



**United Nations
Environment
Programme**

EP



UNEP(DEPI)/MED WG. 316/5
29 May 2007

ENGLISH



**MEDITERRANEAN ACTION PLAN
MED POL**

Meeting of the MED POL National Coordinators

Hammamet (Tunisia), 25-28 June 2007

**REGIONAL PLAN AND POSSIBLE MEASURES
FOR THE REDUCTION OF INPUT OF BOD BY 50%
BY 2010 FROM INDUSTRIAL SOURCES**

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1. Introduction

1.1 Background

The Contracting Parties in their 13th meeting held in Catania, Italy 2003 adopted the recommendation II.A.1.2(2) which stipulated the “adoption of the approach proposed by the secretariat in the regional Plan for a 50% reduction in BOD from industrial sources considering the target date of 2010 to be reviewed in 2007 (hereinafter ‘the BOD Plan’), and to ask the secretariat to update the data and information included in the Plan on the basis of the national baseline budget of pollutant releases”, in the framework of the implementation of the LBS Protocol and the strategic Action Programme (SAP) .

In this context, the MEDPOL Secretariat has compiled and reviewed the data provided by the CPs on BOD discharges from industrial sources (National Baseline Budgets), in order to analyse the outcome of this information and accordingly suggest specific actions to address the reduction of BOD industrial discharges.

1.2 Objectives and scope

The objectives of this document are the following:

- (a) To analyse the available BOD data from NBB, on a country and sector basis.
- (b) To identify a group of priority sectors, according to their total releases and representation in the Mediterranean countries.
- (c) To review the options to address reduction of BOD discharges, including direct measures (in-plant actions, end-of-pipe actions) and indirect measures (legal, technical...).
- (d) To suggest an overall strategic action programme to implement the BOD regional Plan.

2. Analysis of available data on BOD discharges

2.1 Source of data

The information on BOD discharges has been obtained from the National Baseline Budget database available from the MEDPOL Secretariat, which integrates all the data reported by Mediterranean countries. For the elaboration of the NBBs, the Secretariat provided to the countries a guidelines report [16], indicating the scope and methodology to estimate emissions, and the reporting format for the year 2003.

Some EU countries (France, Italy, Spain) have used the available data from the EPER register¹ to elaborate their NBB. In these cases, data is not available for BOD but for Total Organic Carbon (TOC). This parameter also measures organic pollution of industrial effluents, but relates to a different analysis². The relation between both parameters will depend on the specific effluents and sectors, and therefore TOC values cannot be converted into BOD values.

2.2 Total discharges of organic pollution

In order to present national and total discharges of organic pollution (BOD or TOC) from industrial sources, data available from the National Baseline Budgets have been collected and put together in Table 1. As indicated above, for those countries using the EPER register to elaborate the NBB, organic pollution is reported in terms of discharges of TOC instead of BOD. Both parameters provide information about the organic load in wastewater, but they are different analytical parameters and in principle should not be added together. In this sense, in Table 1 information on BOD and TOC discharges is shown separately.

According to available data, the total annual load of organic pollution from industrial sources in the Mediterranean region is about 2.5 million tonnes of BOD and 53,000 tonnes of TOC (France, Italy and Spain). As expected, the contribution to this total load varies a lot, and some countries can be identified as large emitters (Egypt, Algeria, Lebanon...) and other as low emitters (France, Cyprus, Slovenia...).

Indeed, total BOD discharges from industrial sources can vary between countries according to a range of factors. The size of the industrial activity would be expected to be the most important factor, but other relevant factors can determine total discharges, like the profile of national industrial sectors (some sectors are more intensive than others in the release of organic pollution), the degree of adoption of BAT in industrial sectors, or the availability of wastewater treatment plants.

¹ European Pollutant Emission Register (<http://www.eper.cec.eu.int/eper/>)

² BOD (Biochemical Oxygen Demand) measures the O₂ required by aerobic micro-organisms in the stabilization of the decomposable organic matter in a wastewater. On the other hand, a typical analysis for TOC (Total Organic Carbon) measures both the total carbon present as well as the inorganic carbon (IC); organic carbon is then obtained by subtracting the inorganic carbon from total carbon. It represents the most appropriate measure for total organic content as it also determines the presence of organic carbon which does not respond to BOD or COD tests. Repeatable empiric correlations between TOC, COD and BOD may be established independently either for a given matrix or for a single effluent [2]. However, these empiric correlations should not be applied out of the framework of each specific case. In consequence, total TOC values reported by some countries are not directly convertible to BOD values. They are the sum of TOC values from different installations and sectors which have different contributions of organic compounds and, as a consequence, different correlation between TOC and BOD.

Table 1 Total discharges of organic pollution (BOD or TOC) from industrial sources in Mediterranean countries (Source: NBB 2003).

Country	Discharges (tonnes/yr)	
	BOD	TOC
Albania	54,405	
Algeria	395,834	
Bosnia H.	93,501	
Croatia	19,383	
Cyprus	1,334	
Egypt	1,403,460	
France		470
Greece	30,629	
Israel	5,944	
Italy		27,236
Lebanon	156,082	
Libya	64,421	
Malta	5,935	
Montenegro	8,032	
Morocco	6,869	
Palestine	2,270	
Slovenia	2,396	
Spain		25,517
Syria	45,190	
Tunisia	10,900	
Turkey	266,169	
TOTAL	2,572,754	53,222

The figures shown in Table 1 are considerably higher than those included in the Regional Plan (about 410,000 tonnes/yr). This is consistent with the fact that when the Plan was elaborated the only available data was BOD discharges from Hot Spots [14], which may represent a portion of total regional discharges. However, although both sources of information use different methodologies to estimate discharges (NBB versus Hot Spots), and hence are not directly comparable, it is worth to mention that the relative contribution of countries to BOD discharges shows some similarities, at least for the two major reported emitters (Egypt and Algeria).

2.3 Release intensity indicators

In order to further analyse and compare the available data, total organic discharges (BOD or TOC) have been related to industrial activity and population, which are the most common release intensity indicators. Industrial activity can be measured in terms of the contribution of industry to the national GDP (in current USD). However, it must be noted that economic data is available for the total national industrial activity, while emission data included in the NBBs relates to discharges from industries in the Mediterranean region. This mismatch in the geographic scope of data could influence (decrease) the value of the release intensity indicator in those countries where a significant part of the industrial activity is not placed in the Mediterranean region. In terms of comparison, and on the basis of available information, another release intensity indicator has been calculated using population data for Mediterranean coastal regions. Results for both indicators are shown in Table 2 and Figure 2. Significant differences in the release intensity of organic pollution can be observed among countries in both cases. Comparing total loads (Figure 2 – a) with loads relative to industrial

activity (Figure 2 – c), some ‘normalization’ effect can be appreciated, in the sense that a group of countries with different total loads are grouped by a similar release intensity (i.e. Egypt, Albania, Bosnia H. and Lebanon). Comparing to these countries, the others show much lower release intensities. This variability is also observed when the release intensity is calculated in relation to population from Mediterranean regions. In this case, a high value is observed for Bosnia H., while for the rest of countries results varies gradually, without suggesting any grouping. Again, higher release intensities are very different comparing to the lower values.

As indicated above, these differences can be related with different industrial profiles or different degree of implementation of end-of-pipe technologies, but even assuming these factors, a lower variability would be expected for release intensity indicators. In any case, release intensity indicators can be useful to identify different priority actions for different countries or groups of countries. For example, the available data indicates that a group of countries have a significant opportunity for the reduction of their release intensity.

Table 2 BOD-TOC discharges in relation to industrial activity and coastal population.

Country	BOD-TOC	National GDP - Industry	Population – coastal region	BOD-TOC / National GDP Industry	BOD-TOC / coastal population
	(tonnes/yr)	(million current USD)	(1000 inhab.)	(tonnes / million current USD)	(kg / inhab.)
Albania	54,405	1,094	1,193	49.71	45.60
Algeria	395,834	37,909	12,271	10.44	32.26
Bosnia H	93,501	2,247	226	41.61	413.72
Croatia	19,383	8,669	1,529	2.24	12.68
Cyprus	1,334	3,293	785	0.41	1.70
Egypt	1,403,460	28,016	22,929	50.09	61.21
France	470	441,000	6,265	0.00	0.08
Greece	30,629	40,984	9,482	0.75	3.23
Israel	5,944	31,958	5,045	0.19	1.18
Italy	27,236	417,000	32,837	0.07	0.83
Lebanon	156,082	3,979	2,906	39.23	53.71
Libya	64,421	8,213	5,179	7.84	12.44
Malta	5,935	954	389	6.22	15.26
Montenegro	8,032	6,613	266	1.21	30.20
Morocco	6,869	12,935	3,233	0.53	2.12
Palestine	2,270	--	1,119	--	2.03
Slovenia	2,396	9,712	101	0.25	23.72
Spain	25,517	248,255	15,560	0.10	1.64
Syria	45,190	6,140	1,533	7.36	29.48
Tunisia	10,900	7,025	6,762	1.55	1.61
Turkey	266,169	52,648	13,691	5.06	19.44

Source / Year: NBB / 2003 World Bank / 2003 BP-RAC / 2000

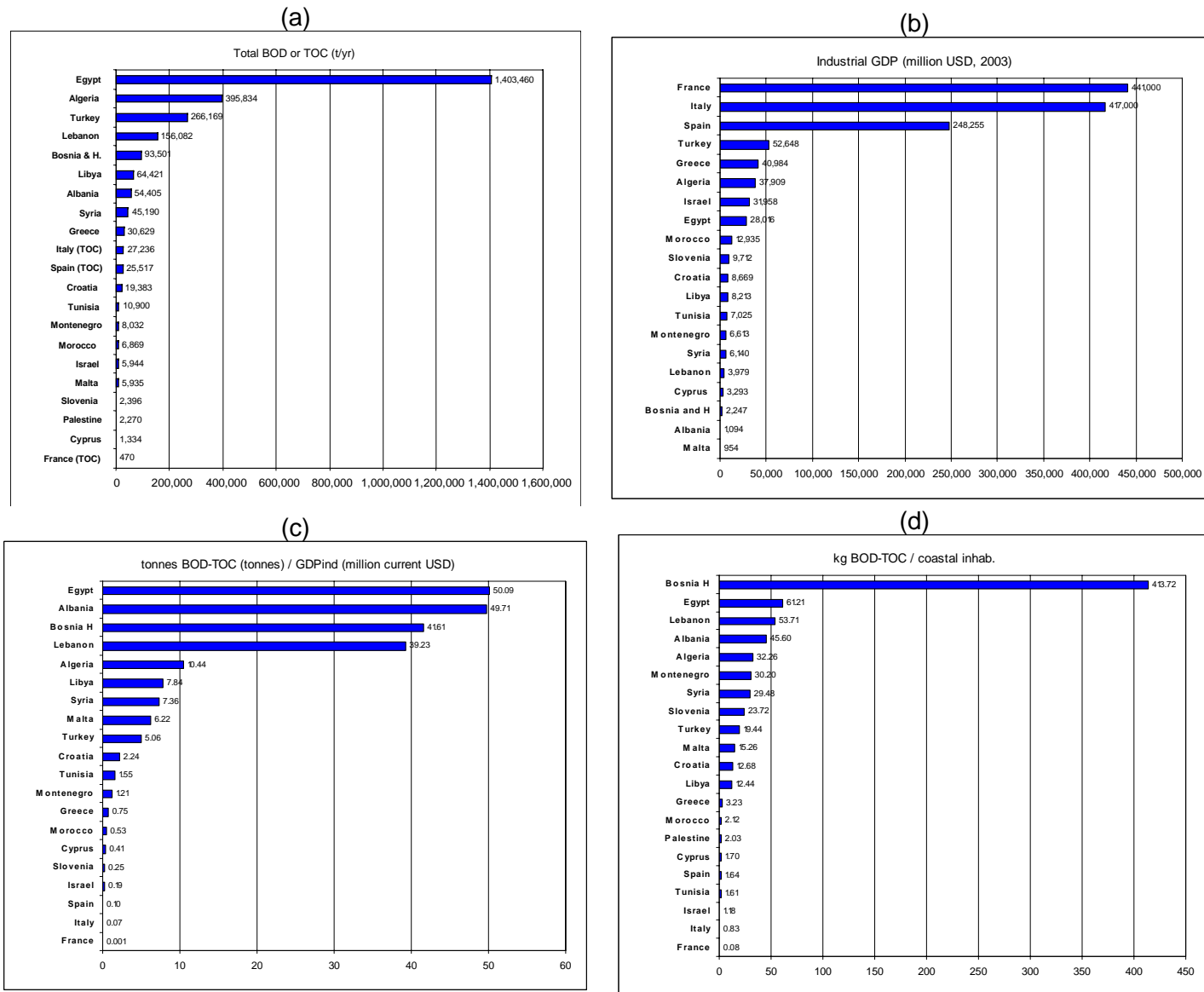


Figure 1 Relative position of countries on the basis of total loads of organic pollution (a), industrial activity (b), and discharges relative to industrial activity (c) and population of Mediterranean regions (d).

2.4 Sectors contributing to organic pollution

The NBBs include data on the sources of industrial BOD discharges in each country, organized on a sector basis. The industrial sectors included in the NBBs are those listed in Annex I.A of the LBS Protocol, although some variations may occur depending on the classification followed by each country to elaborate its NBB. The data on BOD discharges provided by all countries have been integrated within a common group of sectors, and the resulting contribution to organic pollution is shown in Table 3.

Table 3 Sectors contributing to organic pollution (BOD or TOC) in the Mediterranean Region.

Sector	Kg/yr	%
Oil refining	1,492,995,186	56.85%
Food packing	554,778,671	21.13%
Farming of animals	186,114,684	7.09%
Urban wastewater treatment	133,036,421	5.07%
Textile industry	91,819,826	3.50%
Paper industry	32,822,294	1.25%
Organic chemicals	32,076,932	1.22%
Tanning	30,476,489	1.16%
Fertilizer industry	18,613,984	0.71%
Pharmaceuticals	13,063,153	0.50%
Manufacture of metals	10,162,137	0.39%
Waste management activities	7,742,581	0.29%
Tourism	6,352,954	0.24%
Other inorganic chemicals	4,768,577	0.18%
Aquaculture	4,033,244	0.15%
Agriculture	3,241,103	0.12%
Manufacture of cement	1,492,595	0.06%
Production of biocides	848,410	0.03%
Production of energy	531,921	0.02%
Transport	447,121	0.02%
Other industry	331,500	0.01%
Building and repairing of ships	109,622	0.00%
Manufacture of Wood	59,075	0.00%
Mining and quarrying	44,000	0.00%
Manufacture of electronics products	7,288	0.00%
Port services	6,834	0.00%
TOTAL	2,625,976,601	100.0%

In the table above, in order to facilitate the analysis and presentation of results, some sectors have been aggregated within the category of 'waste management activities' (e.g. recycling activities, management of municipal solid waste, incineration...), due to their relation and low contribution to BOD discharges according to reported data.

In the case of Spain, the information provided to the NBB classifies industrial sectors according to the EPER register (IPPC codes), so the equivalencies between NBB codes and IPPC codes were established in order to transfer the Spanish data to the common database.

For those countries that have reported sector discharges using the TOC parameter instead of BOD (France, Italy, Spain), the data has been directly transferred to the database. Although TOC and BOD data is not directly comparable (as discussed previously), both parameters provide information of total loads of organic pollution. Moreover, the combination of both types of data does not affect significantly the identification of priority sectors.

The results obtained (Table 4) indicate that a few sectors concentrate most of regional discharges of organic pollution. As it can be observed in Figure 2, oil refining and food packing account for more than 75% of total discharges, followed by farming of animals (which includes slaughterhouses) (7.1%), urban wastewater treatment (5.1%), and textile industry (3.5%). As a whole, according to available data, 10 sectors out of 26 account for 98.5% of total discharges in the Mediterranean region.

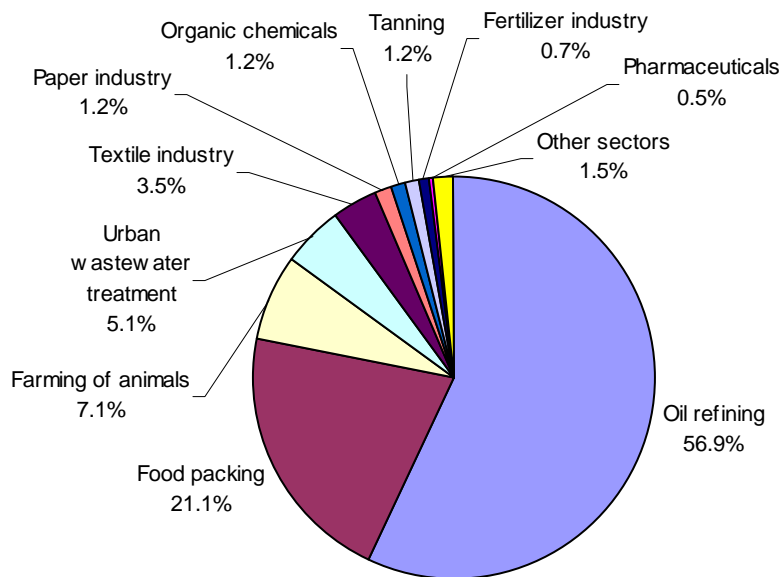


Figure 2 Main sectors contributing to organic pollution (BOD-TOC) in the Mediterranean region.

It must be noted that some discharges are also highly concentrated in some countries. For example, the oil refining discharges have been reported basically in the Egypt NBB. Detailed data on the contribution of each sector in the different countries is included in Table 4 (total loads) and Table 5 (relative contributions).

3. Identification of priority sectors

3.1 General criteria

The objective of this section is to identify those sectors with a major priority to be addressed in the Mediterranean region to reduce the overall input of BOD, on the basis of available data. To this aim, different criteria can be used:

- Total discharges. The total amount of BOD discharged by each sector is the key criteria to be considered in a Plan intended to reduce the input of regional BOD inputs from industrial sources.
- Representation / frequency at regional level. Besides total load, considering the regional dimension of the Plan, it is also recommended to identify the main discharging sectors in a major number of countries.
- Release intensity / effluent concentrations. Sectors whose effluents typically contains a major concentration of organic pollution should be specially considered, as these will have a major potential to create an impact on the receiving environment, and at the same time these offer the opportunity to achieve major reductions on total loads. These sectors are in fact well known and already mentioned in the SAP and the BOD Plan:
 - (a) Food industry (including slaughtering)
 - (b) Manufacture of textiles
 - (c) Tanneries
 - (d) Pulp and paper industry
 - (e) Fertilizer industry (phosphates)
 - (f) Pharmaceutical industry
 - (g) Chemical industry

On the basis of available information from NBBs, the first and second criteria (total loads and frequency) have been chosen to be applied for the identification of priority sectors. In any case, sectors with high release intensities of organic pollution are already identified a priori, and will be similar to those accounting for major total loads.

It must be noted that the above criteria are intended to identify *priority sectors at regional level*, which is the scope of the Plan. However, other site specific criteria can be used in each country to further identify the priority sectors or subsectors, such as:

- Ability and opportunity to abate discharges (cost-effectiveness). Those sectors (or facilities) with high release intensities and/or low adoption of wastewater treatment technologies, will offer a key opportunity to reduce total loads.
- Sensitivity of the receiving environment. Those sectors (or facilities) discharging BOD in sensitive areas (that is, confined areas of the sea such as estuaries, lagoons, close narrow bays or sea enclosures) should be paid a major attention to abate loads of BOD, especially in those cases where domestic discharges are already taking place.

3.2 Priority sectors in the Mediterranean Region

a) Total discharges

Total sector contributions at regional level have already been presented previously in Table 3. According to results obtained from the aggregation of available data, the top 10 sectors accounting for the majority (98.5%) of discharges in the Mediterranean region are the following:

1. Oil refining
2. Food packing
3. Farming of animals
4. Urban wastewater treatment
5. Textile industry
6. Manufacture of paper
7. Organic chemicals
8. Tanning
9. Fertilizer industry
10. Pharmaceuticals

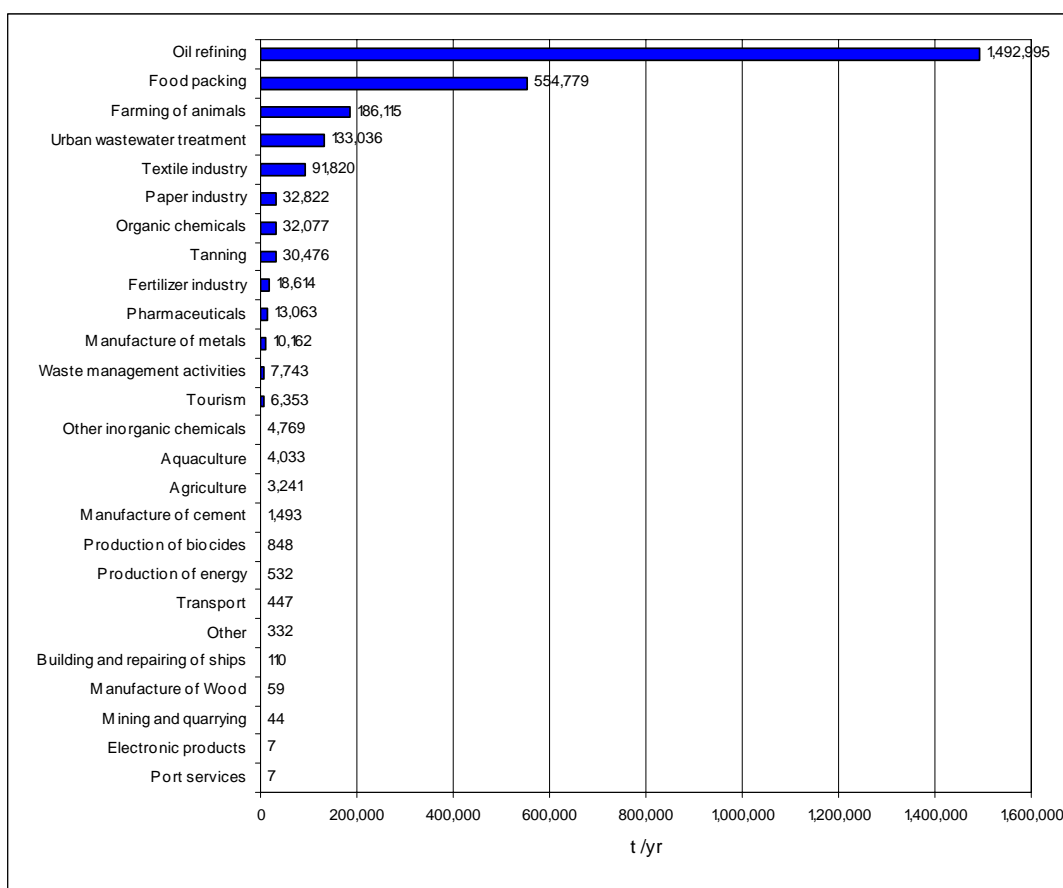


Figure 3 Sectors contributing to organic pollution (BOD or TOC) in the Mediterranean Region.

b) Frequency of high discharging sectors

According to the previous criteria, it can happen that a sector which has been identified as a priority one according to their total loads, is in practice concentrated in a single country. Considering the regional dimension of the Plan, it is also proposed to identify those sectors which are most commonly identified as large emitters in more than one country. To this end, the 'top 3' emitting sectors in each country have been identified. As a result, sectors frequently included within the top 3 emitting sectors (in at least 2 countries) have been identified as the following:

1. Food packing
2. Urban wastewater treatment
3. Manufacture of textiles
4. Farming of animals
5. Manufacture of paper
6. Oil refining
7. Organic chemicals
8. Aquaculture
9. Other
10. Tanning
11. Tourism

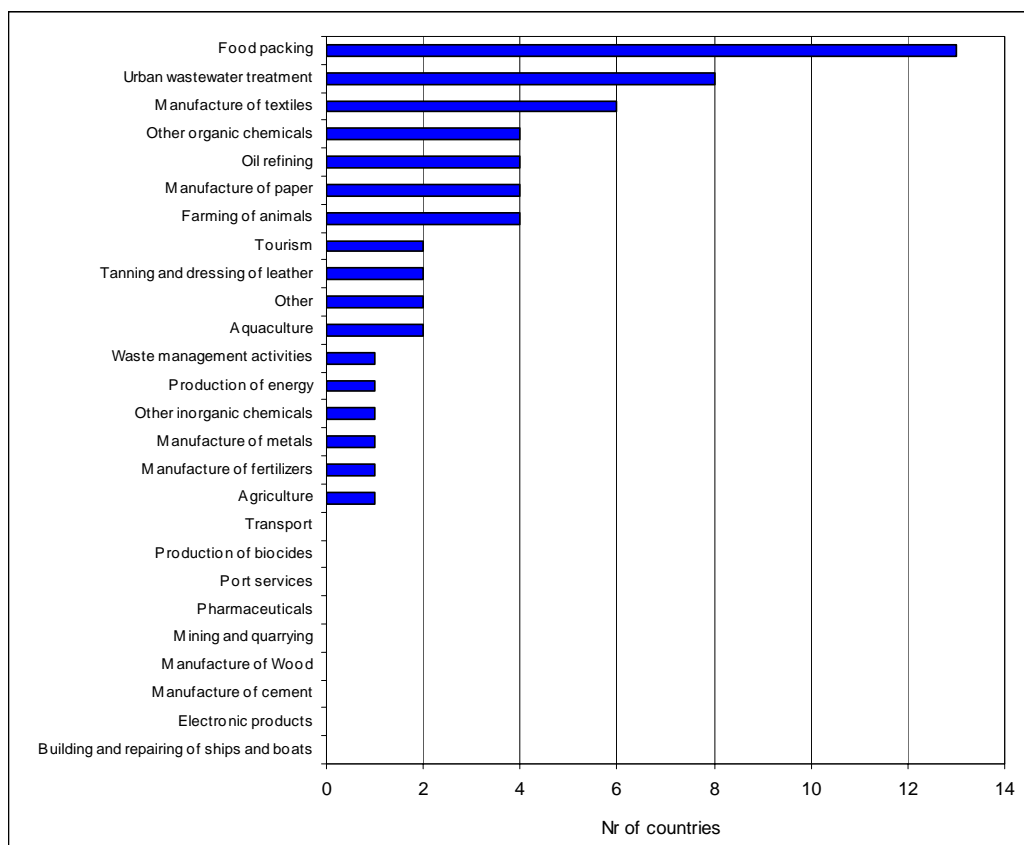


Figure 4 Frequency of sectors included within top 3 country discharging sectors.

As it can be observed, the oil refining sector, which accounts for the majority of total organic discharges (57%), is not as frequently identified as a major emitter as other

sectors, like the food industry. This means that oil-refining discharges are concentrated in a limited number of countries. On the other side, the textile industry is a common discharging sector in Mediterranean countries, while their total contribution (3.5%) is not as high as other sectors. The main discharging sectors identified in each country are shown in Table 6.

Table 6 Top 3 sectors accounting for major BOD - TOC discharges in each country.

COUNTRY	Top 3 sectors
ALBANIA	1. Treatment of urban wastewater 2. Farming of animals 3. Food packing
ALGERIA	1. Food packing 2. Oil refining 3. Manufacture of textiles
BOSNIA H	1. Food packing 2. Treatment of urban wastewater 3. Manufacture of textiles
CROATIA	1. Treatment of urban wastewater 2. Tourism 3. Food packing
CYPRUS	1. Agriculture
EGYPT	1. Oil refining 2. Manufacture of textiles 3. Manufacture of paper
FRANCE	1. Other organic chemicals
GREECE	1. Food packing 2. Manufacture of textiles 3. Oil refining
ISRAEL	1. Manufacture of textiles 2. Manufacture of paper
ITALY	1. Manufacture of metals 2. Other inorganic chemicals 3. Other organic chemicals
LEBANON	1. Farming of animals 2. Treatment of urban wastewater 3. Food packing
LIBYA	1. Oil refining 2. Manufacture of fertilizers 3. Aquaculture
MALTA	1. Treatment of urban wastewater 2. Other 3. Production of energy
MONTENEGRO	1. Tourism 2. Waste management activities 3. Food packing

COUNTRY	Top 3 sectors
MOROCCO	1. Manufacture of paper 2. Manufacture of textiles 3. Food packing
PALESTINE	1. Treatment of urban wastewater 2. Other
SLOVENIA	1. Treatment of urban wastewater 2. Food packing 3. Aquaculture
SPAIN	1. Other organic chemicals 2. Manufacture of paper 3. Food packing
SYRIA	1. Farming of animals 2. Other organic chemicals 3. Food packing
TUNISIA	1. Treatment of urban wastewater 2. Food packing 3. Tanning and dressing of leather
TURKEY	1. Food packing 2. Farming of animals 3. Tanning and dressing of leather

c) Combination of criteria

It is proposed to combine both criteria presented above to identify the priority sectors to be addressed by the regional Plan. This combination is presented in Table 7, and the resulting priority sectors are indicated below:

1. Oil refining
2. Food packing
3. Farming of animals
4. Urban wastewater treatment
5. Textile industry
6. Manufacture of paper
7. Organic chemicals
8. Tanning

Table 7 Combination of criteria to identify priority sectors (green coloured) in the Mediterranean region.

Criteria 1: TOTAL LOAD (Sector discharges accounting >0.5% of overall regional discharges)		Criteria 2: REGIONAL REPRESENTATION (Sectors within top 3 discharging sectors in at least 2 countries)	
Sector	%	Sector	Nr of countries
Oil refining	56.9%	Food packing	13

Criteria 1: TOTAL LOAD (Sector discharges accounting >0.5% of overall regional discharges)		Criteria 2: REGIONAL REPRESENTATION (Sectors within top 3 discharging sectors in at least 2 countries)	
Sector	%	Sector	Nr of countries
Food packing	21.1%	Urban wastewater treatment	8
Farming of animals	7.1%	Manufacture of textiles	6
Urban wastewater treatment	5.1%	Farming of animals	4
Textile industry	3.5%	Manufacture of paper	4
Manufacture of paper	1.2%	Oil refining	4
Organic chemicals	1.2%	Organic chemicals	4
Tanning	1.2%	Aquaculture	2
Fertilizer industry	0.7%	Other	2
Pharmaceuticals	0.5%	Tanning	2
		Tourism	2

So, after applying the criteria proposed above, and on the basis of available data, 8 priority sectors out of a total of 26 analysed sectors have been identified. This group of sectors account for 97.3% of total discharges of organic pollution in the Mediterranean region.

One of these sectors appears to be the treatment of urban wastewater. It is not strictly an industrial sector, but in many countries is one of the main contributors to total organic discharges. In this sense, it could be considered as a priority sector in the sense that an increase in the efficiency of urban wastewater treatment can lead to significant reductions of BOD discharges in several countries.

In general, these priority sectors are in agreement with the sectors identified by the SAP (section 5.2.5) as the most important sources of BOD, except for the exclusion of the fertilizer and pharmaceutical industry, and the inclusion of oil refining, the organic chemical industry, and the treatment of urban wastewater.

d) Distribution of priority sectors among countries

From a regional perspective, and to achieve the objectives of the Plan, it is not necessary that all countries address all sectors. According to available data, it can be observed that if priority sectors are addressed by those countries where these sectors are more important (as identified in Table 6), the majority of organic discharges (95.6%) will be addressed in the Plan. This can be observed in Table 8.

Table 8 Distribution of priority sectors among countries.

Priority sectors	Priority countries	Sector coverage (%)
Oil refining	Algeria, Egypt, Greece, Libya	99.8%
Food packing	Albania, Algeria, Bosnia H., Croatia, Greece, Lebanon, Montenegro, Morocco, Slovenia, Spain, Syria, Tunisia, Turkey	99.8%
Farming of animals	Albania, Lebanon, Syria, Turkey	88.2%
Urban wastewater treatment	Albania, Bosnia H., Croatia, Lebanon, Malta, Palestine, Slovenia, Tunisia	99.9%
Textile industry	Algeria, Bosnia H., Egypt, Greece, Israel, Morocco	90.6%
Paper industry	Egypt, Israel, Morocco, Spain	75.5%
Organic chemicals	France, Italy, Spain, Syria	97.6%
Tanning	Tunisia, Turkey	92.1%
TOTAL		95.5%

4. Review of options to address reduction of BOD discharges

4.1 Overview of options

This section includes an overview of the different options that can be taken into consideration to address the reduction of BOD discharges. As shown in Figure 4, two basic types of measures can be distinguished:

- a) Direct measures: those actions that will result in an effective reduction of BOD discharges. These include the reduction of BOD load or concentration in process effluents (through the adoption of BATs and BEPs), and the implementation of end-of-pipe technologies for the treatment of process effluents, to abate the final load of BOD discharged to the sewer network or directly to water bodies.
- b) Indirect measures: those actions which will 'motivate' and facilitate the adoption of adequate direct measures to reduce BOD discharges. These kind of measures include legal actions (e.g. adoption and enforcement of emission limit values), technical (e.g. elaboration of guidelines for the adoption of BATs/BEPs), economic (e.g. subsidies, taxes...), or market-based mechanisms (e.g. promotion of Environmental Management Systems).

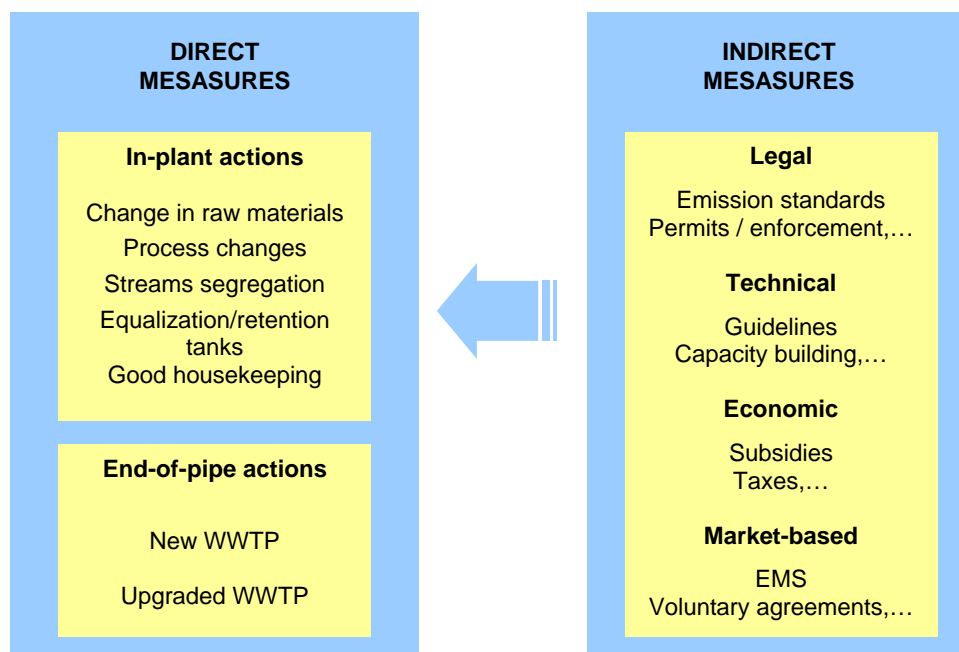


Figure 5 Options to address the reduction of BOD discharges from industrial sources.

It is important that a regional Plan takes into consideration indirect measures, as specific direct measures will be needed to be rather evaluated at local level, for each facility or industrial area.

4.2 Direct measures

4.2.1 In-plant actions

The main type of actions that can reduce the BOD load and concentration in process effluents of industrial facilities include [17]:

- Change in raw materials, product design.
- Process changes to eliminate or reduce the BOD content of effluents
- Segregation of process streams, to facilitate the re-use and treatment of wastewater.
- Equalization or retention tanks or basins, which provide for the controlled release of large quantities of chemicals to the sewers or receiving waters.
- Good housekeeping, including proper maintenance of plant and machinery, and prevention measures for accidental spills.

A good identification and quantification of sources of BOD pollution and the adoption of a monitoring system, can facilitate the identification of alternatives for reduction of BOD discharges.

A comprehensive review of potential in-plant actions for most of identified priority sectors can be obtained from the BOD Plan [17] and especially from the UNEP/MAP report on 'Guidelines for the Application of Best Available Techniques (BATs) and Best Environmental Practices (BEPs) in Industrial Sources of BOD, Nutrients and Suspended Solids for the Mediterranean Region' [18]. Another source of information is the European Integrated Pollution Prevention and Control Bureau (EIPPCB) [3], which elaborates the Reference Documents on Best Available Techniques (BREFs) for a range of sectors (more than 30 sectors have already been addressed). Additional information can be obtained from sector associations, like CONCAWE for the oil refining sector [1], and cleaner production sector guidelines elaborated by the CP/RAC and UNIDO.

In general, the adoption of BATs and BEPs will reduce the BOD emission factor, that is, the average emission rate of BOD relative to units of activity, which would be a key objective to be pursued in priority sectors. The above sources of information have been reviewed in order to collect the typical emission factors of BOD in the priority sectors (see Table 9), as well as the target emission factor to be achieved in modern facilities or facilities adopting BAT and BEPs ('BAT target').

Table 9 Emission factors for BOD in priority sectors.

SECTOR	BOD Pollution load		
	Unit	Typical Range	BAT target
OIL REFINING	kg / t oil processed	0.01	0.006
FOOD	Kg / t raw material or product	< 2.5 - 50	1 – NA
FARMING (Slaughtering)	Kg / t carcass	2 - 26	NA
TEXTILE	Kg / t textile	16 - 156	NA
PAPER INDUSTRY	Kg / Adt pulp	12 - 25	4 - 10

SECTOR	BOD Pollution load		
	Unit	Typical Range	BAT target
ORGANIC CHEMICALS	Kg / t	NA	NA
TANNING	Kg / t raw hide	40-100	10-12

As it can be observed, emission factors vary among sectors and even within subsectors. For example, within the food and drink sector, as shown in Table 10, the dairy industry has a lower emission factor than the sugar manufacturing, and different ranges of BOD concentration in process effluents (before treatment) can be appreciated. The unit of activity will vary among subsectors, which can be related to production (e.g. in vegetal oil processing) or to raw material (e.g. in fish processing), so in fact they cannot be directly compared. Accordingly, it is important to analyse emissions and to establish target emission factors on a subsector basis. However, detailed information is not always available, especially for target emission factors, as it depends on many factors.

Table 10 BOD emission factors and effluent concentrations in the food and drink sector.

SECTOR	BOD effluent concentration	BOD Pollution load		
	mg / L	Unit	Typical Range	BAT target
FOOD				
Dairy industry	3,000 – 5,000	Kg / t milk	< 2.5	1 – 1.5
Breweries	1,000 – 1,500	Kg / m ³ beer	5 - 15	NA
Vegetal oil processing	20,000 – 35,000	Kg / t product	< 2.5	1 – 1.5
Fish processing	2,000 – 28,000	Kg / t raw material	9 - 50	NA
Sugar manufacturing	1,700 – 7,000	Kg / t sugar	10 - 24	NA

It must be emphasized that previously to dispose an end-of-pipe treatment technology, it is strongly recommended to analyse all the feasible options to reduce the BOD load of process wastewater. Specific case studies on cleaner production in the Mediterranean region, as those published by the CP/RAC (the 'MedCleans') show how the adoption of in-plant actions can lead not only to significant reductions of BOD discharges, but also to significant economic savings. Some of these examples are shown in Table 11.

Table 11 Case studies of cleaner production actions leading to reduction of BOD discharges.

Sector /Country	Action	Reduction in organic pollution	Investment (EUR)	Payback (years)
Brewery (Spain)	New installations for the wastewater process and improvements in process	18% COD	252,425	2.1
Textile (Spain)	Process control	20% COD	327,625	6.6
Food (milk) (Spain)	Improvement the use of detergent	23% COD	23,200	0.11
Slaughterhouse (Bosnia H.)	Modification of the process	42% BOD	Low	< 1 month
Food (oil and soap) (Egypt)	Oil and fats recovery	85% BOD	180,547	1
Tanning (Croatia)	Introduction of low pollution processes (hair savings)	25% BOD	49,384	1

4.2.2 End-of-pipe actions

End-of-pipe treatment methods to abate BOD discharges are already reviewed in the BOD Plan [17]. Many different treatments can be implemented, including physical and biological methods. Physical methods include screening and settling tanks. Biological methods include stabilization ponds and mechanically aerated lagoons, activated sludge and trickling filters.

According to the BOD Plan, the use of municipal wastewater treatment plants is the most practical and economic solution for dissolved organic wastes, provided that:

1. secondary treatment is provided by the facility;
2. there is sufficient excess oxidative capacity above that required for domestic sewage; and
3. the organic wastes are readily biodegradable.

Generally, sewer networks are governed by local sewer ordinances, which regulate the discharge of industrial wastewater and usually specify the manner by which the effluents may be admitted. Pre-treatment may be required to remove toxic substances, flammable compounds, heavy metals, or to adjust pH prior to discharge to the sewers.

Joint municipal-industrial treatment has the advantage of lower costs, and dilution and addition of nutrients that speed biological processes which break down the wastes to harmless substances. Nevertheless, extensive pilot plant or laboratory work is frequently needed to determine properly the treatment method(s) for a given waste prior to discharge to receiving water.

When industrial wastewaters need to be treated before being discharged to the sewer system, specific methods will be required at facility level. The BOD Plan reviews the most common treatments used in the different sectors. Detailed information on current BAT for wastewater treatment can also be collected from the Reference Documents on

Best Available Techniques (BREFs) [3], which are available for the different priority sectors identified.

The method to be applied in each case will depend on a range of factors, such as the total BOD load, the need to abate other pollutants, the local ordinances to discharge in the sewer network, the receiving water body, etc. The more removal of BOD is required, the more combination of treatments (primary + secondary) will be needed. This is illustrated for the tanning sector in Table 12.

Table 12 Different treatments in the tanning sector.

SECTOR	Treatment	BOD removal efficiency (%)
TANNING	Mixing + sedimentation	25-35
	Mixing + chemical treatment + sedimentation	50-65
	Mixing + chemical treatment + flotation	55-75
	Primary or chemical + extended aeration	90-97
	Primary or chemical + Extended aeration with nitrification and denitrification	90-97

Source: BREF [6]

As for the identification of target emission factors, the analysis of treatment options need to be done on a subsector basis, as the organic load and effluent characteristics can be very different within a general sector like the food and drink industry (see Table 13). In each subsector, the achieved BOD effluent concentration will depend on the selected method. Some examples are shown in Table 13.

Table 13 Different treatments and achieved BOD effluent concentrations in the food sector.

SECTOR		BOD effluent concentration (mg / L)		
		Typical range (without treatment)	Treatment	Range (after treatment)
FOOD	Dairy industry	3,000 – 5,000	Anaerobic	5 – 20
	Breweries	1,000 – 1,500	Activated Sludge	15 – 25
	Vegetal oil processing	20,000 – 35,000	DAF - precipitation	500 – 300
	Sugar manufacturing	1,700 – 7,000	Anaerobic + aerobic	0.01 – 2

Source: BREF [4] and MAP/MEDPOL [17] / [18]

For the different priority sectors previously identified, potential target BOD effluent concentrations after the adoption of BATs and BREFs to prevent and treat organic loads, have been reviewed from the available sources of information and are presented

in Table 14. As indicated above, these targets should be detailed at a subsector level, but can serve as a starting point to define the achievable targets in the Mediterranean region.

Table 14 Potential reductions of BOD effluent concentrations in the priority sectors.

SECTOR	BOD Effluent concentration (mg/L)	
	Typical range (without treatment)	Target range (after treatment)
OIL REFINING	150 - 250	<30
FOOD	1,000 – 35,000	<50
FARMING (Slaughtering)	600 – 8,000	10 – 40
TEXTILE	700 – 2,000	<50
PAPER INDUSTRY	250 – 1,000	10 - 25
ORGANIC CHEMICALS	NA	< 20
TANNING	900 – 6,000	<20

Source: BREFs [3] and MAP/MEDPOL [17] / [18]

4.3 Indirect measures

4.3.1 Legal

Legal initiatives are the measures which can have a major effect on the adoption of direct actions to reduce BOD loads in industrial facilities. From the regulatory point of view, the most common approach to address the prevention and control of wastewater discharges is the setting and enforcement of emission standards:

a) Setting of emission standards

Environmental regulation is usually characterised by two approaches: environmental quality regulation and technology regulation. The environmental quality approach attempts to regulate on the basis of the assimilative/carrying capacity of an ecosystem while the technology strategy focuses on minimising emissions. The two approaches are not mutually excluding; they are rather used simultaneously by governments when establishing standards.

Emission standards may be set numerically (either in legislation or administratively) as parts of a substance per million of effluent (Emission Limit Values) or per unit of output (Emission Factors), as we have seen previously. Alternatively an obligation may be placed on the discharger to use the 'best available techniques' for reducing emissions or 'to attempt the waste minimization'.

On the other hand, emission standards may be set individually for each discharge, or uniformly for a particular type of discharge (e.g. for a sector or subsector) within a whole area or country. In the previous section several examples of typical and target BOD emission standards (both emission factors and emission concentrations) in

priority sectors have been reviewed. These achievable emission standards are taken into consideration when setting legal standards and permits. As an example, Emission Limit Values for BOD have been reviewed for some Mediterranean countries, which are shown in Table 15. As it can be observed, emission limit values in Algeria (general limits) and Spain (regarding discharges into surface waters) are the same, while Lebanon shows even more restrictive values for new facilities.

Table 15 BOD Emission Limit Values (ELV) in some Mediterranean countries.

Country		ELV for BOD5 (mg/l)
Algeria		40
Lebanon	Existing	100
	New facilities	25
Spain		40

It must be noted that feasible environmental standards will determine the effectiveness of regulations. To this end, the process of establishing environmental standards is essential, as an appropriately designed procedure ensures the legitimacy of the requirements and their acceptance by the regulated community. It is therefore important that environmental standards are established through a process of deliberation which seeks to meet a multiplicity of constraints and viewpoints. Otherwise, the compliance and enforcement of standards can be very difficult to be achieved.

b) Permitting and enforcement

Permits, compliance and enforcement represent the mechanisms by which standards are effectively adopted by industry, and therefore constitute a critical element in the process of reducing pollution from industrial sources. Monitoring will also be essential to evaluate the progress on adoption of standards and the need to review the system, as illustrated in Figure 7.

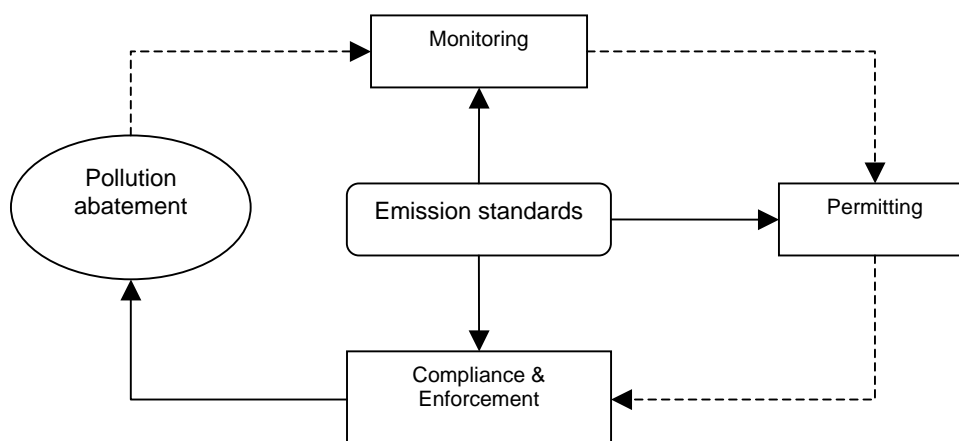


Figure 6 Regulatory mechanisms to implement emission standards in industry [12].

Different factors may be considered when establishing specific permits for wastewater discharges. A general trend is observed towards integrated permits, as approached by the EU IPPC Directive. However, as warned by Macia, V. [12], the IPPC approach applies only to certain (potentially large pollutant) industries, it has proven to be a difficult concept to implement even within EU countries, and it is institutionally and economically costly. Lessons learned from IPPC experiences allow launching some other recommendations on permitting procedures, such as:

- Be flexible and not only rely on end of pipe solutions. Promote pollution prevention.
- Include not only emission limits but also other conditions related to self-monitoring, reporting, efficiency on the use of raw materials and energies, etc.
- Limits for each installation based upon cost effective BATs and environmental standards.
- Let a gate open to the request of specific improvements
- Available for public review

Compliance is the full implementation of environmental requirements, and it occurs when these requirements are met and desired changes are achieved. Enforcement is the set of actions taken to achieve compliance (inspections, negotiations, legal actions, promotion activities [e.g., technical assistance], non-compliance response policies, etc.). It is well known that enforcing a regulation is sometimes more difficult than elaborating it.

There is a direct and interdependent relation between the quality of permitting schemes and the control/inspectorate activities and effectiveness. Enforcement bodies must be aware of regulatory requirements and permits contents in order to check if compliance fits particular conditions or to suggest others to be imposed.

4.3.2 Technical

a) Technical guidelines

The review and publication of technical guidelines is another key mechanism to facilitate the adoption of measures by industrial facilities to reduce BOD discharges. As mentioned previously, several publications are already available concerning the adoption of BATs and BEPs and technologies for wastewater treatment. The main sources of information identified are the following:

- UNEP/MAP – Technical Report Series. In particular, Nr 142 and 144, specific for BOD discharges. (www.unepmap.org)
- UNEP/MAP – CP/RAC Sectoral Studies (which include many of identified priority sectors): www.cprac.org
- European Integrated Pollution Prevention and Control Bureau (EIPPCB). Reference Documents on Best Available Techniques (<http://eippcb.jrc.es/>). BREFs are available also for most of priority sectors.
- Other: UNIDO, World Bank, sector associations (CONCAWE, CEFIC...), etc.

Most of these sources of information include description of techniques to prevent BOD discharges. However, information for some priority subsectors could be lacking for the Mediterranean region. Additionally, information on emission factors and cost figures is not so frequent, except when case studies are included.

b) Capacity building

Although techniques and methods to reduce BOD discharges exist, and technical guidelines are available, it is of crucial importance to ensure their dissemination and the capacity building of industrial operators. Training programmes need to be encouraged at regional level and promoted at national level by industrial and environmental authorities.

It is also highly recommended to undertake dedicated working groups in the Mediterranean region, to address specific issues on the opportunities and difficulties to reduce industrial BOD discharges. These working groups should be output oriented, to produce specific and publishable recommendations.

4.3.3 Economic

The 'economic' or 'market' instruments can be a useful environmental policy tool to complement regulations, under a certain effectiveness conditions, among which:

- previous studies on its effectiveness, cost, benefit and equity
- participation of economic authorities
- public consultation
- gradual implementation
- benefits reverting to the environment

Economic instruments can be classified as [12]:

- Property rights
- Market creation: Tradable permits, Consume incentives,
- Taxes, Charges & Financial:
 - Subsidized prices reduction/elimination;
 - Eco-labeling taxes reduction,
 - Taxes/charges on products, substances, or emissions.
 - User's taxes. Levies. Taxes rebates.
 - Grants.
 - Soft loans.
 - Accelerated depreciations, etc.
- Others: Mandatory insurances, Deposit-refund systems, Warrants, etc.

The impact of economic instruments is strongly influenced by the economic and social context in which they are introduced.

The economic instruments expected to be used to facilitate the reduction of BOD discharges can be both dissuasive (e.g. a charging system on incremental BOD discharges) or of incentive nature (e.g. subsidies to adopt cleaner production techniques; soft loans to build or upgrade wastewater treatment plants, etc.).

A comprehensive review of economic instruments, its advantages and disadvantages, including examples being used in the Mediterranean region, has been carried out by the PAP/RAC [13].

4.3.4 Market based mechanisms

a) Environmental Management systems

The implementation of an Environmental Management System (EMS) is a voluntary option usually motivated by the competitive advantages that it offers as a result of the improvement of efficiency in company activities, as well as a better perception from stakeholders. An indirect effect can be expected on BOD discharges, considering that implementing an EMS implies to review all legal requirements and assess and improve the environmental impacts. The most common EMS are ISO14001 and EMAS (in the EU). In some cases, the adoption of EMS is promoted and subsidised by environmental authorities.

b) Voluntary agreements

Voluntary agreements (which can also be considered some kind of economic instruments), under certain circumstances and conditions can ease the adaptation of companies to environmental requirements or promote industrial behaviour going beyond legal requirements. In this sense, voluntary agreements could be established with priority sectors to achieve target BOD emission standards.

5. Strategic Action Programme for the BOD Regional Plan

5.1 General strategy

The Strategic Action Programme (SAP MED) to address pollution from land-based activities includes as a target a 50% reduction of BOD inputs from industrial sources in the Mediterranean region. To address this target, the BOD regional Plan was adopted by the Contracting parties at their 13th meeting held in Catania in 2003. This adoption implied a review of the Plan in 2007, as well as an update the information on the basis of available data from the National Baseline Budget (NBB).

Additionally, it was stated that the reduction of BOD from industrial sources had to be achieved taking into consideration the SAP Operational Plan¹ and the guidelines for the preparation of National Action Plans (NAPs), under which any targeted reduction are to be implemented only in industrial sites which are not in compliance with the related national and/or international standards.

The analysis of available data from NBB has shown that there is a limited group of industrial sectors which account for the majority of BOD discharges in the Mediterranean region. The SAP Operational Plan suggests that the achievement of some target emission standards in these sectors would be an appropriate approach to address the overall reduction of BOD discharges. Furthermore, the analysis of NBB data also indicates that for each priority sector there is a limited group of countries accounting for the majority of discharges. This also suggests that actions could be focused in different groups of countries depending on the sector.

According to this framework, a sector-based approach is proposed, which can be made operational through specific Sector Action Plans. These Sector Action Plans would include the setting of reference emission standards for each priority sector or subsector, and the specific options recommended for reducing BOD discharges.

Besides this sector approach, an integrated BOD Plan should also include those actions needed to address urgent reductions of BOD loads, as those taking place in hot spots. Many of these hot spots have already been identified in regional programmes [14] and in the National Action Plans. These sources of information can facilitate the identification of those areas which require specific Hot Spots Action Plans to reduce BOD loads.

The overall strategy is presented in Figure 8. A description of the Action Plans to be considered by the BOD Regional Plan is presented in the next sections.

¹ Adopted by CPs at their 12th Meeting in Monaco, 2001.

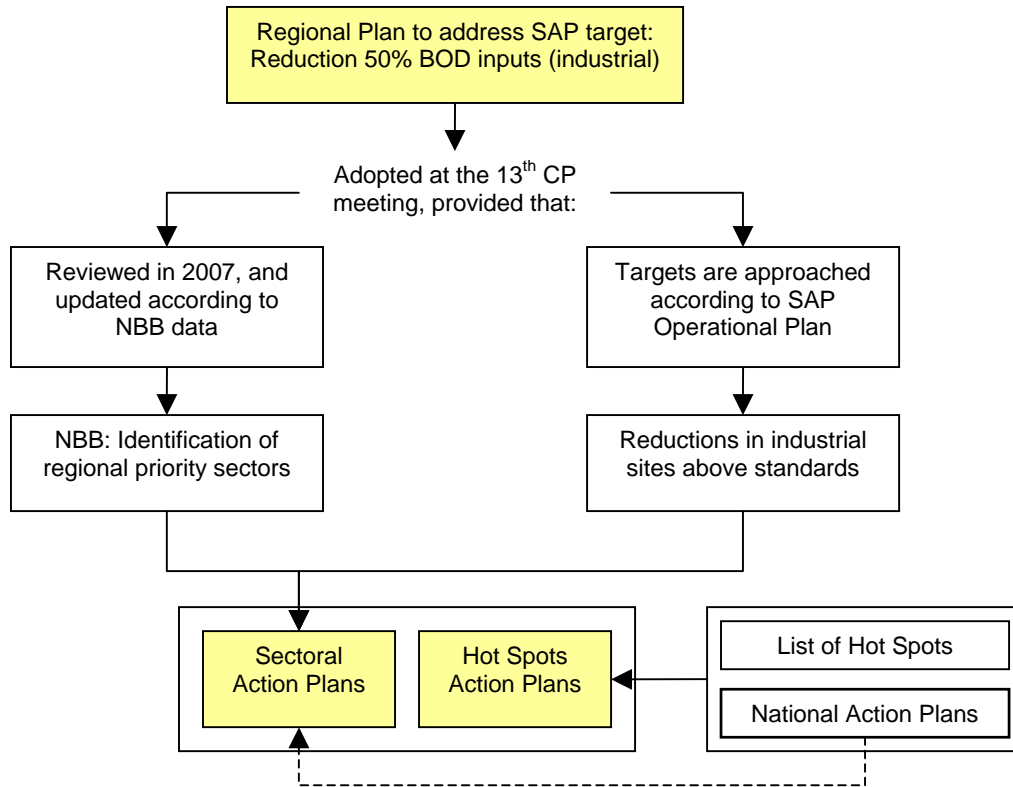


Figure 7 General strategy to address reduction of BOD discharges in the Mediterranean region.

5.2 Sectoral Action Plans

- Objective: to address the overall regional reduction of BOD inputs from industrial sources through the achievement of common emission standards on a sector basis.
- Scope of action: to focus actions on the priority industrial sectors, identified according to current BOD discharges reported on NBBs. Actions should be specially addressed in those priority countries identified for each sector, although all countries are expected to promote the reduction of pollution in the overall industry. According to available data, a preliminary identification of priority 'sector-countries' has been obtained (covering >95% of total regional discharges, see Table 8).
- Key measures to reduce BOD inputs: to achieve common sector standards for Emission Limit Values (ELV), emphasizing the adoption of BATs and BEPs in each sector, but also the most adequate wastewater treatment technologies.

PROPOSED ACTION PROGRAMME:

1. Review of BATs and BEPs. For each priority sector, national experts and sector experts should work together to review and agree on the most suitable BEPs and BATs to reduce the BOD load. Several sources of information on this topic are already available, but a further effort would be needed to focus on BOD, to

consider the different subsectors, and to adapt to industry in the Mediterranean region. Costs of adoption of BEPs/BATs and achievable reductions should be compiled.

2. Review of WWT technologies. A similar initiative as above is recommended to determine the state of the art in wastewater treatment technologies to abate BOD discharges in the different priority sectors, and the most appropriate systems in the Mediterranean region. As above, cost figures and BOD removal potential for each system should be reviewed.
3. Determine reference emission standards. On the basis of the tasks developed above, an integrated assessment of achievable BOD emission standards (Emission Factors and Emission Limit Values) for each priority sector (and subsectors) should be undertaken. To this end, available BATs and BEPs, WWT technologies, costs and expected reductions should be taken into consideration to determine the group of reference BOD emission standards in the Mediterranean region. Some examples of target emission standards collected from literature have been shown in this report (Table 9 and Table 14).
4. Adoption of emission standards. Reference BOD emission standards should be adopted by priority sectors, through their inclusion into national legislation (specially in priority countries) or through voluntary agreements. To this end, appropriate financial, technology transfer and capacity building mechanisms should be facilitated at regional level.
5. Monitoring and assessment. In order to track the progress of the Plan, periodic reporting on the actions developed as well as updating of the National Baseline Budget will be needed. The assessment of the progress and results can suggest adjusting mechanisms during the process of implementation.

5.3 Hot Spots Action Plans

- Objective: to urgently address the reduction of BOD inputs from industrial sources in specific areas with large concentration of BOD loads.
- Scope of action: to focus actions on those Hot Spots with a major concentration of BOD industrial discharges in the Mediterranean region. Actions should be specially addressed in those Hot Spots where large domestic discharges are also taking place and the geographic conditions make the area especially sensitive (confined areas).
- Key measures to reduce BOD inputs: to connect all industrial discharges to sewer networks and to new or improved wastewater treatment plants. Initiate actions to adopt BEP and BATs oriented to reduce BOD loads in all industrial facilities in the Hot Spot area.

PROPOSED ACTION PROGRAMME:

1. List of BOD priority Hot Spots. As a first step, to analyse all available information on Hot Spots to identify those areas with a major priority to initiate actions according to their total industrial BOD loads, domestic discharges, and sensitivity of the receiving environment. This information should be available from the MAP/MEDPOL Hot Spots reports [14] and National Action Plans.

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