

Dr. Gerald Altnau – Managing Director CreaCycle GmbH, Germany
Published on LinkedIn: 18th February 2019
Amended: 12th February 2020

Plastic Waste Pollution The visible “Tragedy of the Commons”



Circular Economy is not for free!

Since approximately 2 years plastic waste pollution is in the media on a weekly base and it seems that the MacArthur Foundation and its support of the World Economic Forum: "*The New Plastic Economy - Rethinking the future of plastics*", in 2016 has catalyzed a new awareness and sensitivity.

Not a single day passes that we are not reminded to all the plastic wastes on the beaches, the Great Pacific Garbage Patch and its siblings in the other Oceans. We see pictures of dead marine life, sea creatures and ocean birds, which painfully starved to death because their stomachs were filled with plastics they could not digest. Repeatedly we are informed about the existence of micro-plastics which can contain dangerous impurities and find their way into our food-chain.

Without alternative we are victims in the experiment on the adaptability of our metabolism and one can only hope that this momentum will continue and we start cleaning up and resolving our plastic waste problems sustainably and that we have not already passed the point of no return.

The Sea as Waste Dump

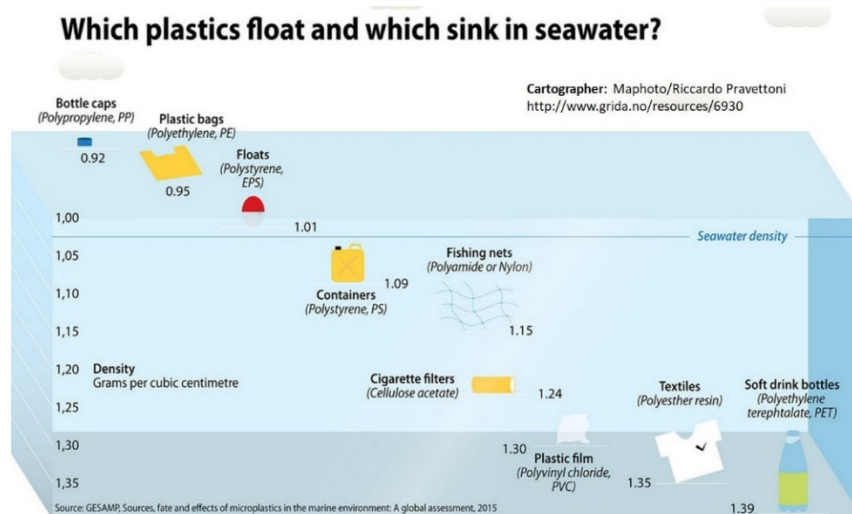
The Sea has a long tradition as a "robust" waste dump¹⁾ but we should not be too sure that the concept "too big to fail" - commonly used for banks or large companies - also applies for our environment. After World War II and until today we dispose chemical and other weapons in the Sea.

The disposal of radioactive waste is forbidden for solids since 1994 but the direct discharge of radioactive waste water from nuclear power plants is legal and practiced. And then there are unintentional events like Tschernobyl and Fukushima.

The disposal of sulphuric acid into the North Sea is prohibited effective January 1990. Off-shore platforms are made to sink if no longer needed. For drilling platforms this is forbidden since 1998 in the North Atlantic.

What makes Plastic Waste so unique in this Framework?

When all the other wastes visibly disappear according to the concept "out of sight, out of mind", when being dumped into the Sea²⁾, not all of the plastic waste sinks to the ground. Plastics which have a higher density than sea water (e.g. PET polyethylene terephthalate, PVC polyvinyl chloride and PS polystyrene) will sink and the lighter ones (PE polyethylene, PP polypropylene and EPS expanded polystyrene) will float³⁾.



With time all will break down to micro-plastic that is less visible⁴⁾ but a lot of the plastic waste will be eaten and will show up again when dead whales, seagulls or other creatures are examined. Studies have shown that 70% of the plastic sinks to the ground and what we see is only the minor part of the total mass⁵⁾.

Some people may consider it as really unfortunate that still so much plastic waste

swims and ends up at beaches where everybody can see it, especially when masses of tourists try to enjoy their vacations. And it is even more unfortunate, that packaging waste is printed and allows an identification of major brands and their owners, what is of course not good for the image.

It is only a very tiny part of the swimming plastic waste that ends up at beaches and we are shocked by these massive volumes. But we only react on the "tip of the iceberg" that makes the "**Tragedy of the Commons**"⁶⁾ visible to all of us. At present no one can escape watching the mis-use of our environment on TV, in newspapers and YouTube, what is good, because we need to realize in what danger we are.

*The **Tragedy of the Commons** is a situation in a shared-resource system where individual users, acting independently according to their own self-interest, behave contrary to the common good of all users by depleting, spoiling or poisoning the shared resource through their collective or individual action. In an actual economic context, "commons" is taken to mean any shared and unregulated resource such as atmosphere, oceans, rivers, fish stocks, beaches, soil, roads and highways, or even an office refrigerator.*

We all are victims of this mis-use of the common good "environment" as cheap (or free) dumping ground for or uncontrolled incineration of plastic waste. We all pay the price for this with the health of all creatures and the pollution of our food-chains, water and air quality.

How plastic descends to the deep ocean is, for the most part still a mystery. Scientists from the Monterey Bay Aquarium Research Institute identified two kinds of animals, red crabs and translucent, filter-feeding creatures called giant larvaceans, which consume plastic and moving it to deeper water

– either by eating it near the surface and expelling it lower down, or in the case of the larvaceans, in a layer of mucous they periodically discard and let sink¹⁸).

20 Years of Blindness?

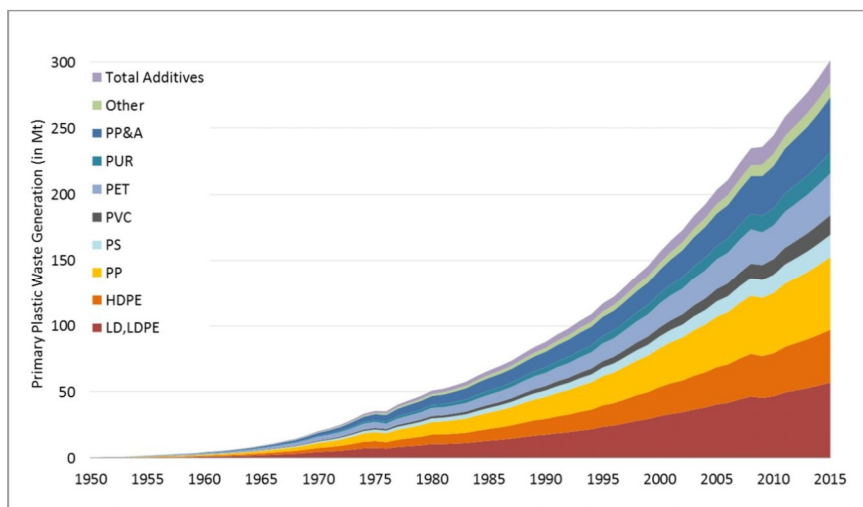
I am old enough to remember that

- Charles J. Moore⁷) and his crew ended up in the Great Pacific Garbage Patch already in 1997.
- Kofi Annan (U.N. Secretary-General) already stated in 2004 that plastics are killing millions of seabirds and other animals⁸) and it is well known that plastic pellets are "magnets" for toxic chemicals like DDT and PCBs.
- Dr. Richard Thomson has been studying the micro plastic issue since 2004 and we know since then what "Mermaid's tears" are⁹) and that the sand of our beaches contains micro-plastics.

So why did we need 20 years or a whole generation to come up with Circular Economy?
 Plastic Recycling is not new.

Different technologies to improve plastic recycling have been known, but for more than 20 years we focused on land-filling and incineration and listen to the mandatory concept "**Recycling needs to pay for itself**" and actually our leaders from industry and government call for a "voluntary commitment" from the plastic producing industry.

If we would accept plastic pollution as an incorporated systemic "Tragedy of the Commons" and understand what this means, then the explanation for lacking plastic recycling activities or technologies or different packaging is simple.



Global primary plastics waste generation (in million metric tons) according to polymer type from 1950 to 2015.
 Credit: Geyer, Jambeck, Law, 'Science Advances', July 2017

Producers of low-price commodity plastics have been able to ignore and disregard the cost for End-of-Life treatment in their production cost. And governments or authorities didn't make them aware of this "mistake" in their business model and aim for profitability. It is obviously officially accepted that societies will have to suffer from this intended collateral damage and pay the reparation cost.

A Resource is a Material or Immaterial Good/Asset

Since more than 20 years plastic waste is described as a resource.

But a resource has a value and typically there exists a demand for it. Old steel or copper cables are collected because someone is willing to pay for it. In certain countries polyester bottles are collected because they can be recycled via re-granulation at low cost (one polymer - one application) and/or depending where one lives, they are part of a deposit system and the collector gets a monetary reward for his work.

If plastic (and especially packaging) waste would be a resource and of value in our free market monetary economy, the beaches would be clean every morning. They would be as clean as the places in Germany where unemployed or homeless people or retirees with low pensions collect glass &

plastic bottles or aluminum cans to get the deposit surcharge value and finance their living. All other plastic wastes, which carry no value are left for the municipal street cleaning services.....and may end up as export to developing countries after they have been sorted and counted for a recycling quota.

Beaches in other countries are cleaned by volunteers, which try to save the environment and once collected the waste may end up in land-fill or incineration because effective sorting and recycling doesn't exist.

This reminds to Sisyphos from the Greek mythology, who was punished to roll an immense boulder up a hill only for it to roll down when it nears the top, repeating this action for eternity. In our world companies can make money on this concept, as long as no-one sees the plastic waste boulder rolling down on the other side of the hill.

How Packaging became Waste by changing its Ownership

At the Sustainable Packaging Summit 2019 (Fachpack 2019 – Nuernberg September 24-26, 2019) Tom Szaky (CEO Terracycle) explained how packaging turned from an asset into waste over time¹¹).

At the beginning in the 1950-ties the package of a product was considered an asset. The more durable the package was and the more often it could be reused, the lower the cost per fill (e.g. milk bottle) for the producer of the sold good. The producer of a product was motivated to have a durable packaging that was returned for multiple uses (circular economy).

This changed during the 1950-ties and the disposability of the package was promoted as convenience and affordability. And this is still the mindset today.

With this change the packaging became the property of the consumer and as such "cost of goods sold" (COGS) to the manufacturer.

*The built-in error: **Who wants to own disposable packaging when there is nothing left in it?** Unfortunately, 99% of what we purchase today falls into this category.*

On the other side manufacturers follow economic principles and when viewing packaging as cost, their goal is to reduce cost as much as possible.

T. Szaky explained the historical trend at the example of their partner Pepsi.

1. Glass bottle (89% re-use)
2. Aluminum can
3. PET bottle
4. Cartons (e.g. Tetrapak)
5. Pouches (0% re-use)

Positive:

- *The cost went down significantly from glass bottle to pouch.*
- *The pouch needs 97% less material (weight) compared to a bottle. This is a valid sustainable benefit.*

Negative:

- *Recycling (Re-use) crashes down because there is less profit left for waste-management companies. Collecting a pouch costs more than recycling it.*
- *Consumers would prefer glass bottles. Result: Delight declines towards pouches.*
- *Plastic waste crisis increases simultaneously with declining consumer delight.*

It is no surprise that we have a plastic packaging waste problem and in order to get to a Circular Economy we need to take back the ownership from consumers for empty single-use packaging and give it back to producers.

Plastics or Plastic Articles are too cheap!

We all are aware that oil is a limited fossil resource. The market price of crude oil is dependent on the extraction cost or the financial situation of the individual owner or a country.

An owner of a forest can sustainably manage it and plant new trees for those being cleared, to have a consistent business.

But the owner of an oil well can only pump until it is empty.

Maybe our limited fossil resources are priced & valued incorrectly in a globalized world.

The prices of polymers depend on the oil price and the processing cost to make polymers and articles. Cheap polymers with versatile unique properties allow their use in many applications. In the case of plastic packaging (only as one example) industry developed a very cheap single-use protection for food or valuable articles and we end up with huge increasing volumes of plastic waste.

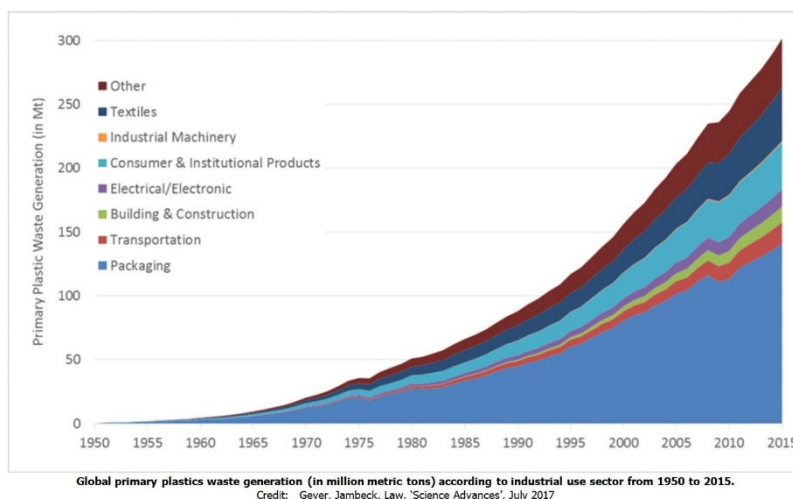
This waste – empty single-use packaging - has no value and it is definitely not considered as a resource by its owner.

It is considered as a problem and a cost factor because someone needs to make it disappear and wants to get paid for this.

Our societies always tried to avoid to include end-of-life cost as a part of the cost of produced articles. In industrialized countries the preferred option was land-fill until we run out of places to dump it. Today we have in certain countries exceptions like deposit systems for bottles and cans or dismantling cost for end-of-life-vehicles (ELV).

Then we added incineration until someone became concerned about the greenhouse gas CO₂ being released.

To cope with this, we stepped up the next level and added "incineration with energy recovery" in order to get at least back some of the imbedded process energy of plastics.



Dependent on the locally available incineration capacity and its cost, paired with the lack of interest in developing more sophisticated recycling techniques countries started exporting their plastic waste to developing countries because the plastic waste generation increases steadily and strongly.

Germany as European champion of plastic recycling has even invented the "heating value clause"¹⁰ that gives equal status to incineration and recycling, if

the heating value of a single waste stream accounts for at least 11.000 KJ/kg. Plastics fall into this category and with this regulation the EU recycling priority over incineration was generally cancelled.

Germany has been able to report excellent recycling quota and it lasted until July 2017 until this regulation was taken back again.

Lacking Recycling Technologies, Sloppy Sorting and no help from Microbes

Since we started to deal a bit more seriously with the plastic waste pollution, some have already realized that this problem might be larger than we thought.

A recent assessment study from the Technical University of Lyngby, Denmark¹²) trying to quantify the circularity potential of material recovery and recycling systems for plastics from household waste, concluded that industrialized countries with existing waste collection systems (like in the EU) can only recycle less than 40% of the plastic waste, because they lack the necessary sorting, source-separation

and material recovery effectiveness, as well as the capability to cope with the actual requirements for Circular Economy and more sophisticated plastic recycling processes.

A recent study from 2018¹⁶⁾ reveals that the flame retardant hexabromocyclododecane (HBCDD) was present in 90% of 20 Irish and 50 UK polystyrene packaging samples examined. The source of HBCDD in polystyrene packaging was identified as recycled EPS insulation foam. HBCDD is considered as a POP (persistent organic pollutant) and its production and placing on the market is banned since March 2016. Flame retardants are used in expanded polystyrene (EPS) building insulation materials but not for packaging!

An actual study from the Leibniz Institute for Baltic Sea Research Warnemuende (IOW), Germany¹³⁾ clarifies that microplastic in the marine environment will probably not be microbially degraded in any period of time relevant to human society.

A new study by researchers from Scripps Institution of Oceanography at the University of California San Diego suggests there could be a million times more pieces of plastic in the ocean than previously estimated¹⁴⁾. The traditional way of counting marine microplastics is likely missing the smallest particles, suggesting the number of measured microplastics in the ocean is off by five to seven orders of magnitude. On average, the ocean is contaminated by 8.3 million pieces of so-called mini-microplastics per cubic meter of water when previous studies measuring larger pieces of plastic found only 10 pieces per cubic meter.

Thomas Maes et al. worked with bivalve filter feeders, such as oysters, which filter large volumes of water and are particularly exposed to microplastics (MP). Consequently, these animals digest and assimilate high levels of MP in their bodies that may likely impact their physiology, and potentially affect shellfish stocks, benthic habitats and, indirectly, the health status of the marine ecosystem and human consumers. Unfortunately, they detected an increased mortality in those oysters who were chronically exposed to high loads of MP¹⁵⁾.

According to BBC News the burning of plastic waste in Indonesia, much of which has been sent there by the West, is poisoning the food chain¹⁷⁾. Environmental group IPEN found, in one East Java village, toxic dioxins in chicken eggs 70 times the level allowed by European safety standards. Long-term exposure to the chemicals is linked to cancer, damage to the immune system and developmental issues.

The Dilemma with End-of Life Cost

In the mean time we slowly realize that we have polluted the globe with plastic waste everywhere and globalized the "Plastic Waste Tragedy of the Commons". Probably most of it cannot be cleaned up afterwards and we have to wait for centuries until it is decomposed. The environment and all creatures (including us) will have to pay the non-monetary price for it.

And the price for our individual health is unaffordable.

At present many large companies, organizations and authorities sponsor new recycling technologies in order to find a way out of the problem and create an atmosphere of hope. But as long as our societies are not aggressively creative and successful in transforming into a business environment that includes end-of-life-treatment cost into the price for a plastic or an article made with it, in order to pay for recycling or any other meaningful waste treatment, we can wait long for investors to be interested in making money by sorting plastic waste streams and bringing back polymers into their original applications, thus closing the loops for a Circular Economy.

As long as plastic waste is not considered as a true valuable resource and ideally companies compete with each other to make money by really recycling it, it is doubtful that we see a major change.

CreaSolv® is a registered trademark of CreaCycle GmbH

Sources:

1. Toxic waste in the Sea - https://de.wikipedia.org/wiki/Altlasten_in_den_Meeren
2. Marine Debris - https://en.wikipedia.org/wiki/Marine_debris
3. Plastic Soup (swim & sink) - <https://blogs.ei.columbia.edu/2011/01/26/our-oceans-a-plastic-soup/>
4. How much plastic is in the Ocean - <https://www.weforum.org/agenda/2016/01/how-much-plastic-is-there-in-the-ocean/>
5. Project Kaisai - <https://projectkaisei.org/>
6. Tragedy of the Commons - https://en.wikipedia.org/wiki/Tragedy_of_the_commons
7. Captain Charles J. Moore - https://en.wikipedia.org/wiki/Charles_J._Moore
8. Drowning in an Ocean of Plastic - https://www.creacycle.de/images/09-2004.06.05_Culture_Change_-_Drowning_in_an_ocean_of_pla-205.pdf
9. Plastics poisoning world's seas - <http://news.bbc.co.uk/2/hi/science/nature/6218698.stm>
10. Heizwertklausel: §8 Absatz 3 Satz 1 des Gesetzes zur Förderung der Kreislaufwirtschaft und Sicherung der umweltverträglichen Bewirtschaftung von Abfällen vom 24. Februar 2012, BGBl. I / Streichung der Heizwertklausel - <https://abfallr.lexion.eu/article/abfallr/2017/2/4>
11. Tom Szaky talk at the Sustainable Packaging Summit 2019 (September 24-26, 2019 in Nuernberg, Germany) – Link <https://www.youtube.com/watch?v=crtOVfq1MO4>
12. Department of Environmental Engineering, Technical University of Lyngby, Denmark funded by the Danish Environmental Protection Agency and the IRMAR project “Quality Assessment and Circularity Potential of Recovery Systems for Household PlasticWaste”, published 02 November 2019 – Link: <https://onlinelibrary.wiley.com/doi/full/10.1111/jiec.12822>
13. Sonja Oberbeckmann and Matthias Labrenz - Department of Biological Oceanography, Leibniz Institute for Baltic Sea Research Warnemuende (IOW) – “Marine Microbial Assemblages on Microplastics: Diversity, Adaptation, and Role in Degradation” Annual Review of Marine Science, publication in January 2020 – Link <https://www.annualreviews.org/doi/10.1146/annurev-marine-010419-010633>
14. Scripps Institution of Oceanography at the University of California San Diego – “Microplastics a million times more abundant in the ocean than previously thought, Scripps study suggests” – published December 03, 2019 – Link <https://scripps.ucsd.edu/news/microplastics-million-times-more-abundant-ocean-previously-thought-scripps-study-suggests>
15. Thomas Maes et al “The world is your oyster: low-dose, long-term microplastic exposure of juvenile oysters” Link: <https://www.sciencedirect.com/science/article/pii/S2405844019367623>
16. Chemosphere Volume 199, May 2018, pages 612-616 Link <https://www.sciencedirect.com/science/article/pii/S0045653518302868?via%3Dihub>
17. BBC News “Western plastics poisoning Indonesian food chain” – published 14 November 2019 – Link <https://www.bbc.com/news/science-environment-50392807>
18. The Guardian “The missing 99%: why can't we find the vast majority of ocean plastic?” Speshen Buranyi published 31 December 2019 – Link <https://www.theguardian.com/us-news/2019/dec/31/ocean-plastic-we-cant-see>

In order to protect resources and our environment, high-quality recycling technologies for plastic waste are required, which allow the reuse of polymers without breaking up the polymer chains. CreaCycle GmbH and the Fraunhofer Institute for Process Engineering and Packaging (IVV) in Freising, Germany combined their competencies in a cooperation aimed at "Plastic/Raw-Material Recycling with a Solvent-based Purification Technology" (selective extraction) and developed the CreaSolv® Process that is based on physical changes and leaves the polymer composition intact. Proprietary CreaSolv® Formulations from CreaCycle with the lowest risk potential possible for user and environment dissolve selectively a target polymer. This reduces besides the hazard also the cost for the equipment. After the separation of imbedded impurities or undesired polymers the recycled polymer can be reused in its original application.

CreaCycle GmbH
 Auf der Artwick 74
 41515 Grevenbroich
 Germany
 Email: gerald.alttau@creacycle.de
 Homepage: www.creacycle.de

