Industrial Emissions Indicator IND 6.1:
Release of nutrients from industrial sectors

Sub-indicators

6.1.1) Total BOD load discharged from industrial installations to the Mediterranean marine environment.

6.1.2) Total Nitrogen load discharged from industrial installations to the Mediterranean marine environment.

6.1.3) Total Phosphorus load discharged from industrial installations to the Mediterranean marine environment.

Rationale

Justification for indicator selection

This indicator represents the emissions from industrial sources from individual facilities within the Mediterranean coastal zone with regard to nutrients. It is a pressure indicator.

This indicator is referenced by a number of pollution reduction programmes and environmental initiatives including H2020 and NAPs. The indicator complements IMAP indicator 13 (eutrophication) and is in line with the requirements of the Regional plan on the reduction of BOD5 in the food sector. It also provides data and information regarding the operational target identified by the Mediterranean countries with regards to reduction of BOD discharges to the Mediterranean Sea.

The main reason for selection of nutrients is due to their effects on the marine environment. This is manifested by enhanced productivity, which can result in changes in species diversity, excessive algal growth, dissolved oxygen reductions and associated fish kills, and increased prevalence or frequency of toxic and other species algal blooms. This process is linked to the "eutrophication" phenomena, which is caused by an augmentation of nutrient inputs to coastal and marine areas as a consequence of human activities. Marine eutrophication is mainly an inshore problem that affects lagoons, harbors, estuaries and coastal areas adjacent to river mouths of highly populated river basins and/or which receive sewage from coastal cities.

Indicator definition

Nutrients

Nutrients consist of various anthropogenic sources including municipal sewage, industrial wastewater and agriculture. Of concern is biodegradable organic matter (BOD) of industrial wastewater effluents discharged from the food and other industrial sectors; Total Nitrogen (TN); and Total Phosphorus (TP) from agricultural effluents collected by the hydrologic network in the coastal zone of the Mediterranean Sea.

(1) Biological Oxygen Demand (BOD) is the amount of dissolved oxygen needed (i.e. demanded) by aerobic biological organisms to break down organic material present in a given water sample at certain temperature over a specific time period. This indicator presents information on the BOD estimate of industrial wastewater effluents discharged from food sector industries listed in Appendix I of Decision IG.20/8.2 and other industries within the hydrological basin discharging directly or indirectly into the Mediterranean Sea.

(2) Total Nitrogen (TN): This indicator comprises the ions nitrate, nitrite and ammonium in the dissolved phase (DIN) and the organic forms of nitrogen (mostly proteins and other N-containing substances) existing in biota and other particulate materials and in dissolved organic matter.

(3) Total Phosphorus (TP): This indicator comprises the dissolved ion phosphate and the organic forms of phosphorus existing in biota and other particulate materials (POP) and in dissolved organic matter (DOP).

Industrial installations

Industrial installations are facilities intended for use in the manufacture or processing of products involving systematic labor or habitual employment. It consists of a fixed or semi-fixed location of a complete system or a self-contained unit, with its accompanying assemblies, accessories and parts. The principal contributors to nutrients discharges from industrial installations are food industries and food processing including olive oil production, vegetable oil processing, sugar beet processing, canned fruits and vegetables, fish processing, livestock production, wine and spirits, beer production and soft drinks. Other industries contributing to discharge of nutrients include pulp and paper industries, textile dyeing, leather processing, fertilizers and inorganic chemicals, and petroleum refineries.

Units

Nutrient pollution load indicator may be reported to population-equivalent and measured as BOD or TN or TP load discharged from industrial installations in metric tons per year.

Policy context and targets

Policy context description

In November 1995, the Global Program of Action for the Protection of the Marine Environment from Land-Based Activities was adopted. It is designed to be a source of practical guidance to States in taking actions within their respective policies, priorities and resources. In 2012, the Manila Declaration on Furthering the Implementation of the Global Programme of Action for the Protection of the Marine Environment from Land-based Activities was adopted. It contains 16 provisions centering on programs to be undertaken for the period 2012-2016 on GPA's priority areas such as marine litter, wastewater, pollution from fertilizer and biodiversity loss. The Declaration also calls on member-countries to engage and step up their efforts to develop strategies and policies on the sustainable use of "nutrients" so as to improve nutrient use efficiency and to mitigate negative environmental impacts.

In 1975, 16 Mediterranean countries and the European Community adopted the Mediterranean Action Plan (MAP); the first-ever Regional Seas Programme under UNEP's umbrella. In 1995, the Action Plan for the Protection of the Marine Environment and the Sustainable Development of the Coastal Areas of the Mediterranean (MAP Phase II) was adopted by the Contracting Parties to replace the Mediterranean Action Plan of 1975. The Barcelona Convention has given rise to seven Protocols addressing specific aspects of Mediterranean environmental conservation. The Protocol on Land-Based Sources (the LBS Protocol) was adopted on 17 May 1980. The Protocol entered into force on 17 June 1983. The original Protocol was modified by amendments adopted on 7 March 1996 by the Conference of Plenipotentiaries on the Protocol for the Protection of the Mediterranean Sea against Pollution from Land-Based Sources (UNEP(OCA)/MED IG. 7/4). The amended Protocol, recorded as "Protocol for the Protection of the Mediterranean Sea against Pollution from Land-Based Sources and Activities", entered into force on 18 May 2006.

In 1999, the parties to the Barcelona Convention adopted a Strategic Action Programme to Address Pollution from Land-Based Activities (SAP-MED). SAP-MED identified categories of pollutants and activities to be eliminated or controlled by the Mediterranean countries by 2025. In this context, countries prepared inventories of all pollution sources on their coasts in the framework of the National Baseline Budget of emissions and releases (NBBs), as well as National Action Plans (NAPs) describing the policies and investments that each country intends to undertake to reduce pollution from identified "pollution hotspots." SAP-MED includes special provisions on nutrients and suspended solids.

Ten Regional Plans in the framework of Article 15 of the LBS Protocol were adopted. These plans specify and strengthen the SAP-MED with regards to industrial pollution sector (POPs, heavy metals and food industry), urban development (BOD5 from WWTP and marine litter), as well as enhance monitoring and reporting requirements. Of particular interest is the Regional Plan on the reduction of BOD in the food sector [Decision IG.20/8.2].

In 2012, the Contracting Parties to the Barcelona Convention adopted Decision IG. 20/4 of the 17th Conference of the Parties on the ecosystem approach. Eleven (11) ecological objectives were approved including EO5 on eutrophication. The Ecosystem Approach is the guiding principle to MAP Programme of Work and all policy implementation and development undertaken under the auspices of UNEP/MAP Barcelona Convention, with the ultimate objective of achieving the Good Environmental Status (GES) of the Mediterranean Sea and Coast. Following up on the latter, Decision IG. 21/3 on the ecosystems approach adopted definitions of Good Environmental Status (GES). The Decision provides details of the operational objectives, indicators, GES and proposed targets.

Mainstreaming EcAp into the work of UNEP/MAP Barcelona Convention and achieving the GES of the Mediterranean Sea and Coast through the EcAp process have been supported by several European Union funded projects including EcAp-MED I (2012-2015) and EcAp-MED II (2015-2018) projects.

The Euro-Mediterranean Environment Ministers at their meeting in Cairo in 2006 invited "the European Commission to coordinate the partnership of the Horizon 2020 initiative through the establishment of an efficient institutional steering mechanism with key representatives from the Euro-Mediterranean governments and other partners to provide overall guidance, review, monitoring and effectively coordinate with other related initiatives." As of 2008, this initiative is one of the main pillars of the UfM. Based on the Mid-term review of the Horizon 2020 initiative, the Union of the Mediterranean (UfM) Environment Ministers at their meeting in Athens in May 2014 called for modifications to the structure of the Initiative. Specifically, the final declaration of the UfM Ministerial meeting undertook to address outstanding data needs by applying the principles of Shared Environment Information Systems (SEIS) in line with the commitments under the Barcelona Convention and the NAPs, also contributing to its regional integrated monitoring programme. On this basis, the 2nd phase of this initiative aims to expand the existing H2020 priorities with regards to water, solid waste and industrial emissions to the Mediterranean Sea.

Targets

SAP-MED proposes the year 2025 as a target date for disposal of all wastewater from industrial installations which are sources of BOD, nutrients and suspended solids. The Regional Plan on the reduction of BOD5 in the food sector states that Industrial Food Plants shall implement by 2014 the stipulated emission limit values, taking into account their national circumstances the respective capacity to implement the required measures. Mediterranean countries presented in their NAPs national targets for reduction of BOD in conformity with the provision of SAP-MED and the legally binding requirements of the regional plans. Decision IG. 21/3 on the ecosystems approach includes also targets on eutrophication for achieving GES.

The Euro-Mediterranean Ministers adopted the Athens Declaration in May 2014 in which it was pledged to implement instruments, programmes, action plans and guidelines adopted at Barcelona Convention CoP19 to prevent pollution from maritime transport, marine exploration and land-based activities, as crucial means for the achievement of the objectives of the Barcelona Convention and targets set in its Protocols.

Methodology

Methodology for indicator calculation

Two common methodologies are presented for calculating this indicator:

1. Emission factors method: An emission factor is a representative value that attempts to relate the quantity of a pollutant released to the marine environment with an activity associated with the release of that pollutant. These factors are usually expressed as the weight of pollutant divided by a unit weight, volume, distance, or duration of the activity emitting the pollutant. In most cases, such factors are simply averages of all available data of acceptable quality, and are generally assumed to be representative of long-term averages for all facilities in the source category (i.e., a population average).

The US EPA[1] defines the general equation for emissions estimation:

$$E = A \times EF \times (1-ER/100)$$

where:

E = emission
A = activity rate
EF = emission factor
ER = overall emission reduction efficiency (%)

The emission factors technique can be used to obtain data that complement those reported in the NBB or PRTR systems. As these systems are based on information of releases of a specific list of pollutants to water, air and land, some pollutants included in these lists may not be routinely analyzed in the effluents and emissions, and therefore no extensive data sets may be available. To bypass the lack of such analytical data, the pollutants releases can be estimated by using the Emission Factors (EF) technique.

Required data for estimating pollution loads from industrial installations are:

- Relevant industrial sectors per administrative region.
- Relevant industrial processes generating pollutant of interest.
- Unit production quantity.
- Emission factor for relevant pollutant for each industrial sector.

2. Field measurements should be undertaken when datasets needed for calculating the indicator are lacking. Field measurements should be performed by trained personnel who possess the knowledge about the specific aspects pertinent to the industry in question. They should be properly equipped with regards to sampling and testing equipment and protective clothing. Field measurements are executed according to standard protocols and working instructions. This involves desk study whereby relevant information on the specific industrial installation(s) is collected and spots to be checked are mapped. In the field, it is critical to verify that production lines are working, and to locate emission points and corresponding effluent flow rates from each point. Samples may be obtained if the inspector deems it necessary for counter-checking of the self-monitoring results (i.e. field measurements). Objective evidence of state of pollution at the effluents' points should be acquired such as photographs and oral/written statements, reports of previous test analysis, etc. Standard methods for laboratory determination of nutrients concentrations are as follows:

   - Determination of BOD: The most common method recognized for the measurement of BOD is the dilution method. It is the standard method recognized by U.S. EPA NS labeled Method 5210B in the Standard Methods for the Examination of Water and Wastewater for determination of BOD5.
   - Determination of Total Nitrogen: The test for determination of total nitrogen in seawater (and fresh water as well) consists in the digestion of the unfiltered sample followed by Kjeldahl (ammonium) or, after oxidation, by the standard photometric technique used for analysis of nitrate.
   - Determination of Total Phosphorus: The test for determination of total phosphorus in seawater (and fresh water as well) consists in the oxidation to phosphate, which is then determined by standard photometric technique.

   Required data to calculate pollution load from effluent points of the industrial facility are:

   - Effluent flow rate from the emission point, and duration of flow.
   - Concentration of pollutant from the emission point.

Description of required data

- Relevant industrial sectors per administrative region.
- List of industrial facilities for a particular sector in an administrative region.
- Estimated or calculated pollution loads for the relevant pollutant for each industrial facility.

[1] https://www.epa.gov/air-emissions-factors-and-quantification/basic-information-air-emissions-factors-and-quantification

Geographical coverage

Administrative regions of the whole Mediterranean sea watershed as defined in section 3.1 of the "Updated guidelines to assess national budget of pollutants (NBB)" [UNEP(DEPI)/MED WG. 404/4].

Temporal coverage

Three data series for the years 2003, 2008 and 2015 are available. However, not all Mediterranean countries have reported in all three time periods.

Basis for aggregation

Due to the very complex nature of this indicator, the only possible aggregation is per substance (measured in the same phase) at the national level or at the coastal hydrological basin. This entails the presentation of nutrients in three sub-indicators for BOD, phosphorus and nitrogen.

Trend analysis

Can be performed based on the three data series in 2003, 2008 and 2015 for a limited number of substances and only in some countries.

Methodology for gap filling

Two methodologies are presented for the indicator on release of nutrients from industrial sectors. In principle, the two methods constitute two alternatives for estimates of releases. However, in case of lack of actual data on the industrial processes generating the pollutants of interest and their unit production quantities for use in the emission factor method, required data may be obtained from records maintained by relevant governmental authorities that issued the permit for the industrial facility in question.

Data specifications

Data sets availability

Key source of data needed for estimating pollution loads for this indicator can be found in the NBB or PRTR registers. Alternatively:

- Data on types of liquid effluents generated from industrial facilities may be found in records of industrial permitting authorities for each administrative region.
- Concentrations of pollutants in liquid effluents may be available in national/ regional inspection registers of pollutants discharged by industrial facilities, if such registers are institutionalized.
- Data on industrial sectors operating in a particular administrative region are available from records of industrial permitting authorities for each administrative region.

References for data collection

- 'Updated guidelines to assess national budget of pollutants (NBB)', UNEP(DEPI)/MED WG.404/4, Barcelona, 18-19 December 2014.
- 'National Baseline Budget for 2008', UNEP-MAP, Athens 22 August 2008.
- 'Web based NBB reporting system specification requirements', UNEP(DEC)/MED WG.393/3, 4 March 2014.
- UNEP/MAP, 2014a. Introduction to pollutant release and transfer register (PRTR) and guidelines for reporting (UNEP(DEPI)/MED WG.399/3).
- UNEP/MAP, 2014b. Industrial emission factors. Updated version 2012. (UNEP(DEPI)/MED WG.393/Inf.5).
- Regulation (EC) No 166/2006 of the European Parliament and of the Council of 18 January 2006 concerning the establishment of a European Pollutant Release and Transfer Register and amending Council Directives 91/689/EEC and 96/61/EC. European Union, 2006.
- 'International Standard Industrial Classification of all Economic Activities (ISIC), Rev4', Department of Economic and Social Affairs, Statistics Division, United Nations, New York, 2008.

Uncertainties

Methodological uncertainties

Methodological uncertainties depend on whether the emission factor or field measurement method is used. With reference to:

- The emission factor method, uncertainty is related to whether the characteristics of the industrial process for which the emission factor was developed are similar to those of the industrial process in question. Typically, emission factors are derived for specific industrial processes using certain manufacturing technology operating in a specific environment. In case the technology is different, then the level of pollutants it emits will vary, and the emission factor is no longer representative of the process in question.
- The field measurement method, uncertainty is related to the accuracy of measurements of concentration in industrial effluents, and to proper estimates of flow rates which can be averaged over the daily or monthly production of the industrial unit. These two factors affect the calculation of the pollution load for the industrial facility. Another source of uncertainty is related to the number of emission points and ability to estimate actual pollution load.