Reducing the ecological footprint of vessels during their life at sea and their discard at ports

PECC, December 2016

Veolia and the sea

- **Veolia is partner of many major cities of the world located on the seashore.**
- **Veolia has direct activities with port to collect and treat domestic and hazardous waste issued from vessels, either during their construction or their operating life.**
- **Due to the growing needs for managing the end of industrial cycles, infrastructure and equipments, Veolia has selected dismantling (ships, oil rigs…) as one of its priority segment of development for the coming years.**
- **The Veolia Group contributes to scientific and research programs to better know and protect the sea (eg: Tara).**

Public clients located on the seashore:

New York
Hong-Kong
Shanghai
Sydney
Honolulu
Singapore
Incheon
Perth
Kyoto
Hiroshima
Leeds
Durban
Oman
…

Part I – Reducing the ecological footprint of vessels during their construction

During vessel construction (1): The example of the Harmony of the Seas

- **In May 2016, the World's largest cruise liner *Harmony of the Seas* docked at Southampton. Over 2 days, it was serviced by the Veolia Seagreen barge, operated from our Marchwood marine base.**
  - *The £783m ship is the length of 4 football pitches and can carry over 6,500 passengers! It has 23 restaurants, 20 swimming pools.*
  - *Contractors were currently on board finalising the interior of the ship, before it takes paying customers at the end of the May 2016.*
- **The Veolia team provided a complete waste service to the Harmony of the Seas, removing significant volumes of waste produced on the board by contractors (including packaging, wooden pallets, grey water and general waste).**
- **Veolia service some 70 ships a month at Southampton, ranging from cruise liners to cargo vessels.**
  - *Our Marchwood base often manage high volume of waste requests from cruise ships which have been in, for a refit or are a new build. This is made easier by the scope of services we offer, comprising administration, marine services, oil and water treatment, packaging and waste transfer.*

Part II – Reducing the ecological footprint of vessels during their life at sea

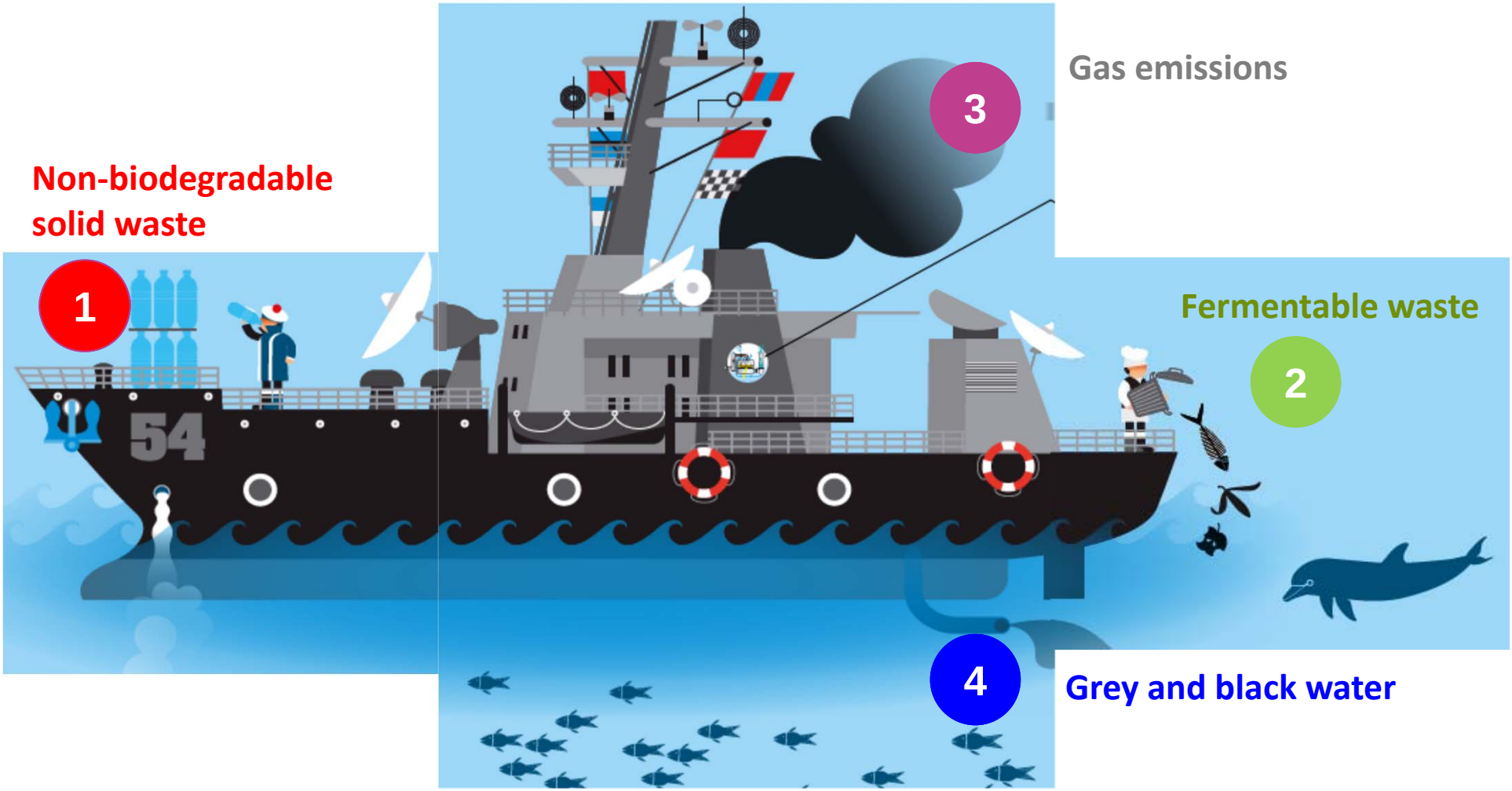
NACRE project (1): Designing and operating eco-friendly ships

- **A 5-year R&D program, started in 2009 and completed in 2013, aiming at:**
  - *Offering a complete waste management package for solid, liquid and gas emissions, so that existing ships and those under construction meet environmental standards*
  - *Contributing to respond to the environmental and economic challenges of maritime transport and ship repair and maintenance*
- **A 2-step program:**
  1) *Measuring the overall environmental footprint of merchant and naval ships currently in operation, by taking account of all their waste*
     - *Detailing the impact of the 4 main waste flows that can be found on a ship: solid, gas, fermentable waste, and black and grey water.*
     - *Sampling campaign on 15 civilian and military ships,*
     - *Quantification of emissions to determine the most harmful to the environment.*
  2) *Designing innovative solutions, taking into account the financial and operational constraints of vessels. Specifications anticipate changes to existing norms.*

NACRE project (2): Designing and operating eco-friendly ships

- **A R&D consortium bringing together various skills:**
  - *Developed within the Atlantic Brittany Marine competitiveness cluster*
  - *Industrial Groups such as DCNS, Bertin Technologies, Veolia*
  - *Clients and shipowners such as the French Navy, Genavir and Louis Dreyfus Armateurs*
  - *Institutions and research laboratories like IFREMER, EME Vocational Environmental Studies College, ENSTA Bretagne, the National Merchant Navy College and the Institut Pasteur in Lille*
- **3 patents are being drawn up.**

NACRE project (3):
Four ecological footprints for a ship



NACRE project (4): Solutions proposed

Non-biodegradable solid waste

- **Issues at stake:** Ban on disposing solid waste, such as plastics, at sea, especially in ECA1 zones (Emission Control Areas).
- **Solution:** Development of a shredder-pasteurizer, that reduces the volume of solid waste by 80% and its weight by 15 to 20%.
- **Advantages:**
  - No need to use a cold storage room for waste: lower economic impact with regard to ship building and maintenance, lower environmental impact.
  - Makes waste inert through pasteurization and simplifies its storage.

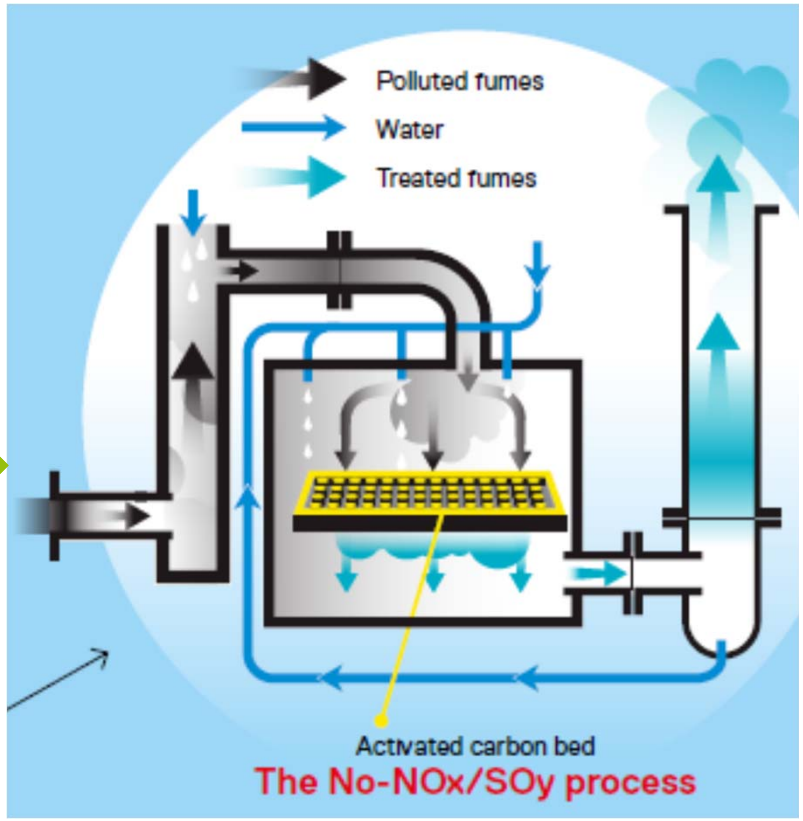
Fermentable waste

- **Issues at stake:** Disposal of waste at sea is no longer permitted (Marpol VI).
- **Solution:**
  - Creation of a prototype for a crew of 100 to 200, that can operate in 2 modes: stabilization and stabilization/neutralization of fermentable waste.
  - It is also possible to carry out surface sterilization.
  - The system may be adapted to land, for example in coastal waste treatment plants.
- Advantage: Leaktight containment of waste in thermosealed bags, combined with controlled fermentation, without recourse to a cold room.

NACRE project (5): Solutions proposed

Gas emissions

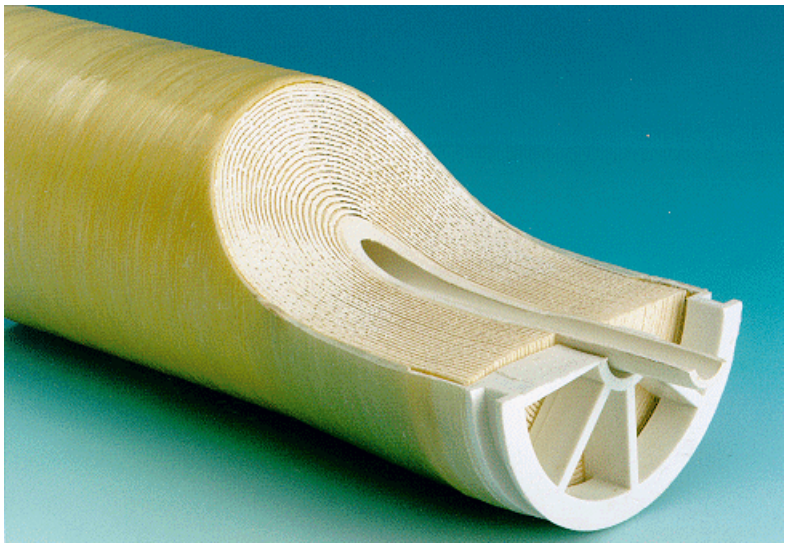
- **Issues at stake:**
  - For nitrogen oxides, obligation in 2016, at an engine speed of 500 rounds per minute, to reduce emissions to 2.6 g/kWh in ECA1 (OECD countries).
  - For sulfur oxydes, obligation in 2020 not to exceed 0.5% sulfur content in fuel oil. In the ECA1 zones, the requirements are stricter: 0.10% in 2016.
- **Solution:** Creation of an innovative equipment, the first of which is the No-NOx/SOy process.
- **Advantages:**
  - No drop in carbon adsorption efficiency over time.
  - Continuous wetting of the carbon by an inexhaustible resource. No on-board reagent.
  - Simultaneous treatment of NOx and SOx.



NACRE project (6): Solutions proposed

Grey and black water

- **Issue at stake:** Gradual tightening of the regulations on hydrocarbons in bilge water (threefold reduction in emission thresholds), grey water (kitchen, shower, etc.) and black water (WC).
- **Solution:** Recourse to membrane bioreactors (small water treatment facilities) or separation systems (centrifugation, membrane filtration).
- **Advantage:**
  - Technology that can be easily transposed to the naval sector (modularity, size, etc.).
  - With separation techniques, possibility of isolating and reducing the dirtiest flows, in order to store and treat them on land or treat them at the same time as the solid waste produced by the ship.



Membrane to treat water

NACRE project (7): Synthesis of the results and next step

Towards compact and autonomous technical solutions

- *Some ships are already using equipment capable to collect and treat various types of waste on board.*
- *However, the variety and complexity of these systems and the trend towards reducing the number of on-board crew and the dimensions of equipment led to develop a compact multifunction tool, which is easier to bring on-stream and facilitate cost control.*

Solid and liquid waste:

- *The work carried out on grey and black water helped improve the treatment of wastewater, using centrifugation combined with membrane filtration.*
- *Tests are therefore due to continue on treating fermentable waste, involving adapting an installation to treat the mud produced by the membrane filtration process.*
- *Solutions can now be offered to passenger ships operating in special areas, where waste disposal is banned, such as the Arctic and Antarctic, or to drilling platforms concentrated in specific areas.*

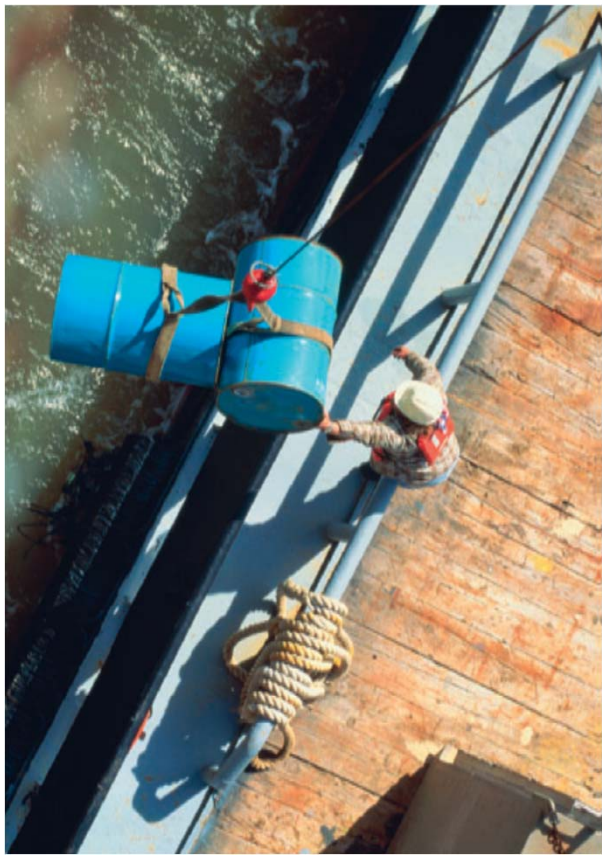
Atmospheric pollutants.

- *Lab tests involving treating gases and the resulting prototype will be transferred to other activities that require NOx and SOx emissions to be treated. A new greenhouse gas emissions process (No-NOx/SOy), will be assessed for treating cogeneration gases.*

Part III – Collecting and treating waste at ports

Treating marine pollutants, mainly MARPOL, in Hong-Kong (1)

- **Client: Hong Kong government (HKSAR Environmental Protection Department). No direct contract with the shipping companies nor their agents.**
- **A general contract for treating all hazardous waste: chemical waste, clinical waste and MARPOL waste generated from ocean-going and local vessels.**
- **Operation contract of 10 years awarded in 2009 to Ecospace Ltd, a wholly-owned subsidiary of Veolia, further to the DBO contract awarded in 1990:**
  - *This infrastructure is one of the most comprehensive and sophisticated hazardous waste treatment facilities in Asia.*
  - *It is located in the Tsing Yi industrial area.*
- **Various types of vessels serviced: container ships, chemical tankers, cruises, tugs, yachts, warships...**



- **Origin of the volumes treated: ocean-going vessels, with disposal requirement, while staying in Hong Kong port. Waste to be treated are mainly oily waste generated from the ships' engine room.**

Treating marine pollutants, mainly MARPOL, in Hong-Kong (2)

Type of treatment for marine waste:

- *Majority of volumes refer to MARPOL Annex I: liquid oil waste (Marine Pollutants)*
- *Very limited quantities refer to Annex II: noxious liquid substance*
- *Limited quantities refer to Annex V: sludge (non pumpable oil-contaminated solid)*

Type of treatment:

- *MARPOL annex I: incineration*
- *MARPOL annex II:incineration or physical chemical-treatment*
- *MARPOL annnex V: incineration*

Recycling:

- *Marine oil recovered is used as supportive fuel in the incinerator.*

Treating marine pollutants, mainly MARPOL, in Hong-Kong (3)

- **A great diversity of treatments offered:**
  - *Chemical waste treatment process:*
    - *Physical or chemical treatment,*
    - *Oil / water separation treatment*
    - *Incineration*
    - *Stabilization and solidification*
  - *Mercury waste treatment process:*
    - *Crushing and separation*
    - *Distillation and mercury recovery*
    - *Recycling of materials*
  - *Clinical waste treatment process:*
    - *Radioactive scanning*
    - *Incineration*
    - *Cleaning and disinfection of skip*

Part IV – Reducing the ecological footprint of vessels during their discard at ports

Managing the ends of marine industrial cycles

- **For the sake of their reputation, blue-chip industrial firms must comply with tough environmental standards: they need high quality services in order to respect these standards, included during decommissioning which is a sensitive operation.**
- **They also need to reduce safety risks to a minimum during this critical phase.**
- **Therefore, dismantling ships, tanks, offshore platforms, submarines… requires a combination of very advanced technical skills.**

The dismantling of the Jeanne d'Arc cruiser, the former French Navy teaching and training ship

- **Veolia positions itself as a reliable integrator throughout the whole value chain (dismantling, compliance, material recovery).**
- **The main objectives of dismantling are:**
  - *Avoiding contamination risks in the sea or in the seashore*
  - *Optimizing materials recycling and reuse of equipment (locally and at a lesser cost)*
  - *Minimizing costs and maximizing assets' value.*
  - *Soil remediation in order to restart later new activities on the same site.*

Recycling shipping containers (1)

Photo : © Japhet Alvarez

Recycling shipping containers (2): the container home

Photo : © Japhet Alvarez

Recycling shipping containers (3): the container home

- **In the middle of the Canadian forest, Joseph Dupuis fulfilled his dream of living in a hut. But this one is not made of logs, but sheet metal issued from shipping containers.**
- **33 m^2 for only 15,000 US $**
  - *3 shipping containers were recycled into a comfortable home – and bought for just 2,600 US dollars each, from the port of Hamilton, south of Toronto.*
  - *Their owner has a 33 m^2 space in the forest 55 kilometers from Ottawa - for an investment of just 15,000 US $. And what's more, the house costs him less to run than his phone!*
  - *With 17 million empty containers now available in North America, this could be a solution to help disadvantaged young people build their own low-cost homes.*
- **Warm, even in minus 42°C**
  - *The "cabin" exclusively uses renewable energy. Photovoltaic panels on the roof supply electricity to the house.*
  - *When the biting winter temperatures fall to minus 42° C, the container, although not insulated, stays at a sufficient temperature.*

Part IV – The issue of microplastics disseminated into the sea

TARA expedition:
Assessing pollution by plastics in the Mediterranean (1)

- **The oceans have become rubbish dumps. Some of the rubbish comes from maritime activities. However, 80% of waste discharged into the sea comes from the land, transported by sewage systems, rivers, winds and storms.**
- **The great majority of the floating detritus is plastic.**
- **The schooner Tara travelled 15,000 kilometers in the Mediterranean from May to November 2014, in order to study the impact of plastic waste on the ecosystem of this virtually closed sea.**
  - *The Veolia Foundation supported Tara Méditerranée.*
  - *The scientific team collected samples to study the nature, quantity and diversity of plastic waste and everything it transports: pathogenic bacteria, algae, mollusks, pesticides, etc.*
  - *Research focused on micro-plastic particles of under 2 cm to find out how they enter the food chain of plankton and end up in human food!*

TARA expedition:
Assessing pollution by plastics in the Mediterranean (2)

- **88% of the surface of the ocean is polluted with microplastics.**
  - *Tiny fragments, known as primary microplastics, can enter the marine environment in various ways, such as through cosmetics, toothpastes, washing machines rejects…*
  - *Secondary microplastics, derived from the breakdown of larger plastic debris, are much greater in volume, because the fragmentation process is, over time, infinite as more and more micro- and nanoparticles are released into the environment. It will take hundreds of years for them to disappear.*
  - *These fragments are omnipresent in the marine environment, at the surface and at depth, on the coast, in estuaries, in the open sea, in the most remote parts of the globe.*
  - *As most microplastics are floating debris, they are borne along by currents and the wind.*
  - *Plastic vortexes develop in the major oceans and concentrate these billions of fragments.*
  - *In the "Great Garbage Patch" of the North Pacific, there is 10 times more plastic than plankton. This "plastic soup" is ingested by fish and even plankton, the very basis of the food chain.*

TARA expedition:
Assessing pollution by plastics in the Mediterranean (3)

- **Plastic pollution is today one of the biggest ecological threat for the ocean and biodiversity.**
- **Unlike the Pacific, no permanent plastic vortex have been observed in the Med.**
- **However, it is one of the most polluted expanses of water in the world. The concentration of microplastics is among the highest on the planet, as in the North Pacific.**
  - *Nearly 250 billion plastic particles float on its surface. Common plastic materials in use today are polystyrene (PS), polyethylene (PE), polypropylene (PP), polyvinyl chloride (PVC) and poly-ethylene terephthalate (PET). Some plastics are inert while others contain substances added during the manufacturing process (e.g. colouring agents, fireproofing agents, stabilizers) which make the product more durable or improve its resistance to degradation.*
  - *Once they have entered the environment, these materials may release chemicals such as phthalates, bisphenol A (BPA)...*
  - *Plastics are veritable sponges, when it comes to soaking up persistent organic pollutants (POPs), such as pesticides, combustion products and industrial chemicals…*

TARA expedition:
Reducing pollution by plastics in the Mediterranean (4)

Plastic interact with living organisms

- *These noxious substances are very resistant to biodegradation, which means they remain in the environment for a long time before becoming harmless.*
- *Organisms on the surface of the microplastics absorb these contaminants, while additives contained in them are released into the marine environment. As a result they can accumulate in living tissue at every stage of the food chain and thus find their way into humans. Some of these additives are endocrine disruptors whose toxicological consequences on biodiversity, food safety and human health are only now coming to light.*
- *While macroplastic fragments directly affect marine birds, turtles…, microplastics are a far more complex pollution, invisible and difficult to deal with. And because they are so small, they can then be ingested by all types of filter feeders, such as mussels and oysters. They can enter the food chain very easily.*
- *Hydrophobic and non-biodegradable plastics are also colonized by microorganisms such as bacteria, algae and fungi. Carried thousands of kilometres by marine currents, these plastics act like rafts to spread invasive species and pathogens.*

Floating islands, made in recycled plastic (1): the recycled park project in Rotterdam

Floating islands, made in recycled plastic (2): the recycled park project in Rotterdam

- **In the port of Rotterdam, a completely new island could be about to float at the end of the year: a 100% recycled plastic green island.**
- **This artificial island will float on the New Meuse river and be made from recycled waste.**
  - *The waste will come from collecting the tons of plastic dumped in the river flowing into the port of Rotterdam. It will be collected, before reaching its usual last resting place in the North Sea.*
  - *A 6 x 12 floating platform, called the Plastic Visser (fisher), retrieves plastic waste from the New Meuse river, preventing them entering the North Sea.*
- **Plastic waste collected will be transformed into floating building blocks.**
  - *These blocks will be used as basic units to build the island.*
  - *They are designed in such a way, that they can grow nature on top. The bottom of the platform will have a rough finishing, where plants can have enough surface to grow and fish a place to leave their eggs.*
- **This 150 m^2 island will be an extension of the city in the form of park, where people take walks, birds come to nest and fish lay their eggs.**
- **The concept of a recycled eco-island has been invented by Ramon Knoester, who works in the Dutch Wihm firm of architects.**

Conclusion

- *A sustainable management of seawater depends heavily of the sustainable management on the land: ships, waste (e.g. plastic), wastewater, old marine infrastructure dismantling…*

- *The linkage between economic and environmental performance is the bedrock of services to industrial customers. It conditions their acceptance to adopt stricter environmental protection measures.*

- *The quality of the sea is the end result of the quality of the whole environmental protection policies of neighboring countries. As the effects of pollution accumulate in them, it is always coastal waters and seawater, that form the real barometer of cleansing policies that have been carried out. Their quality – or lack of it – is the final marker of the effort made by the international community to monitor and preserve its seawater.*

Thank you for your attention