



NATIONAL GUIDANCE FOR PLASTIC POLLUTION HOTSPOTTING AND SHAPING ACTION

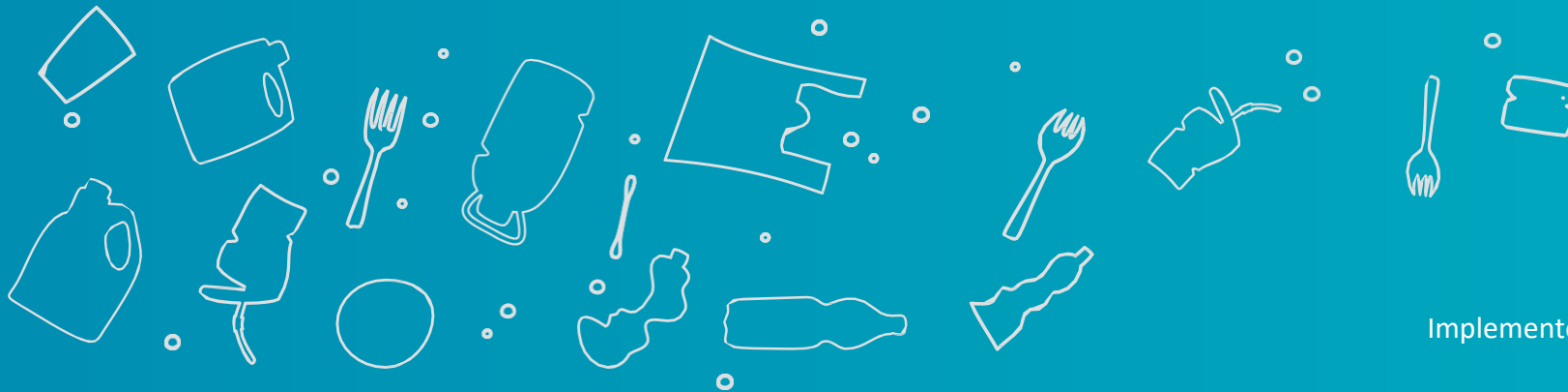


MODULE

T6

Assessing Impacts

September
2020



Implemented with



NATIONAL GUIDANCE FOR PLASTIC POLLUTION HOTSPOTTING AND SHAPING ACTION

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HOW TO READ THIS DOCUMENT



MODULE

Modules are the instruction for the tools. Each module is composed of one or several tools. Technical modules focus on generating hotspot information by the technical team. Strategic modules focus on generating interventions and instruments by involving a wider group of stakeholders.



TECHNICAL MODULE



STRATEGIC MODULE



TOOL REFERENCE

Tools are the building blocks of the guidance. Tools are of three categories: input tools (for data collection), assessment tools (to generate the hotspots, interventions and instruments) and output tools (to provide summarised information and shareable data repository).



INPUT TOOL



ASSESSMENT TOOL



OUTPUT TOOL

White background

WORKFLOW SLIDE

Describes key stages and main actions to run the module and associated tools.

Grey background

SUPPORTING INFORMATION

Provides supporting information, references of background data.

Blue background

DEFINITIONS AND DESCRIPTIONS

Provides key definitions and high level objectives of the modules and tools.



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OBJECTIVE OF THE MODULE

This module aims at identifying plastic applications (or products) that may have critical environmental impacts within the marine ecosystem. Indeed, if module T3 yields a quantitative and state-of-the-art tool to assess plastic leakage from different applications (“inventory” stage in LCA jargon). These leakage quantities (expressed in mass) may not directly correlate with their environmental impacts as some applications may be more or less bio-available and/or harmful to wildlife and ecosystems than others.

DISCLAIMER ON IMPACT ASSESSMENT

There is currently (status sept. 2020) no available method for performing quantitative assessment of the environmental impacts of plastics in the environment and more specifically in oceans. LCIA (Life Cycle Impact Assessment) methods are currently not developed and do not allow access to end-points impact metrics for leaked plastics, such as damage on human health or damage on ecosystem quality. The reader can refer to the MariLCA project to access the latest science on this topic (<https://marilca.org>).

Module T6 provides a novel semi-quantitative impact assessment method to rank the potential impacts of leaked plastic applications. The approach leaves room for interpretation as the different criteria can be weighted in various ways when performing the scoring. It is highly encouraged that this scoring result from a group process (based on a specific workshop where key stakeholders are conveyed), rather than as an individual desktop work.

SPECIFICITY OF THE T6 MODULE

The approach we propose here is thus a semi-quantitative proxy of impact assessment, but mimicking the classical impact assessment pathway with fate, exposure and effect stages.

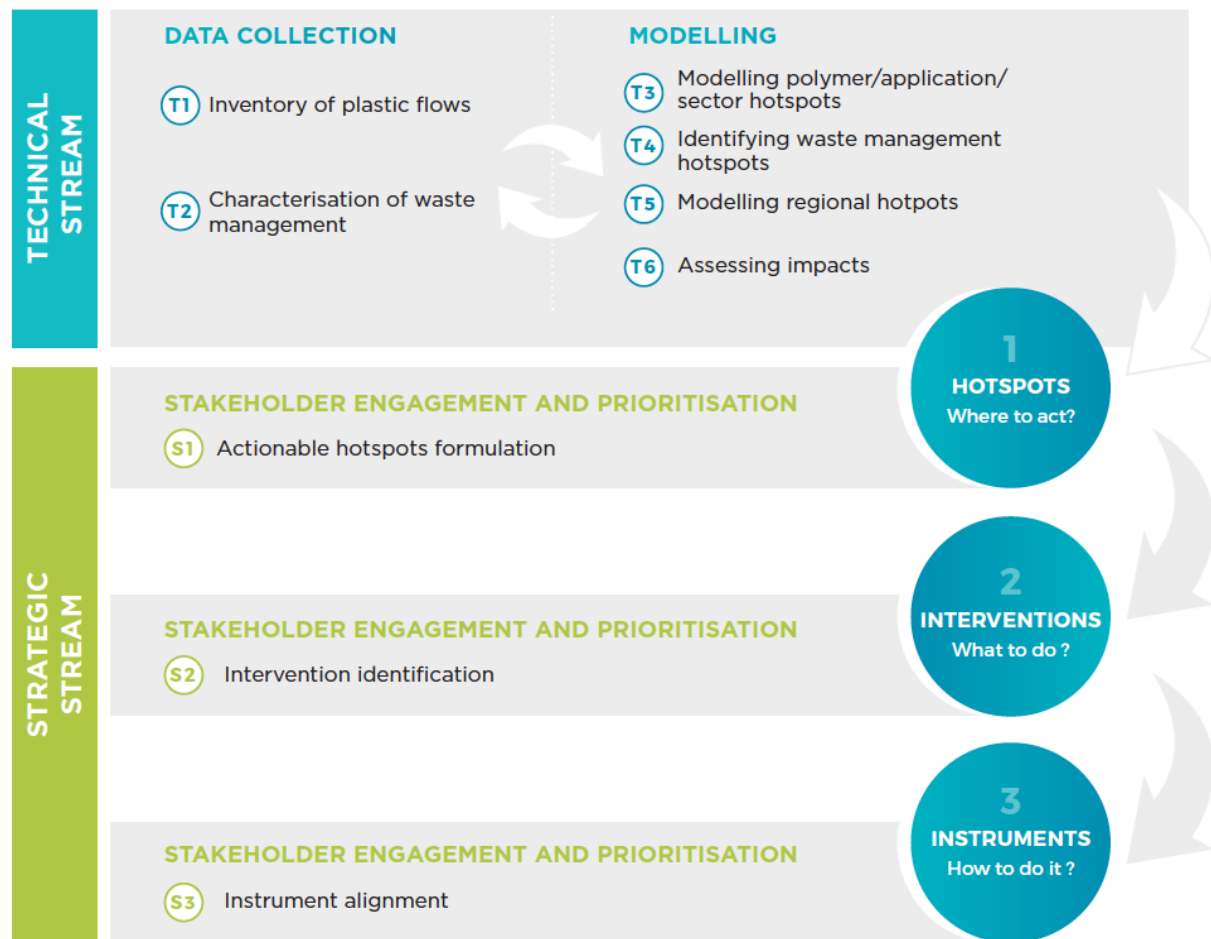
This semi-quantitative process includes 5 parameters that need to be characterised with qualitative or quantitative assessments, thus yielding a scoring system.

The value of this approach allows also to include in the hotspotting process some bottom-up data gathered during field studies and beach clean-ups in the country. These data complement the rest of the hotspotting process mainly based on top-down modelling using socio-economic data. In other words, an application that is commonly found on beached will display higher chances to end-up being tagged as a hotspot. This approach allows to encompass some elements that would otherwise not show up in the hotspotting process if only relying on a mass balance approach.

Note that the assessment performed through this tool is “per application unit”, meaning that it is not weighted by the quantity of plastic leaking from this application.

OUTPUT OF THE T6 MODULE

The output of this module is a short list of applications that will then be flagged in the application hotspots graph (from tool T3.4 in module T3) as potentially harmful to the marine ecosystem.



RELATIONSHIP OF MODULE T6 WITH OTHER MODULES

Module T6 is part of the technical work stream. The result of this module is the identification of the plastic with the most critical impact on the environment.

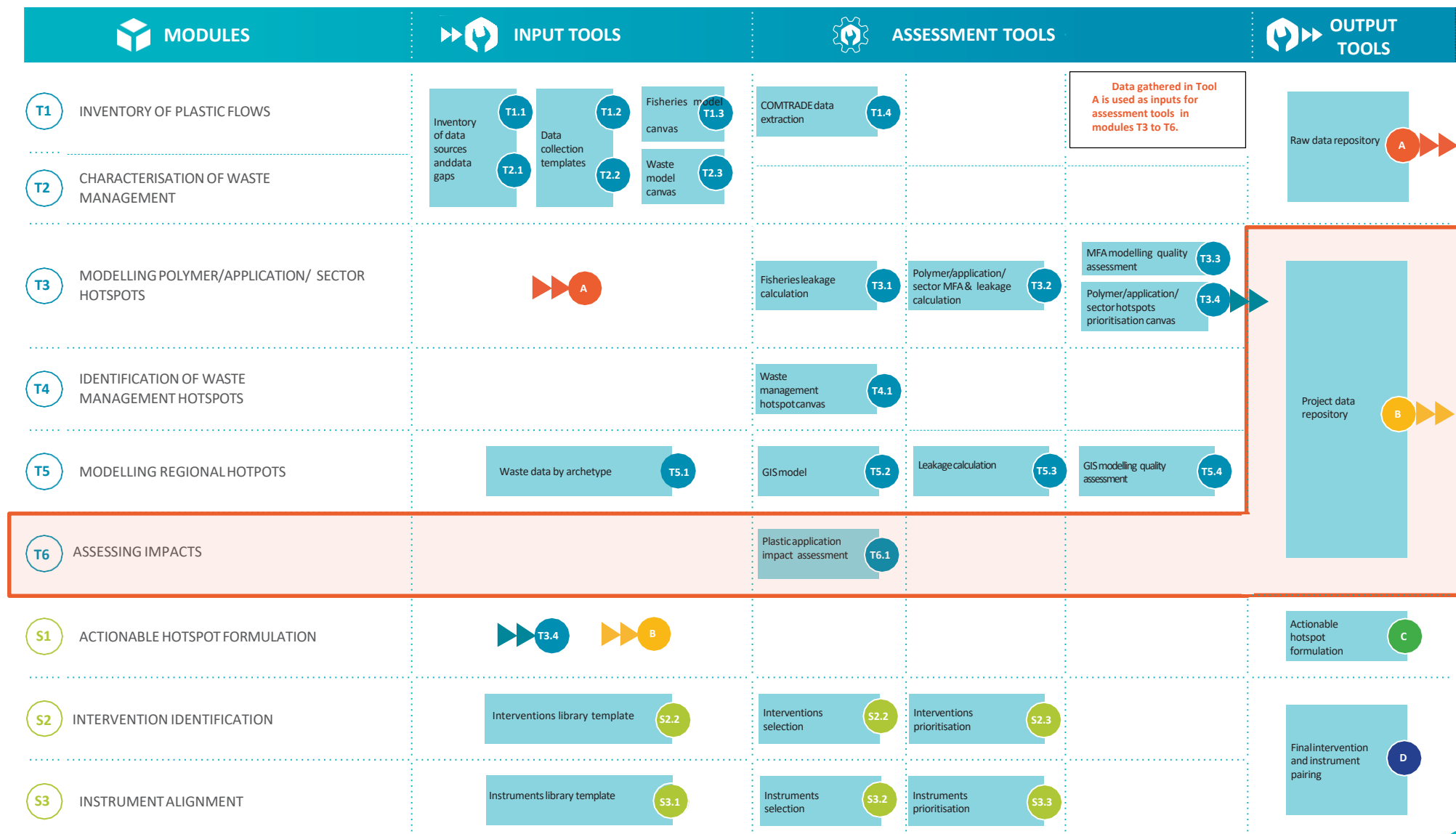
Module T6 uses data on beach clean-ups compiled in the “raw data repository” (tool A) of modules T1 and T2. Otherwise, it relies on the worldwide data on beach clean-ups taken from the Ocean Conservancy reports¹.

¹ Ocean Conservancy (2019), the beach and beyond – cleanup report

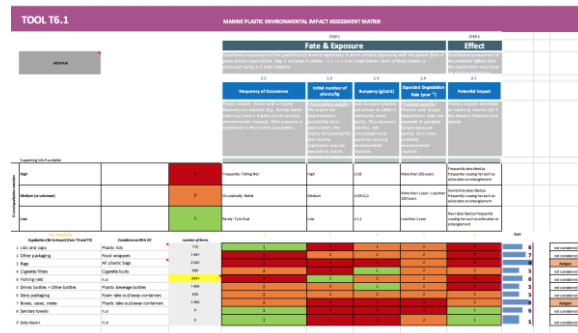


T6

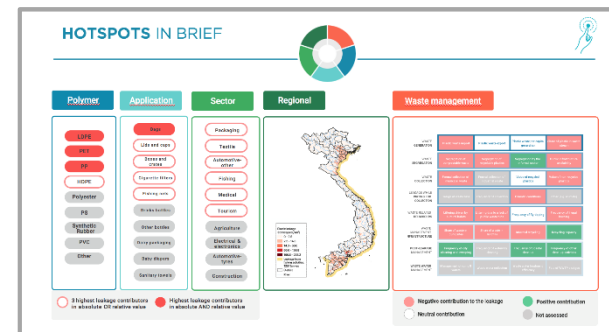
TOOLS ASSOCIATED WITH MODULE T6



T6



Generate a list of applications with critical environmental impact on the marine ecosystem.



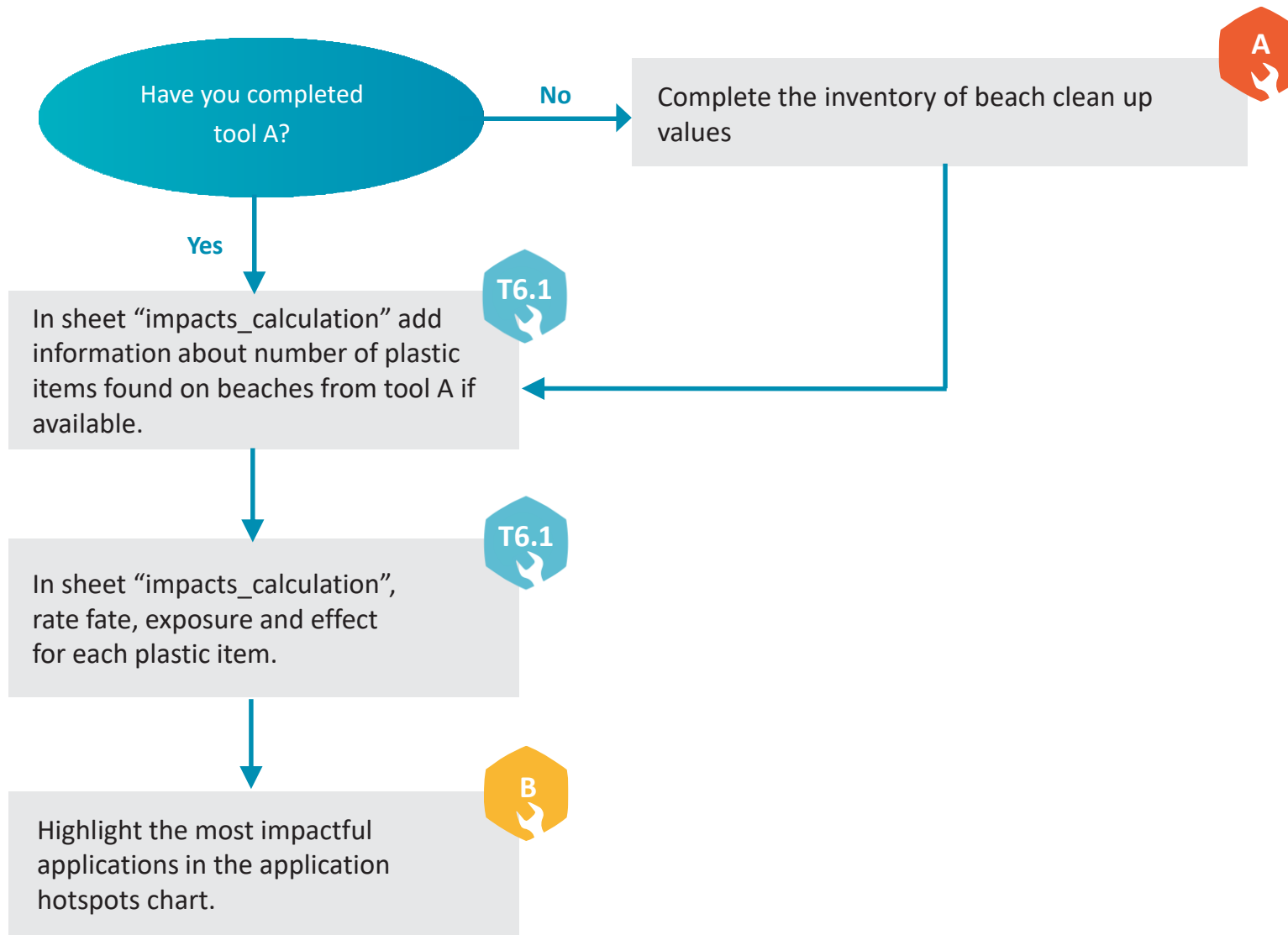
Canvas in PowerPoint to recap all hotspots.

NATIONAL GUIDANCE FOR PLASTIC POLLUTION HOTSPOTTING AND SHAPING ACTION



T6

HOW TO USE THIS MODULE?





TOOL

T6.1

Plastic application impact assessment



HOW TO USE THIS TOOL ?

Go to the sheet “impacts_calculation” in tool T6.1. First, fill the number of items found during beach clean-ups in the country **(1)** (use either inputs from tool A or by default values from the sheet “Ocean_Conservancy_database”). Then rate the levels of fate & exposure **(2)** and effect **(3)**. “Fate & exposure” are the assessment of the probability of marine organisms to be in contact (exposure) with the plastic from a given item, while “Effect” is the qualitative assessment of the potential harm that the application may have on marine organisms.

The fate & exposure stage includes the following criteria: *frequency of occurrence*, *fragmentation potential (number of pieces/kg)*, *buoyancy (g/cm3)* and *degradation rate (year-1)*. The unique criterion to assess the effect stage is the *potential impact* of specific items on marine wild life (i.e. the propensity of a plastic object to cause harm such as suffocation or entanglement). Each criterion is scored based on a scale of 3 (1 = low, 2 = medium and 3 = high). Detailed information on all criteria are provided in the supporting information slides.

Eventually, the tool sums up all criteria scores and highlights as hotspots the applications included in the top 20% items with highest impact scores **(4)**.

The “impact hotspots” are then transferred to tool B where the corresponding applications are tagged in the “application hotspot” chart as harmful to wildlife.

(2) **(3)**

STEP 1 Fate & Exposure					STEP 2 Effect				
Qualitative assessment of the probability of marine organisms to be in contact (exposure) with the plastic from a given plastic application. Step 1 includes 4 criteria : 1.1 → 1.4 as listed below. Each of these criteria is assessed using a 3 level notation.					Qualitative assessment of the potential effects that the application may have on marine organisms. Includes 1				
1.1	1.2	1.3	1.4	2.1					
Frequency of Occurrence	Initial number of pieces/kg	Buoyancy (g/cm3)	Expected Degradation Rate (year ⁻¹)	Potential Impact					
Plastic objects found with a higher frequency on beaches (e.g. during beach clean-up) have a higher risk of causing environmental impacts. Their presence is ascertained in the marine ecosystems.	(Application specific) The higher the fragmentation possibility of an application, the higher the probability that marine organisms may be exposed to plastic debris	Less buoyant plastics are known to settle in sediments more easily. Thus buoyant plastics, are considered more prone to causing environmental impacts.	(Polymer specific) Plastics with longer degradation rates are expected to generate longer exposure period, thus more potential environmental impacts.	Plastics objects described as harming marine life in the relevant literature and reports					
Supporting info if available									
High		3	Frequently: Fishing Net	High	≤ 0,9	More than 100 years	Frequently described as frequently causing har such as suffocation or entanglement		
Medium (or unknown)		2	Occasionally: Bottle	Medium	≥ 0,9 ≤ 1,1	More than 1 year ; Less than 100 years	Sometimes described as frequently causing har such as suffocation or entanglement		
Low		1	Rarely: Tyre Dust	Low	≥ 1,1	Less than 1 year	Never described as frequently causing har such as suffocation or entanglement		
User Weighting					1	1	1	1	Sum
Application (list to import from T3 and T4)		Considered as XX in OC	number of Items	1	1	1	1		
1 Lids and caps	Plastic lids	112	1	3	2	2	3	6	not considered
2 Other packaging	Food wrappers	1 461	3	2	2	2	3	7	not considered
3 Bags	All plastic bags	2 325	3	3	2	3	9	9	hotspot
4 Cigarette butts	Cigarette butts	999	2	3	1	2	2	5	not considered

(1) **(4)**



SUPPORTING INFORMATION FOR TOOL T6.1

HOW IMPACT ASSESSMENT CRITERIA ARE DEFINED AND WHAT ARE THEIR ASSOCIATED IMPACT LEVELS?

- **Frequency of occurrence:** Plastic objects found with a higher frequency on beaches (e.g. during beach clean-up) have a higher risk of causing environmental impacts. Their presence in the marine ecosystems is thus ascertained. (see *table 1* for impact levels)
- **Fragmentation potential:** The higher the fragmentation potential of an application (or plastic item), the higher the probability that marine organisms may be exposed to plastic debris. It is estimated based on the initial number of pieces / kg. (see *table 1* for impact levels)
- **Buoyancy:** Less buoyant plastics are known to settle in sediments more easily. Thus buoyant plastics, are considered more prone to causing environmental impacts as their particles remain in suspension in the water column. Buoyancy is measured in g/cm³. (see *table 1* for impact levels).
- **Expected degradation rate:** Plastics with longer degradation rates (in year⁻¹) are expected to generate longer exposure period for marine organisms, thus potentially causing more environmental impacts. (see *table 1* for impact levels)
- **Potential impact:** Plastic objects described as harming marine life in the relevant literature and reports, for instance with risks of suffocation and entanglement. (see *table 1* for impact levels)

Fate & exposure

Effect

Supporting info if available			Frequency of Occurrence	Initial number of pieces/kg	Buoyancy (g/cm ³)	Expected Degradation Rate (year ⁻¹)	Potential impact
3 Level qualitative notation	High	3	Frequently: Fishing Net	High	≤ 0,9	More than 100 years	Frequently described as frequently causing harm such as suffocation or entanglement
	Medium (or unknown)	2	Occasionally: Bottle	Medium	≥ 0,9 ≤ 1,1	More than 1 year ; Less than 100 years	Sometimes described as frequently causing harm such as suffocation or entanglement
	Low	1	Rarely: Tyre Dust	Low	≥ 1,1	Less than 1 year	Never described as frequently causing harm such as suffocation or entanglement

Table 1



SUPPORTING INFORMATION FOR TOOL T6.1

WHAT VALUES ARE USED TO ASSESS IMPACT CRITERIA?

The number of items found on beaches allows to estimate the frequency of occurrence of specific plastic objects in the marine environment. These values can come from tool A (module T1 & T2) if the user found specific beach clean up reports for the country, or be taken from the global Ocean Conservancy database provided in sheet “Ocean_Conservancy_database” (see figure A). This database should be updated for the year of study.

ITEM	COUNT	DATE	LOCATION	ASSESSMENT CRITERIA
PLASTIC BOTTLE	100	2020	BEACH 1	...
PLASTIC BAG	50	2020	BEACH 2	...
...	...	...	...	...

Figure A

The evaluation of impact assessment criteria is based on a diverse sources including database compiled for the PLP project1 and provided in the sheet “PLP_All_values_found” (source [Plastic Leak Project](#)). This sheet provides an extensive list of studies on plastic products and their associated exposure time and biodegradation rates in different environmental compartments (see Figure B). Other sources and justifications for the choice of criteria level for generic plastic applications and polymers are provided in sheet “Assumptions”.

PRODUCT NAME	EXPOSURE TIME	BIODEGRADATION RATE	ASSESSMENT CRITERIA
PLASTIC BOTTLE	100	2020	...
PLASTIC BAG	50	2020	...
...	...	...	...

Figure B



SUPPORTING INFORMATION FOR TOOL T6.1

TYPICAL SHORELINE OCCURRENCE OF KEY PLASTIC APPLICATIONS

TABLE 3

Merged National Datasets: The Top 20 Products in Shoreline Data

Plastic Product	ICC	NOAA	MOT	Heal the Bay	COA	Project Aware	Total	Percent
Food Wrappers (candy, chips, etc.)	318,880.0	272.0	16,315.0	307.0	14,827.0	217.0	350,818.0	18.6
Bottle Caps (Plastic)	273,089.0	779.0	11,735.0	27,352.0	2,328.0	205.1	315,488.1	16.7
Beverage Bottles (Plastic)	206,993.0	122.0	7,809.0	6,297.0	5,508.0	289.0	227,018.0	12.0
Bags (Plastic)	157,702.0	39.0	6,970.0	5,249.0	7,871.0	313.0	178,144.0	9.4
Straws, Stirrers	125,635.0	172.0	4,645.0	4,026.0	8,102.0	165.0	142,745.0	7.5
Lids (Plastic)	75,921.0	186.9	409.0	5,829.5	15,347.0	57.9	97,751.2	5.1
Utensils	42,599.0	33.0	1,848.0	47,133.0	1,864.0	352.0	93,829.0	4.9
Cigarette Butts*	51,550.5	25.3	2,337.9	6,775.9	643.0	9.1	61,341.7	3.2
Take Out/Away Containers (Foam)	41,805.0	102.9	537.7	17,696.0	548.0	8.3	60,697.8	3.2
Take Out/Away Containers (Plastic)	49,973.0	123.0	37.0	5,624.0	1,021.7	9.9	56,788.6	3.0
Cups, Plates (Plastic)	48,559.0	14.6	732.6	1,862.2	1,766.0	9.6	52,943.9	2.8
Cigar Tips	41,211.0	47.0	328.0	6,243.0	2,351.0	16.0	50,196.0	2.6
Cups, Plates (Foam)	42,047.0	12.4	4,495.7	690.0	2,021.0	8.3	49,274.5	2.6
Tobacco Packaging/Wrap	33,434.0	82.3	604.5	352.0	694.0	19.0	35,185.8	1.8
Balloons	23,492.0	19.0	1,442.0	5,263.0	480.3	13.0	30,709.3	1.6
Other Plastic Bottles	17,548.0	62.0	1,578.0	4,769.6	1,429.0	9.0	25,395.6	1.3
Cigarette Lighters	10,750.0	24.0	676.5	10,750.0	405.0	3.0	22,608.5	1.2
Personal Care Products (Condoms & Tampon Applicators)	11,555.0	37.4	827.5	2,213.2	1,875.1	14.0	16,522.2	0.8
6-Pack Holders	8,224.0	3.0	180.0	641.0	130.0	10.0	9,188.0	0.4
Diapers	3,938.0	12.5	276.8	2,150.6	82.0	7.0	6,466.9	0.3
Total	1,584,905.5	2,169.3	63,785.2	161,223.9	69,293.0	1,735.1	1,883,112.0	100

* Counts of cigarette butts were divided by 20 to represent packs rather than individual cigarettes.





SUPPORTING INFORMATION FOR TOOL T6.1

TYPICAL DENSITY OF POLYMERS (INFLUENCING EXPECTED BUOYANCY)

Polymer	Abbreviation				Common applications
		Density			
		g/cm3			
		low	median	high	
Polyethylene	PE	0.926	0.933	0.94	Plastic bags, storage containers
High-Density Polyethylene	HDPE	0.915	0.92	0.925	Containers for milk, motor oils, shampoo and conditioners, detergents, bleaches
Low-Density Polyethylene	LDPE	0.94	0.955	0.97	Lunch boxes, plastic bottle caps, yoghurt pots
Polypropylene	PP	0.855	0.9005	0.946	Rope, bottle caps, gear, strapping
Polystyrene	PS	0.96	1	1.04	Utensils, containers
Polyvinylchloride	PVC	1.1	1.275	1.45	Film pipes, containers, housing
Polyamide (Nylon)	PA	1.13	1.315	1.5	Fishing nets, rope, clothing, carpet fibre

Source:

Cincinelli, Alessandra, Tania Martellini, Cristiana Guerranti, Costanza Scopetani, David Chelazzi, et Tommaso Giarrizzo. « A potpourri of microplastics in the sea surface and water column of the Mediterranean Sea ». *TrAC Trends in Analytical Chemistry* 110 (1 janvier 2019): 321-26. <https://doi.org/10.1016/j.trac.2018.10.026>.



SUPPORTING INFORMATION FOR TOOL T6.1

TYPICAL DEGRADATION RATES OF POLYMERS

Table 12: Conventional degradation rates of different categories of plastic and plastic applications.

Sources: ⁽¹⁾ MOTE Marine Laboratory Marine Debris Biodegradation time line, 1993. ⁽²⁾ BIOTEC Environmental, 2019.

Common plastic object	Reference polymer	Degradation time (years)
Cigarette filter	Cellulose acetate	1-5 ⁽¹⁾
Plastic bag	Polyethylene	10-20 ⁽¹⁾
Marine buoy	Styrofoam	80 ⁽¹⁾
Plastic bottle	Polyethylene terephthalate	450 ⁽¹⁾
Fishing line	Nylon	600 ⁽²⁾
Building insulation	Extruded polystyrene foam	5,000 ⁽²⁾

More detailed degradation rates data base is provided within Tool T6.1 ; provided in the sheet “PLP_All_values_found” (source: [Plastic Leak Project](#)).



SUPPORTING INFORMATION FOR TOOL T6.1

TYPICAL HAZARD CLASSIFICATION OF POLYMERS

TABLE 2

Ranking of Some Plastic Polymer Types Based on Hazard Classification of Constituent Monomers

Polymer	Monomer(s)/additives	Relative hazard score	Recycling code	Constituents measured in NHANES?
Polymers with the highest relative hazard scores				
Polyurethane PUR as a flexible foam	Propylene oxide	13,844	6	
	Ethylene oxide			
	Toluene-diisocyanate			
Polyacrylamide PAN with co-monomers	Acrylonitrile	12,379	7	Acrylamide
	Acrylamide			
	Vinyl acetate			
Polyvinylchloride PVC, plasticised	With plasticizer	10,551	3	Benzyl butyl phthalate (BBP)
	Benzyl butyl phthalate (BBP) at 50 wt%			
Polyvinylchloride, PVC, unplasticised		10,001	3	
Polyurethane, PUR as a rigid foam	Propylene oxide	7,384	6	
	4,4'-methylenediphenyl diisocyanate (MDI)			
	Cyclopentane			
Epoxy resins DGEBA	Bisphenol A	7,139	7	Bisphenol A
	Epichlorohydrin			
	4,4'-methylenedianiline			
Modacrylic	Acrylonitrile	6,957		
	Vinylidene chloride			
Acrylonitrile-butadiene-styrene ABS	Styrene	6,552	7	Styrene
	Acrylonitrile			
	1,3 butadiene			
Styrene-acrylonitrile SAN	Styrene	2,788	7	Styrene
	Acrylonitrile			
High impact polystyrene HIPS	Styrene	1,628		Styrene
Polymers with the lowest relative hazard scores				
Low density polyethylene LDPE	Ethylene	11	4	
High density polyethylene HDPE	Ethylene	11	2	
Polyethylene terephthalate PET	Terephthalic acid	4	1	
Polyvinyl acetate PVA	Vinyl acetate	1		
Polypropylene PP	Propylene	1	5	

Of the thousands of additives used in the synthesis of plastic products, certain plastic types contain more additives than others. The table ranks polymer types based on hazard classifications.

NOTE: Relative hazard score derived from different constituent monomers. Higher ranking = greater hazard.

SOURCE: Adapted from Lithner et al. (2011).

3 level notation group

> 10

High hazard score

Medium hazard score

< 3

Low hazard score





SUPPORTING INFORMATION FOR TOOL T6.1

TYPICAL ADDITIVES IN PLASTICS AND POTENTIAL TOXICITY

TABLE 4

Common Toxic Chemical Additives to Plastic

Toxic Chemical Additive	Products in Which They Can Be Found	Health Impact
Acrylonitrile	Drinking cups, acrylic carpet and other textiles, plastic furniture, 3-D printing, automotive parts, and appliances.	Carcinogen
Bisphenol A	Polycarbonate plastics, plastic tableware, dental fillings, and lenses for glasses. BPA is also used to make epoxy resins that are used as coatings in lids of glass containers and in the linings of aluminum cans. BPA is also used to coat some thermal papers.	BPA is an endocrine disrupting chemical. Breast cancer, prostate cancer, endometriosis, heart disease, obesity, diabetes, altered immune system, and effects on reproduction have all been tied to BPA's ability to disrupt the normal functioning of endocrine systems. In young children, BPA exposures before and after birth are linked to changes in brain development and behavior.
Cadmium	Used as a colorant and stabilizer in plastic.	Lung cancer, endometrium, and bladder and breast cancer have been associated with cadmium. Cadmium can also damage the body's cardiovascular, renal, gastrointestinal, neurological, reproductive, and respiratory systems.
Flame retardants	Plastic-based home furnishings (foam, upholstery, curtains and blinds) and electronics (computers, laptops, phones, televisions, and household appliances).	Some flame retardants are endocrine disrupting chemicals. Studies have also linked flame retardants to thyroid disruption, impacts on fertility and the functioning of the immune system, and harm to the development of babies' brain and nervous systems both before and after birth. Several flame retardants are banned from production or use under the Stockholm Convention because they pose an unmanageable threat to human health and the environment.
Lead	Lead is used as plastic stabilizers and has been found in plastic jewelry, ¹ vinyl raingear, ² lunchboxes, ³ and vinyl window blinds.	In children, lead can cause reduced growth both before and after birth, decreased IQ and increased attention deficit and problem behaviors. In adults, lead exposures are linked to decreased kidney function and increased risk of hypertension, nerve disorders, and memory problems. ⁴ There is no safe level of exposure to lead.
Perfluorinated Substances (PFAS)	Grease and stain repellent in plastic-based fabrics used for raingear, upholstery, and carpeting, and as a plastic coating on cookware.	PFOA and PFOS are linked to human diseases including pregnancy complications, low birth weight, testicular and kidney cancer, and thyroid problems. The Stockholm Convention POPRC recommended not using any of the fluorinated alternatives to PFOA and PFOS, "due to their persistency and mobility as well as potential negative environmental, health, and socioeconomic impacts."
Phthalates	Plasticizer used to make plastic soft and pliable.	Phthalates are endocrine disruptors. They harm the reproductive and nervous systems, especially in children before and after birth. Deformities of the penis and learning and behavior problems are all associated with phthalates exposure. ⁵ Studies have also shown that the higher the levels of phthalates are in a home, the more likely children in that home are to have asthma or other respiratory conditions. ⁶
Styrene (also known as Vinyl Benzene)	Polystyrene plastics and expanded polystyrene.	Carcinogen
Vinyl Chloride	PVC: plastic furniture, carpet backing, packaging or wall covering.	Liver cancer
SCCP	Plastic consumer product, children's products.	SCCPs adversely affect the kidney, liver, and thyroid, disrupt endocrine function, and are believed to be human carcinogens. ⁷

1 Center for Environmental Health, Jewelry Brands with High Levels of Lead, <https://www.ceh.org/campaigns/legal-action/previous-work/fashion-accessories/lead-in-jewelry/jewelry-brands-with-high-levels-of-lead>.

2 Center for Environmental Health, Lead in Children's Raingear, <https://www.ceh.org/campaigns/legal-action/previous-work/childrens-products/lead-in-childrens-raingear>.

3 Center for Environmental Health, Lead in Lunchboxes, <https://www.ceh.org/campaigns/legal-action/previous-work/childrens-products/lead-in-lunchboxes>.

4 National Institute of Environmental Health Sciences, Lead (October 12, 2018), <https://www.niehs.nih.gov/health/topics/agents/lead/index.cfm>.

5 Coalition for Safer Food Processing and Packaging, The Everywhere Chemicals in Your Food, <http://www.kleanupkraft.org/#info>.

6 Center for Health, Environment & Justice, PVC, the Poison Plastic Unhealthy for our Nation's Children and Schools, http://www.chej.org/pvcfactsheets/The_Poison_Plastic.html.

7 UNEP/POPS/POPRC.11/Q/Add.2 Risk profile on short-chained chlorinated paraffins Nov. 2015





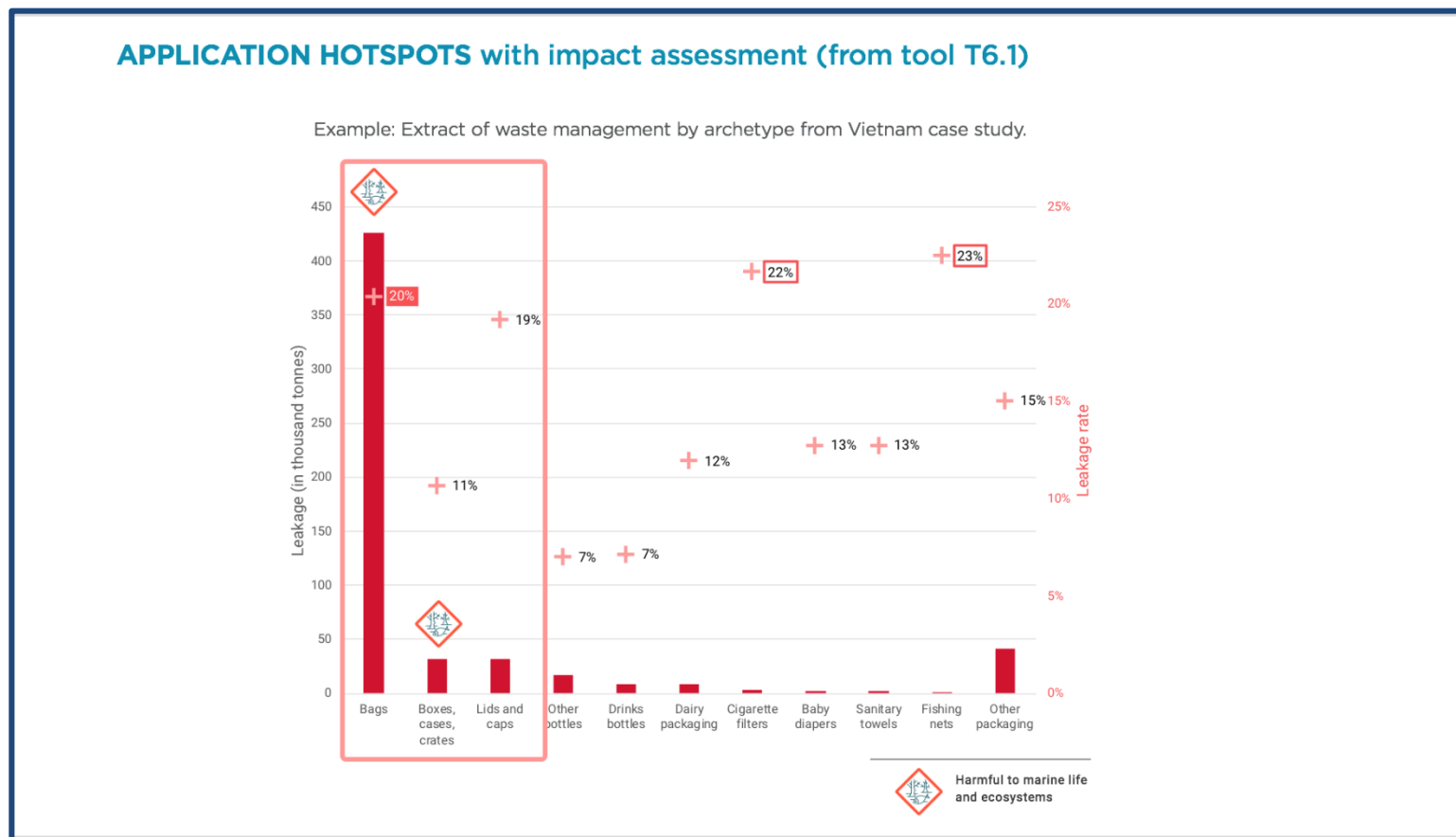
B

Project data repository

HOW TO USE THIS TOOL ?



Impact hotspots from tool T6.1 are to be tagged with an icon in the application hotspot graph stored in the ppt file of the project data repository (tool B).



This powerpoint recap allows to summarises all hotspots results from modules T1 to T6.



Life Cycle Initiative

Implemented with



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