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REVIEW OF THE ENVIRONMENTAL IMPACT ASSESSMENT PROCESS OF WASTEWATER TREATMENT PLANTS IN SPAIN

The environmental impact over natural water systems, both marine and land, of the sewage is minimized with the treatment at Wastewater Treatment Plants (WWTPs), but these facilities also generate environmental impacts during the construction period and during the operation period. A review of the environmental impact assessment (EIA) process of WWTPs in Spain through the analysis of records of decision (RODs) between 2000 and 2016 has been performed in this work. The major environmental impacts during the construction period are noise, land use and disturbance of the air and water's quality. During the operation period, the major environmental impacts are noise, odors from the depuration process and the visual impact of the facilities. About the EIA process, results show the processing time is too long, scoping phase has a success rate about 57.2% and regional public administrations are the most participative, both at scoping phase and at public participation phase. In general, public participation during period of exhibition is very low, in twelve of the RODs nobody submitted any report. The role of environmental project manager and the work environmental journal must be strengthened.

1. INTRODUCTION

Population growth, industrialization, agricultural practices and urbanization increase the water demand and thus the quantity of wastewater generated. The discharge of wastewater without any treatment process or the direct irrigation in landfills, cause environmental pollution and health problems [1]. The main objective of the wastewater treatment plants (WWTPs) is to minimize the environmental impact of discharging untreated water into natural water systems and its consequences [2]. Many countries of Europe, especially in the Mediterranean area, have witnessed growing levels of water stress, both in terms of scarcity and the deterioration of quality [3]. These situations have provoked wastewater treatment and its reuse to become more and more important [4]. Therefore, another objective of WWTPs is to get reclaimed water to be used safely in agricultural and

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landscape irrigation, industrial applications, environmental applications (surface water replenishment and groundwater recharge), recreational activities, urban cleaning, fire-fighting, etc. Nowadays, society demands that all process, product or services must be also analyzed from an environmental point of view, including those that are considered for emission treatment such as WWTPs. In these systems, a variety of processes takes place: energy is consumed, chemical reagents are used, and sludge and environmental emissions are derived [5].

European Union regulates the wastewater process and plants mainly through three directives. The first of them is the Water Framework Directive (WFD) [6] that establishes a framework for the community action in the field of water policy. The second law is the Directive 91/271/EEC [7] that regulates the emission limit values of the urban wastewater, as total nitrogen (TN) or chemical/biochemical oxygen demand. The third of them is the Directive 2014/52/EU [8] (and its previous predecessors) on the assessment of the effects of certain public and private projects on the environment. The environmental advantages of the project of new WWTPs or extension WWTPs can be evaluated by conducting an environmental impact assessment (EIA). The EIA process in Europe is regulated by two laws, the Directive 2014/52/EU on the assessment of the effects of certain public and private projects on the environment (known as Environmental Impact Assessment – EIA Directive) and the Directive 2001/42/EC [9] on the assessment of the effects of certain plans and programmes on the environment (known as Strategic Environmental Assessment – SEA Directive).

In Spain, two main regulatory levels can be found: national regulation, which has a general scope and applies to the whole of the national territory, and a regional regulation, which applies to just one of the seventeen regions into which the country is divided. At national level, EIA's framework during the period of study has been regulated by some laws. First, the Royal Decree 1302/86 [10] and the Royal Decree 1131/88 [11], which defined the stages of environmental impact assessment and the content of the Environmental Impact Statement (EIS). Then, the Royal Decree 1/2008 [12] that included aspects of public participation and modified aspects of the administrative process (processing time, consultation, etc.), expanding the list of projects of Annexes I and II. The Act 6/2010 [13] amended the definition of planning authorities, organized the process in three phases and changed the processing time. Finally the Act 21/2013 [14] joined the EIA and the SEA process in the same law and expanded another time the list of projects of Annexes I and II.

As the present review study includes files submitted to different EIA regulations across the time, without specifying processing time, the EIA process can be divided into three phases. The first phase consists in determining the scope of the environmental impact statement (EIS) by the environmental agency (this is also known as scoping). In this phase, the environmental agency makes the consultations to interested agencies and persons, both public and private. This phase was mandatory until Act 21/2013 and voluntary after it. The second phase involves the preparation of the EIS by the developer

and the process of public information and further consultations to previous interested agencies and persons. Finally, the third phase of the process is the revision by the environmental agency and the publishing of the record of decision (ROD) (also known as development consent), which determines the environmental viability of the project, as well as the conditions and requirements to be imposed.

A project will have to undergo the EIA process if its activity is on the list of Annex I activities of the regulations in force or if it is on the list of Schedule II activities and the environmental agency decides that the assessment process is necessary. In the case of WWTPs, the EIA process is required because such plants belong to Group 7, Section D wastewater treatment plants with capacity greater than 150 000 population equivalent (as specified in Schedule I) or to Group 8, Section D wastewater treatment plants with capacity greater than 10 000 population equivalent (as specified in Annex II).

The aim of this study is to review the EIA process for WWTPs in Spain, describing the main aspects of the process (assessment methodologies, public participation, monitoring, etc.) and identifying areas for improvement. The results of this research can help to the management or to the execution of the EIA projects and can be applicable for other cases, improving the EIA body of knowledge, both at national and global level.

This article is structured into five sections. Following the introduction, the second section develops the methodology used in this study. The Results section describes and analyzes the main features of the EIA process. In the fourth section, Evaluation of the Results, the areas for improvement and the applicability of the results are described. Finally, the main findings are developed in the Conclusion section.

2. METHODS

This research is based on the analysis of RODs for WWTPs issued by the Central Government since 2000 to 2016 and published in the official Spanish gazette (Boletín Oficial del Estado). This methodology has been frequently used in Spain in research about EIA, e.g., consideration of ecological compensation [15], dams [16], LNG regasification plants [17], seawater desalination plants (SWDPs) [18], and climate change [19]. A ROD is the available public document where the approving agency presents the main factors that were contemplated to reach the final decision on every project, including the practical means to avoid or minimize environmental harm. The RODs in Spain contain an account of the EISs prepared during the EIA procedure.

The main aspects and parameters of the EIA process for each project were collected:

- Basic data (project description, location, start date, termination date, environmental agency, and date of publication in the gazette).
- Number of consultations made by the environmental organisation, identification of interested agencies and persons according to their geographic scope (local, provincial, regional and national) and by ownership (public or private).

Table 1

RODs published in official state gazette (2000–2016)

No.	Environmental impact statements published in official gazette	Date
1	Expansion of WWTP of Bens (A Coruña)	04.12.2002
2	Expansion of collector net and WWTP of Guadalajara (Guadalajara)	21.01.2003
3	Expansion of WWTP of Cabo Prioriño (A Coruña)	19.09.2003
4	Expansion and upgrading of the systems of sanitation, treatment and reuse of WWTP of Puerto del Rosario, Fuerteventura (Las Palmas de Gran Canaria)	19.12.2003
5	Expansion and upgrading of the systems of sanitation, treatment and reuse of WWTP of Gran Tarajal, Fuerteventura (Las Palmas de Gran Canaria)	19.12.2003
6	Expansion and upgrading of the systems of sanitation, treatment and reuse of WWTP of Corralejo, Fuerteventura (Las Palmas de Gran Canaria)	19.12.2003
7	Expansion of WWTP of Lugo (Lugo)	07.06.2004
8	WWTP of Azuaga (Badajoz)	07.02.2005
9	WWTP of Garganta la Olla (Cáceres)	07.02.2005
10	WWTP of Ceuta	01.03.2005
11	Sanitation and treatment of the municipalities of César de Cáceres, Torremocha, Torreorgaz and Trujillo (Cáceres)	24.05.2005
12	Sanitation and treatment of Cedilla and Alcántara (Cáceres)	31.01.2006
13	WWTP of Algeciras (Cádiz)	29.03.2006
14	WWTP of Lamiaren-Aramburu (Vizcaya)	07.06.2006
15	Construction of WTP, collectors, pumping stations and outfall of Torrox (Málaga)	03.07.2006
16	Construction of WWTP of Los Alcázares and auxiliar works of sanitarion (Murcia)	20.07.2006
17	Outfalls and WWTP of the municipalities of Alto Órbigo (León)	13.10.2006
18	Expansion and reuse of treated water of WWTP of Sueca (Valencia)	24.05.2007
19	WWTP of the Gafo River in Casielles-Las Caldas, Oviedo (Asturias)	17.12.2007
20	WWTP of Gijón (Asturias)	26.06.2009
21	WWTP of Santiago de Compostela (A Coruña)	10.08.2009
22	WWTP of Estiviel (Toledo)	12.11.2010
23	WWTP and improvement of the sanitation of Ourense (Ourense)	06.05.2011
24	WWTP, collectors and pumping stations of Nerja (Málaga)	26.01.2011
25	WWTP of Lamiako in Leioa (Bizkaia)	21.07.2011
26	Sanitation and treatment of Vegas Bajas. WWTP of Badajoz (Badajoz)	23.01.2013
27	Sanitation and treatment of the agrarian region of Hervás, municipalities of Hervás and others (Cáceres)	24.01.2013
28	Sanitation of Soria: WWTP and outfall (Soria)	28.11.2013
29	WWTP, collectors and land-maritime outfall of Addaia, municipality of Es Mercadal (Menorca)	24.01.2014
30	WWTP of Santa Eulària (Ibiza)	22.04.2014
31	WWTP of Santiago de Compostela (A Coruña)	27.06.2014
32	WWTP of Ibiza (Balears Islands)	31.07.2014
33	Expansion and improvement of sanitation system of Plasencia (Cáceres)	30.12.2015

Table 2

Characteristics of WWTPs under study

No.	Population equivalent	Average flow [m ³ /day]	Water treatment line							Sludge treatment line				
			Pretreatment ^a	Primary treatment ^b	Secondary treatment			Tertiary Treatment		Thickening	Anaerobic digestion	Dewatering	Storage	Gas utilization
					Extended aeration	Biofilter	Not specified	Reverse osmosis	UV					
1, 2	no data	no data	×	×	–	–	×	–	–	×	×	×	×	×
3	155 996	no data	×	×	–	–	×	–	–	×	×	×	×	×
4	no data	3 000	×	×	×	–	–	×	–	no data about process				
5	no data	1 500	×	×	×	–	–	×	–	no data about process				
6	no data	900	×	×	×	–	–	×	–	no data about process				
7	200 000	76 464	×	×	×	–	–	–	–	×	×	×	×	–
8	19 933	no data	×	×	×	–	–	–	–	×	–	×	×	–
9	2795	no data	×	×	×	–	–	–	–	×	–	×	×	–
10	120 000	no data	×	×	–	–	×	–	–	×	×	×	×	–
11	31 665	no data	no data about process											
12	no data	no data	×	×	×	–	–	–	–	×	–	×	×	–
13	204 000	51 000	×	×	–	–	×	–	×	×	×	×	×	–
14	78 000	no data	no data about process											
15	20 000	no data	×	×	–	–	×	–	×	×	–	×	×	–
16	120 000	no data	no data about process											
17	no data	no data	no data about process											
18	no data	12 100	×	×	–	–	×	–	×	×	–	×	×	–
19	56 105	no data	×	×	–	–	×	–	–	×	–	×	×	–
20	150 000	45 000	×	×	×	–	–	–	–	×	–	×	×	–
21	264 000	no data	×	×	–	–	×	–	–	×	×	×	×	–
22	270 000	36 000	×	×	–	–	×	–	×	×	×	×	×	–
23	227 733	50 664	×	×	×	–	–	–	–	×	×	×	×	×
24	322 000	76 464	×	×	–	×	–	–	–	×	×	×	×	–
25	80 000	25 000	×	×	–	–	×	–	–	×	–	×	×	–
26	385 000	66 000	×	×	×	–	–	–	–	×	×	×	×	×
27	15 963	172.5	×	×	–	×	–	–	–	×	×	×	–	–
28	111 691	1 015	×	×	×	–	–	–	–	×	×	×	×	–
29	24 844	6 000	×	×	×	–	–	–	–	no data about process				
30	58 333	14 000	×	×	×	–	–	no data about process						
31	264 000	86 400	×	×	×	–	–	no data about process						
32	150 000	no data	×	×	×	–	–	–	×	×	×	×	×	–
33	145 833	25 000	×	×	–	×	–	–	–	×	×	×	×	–

¹Pre-treatment removes all materials that can be easily collected from the sewage, as cans, sticks, plastics, etc. Sewage pass through some screens of different size.

²Primary treatment is composed of physical-chemical tanks for flocculation-coagulation of colloids and primary sedimentation tanks to pick the sludge of the base of the tank and to skim off the grease and oils of the surface.

- Number of consultation responses received (and summary of contents) by the environmental organisation, identification of interested agencies and persons according to their geographic scope (local, provincial, regional and national) and ownership (public or private).

- Description and number of options considered.
- Methodology for identification and assessment of environmental impacts.
- Environmental impacts identified in the process, and classified according to the physical, biological, perceptual, and socio-economic factors; as well as cultural-historical heritage.

- Proposed corrective measures.

- Number of responses received (and summary of content) during the public exhibition period.

- Instructions for monitoring project (environmental monitoring plan, determination of technicians responsible for monitoring: environmental project manager).

- ROD results (positive, or negative, or positive with conditions)

In the study period, regardless of the ministerial structures of the various Spanish governmental institutions, the RODs were issued by the Directorate General of Quality and Environmental Impact Assessment. A total of 33 RODs of WWTP were found, and their description is shown in Table 1. WWTP can be divided in two lines: wastewater and sludge. Table 2 gives a detailed description of the characteristics for each WWTP that are described in the official state gazette.

3. RESULTS

An analysis and comparison of the various WWTPs and the corresponding RODs enables us to establish the following characteristics in relation to the process of EIA.

3.1. PROCESSING TIME

EIA regulations specify deadlines for the processing of cases. Specifically, article six of Act 6/2010 [13] states that for projects to be authorized or approved by the National Government, the second phase of the EIA procedure cannot exceed 18 months. The main objective of setting deadlines has always been to speed up the process in which various administrations are involved. However, processes often miss their deadlines and so endanger the whole project because of subsequent funding problems or the changing needs of sponsors. In the case of WWTPs, the average processing time from the start of the process until the publication of the ROD in the official gazette is 2.84 years with a standard deviation of 1.21 years. The fastest project was the Ceuta treatment plant (ROD No. 10) with 1.43 years and the longest project was the Lamiako treatment plant (ROD No. 25), where processing took 4.52 years.

In the European Union the average duration of the EIA procedure is 11.3 months. Spain has the longest process within the seventeen countries studied in 2009 with duration of 27 months [20]. In the case of WWTPs, the average length is 2.84 years (34.1 months), much longer than the period initially proposed by the current regulations [13] and projects such as SWDPs with 1.78 years (21.4 months) [18]. There are still some projects with longer processing time such as liquefied natural gas (LNG) regasification plants with a total of 3.78 years (45.4 months) [17] and major dams with 5.3 years (63.6 months) [16].

3.2. OPTIONS CONSIDERED

An EIS is intended as a technical document that assesses a project (or several project options) on one or more sites (including the zero option, namely, no project) and determines the best option from the environmental point of view. In the RODs, the studied alternatives for WWTPs are briefly described and pointed the justification of the chosen alternative.

All the RODs studied considered several options – with the exception of records of Puerto del Rosario, Gran Tarajal, Corralejo, Azuaga and Lamiaren-Aramburu. Some of records (for example Soria, Badajoz and Plasencia) pointed a multicriteria method is used to support the decision, but there is not any description or reference of the method.

Some of the listed options studied in the RODs were:

- alternative zero (current situation) or build the WWTP,
- build a new WWTP or extend the current WWTP,
- different sites for the WWTP,
- water treatment line: extend aeration or biofilters,
- if water can be reused, for example for the agriculture, alternatives about the tertiary treatment (reverse osmosis or UV),
- different sites for the outfall,
- use of dewatering sludge for agriculture or only storage and subsequent transport to landfill,
- utilization of gas from anaerobic digestion of sludge or not.

3.3. CONSULTATION

The period of consultation (or scoping) aims at determining the scope of the environmental impact study. This process begins with the submission of a project summary report to the planning authority, which refers to the report of the environmental agency which, in addition, is responsible for consulting with the affected organisations and communities [12]. For WWTPs, an average of 14.0 consultations occurred – with an average of 10.3 affected public organizations and an average of 3.7 affected private corporations being consulted. If the overall sample is analyzed, the response rate to consultations is 57.15% for the public sector but only 6.99% for the private sector, with an overall average response rate of 46.40%.

Table 3

Questions and responses received

No.	WWTPs	Consultations			Replies received			Response rate		
		Public sector	Private sector	Total	Public sector	Private sector	Total	Public sector [%]	Private sector [%]	Total [%]
1	Bens	14	7	21	8	0	8	57.14	0.00	38.10
2	Guadalajara	3	1	4	1	0	1	33.33	0.00	25.00
3	Cabo Prioriño	13	1	14	5	0	5	38.46	0.00	35.71
4	Puerto del Rosario	7	2	9	6	0	6	85.71	0.00	66.67
5	Gran Tarajal	7	2	9	6	0	6	85.71	0.00	66.67
6	Corralejo	6	2	8	5	0	5	83.33	0.00	62.50
7	Lugo	7	2	9	3	0	3	42.86	0.00	33.33
8	Azuaga	5	2	7	2	0	2	40.00	0.00	28.57
9	Garganta la Olla	7	3	10	2	0	2	28.57	0.00	20.00
10	Ceuta	3	0	3	3	0	3	100.00	0.00	100.00
11	Municipalities of Cáceres	9	3	12	3	0	3	33.33	0.00	25.00
12	Cedilla and Alcántara	–	–	–	–	–	–	–	–	–
13	Algeciras	–	–	–	–	–	–	–	–	–
14	Lamiaren-Aramburu	12	5	17	4	1	5	33.33	20.00	29.41
15	Torrox	9	1	10	7	0	4	77.78	0.00	40.00
16	Los Alcázares	6	1	7	4	0	9	66.67	0.00	128.57
17	Alto Órbigo	21	4	25	8	1	9	38.10	25.00	36.00
18	Sueca	14	8	22	5	1	6	35.71	12.50	27.27
19	Gafo River	5	6	11	3	0	3	60.00	0.00	27.27
20	Gijón	8	4	12	5	2	7	62.50	50.00	58.33
21	Santiago de Compostela	8	4	12	5	0	5	62.50	0.00	41.67
22	Estiviel	10	5	15	6	0	6	60.00	0.00	40.00
23	Ourense	13	5	18	8	1	9	61.54	20.00	50.00
24	Nerja	15	8	23	7	2	9	46.67	25.00	39.13
25	Lamiako	12	2	14	7	0	7	58.33	0.00	50.00
26	Badajoz	8	4	12	5	0	5	62.50	0.00	41.67
27	Hervás	7	5	12	3	0	3	42.86	0.00	25.00
28	Soria	12	6	18	8	2	10	66.67	33.33	55.56
29	Es Mercadal	22	6	28	15	1	16	68.18	16.67	57.14
30	Santa Eulària	21	7	28	14	1	15	66.67	14.29	53.57
31	Santiago de Compostela	10	4	14	5	0	5	50.00	0.00	35.71
32	Ibiza	15	2	17	11	0	11	73.33	0.00	64.71
33	Plasencia	10	4	14	5	0	5	50.00	0.00	35.71
Averages		10.3	3.7	14.0	5.8	0.4	6.2	57.15	6.99	46.40

As Table 3 shows, participation by the private sector is scarce – in twelve of the procedures as maximum two private organisations were consulted and in twenty-two of the procedures there was no response from any private corporation. If the above data

are analysed according to the geographical scope of the organisations consulted (local, provincial, regional and national), findings are that the largest number of consultations were directed to regional organisations (Fig. 1) and that regional organisations also produce the highest percentage of responses (Fig. 2).

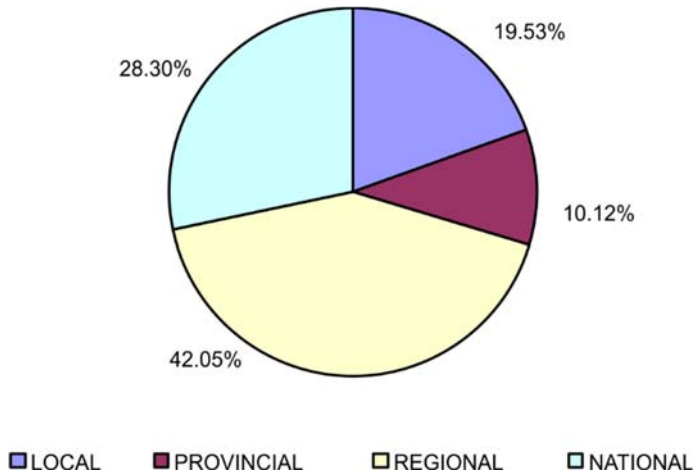


Fig. 1. Consultations of the scoping phase in the WWTPs files (2000–2016)

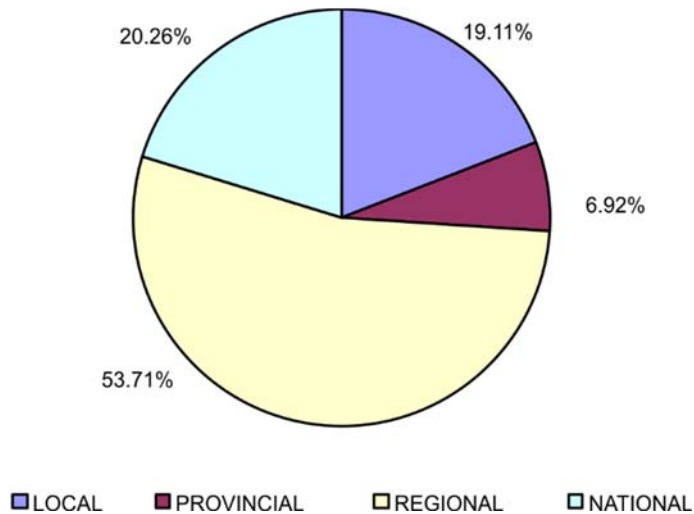


Fig. 2. Responses received of the scoping phase in the WWTPs files (2000–2016)

Unlike what happens globally and among public corporations, most consultations (50.9%) directed towards private organisations are from corporations that are national in scope (including Adena, Ecologists in Action, the Spanish Ornithological Society,

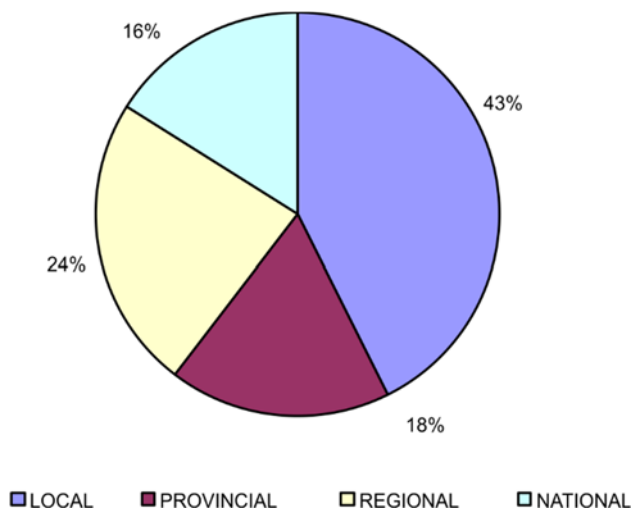


Fig. 3. Response rate to consultative enquiries of the scoping phase in the WWTPs files (2000–2016)

Greenpeace Spain), and the most highest percentage of replies come from organisations based on regional scope (36.4%). If a rate between responses and consultations is calculated, the values of 55.5% for the public sector, and 9.5% for the private one were reached. By geographical scope, as shown in the Fig. 3, organisations based on local level were the most likely to respond to consultative enquiries.

3.4. ASSESSMENT METHODS

The EIA regulations indicate that the assessment of impacts should be performed quantitatively if possible, and if not possible, then qualitatively. The indicators or parameters used should be described through the application of tested or generally accepted standards, studies, and methods. The ROD, as the only public document at the end of the process, should show all aspects of the assessment process and describe the impact assessment methodology employed.

In the study sample, only in ROD No. 9 (Garganta la Olla, Table 1) indicates that the method used is in accordance with the law [17] and in ROD No. 19 (Casielles-Les Caldas) gives a brief description of the method used. This assesses the impact of the full project according to the assessments of the different components of the environment (abiotic, biotic and perceptual), but does not describe its weights nor identifies or evaluates the environmental factors. In the description of the major environmental impacts performed in the ROD No. 28 (Soria), there is not any reference about the assessment method and its scale, but it indicates major impacts are assessed according to magnitude, persistence and extension.

3.5. MAJOR ENVIRONMENTAL IMPACTS

In all the RODs gathered in the sample there is a brief description of the main impacts identified and assessed. These impacts depend on the technology used, the location of the plant, the receiving environment of the treated water and if the treated water is reused. Impacts most often identified in the study sample during the construction period are:

- Land use as consequence of the WWTP construction. It is a permanent impact that starts with the construction and continues during the operation. It has indirect effects as removing habitats, the movement of the wildlife and the visual impact.

- Spilling oils, fuel remains, concrete grout, liquids stripping, etc. over the land.

- Disturbance of the waters, especially in the WWTPs located in the banks of the rivers because the earthmoving works generate an increasing quantity of suspended solids and turbidity of the water. This leads to an increase of the possibility of accidental releases of dangerous products, such as oil or petrol, from the machinery used.

- Noise generated by the machinery used in the phases of the work.

- Disturbance of the air's quality, especially during the earthmoving works, as a consequence of dust emission and gas engines from the machinery.

- Impacts most often identified in the study sample during the operation period are:

- Odours from the depuration process, especially from the pre-treatment phase (screens and collectors) and the sludge treatment. For example, at ROD No. 28 (Soria) a percentage data from the main odors points are presented: primary sedimentation tanks (36%), dewatering and storage of sludge (16%) and secondary tanks for extended aeration (13%).

- Noise generated by the pumps.

- Water's quality. Treated water will usually get better quality than previous WWTP constructions, but in some cases an amount of total nitrogen that causes eutrophication could be generated. Some WWTPs have tertiary treatment to get reclaimed water to reuse the agricultural and landscape irrigation, industrial applications, urban cleaning, etc., and in other cases the tertiary treatment is required by the receiving environment that needs a high quality of reclaimed water, for example in rivers classified as salmon's water category (ROD No. 23, Ourense).

- On the other hand, another impact identified in marine environment reclaimed water after a tertiary treatment with reverse osmosis (RO) (RODs No. 4, 5, 6), is the brine discharge in the sea that increases the salinity of the seawater and harms the underwater meadows of neptune grass and Mediterranean tapeweed, as occurs in the seawater desalination plants (SWDP) [21].

- Visual impact of the buildings, tanks and facilities of the process.

3.6. CORRECTIVE MEASURES

All of the sample RODs describe the main corrective measures to be implemented necessary to avoid or reduce the impact of the plants on the environment. Impacts associated with the construction phase are lower than those corresponding to the exploitation phase [5], then a good design is mandatory for corrective actions and strict monitoring plan during operation of plants. Regarding the identified impacts of the previous point, the following corrective measures are proposed.

In the construction period:

- Areas will be able to store construction materials and park machinery. They will be properly waterproofed to avoid any damage to the soil or to the next watercourses. Some of the RODs (for example No. 28 Soria, and No. 32 Ibiza) pose as a preventive measure a minimum distance of 50 m.
- Work schedules will be limited and work periods will depend on the nearby towns or protected wildlife (as for example in the ROD No. 26 Badajoz where some works cannot be performed between 15th March and 15th June to avoid to affect the nesting of birds).
- Earthmoving works will be realised with machinery in good conditions, the work surfaces will be irrigated as well as the truck body will be covered with tarps.

In the operation period:

- Air extraction systems will be installed from the main focus of odor emissions until the deodorization system. The most used equipment consists on towers installed in series where wet washing of polluted air is performed. This solution can be complemented, as it is arisen in the ROD No. 13 Algeciras, with perimeter vegetal screen formed by species of perennial leaf and fast growth that makes difficult the dispersion of odoriferous particles by the air,
- Pumps or blowers will be installed in buildings with adequate soundproofing, as well as localized shielding which will be performed with absorbents.
- Treated water to later use must meet greater demands regarding biological and physicochemical parameters, as well as the presence of heavy metals and hazardous substances. Analysis and periodic inspections will be conducted more frequently. Concerning brine discharge into the sea in WWTPs with tertiary treatment with reverse osmosis, the brine will be diluted with treated water before discharge.

WWTP integration in the landscape will be achieved through three main actions, the first and second measure are common for all RODs and the third action depends on the characteristics of the location. First measure is that buildings must have a limited height and their colours and textures will be used according to its surrounding space. Second measure is to plant vegetable screens with tall and native species in the area, with the objective to avoid the direct view of the treatment tanks. The third measure is complementary with the second. As it is described at ROD No. 14 Lamiaren-

-Aramburu, it is to keep a strip of land around all the facility to isolate it with wide vegetable screens.

Preventive and corrective measures for WWTPs are proposed both in the EIS as in the EIA process, but it is not usual the proposal of compensatory measures. There are some cases, for example the ROD No. 1 Bens where an environmental education classroom is proposed. The objective of this classroom is to carry out a teaching activity about the importance of urban wastewater purification and its contribution to sustainable development, as well as about the wastewater treatment of the facility.

3.7. PUBLIC PARTICIPATION

Information regarding projects that are subjected to environmental assessments must be made public, either by the environmental agency involved or the planning authority. The minimum period of public exhibition is one month and during this process any organisation or person can consult the documentation available and make relevant submissions. Table 4 shows the low number of public submissions made in the study sample. In fact, in twelve of the procedures there were no public submissions at all, and in eight of the procedures there was only one public submission. From 2009 the number of public submissions has grown slightly, especially at local level.

Table 4

Submissions received during public exhibition period

No.	WWTP	Submissions received				
		Local	Provincial	Regional	National	Total
1	Bens	–	–	–	–	–
2	Guadalajara	–	–	–	–	1
3	Cabo Prioriño	1	–	1	–	2
4	Puerto del Rosario	–	–	–	–	0
5	Gran Tarajal	–	–	–	–	0
6	Corralejo	–	–	–	–	0
7	Lugo	1	–	1	–	2
8	Azuaga	–	–	–	–	0
9	Garganta la Olla	–	–	–	–	1
10	Ceuta	–	–	–	–	1
11	Municipalities of Cáceres	–	–	–	–	0
12	Cedilla and Alcántara	–	–	–	–	0
13	Algeciras	–	–	–	–	2
14	Lamiaren-Aramburu	–	–	–	–	0
15	Torrox	–	–	–	–	0
16	Los Alcázares	–	–	1	–	1
17	Alto Órbigo	–	–	–	–	0
18	Sueca	2	–	–	–	2

Table 4

Submissions received during public exhibition period

No.	WWTP	Submissions received				
		Local	Provincial	Regional	National	Total
19	Gafo River	8	–	5	–	13
20	Gijón	93	–	–	–	93
21	Santiago de Compostela	25	–	1	–	26
22	Estiviel	1	–	–	–	1
23	Ourense	31	–	–	–	31
24	Nerja	6	1	1	–	8
25	Lamiako	2	1	–	–	3
26	Badajoz	–	–	–	–	0
27	Hervás	1	–	–	–	1
28	Soria	2	–	–	–	2
29	Es Mercadal	1	–	–	–	1
30	Santa Eulària	1	–	–	–	1
31	Santiago de Compostela	18	–	–	–	18
32	Ibiza	–	–	–	–	0
33	Plasencia	–	–	–	–	0

Table 5

Reports received in the public exhibition

No.	WWTPs	Reports received				
		Local	Provincial	Regional	National	Total
20	Gijón	3	–	3	–	6
21	Santiago de Compostela	–	–	3	–	3
22	Estiviel	–	–	2	1	3
23	Ourense	–	–	3	–	3
24	Nerja	–	–	–	–	0
25	Lamiako	–	1	1	1	3
26	Badajoz	1	–	1	2	4
27	Hervás	2	1	1	0	4
28	Soria	2	1	3	1	7
29	Es Mercadal	1	0	3	2	6
30	Santa Eulària	2	0	6	1	9
31	Santiago de Compostela	0	0	3	0	3
32	Ibiza	3	0	4	1	8
33	Plasencia	0	1	1	0	2

It is necessary to emphasize the number of submissions during public exhibition of the WWTP of Gijón. This is due to the proximity of the WWTP to the city, so local population showed their concern for possible disturbances due to odors and noise. As

consequence of RD 1/2008 [18], the EIS has to be sent to the organizations and communities previously viewed to determine its scope. This is mandatory from ROD No. 20 (Table 5). The average of reports received is 4.4, somewhat lower than the average of initial responses in the consultation phase, but the number of reports received has increased since 2011 (ROD No. 25).

3.8. MONITORING AND ENVIRONMENTAL CONTROL PLAN

EIA follow-up definition consists of four components: monitoring, evaluation, management and communication [22] and its importance in the EIA process is an accomplished factor by many researchers and practitioners [19]. One of the basic tools of EIAs' follow-up is the environmental monitoring plan (EMP) that should imply a control and monitoring of the environmental impacts effectiveness regarding the corrective measures stated in the EIS as well as the specific conditions established in the ROD.

All RODs analysed present references to EMP, though in more detail in the last files. The operation phase reflects the controls on the treated water, the controls in the receiving environment (analysis of water, sediment and organisms), controls of the noise levels of the facilities and the controls (both inside and outside of the WWTP) of the chemicals (chiefly H_2S and NH_3) that cause the odour chemicals.

There are three types of reports when the plant is operating. First the monthly monitoring reports, which register collected data during this period. Their evolution and the variations consist of the previous report. The second type are the valuation reports drafted at the end of the year which collect parameter's evolution, problems detected and the measures implemented for the overall system improvement of deviations. Finally, the third type are the special reports, which are made only if there are risks or environmental damages of importance.

Eight of the RODs (Cabo Prioriño, Garganta la Olla, Ceuta, Municipalities of Cáceres, Algeciras, Lamiaren-Aramburu, Gijón, Santa Eulària) require somebody to be responsible for environmental tracking and monitoring. The environmental project manager (EPM) [22, 23], should be independent of the contractor and in constant contact with the project manager. This monitoring responsibility should be extended to include various preventive and corrective measures in the plan; as well as the control and analysis of the evolution of selected environmental indicators, and the issuing of periodical technical reports on the results and conclusions obtained from the checks made. The individual should be responsible for communicating to the relevant authorities any anomaly that may affect the environment. Three of the RODs (Bens, Cabo Prioriño, Santa Eulària) indicate a work environmental journal (WEK) where aspects of monitoring must be reflected.

Each ROD concludes by indicating the environmental viability of the project, and in the case of this sample, all 33 projects were approved with the conditions identified in either the study or assessment process.

4. EVALUATION OF THE RESULTS.

After the analysis of all the RODs of WWTP submitted to EIA since 2000 to 2016 some activities can be proposed to improve the EIA process.

4.1. AREAS FOR IMPROVEMENT

The processing time must be reduced. One cause of this long duration is to be found in the scoping phase, where only an average response rate/consultations 55.5% for public sector and 9.5% for private sector were reached. These values are not an isolated event but an endemic problem of the EIA process that must be corrected in order to get optimal solutions from an environmental point of view [5]. Another problem that delays this process is the revision of the environmental agency caused by lack of resources, both human and technician. Recently, the Spanish government, aiming to get a reduction of processing time in revision of competent authorities, has published a new law, act 21/2013 [14]. The time used for the revision of the environmental agency has been reduced to three months for minor projects and four months for major projects (these last with the possibility of extending to six months).

Another aspect that should be addressed is related to the evaluation methodology employed – only one of the EIAs contains a brief description of the methodology. It is necessary to remove the sense of subjectivity that an assessment can generate by making a complete and detailed definition of the methodologies used for identifying and evaluating environmental impacts.

As a sign of respect for public participation, many administrations use their web pages as well as local newspapers. Usually, the administrations' web pages are too complicated for the public and newspapers are rarely used. One of the proposed activities will be to build a web page for each project and use banners or link connections from the administrations' web pages or from web pages that are most related to the location of the project. The main purpose is to enable people to consult the project and the EIS so that they have the possibility of writing their allegations and opinions.

Finally, in regards to the monitoring, the role of environmental project manager must be strengthened and empowered by legislation to ensure the correct execution of the environmental aspects of a project [24].

4.2. APPLICABILITY OF THE RESULTS

The technologies used in the WWTPs study are conventional technologies used in other parts of the world. Therefore, the results obtained from the main environmental impacts (noise, disturbance of the water's quality, odors from the pre-treatment and the sludge treatment) can be extrapolated to other parts of the world. This type of study on the EIA process in a certain country improves knowledge about EIA both nationally and

globally. The awareness of the process facilitates the work of engineers when drafting new infrastructure projects or processes in Spain. In the research field, this study allows scientists to analyze various EIA systems and propose EIA practices used in other countries.

It is important to keep in mind that the globalization of the economy makes it feasible for foreign sponsors to invest in Spanish infrastructures. An important aspect to consider in an investment analysis is the EIA processing time, since it can modify the period of payback or impose such a threat that the investment is consequently rejected.

Public participation is an endemic problem of environmental impact assessment [25]. In most EIA processes at a global level, the management of public participation is conducted by the public administration and it is usually limited to meeting deadlines and established mechanisms, but never focusing on improving citizen participation. In the RODs of the study, it has been shown that in procedures with greatest participation, options were modified to achieve better solutions from the environmental point of view.

To improve the public participation process, the government must introduce new technologies (web pages, social networks, etc.) to encourage and help participation. Sponsors should also promote mechanisms to explain the project to the citizens (web pages, conferences, assemblies), and add environmental improvements proposed by citizens in order to achieve the greatest social consensus possible.

5. CONCLUSIONS

The wastewater treatment is necessary both by regulatory rules as by benefits to the environment, so the construction and operation of WWTPs is necessary, but these facilities also generate environmental impacts during the construction period and during the operation period.

The main impacts of WWTPs during the construction period are noise, disturbance of the waters and disturbance of the air's quality caused by the machinery. In the operation period, the main impacts are visual impact of the buildings, tanks and facilities used in the process, noise of the pumps and machinery and odours from the pre-treatment and the sludge treatment.

About the EIA process, results show the processing time is too long (34.1 months versus 18 months pointed at the law), scoping phase has a success rate about 57.2% and regional public administrations are the most participative, both at scoping phase and at public participation phase.

Public participation during the exhibition period is generally negligible (in twenty two of the RODs nobody submitted any report), except in general terms in the most recent files. In the procedures where there was greater participation, options were modified to achieve better solutions from the environmental point of view. Therefore, the public administration should improve and enhance mechanisms for public participation.

Environmental project manager (EPM) and the work environmental journal (WEK) must be a necessary figure and a necessary tool during the monitoring phase to achieve the objectives of the EIS as well as the ROD, and as consequence, the protection of the environment.

REFERENCES

- [1] FOLEY J., DE HAAS D., HARTLEY K., LANT P., *Comprehensive life cycle inventories of alternative wastewater treatment systems*, Water Res., 2010, 44, 1654–1656.
- [2] RODRIGUEZ-GARCÍA G., MOLINOS-SENANTE M., HOSPIDO A., HERNÁNDEZ-SANCHO F., MOREIRA M.T., FEIJOO G., *Environmental and economic profile of six typologies of wastewater treatment plants*, Water Res., 2011, 45, 5997–6010.
- [3] MOLINOS-SENANTE M., HERNÁNDEZ-SANCHO F., SALA-GARRIDO R., *Cost-benefit analysis of water-reuse projects for environmental purposes: A case of study for Spanish wastewater treatment plants*, J. Environ. Manage., 2011, 92, 3091–3097.
- [4] HERNÁNDEZ-SANCHO F., MOLINOS-SENANTE M., SALA-GARRIDO R., *Economic valuation of environmental benefits from wastewater treatment process: An empirical approach for Spain*, Sci. Total Environ., 2010, 408, 953–957.
- [5] GALLEGO A., HOSPIDO A., MOREIRA M.T., FEIJOO G., *Environmental performance of wastewater treatment plants for small populations*, Res. Cons. Rec., 2008, 52, 931–940.
- [6] European Union. Directive 2000/60/EEC of the European Parliament and of the Council of 23 October 2000 establishing a framework for the community action in the field of water policy (EEU Water Framework Directive), Off. J. Eur. Union, 2000, L327, 1–72.
- [7] European Union. Directive 91/271/EEC of the Council of 21 May 1991 concerning urban wastewater treatment. Off. J. Eur. Union, 1991, L135, 40–52.
- [8] European Union. Directive 2014/52/EU of the European Parliament and of the Council of 16 April 2014 amending Directive 2011/92/EU on the assessment of the effects of certain public and private projects on the environment. Off. J. Eur. Union, 2014, L124, 1–18.
- [9] European Union. Directive 2001/42/EC of the European Parliament and of the Council of 27th June 2001, on the assessment of the effects of certain plans and programmes on the environment. Off. J. Eur. Union, 2001, L197, 30–37.
- [10] Spanish Government. Royal Decree 1302/1986, of the 28th June, on Environmental Impact Assessment. Bol. Oficial Estado, 1986, 155, 23733–23736.
- [11] Spanish Government. Royal Decree 1131/1988, of the 30th September, that develops the EIA regulation on RD 1302/1986. Bol. Oficial Estado, 1988, 239, 28911–28915.
- [12] Spanish Government. Royal Decree 1/2008, of the 11th January, of Environmental Impact Assessment of Projects. Bol. Oficial Estado, 2008, 23, 4986–5000.
- [13] Spanish Government. Act 6/2010, of the 24th March, for modification of the Act 1/2008 of the Environmental Impact Assessment Regulation. Bol. Oficial Estado, 2010, 73, 28590–28597.
- [14] Spanish Government. Act 21/2013, of the 11th December, of Environmental Impact Assessment. Bol. Oficial Estado, 2013, 296, 98151–98227.
- [15] Spanish Government. Resoluciones de la Secretaría General para la Prevención de la Contaminación y el Cambio Climático, por la que se formulan declaraciones de impacto ambiental de plantas de desalación de agua marina. Bol. Oficial Estado, 2000–2016.
- [16] VILLARROYA A., PUIG J., *A proposal to improve ecological compensation practice in road and railway projects in Spain*, Environ. Impact Assess., 2013, 42, 87–94.

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- [17] PIZARRO-CAMACHO D., SOCA-OLAZÁBAL N., *Análisis del cumplimiento de la normativa estatal sobre la evaluación de impacto ambiental para proyectos de grandes presas*, Inf. Constr., 2001, 53 (476), 21–26 (In Spanish).
- [18] FUENTES-BARGUES J.L., *Análisis del proceso de Evaluación de Impacto Ambiental de los Proyectos de Plantas de Regasificación de Gas Natural Licuado*, Dyna Ener. Sosten., 2013, 2, DOI: 10.6036/ES6941 (in Spanish).
- [19] FUENTES-BARGUES J.L., *Analysis of the process of environmental impact assessment for seawater desalination plants in Spain*, Desalination, 2014, 347, 166–174.
- [20] ENRÍQUEZ-DE-SALAMANCA A., MARTÍN-ARANDA R.M., DÍAZ-SIERRA R., *Consideration of climate change on environmental impact assessment in Spain*, Environ. Impact Assess., 2016, 57, 31–39.
- [21] GHK, *Collection of information and data to support the IA study of the review of the EIA Directive*, http://ec.europa.eu/environment/eia/pdf/collection_data.pdf. Accessed: January 2014.
- [22] DE LA FUENTE J.A., OVEJERO M., QUERALT I., *Environmental management of residual brines from sea water desalination plants*, Geo-Temas, 2008, 10, 1125–1128.
- [23] MORRISON-SAUNDERS A., ARTS J., BAKER J., CALDWELL P., *Roles and stakes in environmental impact assessment follow-up*, Impact Assess. Proj. A, 2001, 19 (4), 289–296.
- [24] RUIZ-ARRIAGA S., GARCÍA SÁNCHEZ-COLOMER M.R., *Análisis descriptivo de la Dirección Ambiental de Obra en las Declaraciones de Impacto Ambiental de proyectos de Ingeniería*, Civil. Ing. Civ., 2010, 160, 92–101 (in Spanish).
- [25] ZHAO T.N., WU J.W., WANG X., SHI M.C., *Current conditions, problems, and countermeasures of environmental impact assessment in China*, J. Beijing Forest. Univ., 2001, 23 (2), 67–71.