Industrial Emissions Indicator IND 6.2:
Release of toxic substances from industrial sectors

Sub-indicators

6.2.1) Total heavy metals load released from industrial installations to the Mediterranean marine environment.

6.2.2) Furans and dioxins load released from industrial installations to the Mediterranean marine environment.

6.2.3) Polycyclic aromatic hydrocarbons (PAH) load released from industrial installations to the Mediterranean marine environment.

6.2.4) Volatile organic compounds (VOC) load released from industrial installations to the Mediterranean marine environment.

Rationale

Justification for indicator selection

This indicator represents the emissions from industrial sources originating from individual facilities within the Mediterranean coastal zone with regard to toxic substances, and hydrocarbons. It is a pressure indicator.

This indicator is referenced by a number of pollution reduction programmes and environmental initiatives including Regional Seas, MED POL, H2020, NAPs and SDG. SDG indicators are regarded as the main drivers for updating the scope of the industrial emissions indicators. They are a measure of the strength of economic activities which represent at the same time the drivers of pollution generation and environmental pressures on the marine and coastal ecosystems. As these economic activities contribute to the wealth of the Mediterranean countries and to the social well-being of its people, this indicator should lead to an effective monitoring process capturing the principle of sustainable development, while promoting at the same time the creation of functional synergies among all stakeholders. Pollutants addressed by this indicator are based on SAP-MED categories and substances included in Annex I.C of the LBS Protocol, which are compiled in the NBB and PRTR registers. Furthermore, the indicator is in line with the requirements of the Regional plans on the reduction, elimination and phasing out of POPs and mercury. It provides data and information regarding the operational target identified by the Mediterranean countries with regards to reduction of discharges of hazardous substances from industrial plants or their safe disposal.

The main reason for selection of toxic substances is due to the fact that industrial development in the Mediterranean countries varies greatly from one country to another. From the thirty sectors of activity primarily considered in the Annex I of the LBS Protocol, twenty-one are industrial. Furthermore, most countries in the region have an important public industrial sector which is composed of large industries including energy production; oil refineries; petrochemicals; basic iron and steel metallurgy; basic aluminum metallurgy; fertilizer production; paper and paper pulp; and cement production. These industries are major contributors for toxic substances and hydrocarbons which are generated in large quantities causing damage to human health, ecosystems, habitats and biodiversity. On the international level, priority has been given to toxic, persistent and bioaccumulable pollutants for their effects on human health, biodiversity and the preservation of ecosystems and long-term and long-distance effects. Successive releases of these chemicals over time will result in the continued accumulation and ubiquitous presence of POPs in the global environment. Their high persistence poses a risk of causing adverse effects to the environment and human health.

Regarding hydrocarbons, this includes various groups such as halogenated hydrocarbons, polycyclic aromatic hydrocarbons (PAH) and volatile organic compounds (VOC). All of these substances were reported by most of the Mediterranean countries in NBB inventories carried out in 2003 and 2008.

Halogenated hydrocarbons include polychlorinated dibenzo-dioxins (PCDDs) and polychlorinated dibenzo-furans (PCDFs). These substances are amongst the most toxic and persistent substances reaching the marine and coastal environment through point and diffuse sources. Polycyclic aromatic hydrocarbons (PAHs) are ubiquitous environmental pollutants generated primarily during the incomplete combustion of organic materials (e.g. coal, oil, petrol, and wood). Many PAHs have toxic, mutagenic and/or carcinogenic properties. PAHs are highly lipid soluble and thus readily absorbed from the gastrointestinal tract of mammals. Volatile Organic Compounds (VOC) are organic compounds having initial boiling points less than or equal to 250 °C and can do damage to visual or audible senses. VOCs are numerous, varied, and ubiquitous. They include both human-made and naturally occurring chemical compounds. Some VOCs are dangerous to human health or cause harm to the environment. Harmful VOCs are typically not acutely toxic, but instead have compounding long-term health effects.

Indicator definition

Toxic substances

1. **Heavy metals**: This indicator presents information on heavy metal annual emissions reported from point sources in the Mediterranean Sea area (land based sources/coastal zone discharged to air or water). Six heavy metals have been identified in SAP-MED. These include:
    i. Mercury. The most important industrial sources of mercury are combustion of coal in power plants; chlor-alkali production; manufacture and disposal of batteries; waste incineration and roasting and smelting in non-ferrous metal smelters.
    ii. Cadmium. The most important industrial sources of cadmium are zinc and lead metal processing; electroplating; the production of cadmium compounds; pigment production; the manufacture and disposal of batteries; the production of stabilizers for plastics and phosphate fertilizers.
    iii. Lead. The most important industrial sources of lead are lead metallurgy; the manufacture and disposal of batteries; additives for petrol; enamels and ceramic glazes and glass manufacture.
    iv. Zinc is a commonly occurring trace-metal and is essential to living organisms for enzymatic functions. High levels of zinc are found in coastal areas and biota. Dispersion and diffusion can rapidly remove zinc.
    v. Copper: The most important industrial sources of copper are metallurgy, covering of metallic surfaces; electric cables and pesticides.
    vi. Chromium: The most important industrial sources of chrome are: chrome metallurgy; covering of metals; tanneries; textile and wool dyeing; corrosion inhibitors in closed cycle cooling systems.
2. **Halogenated hydrocarbons.** This indicator presents information on dioxins and furans. These substances can be found as contaminants in some products and can be produced in combustion processes. The most important anthropogenic sources of dioxins and furans are combustion installations such as incinerators of wastes, combustion of residual sludge, fossil power plants, manufacture and use of certain pesticides, paper pulp bleaching, metallurgy of metals, and recovery of metals (mainly copper wire and electric motors and copper and aluminum turnings). Halogenated hydrocarbons include Polychlorinated dibenzo-dioxins (PCDD) and Polychlorinated dibenzo-furans (PCDF).
3. **Polycyclic aromatic hydrocarbons (PAH).** This indicator presents information on the PAH group. PAHs contain hundreds of substances occurring naturally in oil in ppm levels. PAHs are formed from the incomplete combustion of organic matter and this process is the main source of PAHs in air. Major anthropogenic sources of PAHs include residential heating, coal gasification and liquefying plants, carbon black, coal-tar pitch and asphalt production, coke and aluminum production, catalytic cracking towers and related activities in petroleum refineries as well as and motor vehicle exhaust.

4. **Volatile Organic Compounds (VOC)**. This indicator presents information on VOC emissions reported from point sources (land based sources/ coastal zone). VOCs are organic compounds that easily become vapor or gas. VOCs are emitted from a variety of sources including motor vehicles, chemical manufacturing facilities, refineries, factories, etc.

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.

Units

Toxic substances indicators may be reported in kilograms per year for emissions of contaminants consisting of total heavy metals, PAH and VOC, and in grams per year for furans and dioxins.

Policy context and targets

Policy context description

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 toxic substances including heavy metals and hydrocarbons.

Ten (10) Regional Plans in the framework of Article 15 of the LBS Protocol were adopted. These plans present an important added value as they further specify and strengthen the SAP-MED with regards to the industrial pollution sector, including POPs and heavy metals, as well as enhance monitoring and reporting requirements.

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 EO9 on contaminants. 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, and GES 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, including hazardous waste to the Mediterranean Sea.

Finally, it is noted that toxic substances are addressed in the Water Framework Directive (2000/60/EU), the Dangerous Substances Directive (76/464/EEC); Directive (2008/105/EC) on environmental quality standards in the field of water policy, etc. Halogenated hydrocarbons are also on the EU's list of priority substances [2455/2001/EC (EU, 2001a)].

Targets

SAP-MED proposes the year 2025 as a target date for phasing out to the fullest possible extent discharges, emissions and losses of mercury, cadmium and lead, and inputs of PAHs. SAP-MED also proposes reduction of inputs of dioxins and furans by 2010, and elimination of discharges of zinc, copper and chrome to the fullest possible extent. The Regional Plan on the reduction of inputs of Mercury (Decision IG. 20/8) stipulates that the Parties shall adopt by 2019 National ELVs for Mercury emissions from other than Chlor Alkali industry. The Parties shall ensure also that the releases of mercury from the activity of Chlor alkali plants shall cease by 2020 at the latest. Decision IG. 21/3 on the ecosystems approach includes targets on contaminants for achieving GES.

The Euro-Mediterranean Ministers adopted the Athens Declaration in May 2014 in which they 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

The two common methodologies for calculating this indicator are (1) the emission factors (EF) technique and (2) field measurements:

1. Emission factors: An emission factor is a representative value that attempts to relate the quantity of a pollutant released either by direct aqueous discharges or indirectly by air emissions 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:

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

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

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 contaminant of interest.
- Unit production quantity.
- Emission factors for relevant contaminant 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.

   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 contaminant 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 contaminant for each industrial facility.

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. Hence*:*

- Heavy metal indicators can be aggregated and reported as a single sub-indicator.
- Halogenated hydrocarbons indicators (PCDD and PCDF) can be aggregated and reported as a single sub-indicator.
- Polycyclic aromatic hydrocarbons (PAH) are reported as a single sub-indicator.
- Volatile organic compounds indicators (VOC) are reported as a single sub-indicator.

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 toxic substances from industrial sectors. In principle, the two methods constitute two alternatives for estimates of releases. However, in case of lack of data on the industrial processes 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 aqueous discharges and air emissions from industrial facilities may be found in records of industrial permitting authorities for each administrative region.
- Concentrations of contaminants in aqueous discharges and air emissions 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 may be found in 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 technique or the field measurement method is used.

- With regards 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. Typically, emission factors are derived for specific industrial processes using a manufacturing technology operating in a specific environment. In case the technology is different, or the raw material varies, then the level of contaminants it emits will vary, and the emission factor is no longer representative of the process.

- For the field measurement method, uncertainty is related to the accuracy of measurements of concentration levels 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 addressing all emission points in a facility and estimating its actual pollution load.