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Wastewater generation & treatment statistics

Reliable statistics on wastewater

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Executive summary

The Joint Questionnaire is supported by a Manual, developed and published in 2004 to explain concepts, identify best practices, and recommend approaches for each table .
For wastewater, technical and conceptual problems and obstacles to good quality data were identified, that may apply to any statistical data collection in this field.

First, the correct understanding and definition of boundaries between the various steps from the generation to discharge, but also the objectives for each part of the questionnaire and the connections between the tables, is a clear prerequisite to correctly allocate the figures in the various parts of the questionnaire.

Second, most of the misunderstandings between technical and statistical experts can be solved by clarification of the definitions and terms, especially through the use of simple schemes and available norms, EN 1085 being the most important.

Third, reliable statistics look for a complete coverage, but most of the existing data collections use thresholds to report only the biggest sources or only the biggest discharges. As they are reliable, the use of these figures is recommended but should be completed by expert judgement, specific surveys or emission factors and to set priorities for the data collection effort. Furthermore in the reporting process, a clear description of the main hypothesis and limits sent together with the national return should help the correct use of the data.

1. INTRODUCTION

The EUROSTAT/OECD Joint Questionnaire (JQ) on Inland Waters collects annual data on water issues at national level. It is sent out every second year. It consists of 9 tables covering the various parts of the water cycle as well as various aspects of water supply, sanitation and water pollution. (Manual, 2004)
It is supported by a Manual, developed and published in 2004 to explain concepts, identify best practices, and recommend approaches for each table.

For wastewater, technical and conceptual problems and obstacles to good quality data were identified. These obstacles are most often not specific to the questionnaire but related to the intrinsic specificities of wastewater generation and discharge, or to the specific needs for reliable statistics. In the following paragraphs, three main aspects will be addressed that are one of the main properties of the wastewater generation and treatment, the need for shared references and the problems identified for the data collection.

2. THE PATHWAYS

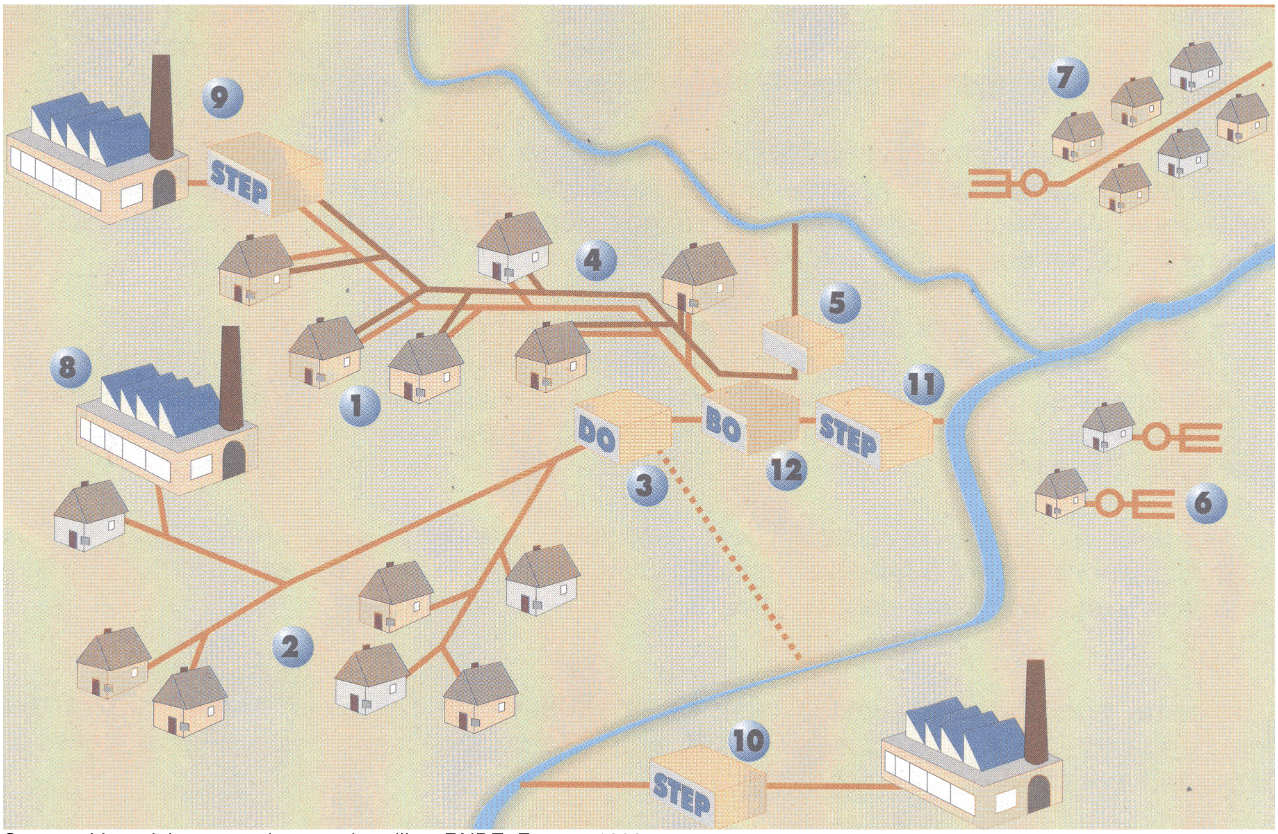
First, the correct understanding and definition of boundaries between the various steps from the generation to discharge, but also of the main elements to consider in each step, and the objectives for each part of the questionnaire that explains the connections between the tables, is a clear prerequisite to correctly allocate the figures in the questionnaire.

In general, waste water is generated by a source, collected in a collecting system, treated in a treatment plant and discharged in the natural aquatic environment. But the situation is far from being so linear, and every combination of generation, collection, treatment and discharge steps are possible.

The figures are first needed for evaluation of water flow and volumes, allowing to complete the picture of the water cycle. But another objective is also looked for with this part of the water cycle that is the evaluation of pollution flow and volumes measured in terms of polluting parameters, and the link with economic figures to allow for a first evaluation of the efficiency concerning pollution. The latter is complicated by the non conservative property of the pollution: purification and transformation processes may occur and lead to the generation of some pollutants along the pathways and the destruction or transfer of others thus needing to also assess the variations of stocks.

The following figure illustrates, on examples of situations found in European countries, some possible combinations, adding to the above the case of rainwater collection and treatment that often introduces an additional complexity.

Figure 1 : main components of a wastewater system (STEP = wastewater treatment system; DO = Stormwater overflow)

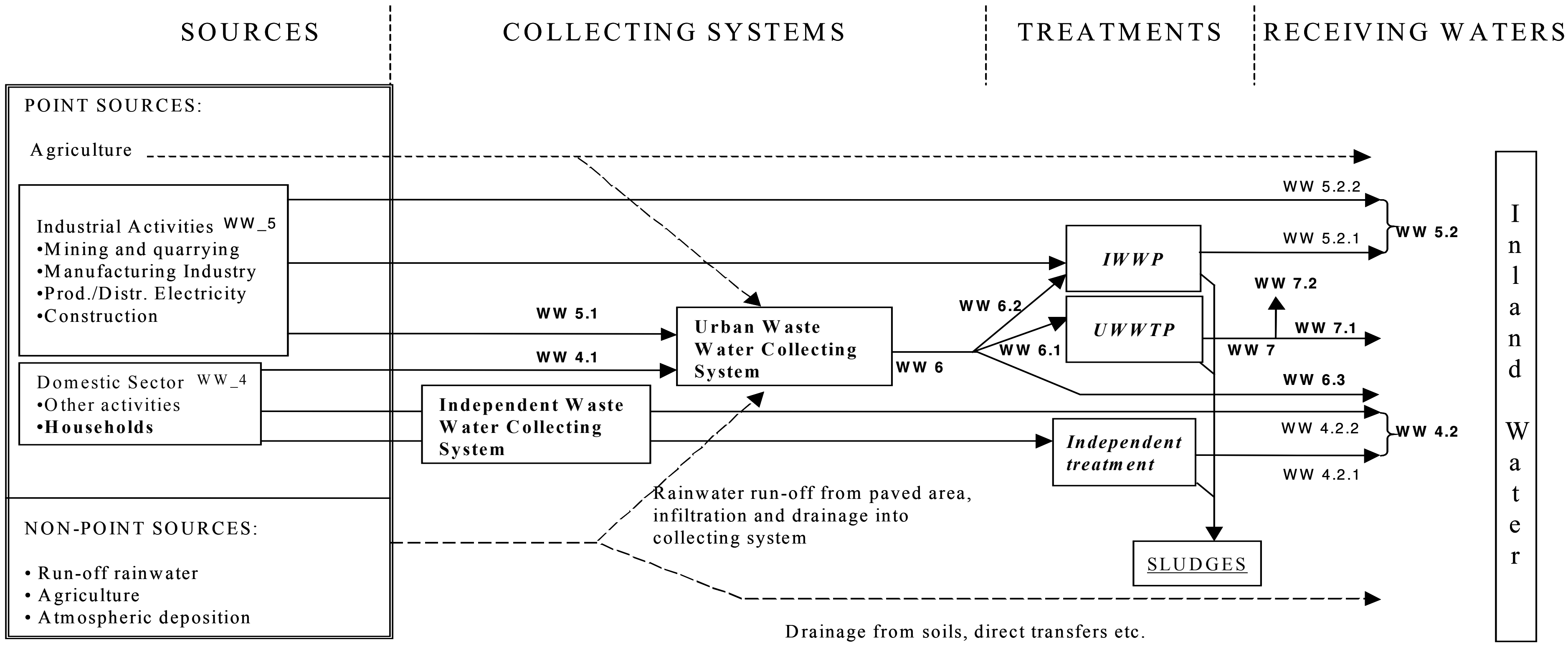


Source : L'assainissement des grandes villes, RNDE, France, 1998

The following figure illustrates the main pathways addressed by the questionnaire that represent the possible pathways from the generation by every possible source, to discharge in the natural water environment, that were found to cover the majority of existing situations.
Many other more complex situations may exist and expert judgement is then needed. The recommendation from the Manual for the specific situations not reflected by this is to stick to the closest possible situation.

This complexity, combined with the high cost of environmental monitoring, asks for a pragmatic approach with the first priority on the discharge to the aquatic environment and on obtaining reliable figures on the biggest systems and quantities, completed by estimations.

Figure 2 : The Waste water loading scheme



Source : Data Collection Manual for the OECD/Eurostat Joint Questionnaire on Inland Waters, Tables 1 – 7, June 2004

3. THE DEFINITIONS PROBLEMS

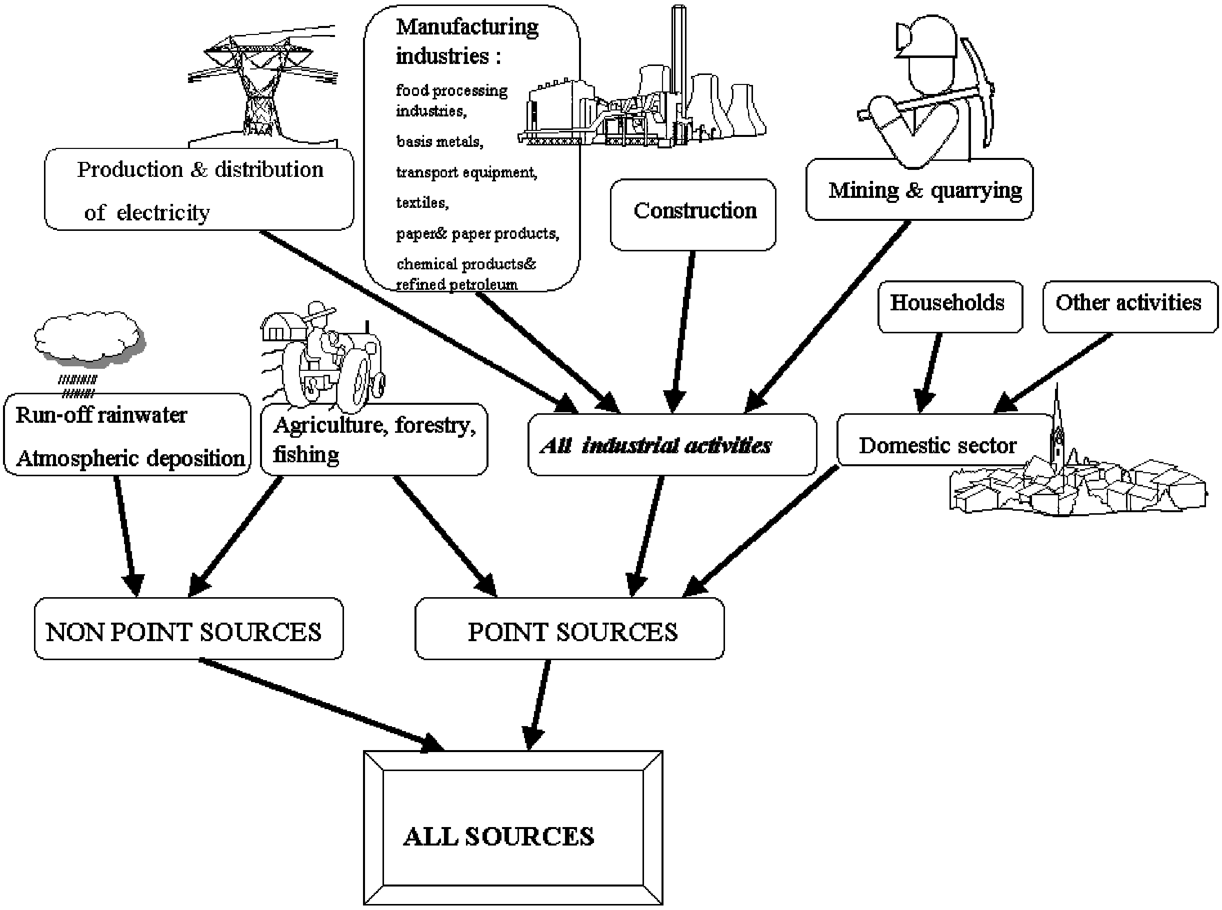
Second, most of the misunderstandings between technical and statistical experts can be solved by clarification of the definitions and terms.

In many cases, due to specificities of one economic sector or practices among technicians in a field, the same term does not designate exactly the same thing, and some major elements need to be clearly defined.

3.1. The sources

First as regards the source, the generation of wastewater is most often attributed to a source or a group of sources. The source is a point source when it is possible to identify one or some geographically located points of discharge and a non point source when no point of discharge can be identified.
The following figure illustrates the organisation proposed by the questionnaire:

Figure 3 : Organisation of sources and sectors



Source : Data Collection Manual for the OECD/Eurostat Joint Questionnaire on Inland Waters, Tables 1 – 7, June 2004

This tree organisation allows a clear link with economic figures through the use of the NACE codification for the sectors, the European counterpart of the international ISIC classification of economic activities.

However, common practice is to include in non-point sources also all the small point sources that are most often not individually monitored or reported, for instance the future European Pollutant Release and Transfer Register (E-PRTR) will include in this last category all the Waste Water Treatment plants of less than 100 000 population equivalent (p.e.). This implies to disaggregate these in two parts that are the non-point and the small point sources and the use of a sector classification such as the NACE codification with an aggregated level also for these sources.

An other problem, especially for a link with other approaches that are based on the final product and stock variations, comes from the attribution of the NACE code of the main activity to the whole source, whatever the number of activities, the processes used and the economic branch to which they should be attributed. The NOmenclature for Sources of Emissions (NOSE) that was developed by Eurostat and used for the European Pollutant Emissions Register (EPER) was focussed on this aspect but application problems still exist.

3.2. The wastewater collection

The collection part of the pathway is an important part of the system and contributes to the overall performance of a wastewater collection and treatment system.
Nevertheless, most often, this part is reduced to a connection rate, of the source to the network and of the network to the various treatment systems, or even of the source to the treatment without considering the network. This last is most often the case for the independent treatment systems. This approach is also linked to the fact that information is often scarce on the other aspects, especially on the real pollution received in the network: small sources are not individually monitored, rainwater or groundwater can be drained by the network, leakages of the sewer networks can exist, the performance of the stormwater overflows or quantities by-passed through other equipments are unknown: a balance between inputs and outputs is almost impossible to obtain.

Moreover, common practice is that the specific part of the sewer network that is private, e.g. from the generation of the wastewater to the input in the public sewer is often neglected, due to high difficulties in obtaining data and information on the private properties. This thus excludes all the related processes such as direct discharge in the environment, leakages and wrong connections (e.g. to rainwater sewer).

For the specific case of the population, that is one of the important sources of wastewater, a reliable estimate of the real population connected is difficult to obtain. Two approaches exist, on the one hand considering the population served: in the area where the network is built all the population is considered to be connected, on the other hand considering the population connected : only the households really connected and the associated population is considered.
To obtain reliable estimates, the estimation of the population connected should be preferred to the population served.

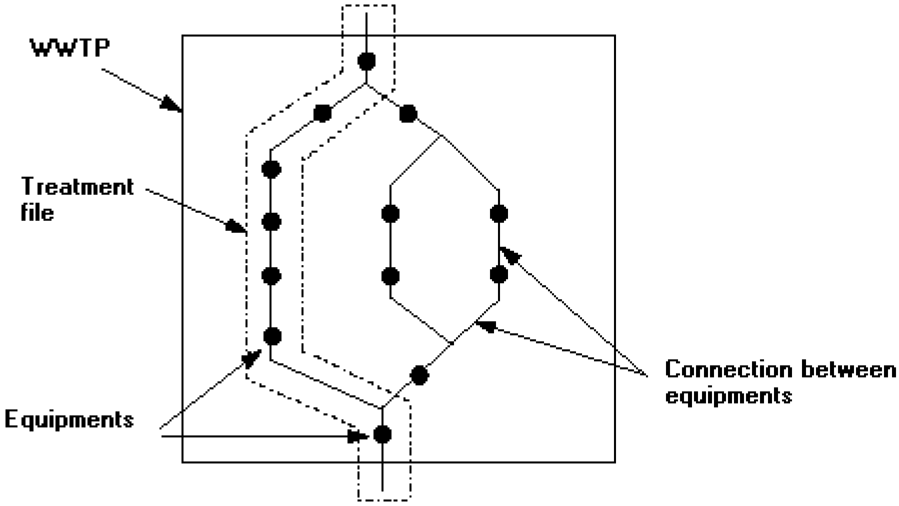
3.3. The wastewater treatment

This part of the system introduces various problems. From a technical point of view a wastewater treatment system is generally defined as a facility aiming at treating waste water, by various ways, and localised in an homogeneous place, that is to say with one geographical location, and often one entry point and one discharge point (see figure 4). Some equipments such as the by-pass at the entry of the station may be included in the station or not, but the main goal of this system is to reduce the quantities of pollution or its impact on the aquatic environment.
The evaluation of the overall performance of the system is thus important but a complex feature.

A classification in three levels from the least to the most stringent, that are the Primary, Secondary and Tertiary treatment, was then established. This classification is used for the real performance of the treatment plant as regards the reduction of some pollution parameters or for the design capacity, this last being the maximum flows and loads the plant can treat with a specified performance.

Each equipment in the plant may have specific performances depending on the parameters considered and this classification is also used, and the combination of these allows the classification of the plant. But the wide number of possible combinations of equipments asks to focus on the whole plant.

Figure 4 : A waste water treatment plant



Source : SANDRE-OIEau 1997

The design capacity is very much linked to the investments and working costs, whereas the performance is important to assess the transfer or destruction of the quantities of the various pollution parameters.

Due to a lack of monitoring for every wastewater treatment plant, the design capacity is often used. This however should be completed by an estimate of the performance, as the design capacity may be reduced by specificities of the waste water received or other technical or economic elements.

3.4. The pollution

The pollution is generally measured in terms of the quantity of a measured parameter (generally physico-chemical parameters), or reported to an arbitrary unit that can represent one or more parameters (e.g. population equivalent), and released during a certain period. These parameters can be whether physical parameters (e.g. temperature, volume…), chemical parameters (e.g. pH, substance) or biological parameters (e.g. faecal coliforms, parasites). A substance can be whether a chemical species found in the wastewater and clearly identified individually (e.g. nitrate, mercury), groups of individual chemical species (e.g. total phosphorus) or functionalities defined by the measurement method (e.g. BOD5). For wastewater, they are often reported as a concentration in a volume, and for sludges produced by the purification systems, they are often reported as a concentration in the dry matter, but they can also be reported as a quantity over a time period.

The exact definition of the parameters used allow to compare like with like and the use of available classification systems like the Chemical Abstract Service (CAS), the European INventory of

Existing Commercial Chemical Substances (EINECS) or the European LIst of Notified Chemical Substances (ELINCS) is recommended.

Finally, considering the data exchange in the water sector: it has proved to be very time- and resources-saving to use shared terminology from definitions of the terms used up to the format the data should have, based on consensus established among all the water partners, as well public as also private. This allows all the partners to speak of exactly the same thing with the same format, the same unit, the same codes… A wide variety of nomenclatures and tools does exist for that, of which the NACE and ISIC classification, the CAS classification for substances, many on-going or available work of the CEN of which EN 1085:1997 is a major one, the definitions included in the European Directives (see especially the Reporting Obligations Database of the European Environment Agency, and Eurostat classification server), and various national tools and approaches.

4. THE DATA COLLECTION PROBLEMS

For the purpose of statistical questionnaires, the complete coverage of the field addressed is an important aspect. This in turn poses some major problems.

4.1. Collecting data

Unlike other fields of statistics, more based on economic processes and human activities, flows and volumes of waste water and the associated water pollution are based on technical or physico-chemical processes largely influenced by the biological part of the ecosystem. Figures of high confidence level are obtained through the observation of the real situation in the environment.
As stated in the previous chapters, a wide combination of pathways is possible. In principle from the technical side, it is possible to measure each route and each step to obtain reliable figures and a complete picture.
However, the wide variety of elements to take into account including seasonal or geographical variations, leads in turn to variations in wastewater generation and treatment. And the cost of monitoring seldom allows continuous measurements. It is then most often a combination of monitoring and measurements with a defined temporal frequency, calculations and estimations using formula, emission factors, expert judgement, models and others.

4.2. Aggregating data

Due to this cost and the setting of priorities most of the existing data collections use thresholds to report only the biggest sources or only the biggest discharges. As they are reliable, the use of these figures should not be banned, however the goal of reliable statistics that is a complete coverage should not be forgotten.

Furthermore, the figures on each individual system or even each part of the pathway are useful for technical and management purposes but not for international level, and it is necessary to aggregate the figures to the relevant level.
This aggregation can be on the geographical level, whether the administrative level from local to national, or on the river basin level, from the small catchment to the whole river catchment.
The aggregation can also be on the temporal level, from the individual monitoring result to the yearly average, a seasonal aggregation, or even specific aggregations to reflect special needs such as the average of all the maximum found in a series.
The aggregation can be on the source responsible for the emission and it then leads to emission inventory, or on any aspect of the pathway such as the Waste water treatment plant, the final discharge to water...
All these aggregations need a thorough checking of the minimum requirements for reliability of the results: among other elements exact localisation for geographical aggregation, minimum frequencies and seasonal apportionment of monitoring for temporal aggregation, all pathways considered for source apportionment, complete coverage for the pathway.

The aggregation of data is thus a crucial aspect for the reliability of the results. Availability and reliability are linked to the size of the respective systems, and depend on the use of these datasets for one or more purposes like conformity control, but the overall goal should prevent from using only the most reliable figures, as they are often incomplete.

It thus requires to complete these by expert judgement, specific surveys or emission factors and to set priorities for the data collection effort dedicated to statistics. A clear description of the main hypothesis and limits with the national return should also help the correct use of the data.

5. CONCLUSION

The reliability of wastewater generation and treatment statistics is crucial to enable early warning identification of long term trends and therefore to support the wastewater investments planning and set priorities.

At a national or international level, they need to include many different datasets with a different level of confidence attached to them. They should then not be used for a detailed analysis of one country, without being completed by other sources of information such as national databases or consultation of experts.

The understanding of the main goals for statistics, but also of the main physical and functioning elements in this part of the water cycle, together with the use of available tools such as clear definitions and shared technical language should greatly help the elaboration of reliable statistics.