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INDIRECT METHODS USED FOR WASTE STATISTICS AND WASTE INDICATORS

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ABSTRACT

Waste statistics is a broad subject with many different sectors that produce refusals and wastes starting with liquid sewage, wet organic waste, dry municipal waste, hazardous material, pesticides and toxic chemicals, medical, nuclear, sludge containing heavy metals, metals, to iron and car scrapes.

In many countries, especially those who are referred to as developing countries (with new development of industrial centers) no ***organized reporting system*** about waste is available. We are interested to construct lists of materials that serve as inputs to research and industry, as well as lists of products (outputs) from industries. From the relationship between input and output we may estimate the sort and the quantity of waste, refusals, recycled, reused and reduced materials.

To overcome lack of information sources, data are received by ***Indirect Methods*** of collection, and from it – analyzing and constructing waste registers and indicators.

Examples of indirect data are given in chapter 6, from the Municipal Waste sector, Recycling data, Hazardous data and Ruling from the Courts, describing lawsuits with the offences and the fines.

The conclusion is that governments have to make sure that professional sampling surveys are performed constantly, in all waste sectors, as only good statistics and reliable estimates will help the waste management to be efficient and prevent destruction of the natural environmental resources as air, water and soil.

Indirect Data (not perfect data) as they are obtained currently, are a cheap way to get a crude idea about the situation, but the estimates are not professionally done, and lack reliability. No knowledge about the error term is available from Indirect Data that has been obtained without a sampling plan, to back it up.

On the other hand, waiting for the designated sample survey, without knowing the limitations that may develop from it, is not the right policy. It is necessary to continue estimating or modeling with the indirect data and simultaneously, to try and get a small survey financed. These surveys should be performed in order to check the basic assumptions and to reassure ourselves that the modeled parameters and estimations were not very far from what we may get in a desired survey.

Indicators have been suggested for the various waste sectors. But as long as the input data for the indicators and the models are of low quality, the indicator and the estimates from the models are of even worse quality. (GIGO). Nevertheless, we have to use them, as they are the only outputs from the data that are available to us.

Proposals:

- Whenever we provide data and **describe results** from our Tables / Indicators, rather than leaving them in a tabular form it would be efficient to present them also in a literary form to make the results easy to grasp by the policy makers.
- **Describe the conclusions** that follow the results in the Tables / Indicators, so that the policy maker will have it easier to understand what the consequences and the policies should be.
- Set up a **steering committee** from all the ministries who are connected to environmental problems (see chapter 8) to encourage replacing or strengthening indirect data with designated surveys, and plan sampling surveys, instead or in addition of indirect data, for all different waste sectors.
- Decide whose responsibility it is to update, collate, analyze and manage the databases and the Pollutant Release Transfer Register.

1. INTRODUCTION

Dealing with waste is a heavy, dirty, smelly, difficult, expensive and technically complicated task. At the same time its transportation and treatment is an important objective. Waste, if not treated properly, may potentially induce not only inconveniences for the population but also serious health risk.
Waste data collection, is differentiated by methods, instruments and therefore by the accuracy achieved, from water and air quantitative and qualitative measurements. Air and water quantities and qualities are measured with instruments, at a network of stations located where the planner designed and planned them, according to scientific considerations. In the fields of air and water we measure chemical, physical and biological processes. Whenever dealing with waste weights, we are not fully aware of what we collect, as we may deal only with part of the residuals. The quantity of waste that we did not lay our hands on is unknown. The comparison between natural sciences and the social sciences is of the same nature. If the correlation between two variables in the natural sciences does not come close to 1, the correlation is disregarded. In social sciences any correlation (as long as it is significant) is accepted as a genuine relationship. In the waste field – any information we may be able to produce is cherished.
Models and functional (mathematical) relations between waste quantities, transportation costs, treatment expenses etc. are often difficult to build.
Some estimates use models and assume mathematical relations and functional dependency. For example, size of forests and its relation to extinct species. These relations may be based on wrong assumptions and we may continue to use them. It is important to use sensitivity analysis on different parameters of the model to make sure that we use the optimal values. If we do not achieve the optimal model, then as a consequence, the erroneous functional relation effects the estimates. The errors may be of the order of magnitude, and not just a neglected difference.[a]

The individual "economic entity" (industry, organization, decision maker) will make the right decision from the social point of view, i.e. based on an economy wide interest, only if faced with the true shadow prices of various variables. One of the objectives of the "economic unit" is to optimize calculations and to decide according to the optimal mix of methods for waste transportation, waste reduction, abatement, cleaner technologies, etc. It is important to maximize the value of the end results and minimize the cost. The shadow prices will dictate the policy, which will be chosen by the management. If it is very expensive to reduce waste in one sector and cheaper to recycle in another branch – the decision has to take into account this cost / benefit consideration. People do (hopefully) act in a rational way when facing different cost alternatives, and the abatement taxes should be accordingly. Taxes should be reasonable, in such manner that the economic entity will have an incentive to follow the policy that the government tries to implement.

To design surveys for every sort of waste (household (HH) waste, hazardous, construction, industrial, medical, agricultural etc.) is an expensive project. Countries at the beginning of their industrial development are not yet fully aware of the importance of setting up a complete data base of the waste dynamics, for every year.

The fact that the waste data are often obtained from administrative forms which are not designed to report and collect data on waste quantities, content and characteristics, opens a new term for dealing with this material: ***Indirect estimates or Indirect Methods.***

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The views, conclusions and errors described in this paper are solely the author's responsibility.

2. OBJECTIVES

Governments need to have good knowledge about the quantities and contents of the different wastes produced in the Municipalities (as households, waste resulting from economic activities etc.). Local authorities and even the central government spend huge amounts out of the Gross Domestic Product (GDP) for treatment of waste. The availability of waste data and calculation of waste indicators are crucial for policy forming and decision-makers.

Following, are a few tools to achieve the objective of managing the waste activity in a manner that will minimize the harm to the environment and maximize the economic and industrial profits. These tools rely on waste data collection, even if the data are of low quality and ***indirectly achieved from forms and questionnaires that were designed for different administrative purposes. Analyzing such data and building models with it, is referred to as Indirect Methods.***
Collection of indirect data as well as estimates resulting from models based on such indirect information may either underestimate or overestimate the results.

3. A TOOL TO ACHIEVE THE OBJECTIVES

The objective to manage the waste in an optimal manner needs to rely on several tools:

- A register of waste – ***Pollutant Release and Transfer Register*** (PRTR) for different sorts of waste.
- An economical model of ***Green Accounting*** - National Accounting on public waste expenditures and abatement cost.
- A set of ***Waste Indicators*** to enable analysis of the pressures, state and responses.

3.1 A register of waste – Pollutant Release and Transfer Register (PRTR) for different sorts of waste.

One goal of trying to get as much information on waste as possible (even though it is achieved ***indirectly***), is to construct a national register of pollutants, (with quantities and qualities). This PRTR will include raw data for the following waste groups: municipal waste (including household wastes, commercial, and yard waste), construction waste, hazardous waste, industrial waste, agricultural waste, medical waste etc. This PRTR has to be planned in consultation with other interested and affected parties (stakeholders).
The register should have a section on recycled matter (methods and quantities), composition of household waste, reuse and reduction of various wastes.
These registers differ from country to country, depending on the local priorities and are not yet standardized. Such a register, made available to the public, to planners in different areas, to the government and to private enterprises, has many and varied benefits.
The cost, though, of collecting data according to geographical areas, and managing such a register, is high. At the onset one has to decide what data to collect, which parameters to

register, which indicators to calculate, who is collating, organizing and disseminating the input data and how the public may access the outputs (estimates, models and indicators).

Constructing databases to be included in the PRTR for different waste sectors:

In Israel the data that we collect in an indirect collection procedure, are the basis for waste files, some of them listed below:

1) Solid household waste, including commercial and yard-waste.
2) Hazardous waste (from: households, industry, research institutes, agriculture, veterinary, municipal, medical etc.), and its treatment at a lawful treatment plant..
3) Sewage and effluents: including sludge with heavy metals, waste water (sewage), treated waste water (effluents), recharged effluents, reclaimed water.
4) Agricultural waste.
5) Industrial waste and its release.
6) Waste from construction and building restoration (and its destination).
7) Other wastes (nuclear, etc).

Israel started to build several of the databases mentioned above, collected by various different organizations, without having a TOR (Term of Reference) to a general decision. Israel has no decision yet on the structure of a national PRTR. Lists of hazardous materials and allowed pesticides are available in an official manner at the Ministry of the Environment, the Ministry of Agriculture and the Ministry of Health.

Proposal: The Ministry of the Environment together with the Central Bureau of Statistics and other interested parties have to work out a broad plan, and decide on:

- Structure of the PRTR,
- Content of the Data Base (DB),
- Responsibilities for the definitions,
- Responsibilities for the management,
- Sources of input data,
- Designing surveys and constructing questionnaires,
- Financial arrangements to construct the DB,
- Financial arrangements for updating and managing the DB.

3.2 National accounting on waste-expenditure and pollution abatement cost.

The PRTR may be helpful for the input needed to calculate environmental expenditures. The expenditures on public services for environmental protection, by operating sector, type of services and type of expenditures are reported in Israel since 1993 according to the new UN and ***Eurostat*** categories for type of service (**SERIEE** – see details in definition section). Similar calculations, with different categories, were performed for 1978/79 up to 1980/81. Most recent calculation for the public sector's environment expenditure for management and pollution abatement data refers to 1998, while the current CBS publications in its yearly abstract refer to the 2000 data for almost all other topics. Collection of all expenditure sources seems to be a tedious and difficult task.

3.3 Waste Indicators for analysis of the pressures, state and responses.

The intention is to collect, analyze and report all kinds of wastes created by human beings either in their home or at their working place. Various indicators calculated from the data should present the ***Pressure (Driving Force)***, the ***State (Impact),*** and the ***Response*** to various

waste sectors and it should indicate trends and flaws. It has to be taken into account that since waste data in many developing countries are not obtained via a designated waste survey, but rather received by ***Indirect methods***, the data and the information should be taken with some caution. It is not as reliable as data obtained directly from a designated sample survey.

4. SELECTIVE DEFINITIONS, EXPLANATIONS AND UNITS

- **Pollutant release and transfer registers (PRTR)**

"A PRTR is an environmental data base or inventory of potentially harmful release to air, water and soil as well as wastes transported to treatment and disposal sites. Facilities releasing one or more of the substances must report periodically on what was released, the quantities involved and to which environmental media the materials were transported." [b]
The PRTR is a tool that can augment government efforts to achieve integrated environmental management and to promote pollution prevention.
Most western countries that have established PRTRs make the data available to all interested parties.
The register in Europe (since 1996) is referred to as **Pollutant Emission Register.** In the US, it is called The US **Toxic Release Inventory** (TRI).
Israel started a PRTR only for hazardous waste.

- **National Green Accounting**

Green Accounting is calculated in Israel only for the public sector. All the definitions and categories are taken from the manual ***SERIEE*** – **System for the Collection of Economic Information on Environment, version 1994**.
This manual is up to this day the source of the definitions. Nowadays, the intension is to change to the UN definitions.

Operating sectors: government (including national institutions), governmental companies, local authorities, and non-profitable enterprises.
Type of service: waste water management, waste management, protection of the biosphere - landscape and air, general administration services other services. (According to the ***Eurostat*** definitions and categories).
Type of expenditure: compensation of employees, current purchases, depreciation, building and other construction works, machinery and equipment.

The ICBS division of national accounting are planning, in cooperation with the environment and agriculture statistics division, to perform a survey on expenditures for environmental protection, in private industries whose expenses are probably very large for waste management of different sorts, reuse, recycling and reduction of waste and sewage treatment. Shortage of financial resources postponed the survey for the time being.

- **Municipal Waste Definition (from the European Experience)**

Municipal Waste is waste collected by or on the order of municipalities. It includes waste originated from:

- **Households:** garbage, bulky waste, separately collected waste, unclaimed cars, carcass of dead animals, hazardous waste.

- **Small business:** offices, commercial activities, non hazardous waste collected on a regular basis or on separate basis.
- **Institutions:** schools and office buildings.
- **Community Waste:** sewage sludge, waste from curbsides, food markets and open spaces (parks and garden waste).

- **Hazardous waste**

The definition of hazardous waste is not simple and differs between countries. The Israeli definition is based on the UN convention with identification numbers as in the "Orange Code-Book". In addition a vague "literary" definition that includes additional material that may have dangerous outcomes or unpleasant signs, is used. This allows a wide range for changes, updates, additions or removals of materials.
These materials are usually insoluble (such as hard metals, sludge from chemical plants, clinical waste, contaminated oils, material that do not degrade fast etc.).
Proper management and disposal of hazardous waste is an expensive process, which gives a high incentive to dump the waste at some areas outside of designated landfills.
.
The European Experience came up with the following definition:
According to the definition of the ***Basel Convention*** and other related conventions, hazardous wastes are wastes that have a direct impact on health and the environment. It includes:

- Industrial waste
- Medical waste
- Household waste: sprays, paints, batteries…etc.

Remark: Until last year (2000), hazardous wastes included all industrial wastes: ***SIW*** (Special Industrial Waste) and ***OIW*** (Ordinary Industrial Waste). The present change in definition will cause a break in the time series. OIW will be included in municipalities' waste statistics.

- **"Indirect Methods" for estimating waste quantities**

Indirect Methods of estimation are ways of extracting information for a **certain variable that is of national interest at the CBS**, from data that has been collected for a **different purpose.** The methods and the surveys that have been designated for a completely different purpose are not adequate to serve as a source of data (content, composition, quality) of the above mentioned **variable of national interest.**

- **Waste Units**

Usually the dry waste is measured in tons, the liquid waste – in cubic meter. The problem arises when some of the waste is measured in different units. Many countries encounter the problem that part of their waste is measured by the number of trucks (volume), with different sizes of trucks which are not indicated, barrels, etc. A conversion table has to be worked out for each country according to units and measuring methods at the waste sources.

5. WHY IS "WASTE STATISTICS" A SPECIAL ISSUE IN ISRAEL?

Waste Statistics is a special issue in Israel, as most of it is obtained through ***Indirect Data Collection methods.*** Currently there is no designated survey on waste**.**
Private industries are not obliged by law to reveal their amounts of waste, refusals, quantities diverted to reuse, recycling etc.
Dealing with all waste types, is a diversified process, with specifications for each type of refusals and waste. The data are, often, of vague nature and inaccurate. The quality of most of the data is similar to social science data (aptitude tests) as compared to physical, chemical and biological laboratory measured data.
The characteristics of the instruments and statistical methods used for chemical, biological or physical laboratory measurements are known and the manufacturer indicates their accuracy and the measurement error. Researchers also have a scientific way to calculate the sampling error, in sampling surveys. The ***Indirect Methods*** by which we regularly collect the waste data, does not enable us to estimate the error term of the estimates, without additional assumptions about the accuracy of some technical and functional relations.
If, under some assumptions and limitations, we think that we may have a mathematical relation between several variables (a functional relation, i.e., a model), than we have to decide on the coefficients (parameters) that furnish this functional relation. To establish the values of these coefficients we have several methods. One of them being a simulation process, entering different "guesses" until the model "behaves" according to our assumptions. Another way of deciding on the coefficients is to use real data for the variables and calculate (estimate) the coefficients. We use the ***Indirect data*** that is available to us to derive estimates for the coefficients (parameters).
These models are in some sense indirect methods of estimation. The models (the mathematical relations) may be wrong, resulting in **under** or **over estimates** of waste quantities. The input to these models (under the assumptions of the specific model) is valid and the measurements are of known error. The sampling methods and the laboratory tests have been designed especially for the announced zeal and error calculations are available.
The above mentioned situation is almost never the case when dealing with waste. The sources that produce waste are countless. They originate from different types of sources, such as households, commerce, industry, construction, energy production (solar, nuclear or conventional), agriculture, medical, hazardous waste, tourism (and recreation) waste, etc. The methods used to deal with waste differ for each one of these types of sources. One type may differ from another type by many dimensions such as: collection, treatment, recycling, reusing, reducing and quantification system, even in the same type of source. For example: "municipal dry waste" (not sewage), has organic matter that goes to recycling (compost), paper and cardboard, glass, metal, construction waste, such as dirt, stones, building blocks, metals, wood beams etc. A similar diversity is found in the type "Industrial waste".

The waste quantities are usually estimated by crude guesses, as only part of the information is available. The recorded measurement never reveals if we measure all the waste that was produced, or if only part of it – what part? This statement holds for all sorts of waste, unless a very intensive survey is designed and performed for each one of the different sectors. Such surveys (well planned and scientifically executed) are very expensive, and many of the developing countries are unable to finance the cost. As high cost is involved in the transportation and treatment of waste, the involved parties may have the incentive to minimize the cost, at the expense of treating the waste in a required lawful manner.

Waste is usually produced by a polluting source. The polluter is responsible for handling the waste and to make sure that it gets to the proper treatment lot. Households (HH) are required to pack the waste produced in the HH into a bag and bring it to a waste collection lot (in the vicinity of the waste source). Industries creating hazardous waste are required to transport the waste (on their own expense) to a special treatment plant, and in addition to pay extra fees for the treatment. The local authorities have to transfer the HH waste to landfills or incinerators (wherever they are allowed to operate) on their own expense.

This is not the case with air or water measurements. The government has to follow the laws that require orderly management, sampling, tests and laboratory analysis and hence also providing statistical information about the current state of air and water.

Waste is not yet on the same footing (collection, treatment, data collection, analysis), as other topics of environmental data. Even the well-intended phrase ***PAYT*** (Pay As You Throw), is not fully implemented and is not always a justified requirement.

Q: When is it justified to demand the PAYT and when should governments pitch in and subsidize waste management?

Related questions:

Q: Models versus Surveys – When is the one preferred over the other and Why? Do Surveys give better results than models?

Q: Are there any logical procedures that may improve indirect (low quality) data?

6. "INDIRECT METHODS" FOR WASTE ESTIMATION

The Israeli Central Bureau of Statistics is producing its waste data using mainly indirect methods, as there are no designed surveys on the diversified waste topic, neither for household waste, construction waste, hazardous waste, industrial waste, nor in sewage and its treatment.

One way of looking on ***Indirect waste data*** is to form the Input / Output matrix of raw materials that are used as the input to an industrial process and the output of the final products. Knowing the kind of waste that is expected from the industrial process and the quantity of the raw input data – makes it possible to calculate an estimate for the expected waste quantity. (Models of simulations and estimations).

6.1 Examples of indirect waste statistics

Example 1: Yearly estimate of solid municipality waste (HH, commerce, yard), with geographic distribution

The certain **variable that is of interest** is the following: The Central Bureau of Statistics (CBS) has to estimate the total quantity of solid HH waste (excluding sewage and pesticides produced and used in the HH). The reports of the estimates of the annual quantity for the country should be published by a geographic distribution and according to different economic sectors in the municipalities, as supermarkets, small industries, commerce, etc.

The **different purpose** variable is: The Ministry of the Environment (MOE), is interested to motivate local authorities to transfer the dry HH waste to declared landfills, that have adequate treatment techniques. The transportation and treatment costs are high. The MOE subsidizes these costs with a special 4 years program.

Government	Subsidies
End of the year	**Payment that the waste producer has to Pay - %**
First year	0
Second year	25
Third year	50
Fourth year	75
Fifth year and on	100

After 4 years the local authority will pay fully for the transport and the burial of the municipal waste and will continue (by inertia) to transfer all its HH waste to the lawful landfills. To be eligible to get the subsidy, the municipal waste has to be weighed at the entrance to the landfill and reported monthly to the MOE. One should remember that:

- Many local authorities do not care to get involved and receive the subsidies, and we have to impute their waste quantities by statistical estimation methods.
- It is not clear what will happen with the waste transportation to designated landfills after the subsidies "dry out" and disappear.
- Once the subsidies stop, the source of the indirect data stops and the source of information disappears.

The program is in its final phase. No previous experience exists, and the main question is will the local authorities continue to transfer the waste to the lawful landfills, once the subsidies stop?

The collection procedure at the CBS is:

- No local authority is reporting to the MOE on a monthly basis. The procedure is that **the landfill site** management furnishes the MOE with a list of monthly amounts weighed at the site, for local authorities that used the landfill site in the previous year.
- The lists trickle into the MOE at a very slow rate. The file is ready half a year into the next calendar year and with a huge percent of missing values.
- About 40-60 % of the local authorities are not reporting to the MOE. (Maybe that they have a better (= cheaper) solution for their waste, than sending it to a far and costly landfill site.
- The CBS imputes missing waste quantities, with a statistical imputation method for the missing values.

The outcome of the indirect data:

From this indirect file (not designed for the purpose it serves at the CBS):

- The national parameter for total HH waste is estimated, via statistical Imputation,
- The data are analyzed and collated to get a geographical distribution of the HH waste production,
- Indicators for waste (regional and national) are calculated,
- It is not possible to estimate and calculate an error term.

Statistical Imputation

In a statistical imputation method no subjective argument is influencing the imputed value. Out of 260 local authorities circa130 had to be imputed. The population in those local authorities added up to about 25%, not 50%, which indicates that the local authorities with a small population are the ones that do not weigh their HH waste.

The method is "Hot Deck" imputations, i.e.; values that have been received from the survey are used as the imputed values. The "donor" of the value is the "next nearest neighbour" who resembles the missing value the most in a well defined neighbourhood that the statistician decides upon (for example: a donor has to be from the same sub-district or just from the same district or the whole country – without limitations). The next nearest neigbour is defined according to auxiliary variables (resembling variables). The variable to be imputed should be taken at the finest resolution possible. The imputed variable is Kg per capita per day, and not the total yearly waste quantity for the local authority. This value is multiplied by the population of the locality and by 365 days, to get the total annual waste, which is added to the national estimate. In our example the geographical area was a "sub-district", the auxiliary (resembling) variables (which may not have any missing values in them) were Type of Locality and size of Population. If it occurs that for a specific local authority there is no donor available at the sub-district, we have to supply a deterministic imputed value. We ask the responsible person for waste at the local authority for a "crude guess" for the daily quantity.

Statistical Waste Indicators

The main indicator for HH waste is: "Kg waste per capita per day" for every local authority. In addition we calculated a trend indicator "Sum of waste per year" for every local authority, and for the whole country, by calendar years.

We have to make sure that we derive the correct indicators. Definitions have to be harmonized for different countries and continents.

Q: In a tourism town, does the indicator "Kg per capita per day" include/not include the number of all the tourists who produce HH waste as much (or even more), as the inhabitants.

Proposal: Calculate both indicators and make a new indicator of ratio or difference between the two – to indicate the load of tourism on the waste quantities for a country.

Error term calculation

Once we perform an unorthodox imputation (imputing more than 5-10% of missing values), the error term may be almost everything. We work with low quality data, and such situation is defined as GIGO. The way surveys are done by outside organizations (non-statisticians), sometimes lacks professionalism. Often they have no knowledge on how to design a sample survey, to define the error they are willing to take, and accordingly to define the sample size. Sampling rate may be different according to the type of the locality (stratified sampling or cluster sampling, or two stage sampling as for example cluster sampling in strata, or any other design that is suitable to the underlying assumptions). For each different sampling plan the error calculation varies.

If no sampling plan has been used – it will be impossible to learn anything about the whole population, and no error term can be estimated.

Example 2: Industrial recycling quantities and composition

The **topic of interest (of the CBS)** is to estimate industrial waste that is recycled, reused or reduced in a calendar year by industrial / economic branches.

The **specific different purpose** is: the MOE is sending out questionnaires to the companies that officially recycle and reuse industrial waste (from industries or landfills that use their services). These companies produce compost from organic waste to be used as agriculture fertilization, companies that deal with recycling of paper and plastic, and to the factories that reuse metals. The purpose of the MOE is to get an idea how much of the waste is recycled, reused or reduced by these few companies and the components (paper, textiles, glass, metals, organic compounds etc.) that were recycled out of the total recycled material.

Problems that the CBS faces:

The CBS gets from the MOE the tonnage of the raw material that is recycled by these companies mentioned above. That data may have nothing to do with the **real national estimate of recycling that may be going on** (or not) **in hundreds of factories, organizations, research centers and companies**. But the CBS uses these numbers as the "Delphi Oracle" and uses this estimate as the national estimate from informal data that were achieved without designing a representative sample, without calculating sampling errors, without returning to the refusals, with nonprofessional enumerators and with a "home made unprofessional questionnaire".

The ministries and organizations are unaware that the way the data are collected is not professional and, at the end, do **not** provide a reliable national estimate. It is difficult to convince the parties involved that a professional sample (with an well-organized frame and a representative sample that may be expanded to the entire population) will be more valid and accurate.

The MOE has a different goal. They have decided on quinquennial plan for municipalities: "15% of recycling - as an immediate target, and (double the proportion) 30% recycling or incineration (waste to energy technologies) by the year 2005."

Example 3: National estimate of hazardous waste

The **topic of interest for the CBS** is: to estimate the quantities and sorts of hazardous waste that are produced in the industry, research institutes, hospitals etc., during a calendar year, by industrial branches and treatment techniques.

The **different purpose** of the treatment plant is to keep daily records of the amount of waste that is delivered to the hazardous waste site. Different interests dictate the kind of variables collected by the treatment plant for hazardous waste (there is only one in Israel). These records serve as evidence of deliveries made to the plant for managerial purpose as records for the IRS (Internal Revenue Service), for payments charges, etc. The variables are: Sequential number of delivery, amount delivered (usually in tons), sort of material, date, name of the company that delivered the waste (Text) and the treatment technique (text) to be used on the hazardous waste. The data is a census – all the hazardous waste that has to be treated in the special plant.

The procedure at the CBS is:

The records mentioned above are analyzed once a year, according to materials and techniques of treatment (incineration, landfill, anaerobic disintegration etc.).

The estimates that the CBS is capable to produce lack validity, as we have no checks and balances. The CBS accepts administrative records as the only data available on the quantity and content of hazardous waste. An unofficial guess is that the real quantity has to be at least double, and maybe triple, the amount arriving in the plant.

In addition, the CBS is unable to sort the companies according to economic activity or industrial branch, as the names are text names and differ, in the administrative records, from one record to the other, for the same company. Lack of resources and relying only on Indirect Methods (because they are available for free!) may produce unsatisfactory estimates.

Management of hazardous waste[c] is a growing concern in many countries. It is needed for:

- Policies and regulations,
- Implementation techniques and checking methods,
- Adequate treatment plants,
- Well trained engineers.

The lack of a designated survey for different industries, their waste production, their reuse and recycling methods, makes it impossible to produce reliable hazardous waste statistics.

Example 4: Legislation Enforcement – "Rulings from the courts"

The courts in Israel have started to enforce the law on abatement of the environment, and fine organization that litters.
From few of these lawsuits we may get an idea where the non-measured waste is disappearing. **No statistical series has yet been developed from the following cases.**

Following are several cases from a publication by the MOE (2001).

> **Discharge of Wastes to the Sea.** …"the company was fined $7250 and signed an undertaking in the sum of $11,250 to refrain from similar offense…under the Prevention of Seawater Pollution from Land-Based Sources Law and the Cleanliness Law…The director general was fined $250 and signed a $3750 undertaking to refrain from similar offenses for two years."
>
> **Discharge of Oil to the Sea.** …" As part of a plea-bargain agreement…. the company was fined $31,250 and signed an undertaking in the sum of $50,000 to refrain from similar offenses for three years."…
>
> **Land Reclamation and Littering**. …"During the course of several years, from 1995-1997…the defendant carried out land reclamation activities at the Olga Beach by disposing building debris, rocks, and sand along the coastal stretch.
> …The director …was convicted and sentenced to 90 hours of public service. The municipality….was fined $37,500…and an undertaking in an identical sum….for two years period."
>
> **Illegal Storage of Hazardous Substances**. …Dealing with the production, import and distribution of chemicals to the electroplating industry of operating without a Poison Permit and a business license. The company stored sodium cyanide in a warehouse adjacent to a toy factory. … The company was fined $45,000 and signed an undertaking for double this sum…"
>
> **Discharge to the Sea.** …"discharging toxic waste to the sea in 1998…. Some 11 tons toxic materials (ethylene dichloride (EDC)) to the sea, due to a failure in the pipeline… The investigation revealed that the failure was caused by faulty and negligent maintenance on the part of the company. The discharge

caused wide scale mortality of marine life and corals at a radius of about 100 meters from the discharge point… The company was fined $27,500 and an undertaking of $37,500…for three years."

Q: How is it possible to construct a new statistical series out of the court cases, that will reveal information related to the environment?
Q: Do the fines rise with time?
Q: Is there a correlation between the severity of the offense and the magnitude of the fine and the punishment?

6.2 Which "Waste Indicators" are essential [d]?

To be sure that waste indicators will be comparable with other countries, the different parties have to verify that they are referring to the same waste categories, to the same catalogue of waste sorts. The frequently used lists for hazardous wastes are:

- the Basel convention list,
- the HWL (Hazardous Waste List),
- the EWC (European waste Catalogue ~600 materials),
- the short Hazardous waste list (EWC~300 materials) .

The waste treatment technique has to be specified.
The indicator has to be simple and easy to use.
The economic classification has to be unique, either ***ISIC*** or ***NACE***.
The expenditure indices have to follow the conventions that have been decided upon.

The main reason for the collection of waste statistics is to try and reduce the pollution at the sources, to collect the waste in an efficient way and to ***treat waste in a lawful manner, in order to minimize deterioration of the resources like air, water and soil.***
The list of indicators that will be of interest to measure the trends of waste disposal, recycling, a treatment activity is not unique. Each country may have a different list of waste indicators.

The UK has a set of environmental indicators that may be worth to follow.
The Blue Plan Glossary gives a list of indicators, for waste with accordance to the questions asked in the OECD questionnaire. The indicators are described as following:

Definition; Unit; Methodological description of the indicator;
Data sources identified and possible; Geographical coverage of the indicator;

The kind of questions that are asked and the policies that follow, will dictate the list of indicators for each country:

General Indicators and waste management:

- Time series (yearly, seasonal or monthly) of quantities – indicating trends.
- Sewage sludge quality – indicates possible use of the sludge as an agricultural fertilizer.
- Indicator of trans-boundary movements of wastes as defined by the Basel convention. The unit is metric tons per year.
- Number of fires and bad odor occurrences in the landfills – indicate the Management of the waste treatment.

Environment and industry:

- Strict standards for industrial combustion of waste – calls for the use of air indicators.
- Friendly industrial techniques – may show reduction in the waste quantity. Indicator.
- Industrial waste quantities by economic branches.
- Industrial waste quantities by branch – Kg per number of workers per day for the specific economic branch and comparing the various industrial sectors.

Monetary indicators:

- PAYT - Pay As You Throw – indicates the pollution sources.
- Public Expenditure on environment protection and abatement, out of the GDP, indicates the rate of involvement of the government.
- Private sector's investments in "green" (environmental friendly) techniques.

Hazardous waste:

- Time series of hazardous waste generated.
- Time series of hazardous waste accident occurrences.
- Accident occurrences related to hazardous waste, by reasons of the accidents.
- Accident occurrences related to hazardous waste, by economic branch.
- Area of land contaminated by hazardous wastes (hazardous waste landfills).
- Recycling (reusing, reducing) trends of hazardous waste over the years;
- Hazardous Waste quantities - volume and Kg per capita per day.
- Hazardous Waste incinerated quantities - volume and Kg per capita per day.

Municipal waste:

- Time series of municipal waste quantities that are generated by geographical distribution.
- Time series of building and demolition waste generated.
- Area of land contaminated by solid municipal (HH) wastes – potential volume of the landfill and the current situation.
- Composition of the solid municipal (HH) waste – in percentages.
- Recycling (reusing, reducing) trends of municipal waste over the years;
- The percentage of solid municipal waste treated by incineration, sanitary landfills, composted waste; recovered for recycling.
- Household Waste - Kg per capita per day.
- Municipal Waste incinerated - Kg per capita per day.

Environmental legislation:

- Law suits regarding waste issues – indicates the enforcement of the environmental laws and the loopholes that are exploited by the polluters.
- Counting of lawless landfills – indicates the law enforcement level.
- Laws and regulations with regard of waste management – number of laws.

A substantial portion of the above-mentioned indicators can not be calculated from data that we achieve by ***informal methods of collection.*** We have no way to decide if the indicators that we calculate from indirect methods, apply to all events, i.e., represent the whole universe

of events (we shall never know if the "so called SAMPLE data that we get, represents the whole "population").
Better statistics on waste may be a leverage for better waste management.

6.3 Artifacts in indirect waste data collection

Some of the suggested indicators are not available from indirect waste data collection.
For example: "the amount of waste weighted at the place of production" is not possible to estimate without a well designed survey of the private and public industries.
We may be able to give an estimate for the kilograms of household waste per inhabitant per year, or an estimate of tons industrial waste per worker, per year, for a specific industry and from these crude estimates to reach an overall estimate for the country. This is a different way ***of Indirect Estimation***.
We estimate from the ***Input /Output*** matrix of materials and products of a factory the amount of waste that may be produced during the production process.
From the ***Indirect estimations as described above,*** we probably often get "side effects" that are out of proportion to the facts, which are not measured adequately.
From ***indirect data*** we may observe that the amount of waste is growing from one year to the other. It may be that actually the amount of waste really grew. On the other hand, it may just be an artifact due to the fact that the CBS asks for the file (which is created for different reasons) – and this request encourages the organizations to be more careful in filling out the questionnaire (with indirect information), the registration improved and it seems as if the quantities grew.
Tourism pollutes and produced HH waste. The indicator "Kg per capita" is very high in those cities, but it happens to be an artifact, as the ***number of tourists*** is not added to the denominator.
As mentioned before, it may be necessary to calculate both and construct a new indicator based on the two of them.
Number of accident occurrences (collected from an ***indirect accident occurrences file***) may be biased and underestimated, as organizations may prefer to hide some of their accidents.
The source of the hazardous waste that is delivering waste to the treatment plant may appear several times a year, each time with a different name. This makes it very difficult to classify the organizations according to the NACE or ISIC economic branch classifications.

Improvement of the list of waste components may result in increase in reporting rather than incorrectly suggesting more waste.

Reduction in the total amount of waste (from the indirect methods of collection), but in reality there was a new outlet for the waste as "land-farming", that releases the organic compounds, and the leftover are only the heavy metals in the sludge. If we use indirect files, we are unaware of changes in the technology.

6.4 Modeling and Cost / Benefit considerations

It may be worth while to subsidize friendly technologies, if the result reduces wastes. It may be reasonable to subsidize transportation cost to landfills, subsidize recycling methods to reduce waste etc.
This rigorous model is easier said than done.

1) It requires ***estimates of technical relations*** between the inputs to the "economic unit", to the production processes and the resulted waste from these relations.

2) It requires behavioral assumptions, i.e. what will be the affect of a certain policy (subsidies or fines for polluting) on the behavior of the "economic unit".

Both above requirements are the difficult problem of dealing with data that in it self is not very accurate. Adding to this "indirect waste data" requirement about relations in the broader model and assumptions about the behavior of human beings may be a difficult task.

<u>Proposal:</u> A possible feasible and efficient solution would be to use modeling as a main method with designated survey samples as an aid for calibrating the used coefficients (in the model). A mixture of indirect data with small-designated surveys may turn out to be a solution to improve the statistical series that up to this day are based completely on indirect methods.

7. ENCOUNTERED DIFFICULTIES IN DEALING WITH WASTE DATA

- Waste data obtained by indirect methods are in many cases not obtained by a designated sampling plan, and therefore the estimates can not be inflated (by the right calculation) to result in a national estimate.
- Whenever we deal with indirectly obtained waste data, we are unsure if we covered all the grounds. We have no valid (consistent) estimate and are unable to estimate an error term.
- Indicators are not yet well defined. They may change from one country to the other according to the special needs of the country. There is not yet a broad agreement about what to report on each waste sector. An index (combining all the indicators) is not yet in the doing.
- Data is available but it is found in various formats of raw data. Aggregation is Complicated as we obtain data from various sources.
- It is difficult (impossible?) to convince organizations to change their reports or add information to their files.
- It is difficult to convince private enterprises to report quantitative information to a government office.

Q: How does a country go about *constructing an Index from many Indicators*? Experts in the specific field have to give their input in steering committees.

8. DISCUSSION AND CONCLUSIONS

- Statistical waste series are intended to raise the awareness of the decision-makers in the government towards the real problems. To do so, we need to collect the statistics of the exact facts, as far as the data are available, surveys and indirect data. From the data we shall produce indicators for all different sorts of waste.
- The theory on many natural, chemical and physical current events affecting the environment are not yet fully understood. Many of them may occur as a consequence of pollution of different sources. (As air pollution in a landfill).
- Relationship between inputs and production, with the waste estimates as close to the reality as possible, have to be set up. This is almost an impossible mission, especially as the waste quantity estimates, from indirect methods, are probably wrong estimated.
- Waste data collection, and its analysis, has been shown to be less rigorous than data of air and water quality.

- Data on waste is currently collected only from informal sources, which were not designed for collecting waste data. The data that has been collected can not be considered as a representative sample.
- The data collected by indirect methods is usually an underestimate. Estimates from a model may be either under or over estimates.
- As long as we get data from sources that were not designed for the question asked – the reliability of the estimates is low.
- Waste management and estimation of waste parameters and indicators is a difficult field, especially when even the data that is coming in is indirect, and far from being exhaustive.
- We have to be content (for the time being) with what is feasible to collect and achieve, until the government will allocate a budget for a survey, planned and designed for the waste questions. These surveys will enrich the indirect data and give the statistician a tool to check the series and calibrate the indirect methods.
- Cost / Benefit calculations, optimization under limitations, and calculating the shadow prices is a good method to make environmental policies, under the condition that we understand the technical and functional relations of Inputs / Production / Wastes.
- "Business as Usual" is the wrong national policy. The cost of such attitude may be, in the future, very expensive, wasteful and socially intolerable.

Q: Are our endless tables the best policy to communicate with policy makers?

Q: Are the calculated indicators (Pressure–Driving Force / State – Impact / Response) a clear tool to present results to policy makers?

Proposal: In addition to presenting tables, indicators and graphs to the policy makers, it may be useful for them to receive from the statistician a short passage *explaining the result* of the table / indicator and *write down the conclusions of the result* which are demonstrated in the table / indicator. These semi-products (less scientific) may turn out to be more efficient than just presenting tables. It may implement faster action and intervention from the policy makers to enforce pollution abatements and activate processes that may save the natural resources of the environment (air, water and soil).

Proposal: Nature Scientists (those who are in the Ministries of Environment, Science, Agriculture, Health, Infra Structures, Transportation) together with the Scientist and Biologists in the Nature Protection Authorities, Nature Lovers etc., with the Environmental Lawyers, together with the Statisticians of the Central Bureau of Statistics have to collaborate and decide about the ENVIRONMENTAL minimum data set, data quality assurance, analysis, Data Base construction, Pollutant Release and Transfer Register construction, divide responsibilities and decide on working patterns. These mentioned scientists have to meet regularly to update their decisions and to follow up and check the databases and to evaluate the work that has been done.

[a] Bjorn Lomborg, "The truth about the environment", The Economist, August 4th 2001-09-01

[b] OECD. "Pollutant Release and Transfer Register: Guidance Manual for Government" OECD Paris 1996.

[c] IMO (1995): Global Waste Survey – Final Report Draft ", International Maritime Organization, London.

[d] Towards environmental pressure indicators for the EU, European Comission, Eurostat 1999.