Assessing the progress in depolluting the Mediterranean Sea

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1. Introduction

The Mediterranean region, home to around 480 million people living across three continents: Africa, Asia and Europe, has been undergoing intensive demographic, social, cultural, economic and environmental changes in the last decades. Since 1950s, the countries bordering the Mediterranean Sea have experienced a drastic increase in population, especially in the southern and eastern rim where further growth is still expected. Most of this urbanisation takes place in the coastal zone where people live in increasingly overcrowded coastal strips, exacerbating the pressures on the environment, such as through waste and wastewater generation. Such land-based sources of pollution constitute a major threat to the health of coastal and marine ecosystems.

In response, the countries bordering the Mediterranean Sea have been cooperating to protect the fragile and vulnerable marine ecosystem for 40 years. In 1976, the Mediterranean countries and the European Union (EU) strengthened their commitment to the Mediterranean Action Plan (MAP) by adopting the Convention for the Protection of the Mediterranean Sea against Pollution (Barcelona Convention) and the Mediterranean Strategy for Sustainable Development (MSSD) in 2005. This was followed by the adoption of seven associated Protocols that address the operational, legal and technical obligations of specific aspects of environmental protection and sustainable development in the Mediterranean. Since 2008, UNEP/MAP has committed to applying the Ecosystem Approach (EcAP; UNEP/MAP, 2012) as an overarching principle of its policies and actions, with the view of achieving good environmental status according to an ambitious implementation roadmap and cyclic-based timetable. The Euro-Mediterranean Partnership (EUROMED), referred to as the Barcelona Process, was first launched in 1995. It was then re-launched in 2008 as the Union for the Mediterranean (UfM) to enhance the partnership between the EU and its Mediterranean neighbours, providing a regional platform for political dialogue and acceleration of projects towards cooperation, security and sustainable development. The protection of the Mediterranean Sea from pollution is one of the first mandates given to the UfM in the field of environment and water.

In spite of all the measures taken to improve the marine environment and ecosystems in the Mediterranean region, pressures from the land-based sources remain high across a considerable part of the region. The measures taken do not operate effectively in all areas due to legislative gaps, lack of proper enforcement, limited human and technical capacities, financial constraints as well as population growth and development paths. As a consequence, there is little evidence of tangible progress in the depollution of the Mediterranean Sea and for most Mediterranean countries pollution control and monitoring still constitute a major challenge.

2. The Horizon 2020 Initiative (H2020)

In an effort to rectify environmental deterioration in the region, during the 10th Anniversary Summit of the Barcelona Process in 2005, the...
Euro-Mediterranean Partners committed themselves to substantially reduce land-based pollution to the Mediterranean by 2020 — the “Horizon 2020 Initiative” (H2020). H2020 is established under the former Barcelona Process and current UfM, and is financially supported by the European Commission as part of the European Neighbourhood Policy Instrument. The overarching objective is to depollute the Mediterranean by 2020, focusing on three priority areas: a) municipal waste, b) urban wastewater and c) industrial emissions. H2020 builds on the work carried out by other institutions and operates within the framework of existing and developing environmental policy instruments. It supports the implementation of the pollution reduction commitments undertaken in the framework of MAP and its Barcelona Convention. A roadmap for the first phase of implementation (2007–2013) of H2020 was adopted by the environment ministers, marking an important milestone for regional environmental cooperation and commitment. The roadmap focused on addressing the primary question: What is the progress in depolluting the Mediterranean? by tackling the following aspects:

- The identification of projects to reduce the most significant sources of pollution;
- The identification of capacity building measures to help neighbouring countries to create national environmental administrations that are able to develop and police environmental laws;
- The use of the EU research budget to develop and share knowledge of environmental issues relevant to the Mediterranean;
- The development of indicators to monitor the success of H2020.

To implement and monitor these actions, three thematic subgroups were established (Fig. 1): Pollution reduction (PR), Capacity building (CB) and Review, Monitoring and Research (RMR). The latter, the RMR subgroup chaired by the European Environment Agency (EEA), was mandated to monitor the progress of the implementation of H2020 through the development of common indicators and shared information systems that support a mechanism for regular reporting on environmental issues.

This paper presents the results of the work of RMR subgroup and its corresponding implementation project — Towards a Shared Environmental Information System in the European Neighbourhood (ENPI-SEIS) on the implementation of a pilot review mechanism in the 9 European Neighbourhood Policy Instrument (ENPI) South countries, following the experience of establishing Shared Environment Information System (SEIS) in European countries. Throughout the ENPI-SEIS project, a distinction is made between putting in place the ‘process’ for regular reporting, based on setting up and maintaining the infrastructure and cooperation needed to allow for the exchange of data and information; from generating the ‘content’ or knowledge required to assess progress on H2020 issues. In the first section, a brief description of how the ‘process’ supports the generation of the ‘content’ is provided. More detailed information and the key messages drawn from the first reporting exercise and indicator-based assessment of the three H2020 thematic areas are presented in the second section, aimed at addressing the question “What is the progress in depolluting the Mediterranean?”.

3. Setting up the process

3.1. Implementation of SEIS

The concrete implementation of the proposed review mechanism was fully embedded into the activities of the EU-funded ENPI SEIS project, which aimed at progressively developing the SEIS principles (EC, 2008) in the ENP partner countries. The conceptual framework of SEIS, built on three pillars — content, cooperation and infrastructure (Fig. 2), was used to design and implement of a coherent indicator process for regular indicator-based analyses, fulfilling the mandate of the RMR subgroup.

The work on the content pillar was organised around the priority areas identified under H2020: municipal waste, urban wastewater and industrial emissions. These land-based sources of pollution account for ~80% of the overall pollution to the Mediterranean Sea. Following an initial consultation with the ENP South countries, the scope of the water thematic area was enlarged to also include fresh and marine water, both in terms of consultation and quality. The review process was based on the different level of aggregation and analysis of environmental information: monitoring, data, indicators, assessment and knowledge (MDIAK). This MDIAK reporting chain has been developed by the EEA to support the provision of observations, data processing and the production of indicators that underpin thematic assessments that can later support policy-making. Data on the priority areas was processed and aggregated based on common definitions, harmonised methods and standards, to produce regionally-coherent indicators and indicator-based assessments, as described in more details below.

Under the cooperation pillar, focus was given to setting up and maintaining strong and long-term (human) networks between providers and users of data ensuring that the necessary data, information and knowledge were exchanged at every level; local, national and regional. This strong inter-institutional cooperation is essential for streamlining dataflows and network infrastructures. The institutional cooperation at national level is ensured by the appointed two National Focal Points (NFPs), representing the environmental and statistical organisations leading in the field of environmental information in each of the ENP South countries.

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1 The 9 ENP South countries are Algeria (DZ), Egypt (EG), Israel (IL), Jordan (JO), Lebanon (LB), Morocco (MA), Palestinian Authority (PS), Syria (SY) and Tunisia (TN). Due to the political situation, Syria is currently not part of the process.

4. Use of the underlying datasets to populate the selected indicators, the three priority areas (countries endorsed the following six H2020 core indicators related to exhaustive coverage of the priority areas and f) allow for the periodic re-
ous activities and initiatives in the region to ensure the full use of the pret, b) be issue-speci
gether with the partner countries and was guided by a number of

3. Establishment of the necessary national dataflows and common in-
frastructure (e.g. information system, reporting tools) for the deliv-
ery of data according to the indicator specification factsheets. This mapping exercise required bringing together all national actors that are involved in the production of the agreed datasets and outlining the necessary steps for mobilising this data.

4. Use of the underlying datasets to populate the selected indicators, aimed at providing a quantitative and comparable measure for the evaluation of the state as well as trends over time.

The selection of the H2020 priority indicators was undertaken to-
gether with the partner countries and was guided by a number of criteria, including a) be simple, straight-forward, concise, easy to inter-
pert, b) be issue-specific yet relevant to all countries, c) build on previ-
ous activities and initiatives in the region to ensure the full use of the existing information and data, d) provide a realistic and representative baseline of the current situation, e) give a comprehensive, yet non-
exhaustive coverage of the priority areas and f) allow for the periodic review and update in line with future developments. The participating countries endorsed the following six H2020 core indicators related to the three priority areas (Table 1).

Data for these six indicators was reported by the countries following the process described above. It formed the core of the indicator-based assessment for assessing the state and trends of the H2020 priority themes, supplemented by external sources, data and information on drivers (e.g. socio-economic aspects) and responses (e.g. legislation, depollution investments).

4. Indicator-based thematic assessment

When assessing the progress in depolluting the Mediterranean Sea, it is not possible to dissociate the state and impacts of human pressures on the environment from the socio-economic drivers affecting the region. The main drivers in the region are population growth, particularly in urban areas; growth and development and tourism. The population of the Mediterranean countries (including Jordan) has been steadily in-
creasing over the last 50 years (Fig 3). It doubled from 240 million in
1960 to 480 million in 2010.

The distribution of population between EU Med and ENP South coun-
tries has changed dramatically over the years. In 1960, EU Med coun-
tries represented 59% of the total population, while today this fig-
ure has dropped to 40%. Of the ENP South countries, Egypt, Algeria and Morocco are the most heavily populated: they have 151 million inhab-
habitants, representing 71% of the population in ENP South countries.

Most of the population growth occurs in urban areas. The urban pop-
ulation in the Mediterranean region has increased significantly over the last 50 years (Fig 3). In 1960, the urban population represented 48% of the whole Mediterranean population, whereas in 2010 around 67% of the population lived in urban areas. In particular in the ENP South region, the urban population increased by around 100 million inhabitants, reaching 123 million in 2011. Of the ENP South countries, Israel, Lebanon and Jordan are the most urbanised, with an urban population rate higher than 80%.

This urbanisation takes place along the coastal zones. The population in the coastal regions is about 150 million, implying that one third of the population of the countries resides in 15% of the area. Moreover, about 1600 cities with around 100 million inhabitants are located in the Med-
iterranean coastal regions. About 250 million inhabitants (55% of the total population) live in the coastal hydrological basin draining in the Mediterranean Sea. In the ENP South region, this amounts to around 120 million inhabitants or 65% of the population.

Population growth combined with the growth of coastal (peri) urban hubs generates multiple environmental pressures stemming from increased demand for water and energy resources, generation of air and water pollution in relation to wastewater discharge or sewage overflows, waste generation, land consumption and degradation of habitats, landscapes and coastlines. These pressures are further amplified by the development of tourism, often concentrated in Mediterranean coastal areas and peaking during the summer season, coinciding with

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Under the infrastructure pillar, efforts were focused on the application of modern web-based information and communication technologies to improve and facilitate the open and public access to information. Currently, the exchange of data between institutes is mainly through paper reports and information posted on websites. Such shared technical infrastructures rely on the use of compatible and freely avail-
able exchange tools for the generation of policy-relevant and compara-
ble content. The EEA’s own infrastructure and related suite of web-
based tools and applications for supporting and improving environmen-
tal data and information flows were made available to the ENP South
countries. Referred to as Reportnet, this system of tools assists countries to report data and information into a formal reporting process, to keep track of all obligations, including the quality assurance of delivered data.

3.2. Indicator development process

The design of a coherent regional indicator process was the basis of regular and indicator-based reviews on progress within H2020. This process was comprised of the following steps, many of which include an agreement on common content, cooperation and infrastructure:

1. Selection of a set of priority indicators that best capture the state and trends of the issue to be monitored.

2. Development of detailed guidelines (the Indicator Specification Factsheets), specifying the methodological aspects, such as definition, units, geographical and temporal coverage, methods for gap filling and uncertainties.

3. Establishment of the necessary dataflows and common infra-
structure (e.g. information system, reporting tools) for the deliv-
ery of data according to the indicator specification factsheets. This mapping exercise required bringing together all national actors that are involved in the production of the agreed datasets and outlining the necessary steps for mobilising this data.

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4 EU Med refers to the nine European countries bordering the Mediterranean Sea: Cyprus, Spain, France, Greece, Croatia, Italy, Monaco, Malta and Slovenia.
periods of water stress. The Mediterranean region is the world’s leading tourist destination. Since 1995, tourism in the Mediterranean has grown by almost 75% (Fig. 4). In 2010, it accounted for 285 million tourist arrivals or 28% of international tourism in the world (5% in the ENP South countries).

The tourism industry is one of the activities that have contributed to an increase in the overall gross domestic product (GDP) of ENP South region since 1980 (Fig. 4). Although the registered growth is not so remarkable when compared to the corresponding population growth rate, the GDP in the EU Med over the same period has been declining: in 2011, the EU Med countries contributed to around 69% of the Mediterranean GDP, as compared to 82% in 1980. As a result of increasing development, the Mediterranean region has experienced a change in consumption patterns combined with a drastic increase in the quantity and composition of waste generated and in the volume of water used and wastewater generated by the population. Such changes are more pronounced in the ENP-South region where progress in waste management and wastewater treatment is inadequate for meeting growing needs.

4.1. Priority area: municipal waste

Waste is a significant pressure on coastal and marine environments, causing visual pollution and contributing to beach and marine litter. Such threats to the coast and sea are widespread in areas where coastal dumpsites are still in use, especially without rehabilitation. The situation in municipal solid waste generation and management in the ENP South countries was assessed through H2020 indicators 1 and 2 (Table 1). The amount of municipal solid waste generated in a country is closely related to its economic development, rate of urbanisation, its

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<td>Share of total, urban and rural population with access to an improved sanitation system</td>
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<td>Industrial Emissions</td>
<td>Release of toxic substances and nutrients from industrial sectors</td>
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types and patterns of consumption of raw materials, and household revenue and lifestyles. The amount of waste collected and treated, including information on the type of treatment, give an indication of the types and effectiveness of the responses (such as investments, policies and measures) put in place to tackle the growing environmental pressure.

### 4.1.1. Municipal waste generation

In the ENP South countries, 272 kg of municipal solid waste were generated per person in 2010–2011, as compared to 503 kg in the EU 27. While the situation varies widely from country to country and more particularly between local areas, it is estimated that the average municipal solid waste generation in the EU 27 is twice that currently produced in the ENP South countries. Although waste generation in the ENP South countries is still relatively low, it has risen by 15% over the last 10 years. It is expected to continue growing in the coming years and estimated to reach almost 135 million by 2025. These trends can be attributed to population growth and growing economies in these countries. The amount of municipal solid waste generated in the coastal areas of ENP South countries is around 20 million tonnes or 294 kg per capita. This is equivalent to 41% of the amount generated at the national level. Based on the indicator data, Egypt has the highest waste generation rate (21.4 million tonnes per year), on account of having the highest national population (82.5 million), followed by Algeria (9.3 million tonnes per year). When normalised per capita, Israel and Lebanon top with 615 kg/capita and 459 kg/capita, respectively whereas the lowest value is found in Morocco (209 kg/capita) (Table 2). In Palestine, the generation rate per capita remained constant from 2000 to 2011 at around 350 kg/capita. The quantity of municipal solid waste generated in the coastal areas of ENP South countries is around 20 million tonnes or 294 kg per capita. This difference can be up to a factor of five times higher, as is the case of Tunisia. In Jordan, however, the rural rate (310 kg/capita) is higher than the urban rate in Tunisia, Palestine, Morocco, Egypt and Algeria.

Calculating municipal solid waste generation per GDP is a means of viewing the extent of decoupling of waste generation from economic growth, i.e. to assess the increase in waste generation with respect to economic growth. Decoupling the increase in waste generation and GDP growth forms part of the 2015 waste management objectives set by the Mediterranean Strategy for Sustainable Development (MSSD). Other objectives include reducing the current rate of waste generation by around 50%, doubling recycling rates and transforming at least half of unregulated waste dumps into sanitary landfills. In general, the decoupling of municipal solid waste generation from economic growth was not so evident, except for a few countries. In Jordan, this decoupling was found to be important as the quantity decreased from 151 kg/1000 constant 2005 international USD in 2002 to 81 kg in 2011. In Egypt, a decrease from 61 kg/1000 constant 2005 international USD to 47 kg was also observed between 2003 and 2012.

### 4.1.2. Municipal waste collected and treated

When it comes to waste management, indicator data for waste collection (Table 3) showed that the amount of municipal solid waste collected in the ENP South region is about 40 Mt/year. The municipal solid waste collection rate is around 76%, varying between 50% and 100% (Table 4). It reaches near-complete collection in Lebanon and Israel, as is the case for European countries. The extent of municipal solid waste collection varies across countries and also within each country. The coverage of collection and collection rates are in general higher in urban areas than in rural zones. For example, the collection rate in Cairo varies from 72% to 85%, as compared to the national average of 60%.

The municipal solid waste treatment rate allows for measuring the efficiency and effectiveness of the municipal solid waste management system. The total amount of municipal solid waste treated in the ENP South countries is not well known, with the exception of Israel, Jordan

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**Table 2**

Municipal solid waste generated per capita (kg/capita).

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**Table 3**

Municipal solid waste collection (1000 t).

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and innovative legally-binding measures on solid waste hierarchy

The Barcelona Convention. This regional plan provides for ambitious

seabed (benthic). In 2013, the Regional Plan on Marine Litter Manage-

waste management is responsible for the presence of litter on beaches

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and in the present situation. The Mediterranean is considered to be

and functioning, reduced water transparency due to an increase in

phenomenon termed as eutrophication. Eutrophication can cause a

agriculture and industrial facilities. Enrichment of water by nutrients,

receiving waterbodies. Some coastal hotspots along the Mediterranean

sanitation systems, these should be coupled to adequate collection

sanitation, wastewater (Indicator 4), in order to safeguard the re-

sanitation facilities, and increased water demand for agriculture and tourism

water scarcity is a long-term and widespread problem, climate change

water resources. Limited and sporadic rainfall in the ENP South countries

safety measures (reduction of marine litter generation at source) and up-to-date sustainable production and consumption tools application. It sets strict deadlines (2020 and 2025) for the imple-

management, prevention measures (reduction of marine litter genera-

4.2. Priority area: water

Limited and sporadic rainfall in the ENP South countries makes water a vulnerable, yet highly valuable, natural asset. Water resources are scarce with shortages generally occurring in areas with low rainfall and high population density, or in areas where agricultural or industrial activities are intense. The marked population growth in ENP South countries and increased water demand for agriculture and tourism have intensified the pressure on available water resources. Although water scarcity is a long-term and widespread problem, climate change is likely to aggravate this issue, in particular by increasing the frequency, length and severity of extreme events, such as droughts.

The pressures on water resources are further compounded by anthropogenic contamination that deteriorates the water quality, greatly limiting its use. One of the main sources of water pollution in the ENP South region is the discharge of inadequately-treated municipal and industrial wastewater into the environment. In regions where a large proportion of the population is not served with adequate water supply and sanitation, wastewater flows directly into groundwater reservoirs, lakes, streams, rivers, coastal lagoons and oueds (non-permanent riv-

ers). Eventually, it reaches coastal and marine areas, creating patholog-

ical risks through the contamination of fish and seafood products and the deterioration of bathing water quality.

The H2020 Water Indicators 3 to 5 (Table 1) were used to assess the efforts in depolluting the Mediterranean from the discharge of insufficiently treated wastewater and the ‘downstream’ impact of water management practices and policies on the receiving coastal and marine waters. Indicator 3 on the access to improved sanitation systems monitors progress towards more adequate sanitation services, both in urban and rural areas. Although sanitation services strongly determine the quantity and quality of municipal wastes that are produced, the availability of adequate sanitation facilities on its own does not guarantee the ‘downstream’ protection of coastal and marine environment from discharge of untreated wastewater. In other words, in areas where adequate sanitation services are currently being provided, typically quantified by a high share of the population with access to improved sanitation systems, these should be coupled to adequate collection and treatment of wastewater (Indicator 4), in order to safeguard the receiving waterbodies. Some coastal hotspots along the Mediterranean shores receive excessive loads of nutrients, notably from untreated wastewater effluents, as well as other land-based sources, such as agriculture and industrial facilities. Enrichment of water by nutrients, especially compounds of nitrogen and/or phosphorus (Indicator 5), leads to increased primary production and growth of algal biomass, a phenomenon termed as eutrophication. Eutrophication can cause a chain of undesirable effects, including changes in species composition and functioning, reduced water transparency due to an increase in suspended algae, oxygen depletion and noxious odours due to the

Table 5

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http://dx.doi.org/10.1016/j.marpolbul.2015.08.009
decay of organic material. Although the main body of water of the Mediterranean Sea is characterised by very low nutrient concentrations (oligotrophic), eutrophication in the Mediterranean is mostly limited to coastal areas, enclosed bays, river estuaries, coastal lagoons or embayments with restricted water exchange to the open sea.

4.2.1. Access to improved sanitation

According to the analysed indicator data, in 2011 around 92% of the population in the ENP South region had access to improved sanitation systems. Most countries reached connection rates as high as 95% of the total population, as compared to an overall coverage of 87.5% in 2003 (Fig. 5). This implies that steady progress has been achieved since 2003 in all ENP South countries, particularly in Egypt and Tunisia, where coverage increased by more than 5% of the total population over the time period from 2003 to 2011. Since 2003, more than 3 million people have gained access to improved sanitation in the region, in large part made possible by investments from regional and international cooperation. Although the indicator data showed general progress in access to sanitation services, this did not fully take into account the current population growth and (especially the informal) urban sprawl, which are amongst the major drivers and pressures in the region. These figures should therefore be interpreted with caution, accounting for a possible bias that depicts a more favourable situation than exists in reality. Most countries have already reached the Millennium Development Goals (MDG) target set for 2015 (United Nations, 2013). However, data for 2011 showed that an estimated 17.6 million people continued to rely on unimproved sanitation solutions, calling for more localised efforts. Assuming that ~65% of the population in the ENP South countries reside in the coastal hydrological basins, it is estimated that 11.5 out of the 17.6 million inhabitants without access to sanitation systems are concentrated in this coastal area. Although this is a highly approximate calculation, it is a strong indication that the inhabitants and environment in coastal hydrological basins draining into the marine waters are the most severely impacted by inadequate sanitation systems.

The breakdown between the urban and rural population (Fig. 6) showed that in most cases access to improved sanitation in rural areas was lagging behind. More than 5.5 million people living in urban areas and no less than 12 million rural dwellers were deprived from access to improved sanitation systems in 2011 and had to revert to public or shared solutions and open defecation. The corresponding data from 2003 showed that the number of people without access to improved sanitation systems was 5.5 million and 18 million in urban and rural areas, respectively. This implies that the gap between the urban and rural coverage has been gradually narrowing in most countries over the time period from 2003 to 2011.

4.2.2. Wastewater collection and treatment

The lack of adequate sanitation systems results in the discharge of untreated municipal wastewater in coastal areas or rivers flowing into the Mediterranean Sea. This remains a major environmental issue in most ENP South countries and therefore constitutes one of the challenges of H2020. Indicator 4 on wastewater management (Table 6) showed a general increase in the volume of wastewater collected and treated in Israel, Jordan, Lebanon, Palestine and Tunisia over the past 10 years. In some countries, such as Palestine and Jordan, the volume of wastewater collected in 2011 was nearly 50% higher than in 2003. A similar increase in the volume of wastewater treated was observed, implying that most of the collected wastewater (~80–98.6%) underwent treatment. Time-series data on volumes of wastewater collected and treated are not available or accessible for Algeria, Egypt and Lebanon. In Egypt, data on the volume of wastewater collected and treated are available at the Holding Company for Water and Wastewater and its affiliated companies that run a number of water and sanitation projects.

The indicator data delivered by the countries suggested that the volume of treated wastewater closely follows the volume of collected wastewater. This could be explained by the fact that the volume of wastewater collected is generally estimated based on the volume of wastewater entering the wastewater treatment plants (WWTPs), whereas the volume of wastewater treated is estimated on wastewater leaving the WWTPs. In those countries for which data were available, an increase in the fraction of volume collected and treated was observed.
over the period from 2003 to 2010 (Table 6). The normalisation of the volumetric data by population indicated that the reported increase in the volume of wastewater collected and treated not only covered the concurrent population growth but also contributed to the relative improvement of wastewater management practices in the region. Particularly in Palestine, between 2003 and 2010, the volume of wastewater collected increased remarkably by 52.5%, from 35.6 million m³ to 54.3 million m³ (Table 6). However, data on the volume of wastewater treated and type of treatment is very limited. Wastewater treatment facilities are restricted to a few localities in Palestine and the lack of appropriate infrastructure for wastewater collection and treatment has been the limiting factor in development of the wastewater sector. In Egypt, the volume of treated wastewater also increased over the same time period by a staggering 153% (from 1900 million m³ to 4800 million m³). However, it was not possible to confirm whether the drastic increase and trends were the result of increased data coverage, or of heavy investments in wastewater treatment, contributing towards social and economic development. According to official data from Tunisia, more than 90% of the wastewater collected by the National Office of Sanitation (ONAS) is treated, and more than 20% of treated wastewater is reused.

Although the indicator data provided in the context of the H2O20 showed that the volume of treated wastewater closely follows the volume of wastewater collected, the fraction of collected wastewater does not always reflect the volume of wastewater that is generated. This implies that the fraction of generated wastewater that remains uncollected (and therefore untreated) is not accounted for by this indicator. The proportion of wastewater treated is much lower when expressed as a function of wastewater generated rather than wastewater collected. For instance, in Algeria the % treated as a function of wastewater collected is as high as 100%. However, when considering the extent of treatment in relation to the generated volumes (estimated at 730 million m³: FAO Aquastat database), only 20.5% undergoes treatment. This means that a significant volume of generated wastewater remains uncollected (~530 million m³ in 2010: the difference between 730 million m³ generated wastewater and 150 million m³ treated wastewater) and therefore also untreated. Estimates of the amount of untreated wastewater show that at least 5000 million m³ of raw wastewater are discharged to the environment on an annual basis. This estimate does not include Israel, Lebanon, Libya and Syria.

Data showed that the most common type of treatment in the region is secondary treatment. In ENP South countries, tertiary treatment is not so commonly operated and is registered in two countries only, namely Israel and Morocco. Only a limited number of countries provided time series data on the type of wastewater treatment (primary, secondary and tertiary) as part of H2O20 Indicator. In Israel, a gradual shift from primary treatment to tertiary treatment was observed, with around 10% of wastewater undergoing primary treatment, 50% subject to secondary treatment and 40% to tertiary treatment in 2012. Jordan also experienced a drastic shift from primary to secondary wastewater treatment, with more than 90% of the wastewater treatment being subject to secondary treatment in 2010. The most significant change occurred between 2006 and 2007 when the WWTP Alkerbeh Al-Samra, which treats more than 50% of wastewater, was upgraded to perform biological treatment in addition to mechanical treatment. Tunisia reported that all WWTPs perform secondary treatment, while a few plants operate tertiary level of treatment. In Palestine, wastewater treatment facilities are restricted to a few localities only, due to the lack of adequate and appropriate infrastructure for wastewater collection and treatment. A marginal fraction (~5% to 6%) of the wastewater generated in the West Bank is being treated in centralised and collective WWTPs. The rest is discharged untreated into the environment. No information on the actual volume of treated wastewater and level of treatment is reported by Lebanon. However, data provided indicate that the nominal capacity of the operational WWTPs (97.46 million m³ or 267 000 m³/day) greatly exceeds the estimated annual volume of collected wastewater (~13.87 million m³).

In the last years, a number of inventories of municipal wastewater treatment facilities in Mediterranean countries have been published (UNEP/MAP/MED POL/WHO, 2004, 2011). These studies provided information on the population served by WWTPs, the degree of treatment provided, quantities of wastewater produced and disposal alternatives. The most recent inventory (UNEP/MAP/MED POL/WHO, 2011) also considered a number of cities with a population over 2000 inhabitants that discharge their municipal wastewater (treated or untreated) into major rivers and thus indirectly contributing to the pollution of the marine environment. Analysis of the information collected for the 2011 inventory of WWTPs showed that a significant volume of wastewater (over 1 million m³ per day) remains untreated in the ENP South countries, as compared to 2.8 million m³ per day for the whole region. However, it should be noted that the information provided on the volume of wastewater discharged untreated was limited, and therefore these figures are only indicative. An overview of the number and type of WWTPs showed that the proportion of WWTPs that were out of order was much higher in ENP South countries (58 out of 393 WWTPs, i.e. 15%) as compared to the overall region (72 out of 1555 WWTPs, i.e. 5%). In other words, 80% (58 of 72) of all WWTPs reported to be out of order were located in ENP South countries.

The type of discharge/disposal determines the fate of treated and untreated wastewater and its impact on the environment. Untreated wastewater is a main source of nutrients in receiving inland, coastal and marine waters. Nutrient enrichment in the southern shores of the Mediterranean basin deserves special attention, particularly in areas where wastewater treatment facilities are largely lacking (Fig. 7).
4.2.3. Nutrient concentrations in transitional, coastal and marine waters

The main source of data for Indicator 5 on nutrient concentrations in transitional, coastal and marine waters was the Mediterranean Marine Pollution Assessment and Control Programme (MED POL) programme of UNEP/MAP. MED POL, established in 1975 as the first operational programme of UNEP/MAP, receives and collects data on nutrients from various countries, though not on a regular basis. This monitoring programme focuses on hotspot locations as most of the stations are located near coastal wastewater effluents and treatment plants.

Analysis of the summer mean nutrient data reported by the ENP South countries over the time period 2003–2012 showed almost no variability in the total nitrogen data from Morocco and Egypt, with values around 35 μmol/L and 10 μmol/L, respectively. However, they were too few data points to form a time series (2006, 2007, 2009, and 2010, respectively) and therefore it was not possible to assess trends. The time series data from Tunisia showed significant variability and a clear peak between 2005 and 2010 (Fig. 8). This can be attributed to a variety of reasons and definitely calls for further examination. The high concentrations recorded during the period 2007–2010 were found in the stations in the Gulf of Tunis and Bizerte. Data from Israel formed a time series with low variability, although a clear, linearly increasing trend was observed after 2007 (Fig. 8). The increase from 2007 to 2011 was approximately 0.7 μmol/L per year.

Total phosphorus concentrations range from 1 to 9 μmol/L and from 1 to 3 μmol/L in Morocco and Egypt, respectively. Similar to total nitrogen, data for total phosphorus from Morocco and Egypt were too few to form a time series (2006, 2007, 2009, and 2012, respectively) and were therefore not assessed in detail. As in the case for total nitrogen, total phosphorus in Tunisian stations CHOU, S3A and to a lesser degree B3 were found to be substantially high, reaching 120 μmol/L during 2006 and 2008. For the rest of the stations, concentrations were more or less stable, with values ranging from 4 μmol/L to 10 μmol/L, depending on the station (Fig. 9). Israel reported orthophosphate (o-PO₄) data instead of total phosphorus. Data from Israel showed a steady and continuous decrease in o-PO₄ values, going from 0.8 μmol/L to 0.08 μmol/L from 2004 to 2012 (a decreasing trend of 0.09 μmol/L per year) (Fig. 9).
At this stage, a comprehensive regional eutrophication assessment is not possible due to the following main reasons: a) the location of stations may differ substantially from one country to another; in one case, stations may all be location next to an effluent, whereas in other cases they may cover a larger area, b) bathymetry may substantially differ from one case to another and c) thresholds and targets for nutrients in coastal and offshore areas are not yet established for the Mediterranean Sea. These targets are currently being defined in the framework of EcAp, and H2020 Indicator 5 should be aligned with EcAp indicator agreed under the ecological objective related to eutrophication (Ecological objective 5 — Human-induced eutrophication is prevented, especially adverse effects thereof, such as losses in biodiversity, ecosystem degradation, harmful algal blooms and oxygen deficiency in bottom waters). Within the framework of EcAp implementation, UNEP/MAP will also undertake an adjustment in the monitoring programme to expand its geographical scope to non-hotspot locations and open seas and to enlarge the number of related parameters, such as chlorophyll-a and dissolved oxygen. This will allow for a better regional eutrophication assessment in the near-future.

4.3. Priority area: industrial emissions

Industrial emissions to air and water are generated on a wide scale along the Mediterranean coastline. In fact, industrial pollution is one of the major environmental pressures addressed by the LBS Protocol of the Barcelona Convention and its related policy and regulatory framework both at the regional and national level, including the Strategic Action Programme (SAP MED) and the National Action Plans (NAPs) to combat pollution from land-based sources and activities. All Mediterranean countries have put in place a marine pollution monitoring and reporting system from industrial sources in the framework of UNEP/MAP and other EU policy frameworks. A pollutant inventory to the UNEP/MAP Secretariat, the National Baseline Budget (NBB), takes place every two and five years. Two inventories (2003 and 2008) are available and a third one is currently underway. The NBB 2003 database was populated by 21 countries and included emissions for 75 different pollutants, with a total of 7509 records. The NBB 2008 database contained a total of 12560 records for 103 substances from 19 countries.

For the purpose of H2020 assessment, Indicator 6 on industrial emissions was based on the NBB 2003 and 2008 databases. A subset of the NBB substances was considered under Indicator 6, including BOD5, cadmium (gas), chromium (gas), chromium (liq), lead (gas), lead (liq), mercury (gas), PAH (gas), total nitrogen and total phosphorus (Table 7). Although the NBB covers the whole Mediterranean Sea, for the purpose of H2020 the focus was on ENP South countries.

The selection of pollutants was based on the following four criteria:

a. Legal/regulatory context (supported by relevant strong policy and legal framework: UNEP/MAP Barcelona Convention/LBS Protocol, SAP MED, regional plans, UfM and H2020, UNEP/GPA and global conventions);

b. Representativeness (the most representative group of contaminants at the regional level in terms of data availability and reported by a considerable number of Mediterranean countries);

c. Availability of reporting tools and dataflow available (inventory system in place through NBB and Pollutant Release and Transfer Register (PRTR) tools that guarantee a further improvement of the data generated and collected, and therefore, a sustainable reporting system);

d. Data availability (existing data series from 2003 and 2008 per source, administrative region and at national level).

Each pollutant may originate from different industrial activities, whereas a particular activity and/or industrial sector may result in the emission of one or more pollutant, depending on the country and the year (Table 8). The main pollutants from industrial emissions are nutrients and oxygen-depleting substances, VOCs and specific heavy metals. Although it is not possible to assess long-term trends based on two data sets, a number of insightful observations can be drawn on the main industrial sectors and substances contribution to industrial pollution in the ENP South countries.

Fig. 10 shows the % emission loads for nutrients and oxygen-depleting substances for 2003 and 2008 in the ENP South countries.

Based on the available data, the main sources of BOD5 were the...
manufacture of refined petroleum products, followed by food packing. Farming of animals was an important source of total nitrogen emissions, particularly in 2008. However, the treatment of urban wastewater also contributed to the total nitrogen emissions. The main contributing sectors for total phosphorus were the manufacture of fertilisers and farming of animals. From 2003 to 2008 a significant decrease of total phosphorus emissions from the manufacture of fertilisers was observed in ENP South countries, causing also a decrease in the whole

Table 8
Overview of substances emitted by sector (2003 and 2008).

<table>
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<th>Sector</th>
<th>Substance</th>
<th>BOD 5 (gas)</th>
<th>Cd (gas)</th>
<th>Cr (gas)</th>
<th>Cr (liq)</th>
<th>Pb (gas)</th>
<th>Pb (liq)</th>
<th>Hg (gas)</th>
<th>PAH (gas)</th>
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Note: X= 2003; X= 2008
Mediterranean. On the contrary, the contribution of farming of animals has increased from 2003 to 2008.

The interpretation of total suspended solids (TSS) data was hampered by the inconsistencies in the reported sectors in 2003 and 2008. No data for the treatment of urban wastewater in ENP South countries was reported in 2008, whereas in 2003 this sector was identified as a major contributor. In general, the manufacture of paper and textile and food packing were identified as the main sectors emitting TSS.

A similar analysis of the heavy metal data (Fig. 11) revealed the main sectors contributing to the emissions of heavy metals (Pb, Hg, Cr and Cd) in the ENP South countries for the years 2003 and 2008. Although the contributing industrial sectors vary from one heavy metal to another, the following observations could be drawn: the manufacture of fertilisers was a significant source of Pb (liq) and Hg (liq); the manufacture of refined petroleum products emitted Cr, both in liquid and gaseous form; gaseous Pb and Hg were mainly emitted through the manufacturing of metals and cement; and the treatment of urban wastewater was responsible for the emission of Cd (liq).

The comparison of the 2003 and 2008 datasets led to the following observations:

- Cd (g) emissions from the manufacture of fertilisers in southern countries have drastically decreased from 2003 to 2008;
- Cd (g) emissions from the production of energy have increased at the Mediterranean level while they have remained the same in the ENP South countries;

![Fig. 10. Loads of emissions (%) for nutrients and oxygen-depleting substances per sector in ENP South countries. Source: UNEP/MAP MED POL NBB database 2003, 2008.](image1)

![Fig. 11. Loads of emissions (%) for heavy metals per sector in the ENP South countries. Source: UNEP/MAP MED POL NBB database 2003, 2008.](image2)

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of information requirements, different reporting approaches, data collection and exchange within and between the countries.

The review mechanism provided some answers to the overarching question “What is the progress in depolluting the Mediterranean?” for each of the three H2020 priority areas. Unlike previous regional environmental assessments (e.g. EEA/UNEP-MAP, 2006), this assessment was based on a set of coherent indicators developed together with the partner countries following the principles of SEIS and used as a way to set up a long term reporting mechanism for future assessments. The key messages per priority area are summarised below.

6. Municipal waste

Based on the indicator assessment, the generation of municipal solid waste in the ENP South countries is on the increase (+15% over the last 10 years), mostly due to population and economic growth. Although the situation varies widely from country to country and more particularly from one local area to the next, the generation of municipal solid waste in ENP South countries is still half that produced in European countries. Despite important improvements in the last decade, the collection and treatment of municipal solid waste is a significant issue in most ENP South countries. With national collection rates at around 76%, only few countries succeed in reaching full waste collection coverage, especially in rural areas. In recent years, major efforts took place to decommission unregulated dumps and to open controlled, sanitary landfills. Yet, the management of municipal solid waste in most ENP South countries still relies almost exclusively on disposal in open dumps (58% of the collected waste) as opposed to disposal in sanitary landfills (31%). The share of recycling and composting represents less than 10% of the total collected amount. However, with the development of more integrated waste management policies, countries have reported an increasing number of waste sorting initiatives that promote recycling and reuse.

7. Water

Steady progress in access to improved sanitation services has been achieved since 2003 in all the ENP South countries. In 2011, 92% of the population in the ENP South countries had access to improved sanitation as compared to 87.5% in 2003, in large part made possible by investments from regional and international cooperation. However, it is estimated that 11.5 million out of the 17.6 million inhabitants without access to sanitation systems are concentrated in coastal areas. Therefore, access to sanitation systems still deserves attention in certain areas. Due to the migration from rural to urban areas and the emergence of urban poverty ‘pockets’, the inequities between urban and rural areas are still significant. More than 5.5 million people living in urban areas and 12 million in rural areas were deprived of access to improved sanitation systems in 2011.

The progress in municipal wastewater management is more difficult to assess as the data available do not provide sound evidence or trends at the regional level. In general terms, an increase in the volume of wastewater collected and treated was observed in those countries for which data is available. This increase did not only cover the concurrent population growth but also contributed to the relative improvement of the wastewater management practices in the region. However, it was not possible to confirm whether these trends are the result of increased data coverage, the result of heavy investments in wastewater treatment contributing towards social and economic development or a combination of both. Although local improvements have been observed, it is difficult to assess the progress at the regional scale. There is strong indication that the inhabitants and environment in coastal hydrological basins draining into the marine environment are the most severely impacted by the lack of appropriate sanitation systems and wastewater infrastructure, possibly resulting in the eutrophication of coastal hotspots subject to the discharge of untreated wastewater. Nutrient
concentrations have been assessed using data already reported by the countries to the MED POL programme of UNEP/MAP. The nutrient dataset presented a number of limitations in producing a regional assessment on eutrophication. One of the reasons is that the national monitoring programmes are not streamlined; some countries focus on hotspot locations close to effluents, others cover a broader area. Moreover, not all countries have reported the same data on a regular basis. The monitoring programme is currently being revised by UNEP/MAP in the framework of ECAP Ecological Objective 5 on eutrophication.

8. Industrial emissions

As for nutrient concentrations, industrial emissions have also been assessed using data reported by the countries as part of the MED POL programme. The analysis confirmed that pressures from land-based sources remain high and that attention needs to be given to the following key sectors: the production of energy, manufacture of refined petroleum products, treatment of urban wastewater, food packing, manufacture of cement and metals. The existence of only two reporting years (2003 and 2008) did not allow for thorough assessment of trends and precise conclusions, highlighting the importance of regular pollutant reporting. Yearly reporting of pollutants to UNEP/MED POL including the establishment of a PRTR would be worthwhile investments for establishing a sustainable dataflow for reporting purposes, assessing the trends in pollution reduction and measuring the effectiveness of measures taken.

This assessment highlighted the progress in depollution in the region and identified the issues that deserve more attention in the next phase of H2020 (2014–2020). These priorities will be implemented together with the other two subgroups of H2020 (Pollution Reduction and Capacity Building), in synergy with other ongoing initiatives, such as UNEP/MAP-Barcelona Convention and other activities of the UfM aimed at protecting the Mediterranean marine environment.

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