extent on their specific needs and also: their expectations. This implies that what one user considers to be insufficient, may at the same time be excellent for another. Another useful definition of quality is therefore: 'fit for purpose' (i.e. the purpose of a specific user). To illustrate this with an example in the area of official statistics: macro-economic policymakers will generally be satisfied with fairly quick, reasonably accurate, highly aggregated statistics about international trade, while these same statistics, in that particular format, will be virtually worthless for a user who needs numbers for market research in the area of cosmetics or Scotch whisky. Therefore, it is rather difficult to assess the quality of statistics in simple 'objective' terms. In addition, as mentioned before, there are quite a few aspects to the 'quality of statistics'. Statistics are indeed a fairly complex product. If McDonalds needs several pages of text to properly define the quality of a Big Mac, which is, with all due respect, just a bun with two hamburgers inside, it is no wonder that it takes a whole book to properly describe, say, the quality of the Consumer Price Index, let alone the quality of the national accounts.

ISO or not ISO

Quality systems encompass the organisational structures, responsibilities, procedures, processes and infrastructure for the implementation of quality care. There are several types of quality systems, differing in philosophy, degree of 'regulatory ambition' and applicability. Nearly all activities and instruments of an organisation affect the quality of its products. Therefore, quality care is strongly linked to organisation and management issues. This is not the place to go into these different systems in depth and detail , but some remarks about the so-called ISO-norms are appropriate. The general philosophy of ISO is that, in order to ensure a certain minimal quality level of final products, an organisation must be able to demonstrate that all details of the production process are in some way formalised and are thus in principle kept 'under control'. Under ISO, quality audits are used to monitor whether the system is actually in place, and whether it is respected by staff and maintained by managers.

Some authors, at least in the Netherlands, are critical of the ISO system (Swinkels et al., 1995). Indeed, ISO seems to be rather bureaucratic and costly. Other authors think that certain preconditions have to be met before it is useful to introduce any quality system at all.(Spoelstra et al., 1993).They think that some of the necessary conditions to be met are: a shared strategic

vision of top management, effective communication, effective management at all levels, in particular also the lower management levels, clear targets and objectives, and lastly: an organisational climate and culture in which success and good performance are systematically recognised and rewarded.
After careful consideration, Statistics Netherlands decided not to go for ISO, but to adopt a more modest pragmatic approach. One particular reason for this decision was that the statistical process is in such a phase of dramatic changes (redesign of many statistical processes, introduction of electronic data interchage [EDI], combining external registrations with Statistics Netherlands data collections, organisational changes), that investing in a system that would primarily describe the present situation and procedures was deemed to be inefficient. However, we did expect local managers to operate some kind of quality system, and to promote the introduction of such systems we issued provisional guidelines. These will be discussed later. Ultimately, we want to establish more binding guidelines for quality systems, but in the meantime one of the main purposes of statistical auditing as we see it is to find out just exactly which quality systems are in place to guarantee a certain level of quality of the statistical product. The final guidelines will be developed on the basis of the best practices applied in our office.

SN Business Plan

As mentioned before, SN adopted a general quality programme (business plan) in 1996. The SN Business Plan (SN 2000 for short) sets out six major objectives:

A relevant work programme.

This objective has to do with all mechanisms to ensure that the work programme of Statistics Netherlands meets the needs of the users. Decisions about the work programme are made by the Central Commission for Statistics.
To assess user satisfaction, regular 'evaluation rounds' will be held among all major user groups: ministries, government research and planning institutions, organisations representing employers and employees, academia etc. In addition, and this has to do in particular with the aim of Statistics Netherlands to flexibly approach new user needs, proposals to exchange 10 per cent (in budgetary terms) of 'old' for 'new' statistics will in the future be made in each four-year work program (starting with the work program for 2001-2004) that is presented to the Central Commission for Statistics, enabling the Commission to make real choices and to set priorities.

A substantially reduced response burden.

This objective will be achieved by a mix of different instruments, such as increased use of registrations kept by other government institutions, more cooperation with other data-collecting agencies, 'speaking the language of the respondents' better, introduction of EDI-techniques and the systematic promotion of advanced statistical methods.
To monitor the response burden, a 'response burden meter' was introduced in 1996. It shows the development of the statistical response burden as an index (1994=100). Each year, parliament is informed about how and to what extent the response burden has been reduced, with the target to achieve a reduction of 12.5 per cent by 1998. In addition, despite the fact that the Dutch system of official statistics is highly centralised, a Centre for Government Surveys has been created. This Centre has two basic functions: a) to detect where statistical activities (in particular: surveys) are taking place or are being planned elsewhere within central government and b) to try and help the people making such plans to get the data via SN, by means of either adapting or expanding existing data collections or applying special analyses to data already collected.
Effective statistical information.

To measure the effectiveness of the statistical information it produces, Statistics Netherlands uses some specific targets and indicators. For example: the sales of printed publications in the year 2000 must be twenty per cent higher than in 1994. Sixty per cent of SN's press releases, on average, must be picked up by the seven main national daily newspapers. More importantly, by the end of 1997, all important SN data, including all necessary meta-information, must be available through the user data base StatLine. Lastly, by the year 2000 a broad range of 'client satisfaction monitoring instruments' will be in place.

Comprehensive quality management system.

The aim is to have a comprehensive 'quality management manual' by the end of 1998. In the year 2000, over half of all statistical projects will comply with this manual. In addition, and this is what this paper is specifically about, each statistical project will be submitted to an auditing exercise every five years, including a follow-up to see whether deficiencies have been corrected. Some other specific targets are: a) the response rates in household surveys should be 8 percentage points higher in 2000 than in 1996 and b) SN will publish at least one hundred research papers a year externally.

Adequately trained and motivated staff.

Owing to dramatic changes in the statistical process, we foresee substantial changes in our staff as well over the next five years or so. Increased mobility will be required, both internally (the target is ten per cent yearly) and externally. Quite a lot of tasks will no longer be required; some people may be re-trained for new positions, but others will have to look for employment elsewhere. A major programme of '*empowerment*' and training (at present, two per cent of SN's budget is earmarked for training) is in place to promote internal and external mobility, and some financial incentives are also available. On the other hand, we wish to recruit a substantial number of young, highly trained professionals. Another, more specific target is a reduction in sick leave to an average of five per cent. Lastly, general job satisfaction among staff will be monitored systematically.

An efficient, well managed, flexible organisation.

The present system of management contracts will be further developed. This also requires further improvement of our accounting structure and management information systems.

The ultimate aim of SN 2000 is to create a vital organisation with a manageable budget.

Provisional quality guidelines

As stated above, there are many aspects to 'statistical quality'. In order to measure and monitor quality effectively, in whatever systematic way, it is therefore necessary to define statistical quality more concretely and precisely. We think the quality criteria listed below are the most relevant and important in the area of the production process of official statistics. Therefore, we would expect that quality systems at all levels of the organisation

cover most of these aspects. In the provisional quality guidelines, a number of points to be taken into account are listed for each of five major aspects. The listing here is merely meant as an illustration and is therefore not exhaustive. The aspects covered in the list are:

1. purpose of the statistical collection
2. the survey design
3. data input
4. data throughput
5. data output

Explicitly *not yet* covered by the points of the list are: marketing, the appearance of publications and management systems (other than statistical management in a narrow sense).

1. The purpose of statistical collections

- Who are the most important internal and external users of the statistics?
- When were they last consulted about their needs?
- What are their needs as regards: detail of variables, levels of aggregation, periodicity, coverage, comparability with other statistics, timeliness, accuracy etc.?
- What is the real value of the statistics in relation to what the users would want?
- Which user needs cannot be met?
- What may be done to improve this situation?

2. The survey design

- Is the survey design documented?
- Are the statistics based on data collection in the field, or on integration of existing data sources?

Data collection:

- What type of sampling (if any) is applied and why?
- Which sampling frames are used?
- To what extent is the sampling frame complete and up-to-date?
- Does the frame contain the right kind of statistical units?
- How do you cope with imperfections in these respects?
- What is the medium of data collection ? (EDI, mailed questionnaires, interviews etc.)

Data sources:

- Which data sources are used?
- Are there alternatives and why are they not used?

Structure of questionnaires:

- Have questions been tested for clarity? Are they answerable?
- Are questions assessed on validity?

3 and 4. Data input and throughput

Input planning and procedures

- Is there a time schedule for the different phases of the statistical process?
- How is the input process organised and monitored?
- Have any efforts been made to optimise the input and throughput process?
- Are there documented procedures for non-response treatment, imputation, data editing, raising, estimation, cross-checking data?
- For integration processes: is the relationship between statistics and their sources documented?
- For data editing: are all questionnaires checked/cleaned individually and if not, what are the criteria for selection?
- How are sampling frame errors treated?
- Imputation: how are non-response gaps filled?
- Weighting and raising: are intermediate results calculated and how are they used?
- How are statistics matched with other numbers and time series?

5. Output

- Does the final product meet the users' needs?
- Are there any discrepancies with other, related SN statistics and what has been done to minimise these?
- Are analyses of discrepancies well documented and publicly available?
- Are efforts made to avoid misinterpretation of the statistics?
- How is the quality of the statistics presented to users?
- Is a complete quality description available for users?
- What is exactly known about non-sampling errors? Is this knowledge well documented?

The questions of these provisional guidelines are meant to increase quality awareness in statistical departments. In the course of an audit, a checklist for self-evaluation is given to the auditees. This is just one illustration of an important principle of auditing as we see it, namely that auditing is *not* in the first place a corrective 'policing' instrument, but rather a coaching tool to enhance the general feeling that quality is important and that auditing therefore should ultimately be perceived as a *preventive* mechanism. As such they are only a first step towards the more final quality guidelines mentioned before.

Introduction of auditing

Now we come to statistical auditing in the sense of this paper. As mentioned before, statistical auditing as it has been introduced in SN is a technique which has three purposes:

- to actually find out what is being done about quality management in statistical departments
- to generate suggestions on how to improve quality management
- to find out what the best quality practices are and to incorporate these into the guidelines for quality systems that will be issued by the end of 1998.

It should be stressed and this has been made clear over and over within SN, that auditing is not intended to be a form of 'policing' in order to find out where things are not going as they should go. On the contrary: statistical auditing should be (and is increasingly) perceived as a form of help and advice to achieve improvements. However, this does not mean that it is entirely innocent and harmless. If the auditors discover weaknesses and unprofessional approaches, they will certainly report these and discuss them with management. Also, in the final discussion about the audit reports, agreements are made about how to achieve specific improvements. Finally, there is a systematic follow-up to check whether the agreements are implemented.

To obtain experience with statistical auditing, two pilots were carried out in 1996. One was about the statistics on Performing Arts, the other about statistics of the Transport industry. The aim of the pilots was to better define the scope of future regular audits and to develop a set of rules on procedures and instruments. The pilot audits were done by two teams of three SN-staff each. A private consulting company, which had broad experience in auditing and quality management, was commissioned to train the auditors and to moderate the process. Auditors were selected by the Audit secretariat on the basis of their statistical and managerial qualities. The techniques applied

during the audits were interviews on the one hand and analysis of documentation on the other. The findings of the audits and the recommendations made on the basis of these findings were laid down in reports.
As to the selection of auditors, the idea was that all audits would have to be done by own SN-staff. The aim was to create a 'pool' of about 25 auditors from various divisions, selected on the basis of their expertise, but to some extent also their personality. We want the auditors to come from various divisions to ensure that a variety of experiences and expertise is represented in the audit teams. The auditors do this work on a part time basis only, because we want them to remain involved in regular statistical activities as well. The disadvantage of full-time auditors would be that such people may 'lose touch' with current practices and new developments. Ideally, an audit team consists of one person who is a specialist in statistical methodology, one who is well versed in statistical organisation aspects and one who has a special affinity with producing outputs. In addition, some of the qualities looked after are:

- good communicative skills at various levels; diplomatic skills
- good analytic qualities
- openness for change
- knowledge of statistical processes
- good editorial qualities and the ability to present results orally

It appeared to be relatively difficult to find a sufficient number of (potential) auditors, not only because of the qualities that auditors must have, but also because people who have these qualities, are usually also much in demand for other priority issues. The envisaged auditors were subsequently trained for four days, in such areas as audit philosophy, norms, rules and procedures, interview techniques, reporting and presenting audit results.

Evaluation of pilots

A first evaluation of the pilot audits showed the following main points:

- most auditors had liked the work
- they were received well in the audited sectors and cooperation of staff and management had been good
- the training had been enjoyed
- in one of the two cases, the terms of reference for the audit had not been explicit enough, which had resulted in an incomplete audit
- drafting a systematic audit plan for the sector to be audited was important (including questions as: who supplies/reads documentation, who interviews who etc.)
- auditing takes time; therefore it is not possible to combine it with other tasks during the audit period
- to remain distant and objective can be difficult, in particular when auditees become emotional and when the auditor is in some way familiar with the audited sector
- on the part of the auditees, more than 70% were convinced of the usefulness of audits; 90% of them had felt that the atmosphere during audit interviews had been relaxed; 71% felt that the evaluation session had been good; 90% thought that the audit report was well written and clear, but some auditees thought that the conclusions could have been harder; 65% thought that the recommendations of the audit report had been useful. It has also been noted that, in general, most auditees very much like to talk about their work and enjoy sharing experiences problems with others.

Code of conduct

As one of the results of the pilot audits, the following code of conduct for audits was agreed.

- The main purpose of statistical audits within the SN is to help identify statistical sectors what the weak and strong points of their statistical processes are and how these may be improved. In a way, audits are liking presenting a 'mirror' to the auditees.
- There will be an audit plan, as part of the management contracts between division managers and the Director-General. Each statistical process in a statistical department will be audited once every five years.
- Audits are organised and moderated by an audit secretariat, which is part of the DG staff
- Audits are carried out by teams of three auditors, selected on the basis of specific expertise. A pool of about 25 auditors will be trained and regularly employed. Their performance will regularly be monitored by the audit secretariat
- Before an audit starts, the procedures and planning will be agreed with the department manager.
- The department manager is responsible for: the supply of proper documentation, including a list of employees and their tasks, work instructions, checklists, handbooks, existing guidelines for quality control. He/she also appoints a contact person from his sector.
- In a workshop, the audit secretariat briefs the audit-team on how the audit will be carried out. Also, the scope of the audit (including any points which deserve special attention) is formulated.
- The audit secretariat organises an introductory meeting, in which the scope and procedures are discussed. After that an interview scheme is drafted (implying, among other things, the final selection of the people to be interviewed). The maximum number of interviews per day is three, by two auditors, because interviews are to be relaxed. Interview reports are only for auditors. However, all reports are given to auditees for correction.
- The audit team drafts first report, which is first discussed with the audit secretariat.
- One audit secretary and the lead auditor discuss the first draft with the department head and contact person.
- The audit report is subsequently discussed in a meeting with department head and auditees.
- The final audit report is then written and sent to the department manager. A copy is sent to the Director-General of SN.
- The department manager has three months to react and to draft a plan for improvements on the basis of the recommendations.
- One year after the audit has taken place a questionnaire is sent to the department manager in order to check what has been done with the recommendations.
- After every five audits, the Audit Secretariat writes a summary report about important results, which may be beneficial for other departments as well. This report is discussed by the Management Committee for Auditing and Quality Care and is also widely circulated.

Planning of future audits

In 1997 a start was made with a regular audit program. This program is rather ambitious: two audits will take place each month (except July and August). However, so far the planning is respected.[4]
It is felt that some points still require further discussion and care:

- The way of reporting about audit results, in particular whether more openness (so far the reports have been treated rather confidentially) may be useful in order to enhance the 'learning effects' of audits for others than the audited sector.
- Whether or not specific priorities will have to be set to audit certain specific aspects of statistical processes that seem to be a 'weak spot' or an urgent problem. It is now tried to expressly formulate this in each individual audit instruction.
- The follow-up of audits; is a plan to remedy weak points drawn up and implemented and how should the implementation be monitored?

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Notes

1) This article is based on paper presented at the DGINS conference in Stockholm, May 1998. It was written on a personal basis and does not necessarily reflect views or policies of Statistics Netherlands
2) CBS 2000: doeltreffende diensten, lage lasten (SN Business plan: SN 2000; effective services, low burden to society)
3) The authors thank Henk van Tuinen, Director for Statistical Policy and Dick Kroeze of the Audit Secretariat for their comments, as well as René Huigen and Josée Nollen, who laid the groundwork for more systematic quality thinking in Statistics Netherlands.
4) One point that is not entirely in conformity with the original planning is that audits (from start to finish) take about two months, while the expectation was: one month. The reason is not so much that auditors have insufficient time (each auditor may spend 80 work hours for an audit), but that it takes more time than expected to write summaries and to formulate recommendations which are applicable for other sectors as well.

Water in the Dutch national accounts: a 'NAMWA' for 1991

Mark de Haan

The Dutch system of national accounts is systematically being extended with environmental statistics in a so-called NAMEA (National Accounting Matrix including Environmental Accounts). The NAMWA (National Accounting Matrix including Water Accounts) is a logical continuation of the NAMEA approach in the direction of water related issues. In the Netherlands water availability and its potential use are highly influenced by the quality of water. Therefore, the water accounts in the NAMWA are not only restricted to water extraction but also to the emissions into water such as nutrients, oxygen-demanding materials and heavy metals. The pressure of economic activities on all water systems in the Netherlands is captured by a limited number of environmental pressure indicators. The article further shows how different expenditures related to water management are explicitly shown in the NAMWA. The final section briefly discusses the relevance of the NAMWA for policy development with special reference to water management in the Netherlands.

Introduction

This article presents the extension of the 1991 NAMEA with accounts for water. These water accounts can be subdivided into two separate types of accounts. The first cover the quantitative use of fresh water, describing water extraction by economic activities in relation to the total natural water availability. Since one of the most important tasks of water boards in the Netherlands is preventing Dutch feet from getting wet, one might conclude that the natural supply of water must be abundant (or sometimes even redundant) with respect to all needs. However, in many parts of the Netherlands the excessive exploitation of groundwater is damaging local ecosystems. Therefore, the water accounts are subdivided again into separate accounts for groundwater and surface water. While physical data on produced tap water are presented in Table 2, the NAMWA presented in Table 4 only provide data on the supply and purchases of tap water in the goods and services account.

The second type of water accounts cover more qualitative aspects. Pollution negatively influences the quality and therefore the utilisable amount of ground and surface water. For example, in the Netherlands the increase of phosphate and nitrate concentrations in groundwater is considered to be a serious threat to the production of tap water in the near future. The emissions of phosphates, nitrates, biological substances and a number of heavy metals by industries and households to surface water are recorded in the water quality accounts. In addition to emissions, these accounts also review the total transported loads of pollutants via the river system from neighbouring countries into the Dutch inland waters, as well as the transportation of pollutants from the Dutch inland waters into open sea. Water extraction (account 11 in Tables 2 and 4) and emissions to water (account 12 in Tables 3 and 4) are shown in two separate accounts in order to improve the comprehensibility of the system; this does not constitute a proposal for a subdivision between water quantity and quality management. Like pollution, water extraction can also contribute to a diminishing quality of water and ecosystems.

The economic accounts of the NAMWA give an explicit presentation of economic transactions which are, at least in theory, relevant for water accounting purposes. The NAMWA provides simultaneously the (intermediate) consumption of tap water in the monetary accounts, as well the corresponding physical use in the water accounts, which implicitly determines the average prices for each user identified within the system. The economic accounts also present the taxation on water extraction and pollution, and further the internal cleansing services related to waste water treatment.

The next section discusses the theoretical backgrounds of the extensions of the 1991 NAMEA in more detail, and the final section discusses possible future work and potential applications of the system. Some of the presented data, such as the emission data on heavy metals in Table 3, are of poor quality. A more elaborate discussion on data issues can be found in De Haan (1997).

Conceptual issues

Water extraction

Defining the total amount of water that is available for a society in a certain period of time is rather difficult 1). In general, the total water quantities transported within the water cycle through all the environmental domains appear to be quite immense in relation to the small amounts of water actually used by man. Much of this water is not really available for human use owing to the technical and economic restrictions of exploitation. The natural water cycle may therefore not be regarded in total as an available resource. Water scarcity will usually arise in specific arid areas or in specific periods of time when the need for water is often the highest. Theoretically, a proper concept of water availability should be able to handle the issues of timelines and location of water resources.

One typical aspect of a water resource is, that it can be seen as a 'renewable-renewable' resource. Not only will the natural water cycle guarantee us a certain annual supply of fresh water from precipitation and river inflows, but each withdrawal of water will be followed by a certain amount of discharged water. Whether these discharges can be added to the total amount of available water depends on among other things the amount of pollution discharges contain and, of course, on specific downstream water needs.

Therefore, water extraction or other uses in the upstream regions of a river may restrict or even fully eliminate possible other uses downstream. For example, dams, large scale irrigation works or other artificial water transportation systems mean that some rivers in the world have almost disappeared by the time they enter the coastal zones. The NAMWA shows that the water in the rivers Rhine and Meuse are already polluted before the Dutch are able to use them in any sense, and Meuse water can be processed into tap water only at considerable costs.

It is rather difficult, then, to determine a set of objective criteria which may help to define the part of the natural water flow which is in potential available for society. One could conclude that the

concept of social water availability seems to be an issue of water management, rather than a concept that can be usefully incorporated into an accounting system. The optimal allocation of water resources, and subsequently the social water availability should ideally be determined by specifying the property rights of all potential users. For the sake of completeness, it should be stated that within this system of property rights, the water requirements for valuable ecosystems should not be forgotten.

Despite all these difficulties, a water account without a notion of what defines a water resource, or water availability, is rather meaningless since resource accounting is meant to express (increasing) resource scarcity which is not directly reflected by particular market prices in the national accounts. A practical solution is found in the Eurostat/OECD questionnaire on the State of the Environment, section F: inland waters. In this questionnaire, the *renewable* water resource is simply defined as the water quantity that is available each year as a result of the movement of water in the hydrological cycle. It covers both water in aquifers and in surface waters. More specifically, the renewable water resource in any year is defined as the net result of annual precipitation minus evapo-transpiration plus annual inflow by rivers and underground flow into a country. The technical, managerial or economic feasibility of exploitation is completely ignored.

Table 1 provides a simplified overview of the renewable fresh water resources in the Netherlands in 1991. The groundwater flow is not expressed in this Table. For the time being, it is assumed that the inflow of groundwater from abroad equals the outflow and can therefore be ignored. As the Netherlands is lower than its neighbouring countries, this assumption is in fact not justified. However, there is no available information on the groundwater inflow from Belgium and Germany. The average annual groundwater inflow is estimated to be approximately 5.800 km^3 [2)]. If the net foreign inflow of groundwater is assumed to be zero, this inflow must originate from precipitation and surface water in the Netherlands (see also Table 2). Table 1 also presents a decline in groundwater stock of 100 million m^3. This estimation is based on an average annual lowering of the groundwater table of 1cm in the last 25 years. Actual year to year changes in the groundwater table may show very divergent patterns. The rivers appear to be the most important suppliers of fresh water in the Netherlands, and over 85% of all fresh water inflow by rivers is transported into the Netherlands by the river Rhine.

Table 2 presents a further extension of the water resource accounts with water extraction by economic activities. The use of water is presented by different economic activities and for three different water categories. All categories refer to fresh water, so brackish and marine water are excluded. The codes underneath the heading of Table 2 refer to the corresponding accounts in the NAMWA presented in Table 4. The origin of water resources, as reviewed in Table 2a, is subdivided into two separate sources. The first category represents the water 'supplied' by economic activities, such as the actual supply of tap water by the water supply sector and water discharges to surface water by all other economic activities.

Table 1
Renewable water resources in the Netherlands

	mln m^3
Origin	
Water inflows via rivers from neightbouring countries	63 127
Precipitation	27 296
Totaal	90 423
Destination	
Water outflows of surface waters to open sea	67 672
(Natural) evapo-transpiration [1)]	22 851
Changes in stock	–100
Total	90 423

[1)] Including net use in the economy

Table 2a
Water extraction in the NAMWA 1991, origin of water

	Tap water 1a	Groundwater 11a	Surface water 11b	Total
	$mln\ m^3$			
Supply of tapwater and discharges by producers				
Public utilities				
Water supply	1 278			1 278
Environmental cleansing and sanitary services			1 642	1 642
Water boards			100	100
[1]			8 130	8 130
Other origins				
Water inflows via rivers from neighbouring counties and precipitation		5 800	84 623	90 423
Total = NAMWA column total 11	1 278	5 800	94 495	101 573

Table 2b
Water extraction in the NAMWA 1991, destination of water

	Tap water 1a	Groundwater 11a	Surface water 11b	Total
	mln m3			
Use by consumers				
Own transport	-	-	-	-
Other consumption	704	-	-	704
Use by producers				
Agriculture, hunting,forestry, fishing [2]	100	130	200	430
Mining and quarrying	1	-	-	1
Manufacturing				
Food, beverages and tobacco industry	34	77	94	204
Textile, wearing apparel and leather industry	4	5	4	12
Wood and furniture industry	2	-	-	2
Paper, printing and publishing industry	13	32	58	102
Petroleum industry	27	0	3	30
Chemical industry	36	43	849	928
Rubber and plastic industry	2	15	2	19
Construction materials, earthenware and glass products industry	5	15	157	177
Basic metal industry	41	7	3	50
Metal products and machinery industry	22	5	2	30
Other manufacturing	27	7	3	37
Public utilities				
Electricity and gas	5	2	5 143	5 150
Water supply	1	842	435	1 278
Construction	5	-	-	5
Transport and storage	9	-	-	9
Environmental cleansing and sanitary services	12	-	1 642	1 654
Water boards	-	100	-	100
Other services	230	-	-	230
Other destinations				
Water outflows of surface water to open sea and evapo-transpiration	-	4 621	85 901	90 523
Net changes stock	-	–100	-	–100
Total = NAMWA row total 11	1 278	5 800	94 495	101 573

[1] No net uses are estimated. All withdrawals are supposed to be discharged in the same year
[2] 'Guesstimates'

Table 3
Emissions to water in the NAMWA 1991

	P	N	Organic pollution	Heavy metals							
				Cadmium	Mercury	Arsenic	Chromium	Copper	Lead	Nickel	Zinc
	12a	12b	12c	12d	12e	12f	12g	12h	12i	12j	12k
	mln kg		*1000 i.e.*	*kg*			*1 000 kg*				
Origin of substances											
Emission by consumers											
Own transport	-	-	-	-	-	-	-	-	-	-	-
Other consumption	13	67	15 068	1 327	665	2 981	27	135	75	24	323
Emission by producers [1)]	134	1 005	62	3 000	-	-	-	120	68	-	640
Mining and quarrying			6								
Manufacturing	6	24	2 133	4	3	108	1	4	-	1	9
Textile, wearing apparel and leather industry	1	-	257	-	-	5	1	2	-	-	2
Wood and furniture industry	-	-	28	-	-	-	-	-	-	-	-
	1	4	283	4	4	-	-	1	-	-	1
Petroleum industry	-	-	-	-	-	-	-	-	1	-	2
Chemical industry	4	3	929	2 235	317	1 925	11	7	8	10	41
Rubber and plastic industry	-	-	5	2	-	-	-	-	-	-	-
earthenware and glass products industry	-	-	12	4				-	-	-	-
Basic metal industry	-	1	117	124	33	72	1	-	1	-	6
Metal products and machinery industry	-	1	222	34	-	41	4	6	1	3	10
Other manufacturing	-	-	180								
Public utilities											
Electricity and gas	-	-	10	-	-	-	-	-	-	-	-
Water supply	-	-	22	-	-	-	-	-	-	-	-
Construction	-	-	209	-	-	-	-	-	-	-	-
Transport and storage	-	-	170	-	-	-	-	-	-	-	-
Environmental cleansing and sanitary services	19	53	5 010	847	316	2 176	17	61	43	27	147
Water boards	-	-	-	-	-	-	-	-	-	-	-
Other services	7	7	3 545								
Other domestic origin											
Waste dumping sites	.	.	.	17	1	32	.	.	.	.	.
Diffuse sources	-	-	5 520	748	374	19 669	14	75	42	14	181
From the rest of the world	19	315	.	14 600	4 980	92 433	294	474	325	282	2 300
Total = NAMWA column total 12	204	1 480	33 788	22 946	6 693	119 442	368	884	564	360	3 662
Destination of substances											
Absorption by producers											
Environmental cleansing and sanitary services	22	106	26 521	2 000	1 000	4 400	42	203	109	39	482
To the rest of the world	18	314	847	6 632	2 572	115 042	225	326	185	254	873
Contribution to environmental themes											
Eutrophication	164	1 060									
Waste water			6 420								
Dispersion				14 314	3 121	-	101	355	270	67	2 307
Total = NAMWA row total 12	204	1 480	33 788	22 946	6 693	119 442	368	884	564	360	3 662

1)

The effluent water of waste water treatment plants is given as a supply of surface water by the environmental cleansing and sanitary services. Similarly, a separate ‘guesstimate’ is made of surface water discharges by the water boards as the result of the artificial lowering of the groundwater table (see also the corresponding withdrawal of groundwater by water boards in Table 2b). Surface water regulation by the water boards, i.e. pumping water from one water body to another, is not shown in the accounts.

Due to insufficient information, other discharges do not have a further breakdown per economic activity. For similar reasons, the discharges of other economic activities have been estimated as the total withdrawals of ground and surface water. Therefore, the accounts do not express the net use of water by economic activity (see also Section 3.1.). Theoretically, this net use must equal the sum of human induced evaporation and water extraction embodied in products. The water supplied by nature determines the last two entries in Table 2a: the water inflow by the river system and precipitation. This natural supply is roughly subdivided into the annual inflow of groundwater and surface water.

The use and other destination of all three water categories are reviewed in Table 2b. The supply and use of tap water can be interpreted as a physical transcription of the corresponding product group in the supply and use table of the national accounts and subsequently account 1a of the NAMWA (see Table

4). For the production of tap water, 842 million m^3 groundwater and 435 m^3 surface water was extracted. The accounts for groundwater and surface water display water inputs which are a direct extraction from nature and these are therefore not considered as an economic transaction in the national accounts. Of the total water consumption of 11 km^3, approximately 6 km^3 was used for cooling. Although all water categories are used for cooling purposes, surface water is by far the most important one in this respect (see Statistics Netherlands, 1994). It has already been mentioned that only fresh water resources are presented in Table 2, since brackish and saltwater can hardly be considered as a scarce resource in the Netherlands 3). Almost all saltwater intake by manufacturing industries - about 1.5 km^3 in 1991 - is used for cooling purposes. Table 2b also reviews other destinations of fresh water such as evapo-transpiration and the water outflow to open sea. The change in stock represents a rough estimate of the average annual groundwater decline in the last 25 years. No changes in stock have been estimated for the other water categories.

The original conceptual design of the NAMEA (Keuning, 1993) distinguishes environmental agents (CO_2, nitrogen, etc.) and environmental resources (oil, water, etc.) on the one hand, and environmental assets (rivers, groundwater, forests etc.) on the other. The latter are depicted in a separate account for changes in environmental assets. The first empirical application of the NAMEA focused on degradation issues and it soon appeared that these issues could not be covered in terms of environmental assets. For that reason, the so-called environmental themes approach was adopted. By now, this approach is fully accepted in the Netherlands. Although resource use has also been included in earlier NAMEAs, this paper is the first attempt at a more elaborate empirical application of depletion in a NAMEA framework. For this reason, in the NAMWA a *Changes in assets account* is introduced for the depletion of water resources (Account 13 in Table 4). Two different water resources have been identified: groundwater and surface water. In general, a changes in assets account should be introduced in the NAMEA to express the depletion of natural resources, i.e. the direct extraction of scarce environmental 'goods' from the environment. The degradation of the environment due to pollution, by contrast, cannot be covered in an assets or changes in assets account, but should instead be summarised in an environmental themes account. This is related to the impossibility of incorporating the interaction between environmental pressure and the related environmental degradation. Changes in natural assets are caused by numerous and diverse threats which may strengthen or weaken each other, not to mention the uncertainties in threshold levels of various ecosystems. Non-linear interactions should not be addressed in the accounting framework. Complex ecological models are needed to estimate dispersion patterns of pollutants and subsequently the time and place of occurring damage. In our opinion, ecological modelling should be excluded from a statistical framework like the NAMEA for that matter. That is why instead, the NAMEA applies an environmental themes account to compile summary indicators on the potential environmental degradation caused by pollution.

Water pollution

The second type of accounts (Account 12 in Table 4) review a number of emissions to water which are related to three environmental themes, i.e. eutrophication, organic pollution and dispersion of hazardous substances; in the NAMWA the latter theme is restricted to heavy metals. 4). The emission accounts represent only the *direct* emissions to surface water, emissions into the sewage system and, in the case of agriculture, emissions to soil. It is assumed that the emissions to soil by agriculture will to a large extent end up in ground or surface water.
However, it must be emphasised that the total pressure on water quality is also determined by emissions to the other domains, such as air, which will in a later stage enter soils and subsequently surface waters. The introduction of environmental domains into the emission accounts will therefore not always provide straightforward answers on the destination of pollution. In general, complex models will be needed to determine the dispersion patterns of pollutants from soil into ground and surface water. In order to avoid unnecessary complexity, the environmental domains were simply ignored in the environmental theme indicators as developed by Adriaanse (1992) and adopted in the NAMEA.

In the accounts for emissions, the usual NAMEA concepts are applied (see also De Haan and Keuning, 1996). The total origin of pollutants is determined, firstly by calculating domestic pollution, i.e. emission by consumers, producers and other domestic sources, and secondly, by computing the inflow of pollution via the river system into the Netherlands. Table 3 shows that a considerable amount of all heavy metals is emitted by diffuse, or indirect sources. By far the greatest amount, however, is 'imported' from abroad through the rivers Rhine, (Germany) and the river Meuse (France and Belgium). The destination of pollutants is determined by the accumulated pollution in Dutch inland waters and the outflow of pollution to other territories, or in the case of the Netherlands, to open sea. A fair amount of pollution is actually eliminated from the water system by the environmental cleansing and sanitary services. For waste water, a an abatement of almost 80 per cent is realised in this way.

The total domestically accumulated pollution is allocated to the following environmental themes, eutrophication, waste water and the dispersion of heavy metals. In the environmental themes account (14) in Table 4, all this pollution is recalculated into environmental theme equivalents and subsequently aggregated per theme. The theme indicators review the total potential pressure on the Dutch environment.

Expenditures

Table 4 is a somewhat aggregated presentation of the NAMWA. Accounts 11 and 12 show how the water extraction account, and the water pollution account are connected to the economic accounts (1-10). The environmental accounts (11-14) are in italics, emphasising that these figures are not included in the row and column totals of the economic accounts. All accounts which are relevant for water issues are explicitly shown in the table. Most of the other accounts are only shown in a consolidated manner. The goods and services account (1) reviews the supply (3c,1) and purchases (1,3c) of tap water and the internal environmental cleansing services related to waste-water treatment (1d). The production account explicitly presents the following economic activities: water supply, water boards, and environmental cleansing and sanitary services. Unfortunately, the latter has no further breakdown and therefore includes the combined collection and sanitation of solid waste and waste water. The taxes account reviews two specific taxes related to water, one levied on water pollution (8a) and a second one on water extraction (8b).

Applications and future work

The NAMEA is an analytical framework that can be used for integrated economic and environmental policy analysis (see e.g.

Verbruggen et al., 1996). More specifically, the NAMWA can be used in the further development of integrated economic and environmental policies with special reference to water management. The water management in the Netherlands, is elaborated in *Watersysteemverkenningen* (Water systems survey, Ministry of Transport and Public Works, 1996), a technical review of all Dutch salt and fresh inland waters, providing a policy evaluation as well as a future outlook. In the water systems survey, the total water system is defined as the total of all surface water, groundwater, waterbeds and water boards, including infrastructure and all its physical and biological qualities. Specific economic or user functions mentioned in the survey are: flood security systems, agriculture, fishery, shipping, recreation, water supply, electricity supply and offshore mineral extraction. The environmental concerns in the survey include eutrophication, hazardous emissions and groundwater extraction.

Otto and Van Den Ende (1994) emphasise the need for an integrated model which supports the further development of integrated water management.
The two main goals of such a model are first a quantitative description of all relevant economic processes, and secondly a complete review of costs and benefits resulting from changes in the water system or in the economy. The model should also be able to review the expected future consequences for the Dutch inland waters of the various economic scenarios as developed by the Netherlands Bureau for Economic Policy Analysis (see e.g. CPB, 1992).

Whether the NAMWA can serve as a statistical framework for the development of such an integrated model will be explored in the near future. However, it is likely that further extensions of the NAMWA will be required. A number of user functions related to water are still missing: fishery, shipping and recreation. Subsequently, the NAMWA does not yet provide any link to the current quality state of Dutch inland waters, and therefore the effects of the changes in state on the different user functions, such as the effects of cleaner rivers on water recreation, cannot yet be analysed. A meaningful regionalisation might be a next step in the development of the NAMWA. In that case, the accounts should not be restricted to fresh inland waters but should also include the coastal areas.

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Notes

1) See for example Jiliberto Herrera and Alvarez-Arenas Bayo (1997) who explain that the potential availability of a water resource can be determined by five criteria concerning time and space aspects as well as technical and economic conditions. They argue that these criteria must in any case have been met for all actual extracted resources. Testing these criteria for other potential resources is not easy.
2) Source: Ministerie van Verkeer en Waterstaat (Ministry of Transport and Public Works, 1990), p.14.
3) From an ecological point of view, most salt inland waters in the Netherlands are considered to be valuable ecosystems which also supports human user functions such as fishery and shipping.
4) The organic pollution is quantified as the number of inhabitant equivalents (i.e.), where one i.e. equals 54 grams of Biological Oxygen Demand (BOD). Besides heavy metals, the environmental theme indicator for dispersion also includes other hazardous substances such as pesticides, organic compounds and radioactive substances (see also Adriaanse, 1992).

Table 4
An aggregated NAMWA for 1991 (account 1 -10 in million guilders)

		Goods and services					Con-sumption
		1a	1b	1c	1d	1e	2
Goods and services (product groups)							
Water	1a						1501
Other product groups	1b						320936
External environmental cleansing services	1c						24
Internal environmental cleansing services related to water purification	1d						
Other internal environmental cleansing services	1e						
Consumption of households	2						
Production (kind of economic activity)							
Agriculture, hunting,forestry, fishing	3a		44202			262	
Mining and manufacturing	3b	3	332367		581	1179	
Water supply	3c	1989	178			228	
Electricity and gas supply	3d		22361		14	35	
Water boards	3e		643		21		
Environmental cleansing and sanitary services	3f		11	2765	377		
Other services and construction	3g		593451	176	40	1955	
Generation of income	4						
Distribution and use of income	5						
Capital	6						
Financial balance	7						
Taxes (types)							
Levy on surface water pollution	8a						
Levy on groundwater extraction	8b						
Other environmental taxes	8c		907				
Other taxes minus subsidies	8d	88	45699	112			
Rest of the world, current	9		267386				
Rest of the world, capital	10						
Water resources (categories, in mln m^3)							
Groundwater	11a						
Surface water	11b						
Water pollution (substances)							
Phosphorus (mln kg)	12a						
Nitrogen (mln kg)	12b						
Organic pollution (1000 i.e.)	12c						
Cadmium (kg)	12d						
Mercury (kg)	12e						
Arsenic (kg)	12f						
Chromium (1000kg)	12g						
Copper (1000kg)	12h						
Lead (1000kg)	12i						
Nickel (1000kg)	12j						
Zinc (1000kg)	12k						
Changes in assets, depletion							
Groundwater (m^3)	13a						
Surface water (m^3)	13b						
Environmental themes, degradation							
Eutrophication (EEQ)	14a						
Waste water (i.e.)	14b						
Dispersion of heavy metals (DEQ)	14c						
TOTAL		2080	1307205	3053	1033	3659	322461

*) The pre-column (12^*) expresses the substances which are allocated to themes in kilograms.
The row totals of account 12 include the figures presented in the pre-column.
The other entries in sub-matrix (12,14) are the corresponding substances converted into theme-equivalents.
These are excluded from the row-totals of account 12.

Table 4 (continued)
An aggregated NAMWA for 1991 (account 1 -10 in million guilders)

		Production					
		3a	3b	3c	3d	3e	3f
Goods and services (product groups)							
Water	1a	155	174	80			8
Other product groups	1b	22520	218661	564	14905	320	1555
External environmental cleansing services	1c	30	709	2	8		24
Internal environmental cleansing services related to water purification	1d		581		14	21	377
Other internal environmental cleansing services	1e	262	1179	228	35		
Consumption of households	2						
Production (kind of economic activity)							
Agriculture, hunting,forestry, fishing	3a						
Mining and manufacturing	3b						
Water supply	3c						
Electricity and gas supply	3d						
Water boards	3e						
Environmental cleansing and sanitary services	3f						
Other services and construction	3g						
Generation of income	4	16265	98316	1065	4378	285	988
Distribution and use of income	5						
Capital	6	4680	14673	461	3075	34	130
Financial balance	7						
Taxes (types)							
Levy on surface water pollution	8a	68	363		6	3	3
Levy on groundwater extraction	8b	8					
Other environmental taxes	8c	66	156		3		1
Other taxes minus subsidies	8d	410	-682	-5	-14	1	67
Rest of the world, current	9						
Rest of the world, capital	10						
Water resources (categories, in mln m^3)							
Groundwater	11a	*130*	*205*	*842*	*2*	*100*	
Surface water	11b	*200*	*1173*	*435*	*5143*		*1642*
Water pollution (substances)							
Phosphorus (mln kg)	12a						*22*
Nitrogen (mln kg)	12b						*106*
Organic pollution (1000 i.e.)	12c						*26521*
Cadmium (kg)	12d						*2000*
Mercury (kg)	12e						*1000*
Arsenic (kg)	12f						*4400*
Chromium (1000kg)	12g						*42*
Copper (1000kg)	12h						*203*
Lead (1000kg)	12i						*109*
Nickel (1000kg)	12j						*39*
Zinc (1000kg)	12k						*482*
Changes in assets, depletion							
Groundwater (m^3)	13a						
Surface water (m^3)	13b						
Environmental themes, degradation							
Eutrophication (EEQ)	14a						
Waste water (i.e.)	14b						
Dispersion of heavy metals (DEQ)	14c						
TOTAL		44464	334130	2395	22410	664	3153

*) The pre-column (12^*) expresses the substances which are allocated to themes in kilograms.
The row totals of account 12 include the figures presented in the pre-column.
The other entries in sub-matrix (12,14) are the corresponding substances converted into theme-equivalents.
These are excluded from the row-totals of account 12.

Table 4 (continued)
An aggregated NAMWA for 1991 (account 1 -10 in million guilders)

			Generation of income				Distribution and use of income
		3g	4				5
Goods and services (product groups)							
Water	1a	162					
Other product groups	1b	242659					77181
External environmental cleansing services	1c	840					1416
Internal environmental cleansing services related to water purification	1d	40					
Other internal environmental cleansing services	1e	1955					
Consumption of households	2						322461
Production (kind of economic activity)							
Agriculture, hunting,forestry, fishing	3a						
Mining and manufacturing	3b						
Water supply	3c						
Electricity and gas supply	3d						
Water boards	3e						
Environmental cleansing and sanitary services	3f						
Other services and construction	3g						
Generation of income	4	306901					
Distribution and use of income	5		429728				574117
Capital	6	39777					71690
Financial balance	7						
Taxes (types)							
Levy on surface water pollution	8a	116					940
Levy on groundwater extraction	8b						
Other environmental taxes	8c	70					1360
Other taxes minus subsidies	8d	3102					88510
Rest of the world, current	9		1170				67720
Rest of the world, capital	10						
Water resources (categories, in mln m^3)							
Groundwater	11a						
Surface water	11b						
Water pollution (substances)							
Phosphorus (mln kg)	12a						
Nitrogen (mln kg)	12b						
Organic pollution (1000 i.e.)	12c						
Cadmium (kg)	12d						
Mercury (kg)	12e						
Arsenic (kg)	12f						
Chromium (1000kg)	12g						
Copper (1000kg)	12h						
Lead (1000kg)	12i						
Nickel (1000kg)	12j						
Zinc (1000kg)	12k						
Changes in assets, depletion							
Groundwater (m^3)	13a						
Surface water (m^3)	13b						
Environmental themes, degradation							
Eutrophication (EEQ)	14a						
Waste water (i.e.)	14b						
Dispersion of heavy metals (DEQ)	14c						
TOTAL		595622	430898				1205395

*) The pre-column (12^*) expresses the substances which are allocated to themes in kilograms.
The row totals of account 12 include the figures presented in the pre-column.
The other entries in sub-matrix (12,14) are the corresponding substances converted into theme-equivalents.
These are excluded from the row-totals of account 12.

Table 4 (continued)
An aggregated NAMWA for 1991 (account 1 -10 in million guilders)

		Capital	Taxes	
		6	8a	8b
Goods and services (product groups)				
Water	1a			
Other product groups	1b	114818		
External environmental cleansing services	1c			
Internal environmental cleansing services related to water purification	1d			
Other internal environmental cleansing services	1e			
Consumption of households	2			
Production (kind of economic activity)				
Agriculture, hunting,forestry, fishing	3a			
Mining and manufacturing	3b			
Water supply	3c			
Electricity and gas supply	3d			
Water boards	3e			
Environmental cleansing and sanitary services	3f			
Other services and construction	3g			
Generation of income	4			
Distribution and use of income	5		1499	8
Capital	6			
Financial balance	7	17340		
Taxes (types)				
Levy on surface water pollution	8a			
Levy on groundwater extraction	8b			
Other environmental taxes	8c			
Other taxes minus subsidies	8d	992		
Rest of the world, current	9			
Rest of the world, capital	10	2350		
Water resources (categories, in mln m^3)				
Groundwater	11a			
Surface water	11b			
Water pollution (substances)				
Phosphorus (mln kg)	12a			
Nitrogen (mln kg)	12b			
Organic pollution (1000 i.e.)	12c			
Cadmium (kg)	12d			
Mercury (kg)	12e			
Arsenic (kg)	12f			
Chromium (1000kg)	12g			
Copper (1000kg)	12h			
Lead (1000kg)	12i			
Nickel (1000kg)	12j			
Zinc (1000kg)	12k			
Changes in assets, depletion				
Groundwater (m^3)	13a	*-100*		
Surface water (m^3)	13b	-		
Environmental themes, degradation				
Eutrophication (EEQ)	14a	*2700*		
Waste water (i.e.)	14b	*6405*		
Dispersion of heavy metals (DEQ)	14c	*175813*		
TOTAL		135500	1499	8

*) The pre-column (12^*) expresses the substances which are allocated to themes in kilograms.
The row totals of account 12 include the figures presented in the pre-column.
The other entries in sub-matrix (12,14) are the corresponding substances converted into theme-equivalents.
These are excluded from the row-totals of account 12.

Table 4 (continued)
An aggregated NAMWA for 1991 (account 1 -10 in million guilders)

				Rest of the world, current	Rest of the world, capital	Water resources	
		8c	8d	9	10	11a	11b
Goods and services (product groups)							
Water	1a						
Other product groups	1b			293086			
External environmental cleansing services	1c						
Internal environmental cleansing services related to water purification	1d						
Other internal environmental cleansing services	1e						
Consumption of households	2						
Production (kind of economic activity)							
Agriculture, hunting,forestry, fishing	3a						
Mining and manufacturing	3b						
Water supply	3c						
Electricity and gas supply	3d						
Water boards	3e						*100*
Environmental cleansing and sanitary services	3f						*1642*
Other services and construction	3g						
Generation of income	4		1880	820			
Distribution and use of income	5	2563	137360	60120			*8130*
Capital	6				980		
Financial balance	7				-17340		
Taxes (types)							
Levy on surface water pollution	8a						
Levy on groundwater extraction	8b						
Other environmental taxes	8c						
Other taxes minus subsidies	8d			1120			
Rest of the world, current	9		160			*5800*	*84623*
Rest of the world, capital	10			-18710			
Water resources (categories, in mln m^3)							
Groundwater	11a			*4621*			
Surface water	11b			*85902*			
Water pollution (substances)							
Phosphorus (mln kg)	12a			*18*			
Nitrogen (mln kg)	12b			*314*			
Organic pollution (1000 i.e.)	12c			*847*			
Cadmium (kg)	12d			*6632*			
Mercury (kg)	12e			*2572*			
Arsenic (kg)	12f			*115042*			
Chromium (1000kg)	12g			*225*			
Copper (1000kg)	12h			*326*			
Lead (1000kg)	12i			*185*			
Nickel (1000kg)	12j			*254*			
Zinc (1000kg)	12k			*873*			
Changes in assets, depletion							
Groundwater (m^3)	13a						
Surface water (m^3)	13b						
Environmental themes, degradation							
Eutrophication (EEQ)	14a						
Waste water (i.e.)	14b						
Dispersion of heavy metals (DEQ)	14c						
TOTAL		2563	139400	336436	-16360	*5800*	*94495*

*) The pre-column (12^*) expresses the substances which are allocated to themes in kilograms.
The row totals of account 12 include the figures presented in the pre-column.
The other entries in sub-matrix (12,14) are the corresponding substances converted into theme-equivalents.
These are excluded from the row-totals of account 12.

Table 4 (continued)
An aggregated NAMWA for 1991 (account 1 -10 in million guilders)

		Water pollution					
		12a	12b	12c	12d	12e	12f
Goods and services (product groups)							
Water	1a						
Other product groups	1b						
External environmental cleansing services	1c						
Internal environmental cleansing services related to water purification	1d						
Other internal environmental cleansing services	1e						
Consumption of households	2	*12*	*67*	*15068*	*1327*	*665*	*2981*
Production (kind of economic activity)							
Agriculture, hunting,forestry, fishing	3a	*134*	*1005*	*62*	*3000*		
Mining and manufacturing	3b	*13*	*33*	*4172*	*2407*	*357*	*2151*
Water supply	3c			*10*			
Electricity and gas supply	3d			*22*			
Water boards	3e						
Environmental cleansing and sanitary services	3f	*19*	*53*	*5010*	*847*	*316*	*2176*
Other services and construction	3g	*7*	*7*	*3924*			
Generation of income	4						
Distribution and use of income	5			*5520*	*748*	*374*	*19669*
Capital	6				*17*	*1*	*32*
Financial balance	7						
Taxes (types)							
Levy on surface water pollution	8a						
Levy on groundwater extraction	8b						
Other environmental taxes	8c						
Other taxes minus subsidies	8d						
Rest of the world, current	9	*19*	*315*		*14600*	*4980*	*92433*
Rest of the world, capital	10						
Water resources (categories, in mln m^3)							
Groundwater	11a						
Surface water	11b						
Water pollution (substances)							
Phosphorus (mln kg)	12a						
Nitrogen (mln kg)	12b						
Organic pollution (1000 i.e.)	12c						
Cadmium (kg)	12d						
Mercury (kg)	12e						
Arsenic (kg)	12f						
Chromium (1000kg)	12g						
Copper (1000kg)	12h						
Lead (1000kg)	12i						
Nickel (1000kg)	12j						
Zinc (1000kg)	12k						
Changes in assets, depletion							
Groundwater (m^3)	13a						
Surface water (m^3)	13b						
Environmental themes, degradation							
Eutrophication (EEQ)	14a						
Waste water (i.e.)	14b						
Dispersion of heavy metals (DEQ)	14c						
TOTAL		*204*	*1480*	*33788*	*22946*	*6693*	*119442*

*) The pre-column (12^*) expresses the substances which are allocated to themes in kilograms.
The row totals of account 12 include the figures presented in the pre-column.
The other entries in sub-matrix (12,14) are the corresponding substances converted into theme-equivalents.
These are excluded from the row-totals of account 12.

Table 4 (continued)
An aggregated NAMWA for 1991 (account 1 -10 in million guilders)

							changes in asset, depletion
		12g	12h	12i	12j	12k	13a
Goods and services (product groups)							
Water	1a						
Other product groups	1b						
External environmental cleansing services	1c						
Internal environmental cleansing services related to water purification	1d						
Other internal environmental cleansing services	1e						
Consumption of households	2	27	*135*	*75*	*24*	*323*	
Production (kind of economic activity)							
Agriculture, hunting,forestry, fishing	3a		*119*	*68*		*640*	
Mining and manufacturing	3b	16	*20*	*11*	*13*	*71*	
Water supply	3c						
Electricity and gas supply	3d						
Water boards	3e						
Environmental cleansing and sanitary services	3f	17	*61*	*43*	*27*	*147*	
Other services and construction	3g						
Generation of income	4						
Distribution and use of income	5	14	*75*	*42*	*14*	*181*	
Capital	6						
Financial balance	7						
Taxes (types)							
Levy on surface water pollution	8a						
Levy on groundwater extraction	8b						
Other environmental taxes	8c						
Other taxes minus subsidies	8d						
Rest of the world, current	9	294	*474*	*325*	*282*	*2300*	
Rest of the world, capital	10						
Water resources (categories, in mln m^3)							
Groundwater	11a						*-100*
Surface water	11b						
Water pollution (substances)							
Phosphorus (mln kg)	12a						
Nitrogen (mln kg)	12b						
Organic pollution (1000 i.e.)	12c						
Cadmium (kg)	12d						
Mercury (kg)	12e						
Arsenic (kg)	12f						
Chromium (1000kg)	12g						
Copper (1000kg)	12h						
Lead (1000kg)	12i						
Nickel (1000kg)	12j						
Zinc (1000kg)	12k						
Changes in assets, depletion							
Groundwater (m^3)	13a						
Surface water (m^3)	13b						
Environmental themes, degradation							
Eutrophication (EEQ)	14a						
Waste water (i.e.)	14b						
Dispersion of heavy metals (DEQ)	14c						
TOTAL		368	*884*	*564*	*360*	*3662*	*-100*

*) The pre-column (12^*) expresses the substances which are allocated to themes in kilograms.
The row totals of account 12 include the figures presented in the pre-column.
The other entries in sub-matrix (12,14) are the corresponding substances converted into theme-equivalents.
These are excluded from the row-totals of account 12.

Table 4 (end)
An aggregated NAMWA for 1991 (account 1 -10 in million guilders)

			Environmental themes, degradation				TOTAL
		13b	*)	14a	14b	14c	
Goods and services (product groups)							
Water	1a						2080
Other product groups	1b						1307205
External environmental cleansing services	1c						3053
Internal environmental cleansing services related to water purification	1d						1033
Other internal environmental cleansing services	1e						3659
Consumption of households	2						322461
Production (kind of economic activity)							
Agriculture, hunting,forestry, fishing	3a						44464
Mining and manufacturing	3b						334130
Water supply	3c						2395
Electricity and gas supply	3d						22410
Water boards	3e						664
Environmental cleansing and sanitary services	3f						3153
Other services and construction	3g						595622
Generation of income	4						430898
Distribution and use of income	5						1205395
Capital	6						135500
Financial balance	7						0
Taxes (types)							
Levy on surface water pollution	8a						1499
Levy on groundwater extraction	8b						8
Other environmental taxes	8c						2563
Other taxes minus subsidies	8d						139400
Rest of the world, current	9						336436
Rest of the world, capital	10						-16360
Water resources (categories, in mln m^3)							
Groundwater	11a						*5800*
Surface water	11b	-					*94495*
Water pollution (substances)							
Phosphorus (mln kg)	12a		*164*	*1640*			*204*
Nitrogen (mln kg)	12b		*1060*	*1060*			*1480*
Organic pollution (1000 i.e.)	12c		*6405*		*6405*		*33773*
Cadmium (kg)	12d		*14314*			*71570*	*22946*
Mercury (kg)	12e		*3121*			*104033,333*	*6693*
Arsenic (kg)	12f		-			-	*119442*
Chromium (1000kg)	12g		*101*			*4*	*368*
Copper (1000kg)	12h		*355*			*118*	*884*
Lead (1000kg)	12i		*270*			*11*	*564*
Nickel (1000kg)	12j		*67*			-	*360*
Zinc (1000kg)	12k		*2307*			*77*	*3662*
Changes in assets, depletion							
Groundwater (m^3)	13a						*-100*
Surface water (m^3)	13b						*0*
Environmental themes, degradation							
Eutrophication (EEQ)	14a						*2700*
Waste water (i.e.)	14b						*6405*
Dispersion of heavy metals (DEQ)	14c						*175813*
TOTAL		0		*2700*	*6405*	*175813,333*	

*) The pre-column (12^*) expresses the substances which are allocated to themes in kilograms.
The row totals of account 12 include the figures presented in the pre-column.
The other entries in sub-matrix (12,14) are the corresponding substances converted into theme-equivalents.
These are excluded from the row-totals of account 12.

Illegal production in the national accounts

Ron van der Werf

Illegal activities like drug transactions, prostitution and theft are not covered in the national accounts. Although such transactions may be looked upon as 'bads' rather than 'goods', they do contribute to the output and income of the (national) economy and should therefore be registered accordingly. Statistics Netherlands calculations show that it is unlikely that the total value added generated by illegal activities exceeds 1 per cent of the gross domestic product.

Introduction

Up to now, illegal activities like drugs transactions, prostitution and theft have usually not been covered in national accounts. Although they may be looked upon as 'bads' rather than 'goods', illegal activities do contribute to the output and income of the (national) economy, and in this respect they should be registered accordingly, as laid down in the 1993 System of National Accounts (UN, 1993).

It is usually difficult to obtain the data needed to estimate illegal production. The following sections discuss the registration of the various illegal activities in the national accounts and present - necessarily unconventional - methods of estimation. More details and reservations, and some theoretic reflections on the (preferable) registration of illegal production in the national accounts can be found in Van der Werf and Van de Ven (1996).

Illegal drugs transactions

The production and possession of and trade in all drugs is against the law in the Netherlands. The sale and possession of *small* quantities of cannabis, however, are 'tolerated'.

From a theoretic point of view, the treatment of the production and use of drugs is quite straightforward. Value added from drugs transactions can be subdivided into domestic production of drugs and (local) trade in drugs.
Assumptions have to be made about the residency of the drug dealers: some of the margins may be generated by non-residents and therefore do not contribute to the gross domestic product (GDP) of the national economy. On the other hand, trade margins may be generated by residents on illegal drugs transactions in the rest of the world.
Although output originating from illegal drugs transactions is not included explicitly in the present Dutch national accounts, some transactions may be included implicitly. Most of the 'coffee shops' where cannabis is sold pay taxes and are included in the General Business Register. As a consequence, they are bound to be part of the random samples on which the production statistics are based. At least part of the turnover may be imputed to cafes as a result of grossing-up procedures. This kind of complication does not occur in the estimation of hard drugs transactions.

Hard drugs

Of the main products in this category - cocaine, heroin and synthetic drugs - only the latter, mostly XTC, are produced in the Netherlands.
There are two sources of reliable information on hard drugs: health and social care provide very reliable estimates on the number of drug addicts in the Netherlands(De Zwart and Mensink, 1992), and law enforcement agencies have information on the quantities of confiscated drugs (CRI, 1995).

The method of estimation is more or less dictated by the available information. First the quantities were estimated: imports were computed using information on confiscated quantities; domestic final consumption using information from health care institutions; and exports were calculated as imports minus final consumption (corrected for confiscation). Subsequently these quantities were valued.

On the basis of a number of reports (Second Chamber, 1996; Grapendaal et al., 1992; Van Dijk et al., 1995; Drug Price Report, 1998), the following assumptions were made for heroin and cocaine: the domestic confiscation rate is 25%, hard drug addicts use an average 0.5 grams of hard drugs daily, the import price of hard drugs is 20 NLG per gram, including costs of transport, the export price of hard drugs is 50 NLG per gram and the street price is 100 NLG per gram.

As stated above, the estimate of the imports is based on the confiscated quantities. To avoid strong fluctuations, a three-year moving average is used. The average confiscated quantity was 6,100 kg per year in the period 1993-1995. In 1995, 5,200 kg was confiscated. As all cocaine and heroine has to be imported, an estimated 24,400 kg must have been brought into the Netherlands.
The number of hard drug addicts is 27,000; at 0.5 grams per day, they consume 5,000 kg. The remaining 14,200 kg (imports minus consumption minus confiscated quantities in 1995) is assumed to be exported. To complete the picture we combined these figures with the prices: the value of the imports (including all confiscated quantities) is 490 million guilders, final consumption can be valued at 500 million, and exports at 710 million. The figures indicate that 720 million of value added was generated by trade in heroin and cocaine.

Unlike heroin and cocaine, synthetic drugs, like XTC, are manufactured in the Netherlands. This means XTC is imported, produced, exported, consumed and last but not least confiscated, rendering it much more complicated to describe the XTC sector than the heroin and cocaine sector. Moreover, health care institutions do not provide numbers of XTC users.

Just as for heroin and cocaine, first of all quantities were estimated. Although police efforts are pushing production away from the Netherlands towards eastern Europe, it is believed that the majority of the XTC is produced locally. Consequently it is assumed here that the imports of XTC are negligible. Exports are estimated using confiscated quantities, and domestic final consumption and intermediate consumption, necessary to produce XTC, using expert opinions. Output is estimated as final consumption plus exports minus confiscated quantities. Subsequently, the estimated quantities are valued.

According to police drugs experts, there are about 200,000 XTC users in the Netherlands, who are believed to take 3 or 4 pills per weekend. A survey by the hotel and restaurant trade organization (Horeca, 1991) revealed that people who visit discotheques do

so 34.5 times a year on average, usually on Fridays or Saturdays. This leads to the assumption that the average number of 'full'l weekends that XTC is used is 17. Half of the visitors are 14–19 years old, forty per cent 20–26 years old.
Based on these assumptions, it is concluded that the domestic final consumption of XTC amounts to 12 million pills per year (3.5 pills x 17 weekends x 200,000 users). In a discotheque a pill costs 25 guilders, elsewhere about half this price. As most users buy their XTC elsewhere, consumption can be valued at 180 million guilders (15 NLG/pill x 12,000,000 pills).

The estimate of the exports is based on the moving average of the confiscated quantities, combined with assumptions on the confiscation rate and prices. The average confiscation of XTC is 2.32 million tablets per year (kilos converted into tablets, average 1993-1995, source: CRI). In 1995, 570,000 tablets were confiscated. For heroine and cocaine, a confiscation rate of 25% is assumed. Most heroin and cocaine passes the border twice: first as imports, later as exports. As XTC is not imported and the larger part of the confiscation takes place at the borders, the total confiscation rate of XTC probably will be less. Here, it is assumed that 10% is intercepted. This means 23.2 million tablets were produced and 10.6 million tablets (production minus final consumption minus confiscation in 1995) were exported from the Netherlands in 1995.

Furthermore, it is assumed that the export price of XTC is 7.5 guilders per tablet, about half of the street price in the Netherlands. The intermediate consumption needed to produce one XTC tablet amounts to 0.25 guilders.

Together, these - quite hazardous - assumptions lead to the following estimates for the XTC sector: imports 0 million guilders, exports 80 million, domestic final consumption 180 million, total output 260 million, intermediate consumption 10 million and value added 250 million.

Soft drugs

The Dutch soft drugs sector is dominated by ‘nederwiet’ - the domestic variant of marijuana - imported marijuana and hashish. A detailed analysis of the subsector of the soft drugs economy has been published by Van Dijk et al. (1995), which combines information from tax authorities and law enforcement agencies with information from interviews with dealers, ‘coffee shop’ owners (where drugs are sold), ‘nederwiet’ growers and cannabis users, and with reports from health care organizations on the use of cannabis. We made grateful use of this publication to compile estimates for this sector. The report gives prices, quantities and information on the intermediate consumption of the ‘nederwiet’ sector (which requires seeds, fertiliser, electricity, lamps, nutrition systems, etc.) for the early nineties. To compile estimates for this period, only some assumptions on export prices and the ownership of confiscated quantities had to be made.

For the year 1995, the figures mentioned above were updated using confiscated quantities (exports, imports, transits and domestic production) and demographic information, i.e. the increase in the number of 15-25 year-olds (domestic final consumption). Excluding confiscated quantities, the estimates for 1995 are: domestic final consumption 100,000 kg, exports 300,000 kg, imports 350,000 kg, domestic production 50,000 kg, transits 675,000 kg. In 1995 confiscation amounted to 330,000 kg imported cannabis and 7,000 kg ‘nederwiet’.

Subsequently, these quantities were valued. The prices mentioned by Van Dijk were updated using the Lycaeum Drug Price Report (Lycaeum, 1998); price indices for electricity and electrical household appliances were used to update intermediate consumption. The resulting estimates are: domestic final consumption 1,000 million guilders, exports (including transits) 4,900 million, imports (including transits and confiscated quantities) 3,800 million and intermediate consumption needed to grow ‘nederwiet’ 60 million. These figures indicate an output of 2,100 million and a value added of 2,040 million guilders.

Prostitution

Like illegal drugs transactions, the registration of prostitution is quite straightforward. However, here too some observations can be made on its treatment in the present national accounts. And besides this, there is the question of whether estimates should actually be made for prostitution in the context of a description of the illegal economy. In the Netherlands prostitution (by adult persons) in itself is in fact legal. Only the exploitation of these services is illegal. Nevertheless, prostitution as well as the exploitation thereof is included here in the illegal economy.

The part of the services sector that includes the operation of prostitution is not surveyed by Statistics Netherlands. On the other hand, if their activities are known, prostitutes and the persons or businesses operating their services are taxed. As such, one can assume that they are (partly) included in the income statistics. However, as the measurement of GDP in the Netherlands is mainly based on a combination of the production and expenditure approach, the output of the prostitution industry may still not be included in the present national accounts.

On the other hand, part of the consumption of prostitution services may already be accounted for implicitly in the national accounts. Services rendered by prostitutes that are paid for by enterprises are accounted in their books as ‘other costs’, i.e. as part of intermediate consumption. As some of these costs are tax deductible, they are usually unlikely to be omitted. Also, the intermediate consumption needed to produce prostitution services is partly accounted for in the national accounts. The necessary lingerie and other objects no doubt are registered as final consumption of households.

Prostitution is a popular theme for PhD theses and essays and these provide a basis for estimates for prostitution. Usually these estimates are computed as the product of the estimated number of prostitutes, the average price of the services and the average number of services rendered. Sometimes the estimates are somewhat refined (Van Mens, 1992). Our preliminary conclusion is that total output of prostitution amounts to about 1 billion guilders per year.

The rent paid for rooms and the sums paid to club owners can be seen as intermediate consumption of prostitutes and as output of (illegal) prostitution operation services. This intermediate consumption is considerable, but it probably does not influence the estimate of the total value added of prostitution including its operation. About half of this output is assumed to be generated by the operation of prostitution, the remaining 500 million is generated by the prostitutes themselves. As about 50% of the prostitutes only stay in the Netherlands for a short period, usually three months, these persons are non-residents and their output has to be accounted for as imports of services. This amount is estimated to be 250 million guilders.

Illegal gambling

The inclusion of illegal gambling in the national accounts is, again, straightforward, at least in theory. In practice, the lack of information on this phenomenon makes it extremely difficult to compile estimates. The only figures encountered are estimates of the number of gamblers in 1989: 21,000 gambling addicts, 360,000 people who regularly play fruit machines, 440,000 people who occasionally play fruit machines, 400,000 people who occasionally visit a casino, 200,000 bingo players (now and again) and 5,300,000 players in the lotteries (Kingma, 1993). We also encountered an estimate of the number of problem 'fruiters': 75,000 (De Zwart and Mensink, 1993). A problem 'fruiter' is someone who loses more than 25% of his net income.

The above figures were used to compile estimates. The 75,000 problem 'fruiters', average net income of 25,000 guilders a year, together would lose some 500 million guilders (stakes minus winnings). The lottery players represent a revenue of around 1,300 million guilders, under the very hazardous assumption that average losses are 20 guilders month. Adding an amount for the other players gives an estimate of total revenues of 2,000 million guilders; if we then subtract the output of the legal gambling industry, we get an output of 600 million guilders for the illegal gambling industry. The assumption that the average losses of the lottery players are 20 guilders a month is not based on solid information. If this guess is wrong by 2.5 guilders either way, the estimate of the output of the illegal gambling industry will be under or overestimated by 150 million guilders. However, the estimate is in line with figures mentioned in a report of the organisation of the legal gambling industry (NRC Handelsblad, 19 September 1996), stating that the output of the illegal gambling industry was between 458 and 817 million guilders in 1995.

Theft and fencing

In contrast with the activities discussed in the previous sections, the inclusion of theft and fencing in the national accounts is rather complicated. In relation to theft, a distinction can be made between theft of capital goods, consumer durables, money or other financial assets on the one hand, and theft from the inventories of producers on the other hand. Both are discussed below. In addition, fencing, an activity related to theft, is dwelt upon.

The 1993 SNA prescribes that if thefts involve a 'significant' redistribution of assets, they should be taken into account. Registration as an 'other flow', i.e. a change in the value of assets or liabilities that takes place as a result of a transaction, is preferred (UN 1993, SNA par. 3.56). Such a registration is comparable with an uncompensated seizure that decreases the assets of the institutional unit losing the asset and increases the assets of the unit doing the seizing (*ibid*. par.12.39) .

Theft of capital goods, consumer durables, money or other financial assets often involves significant amounts. However, because this kind of theft consists of redistribution of assets, it is only important when two different (sub)sectors are involved. All thefts by households from households for example are a mere redistribution within the sector; such thefts will only have to be taken into account if households are divided into subsectors.

Theft from the inventories of producers includes theft from stocks of materials and supplies, and finished goods on the one hand, and theft from stocks for resale on the other. The former consists of theft by employees, the latter also includes shoplifting. In the 1993 SNA, output and intermediate consumption are defined as sales/purchases of goods and services plus/minus the value of changes in inventories. Because recurrent losses caused by normal rates of wastage, theft and accidental damage are considered as (negative) changes in inventories, theft of finished goods leads to a decrease of output, and theft of materials and supplies leads to an increase of intermediate consumption. Value added decreases accordingly. The same holds for theft from stocks of goods for resale: output and value added of wholesalers is influenced negatively by theft. As such, theft is registered neither as a transaction nor as an other change in (the volume) of assets; it is completely removed from the system of national accounts. An alternative method of registration is given by Van der Werf and Van de Ven (1996).

So it can be concluded that no value added is generated by theft as such. This does not apply for an activity related to theft: the trade in stolen goods. The purchase and subsequent sale of stolen goods constitute (monetary) transactions, which should be registered accordingly. Furthermore, value added (trade margin) is generated. Scheme 1 summarises the flows related to the theft of a truck, that is subsequently sold to the rest of the world (excluding insurance transactions)

Scheme 1
Theft of a truck

	before theft	theft	revaluation	fencing	value added	sale
company 1 (initial owner)	100,000	–100,000				
household 1 (thief)		100,000	–50,000	–50,000		
company 2 (fence)				50,000	20,000	–70,000
rest of the world (export)						70,000

For *company 1* this results in an other change in the volume of assets of -100,000, for the *thief* in an other change in the volume of assets of +100,000, a revaluation of -50,000 and disposal of assets (negative consumption) of -50,000, for the *fence* (receiver) in a value added of 20,000 and for the *rest of the world* in an export of 70,000.

Explicit adjustments for these activities have never been made in the present Dutch national accounts. However, some of the value added generated by receivers may be included implicitly. Trade in stolen goods may be mixed with legal trade. Examples are second-hand books, CDs and bicycles. This, and the fact mentioned before that value added only is generated when stolen goods are fenced, or in other words sold and resold, makes it necessary to look into the different types of theft more closely.

First, it was assumed that fencing of 'shop lifted' articles is negligible: these goods are usually consumed by the thief or sold to another consumer, but seldom traded.
Secondly, results from several surveys (Statistics Netherlands, 1993 and 1995) show that theft from households (excluding cars) adds up to about 1.5 billion guilders. The largest part of this, between 1.1 and 1.2 billion guilders, comes from burglary and theft from cars. Most of these goods are probably sold on by a fence. If all stolen goods are sold by a fence, and if the trade margin of the fence is 10%, a maximum of 150 million guilders value added is generated. However, some of the stolen goods (books, CD's) are sold to 'official' traders, who act as a fence, knowingly or not. Value added generated by these traders is already accounted for in the present national accounts. The same is true for many of the stolen bicycles (200 million). Our preliminary estimate is that about 100 million guilders of value added generated by sales by fences of goods stolen from households is not accounted for in the present national accounts.

Thirdly, theft of goods (excluding cars and vehicle loads, and excluding shoplifting etc.) from enterprises amounted to about 300 million in 1995. This estimate is based on an analysis of 1,000 police reports (Ministry of Justice, 1995), that indicated the average value of stolen goods is worth 5,000 guilders. In that year 65,200 cases were reported. About one quarter of the loot was money, and about three quarters of the rest, stolen goods, are sold by fences. This means that goods initially worth about 150 million guilders, are received and re-sold. If the trade margin of the fence is assumed to be 10%, it can be concluded that value added generated by fencing of stolen goods from enterprises will probably not exceed 20 million guilders.

Last but not least, value added is generated by sales of stolen cars. The value of cars stolen from households was just over 300 million guilders (average of 1988, 1990 and 1992). Sixty percent of stolen cars are recovered, some are exported. The report by the Second Chamber (1996) estimates the value of non-recovered vehicles (trucks and cars) at about 220 million guilders a year. The theft of trucks (about 100 million guilders, including loads) and part of the theft of passenger cars is committed by crime syndicates. In this case the thief and the fence may be the same 'company' , which complicates the registration: the loot is sold once only and no value added is generated by fencing. This complication is disregarded here. The margin on stolen cars sold to the rest of the world may be higher than the margin on other stolen goods sold off locally. Most stolen cars are exported, a number are taken apart and sold off as components. Our preliminary estimates are that the value of exported stolen vehicles (including loads) is about half of the initial value (220 million guilders), that is 100 million guilders, and that the value added generated by the sales of vehicles by fences is about 50 million.

To sum up the preliminary estimate of total value added generated by sales by fences is 170 million guilders.

Illegal copies of software, video and audio tapes and CDs

In relation to illegal copies of software, video and audio tapes, a distinction can be made between illegal copies for own final use, and illegal copies in large quantities which are subsequently sold.

Illegal copying for own (final) use especially relates to use of software not bought on the market. Copying video and audio tapes for own use is legal, at least in the Netherlands; royalties are reflected in the price of empty video and music cassettes. Using software without the required licence, however, is clearly illegal. It is a phenomenon that takes place on a regular base, but no monetary transactions are involved.

Illegal copying of originals for subsequent sale clearly involves the generation of income, and output and value added should be adjusted accordingly. In the Netherlands *Buma Stemra* is the authority responsible for collecting and redistributing royalties. This organisation claims that each year illegal copies are sold which would be worth 500 million if they were sold legally. This may indicate an output of 250 million by the illegal 'copying-industry', as consumer prices of illegal copies are assumed to be approximately 50% of the price of the legal versions. Intermediate consumption of this industry is said to be about 10% of the output.

Bribery

Bribery is more common some countries than in others. Blades (1983) mentions two kinds of bribery. First, there are the supplementary payments above 'official' prices. Blades gives the example of hotel guests who are required to bribe the receptionists to confirm their reservation. In this case, the official price plus the bribe should be considered as the genuine market prices.

Secondly, bribery can also consist in illegal payments to someone in a privileged position, e.g. an official who awards a contract to the supplier who offers the highest bribe, or a policeman who accepts a bribe in return for not prosecuting. Blades states that these payments should appear in the secondary distribution of income account as current transfers.
Van der Werf and Van de Ven (1996) indicate that the influence of bribery on GDP is negligible in the Netherlands.

Other illegal activities

In addition to the activities mentioned above, many other illegal activities may also take place in the Netherlands. Examples are smuggling, production and selling of illegal pornography, illegal disposal of (hazardous) waste and refuse, illegal catches by the fishing industry (exceeding EU quotas), poaching, espionage, extortion, contract murder, smuggling of and trade in humans, usually prostitutes or refugees. However, none of these activities are believed to have a significant impact on GDP. Indications of insignificance are given in Van der Werf and Van de Ven (1996).

Conclusion

Table 2 summarises the preliminary estimates of the impact of illegal activities on Dutch GDP.

The GDP of the Netherlands was 639,650 million guilders in 1995. The figures in Table 2 indicate that it is unlikely that total value added generated by illegal activities, that is not included in

Table 2
Preliminary estimates of the impact of illegal activities on Dutch GDP, 1995 (millions of guilders)

	(domestic) final consumption	export	import	output	intermediate consumption	value added
heroin, cocaine	500	710	490	720	0	720
XTC	180	80		260	10	250
cannabis	1,000	4,900	3,800	2,100	60	2,040
prostitution	1,000	0	250	750	0	750
illegal gambling	600	0		600	0	600
fencing	70	100		170	0	170
illegal copying	250	.	.	250	30	220
total	3,600	5,790	4,540	4,850	100	4,750

the present national accounts, exceeds 1% of GDP. Obviously, estimating illegal production involves enormous practical difficulties. Very few reliable sources can usually be found and therefore the methods for estimating illegal production are by necessity unconventional. Each activity requires a different method, and the methods chosen are dictated by local circumstances. This means that each country will probably have to develop its own procedures.

Also, the lack of reliable sources causes the margins of the estimates to be larger than usual. Unfortunately, it has to be expected that the very nature of illegal activities will prevent any improvement in this situation in the near future.

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Measurement of capital stock and consumption of fixed capital in the Netherlands

Piet Verbiest and Peter van de Ven

This article describes the sources and methods applied in the Netherlands to compile the stock of fixed assets and the consumption of fixed capital for national accounts purposes.

Introduction

In the Netherlands, the "perpetual inventory method" (PIM) is applied for the calculation of the stock of fixed assets and the consumption of fixed capital.
Using information on gross fixed capital formation (I) in subsequent years and the expected service life of the assets (d), the gross stock of fixed assets is calculated as follows:

$$(1)\quad SFC_{t,t} = \sum_{i=0}^{d-1} I_{t-i} * P_{t-i,t}$$

where: SFC_{tt} = stock of fixed assets (gross) in year t in prices of year t
$P_{t-i,t}$ = price index of year t with base year t-i

Subsequently, assuming a straight-line depreciation of the fixed assets and an even distribution of the acquisitions of fixed assets over a year, consumption of fixed capital (CFC) is compiled as follows:

$$(2)\quad CFC_{t,t} = 1/d * (SFC_{t,t} + SFC_{t-1,t}) / 2$$

For the calculation of capital stock and consumption according to the PIM, several assumptions need to be made, and certain data requirements need to be met. We shall discuss both the assumptions and the data used in the Netherlands below, and subsequently pay attention to the assets which are (not) taken into account, the survival function, the depreciation pattern, the estimation of the average expected service life, and the availability of data on fixed capital formation. The article concludes with some recommendations for further research.

Fixed assets taken into account

The present Dutch national accounts are in line with the European System of Integrated Economic Accounts (ESA) 1979. As such, consumption of fixed capital is calculated "for all reproducible fixed capital goods, with the exception of capital goods for collective use with an indeterminate life time (roads, bridges, etc.)" (ESA 1979, par. 403). Moreover, livestock is excluded from the calculation of capital consumption. Furthermore, most intangible assets like software and artistic originals, and durable goods acquired by general government for military purposes are not taken into account; most of these goods and services are not treated as fixed capital formation in ESA 1979.

At present, the following eight types of fixed assets are distinguished when compiling estimates of capital stock and consumption:

- dwellings;
- non-residential buildings;
- other civil construction works;
- aeroplanes;
- ships;
- trains;
- other transport equipment;
- machinery and other equipment.

Survival function

An important issue, especially in relation to the calculation of the capital stock, is the survival function applied. A certain vintage of capital goods will almost certainly not be taken out of operation all at once. A spread around the average expected service life is normal. Some capital goods will be retired prematurely because of obsolescence or accidental damage, while others may have a longer than average service life because of careful use. By specifying a survival function, this spread can be taken into account. Introducing a specific survival function, however, considerably complicates the calculations.

The literature on survival functions is extensive. Maddison (1992) and Eurostat (1991) give an overview of the patterns used in a number of countries from which it can be derived that most countries - including the Netherlands - do not take into account this spread: a vintage of capital goods is retired at once when the average expected service life is reached. Exceptions are Germany (gamma-function), the United Kingdom (symmetrical spread of 20% around the average expected service life) and the USA (bell-shaped spread of 55% around the average expected service life). In his study, Maddison (1992) concludes, however, that "Judging by the evidence available for countries where alternative assumptions have been tested (i.e. France, Germany, UK and USA), estimates of the level and growth of capital stock are not very sensitive to plausible variations in the retirement patterns, so I use the simplest (rectangular) assumption". Eurostat (1991) "will use for its own calculations the log-normal function, and recommend to the Member States to do the same".
As stated above, the rectangular retirement is applied in the Netherlands. Only exceptional cases, like the closure of the coal mines in the seventies, are taken into account. In addition, the capital stock is corrected for the disposal of ships and aeroplanes (to the rest of the world), and the selling off of leased cars (to consumers).

Depreciation pattern

Another important issue in relation to the calculation of the capital stock and consumption by means of the PIM is the depreciation pattern applied. From a theoretical point of view, several patterns

can be distinguished, depending on the rate at which the efficiency of a given asset varies over time. SNA 1993, par. 6.190 mentions three possible profiles:

(a) Constant efficiency until the asset disintegrates; for example, an electric light bulb;
(b) linear decline in efficiency; the service life ends when efficiency declines to zero;
(c) A constant geometric, or exponential, decline in efficiency.

It can easily be demonstrated that by combining profiles (a) and (b), a constant rate of capital consumption over the life of the asset can be generated, i.e. a constant or "straight-line depreciation" (SNA 1993, par. 6.193). Ward (1976) states that "for most assets, especially those with long lives and those like buildings where the services they provide do not materially change over time, the conventional straight-line estimate of annual factor services used up seems appropriate. For some machinery and equipment this particular method may be inappropriate because many types of equipment are comparatively more productive when still new. In such cases, a reducing balance, or double declining method, which attaches a greater value to the capital services provided in earlier years, may be more appropriate". For reasons of simplicity, the straight-line depreciation method is applied for all assets in the Netherlands.

Determination of average expected service life

The role of the average expected service life in the calculation of capital stock and capital consumption is twofold. On the one hand, the service life is (one of) the most important determinants in the calculation method. On the other hand, it determines the length of the time series data needed on fixed capital formation.

Information on the expected service life of an asset can be derived from three possible sources: depreciation allowances for income tax purposes, business accounting practices, and direct observation of the interval between the date of installation and the date of final retirement. Each of the methods has its own advantages and its drawbacks; see also Ward (1976). In the absence of information from direct observation, most countries use fiscal data to approximate the service life. In the Netherlands, however, two surveys - the Capital Stock survey and the De-investment survey - provide directly observed data on service lives of different types of assets for a number of industries. These data are used in the calculation of capital stock and capital consumption. If information is lacking, data for comparable industries and/or types of assets are used; in addition, some expert guesses are made. Table 1 gives an overview of the average expected service life per type of asset.

In general, the average expected service life of non-residential buildings is approximately 55 years; the service life of buildings in agriculture, however, is set equal to 20 years because of their rather specific use (cow sheds and pigsties). The service life of other civil construction works normally equals 35 years; exceptions are public transport infrastructure (50 years) and communication works (30 years). For other transport equipment, the service life is usually set equal to 12 years, with one or two exceptions upwards. Not surprisingly, the picture for machinery is rather diverse, because of the heterogeneity of this category; for most industries, an average expected service life of 18-19 years is applied.

In the Netherlands, the average expected service life is assumed to be constant over time. This assumption is questionable. For example, an unexpected price increase of labour input compared with capital input may result in an accelerated retirement of the less efficient old vintages, and vice versa. Furthermore, there is evidence to support the assumption of a systematically decreasing service life of some assets.

A report on German practice states: "As far as motor vehicles are concerned, the available material shows that the lifetime in 1970 was essentially shorter than in 1955. The results of the 1969 survey conducted by the Ifo-institute of Economic Research in Munich among nearly 3,000 manufacturing enterprises also confirm the time trend towards a shorter lifetime" (Lützel, 1977). Eurostat (1991) reported that Germany indeed assumes a systematic decline of the average service life, of 0.5% a year. Besides Germany, in the European Union only the UK assumes a varying service life.

Time series of data on fixed capital formation

Table 1 shows that gross fixed capital formation time series of considerable length are needed to calculate capital stock and consumption. This applies especially to dwellings and, to a lesser extent, to non-residential buildings and other civil construction works. In the Netherlands, the most recent revision of national accounts data was for the reference year 1987; consistent time series of capital formation according to the sources and methods of this revision are available from 1948 onwards. It should be noted, however, that up to now the data for the period 1948-1968 could only be estimated by a rough extrapolation of volume and price changes. In addition to these time series, estimates of the capital stock for enterprises (including owner-occupied dwellings) and government are available for 1948 and 1952, respectively (Korn and Van der Weide, 1960).

The estimation of capital stock and consumption distinguishes 25 industries and 8 types of assets (see table 1). The allocation of capital formation to industries is based on the principle of economic ownership, i.e. capital formation is allocated to the industry that ultimately bears the economic risk of investing. As such, capital formation is allocated to the lessee in case of financial leasing, and to the lessor in case of operating leasing.

Especially in the case of buildings, the average expected service life exceeds the length of the available time series on gross fixed capital formation. As a consequence, additional assumptions had to be made in relation to the vintage-structure of the capital stock in 1948 and 1952, respectively. It was assumed that the stock is equally spread over the relevant years, and that the annual investments for the industries and types of assets distinguished equal

Table 1
Average expected service life by type of asset

Type of asset	Service life in years
Dwellings	100
Non-residential buildings	20–55
Other civil construction works	30–50
Aeroplanes	15
Ships	22
Trains	28
Other transport equipment	12–25
Machinery and other equipment	10–21

$1/d * SFC_{1948}\,(resp.SFC_{1952})$.

Concluding remarks

At the moment, the Dutch national accounts are under revision to align them with SNA 1993 and ESA 1995. In addition, new sources of information will be introduced. The first results of this revision will become available in 1999 for reference years 1995 to 1998. A major project of the 1995 revision is the improvement of the estimates for capital stock and consumption. Special attention will be paid to:

- Inclusion of intangible fixed assets, and fixed capital formation for military purposes in accordance with SNA 1993.
- Further research into the estimates of average expected service life. In this research, more extensive use will be made of the results from the De-investment survey. Besides, the possibility and desirability to introduce survival functions and variable average service lives will be considered.
- Whenever feasible, capital stock estimates calculated according to the PIM will be integrated with recent information on capital stock observed directly. This procedure may be feasible for dwellings, non-residential buildings, and equipment for some industries (especially manufacturing). However, differences in definition and scope between the PIM estimates of capital stock on the one hand and the capital stock directly observed on the other may need to be overcome. Further research is needed into the possibility to quantify these differences.
- For recent years (from 1986 onwards), more detailed information is available for gross fixed capital formation, for as far as industry branches and types of assets are concerned. As a consequence, more accurate calculations of capital stock and consumption can be compiled by introducing more specific information on the average expected life service by industry.

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Settlements, public facilities and customers: using Geographic Information Systems (GIS) for funding purposes

Matthieu Vliegen and Piet van Dosselaar

On 1 January 1997 the Act on the Municipal Fund was replaced by a new law, in which a very comprehensive list of criteria is defined for payments to be distributed from this fund to the local authorities. Some criteria, such as the one described here, are new: the potential of customers of public facilities in settlements within the municipalities - the lowest administrative level in the Netherlands. This article [1)] describes the theoretical model for the criterion, the data sources and the application in a geographic information system (GIS) application used to compile the relevant statistics as well as some preliminary results.

Introduction

The administrative structure in the Netherlands consists of a hierarchical system of three levels of government: central (the Netherlands), provincial (12 provinces) and local (municipalities - 548 in 1998). Each level of government has its own tasks and responsibilities. Central, provincial and local authorities are relatively autonomous, since every authority has its own legislative power. This legislative power can only be exercised, of course, for its own territory. There exists, however, another restriction in exercising this power. Regulations issued by a lower level of government, e.g. a local authority, may not conflict with a regulation issued by an authority of a higher level - in this case: a provincial authority and central government.

In order to perform their tasks the provincial as well as local authorities have their own budgets. Both authorities, however, cannot fully meet their expenditures from their own revenues. Although the local authorities, for example, have their own revenues such as local taxes and rates, these amount to only forty percent of their total receipts. The remainder is financed by central government.

Central government can finance provincial and local authorities in two ways: either for a specific purpose, or with a lump sum which has a general character. The latter has been institutionalised by two structural funds: the Provincial Fund and the Municipal Fund. The total amount of the financial contributions from these funds and the criteria used to determine the share of each provincial or local authority respectively are regulated by law.

On 1 January 1997 the Act on the Municipal Fund of 1984 was replaced by a new law. This new law defines a more comprehensive list of criteria defined for the payments to be distributed from this fund to the individual local authorities. To put these criteria into practice, concrete figures are needed, and this is where Statistics Netherlands plays an important role, as most of these figures are taken from statistics which are published regularly by our office. Examples of such figures are: inhabitants - total, 19 years or younger and 65 years or older - minorities, households with a low income, persons claiming social benefits, as well as land area, area of coastal waters, housing units and address density of the surrounding area (see Vliegen and Van de Stadt, 1994, for more information on address density). Figures for some criteria, however, are compiled at the special request of the administrators of these funds - the Ministry of Home Affairs and the Ministry of Finance. This is, for example, the case for figures on the potential customers of public facilities - a criterion defined in the new Act on the Municipal Fund, which is the topic of this article.

Settlements and public facilities: the attraction model

The criteria used in the new Act on the Municipal Fund were developed on the principle that they should relate to differences in expenditures between local authorities on a certain number of policy fields. One of these policy fields refers to the presence and maintenance of public facilities. The range in public facilities on the local level clearly varies with the size and type of the local community. Cities and towns, generally speaking, have a broader range of public facilities than suburbs or rural areas. Many facilities present in these cities or towns are used not only by the citizens of these communities but also by the inhabitants of suburbs and neighbouring rural areas. From the viewpoint of local expenditures this situation is a peculiar one. The local authorities of cities and towns finance facilities on their territory for customers outside this territory without receiving payment for this service from the respective local authorities.

The study on the development of an appropriate criterion which could take into account this imbalance in expenditures between cities and towns on the one hand, and suburbs and rural areas on the other, took a long time. The Advisory Body for Local Budgets who conducted the study, finally opted for an abstract model to tackle this problem, for models based on levels of actually present public facilities had shown to have too many disadvantages for this aim. The abstract model finally chosen by the Advisory Body was borrowed from models representing consumer spatial behaviour in order to delineate retail trading areas and to define their potential customers. The model presented by David Huff (Huff, 1964) was a particular source of inspiration in this respect.

Unlike the models of other market analysts Huff's theoretical model for defining trading areas and estimating the expected number of customers for a particular shopping area focused on the consumer rather than the firm as the primary agent. In addition to the parameters used in the traditional gravity models in this field of research - population masses of areas and the distance between these areas - Huff introduced the element of possible competition between neighbouring areas by introducing the customer's ability to choose between alternatives.

This particular element of competition Huff had introduced was very important for the Advisory Body for Local Budgets to grasp the potential customers of public facilities in the various kinds of settlements (Raad voor de Gemeentefinanciën, 1995). Since the people living in suburbs, for example, have 'intervening opportunities' for excellent public facilities in the cities, a substantial number of these people will be oriented in this respect towards the neighbouring cities. Inhabitants of a settlement as large as a suburb but geographically located in the middle of an extended rural area will, on the other hand, be oriented towards their own settlements in this respect. Huff's model based on the consumer as primary agent, took such effects into account.

The theoretical model for the estimation of the potential of customers of public facilities the Advisory Body opted for, was based on the following assumptions:

– Larger settlements offer more public facilities and will also attract customers from small settlements;
– People will make use of public facilities less, if the distance to be covered to these facilities increases. Over a certain distance, nobody will make use of the facilities anymore: the distance may be prohibitive or the customers will use facilities which are located nearer to their homes;
– As providers of public facilities settlements will compete with each other in a spatial system of settlements of various size and geographical position. As a consequence the level of public facilities present in a settlement depends not only on the number of its inhabitants, but also on the presence or absence of possible alternatives in its surroundings.

The starting point in the theoretical attraction model chosen can be formulated as follows: the attraction public facilities in settlement *j* exert on the population of settlement *i* (A_{ij}) varies with some function *f* of the population of settlement *j* (M_j) and inversely with some function *g* of the distance between settlement *j* and settlement *i* (D_{ij}). In formula:

(1) $A_{ij} = f(M_j) / g(d_{ij})$

However, various settlements *j* exert an attraction on the population of settlement *i*. From the viewpoint of settlement *i,* A_{ij} can be expressed as a proportion of the total attraction (A_i) added for all settlements *n* ($A_i = \sum_n A_{in}$). In formula:

(2) $P_{ij} = A_{ij} / A_i = (f(M_j) / g(d_{ij})) / \sum_n (f(M_n) / g(d_{in}))$

The proportion (P_{ij}) in formula (2) indicates the probability that an inhabitant of settlement *i* uses the public facilities of settlement *j*. Multiplying P_{ij} by the number of inhabitants of settlement *i* (M_i) yields the estimation of the number of inhabitants living in settlement *i* regularly using the public facilities of settlement *j* (C_{ij}). In formula:

(3) $C_{ij} = P_{ij} * M_i$

Adding the values of C_{ij} for all settlements *i* yields the total number of potential customers of the public facilities in settlement *j* coming from all settlements *i* (including those of settlement *j*). In formula:

(4) $C_j = \sum_i C_{ij} = \sum_i (P_{ij} * M_i)$

Lastly, it is interesting to note that adding the values of C_{ij} in formula (3) for all settlements *j* yields the number of inhabitants of settlement *i*, since the sum of P_{ij} over *j* equals 1. The model yields, therefore, a redistribution of the total population of the settlements: from inhabitants of settlements to potential customers of public facilities in those settlements.

Potential of local and regional customers

Having developed the general attraction model for estimating the potential of customers, the Advisory Body elaborated two variants of this model. As the Advisory Body observed, great differences exist between the various public facilities in scale as well as in geographical range. For the sake of simplicity the Advisory Body made a distinction in this respect between (a) public facilities with a local impact - for example public libraries or sports grounds - and (b) facilities with a regional impact - for example theatres or concert halls. The former can be found in many settlements and operate on a small geographical range; the latter are found only in settlements of a certain size and their geographical range is much wider.

Based on these differences the Advisory Body proposed two criteria: the potential of local customers of public facilities as well as the potential of regional customers of such facilities. In the *local* variant the range of the public facilities is geographically limited to 20 km. Furthermore, the function $f(M_j)$ in formula (1) is defined as $f(M_j) = M_j$ and the function $g(d_{ij})$ in this formula as $g(d_{ij}) = d^2_{ij}$. The *regional* variant, on the other hand, takes only public facilities on a large geographical scale into account, so that the maximum distance in this model is extended to 60 km. The function $f(M_j)$ in this variant, however, is defined as $f(M_j) = M^2_j$; the definition of the function $g(d_{ij})$ remains the same as in the local variant: $g(d_{ij}) = d^2_{ij}$.

The equations used in the general model were subsequently adapted to the functions defined in the local and regional variant. Thus, the probability that an inhabitant of settlement *i* uses the public facilities of settlement *j* (P_{ij}) is computed in the *local* variant by the following formula:

(5) $$P_{ij} = \frac{M_j / d^2_{ij}}{\sum_{n:d_{in} \le 20} M_n / d^2_{in}}$$, if $d_{ij} \le 20$ km and $P_{ij} \equiv 0$ if $d_{ij} > 20$

where:

– M_j = the number of inhabitants of settlement *j*;
– d_{ij} = the distance between the settlements *i* and *j*.
– the sum in the denominator sees to it that the total potential of local customers from settlement *i* equals the number of inhabitants of this settlement

The probability that an inhabitant of settlement *i* uses the public facilities of settlement *j* (P_{ij}) is computed in the *regional* variant by the following formula:

, if $d_{ij} \le 60$ km and $P_{ij} \equiv 0$ if $d_{ij} > 60$ km

(6) $$P_{ij} = \frac{M^2_j / d^2_{ij}}{\sum_{n:d_{in} \le 60} M^2_n / d^2_{in}}$$

where:

– M_j = the number of inhabitants of settlement *j*;
– d_{ij} = the distance between the settlements *i* and *j*.
– the sum in the denominator sees to it that the total potential of regional customers from settlement *i* equals the number of inhabitants of this settlement.

In both variants the estimation of the number of inhabitants living in settlement *i* regularly using the public facilities of settlement *i*

(C_{ij}) is calculated from P_{ij} and M_i by formula (3) above. The total potential of local and regional customers respectively of settlement *j* (C_j) is subsequently obtained by adding the values of C_{ij} for all settlements at a distance of 20 km or less for the local variant, and 60 km or less for the regional variant - using formula (4) above. Since the distribution of payments from the Municipal Fund is based on figures for the whole territory of the local

Figure 1

Settlements in the Netherlands

authorities - i.e. the municipality -, the total potential of local and regional customers respectively of these municipalities (C_m) is obtained by adding the values of C_j for all settlements *j* belonging to municipality *m*.

Practical application

Supplementary definitions

In addition to the development of the theoretical model and the formulas to be used for the calculations it was still necessary to define (a) the settlement, (b) the inhabitants of a settlement as well as (c) the distance between settlements. These definitions, as well as the calculation formulas had to be part of the new Act on the Municipal Fund.

The *definition of the settlement* is based on earlier work of Statistics Netherlands on the delineation of localities. This work refers to attempts to group particular census tracts to localities in a (GIS) environment. Within this framework a map consisting of grids of 500 x 500 metres with at least 25 addresses per grid square was used as a yardstick for grouping these tracts. This grid map had been constructed as a proxy for the continuous built-up area - the basic characteristic of a locality (see, Vliegen, 1993). Hence, the continuous built-up area had been operationally defined as a configuration of such grid squares which are contiguous at least on one side or an isolated grid square with 25 addresses or more. After a thorough scrutiny the Advisory Body for Local Budgets adopted this proxy of a continuous built-up area for the definition of the settlement. Only one amendment was made to the proxy: it should not cross the boundaries of the municipalities. Localities extending to the territory of two or more municipalities therefore had to be split up into more than one settlement.

In applying the criterion the total resident population should be redistributed to potential customers of public facilities. A further specification of the *inhabitants of settlements* was therefore necessary in order to take sparsely populated areas into account. It was decided that people living in such areas should be assigned to a particular settlement. The assignment itself occurs in proportion to the size of the settlements at the level of the individual municipality. Inhabitants of a settlement are thus defined as an enlarged population in settlements.

The *distance* between settlements was defined as a straight line from the centre of one settlement to the centre of another. The centre was operationally defined as the centre of gravity - in terms of a geographic co-ordinate - of the configuration of grid squares mentioned above, re-weighted for the number of addresses in every grid. The distance of a settlement to the settlement itself was set at 1 km.

Calculating the potentials: data sources and data processing

The sources used for the calculation of the potentials of local and regional customers of public facilities are twofold: the Geographic Base File (GBF) and the enumeration files from the Municipal Population Registers (MPR).

The GBF is an automated register with all postal addresses in the Netherlands to which the codes of the municipalities, the census districts and tracts and the postal districts are attached, as well as the geographical co-ordinates of the national system of grid squares of 500 x 500 metres. The GBF is updated annually by a consortium of the Post Office, the National Physical Planning Agency and Statistics Netherlands.
The GBF is used in two ways in the data processing for the calculation of the potentials of customers. First, it constitutes the basic file for gathering the data required for the delineation of the settlements, namely figures on the number of addresses for every grid of 500 x 500 metres. Since the GBF is also a relational system between small areas with the address as the key, it is matched with the enumeration files from the MPRs at the level of the individual addresses. In this matching process the co-ordinates of the national grid system as well as the codes for the census districts and tracts are attached to the MRP enumeration files. In this way it is possible to compile, among other things, figures on the number of persons for every grid square of 500 x 500 metres.

In the further stage of the data processing, the file with the GBF addresses per grid square is introduced in a GIS to determine the contiguity of grids with 25 or more addresses and, consequently, to delineate the proper configurations of grid squares as proxies for the settlements. The GIS is used, moreover, to assign an unique code to the delineated configurations of grid squares as well as to compute their centre of gravity in terms of a co-ordinate of 500 x 500 metres and the distances between the respective configurations. Subsequently, the file with the number of persons for every grid square of 500 x 500 metres is introduced in the system in order to compute the figures on the inhabitants of the settlements.

Having delineated the settlements for every municipality and computed their inhabitants as well as the distances between the settlements, the potentials of local and regional customers can be computed straightforwardly using the formulas described above: first for the individual settlements and then for the municipalities.

Some preliminary results

Settlements and their inhabitants

The new Act on the Municipal Fund took effect on 1 January 1997. In view of a timely administration by the Ministry of Finance preliminary figures were compiled on the potentials of customers. These figures were derived from a provisional version

Table 1
Municipal settlements and their inhabitants by size, preliminary figures 1996

Size of settlements	Settle-ments	Population		
		Total	Average	In % of total population
		x 1 000		*%*
200 000 and more	4	1 851.9	463.0	10.2
100 000 –< 200 000	16	2 201.9	137.6	14.2
50 000 –< 100 000	35	2 388.0	68.2	15.4
20 000 –< 50 000	98	2 912.6	29.7	18.8
10 000 –< 20 000	134	1 913.8	14.3	12.4
5 000 –< 10 000	180	1 285.3	7.1	8.3
2 000 –< 5 000	337	1 112.5	3.3	7.2
1 000 –< 2 000	354	502.1	1.4	3.2
500 –< 1 000	364	259.5	0.7	1.7
500 or less	1 593	250.4	0.2	1.6
Sparsely populated areas		815.8		5.3
The Netherlands	3 115	15 493.9	5.1	100.0

Table 2
Municipal settlements and their potentials of customers by size, preliminary figures 1996

Size of settlements	Potential of customers					
	Local			Regional		
	Total	Average	Per 100 inhabitants	Total	Average	Per 100 inhabitants
	x 1 000					
200 000 and more	2 129.6	532.4	115	4 285.4	1 071.3	231
100 000 - < 200 000	2 554.2	159.6	115	3 960.3	247.5	178
50 000 - < 100 000	2 701.4	77.2	112	3 035.3	86.7	125
20 000 - < 50 000	3 155.5	32.2	105	2 534.5	25.9	84
10 000 - < 20 000	2 004.6	15.0	97	1 044.1	7.8	50
5 000 - < 10 000	1 252.0	7.0	87	420.7	2.3	29
2 000 - < 5 000	1 002.9	3.0	78	173.5	0.5	13
1 000 - < 2 000	385.6	1.1	66	31.7	0.1	5
500 - < 1 000	166.8	0.5	55	6.4	0.0	2
500 or less	141.3	0.1	48	1.9	0.0	1

of the GBF 1996 and from estimates of the number of persons per grid square. These estimates were based on the addresses in the GBF of which the characteristics indicate that they might be inhabited.

The map in Figure 1 shows the result of the first stage of the data processing, namely the delineation of the settlements. Just over 3,100 settlements within municipalities were identified in the process. Some characteristics have been summarised in Table 1. These figures as well as the map show that the Netherlands is highly urbanised. Applying the ECE definition of an urbanised area - i.e. settlements with 2,000 inhabitants or more - it can be deduced from the figures in Table 1 that about 88 per cent of the population in the Netherlands lives in such an urban area. Only four settlements within the municipalities, however, have more than 200,000 inhabitants, namely Amsterdam, Rotterdam, The Hague and Utrecht - the only four big cities in the country.

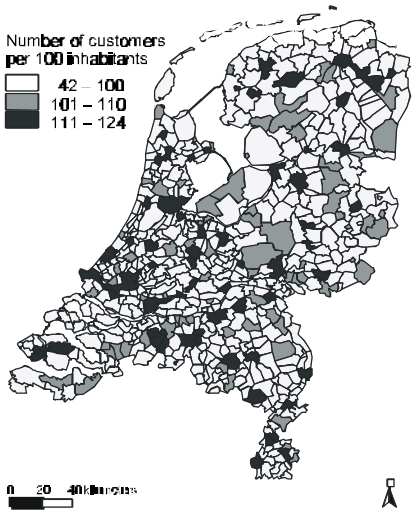
Potentials of local and regional customers

Table 2 summarises the results of the calculations with regard to the potential customers of public facilities in settlements of various sizes. With respect to the figures in this table two general observations can be made. First, the presuppositions made in the theoretical model are clearly reflected in these figures. Larger settlements attract relatively more potential customers than smaller ones. This applies for potential customers of both local and regional facilities. The figures for the first type of potential customers vary from 115 for the largest settlements to 48 per 100 inhabitants for the smallest ones; for the second type from 251 potential customers to 1 potential customer per 100 inhabitants.

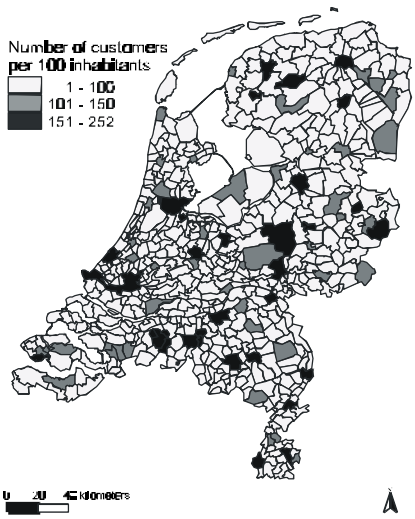
The second observation to be made refers to the difference in ‘break even point’ between the two variants of the attraction

Figure 2

Potential of local customers
Preliminary figures 1996



Potential of regional customers
Preliminary figures 1996



model. The figures show that - generally speaking - for local facilities this point is situated at settlements with 20 thousand inhabitants. For facilities with a wider geographical range, however, the break even point seems to be situated at settlements with 50 thousand inhabitants. Above these break even points the number of potential customers of settlements exceeds the number of their inhabitants. The two maps in Figure 2 give an insight in the geographical distribution of this phenomenon at the level of the municipalities. The municipalities belonging to the highest category in these maps can be considered as occupying a more or less central position in relation to their neighbouring areas.

Payments to be distributed

The payments distributed in 1997 from the Municipal Fund to the local authorities amounted to more than 21 billion guilders. About twelve per cent of these payments - 2.6 billion guilders - is based on the criterion of the potential of customers: 1,778 million guilders for the potential of local customers and 869 million guilders for the potential of regional customers.

The figures on the potentials of customers lead to large differences in the receipts based on this criterion obtained by individual local authorities from the Municipal Fund. These receipts vary from 273 to 50 guilders per inhabitant. Remarkably, the large cities do not receive the highest amount per inhabitant with respect to this criterion. Amsterdam, for example, ranks seventh, Rotterdam fourth and The Hague tenth. It seems as if these cities - all of them located in the most urbanised part of the Netherlands: the so-called Randstad Holland - have more competitive cities in their neighbourhood than cities like Groningen (ranking first), Eindhoven (second) and Nijmegen (third) located peripherally to the Randstad in the north, south-east and east of the country.

Future developments

In the near future GIS is expected to have a still stronger impact on the compilation of statistical figures for the payments to be distributed from the Municipal Fund. At the request of the Ministry of Finance and the Ministry of Home Affairs, Statistics Netherlands recently carried out a pilot project with regard to a possible replacement of an already existing method for the calculation of figures on the total residential and industrial areas at the level of the municipalities by way of a GIS application. The basic input for such an application is the digital topographic map, scale 1:10,000. The results of this pilot were qualified by both Ministries as useful for payments to be distributed from the Municipal Fund. Meanwhile the Ministry of Finance has commissioned Statistics Netherlands to develop and maintain a GIS application for this purpose.

At a later stage the geographic information system which has now been developed for this purpose, will probably have to be extended for other applications. One of the priorities on the list of both Ministries is a diversification of the total residential and industrial area by type of soil on which the respective buildings have been constructed. Building on peat, particularly on bog, for example, is more expensive for local authorities than building on sandy soil.

A stronger impact of GIS for funding purposes makes the need for standards even more important. In addition to the digital boundaries of the municipalities the digital topographic map mentioned above can be also one of such standards. It is, therefore, the policy of Statistics Netherlands in the long run to derive all kinds of area related figures from this map.

Notes

1) This article is based on a paper presented at the ECE work session on Geographic Information Systems in Brighton, September 1997.

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