Proposal for identification methodology for urban agglomerations according to directive 91/271/EEC on wastewater treatment

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ABSTRACT

This paper discusses the problem of the identification and definition of the urban agglomerations in accordance with Directive 91/271/EC. The aim of this identification is to guarantee a satisfactory level of treatment for urban wastewaters and the achievement of the quality objectives for water bodies. The methodology employed, taking into account the existing planning tools in the water service sector, has been based on official national census data, on the Water Protection Plan, on the predictions of Water Service Plans prepared by each Water Authority and on detailed indications provided by the Authorities themselves. The proposed approach, obtained with geographic information systems applications and the calculation of pollution loads, is described and tested in the Veneto region, Italy. In the final part of the paper some considerations on the results obtained are presented and discussed.

Key words | urban agglomerations, urban wastewaters, generated load, water protection plan (WPP), population equivalent (PE), Wastewater treatment plant (WWTP), geographic information systems (GIS)

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INTRODUCTION

The identification and characterization of the agglomerations according to Directive 91/271/EC must guarantee a satisfactory level of treatment for urban wastewaters and the achievement of the quality objectives for water bodies established by Directive 2000/60/EC. The Directive (art. 2) defines an 'agglomeration' as an area where the population and/or economic activities are sufficiently concentrated for urban waste water to be collected and conducted to an urban waste water treatment plant or to a final discharge point.

In Italy, Directive 91/271/EEC has been incorporated into the legal framework with Decree no:152/1999, later revised by Decree no:152/2006 (which also incorporated Directive 2000/60/EC). Decree no:152 3/04/2006 identifies the Water Protection Plan (WPP) as the planning tool which the regions must adopt in order to achieve and maintain the environmental quality objectives and the specific destination objectives of water bodies. The WPP is part of the River Basin Management Plan (RBMP, introduced by Decree no:152/2006).

Decree no:152/2006 supplies the definitions for domestic wastewaters, urban wastewaters, industrial wastewaters and agglomerations according to Directive 91/271/EEC. The Italian definition of an agglomeration is determined by the Region and its WPP on the one hand (responsibility attributed by Decree no:152/2006) and by the Water Authorities (AATOs) on the other, both of which have been the competent Authorities since 1994. The AATO, Optimal District Authority, is the institution responsible for the integrated urban water management for optimal districts, into which the territory is divided.

In Italy some of the most important cases where identification criteria had been established prior to the Veneto Region include the Emilia-Romagna Region with regulation n.1053 dated 9/06/2003 and the Lombardy Region with regulation n. 2557 of 17/05/2006. The results of the application of the criteria in these two cases are available from the websites of ARPA Emilia-Romagna (2008) and AATO of the Province of Milano (2010) respectively, and are indicated in the references.

The Veneto Region created and adopted its WPP in 2004; the final draft was approved by the Regional Council in November 2009, in compliance with Decree no:152/

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2006 (Veneto Region 2009a). In order to define the term 'agglomerations' the Region followed the methodological indications provided by the European Commission to Member States (EC 2007), modifying them so as to take into account the intense urbanization of the territory, the morphological and administrative constraints and, particularly, the existing planning tools for water management (Veneto Region 2009b).

For practical purposes an agglomeration should be an area in which the population or the productive activities are concentrated in a measure in which it is both technically and economically feasible and environmentally beneficial to collect and convey urban wastewaters towards a Wastewater Treatment Plant (WWTP) or towards a final receiving point. Optimization methodologies can be applied, and different alternatives compared, using Geographic Information Systems (GIS) tools in order to define the best connection to sewer mains. Adenso-Diaz *et al.* present the problem of designing new wastewater treatment systems in rural areas according to pre-existing collection networks (2005) and propose a GIS-based Environmental Decision Support System for the evaluation of alternatives. The usefulness of a Decision Support System (DSS) for water management is also reported by Simon *et al.* (2004), Chormanski *et al.* (2007) and, in relation to the DSPIR (Driving forces, Pressures, States, Impacts, Responses) framework for water quality improvement, by Giupponi *et al.* (2004). In all of these cases, and from an optimization perspective, agglomerations are considered to be acquired constraints. This paper does not, however, discuss the alternative choices nor the optimization methods. It tackles the issues of defining agglomerations and of the compatibility of the EC Guidelines with the existing situation in the Veneto region and with the existing water planning tools (common to many regions in Northern Italy). GIS support guarantees a dynamic tool which can be easily and rapidly updated.

The proposed methodological path, applied to the Veneto Region in accordance with Directive 91/271/EEC and Italian executive regulations is presented here. The existence of an agglomeration is neither dependent on the existence of a wastewater collection system nor of a treatment plant. Therefore 'agglomeration' can also indicate areas with low urban population density, but where a collection system does not yet exist and/or where wastewaters are collected through individual systems or other alternative systems. The term *agglomeration* used in this report must not be confused with administrative entities (such as the communes) which may use the same terminology; the boundaries of an agglomeration may or may not correspond to those of an administrative entity. Briefly, some administrative entities can constitute an agglomeration and, *vice versa*, a single administrative entity could be formed by various distinct agglomerations if they represent sufficiently concentrated areas as a consequence of historical and economic development.

The division of a single administrative entity into more than one agglomeration must not be considered acceptable if it reduces treatment standards or delays the collection process. This would not happen if the same administrative entity was considered to be a unique agglomeration. Agglomerations have a dynamic characteristic which is linked to the development of the local population and/or the growth of economic activities. Consequently, the generated load and the boundaries/delimitations of an agglomeration (i.e. the dimension of the agglomeration expressed in population equivalent – PE) should be constantly revised and updated.

The agglomeration can be served by one or more urban WWTPs (1:1 relationship or 1:n relationship respectively); moreover, a single agglomeration can be served by more than one collecting system, each of which is connected to one or more plants (EC 2007). In the same way different collection systems can be connected to the same plant. In short, the agglomeration should therefore include:

1. sufficiently concentrated areas where the collecting system is active and the wastewaters are or should be transferred to a final treatment plant;
2. sufficiently concentrated areas in which urban wastewaters are conveyed into individual systems or other appropriate systems which do not achieve the same level of environmental protection as a collecting system;
3. other sufficiently concentrated areas in which urban (domestic + industrial) wastewaters are not conveyed at all.

MATERIALS AND METHODS

Veneto region

The Veneto Region is one of the most populated administrative units in Italy, comprising 4,912,000 people and with a mean inhabitant density of 267/km^2, one of the highest in Italy (ISTAT 2010). It is situated in the North East of Italy (Figure 1) and is characterized by a highly urbanized territory of 18,391 km^2, made up of 581 municipalities and seven provinces with a very high concentration of

Figure 1 | Northern Italy and Veneto Region.

industrial and agricultural activities (ISTAT 2010). Nearly two-thirds of the region's territory is flat and the remaining part is mountainous.

The methodology applied in the Veneto Region, taking into account existing water service sector planning, has been based on: available census data from ISTAT (Italian National Institute of Statistics; ISTAT 1991, 2001a, b); on the Regional Water Restoration Plan (PRRA; this plan was substituted with the WPP in 2009), on the predictions of Water Plans prepared by each Water Authority and on detailed indications from the Authorities themselves. Considerations on the results obtained are here presented and discussed.

Methodology used for the definition and characterization of agglomerations

In this paper the GIS used cannot be considered to be a DSS as the study comes after decisions already taken in the planning tools of the Water Authorities regarding sewer pipes and WWTPs. It simply presents the way of translating into geographical terms (the agglomerations) decisions concerning scenarios for water collection and treatment already adopted by the Water Authorities. The GIS is simply used as a tool, firstly for building the agglomerations (following decisions already taken) and secondly to represent in the best way possible the various informative layers (geographical details, administrative boundaries, sewer pipes, agglomerations, etc.) and the information tied to them (PE, etc.). The final database is formed with the linked tables: ISTAT section of census; agglomerations, WWTPs. The ISTAT sections with the same agglomeration code, once unified, produce the agglomerations and bring into the aggregated form of agglomeration all information on population. The table of agglomerations and that of WWTPs are linked by means of another table that ties each agglomeration code with the code of the WWTPs that serve the same agglomeration (Figure 2).

The methodological path proposed for the definition and characterization of agglomerations according to Directive 91/271/EEC and its application in Italy is presented below. The methodological proposal is divided into two consecutive stages:

- the first stage identifies the agglomerations from an exclusively geographical point of view; the final result is the map of current agglomerations in the Veneto region;

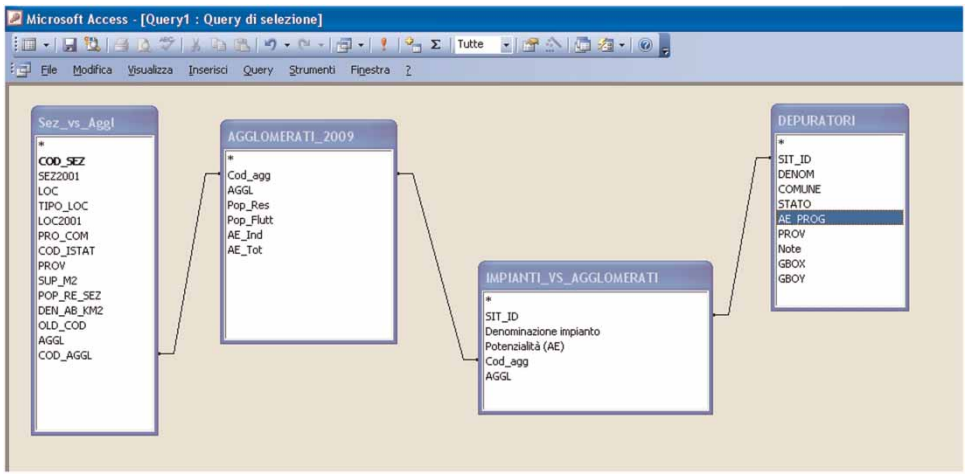

Figure 2 | GIS database; relationships between tables (from left census sections, agglomerations, treatment plants versus agglomerations and WWTPs).

- the second stage relates to the current characterization of the agglomerations in terms of *generated, served* and *treated load*.

The total load of wastewaters generated within the agglomeration gives the measure of the dimension of the same agglomeration in technical terms and is the main criterion for determining collection and treatment requirements for wastewaters established by the Directive and the subsequent collection of data which must be reported to the European Commission concerning the quality of the waters. The definition of 'agglomeration' according to Directive 91/271/EEC, establishes two basic principles around which the definition of agglomerations revolves:

- the concept of the 'sufficient concentration' of population and/or of economic activities;
- the possibility of collection and transport of urban wastewaters.

Regarding the first principle, a simple geographical reference is able to give a reasonably accurate interpretation of the concept of 'sufficient population concentration and/or economic activities' by using the ISTAT localities, or 'inhabited centers' and 'inhabited nuclei' supplied by the population and houses official census of 2001, on the basis of the following definitions:

- *inhabited centre*: an aggregation of contiguous or nearby houses interspersed with streets, squares and the like, with access to local services and shops, which represent the basic conditions for autonomous day to day life;
- *inhabited nucleus*: an inhabited area devoid of a central place system around which everyday activities revolve; the nucleus is made up of a group of contiguous or nearby houses where at least five families live interspersed by streets, paths, squares, small gardens or small plots of land where the distance between the houses is no greater than 30 m.

For each locality (in the Veneto region there are more than 7,800 inhabited centers and nuclei) ISTAT supplies data of resident population, which was used for the characterization of the agglomerations in terms of PE.

Based on EU guidelines defining agglomerations, the requirements of sufficient population density and/or economic activity do not apply to 'scattered houses' which are spread throughout the commune, do not have a nucleus and are not subjected to the obligation of wastewater collection. As far as the WPP is concerned, this also applies to plants and isolated buildings or areas with fewer than 50 PE, which cannot latch on to the public sewer system. In these cases alternative individual systems for the treatment of domestic wastewaters are allowed.

Therefore the ISTAT localities with a resident population of less than 50 inhabitants, have been excluded from the definition of agglomeration, with the exception of those where sewerage collection is already in place or planned. This was done to differentiate them from 'scattered houses' in view of the fact that these may use individual systems for the treatment of domestic wastewaters as set out in the regional WPP and for this purpose they are to be considered 'isolated nuclei'.

Based on this simple geographical reference, the regional territory appears to be divided into two area types the definition of which is completely independent from the presence of wastewater collection systems or of treatment plants. They are: the localities or the areas with sufficient concentration of population and/or economic activities; the areas with scattered houses and isolated localities with fewer than 50 inhabitants. The second basic principle, present in the definition of agglomeration, defines the methods with which the single localities can be aggregated with a view to forming agglomerations and takes into account the technical and economic opportunities and environmental benefits of collection and transfer of wastewater towards an urban wastewaters treatment plant or towards a final discharge point.

From a technical and economic point of view, the possibility of collecting and transferring urban wastewater to specific areas has been determined by the analysis of the Water Plans, which are the Water Authorities (AATO) main planning tools. These Authorities must provide an overview of the conditions of the sewer–pipes and WWTPs in their territory and which must be designed for a scenario of a minimum period of 30 years. They are responsible for defining the objectives that must be reached, the technical and organizational standards, investments that need to be made and what resources are available to carry out planned interventions. In particular they must guarantee that the WFD river quality objectives are achieved and that they conform with the N and P limit values in sensitive areas in accordance with Directive 91/271/EEC. The Water Plans define the future scenarios of the sewers and WWTPs in the Veneto region, the development of the pipe networks and of the WWTPs, setting out the criteria needed for the aggregation of the different ISTAT localities so as to form agglomerations.

On the other hand, where the Water Plan does not indicate the technical or economic feasibility of connecting to a mains system (for example due to the excessive distance or

the unfavorable morphology of the territory due to the presence of geomorphologic and infrastructural elements), a single locality, or a set of small isolated localities, must be considered to be independent agglomerations.

This approach, which uses the provisions supplied by the Water Plans, apparently does not follow the indications of the Directive which show that the existence of an agglomeration should not depend on the presence of a collecting system or of treatment plants. This assumption is incorrect. There are three reasons why the reference to the Water Plans has been considered to be the most rational and effective solution possible, particularly regarding highly populated and industrialized areas (such as Italy's Veneto region which also has a high concentration of tourists along the coastal areas during the summer):

1. the need to have the support of an objective criterion which transforms the concept of the collection and transfer of wastewater into a firm reality;
2. the conformation of the urban texture which has a very high density of population which extends uninterruptedly throughout most of the territory; this identification is based exclusively on urban criterion and excludes references to existing and/or planned collection and transfer systems (which could in some way be a discriminant); the risk in this case is that it would form a massive, unique agglomeration which would extend across the whole region and would disregard the objectives of the Directive;
3. the need to simplify the information system which governs the reporting activity requested by the European Commission concerning the degree of implementation of Directive 91/271/EEC: for example, the basin of a wastewater collection system should be evaluated as a whole rather than being subdivided into different agglomerations (which is more appropriate when dealing with population density); this would make it easier for the Water Authority or the person responsible for integrated urban water management (the producer of the final wastewaters) to supply data on the one hand while on the other it would ensure that data would be more accurate by eliminating artificial cuts or non-optimal subdivisions.

Therefore, the GIS generated map of agglomerations looks like a mosaic.

Characterization of the agglomerations: determining the generated load

Once the agglomerations have been identified from a geographical point of view, the second phase of the project establishes its characterization in quantitative terms or the determination of specific parameters which measure the consistency and the level of sewer and wastewater treatment services also with a view to satisfying reporting obligations in accordance with Directive 91/271/EEC. The distinguishing parameters for the agglomerations are the following: generated, served and treated load, all expressed in PE (a PE unit represents the organic load with a biochemical oxygen demand for 5 days (BOD_5) of 60 gr of Oxygen/day).

The total load of wastewaters generated by the agglomeration (in the following limited to 'generated load') represents the agglomerations' dimension in technical terms and is the main criterion for the determination of the collection of wastewaters and urban requirements. The generated load is the organic biodegradable load of the agglomeration, expressed in PE and consists of urban wastewaters (domestic, industrial and rain drainage wastewaters if not separated) which must be collected or conveyed in various ways according to Directive 91/271/EEC. It does not include industrial wastewaters treated separately and which are discharged directly into surface water bodies. It deals with: resident population; non-resident population (so called 'fluctuating'); industrial wastewaters generated by enterprises and economic activities which are or should be discharged into the public sewer pipe collecting system or into the urban WWTPs. The generated load should include the wastewaters generated in an agglomeration and treated by individual systems as well as in other appropriate systems.

Determining the civil component (resident and non-resident component of the generated load)

The calculation of the civil component (resident and non-resident) of the generated load in each agglomeration previously identified has been assessed on the basis of the following considerations:

- *resident population*: we used resident population data from the National Population census carried out by ISTAT (2001b); data from the 2005 census was not used, as it was only available at commune level (and not at the more detailed level);
- *non-resident population*: a specific ISTAT study was used; the study indicates the assessment of the PE for the establishment of the peaks of maximum polluted load; the assessment of the fluctuating component of the civil load has been obtained by means of an algebraic calculation (and successively attributed to each agglomeration) of the following elements:

1. *commuting population*: population that declares that it moves on a daily basis from the commune of residence for work or study purposes; the estimation of the relative polluting load is reduced in the commune of residence and increased in the commune of destination [Source: ISTAT, Population and Inhabitations census; year 2001b; weight = ±8/24 for workers and weight = ±6/24 for the students)];
2. *potential population present in hotels* (total availability of bed places): hotels, guesthouses, camp sites, vacation villages and private houses used commercially for seasonal and non-seasonal rental are included in the estimation of the availability of bed places in the hotel infrastructure; on the contrary the bed places in holiday farms or in mountain refuges are not included [Source: ISTAT, Tourism statistics, year 2004, weight = 1];
3. *present potential population for tourism or vacations in private houses (empty houses/second homes for a mean commune capacity)*: in order to estimate the potential population present for tourism or vacation in private houses, private empty houses – second homes – have been considered and are multiplied by the mean number of persons present in those occupied in the same commune; the empty houses in localities classified as 'scattered houses' and the 'private empty houses' used for seasonal rent, included in the previous point are excluded [Source: ISTAT, Population and inhabitations census; year 2001; weight = 0.8 (this weight is smaller than 1 taking into account that not all of the secondary housing is occupied at the same time)].

Determination of the industrial component of the generated load

The determination of the industrial component of the generated load is at the moment still in progress: the Italian National Environment Protection Agency (ISPRA) and the Ministry of the Environment put forward an estimation criterion based on the use of ISTAT data bases (ASIA archive of local units) (ISTAT 1991, 2001a). It suggests multiplying the total number of employees in industrial units (separated into their various economic activity codes) by the relative coefficient defined by the Water Research Institute of the National Research Council (IRSA–CNR; Barbiero *et al.* 1991; Barbiero 2004; the calculation is carried out for each economic activity code, class, group or division based on the corresponding typology used by the IRSA–CNR).

The appropriate office for the Veneto Region believes that this methodology would produce extremely inaccurate data which would make it very difficult to compare effective loads of productive origin, flowing into the public sewer pipes. For this reason, ARPAV is looking into modifications and adjustments to the proposed estimation method with a view to making it more accurate and precise. Therefore, the characterization of agglomerations in terms of generated load is currently only possible for the civil component (resident and fluctuating).

Determination of served and treated loads

The other two characteristic parameters of agglomerations, besides the generated load, are the served and the treated loads; they supply a measure of the extent of the sewer and wastewater treatment services available for the agglomeration being considered. The served load is the total biodegradable organic load, expressed as PE generated in the agglomeration and connected to the collecting systems; it does not include the load of the agglomeration's areas which are devoid of collecting systems.

The treated load is the total BOD_5 load, expressed as PE, connected to collecting systems which reaches the WWTP. The difference between the served total load and the treated total load represents the load of the agglomeration's areas with collecting systems, which do not reach the treatment plant. For the determination of the two parameters ARPAV will acquire data from the managers of the integrated urban water management and the water Authorities at established intervals.

Collection requirements for the agglomeration according to Directive 91/271/EEC

As explained, the generated load is the main criterion for the determination of collecting and treatment requirements of urban wastewaters to which agglomerations are subjected. To conform with the requirements of the Directive for collecting systems, Member States must guarantee that all the agglomerations ≥2,000 PE are provided with complete collecting systems, i.e., all urban wastewaters generated in the agglomerations must be collected.

In exceptional cases where the realization of a collecting system is not justified, the urban wastewaters should be conveyed through individual systems or other appropriate alternative systems. These should reach the same degree of environmental protection guaranteed by the urban wastewaters conveyed by the collecting system. For reporting

purposes an agglomeration conforms when it presents a degree of collection towards the sewer pipe mains (served load) equal to approximately 95% of the generated load. According to the Directive it is not compulsory for the agglomerations with less than 2,000 PE to have a collecting system (however the *Regional* WPP and its regulations are in force).

Treatment requirements for agglomerations according to Directive 91/271/EEC

The dimension of an agglomeration (generated load) together with the typology (freshwater, estuary, coastal waters) and the characteristics of the receiving water body (sensitive area, normal area, etc.) determine the treatment requirements of Directive 91/271/EEC, summarized in Table 1. The PE mentioned in tabs 1 and 2 of Annex IB of Directive 91/271/EEC (which report the limit values for discharges of WWTPs) refers to the dimension of the agglomeration and not to the capacity of the treatment plant (which is specified in the Italian regulation Decree no:152/2006 Annex 5). This is because the objectives of the Directive the treatment capacity requirements of a WWTP cannot exist independently from the agglomerations' generated load.

With regard to this point, the 2009 WPP for the Veneto Region establishes that discharges from urban WWTPs which serves agglomerations of more than 10,000 PE, independently of the potentiality of the single plant, and which discharges directly and/or through the drainage basins in sensitive areas, must respect the more restrictive limit values for total Phosphorous and total Nitrogen. According to the Directive 'appropriate treatment' must be guaranteed in the agglomerations with less than 2,000 PE, which discharge into freshwaters or into estuaries, and in the agglomerations with less than 10,000 PE which discharge into coastal waters supplied with a sewage collecting system.

RESULTS AND DISCUSSION

It must be noted that this paper only refers to the civil component (resident and fluctuating) of the generated load, as work is still to be carried out to determine the 'quota' of industrial origin. In the Veneto region 729 agglomerations have been identified, of which only nine with a civil generated load of more than 100,000 PE, 77 between 10,000 and 100,000 PE and 127 between 2,000 and 10,000 PE (Table 2). Most of the identified agglomerations (516) are therefore of small dimensions (under 2,000 PE) but, as can be observed in Table 2, more than 95% of the generated load in the agglomerations can be located in the more than 2,000 PE class; this percentage (%) drops to 88% if the contribution of the isolated nuclei and scattered houses is taken into consideration.

From the given case it is clear that the Water Authorities need to be involved in the composition and identification of agglomerations otherwise the process could be completely ineffective. A comprehensive DSS – but this is beyond the scope of this paper – should be developed including optimization models and sensitivity analysis should be performed.

Table 2 | Subdivision of agglomerations in the Veneto Region and generated civil load for potentiality class in PE

PE	Number of agglomerations	Generated load (civil component)
More than 100,000	9	1,867,863
Between 10,000 and 100,000	77	2,549,206
Between 2,000 e 10,000	127	610,501
Under 2,000	516	205,777

Table 1 | Summary of the Directive 91/271/EEC requirements according to the dimension of the agglomeration and the characteristics of the receiving water body

Cases	Dimension of the agglomeration	Receiving water body	Treatment requirements	Discharge point requirements
Case A	<2,000 PE (freshwaters and estuaries) <10,000 PE (coastal waters)	NA and SA + DBSA	Appropriate treatment	Following discharge, urban wastewaters allow receiving water bodies to fulfil the quality objectives and the dispositions of this and other directives
Case B	≥2,000 PE (freshwaters and estuaries) ≥10,000 AE (coastal waters)	NA and SA + DBSA	Secondary treatment	Annex IB – Table 1 Dir. 91/271/EEC
Case C	>10,000 AE	SA + DBSA	More stringent treatment	Annex IB – Table 1 e 2 Dir. 91/271/EEC

NA, normal area; SA, sensitive area; DBSA, draining basin in sensitive area.

In Table 3 the distribution of the agglomerations in the Veneto Water Authority districts is reported: the district with the highest number of agglomerations is the Alto Veneto (which corresponds roughly to the province of Belluno); this district is substantially mountainous and therefore it indicates a moderate generated civil load (in which the fluctuating component due to tourism is important). The districts with the highest civil contribution are: Bacchiglione, Veneto Orientale and Veronese with a generated load of about a million PE respectively. As indicated, in Table 3 the values do not deal with the industrial component of the generated load, which for some districts is very significant: for example for the tannery district of the Chiampo valley (near the city of Vicenza) or for the petrochemical settlement of Porto Marghera–Venice ('Laguna di Venezia' district).

The paper confirms the peculiarity of the territory of the Veneto region characterized by dense and diffuse urbanization especially in the East-West direction (it could almost be considered to be a quasi-unique agglomeration which runs uninterruptedly from Verona to Mestre-Venice); it is evident that the difficulty applying a definition of agglomeration to a context where there is urban continuity also between different municipalities and in which the degree of compenetration of the wastewater networks is high; moreover, to calculate the polluted loads, a significant industrial component and the civil component must be considered. It is once again necessary to point out that the proposed GIS cannot be considered, at this stage, to be a DSS and therefore no sensitivity analysis has been performed.

Table 3 | Distribution of agglomerations in the districts (AATO) of the Veneto Region and generated load (civil component) in PE

AATO	Number of agglomerations	Generated load (civil component)
Alto Veneto	207	318,265
Veneto Orientale	85	1,019,797
Laguna di Venezia	15	772,638
Brenta	45	542,981
Bacchiglione	99	995,803
Polesine	88	277,610
Veronese	128	967,581
Valle del Chiampo	40	161,941
Interregional Veneto-Friuli Venezia Giulia	22	176,731

CONCLUSIONS

The identification and definition of agglomerations is a requirement set out in Directive 91/271/EEC to guarantee the collection and the adequate treatment of urban wastewaters and to reach the environmental quality objectives of the water bodies according to the Water Framework Directive 2000/60/EC. In Italy, the definition of the agglomerations principally involves two subjects: the region with the WPP and the district Water Authority who is responsible for the organization of the integrated water supply services (aqueducts, the production of drinking water, sewer collection, urban wastewater treatment).

A methodological path is presented and discussed for the structure and identification of the agglomerations according to Directive 91/271/EEC and according to the characteristics of the territory of the Veneto region, which is a highly populated and industrialized area in Northern Italy. The approach requires an analytical stage where the regional territory is subdivided to identify the areas of sufficient concentration of population and/or economic activities (centers and inhabited nuclei) and, subsequently, an assessment of existing and planned sewer and treatment infrastructure by means of planning tools and processes agreed with district Water Authorities.

The proposal highlights the necessity of the institutional involvement of the Authorities responsible in the process of the definition of agglomerations: they cannot be defined in a top-down mechanism but better by using a bottom-up approach with higher regional governance. The study has been developed with GIS support in order to develop a dynamic tool with rapid updating capacity. It is presented as the starting point for the realization of a DSS for the optimisation of sewer pipes and treatment plant localization according to the identified agglomerations. Due to the necessity for comparison between the previous situation and the identification of agglomerations produced with the DSS, when completed with the GIS, a sensitivity analysis for the input data should be performed.

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