# Oceans Flooded With Plastic: Myth or Reality?

## Proceedings of the 4th Interdisciplinary Colloquium

## organized by the W4W Group (Workshop for Water Ethics)

### on 21th March 2017

### at Museum of History of Science of Geneva

WORKSHOP FOR WATER ETHICS

IRSE

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Preview proceedings

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2012 « Eau, besoin vital et Justice Globale »

2013 « Ethique globale de l'eau »

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# Members of the W4W group

A doctor of ecophysiology at the Orsay Faculty of Sciences (Paris-Sud), **Annie BALET** worked on metabolism and the ultrastructure of plants in reaction to environmental problems. She subsequently taught biology at the secondary-school level, raising the awareness of students to associated environmental and humanitarian issues. She helped organize informal week-long seminars on sustainable development.

**Benoît GIRARDIN** is a professor of political ethics at the Geneva School of Diplomacy and International Relations, a university institute. He has extensive international experience, having been responsible for Swiss cooperative development efforts in Cameroon, Pakistan, and Romania, then later for evaluation, finally serving as the ambassador to Madagascar. Initially, he had earned a doctorate in theology at the University of Geneva in 1977.

**Evelyne FIECHTER-WIDEMANN** is a hon. member of the Geneva bar and holds a master's degree (MCJ) from New York University. After obtaining a doctorate in theology at the University de Geneva in 2015, she is pursuing her research on the global ethics of water. She served as a deputy judge on a judicial commission of CRUNI (Geneva's administrative court) and taught Swiss and international public law at the Collège de Genève. She was on the Swiss Church Aid (EPER) foundation's board and also that of the International Museum of the Reformation.

Following her studies at the University of Geneva, **Laurence-Isaline STAHL GRETSCH** spent fifteen years as an archeologist specializing in prehistory, both in Jura Canton (for construction related to the Trans-Jura freeway) and at the University of Geneva. Following the defense of her dissertation in sciences, she was hired by Geneva's History of Sciences Museum, which she headed for over ten years. In 2009 the museum created an exhibit on hydropower in Geneva.

After earning a master's degree in civil engineering at the Swiss Federal Institute of Technology in Zurich, **Christoph STUCKI** initially specialized in analyzing the behavior of materials at the Swiss Federal Laboratories for Materials Science, before joining an engineering firm in Lausanne. He then developed a railway network planning model at the Swiss Federal Institute of Technology in Lausanne. In 1980 he became the general manager of Geneva's public transport system. Currently, he is the president of Unireso, the cross-border transport fare network for a basin encompassing parts of France, Vaud, and Geneva.

**Gary VACHICOURAS,** who holds a doctorate in theology, studied at the Holy Cross Greek Orthodox School of Theology (Brookline, Mass.), the University of Paris IV-Sorbonne, and the University of Athens. He was a teaching fellow at the Ecumenical Patriarchate's Orthodox Center in Chambésy-Geneva and the executive director of the Foundation for Interfaith and Intercultural Research and Dialogue. His involvement in higher education has touched on human security, especially through his teaching, innovative research, and intergovernmental dialogue.

Following his training as a professional IFR pilot, **Renaud DE WATTEVILLE** traveled and created Swissmate, an events management company. For over 20 years he managed projects for various companies in Switzerland and abroad. In 2008 he started Swiss Fresh Water SA, which developed a low-cost decentralized desalination system intended for use by low-income populations. This was an opportunity for him to make a real human difference by making his experience available for a high-impact industrial project.

# W4W Group (Workshop for Water Ethics)

**W4W Group** is an apolitical civic-minded interdisciplinary platform that brings together notable figures from the theological, ethical, political, scientific, economic, and legal spheres who share a common concern for water challenges in a globalized world.

Water is a natural resource that was long considered a free good. Its status is changing as awareness of its increased scarcity grows, and especially as it is used abusively (polluted and wasted, especially in agriculture).

Indeed, this resource is increasingly threatened not only by increasing demand from the public, agriculture, and industry, but also by climate change.

To meet the demand and avoid water wars by defusing water-related conflict, the public sector – in partnership with the private and community sectors – must create appropriate conditions for managing this resource fairly and sustainably.

**It has set the following goals for itself:**

1. Conceptualize and explain the ethical dimension – essential for identifying and implementing solutions – of fair and sustainable water management in a globalized world;
2. Contribute original thoughts that could influence the creation of a favorable environment for implementing the Sustainable Development Goals (in particular 4,5,6 and 14;
3. Take these solutions' interdisciplinarity into account;
4. Using a pluralist and ecumenical approach, establish contacts with existing ethical focus groups, for example IRSE, Gloethics.net, the Institute of Business Ethics, and similar entities globally;
5. Involve influential private-sector players, university researchers and students, as well as civic-minded associations;
6. Organize colloquia on the topic of water's ethical challenges in a globalized world, provide targeted information to decision-makers and influential stakeholders, and exchange thoughts in networks and on blogs.

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# Speakers

**Daniela DIZ** is a member of the Strathclyde Centre of Environmental Law and Governance at the University of Strathclyde exploring the evolution of the international law of the sea and its relationship with other policy and legal instruments contributing to coherent oceans governance. Daniela has an interdisciplinary background in international environmental law, marine science and ecosystem-based management, and first-hand experience of international environmental law-making processes. She is also a Research Fellow with the ESPA (Ecosystem Services for Poverty Alleviation) program. Her Marine Benefits project investigates fair and equitable benefit-sharing specifically in international fisheries law and policy, with a view to connecting different sources of inequity concerning marine ecosystem services that contribute to poverty in small-scale fishing communities. Previously, Daniela has worked for the Brazilian Government as an environmental lawyer, and for WWF-Canada as a senior marine policy officer.

As an Environmental Engineer specialized in water treatment from the Swiss Federal Institute of Technology in Lausanne(EPFL), **Frédéric SCIACCA** worked for several years as consultant in circular economy and resource efficiency with international organizations, as well as the public and private sector. He started as scientific advisor at Race for Water Foundation with the launch of the Odyssey 2015 in order to coordinate scientific work and consolidate scientific partnerships. He is also in charge of waste-to-energy pilot projects implemented recently on diverse costal and insular contexts in order to build up a value chain around mismanaged plastic waste.

**Pascal HAGMANN**, who is 37 years old, studied at the Swiss Federal Institute of Technology in Lausanne where he obtained a Masters in Mechanical Engineering in 2003. Initially he worked on the development of new technologies in the medical sector, and since 2015, he has been focusing on water treatment. Deeply committed to the marine environment, he founded the Oceaneye Association in 2010, while pursuing his engineering career, to contribute to the study and awareness of the problem of marine pollution by plastic waste.

**Sarah STEWART-KROEKER** is assistant professor of ethics at the University of Geneva. After earning her doctorate at the Princeton Theological Seminary in 2014, she undertook a postdoctoral fellowship at the University of British Columbia. Since her appointment at the University of Geneva in August 2016, she has been working on a project that addresses the aesthetic dimension of human action on climate change.

**Vera SLAVEYKOVA** is a professor of environmental biogeochemistry and ecotoxicology at the University of Geneva and director of the F.-A. Forel Department for environmental and aquatic sciences. She works on the development of new tools and concepts to study the basic processes governing the behavior of trace elements, nanoparticles and nanoplastics in aquatic systems, processes that are highly relevant to water quality and environmental risk assessment.

**Annie Balet**, **Eveyne Fiechter-Widemann**, **Benoît Girardin**, **Laurence-Isaline Stahl Gretsch** of W4W Group.

**Foreword**

# Oceans without Plastic! New ethics in play?

Evelyne Fiechter-Widemann, , W4W Group founder and honorary Attorney at Law.

The Workshop for Water Ethics (W4W Group) organized its first three colloquia between 2011 and 2013 to promote a clearer and more realistic perception of the daunting and complex issue of drinking water, to which nearly two billion people globally have no access. In 2014, the W4W was represented in Singapore by Evelyne Fiechter-Widemann for a Conference on the "Singapore Water Story" by Dr. Cecilia Tortajada, Senior Research Fellow at the National University of Singapore (Lee Kuan Yew School of Public Policy).

In 2015, the book "The Human Right to Water: Justice or ... Sham" (Slatkine, 2017 and Wipf & Stock Publishers, 2017) was presented at the University of Geneva (Autonomous Faculty of Protestant Theology) by Evelyne Fiechter-Widemann to earn her doctorate.

In 2016, at the University of Lucerne, portions of her thesis were presented under the title "Pope Francis' and Singaporeans' insights on Economics and Environments" (Springer 2017).

For its fourth colloquium in 2017, the W4W Group continued to pursue its ethical and interdisciplinary approach to shine a spotlight on a new problem affecting water, a vital resource.

Like the pollution of aquifers, which are invisible underground, ocean pollution seems to be a very abstract problem to us here in Switzerland.

But wouldn't we be directly concerned if, by chance, our favorite seafood were to become polluted with tiny plastic particles, causing us to change our eating habits in the not-too-distant future?

With this interactive colloquium open to the public, we tried to gain a better understanding thanks to the panel of very young researchers, to whom we extend our most sincere thanks. We also thank the City of Geneva, which offered the great hall of its History of Science Museum for this forum on a major challenge of our time.

**Introduction**

# Humankind struggling with ocean garbage patches: Observations in the Pacific and Antarctic Oceans

Evelyne Fiechter-Widemann, W4W Group

In its three previous colloquia, the W4W Groupworking group on Water Ethics focused its attention on freshwater issues in lakes, rivers and aquifers. The question was how to avoid dying of thirst.

For its fourth colloquium, the question at stake is how to avoid dying of hunger, if the ocean environment were to become so polluted by plastics that marine wildlife becomes sick.

Biologists know that it is not just fish that are likely to feed on plastic, but plankton and krill, which are the main staple in the diets of many marine species. A whale, for example, eats more than two tons of krill and plankton per day.

During the colloquium, we will be talking about the Pacific, Indian and Atlantic oceans, as well as the Arctic and Antarctic oceans, all affected by a new threat: plastic, thrown indiscriminately into their waters.

The problem is gaining increasing media attention. Why? Because ocean pollution affects the food chain, according to scientists, and therefore our health. Interestingly, doctors do not call it ocean pollution, but instead refer to it as the ocean epidemic. At the interdisciplinary convention in Geneva last June organized by the Société Genevoise d'Utilité Publique [Geneva Public Welfare Society] on the theme "Epidemics and Societies: Past, Present and Future", the question we are dealing with today in this forum was addressed at the end of the event.

To believe that the predicted disaster is a reality, you need to travel far and wide. That is my own experience.

Personally, I saw beautiful clear water during my trip to the Antarctic Peninsula, last January.

And, to my astonishment, the places I visited on Easter Island last January seemed perfectly clean. Granted, I was there for a very short time and saw only the tourist sites on this Pacific island, five hours by plane from Chile.

However, I was shocked when I saw some of the beaches in the South Pacific Islands, a year ago. Even uninhabited islands are strewn with litter. On the Isle of Souvarov, for example, off the Cook Islands, we saw bizarre items like torn-up flip-flops in the midst of a group of giant blue crabs.

That was when I decided to suggest that my group set up a fourth colloquium to examine how this had happened and how to avoid a catastrophe.

This is a genuine ethical reflection, based on data gathered by scientists that we will hear from this afternoon.

Our group is grateful to the IRSE (Institut Romand de Systématique et d'éthique) for allowing us to welcome among the speakers Sarah Stewart-Kroeker, Environmental Ethics Chair at the Autonomous Faculty of Protestant Theology of Geneva.

We also thank the Forel Institute, as well as the Strathclyde University in Scotland, for agreeing to delegate, respectively, Vera Slaveykova and Daniela Diz, for academic presentations. Two young researchers working for the Race for Water Foundation and the Oceaneye Association, Frédéric Sciacca and Pascal Hagmann, will show us striking images of the oceans flooded with plastic. As for the W4W group, four of its members will be on the panel, Laurence-Isaline Stahl Gretsch, Benoît Girardin, Annie Balet and myself.

Now let's address the heart of the matter.

In my opinion, there is nothing like first-person accounts to make a far-off reality more tangible, more real to those of us who are living comfortably here in Switzerland.

So I am going to tell you about three people I met, in chronological order, from November 2015 to January 2017. These meetings occurred in a private capacity, while my husband Eric Fiechter and I were on a world cruise. I am very grateful to him for having suggested the trip.

I took the opportunity to interview politicians in the Cook Islands, located in the Pacific Ocean, then a representa-

tive of a government agency in South Georgia and the South Sandwich Islands located in the Antarctic Ocean, and finally a guide on Easter Island.

## 1. Cook Islands

In November 2015, I had the honor of meeting with Kevin Iro, the representative of the Environment Department of the Cook Islands, located in the South Pacific. He told me about the massive plastic garbage patches floating in the Pacific. They represent an area twice as large as Texas. Mr. Iro helped create a foundation called Marae Moana, which aims to inform the public about the human impact on the Pacific Ocean. This information is not just provided to schools and Cook Islanders, but also at the global level, as will be explained later. The foundation is known today for having created one of the largest marine parks in the world, alongside Australia and the Maldives, as well as the Antarctic Islands. It covers 1,800,000 km2, according to data from November 2016. The purpose of the ocean sanctuary is to protect sharks, manta rays and other fish, as well as coral reefs.

## 2. Islands in Antarctica

In December 2016, I met with a representative of the government of South Georgia. This island is located between the Falkland Islands and the Antarctic Peninsula, in the southern Atlantic Ocean. Simon Browning was categorical: plastic pollution is also threatening the South Pole region. He gave me an example that astonished me: albatrosses – birds celebrated by poets – are beginning to collect plastic for their nests. Inevitably, the birds end up consuming plastic.

## 3. Easter Island

In January 2017, finally, I asked our guide Claudio Tucki about the threat of plastic in the Pacific Ocean. He had the same reaction as the previous two people I had spoken with. First, he was aware of the plastic garbage patches in the Pacific Ocean, which I mentioned earlier. Second, he told me that for about three years now, he has been seeing an ever increasing amount of plastic waste on certain beaches, washing up from the ocean. The authorities are becoming worried and have made the issue part of the school curriculum. They even organize beach clean-up days in which children are asked to participate

alongside the adults. As a parenthesis, in Singapore I met a 16-year-old schoolgirl who is deeply concerned about the problem we are working on today and who is leaving for Bali, Indonesia in a few days, to help clean up plastic-infested beaches.

I found a fundamental difference between the three approaches.

- The first, in the Cook Islands, is driven by multilateralism. Cook Island PM Henry Puna travels extensively and was at the COP 21 in Paris in December 2015 at the Paris Conference on Climate Change. He was also in Morocco last November at the Climate Change Conference to advocate for the Marae Moana marine park and its funding. The people of the Cook Islands want to make their voice heard internationally. They want to be supported in their marine park project and obtain protection recognized by all States.
- South Georgia takes its policing role very seriously in this southern region. Strict regulations are firmly enforced, for example against illegal fishing. Recently, the authorities did not hesitate to seize a pirate fishing ship, haul away the offenders and blow up the boat. Remember that Antarctica is covered by a 1980 International Convention for the Conservation of Antarctic Marine Living Resources.
- On Chilean Easter Island, five hours' flight from Santiago de Chile, the effort to provide access to drinking water and sanitation is still in its infancy. Water is not treated after use, there are only a few pipelines, and the flimsy dwellings are dotted across the island at random, equipped only with pit latrines. Electricity works sporadically. It should be noted that the Islanders do not pay taxes and that Chile has to deal with the problems. Worrisome...

## Conclusion

As we said in our previous colloquia, it's all about governance and framework conditions. Dealing with, and hopefully eradicating, plastic ocean pollution will require international coordination. I am looking forward to hearing about the progress made in the field of legislation in the upcoming presentations.

The objective of our meeting today is to learn as much as we can, with the help of scientists, ethicists and jurists, to address an urgent problem in an interdisciplinary way.

In addition, we aim to establish a bridge between civil society, ourselves, and the academic, political and economic world. We also want to encourage young people to get ready to play a decisive role in the future. Young people have access to extraordinary research centers around the world in the field of sustainability, which also involves ocean conservation. I am thinking in particular of the Swiss Federal Institutes of Technology, which have branches all over the world, in particular in Singapore.

# Consider the depths: the role of myth in ethical action

Sarah Stewart-Kroeker, University of Geneva

> "How are we to explain why nature has so extravagantly spread beauty everywhere, even at the bottom of the ocean, where the human eye (for which, after all, this beauty alone is purposive) rarely penetrates?"
>
> Kant, Critique of the Power of Judgment

The ocean remains largely mysterious, despite the technologies that allow us to explore its depths. Its beauty, its vital and dangerous nature add to the mystery and make it the stuff of myths and legends. From Homer's Odyssey to Melville's white whale to the Inuit's Qalupalik, the imagination populates the ocean with menacing forces.

Myths (mythos) are a form of narrative. Myth as a genre typically refers to a narrative explaining the origin, history or natural phenomenon of the world, often using supernatural figures or events, and often transmitted orally or by tradition. But more broadly, myths can also reflect idealized or figuralized notions of events, people, or other objects – such as the ocean. Melville's white whale is a good example. This creature attains mythic status in the novel Moby Dick through the narrative and characteristics attributed to it. In a broad sense, a myth recounts or explains the world through narratives drawing from the supernatural, the ideal, the figurative. Mythologies cut across genres and day-to-day life.

What is the connection to ethics? Narratives explaining the meaning of life are an essential part of morality. The interpretation and challenge of the narrative of meaning (including mythic narrative) are in some sense central to the intellectual project of ethics. The mythic register is a cultural vector of the meaning of life and values, according to environmental ethicist Willis Jenkins. As such, mythical narratives are an integral part – even if unconsciously or implicitly – of ethical action. Consequently, philosophy and theology also concern themselves with mythologies. And this is also because myth can equally mean a fiction, a false idea that is propagated through narrative repetition.

One reason that can explain why humans pollute the environment and cause climate change is simply the awareness of the magnitude of our natural world. We act and think as individuals, as if we could expect to see the consequences of our actions in just the tiny area we live in day-to-day. But the consequences of these actions extend far beyond our immediate habitat. And not just because individual energy consumption contributes to global warming, affecting populations differently, but also, more concretely, because the trash thrown away here may eventually end up in a far-off ocean. The scale of action required goes far beyond the individual level.

When addressing the relationship between actions and effects, which is increasingly global and personal at the same time, one of the challenges is reconciling two scales of human action: an individual scale and a collective scale[1]. The difficulty is that this all-encompassing figure of the collective scale is outside personal experience. The mythic register can help create a dialog between these two dimensions. The mythic register is a cultural vector of the meaning of life[2]. As such, it enables us to amalgamate these two scales of action, the individual scale and the collective scale. In so doing, the mythic register, blending cultural values and ideals as well as religious and spiritual values and ideals, allows us to recount individual actions in a framework that gives them a meaning that transcends the individual.

We must, however, be wary; for just as the ocean itself is a source of both life and death, myths can both illuminate and obscure, they can arouse us to noble actions and they can drive us into madness (here again, Melville's story is a good example of noble actions and deranged actions induced by a quest for an idealized figure). Faced with environmental challenges, figuring out how to communicate issues to the public means thinking about how to raise their awareness.

Bruno Latour notes that ecologists are often accused of engaging in a strategy of apocalyptic rhetoric[3]. These accusations discredit the message of ecological crisis by associating it with excessive hysteria, turning reality into fiction – a myth, in the pejorative sense. According to Elizabeth Kolbert, a journalist at the New Yorker, this ap-

1 Willis Jenkins, "The Turn to Virtue in Climate Ethics: Wickedness and Goodness in the Anthropocene", Environmental Ethics 38:1 (2016).

2 Jenkins, "The Turn to Virtue", 87.

3 Bruno Latour, Face à Gaïa: huit conférences sur le nouveau régime climatique (Paris: Éditions La Découverte, 2015), 251.

pearance of hysteria reflects the difficulty of representing a reality that is not immediately accessible to us[4]. Both Latour and Kolbert compare the skepticism towards the ecological crisis to the disbelief with which the Trojans met the warnings of Cassandra, a figure of Greek mythology, who had prophesied the defeat of Troy, in vain[5].

Whether in terms of climate change or oceans flooded with plastic, in addition to the importance of biological, chemical and hydraulic analyses, an ethical reflection must be carried out on the way in which this reality is communicated, in a register no longer strictly informative, but relating to meaning and imagination. For the sources of ethical action lie within the framework that gives it meaning, and this framework stems in one way or another from the narrative of the ideal or the figural. The communication of an ethical challenge should not ignore this aspect of the sources of action. A heavy responsibility accompanies this work of representation. If one myth can have the ability to mobilize, another can lie, shake trust and coerce action.

When we ask ourselves the question "Oceans flooded with plastic: myth or reality?", we might view an opposition between myth and reality, the fictitious and the real. My point is that it may be much more valuable to distinguish between myths that are faithful to reality as we understood it and those that are not.

To support this idea, I will use an example from the Republic of Plato. In this text, Socrates tries to convince his companions that justice is better than injustice. It is immediately apparent that Socrates' companions do not share the same definition of justice. This is shown in the different cities described by Socrates and Glaucon. The city of Socrates is simple and healthy while Glaucon sees only a bestial life, lacking in luxury[6]. He does not see justice where Socrates sees it. To respond to this impasse, Socrates has no better solution than to turn to myth, the stories told of the gods[7]. Socrates suggests shaping values differently by utilizing the mythic register.

How to educate the guardians who will watch over the city with justice? They will have to learn to distinguish truth from lies, true stories from false ones[8]. In order to teach them this, we must start with the fables told to the children. Socrates then enumerates a whole series of stories of the gods and heroes of ancient Greece, and all the aspects of the stories that are false. As he continues, he strips the representations of the gods of the characteristics usually associated with this mythology: internal quarrels, fights over women, disguises to seduce, etc. Socrates removes from these stories all the excesses of sex and power, precisely those that Glaucon associates with the fundamental desires of human beings. In doing so, he subtly contradicts Glaucon's idea that everyone, if he could, would indulge in the excesses of those desires for sex and power. This idea of Glaucon refers to another myth, that of the ring of Gyges[9].

Socrates wants to show how the stories of the gods that his companions have heard since childhood have distorted their desires[10]. He emphasizes the fact that these myths should correspond to divine truth[11]; they must have a kind of transparency that reveals the real[12].

What is curious, then, is that the Republic is described as being based on a founding myth understood as a noble lie[13]. This founding myth tells us that every citizen is born with a soul of gold, silver or bronze, a soul that will determine one's place in the city. This myth structures the separation between children and parents and emphasizes the control of the population with respect to function.

But as Socrates says, we must distinguish one myth from another, the true from the false – even when it comes to Plato's own text. There are many inconsistencies. Could that be an irony of the text? Does he implicitly prompt us to see this founding myth of the city in the critical light of Socratic pedagogy – a pedagogy that stresses the fact that the myths of the gods must remain faithful to the truly noble character of the divine? Is this myth truly noble, does it reveal the real, and does it lead to the ethical education of the people? If the first goal of education according to Socrates is to learn to discern the true stories from the false ones, could the myth of the metals be a test of education? This suspicion is reinforced by the fact that, according to the myth of the metals, one would try to convince the first rulers that their education was a dream and that in fact they had been educated underground before being sent to the surface[14]. Is this a counterpoint to the allegory of the cave, where precisely, education consists in escaping subterranean representations?

Setting aside the author's intention, it seems to me that the myth of the metals obscures the world as it is understood today, instead of representing it figuratively. Moreover, this myth supports an authoritarian regime that we would not support in our context. This myth seems to me not only suspicious from a political point of view, but

4 Elizabeth Kolbert, "Greenland is Melting", The New Yorker, October 24, 2016 Issue, http://www.newyorker.com/magazine/2016/10/24/greenland-is-melting.
5 Latour, Face à Gaïa, 283; Kolbert, "Greenland is Melting".
6 Plato, The Republic, II.372d-374e.
7 Plato, The Republic, II.376d-III.403c.
8 Plato, The Republic, II.375a-383c.
9 Plato, The Republic, II.359c-360d.
10 Plato, The Republic, II.377a-378 e.
11 Plato, The Republic, II.379a-383c.
12 Lambros Couloubaritsis, Aux origines de la philosophie européenne (Bruxelles: De Boeck, 2003), 57.
13 Plato, The Republic, III.414b-415d.
14 Plato, The Republic, III.414d.

problematic from an ethical point of view. In Plato's text, we can distinguish between types of myths: myths that reveal, and myths that conceal.

The mythic register is powerful, and it is precisely for this reason that we must proceed with caution in the understanding of the world that it communicates and the values that arise from it. However, we cannot do without the mythic register, if we see it as a vector of meaning and values, capable of captivating the spirit and mobilizing action.

Let us return to the question of how the mythic register is used to communicate the meaning and value of an issue such as the pollution of the oceans, those depths that are outside (for most of us) our direct experience. One way of communicating reality in the mythic register is, of course, through artistic representations. One example of this is the aboriginal art exhibit that will be presented in Geneva in September 2017 in connection with the exhibition "The Boomerang Effect – The Aboriginal Arts in Australia" at the Museum of Ethnography of Geneva. The Torres Strait Pormpuraaw Artists GhostNets Project consists of sculptures created from lost or abandoned fishing nets, known as ghost nets[15]. Thrown into the sea and carried away by the ocean currents, ghost nets are harmful to marine life.

A team of researchers, rangers, volunteers and artists has been formed to help deal with these ghost nets[16]. The clean-up work led to the creation of sculptures of marine animals. This artistic movement seeks to raise awareness of the problems caused by pollution, not just for the ocean ecology but also for the people who rely on the sea for their subsistence. Apart from the economic challenges, many marine animals affected by pollution have a totemic value for the aboriginal people. Ocean pollution also threatens the mythic foundations of certain cultures.

The connection between danger and mythic significance is emphasized by the fact that the nets are called "ghost nets": the term is not only figurative but supernatural – one might say, mythic. The nets pose a real danger, but this danger is also represented figuratively, as are the mythic creatures of another aboriginal people, the Inuit's Qalupalik. Qalupalik is a human-like creature that lives in the sea and that steals children who wander too close to the shore. The Qalupalik represents a real danger – drowning – but in mythic form. This myth aims to keep the children of the community safe by communicating a danger in a figurative form.

The ghost nets project communicates a concrete danger through figurative representation, but in this case the narrative is aimed at a much wider audience than the community, because the ethical responsibility for the safety of this ecosystem and those who depend on it transcends the Aboriginal community. It could be said, moreover, that this project goes even further than the figurative representation of a concrete danger. The project transforms harmful substances into objects that not only raise awareness of danger, but are also objects of beauty. Through artistic creation, the artists found a way to transform materials harmful to the ocean, not just by recycling them, but by creating objects that can convey their message in order to raise awareness about a situation that is unfamiliar and far removed from the target audience. This awareness develops through both the senses and the imagination. We see the nets in their materiality, but we see them also transfigured into representations of the animals that they harm. And in this way, finally, the totemic value of these marine animals can emerge through the artistic creations that are both concrete and symbolic.

Another way of communicating in the mythic register is of course through speech. What words, metaphors or narratives could help us consider the depths and the plastic pollution that threatens them, without obscuring reality (whether by exaggerating or minimizing it)? As of now, I dare not rush to give a concrete answer to this question, because this, like the ghost nets project, would take multidisciplinary collaboration, among researchers in the sciences, humanities, arts, journalism, and more. Given this, I am very pleased to be able to participate in this colloquium that brings us together from various fields, providing an opportunity for me to learn more about the reality of ocean pollution.

15 http://www.artsdaustralie.com/pdf/Presentation-oeuvres-Pormpuraaw.pdf.

16 The following information on the ghost net exhibit was provided by the UNIGE Communications Department. See also http://www.artsdaustralie.com/pdf/sculpture-ghostnet-aborigene.pdf.

# The myth of the huge plastic garbage patches in the oceans

Pascal Hagmann, Oceaneye Association

## Mankind and the oceans

Oceans represent 70% of the earth's surface, 97% of water reserves and contain 80% of the organic matter present on Earth. They are also the main carbon pump and the largest producer of atmospheric oxygen. They have multiple functions, and we are entirely dependent on this tremendous resource: the oceans provide us with oxygen, water, food and fossil fuels, temper the climate and support more than 90% of shipping.

Paradoxically, this resource is particularly threatened by human activities.

Our impacts can be classified into three categories:

- The effects of burning fossil fuels, resulting in increased ocean temperatures, acidification due to absorption of atmospheric carbon dioxide, and rising sea levels;
- The effects of unsustainable fishing such as overfishing (exceeding the thresholds of population renewal), by-catch and destructive fishing practices (bottom trawling, explosives, poison), resulting in depletion of the reservoir of life;
- The effects of pollution, whether physical (radioactivity, noise), biological (invasive species) or chemical (micropollutants, oil spills and plastics).

## Plastic pollution of the seas

Among the many types of man-made threats to the ocean, the issue of plastic waste is extremely concerning, in view of its sharp increase (plastic consumption is rising by 9% per year worldwide). Although most of this pollution lies on the seafloor (60% of plastics sink), pollution in surface waters is of great concern, especially since these waters are so densely populated.

An estimated 8 million tons of plastic waste are dumped each year into the oceans. The plastics break up into particles ranging in size from one millimeter to one micrometer, similar to plankton. The fragments are toxic and/or a choking hazard when ingested and absorbed by marine wildlife that mistake them for plankton.

The consequences, difficult to quantify, are drastic in several respects:

- The environment: plastics lead to hypoxia of the seafloor (reduction of gas exchanges between soil and water); the death of marine wildlife by strangulation, choking, or the irreversible accumulation of plastic in the stomach; the transport of invasive species that attach to marine debris; the concentration of persistent bioaccumulative and toxic substances (PBTs), which have very low water solubility or are hydrophobic. Ingestion of the plastic by plankton eaters could poison the food chain, due to the absorption of PBTs or plastic components;
- Human activities: waste represents a danger to navigation and safety, adversely affects tourism, permanently soils beaches and causes difficulties for fishermen;
- Human health: the consequences for human health are now of great concern, due to the effects of long-term bioaccumulation.

## The myth of the seventh continent

Despite the growing fears of the scientific community, the accumulation of plastic waste in the oceans remains largely misunderstood. It is still unclear what the finality of the floating debris is.

The phenomenon most widely portrayed in the media are the areas with high concentrations of floating debris often incorrectly called "seventh continents", "trash vortexes" or "waste patches". It was long believed that floating debris ended up in the ocean gyres. However, the latest studies show that less than 1% of the floating plastic debris is found in these areas of concentration. The fate of floating plastics still remains very mysterious.

In this sense, it is interesting to compare the popular representation of plastic pollution of the seas and the results of scientific studies. A web search shows an apocalyptic vision of ocean plastic pollution, often represented by islands of solid waste that you could walk on. The reality is quite different: in debris concentration areas, studies show pollution levels on the order of 100,000 particles/km2, or 1 mm-size particle per 10 m2 area.

This surprising difference between popular belief and reality can be explained by several factors:

- Media requirements: the media wants sensational stories and answers about the severity of the pollution;

- Scientists' answers: scientists are often unable to quantify the severity of this problem. Their responses are often based on meaningless data such as the ratio of plastic-to-plankton mass;
- Many studies have focused on the areas of debris concentration. There is a considerable lack of data to provide a more comprehensive view of the plastic pollution of the oceans.

Oceaneye and citizen science, a response to the lack of data

To help provide answers to these basic scientific questions, the Oceaneye Association has set up a project to quickly produce plastic pollution data. Oceaneye develops and coordinates a network of actors contributing to the understanding of this issue. The aim is to motivate, coordinate and collect data from the three types of actors needed to create a pollution assessment:

- Eco-participants: Oceaneye equips volunteer sailboats (eco-participants) to collect samples during their trips. Oceaneye provides the equipment and protocols, trains the crews and coordinates sampling;
- Scientists: Oceaneye works with the academic community to facilitate new studies, analyze samples and publish results;
- Non-governmental organizations: Oceaneye collaborates with NGOs, in particular UN Environment, to disseminate the results via their databases and publications.

# Plastic pollution of the food chain: Myth or reality?

Annie Balet, W4W Group

Pollution of surface water by plastic materials is just the visible part of a problem that is of concern to both scientists and the general public. Press articles talk about the threat of large marine animals disappearing and more recently the presence of small particles of plastic in our food. To untangle myth from reality, researchers have studied the physical and chemical properties of plastic, measured the pollution in the water column and verified the presence of microplastics in the food web[1] and the balance of ecosystems.

Plastics consist of long chains of large molecules or polymers to which additives are added to obtain specific properties. These hydrophobic synthetic molecules have the capacity to adsorb[2] and concentrate persistent organic pollutants and have an estimated lifespan of 100 to 1,000 years. However, under the combined action of light and mechanical erosion (wind, waves, current), plastics break up into small particles measuring less than 5 mm that closely resemble plankton. Other microplastics are directly dumped into the environment, including microbeads in cosmetics and personal care products as well as microfibers shed by fleece textiles made from recycled PET during washing which are not completely filtered out by wastewater treatment plant. Storm runoff also contains pre-production pellets lost during transport. These pellets approximately the size of fish eggs, also called nurdles or mermaid tears, end up with all the other microplastics in rivers and lakes and accumulate in the oceans.

Microplastic concentrations in surface waters measured recently in the Mediterranean, the Great Lakes, Lake Geneva and the Danube, Thames, Rhine and Rhone rivers are very high, comparable to those found in ocean gyres. In some places, there is as much microplastic as there is plankton. Even the waters of very sparsely populated, non-industrialized areas are contaminated, like those of Lake Khovsgol in Mongolia, indicating that the entire hydrosphere is polluted by plastic. Surface water pollution is just part of the problem. Sediments are also heavily contaminated with plastic debris. Not only do plastics that are denser than water fall to the bottom, but lighter plastics that become biofouled[3] lose their buoyancy and sink as well. Thus, the entire water column contains plastics that can interact with organisms in all the trophic levels of the food web, especially with zooplankton and detritivores, small organisms at the bottom of the food chains that live either on the surface of the water or in the sediments.

It has long been known that ingesting plastics can cause large marine animals to die from choking or obstruction of the digestive tract. For example, adult and baby albatrosses die of starvation after mistaking plastic items covered with eggs or edible marine organisms for food. This food confusion is also described in a recent EPFL study on Lake Geneva. Plastic debris is found in the gizzards of 89% of dead aquatic birds (herons, swans, mallard ducks) as well as in the stomachs of 7.5% of small carnivorous fish (dace and bleak) found dead. Pellets from gulls in the port of Vidy contain plastic pellets and other kinds of plastics. According to some authors, plastic debris causes the death of 1.5 million animals from more than 250 species, including crustaceans, fish, turtles, birds and mammals, each year in the marine environment. Plastics also cause a false sense of satiety causing the animals to eat less. Under-feeding not only depletes their vitality and reproductive rates, it threatens the survival of many species and can also disrupt the trophic balance of the ecosystems.

The trophic transfer of microplastics leading to contaminants in seafood is a quite recent issue, but it has been investigated in several controlled studies conducted *in situ*.

Numerous catches in the wild show that plankton-eaters such as small crustaceans or lantern fishes, as well as detritivores (mud worms), which are the first links in the food chain, ingest microplastics because they are so widely available and are similar in size to plankton and sediments. However, in copepods (small crustaceans) that feed on microscopic algae suspended in water (phytoplankton), the researchers found that ingested fluorescent plastic particles are ejected in fecal pellets. Gut transit time takes a few hours in copepods and several days in fish.

While these observations suggest that contamination of the food chain is a myth, other research supports the hypothesis of bioaccumulation and trophic transfer of microplastics. Studies show that North Sea mussels contain 0.2 to 0.3 plastic microparticles in the digestive glands. Under controlled conditions, fluorescent polystyrene microbeads measuring approximately 10 µm taken up via the digestive tract and the gills of blue mussels can accu-

1 The food web is the network of intersecting and overlapping food chains for an ecosystem.

2 Adsorbed molecules adhere to the surface of an object, while absorbed molecules enter the object.

3 Biofouling is the accumulation of living organisms on underwater surfaces.

mulate in the hemolymph (circulatory systems). In addition to this bioaccumulation, another study shows that the particles transfer to crabs. Polystyrene microbeads measuring 0.5 µm are found in the stomach and hemolymph of crabs fed for four hours with mussels exposed for one hour to the particles. Although the retention rate of microfibers by mussels is low (0.28%), as is the transfer rate to crabs (0.04%), this study demonstrates that some plastics are transferred up the food chain.

Although direct ingestion of microplastics is difficult to distinguish from translocation[4], in upper trophic species it is strongly suspected. In fish that prey on small organisms, the level of contamination of the stomach contents is 20 to 40% depending on the species and catch areas (marine or freshwater). Contamination of double-crested cormorants living in the Great Lakes region and sea lions of the Subantarctic islands indicates that microplastics do reach the organisms at the highest trophic levels of the marine food web and those farthest from inhabited and industrialized areas.

More importantly, plastics not only transport additives such as phthalates, bisphenols, and flame retardants (PBDEs) but also adsorb and concentrate persistent organic pollutants (DDT, PCBs[5] or PAHs[6] ) on their surface, up to 1 million times the amount measured in water. All of these persistent bioaccumulative and toxic substances (PBTs) are known to be either endocrine disruptors or carcinogens.

One study shows that DDT, PCBs and PBDEs have been identified in most of the juvenile flounder caught in the North Pacific central gyre. The authors conclude that although the source of the PCBs and DDT cannot easily be determined, the massive presence of microplastics as a source of PBDEs was strongly supported.

The release of toxins, as well as the toxic effect of PBTs resulting from marine pollution, is demonstrated in the medaka, a small laboratory fish. The concentration of PBTs in the adipose tissue of individuals exposed for two months to polyethylene microplastics submerged for three months in San Diego Bay in California contaminated with PCBs, PAHs and PBDEs is much higher compared to controls. In addition to endocrine disruption of gonad function, physiological stress was observed, with glycogen depletion in 74% of contaminated fish, liver cell necrosis in 11%, and a liver tumor in one fish.

Other researchers exposed mussels to polyethylene microplastics contaminated with PAHs for two months. They found that not only do the mussels ingest and accumulate plastic microbeads in the hemolymph, but 20% show stunted growth, 41% have decreased fertility and they also report impaired immunological response and oxidative stress compared to unexposed mussels. These toxic effects indicate that the pollutants transported by the plastic fragments are transferred to the internal tissues of the organisms, even though the retention capacity of PVC is higher than that of sand, as shown by another study carried out with mud worms.

Another little-studied ecological risk of plastic debris in the ocean is the transport of species to sites where they were not previously present. A single piece of plastic measuring 4 m, which washed up on Canada's west coast after the 2011 tsunami in Japan, carried 54 species new to the North American ecosystems. These artificial rafts form an ecosystem (plastisphere) that is different from the surrounding sea water. They can upset the balance of the food chain, as the proliferation of sea skaters (*Halobates sericeus*) demonstrates. The females lay their eggs on the hydrophobic surface of plastics, which are perfect incubators. When they mature, the adults end up in new areas and feed on plankton and fish eggs. In doing so, they not only weaken the bottom of the food chain but also jeopardize the fishing industry.

These floating rafts are also colonized by algae, which benefit from good sunlight and capture more CO2 by photosynthesis. Unfortunately, they can also carry toxic algae and pathogenic bacteria that are dangerous to marine wildlife. For example, vibrio bacteria that cause cholera in humans and attack the digestive system of fish can quickly colonize polypropylene and polyethylene, which are present in large quantities in ocean gyres. These micro-organisms can make wild fish unfit for consumption and endanger fish and shellfish aquaculture.

Other bacteria form a biofilm that generates fissures in the surface of polyethylene particles, suggesting bacterial hydrolysis. This biofragmentation could add to the photochemical and mechanical breakdown of the plastics. It could release nanoplastics whose health and environmental impacts are unknown, and could be completed by bacterial enzymes that break down hydrocarbons.

The reality is that animals at all trophic levels ingest plastics. Recent studies demonstrate microplastic translocation and trophic transfer. They are therefore vectors of toxic substances that can be biomagnified[7] up the food chain and contaminate seafood as well as freshwater fish. Although fish are gutted prior to consumption, this research explores a new source of consumer exposure to chemical contaminants. Not only is there a public health risk, but little research has been done on the adverse ef-

4 Translocation is the passage of small particles into the tissues.

5 The use of PCBs has been prohibited in France since 1987

6 PAHs: polycyclic aromatic hydrocarbons produced during incomplete combustion.

7 Biomagnification is the concentration of toxins in organisms at the top of the food chain.

fects on the food chains. By causing the death of many animals and by transporting invasive species and toxic or pathogenic microorganisms, plastic pollution endangers the ocean resources. This is a global problem that has emerged with the widespread use of plastics, which gives rise to environmental, health, economic, political and social consequences when it comes to managing the waste.

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## Some pictures...

L.-I. Stahl Gretsch (accueil et présentation du modérateur, Benoît Girardin, au 1er rang à gauche)

Sarah Stewart-Kroeker, Pascal Hagmann et Annie Balet pendant leurs interventions

D. Diz, A. Petitpierre, C. Voutsinas, E.Fiechter-Widemann

Présentation de Stéphane Fischer d'instruments du Musée d'histoire des sciences en rapport avec l'eau.

Roland Benz faisant la démonstration d'une invention de l'association ADED (www.aded-suisse.org): « The Drop ».

Vera Slaveykova, Daniela Diz, Frédéric Sciacca et Benoît Girardin pendant leurs interventions

# Impact of microplastics on aquatic organisms: Tiny particles, big problems ?

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Plastics are synthetic materials made from a wide range of organic polymers with more than 20 different types in use, including polyethylene, PVC, nylon, etc. [1]. The production and use of plastic materials is continuously growing and benefit the modern society. In the "age of Plastics", the global plastic mass production steadily increased form 15 million tons in 1964 to 311 million tons in 2014 [2]. The estimations showed that more than 12.2 million tons end up in the ocean each year from different sources, resulting in an increasing environmental contamination. Indeed the accumulation of plastic waste in the oceans is a global, rapidly growing problem which is particularly pronounced in the five major oceanic gyres which represent hotspots of waste accumulation [3]. For example a maximum concentration and mass of 32.76 particles $m^3$ and 250 $mgm^3$ were reported in the North Pacific Subtropical Gyre [4].

Microplastics are generally defined as plastics that are less than 5 mm in size [5]. From ecotoxicological perspective, microplastics, from voluntary or involuntary release, are emerging contaminants of global importance with increasing concerns about their environmental implications. Microplastics can originate from primary and secondary sources. Primary sources include various skin care products, cosmetics, toothpaste, synthetic textile, while secondary sources include breakdown of large items by degradation and fragmentation. For example, single garment was shown to produce >1900 fibers per wash [6]. Various processes can lead to microplastic formation, including physical, photo- and biotransformation and degradation [7]. The microplasticas are characterized with small size and very high surface area, which make them highly reactive. For example if totally transformed to 40nm-size plastic particles, a classical supermarket bag will have a surface area of $2600m^2$. Microplastics account for the larger proportion of plastics in the environment by number of particles per $km^{-2}$, while macro-sized debris account for largest proportion by mass ($kg/km^{-2}$). Microplastic densities varied from 0 to 466,305 microplastics per $km^2$ as reported in the recent review summarizing the available measurements of the concentrations and distributions of micro-sized plastics in ocean surface water, beach sand, deep-sea water, and lake water worldwide [8]. Beside entanglement and ingestion of macro-debris by large vertebrates, microplastics are accumulated by planktonic and invertebrate organisms, being transferred along food chains [9].

Owning to their small sizes, the microparticles can be readily ingested by aquatic microorganisms, can affect them and accumulate in the aquatic food chain thus contributing to human exposure via food. In addition to the intrinsic physical toxicity, microplastics can be vectors for toxic metals and organic micropollutants and thus can induce chemical toxicity in the aquatic organism. They can sorb different environmental pollutants, e.g. persistent organic pollutants, as well as leach additives and monomers.

The present talk focused on the toxic effects intrinsic of micro-sized plastics. The impact of microplastics has been studied since the 1990s and it was shown to affect algae, ciliates, invertebrates, crustaceans, and fish mainly in marine ecosystems [8]. Low-density floating microplastic debris was shown to affect significantly the pelagic biota, while the high-density microplastics - the benthic biota [8, 10]. Factors contributing to the bioavailability of microplastics to marine invertebrates include size and density, and susceptibility of different feeding guilds; the accumulation and translocation were thoroughly reviewed [10]. High-density polyethylene particles of size 0–80 µm were found to accumulate in the gill surface and inside the gills, as well as in the intestine of the edible blue mussel *Mytilus edulis L* [11]. Microplastics can affect feeding of mussel *Mytilus edulis L.* as demonstrated by the significant reduction of the algal filtration rate when exposed to 25 µg/L of polylactic acid and high-density polyethylene microplastics [12]. Exposure to polystyrene microparticles of 2 and 6 microns interfered with energy allocation, reproduction, and offspring performance in oysters [13]. Fluorescently labeled 5 µm-diameter polystyrene microparticles were found to accumulate in zebra fish gills, liver, and gut after 7 days of exposure, while larger-sized 20 µm diameter polystyrene microparticles accumulated only in fish gills and gut and no similar particles were found in liver, demonstrating the importance of microplastics size in the bioaccumulation [14]. Consequently the activities of antioxidant enzymes significantly increased in fish treated with 5 µm polystyrene microparticles in a dose-dependent manner indicating that oxidative stress was induced after treatment with microplastics [14].

More recently such research was extended to freshwater ecosystems [15]. As an example of our own research demonstrated that positively and negatively charged latex particles of 200nm size were consumed by water flea

*Daphnia magna* [16]. The accumulation of the microplastic particles detected in the *D. magna* gut increased with their concentration in the exposure media. The 48h immobilization tests showed that both micro-plastic particles could be classified as hazardous towards the water flea.

Trophic transfer, as one of the major routes of exposure to microplastics was also shown to occur as a common phenomenon concurrently with direct ingestion in few studies mainly in marine ecosystems [17]. A recent study reported the first findings of plastic debris in gut contents of fish and bivalves sold for human consumption, thus raising concerns regarding human health [18]. Briefly, anthropogenic debris were found in 28% and 25% of individual fish for human consumption in Indonesia and USA, respectively. Anthropogenic debris were also found in 33% of individual shellfish sampled [18]. These results revealed the need to include plastic waste when developing seafood safety criteria. Interestingly a recent study also revealed potential to human exposure to microplastics by the consumption of contaminated salt: the microplastics content of 550–681 particles/kg in sea salts was found to be much higher than those in lake salts (43–364 particles/kg ) and rock/well salt (7–204 particles/kg) [19].

Overall, the plastic pollution is ubiquitous and the "tiny" plastic particles emerge as a "big" environmental problem of global concern. Although the environmental impact of macro-plastic waste is extensively studied, the behavior and the effects of micro-plastics, either unintentionally released in the environment, either formed as a degradation of the macro-plastics are not yet fully elucidated. Nonetheless, the existing literature showed that microplastics could induce complex physical and chemical toxicity in aquatic biota. The assessment of the environmental hazard and potential risks induced by the microplastics is important task of the environmental risk assessment. It can provide a scientific basis for establishment of the sound environmental quality criteria. Understanding of the possible alteration of the aquatic systems and thus the potential impacts to aquatic biota and humans, as well as their reduction e.g. via changes of the plastic waste management, reduction of land-based plastic waste input into the aquatic systems is an important research and societal priority in the "age of Plastics".

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# Oceans Governance and the Challenges of Marine Debris

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This contribution explores the fragmented system of marine governance in light of the challenges posed by marine debris, especially plastic (and micro-plastic) impacts on marine biodiversity. In doing so, it explores the obligations under the UN Convention on the Law of the Sea (UNCLOS) and its relationship with the UN Convention on Biological Diversity (CBD) and other relevant instruments, including the Sustainable Development Goals (SDGs).

A holistic approach for tackling the issue is needed (especially from land-based sources), while also considering cumulative impacts of marine debris with other stressors on biodiversity and species. For example, while plastic is chemically inert, plastic can absorb organic pollutants in high concentrations. Microplastics can be retained in tissues of marine species and humans at the top of the food chain, and associated-pollutants might be released upon ingestion [1]. Entanglement of marine species is also a big problem; floating plastic litter can also transport invasive species. UNEP has estimated that 80% of marine debris and plastics are from land-based sources and that 90-95% of marine pollution is composed of plastic [2].

Under Part XII of UNCLOS, Article 192 imposes an absolute obligation on States to protect and preserve the marine environment, with Article 207 (1) binding States to adopt laws and regulations to prevent, reduce and control pollution of the marine environment from land-based sources, taking into account internationally agreed standards and best practices. This article therefore allows for the incorporation by reference of policy instruments such as the CBD Decisions on marine debris and UN environment Assembly (UNEA) resolutions. Article 213 of UNCLOS is also relevant since it also mandates that States not only adopt laws and regulations, but also enforce these, while taking measures to adopt international standards.

Several other international instruments[1] address marine debris in some form both from land-based or sea-based sources, assisting with the interpretation and implementation of UNCLOS obligations on the protection of the marine environment from pollution under Part XII in a systemic manner. On the other hand, given this fragmented nature of the current legal regime governing marine debris, efforts to enhance cooperation and coordination among different international fora is key for a comprehensive implementation of such obligations to take place. In this connection, it is important to note the efforts by UN Environment Assembly (UNEA) through its Resolution 2/11 (2016) on marine plastic to address the issue by recognizing the need for an urgent global response taking into account a product life-cycle approach. The resolution also welcomed the work of different conventions such as the CBD on impacts of marine debris on marine biodiversity, and called for coordination of efforts. The 2017 session of UNEA will be particularly important given its overarching theme of pollution [3].

The UN 2030 Agenda for Sustainable Development and its SDGs are also particularly important, especially the relationship between SDG 14.1 (on preventing and reducing marine pollution, in particular marine debris from land-based sources by 2025) and SDGs 12.1 and 12.5 on sustainable production and consumption, since production life-cycle is at the heart of the problem. In connection with the SDGs, it is noteworthy that CBD Decision XIII/3 (2016) urged Parties, when implementing the 2030 Agenda for Sustainable Development, to mainstream biodiversity in the implementation of all relevant SDGs. Parties can do so, for instance, by implementing CBD Decision XIII/10 on marine debris, which urged States to prevent and mitigate the potential adverse impacts of marine debris, taking into account the CBD Voluntary Practical Guidance on Preventing and Mitigating the Impacts of Marine Debris on Marine and Coastal Biodiversity and Habitats [4]. Despite its voluntary nature, this CBD guidance could be interpreted as internationally agreed standards under UNCLOS Article 207 cited above.

## Habitat impacts

Some areas are more vulnerable than others, for example, there is evidence that as Arctic ice freezes, it traps floating microplastics—resulting in abundances of hundreds of particles per cubic meter [5]. This is three orders of magnitude larger than some counts of plastic particles

1 These include, inter alia: the International Convention for the Prevention of Pollution from Ships (MARPOL), Annex V on Prevention of Pollution by Garbage from Ships; the London Convention and its London Protocol; the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal; the Agreement on the Conservation of Albatrosses and Petrels; the Global Programme of Action for the Protection of the Marine Environment from Land-based Activities, and Regional Seas Programmes and Conventions; the Stockholm Convention on Persistent Organic Pollutants; the FAO Code of Conduct for Responsible Fisheries; UN Agreement for the Implementation of the Provisions of the UN Convention on the Law of the Sea of 10 December 1982 relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks (Fish Stocks Agreement).

in the Great Pacific Garbage Patch. The deep sea has also been found to be a major sink for microplastics [6].

Article 194(5) of UNCLOS establishes the obligation to protect and preserve rare or fragile ecosystems and habitats of depleted, threatened or endangered species as well as other forms of marine life. UNCLOS, however, does not provide criteria for identifying such areas, relying again on other instruments to do so. Several instruments have developed relevant criteria and identification processes. Of particular note is the CBD ecologically or biologically significant marine areas [7] (EBSAs) process. The CBD has described 279 areas globally that meet the EBSA criteria[2]. Even though the EBSA description does not automatically trigger conservation and management measures, given its scientific and technical nature, in light of Article 194(5) of UNCLOS, Coastal States[3] and competent organisations have an obligation to take appropriate conservation and management measures to protect these sites. In light of this, impacts of marine debris on EBSAs should also be assessed when considering conservation and management measures for these areas (e.g. the Sargasso Sea [8] EBSA provides a good example).

## Conclusion

Despite UNCLOS obligations regarding the protection and preservation of the marine environment including from marine debris and plastics from all sources, implementation is lagging. There is an urgent need to improve marine and terrestrial waste management, foster stakeholder partnerships, training schemes and reduction of packaging, and long-lasting products – these are also issues related to the need for sustainable production and consumption practices and regulations. Finally, there is a need for more coordination between international efforts related to marine debris and a comparative review of existing policy and legal instruments would be recommended. Such analysis could also build upon the relationship between UNCLOS and relevant international instruments, including the CBD, to facilitate the implementation of globally agreed standards and best practices incorporated by reference under UNCLOS' obligations to avoid and minimise this enormous threat to marine and coastal biodiversity.

2 The EBSA criteria was adopted by CBD Decision IX/20, Annex I and includes the following features: uniqueness or rarity; special importance for life history stages of species; importance for threatened, endangered or declining species and / or habitats; vulnerability, fragility, sensitivity, or slow recovery; biological productivity; biological diversity; and naturalness. The process to describe EBSAs globally was initiated through CBD Decision X/29.

3 With respect to EBSAs located within national jurisdiction.

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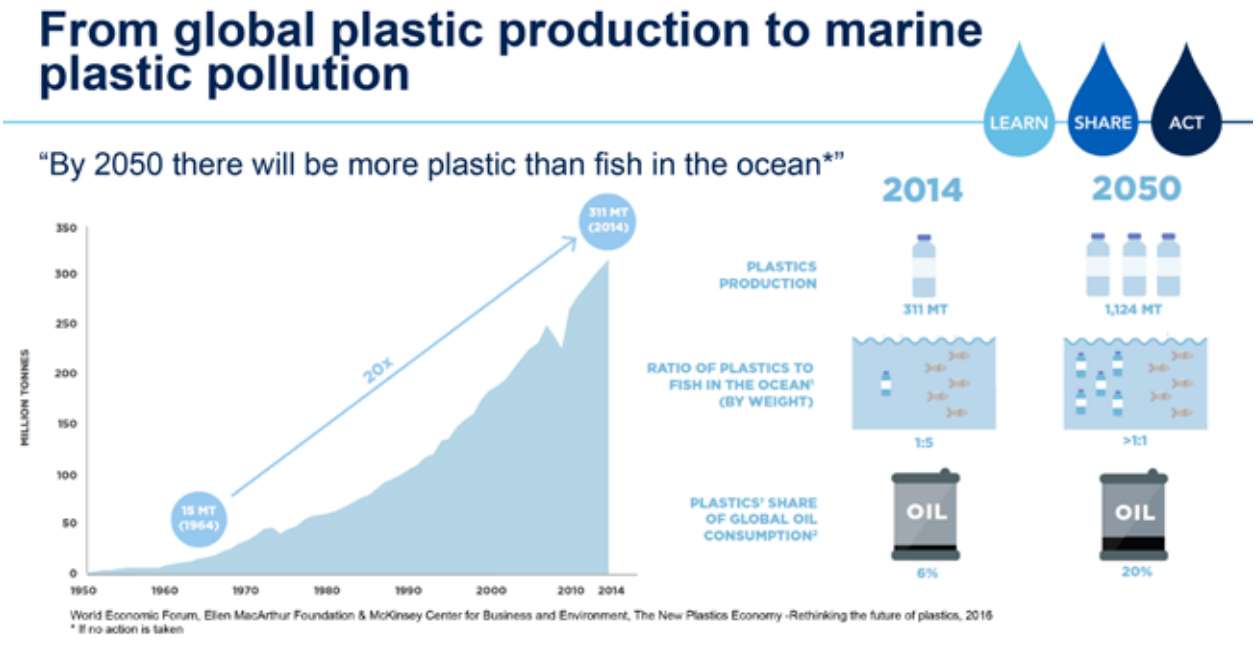
## Race for Water Odyssey and original solutions

Frédéric Sciacca, directeur de la section «Sciences» de la fondation Race for Water


/ In 2010, at least 8 million tons of plastics were estimated to leak into the ocean each year – which is equivalent to dumping the contents of one garbage truck into the ocean every minute. The best research currently available estimates that there are over 150 million tons of plastics in the ocean today | World Economic Forum 2015 (Source Jambeck et al., 2015)

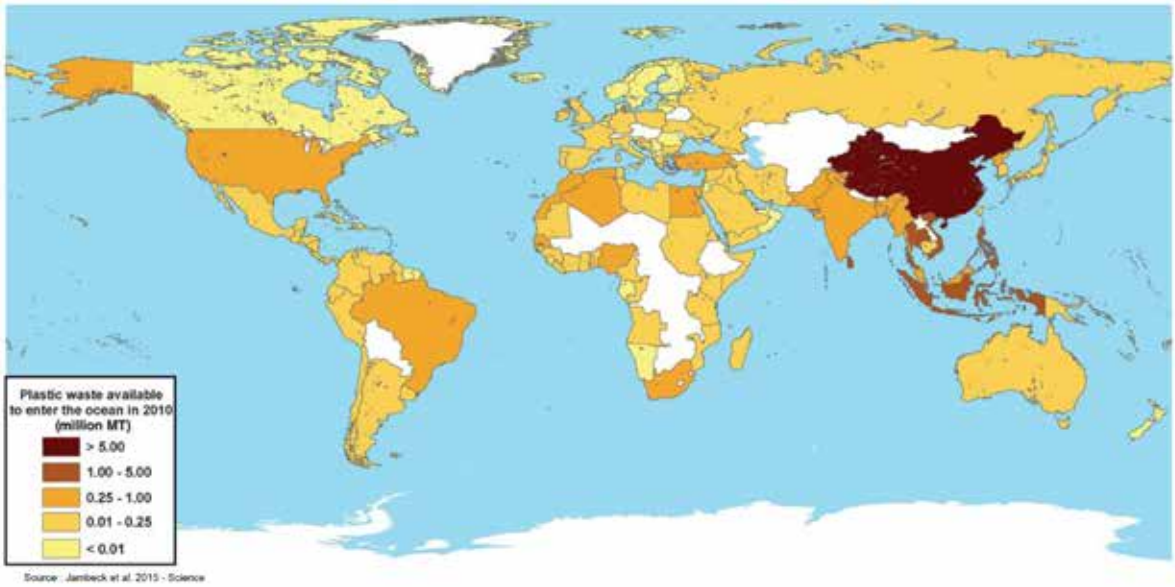
/ Plastic pollution causes at least USD 13 billions' worth of damage every year to industries that include fishing, shipping and tourism | UNEP 2014

/ Improving wastewater and solid waste collection and management presents the most urgent short-term solution to reducing plastic inputs, especially in developing economies | UNEP 2016

2

# Plastic waste produced and mismanaged worldwide

LEARN SHARE ACT




/ 16 of the top 20 contributors to plastic marine litter are middle-income countries, where economic growth is rapidly occurring.

/ The top five countries (China, Indonesia, Philippines, Sri Lanka and Vietnam) account for more than 50% of 'mismanaged' plastics, based on this analysis.

3

# Our Program

LEARN SHARE ACT

Since its creation in 2010 and in order to maximize the impact of its actions, Race for Water developed the LEARN – SHARE – ACT program:

**LEARN**

*Contribute to the advancement of **scientific knowledge on plastic pollution in water***

**SHARE**

***Alert** decision-makers, **raise awareness** among the general public and **educate** younger generations*

**ACT**

*Promote and implement **sustainable solutions with significant social impacts***

4

# Learn Program – support the scientific community

Because so many questions remain open about the scale and the impacts of plastic pollution in the ocean, we are willing to support the scientific community in gaining a better knowledge.

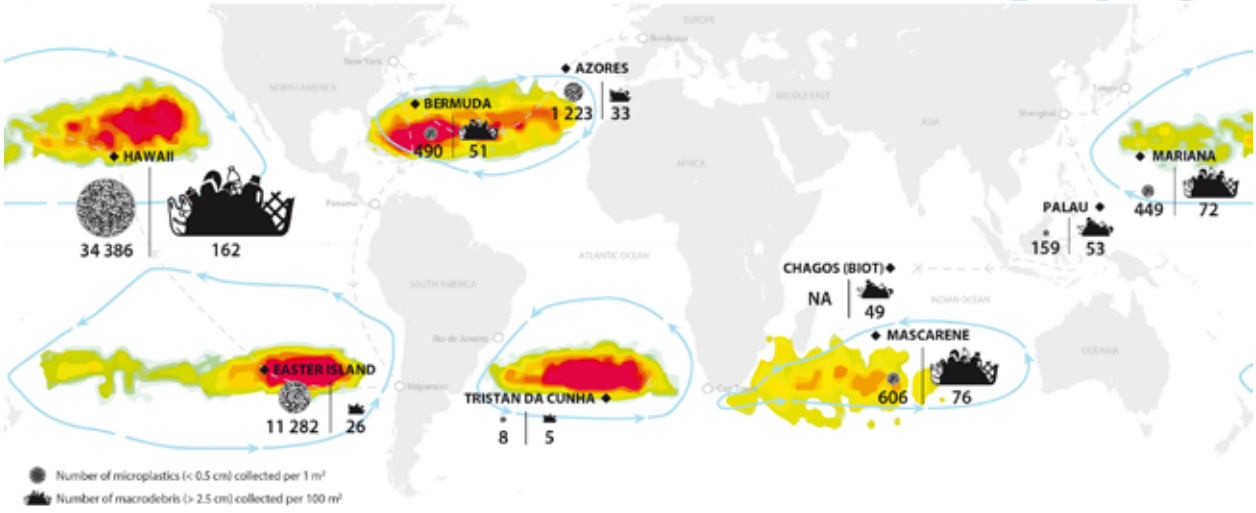



*Contribute to the advancement of **scientific knowledge on plastic pollution in water***

5

# Race for Water Odyssey 2015

## Global assessment and outcomes

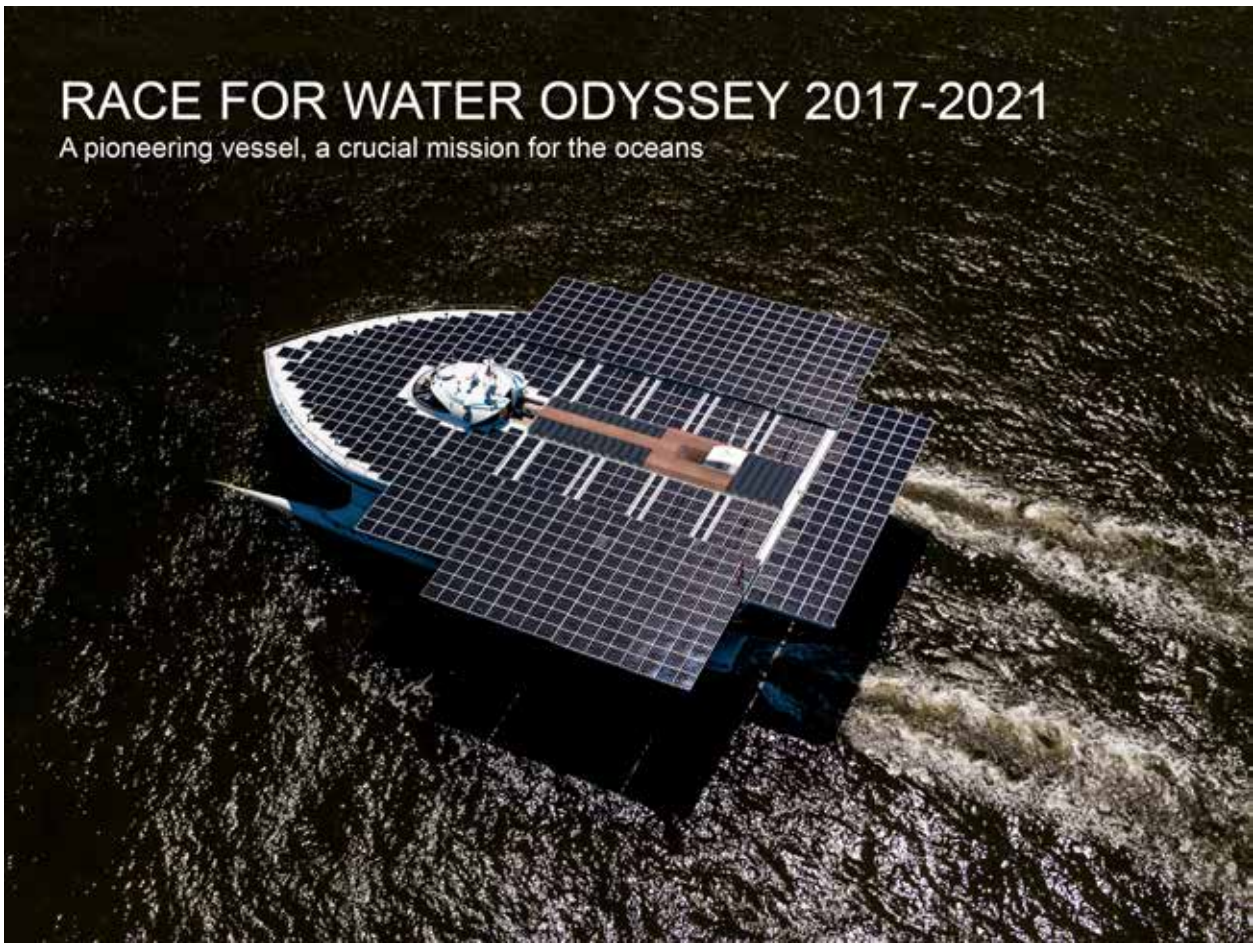

The **Race for Water Odyssey**, our 2015 global assessment of plastic pollution, allowed us to state that:

/ Plastic waste is everywhere

/ There is no 7th continent nor plastic islands but a plastic soup of waste floating in the gyres

/ A grand-scale clean-up of the ocean is unrealistic, land-based solutions are key to be efficient in the fight against plastic pollution in water

6




## THE WIND, THE SUN AND THE OCEAN
## RACE FOR WATER POWER SOURCES

Length: 35m
Width: 23m
Height: 6.3m

Average Speed: 5kts
Maximum Speed: 9kts

4 to 5 crew
While sailing: up to 20 passengers (inc. crew)
When docked: 70 passengers

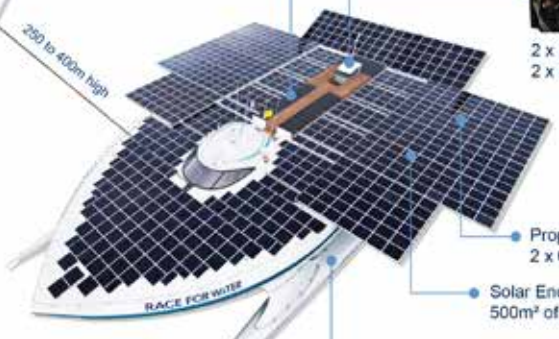

250 to 400m high

### A high-altitude towing kite

Race for Water and the company Skysails are developing a next generation towing kite (40m² of surface area at an altitude of 300m represents the equivalent of 500m² of sails while at sea i.e. the equivalent of 200kW of propulsion).
An innovative and effective solution, entirely managed by an automatic pilot, enabling the vessel to double her speed in certain conditions as well as providing greater autonomy.

Hydrogen Storage:
25 tanks delivering up to 2800kWh of electricity

2 x 30kW fuel cells
2 x 5kW electrolyser




Propulsion:
2 x 60kW electric engines

Solar Energy:
500m² of Solar Panel

Solar Energy Storage:
4 Lithium ion batteries delivering 754kWh

### Hydrogen Power System on board

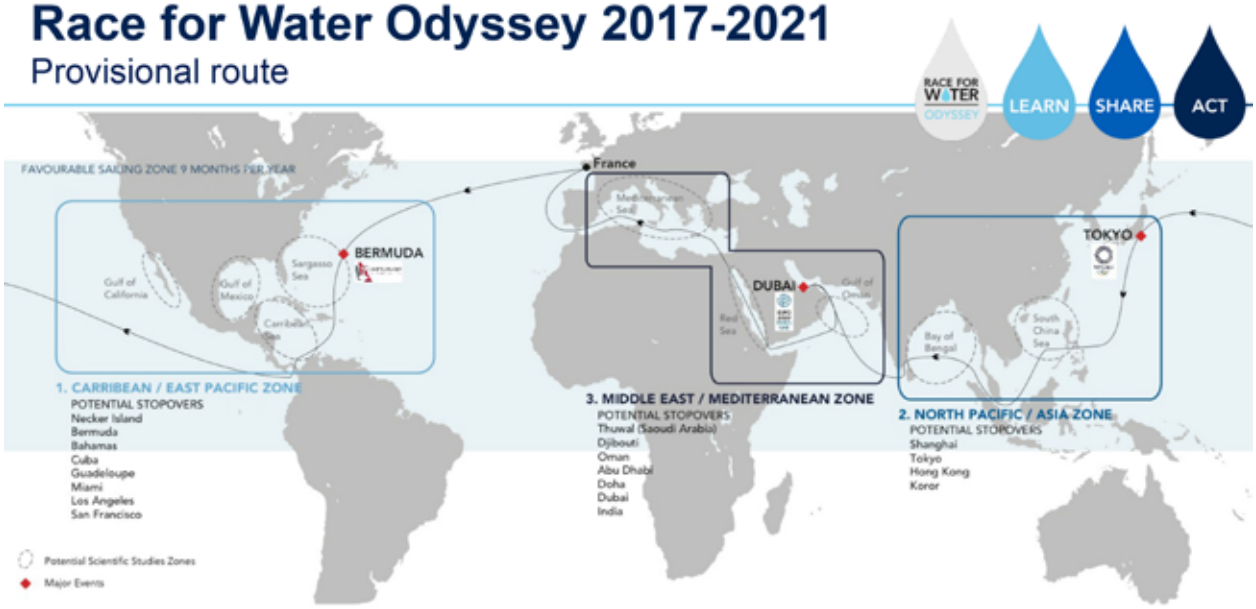
Race for Water and the company Swiss Hydrogen S.A. are installing a hydrogen production unit: 25 hydrogen bottles at 350 bar storing close to 200kg of hydrogen which can be converted into more than 2800kWh of electricity i.e. 4 times the electricity storage contained in the batteries (745kWh).

Thanks to the hydrogen system the vessel will have 6 extra days of autonomy at a speed of 5 knots.

© Race for Water Odyssey 2017-2021 1

# Race for Water Odyssey 2017-2021

## Provisional route




**/ A 5-YEAR EXPEDITION AROUND THE WORLD**

Dedicated to the ocean, science and energy transition using the ocean, the sun and the wind as its sole sources of energy

**/ GOALS**

- Conduct scientific studies supporting the preservation of our oceans
- Act, raise awareness and promote new solutions to fight plastic pollution in the oceans
- Promote "Clean-Tech" innovations

*A dedicated presentation about the Race for Water Odyssey 2017-2021 is available upon request.*

9

# Act Program : «Plastic waste-to-energy» projects

Because it is urgent to take action, in 2016, we put a strong focus on developing the program ACT. This section will present the Business Model of our plastic waste-to-energy concept.


*Promote and implement* ***sustainable solutions with significant social impacts***

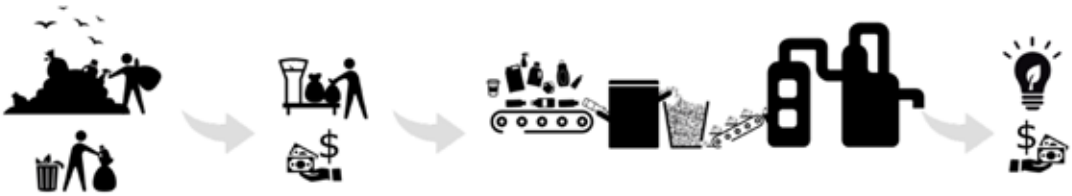
10

# Action plan

## Implement a value chain for plastic waste

ACT

/ Collecting / Remunerating / Processing / Generating energy



### / ENVIRONMENTAL OUTCOMES

- Stop the flow of waste in the streets, in nature and in our oceans
- Protect thousands of species (including humans) from death, illness or injuries
- Preserve zooplankton which produces half our oxygen

### / ECONOMIC VALUE CREATION

- Provide a cleaner and sustainable source of energy
- Apply a long-term model which stimulates local economies (tourism, fishery)
- Reduce expenditures for local authorities (health, pollution clean-ups)

### / SOCIAL IMPACTS

- Create jobs for thousands of waste collectors to gather plastic waste in the streets
- Provide a better quality of life and health improvement for most vulnerable communities
- Educate people to change behaviors and enhance environmental awareness

11

# Timeline for a global environmental, economical and social impact

ACT


### / WASTE-TO-ENERGY TECHNOLOGY INTELLIGENCE

- Build process mapping methodology
- Identify and study various technologies adapted to our plastic waste to energy model

### / MARKET STUDIES

- Identify key strategic places
- Proceed with pre-assessment surveys on local waste management, energy sector, and existing plastic waste to energy equipment
- Validate the environmental, financial, and social impact projection for each region of focus

### / FINANCIAL MODEL ANALYSIS

- Identify, analyze and focus on the most appropriate financial sources and instruments to build an investment pool for plastic waste to energy projects

### / PILOT PROJECT IN SWITZERLAND

- Use our protocol to test the selected technology model in Switzerland and assess its financial, ecological and energy balance
- Showcase to incite the investment community specifically in Switzerland

### / PROOFS OF CONCEPT

- Deploy and monitor our plastic waste to energy value chain in one coastal city and one island
- Showcase our model to launch the scale-up

### / SCALABLE PROJECTS DEPLOYMENT

- Scale the plastic waste to energy value chain in identified key places to reach our environmental, value creation and social strategic objectives targets

12

## We focus on the most relevant factors

Waste-to-energy technology intelligence

ACT

Each waste-treatment option scored differently with regard to the five factors we analyzed.

High impact
Low impact

| Treatment options | Plastics elimination | Technical development | Commercial attractiveness | Pretreatment simplicity | Social/ environmental performance |
|---|---|---|---|---|---|
| Recycling (waste to plastic) | | | | | |
| Waste to oil (pyrolysis)[1] | | | | | |
| Waste to gas (gasification)[1] | | | | | |
| Waste to energy (refuse-derived fuel to cement kiln) | | | | | |
| Waste to energy (incineration) | | | | | |
| Sanitary landfill | | | | | |

RACE FOR WATER — A FOUNDATION TO PRESERVE WATER

1 Other chemical recycling methods are out of scope as they are not economical.

Source: Ocean Conservancy report

13

## From social impacts to economic value

Waste-to-energy technology intelligence

ACT

**CREATING JOBS**

**CREATING ECONOMIC VALUE**

Not-for-Profit collect organisation → Innovative waste-to-energy technology → Profitable outputs

/ Collecting / Remunerating waste pickers


/ Electricity

/ Other types of energy
- Hydrogen gaz
- Methane gaz
- Ethanol

/ Waste pickers can **collect 25kg of plastic litter per day per person**

/ A machine that **treats 12 t/day** produces **8,000MWh* annually** (equivalent to the average annual electric consumption of **2000 four-person households** with no electric heating systems in Switzerland**)

*Detailed projections available upon request.
**Average annual electric consumption of four-person households with no electric heating systems in Switzerland : 4 MWh/year. Source: Des appareils ménagers efficaces - Fiche d'information du WWF Octobre 2012.

## Identified technology : Biogreen® pyrolysis & gazification

Waste-to-energy technology intelligence

Plastic litter

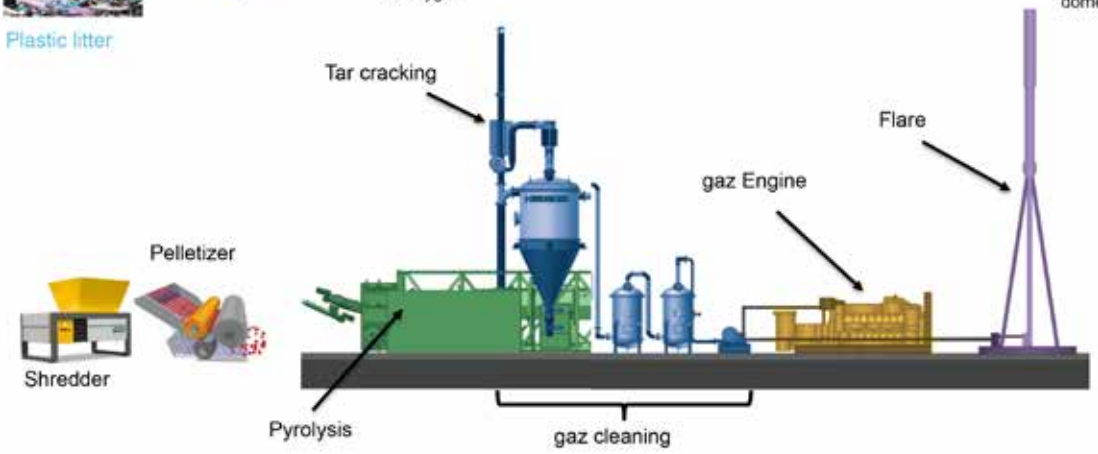
Pellet

**Biogreen® pyrolysis**
high-temperature thermochemical process performer in the absence of oxygen

**syngaz**
gaz suitable for energy applications

**gaz engine**
combined heat and power generation

**Energy**
created electricity & heat can be used for industrial or domestical purposes

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## Proof of concept overview

Proof of concept

### / GOALS

Demonstrate the environmental, social and economical impacts of the model in one coastal city or one island to induce the investment community to participate to future projects based on the same concept.

### / CHOOSE THE RIGHT PLACE

- Strong demand from local stakeholders (communities, philanthropists, foundations, investors)
- Large existing network
- Limited political hurdle thanks to strong relationships with local communities and local authorities, social stability, …

### / ON GOING PROJECTS

- Lima city, Peru
- Borneo, Malaysia
- Easter Island, Chile

# Oceans flooded with plastics: myth or reality. Ethical Considerations

Benoît Girardin, W4W Group

## Some very dire facts as an introduction

What a contrast between the forests on the outskirts of Karachi strewn with plastic bags and those of Kigali that breathe freely ever since plastic bags were banned in Rwanda! And the Rhône reed beds which were nearly suffocating in 2006 and where some 200 tons of waste, mostly plastics, still pile up each year, in spite of awareness campaigns.

"Conserve and Sustainably Use Oceans, Seas and Marine Resources for Sustainable Development" is goal 14 of the sustainable development goals approved by virtually all countries in 2015. In addition to plastic bags and packaging, the International Union for Conservation of Nature (IUCN) indicates the massive presence of microplastics from tires and synthetic textiles.

The 8 million tons of plastics dumped annually and the plastic soup polluting the world's oceans give rise to an original ethical reflection that will be articulated in three phases.

## 1. Political, social and individual ethics

The first challenge is to closely and coherently articulate **political ethics** in charge of responsible management of inhabited territories, **social ethics** of nonprofits, industrial firms and institutions and **individual ethics** of users, residents and citizens. Political ethics should set out the ground rules to tackle the challenge in terms of framework conditions (macro level), social ethics seek to obtain commitments from nonprofits or firms that promote collective behavior changes (meso level) and individual ethics seek to motivate opinion leaders as well as citizens to implement concrete practices (micro level). Too often we content ourselves with approaches that are limited to one or two levels, but ignore the others. Only by integrating all three levels can we make an effective and lasting difference, avoiding the pitfalls typical of unilateral policies and approaches.

Political frameworks often change under pressure from collective or individual engagement and public opinion, but are more likely to succeed when individual, alternative and innovative behaviors are attractive in terms of jobs or income, or coherence and values. A momentum of change can be perpetuated.

A **multi-stakeholde**r approach is essential to success. This means negotiating a strategic agreement between stakeholders involved in ocean plastic pollution, whose interests are naturally different – in particular stakeholders involved in tourism, trade, transport and food security, as well as daily consumption and packaging. This is assuming that an ethical convergence capable of federating stakeholders with different interests can be developed. The stakeholders must not demonize each other, instead they must understand the conflicting interests that motivate them, before seeking to identify and share the ethical values that can bring them together. This will also show how polycentric institutions can hinder or help the necessary innovation through discussions and within the available room for maneuver[1].

Likewise, it is important to link the **formal and informal economy**[2], which complicates, but also enriches, the relationship between macro and micro levels. Too often only the formal economy is analyzed and regulated, while the damage caused by the informal economy is largely ignored. This is especially true where it accounts for more than one-third or one-half of GDP. Specific incentives for the informal sector are not just prudent, they are necessary.

User engagement and incentives are absolutely essential for the management of common resources. Lessons learned from over one hundred conservation projects analyzed demonstrate the importance of local users finding an interest in harvesting and selling a few products and/or being involved in the design and management of such projects[3]. Economist G. Quentin reaches a similar conclusion: effective management of common resources requires the active participation and involvement of users of those resources[4]. Flexible convergence between stakeholders at different levels is more effective in limiting

1 "We need to ask how diverse polycentric institutions help or hinder the innovativeness, learning, adapting, trustworthiness, levels of cooperation of participants, and the achievement of more effective, equitable, and sustainable outcomes at multiple scales" (Theo Toonen 2010).

2 See Ostrom, Elinor; Kanbur, Ravi; Guha-Khasnobis, Basudeb (2007). Linking the formal and informal economy: concepts and policies. Oxford: Oxford University Press.

3 Brooks, J.S., Franzen, M.A., Holmes, C.M., Grote, M.N. and Mulder, M.B., 2006. Testing hypotheses for the success of different conservation strategies. Conservation biology, 20(5), pp. 1528-1538.

4 Grafton, R. Quentin. 2000. 515: "Each is capable of preventing resource degradation and ensuring the on-going flow of benefits to resource users. A comparison of the bundle of rights of the three regimes suggests that a common factor in ensuring successful governance of CPRs is the active participation of resource users in the management of the flow of benefits from the resources".

overexploitation and over-destruction of these common resources and controlling plastic litter. Ethics in negotiation helps overcome the inevitable blocking points. The key to success is also to go beyond sanctions, advocacy and individual solutions by developing economic incentives[5].

In the specific case of controlling plastic litter, this is even more true, whereas implementing such controls is much more difficult. The dynamic does not focus on production, but rather on disposal, liquidation, or what one gets rid of. It is relatively easy to manage what is produced or exchanged, since the products are available at hand, but what one gets rid of elicits few standards, according to the logic of good riddance. In one case it is a question of doing, in the other it is undoing. A sort of denial of responsibility prevails in this case which becomes virtually uncontrollable and seems to escape the imperative of accountability. Such a difficulty is specific.

## 2. Common resources or "commons"

The second phase concerns the territories or resources which belong to the common good, known as "commons", or local and accessible territories: a watershed to be irrigated, a pasture or forests to maintain, springs to be secured and saved[6]. Elinor Ostrom, Nobel Prize winner for Economics in 2009 for her work on the economics of the commons, demonstrated in the cases of forests in Switzerland and South-West Germany, Mongolian grasslands and lobster fisheries in Maine, that the governance of commons managed by communities, which therefore do not count as property in the strict sense, could be better and more efficient. The concept of responsibility does not arise from ownership, an exchange of goods or a lineage, but rather from a collective and lasting responsibility, which is more akin to stewardship[7].

Granted, these traditional management models date back to a predominantly rural world where we shared these common resources within territorial communities in order to ensure their survival. The territory concerned was controlled by local authorities rather than by a distant central authority. In the case of plastic pollution, the oceans, which extend far beyond the limits of territorial or national waters, are out of the reach of communities and may seem almost abstract. Yet this is the challenge: common governance of something that is far beyond the common scope.

The instruments of commons governance must therefore be fundamentally redesigned. In particular, the ethical governance of commons should be re-articulated: Who is responsible for it? How is accountability developed? To whom? With what incentives? The current example of knowledge and digital commons, such as Wikipedia, which is not owned by a company or private individual but by a community, can inspire us. Its quality is ensured by recognized criteria applied voluntarily by a community of contributors. Propaganda or defamation, as well as methodological shortcomings, are quickly sanctioned or at least signaled according to the name and shame principle.

A framework imposed by international conventions has been sought – see the analysis of Daniela Diz. The closest example is the 1961 Antarctic Treaty, supplemented in 1980 (1982) by a Convention on the Conservation of Antarctic Marine Living Resources (CCAMLR), then by a Protocol on Environmental Protection signed in 1991 and in force since 1998. This triangular institutional system for the Southern Ocean – the Antarctic Treaty System – is an original arrangement with respect to regional fisheries management organizations[8]. In October 2016, a significant step forward was made by a treaty drafted and negotiated under the auspices of the Commission for the Conservation of Antarctic Marine Living Resources defining a fishing exclusion zone in the Ross Sea covering 1.1 million km$^2$ [9].

But can such an arrangement be considered effective for managing diversity in **commons**, given that no populations live in the Antarctic and that only fishermen venture there? The Contracting Parties can thus come to an agreement without having to consider the needs of residents or regular users and without being able to solicit their engagement. However, in the case of ocean plastic pollution, there are communities present: residents, users and even polluters, even largely informal, who must be able to be involved in effective management of the commons. Examples of the governance of the Mekong or Danube basins are only somewhat convincing and show

5 In this sense the approach advocated by Race for Water Odyssey is exemplary – as are the new modes of industrial design and production.

6 See the works of Elinor Ostrom listed in the bibliography. Following his analysis of economic governance, particularly of the commons, US businessman and economic journalist Peter Barnes attempted to commodify the sky as a common resource (Sky Trust). See also the Commons platform.

7 The term "steward" comes from the old English "st□weard", house guardian, housekeeper. In his book Pie in the Sky, 2000, Peter Barnes describes it as a framework for capping and sharing of profits, returns and dividends: cap and dividend. The French term "concierge", which is sometimes used as a translation for steward, is too restrictive or pejorative, whereas its original meaning was someone in charge of maintaining a castle, official building or public building: A. Rey ed., 1998 Le Robert. Dictionnaire historique de la langue française, Paris.

8 The Treaty signed by 49 countries makes the Antarctic (land and ice) a demilitarized zone, declares that its sovereignty cannot be called into question and prohibits disposal of radioactive waste (Art. 5); it establishes an Ecosystem Monitoring Program (CEMP).

9 Article 5 of the Convention on the Conservation of Antarctic Marine Living Resources (CCAMLR) specifies an obligation with regard to the protection and preservation of the Antarctic environment.

that their effectiveness is limited to short-term crisis management[10].

We can safely say that Elinor Ostrom's findings on fluid and efficient communication among users are true and call for an ethical upsurge on the part of the latter: "Simply allowing communication, or cheap talk, enables participants to reduce overharvesting and increase joint payoffs contrary to game theoretical predictions. Large studies of irrigation systems in Nepal and forests around the world challenge the presumption that governments always do a better job than users in organizing and protecting important resources"[11].

In the case of plastic pollution that concerns us today, we could limit ourselves to the countries with ocean borders, and first mobilize civil society organizations. Remember that it is the IUCN that set the currently recognized target of protecting 30% of the planet's oceans.

Other stakeholders also want to assume their responsibilities: in February 2017, Dell launched a first shipment composed of 16,000 pounds of plastic recovered from navigable rivers and beaches, destined to be recycled. Other companies are drastically reducing their packaging, and buyers are purchasing in bulk, without packaging.

One could imagine here a sort of contract or barter among **ecosystem or ecological services** offered by biodiversity and a financial, public and community effort. These ecosystem services are the result of the ecological functions of operation, self-maintenance and resilience of systems, such as oxygen production, pollination or water purification. They actually have a measurable economic dimension[12]. The World Bank now calls for including biodiversity loss and climate change costs into national accounts.

In ethical terms, we have a problem when it comes to responsibility – the polluter pays principle is difficult to apply because the polluter is scattered, discreet, anonymous and faceless. The most realistic and responsible solution is to encourage upstream collection and sorting as well as recycling in order to organize a profitable and job-creating activity, with revenue coming from a combination of fines, subsidies from local authorities or business associations and Governments as well as from the sale of recycled products. In this way, responsibilities could be better identified and monitored.

## 3. Ethics of respect for species and responsibility towards beauty

The third phase is to develop an ethic of respect for animal and plant species and their biodiversity and an ethic of responsibility towards the natural beauty of the oceans, the land and the air.

However, stabilizing and then reducing global warming and controlling plastic pollution are different. Both of these challenges call for emotional sensitivity and even for passion in the etymological sense. They invite the community of nations to reinvent a responsibility of stewardship oriented by a long-term economic rationale stemming from aesthetic and emotional stewardship, drawing its source from wonder and compassion. However, the first challenge, from which societies and countries are beginning to suffer directly, requires directly self-interested action to avoid the consequences and contain the major risks, while plastic pollution will affect them more indirectly, requiring more discreet action to reduce the dramatic decline in biodiversity, damage to the food chain and the suffering of animal species. On the one hand, the offense is deliberate and intentional, while on the other, the harm caused is less accepted and deliberate.

Faced with ocean plastic pollution, it is therefore a question of advocating for the **natural beauty** of the sites and the plant and biological species that reside there and affirming the respect due to them. Part of our inhibition in the face of natural beauty has its origin in the predominant emphasis placed by the modern Western philosophical tradition – starting with the Enlightenment – on aesthetic judgment, the observer's tendency to frame the pleasant and the criteria of taste[13] while the ancient and medieval traditions articulated beauty to the being – ideal or

10 The Mekong River Commission (1995) and the International Commission for the Protection of the Danube River (1994) manage water quality and pollution, as well as issues of quantity, distribution, transport and fishing. The crisis involved mercury pollution in the Danube, in very limited territorial segments. On the more convincing case of Franco-Genevan transboundary aquifer management, see de los Cobos G. "A historical overview of Geneva's artificial recharge system and its crisis management plans for future usage". Environmental Earth Sciences 73.12 (2015): 7825-7831. Girardin B., "Gestion juste des aquifères transfrontaliers" in Ethique globale de l'eau. Actes du 3e colloque interdisciplinaire organisé par le W4W, Genève 2013.

11 Ostrom E. 2010, p. 1.

12 The concept of ecological services was developed by US scholars based on the Study of Critical Environmental Problems. Man's Impact on the Global Environment, published in 1970 by MIT Press, then validated internationally in the Millennium Ecosystem Assessment, commissioned in 2000 by the United Nations SG, and the international report published in 2005. Its history is traced by G.C. Daily 1997.

13 Going beyond the emphasis placed by the British tradition (Hutchinson, Hume) on the criteria for declaring certain aesthetic judgments erroneous, Kant states that the judgment of beauty is singular, impossible to generalize. The laws of taste cannot be stated under a rule of beauty. The beauty of works of art remains linked to a message of the artist and conditioned by the context.

concrete[14] – and regarded it as an intrinsic quality or category applicable to everything and not relational.

Asserting the subjective or relative character of an aesthetic approach does not, however, negate natural beauties. The same Emmanuel Kant, after insisting on the subjective criteria of taste and the conditions of possibility of practical aesthetic judgment, strongly expressed the feelings of beauty and admiration which the oceans and their depths inspired in him, with no consideration of utility[15]. This undoubtedly reflects the sublime of nature, beyond the beautiful which belongs to the aesthetic sphere and the human arts. The sublime awakens a feeling of inaccessibility, nature is seen as a force arousing not only fear – for example, fear of the raging ocean – but poetry. The paradox between subjectivism and realism is therefore only an illusion.

Even if traditionally ethics and aesthetics are separate fields, the aesthetic dimension is nonetheless articulated. Aldo Leopold (1887-1948), an American forestry engineer, then professor at the University of Wisconsin-Madison and philosopher, is a pioneer. After realizing the importance of systemic balances between wild predators and victims, he set out to develop an ecological ethic and then add the dimension of beauty, thus articulating ethics and aesthetics: "A thing is right when it tends to preserve the integrity, stability and beauty of the biotic community. It is wrong when it tends otherwise"[16]. Consequently, something that undermines biodiversity by significantly reducing it can be considered here as an attack on beauty or a threat to beauty.

By drawing freely from the innovative philosophical reflections developed more recently by G.E. Moore (1873-1958), Guy Sircello (1936-1992) and Mary Mothersill (1923-2008)[17], who advocate rehabilitating the importance of beauty, we can identify four intrinsic characteristics of the plant and animal worlds to place in resonance with a dimension of beauty: i) diversity, sign of luxuriance, a sort of magnanimity of nature, ii) interactive coherence or the equilibrium in constant motion of a wholeness, iii) innovative and ingenious adaptability, iv) dynamic rhythm and resilience, and consider them as markers of harmony, sublime and therefore, beauty.

There is a reason that these biodiversity hotspots, these sites that are home to specific species as well as the species themselves attract many admirers from all over the world.

We are invited to affirm an **ethic of beauty**, which recognizes values other than economic viability, pure profit or simple biological sustainability.

The main question in ethical terms is therefore to establish what criteria will make it possible to distinguish, on the one hand, the sustainable exploitation of natural resources which does not exclude certain disappearances and, on the other hand, their devastating overexploitation. After all, the history of our planet shows that species have disappeared or will disappear and that others continue to be born. Biodiversity is neither static nor conservationist. The fracture line of devastating overexploitation can be identified based on the volume and rapidity of biodiversity loss, that which destroys the interdependence between species and their environment, that which irreversibly breaks or permanently weakens the dynamic harmony of natural rhythms and the equilibrium of plant and animal systems. This can and should also be analyzed from a perspective of animal suffering, animals suffocating after ingesting microplastics or injured by debris. Advocacy against animal suffering and its consequences as well as the respect due to animals are promoted today by thinkers from very different backgrounds[18].

14 Let us mention (see the speech of Dr. Sarah Stewart-Kroeker) the respective teachings of the Platonists emphasizing the characters of order, clarity, harmony and balance, and the Dionysians emphasizing profusion, sensuality and vehemence. The medieval scholastic philosophy gradually agrees to describe the being as one, good, true and beautiful – the four "transcendentals". Umberto Ecco 1997 Art et beauté dans l'esthétique médiévale Paris Grasset, ch. 3, 5. retraces this evolution initiated in the Summa de bono by Philippe le Chancelier, followed by Guillaume d'Auxerre before being theorized by Albert le Grand, Super Dyonisium de divinis nominibus Ecco shows how Thomas Aquinas Summa Theologiae I, q. 39, a. 8, incorporates the stained-glass tradition, emphasizing clarity and transparency, and then he documents the transition made by Duns Scot and Guillaume d'Ockham who emphasize the link between beauty and unique individual singularity, promoting the intuition of the singular: Ecco U. 1997, ch. 9.

15 In Book II of his Critique of Judgment, devoted to the analysis of the sublime, § 26-30 (French translation by Alexis Philonenko, Paris Vrin, 2000), Kant speaks of the beauty of the ocean depths (§ 29, p. 107). Another passage in § 30, p. 115, speaks about the extravagant beauty spread by nature at bottom of the ocean, where the human eye rarely penetrates.

16 Aldo Leopold 1949. p. 262. See also his reflections on a land ethic on p. 244. "In short, a land ethic changes the role of Homo sapiens from conqueror of the land-community to plain member and citizen of it. It implies respect for his fellow-members, and also respect for the community as such".

17 G: E. Moore goes beyond idealism and skepticism concerning intrinsic beauty and states in his Principia Ethica 1903, 1959 that the total value realized during aesthetic appreciation goes beyond the value of the observer and the value of the observed (Principia ch. 18: 2). Guy Sircello 1975 A New Theory of Beauty characterizes beauty as the absence of impairment (real or perceived), while Mary Mothersill 1984 Beauty Restored notes the intrinsic quality of beauty, a basic, simple and non-analyzable trait of an individual reality. See also the many articles on natural beauty published since 1998 by "Ethics, Policy and Environment. A Journal of Philosophy and Geography".

18 We refer to the philosophical reflections of Albert Schweizer (1875-1965), the legal reflections of Cesare Goretti (1886-1952) on animals as legal entities and the "inclusivist" reflections of Spanish philosopher José Ferrater Mora (1912-1991). Tom Regan argues that certain animals have mental capacities (1938-2017, David Sztybel 1998 art. Encyclopedia of Animal Rights and Animal Welfare; Peter Singer 2004, pp. 60-70; 1995; Brennan A. & Yeuk-Sze L. 2013, art Environmental Ethics, in Stanford Encyclopedia of Philosophy.

Above and beyond the consideration of justice – doing what is right – the fight against plastic pollution also encourages us to rediscover an **ethic of respect**, which contradicts ultra-anthropocentric ethics. Without going so far as to speak of animal rights, in the strict sense of the term[19], animal suffering, particularly when it is unnecessary or results from a logic of pure profitability, is increasingly clearly and widely denounced. Those who are indifferent to this suffering, who deny it or perpetrate cruelty are discredited.

The issue is therefore the importance given to respect and aesthetics. It is a matter of shifting from an absolutely anthropocentric ethic, or rather unlimited anthropocentrism, towards a **relatively or moderately anthropocentric ethic**[20]. Modern Western ethics would gain by better integrating the Asian dimension of appreciation of beauty. The influence of Indian philosophies, in particular Jainism, Hinduism and Buddhism, which value such respect and are less strongly anthropocentric, could prove constructive and provide balance[21].

In both cases we will see the value in holding together and refusing to separate, according to the recommendation of Max Weber, an ethic of responsibility, centered on the consequences of our political, social and individual actions, and an ethic of conviction, centered on adherence to principles.

Of course, the ethical approach developed here is centered on the consequences and, therefore, deliberately minimalist. It can therefore be considered as the most practicable and attractive, therefore having the best chance of effective implementation.

19 In 2003, the Swiss Civil Code recognized that animals are not things and defined animal protection laws: see the government's decision to implement a package of measures on April 1, 2003.

20 The term "shallow anthropocentrism" invented by William Grey seems better suited than "human supremacism", which is difficult to advocate. Bio-centrism and physio-centrism can dilute all responsibility and ethics.

21 François Cheng 2006 and François Jullien 2010 offer stimulating reflections on this type of cross-cultural encounter. The first animal protection laws were enacted under the Indian Buddhist emperor Ashoka (3rd c BC), the Chinese emperor Wudi-Lyang (6th c. AD), the Japanese emperor Tenmu (7th c) the Indian king Kumarapala (12th c).

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# General Discussion

Summarized by L.-I. Stahl Gretsch, W4W

## On the toxicity of plastics

**Thierry Rochat**: Plastics are used for food packaging because they are inert. Are they really inert?

**Annie Balet**: They have the reputation of being inert, but it is known that certain additives, such as bisphenol A, pass into liquids. Moreover, plastics are colonized by potentially invasive and/or pathogenic microorganisms that float with the debris and form an ecosystem in the ocean known as a "plastisphere".

**Cornelio Somaruga** says he prefers tap water. Is there a health risk?

**Annie Balet**: Physical ingestion may not be a problem, but the chemical and biological vector issue seems to be more important.

**Benoît Girardin**: What toxicity?

**Annie Balet**: Physical toxicity has not been demonstrated, but chemical toxicity has, especially on small particles.

**Thierry Rochat**: Same problem with particulates in the air: it is above all what they carry that is toxic, especially the smallest particulates.

**Gilbert Crettaz**: What are the consequences of microplastics in the human body?

**Annie Balet**: The studies are too recent and contradictory to be able to provide an answer.

**Didier Perret**: Plastics. There are hundreds of different polymers, some inert, others biodegradable.

**Annie Balet**: Under certain temperature and humidity conditions, some biodegradable plastics are metabolized. In the ocean, the surface of floating plastics (such as PET) is colonized by a bacterial biofilm that breaks up microplastics into nanoplastics, or even mineralizes them. But these are aerobic bacteria and PET sinks... The main problem of plastics is that they are vectors of exogenous substances that can be pathogenic.

## On the presentations and speeches

**Evelyne Fiechter-Widemann**: How did Pascal Hagmann feel about Sarah Stewart-Kroeker's presentation on myths?

**Pascal Hagmann** focuses on facts. He founded the Oceaneye Association in 2010 after extensive reading. He had imagined something different (for example in quantity). He points out the pressing need for data.

**Evelyne Fiechter-Widemann** stresses the importance of communication through image, education and the importance of words so as not to head in the wrong direction.

**Pascal Hagmann** gives the example of waste patches that maintain the idea that the debris could be cleaned up and that represent humans as all-powerful over their environment.

**Sarah Stewart-Kroeker**: Unreliable representations lead to an image in people's minds that can prove to be false and therefore generate bad reactions, which is serious. It is important to provide appropriate answers.

**Roland Benz**: We can invent mythic narratives to highlight the invisible danger. What kind of narrative can bring good solutions for us today?

**Sarah Stewart-Kroeker**: We create images, we use metaphors, it is a matter of translation, communication. Which images are most useful? I'm asking you!

**Jean-Jacques Forney**: What is the role of scientific communication? A myth summarizes an idea in a very simplified way, whereas science refuses to do this, and demonstrates the complexity that is difficult to translate.

**Evelyne Fiechter-Widemann**: If scientific communication is not the way to go, where can we find answers? How can we create myths?

**Benoît Girardin** points out that there are two opposing messages: banalizing and alarmist.

**Participant**: I liked the image of the big garbage patch. The fact that everything is diluted disconcerts me. What can I do?

**Pascal Hagmann**: We do not even know where it's going...

**Evelyne Fiechter-Widemann** gives the example of Singapore which combines determination and a desire to understand as well as respect for education.

**Anne Petitpierre**: The answer is: stop littering plastics and therefore take action at the source!

## Afternoon Discussion

**Vera Slaveykova** raises the question of the transformation of plastics by pyrolysis.

**Daniela Diz** asks what the cumulative effects of acidity and time are.

**Vera Slaveykova**: it depends on the size of the particles.

**Sarah Stewart-Kroeker** sees a tension between recycling and clean-up, as this conveys a new message that could make consumers less accountable.

**Pascal Hagmann**: The example of waste-to-energy presented by Race for Water is in an island context, where the purchase price of plastic is very high and therefore production from waste is advantageous. This is not necessarily the case in other places. Fundraising associated with environmental values is planned.

**Gilbert Crettaz**: Are ocean dumping and pollution being studied?

**Vera Slaveykova**: No.

**Pascal Hagmann:** In Switzerland, we incinerate most waste.

**Participant**: The law needs to be enforced. Besides, what do cruise ships do?

**Daniela Diz**: It depends on local laws which are generally not very restrictive.

**Benoît Girardin**: The media and NGOs can create standards and put pressure on governments.

**Roland Benz** asks if the movie shown is widely screened.

**Evelyne Fiechter-Widemann** indicates that during cruises, for example in Antarctica, there are efforts to raise awareness about plastic pollution.

# Oceaneye exhibit: plastic at sea! at Geneva's History of Science Museum, 21th March 2017

Pascal Hagmann


The exhibit "Plastic at Sea" introduces the issue of ocean plastic pollution to visitors. The current knowledge, the consequences and causes of the pollution, but also the mysteries of microplastics are addressed.

The exhibition also presents the activities of the Oceaneye Association.

Visitors can look at samples of meso- and microplastics after analysis under a binocular microscope.

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