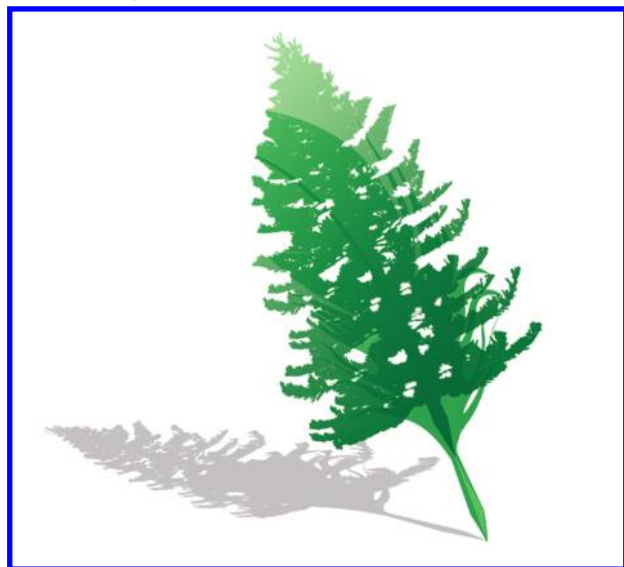


# Are We “Digging Our Own Grave” Under the Oceans?

## Biosphere-Level Effects and Global Policy Challenge from Plastic(s) in Oceans

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Plastic debris in marine environments presents a significant threat to life on earth. It is estimated that 10% of ~200 million tons of plastic produced annually ends up in the oceans. An amount of 20 million tons of plastic in oceans every year? As a result, the area of the Great Pacific Garbage Patch (area of intense ocean currents that accumulate marine debris) is alarmingly expanding every year. An estimated 70% of 20 million tons of plastic eventually sinks into bottom of the oceans damaging precious life on the ocean floor. Fish, sea turtles, dolphins, whales, sea birds, and everything in nature's food chain that makes living off the oceans owe their dependency to the “untouched and super-productive world” of phytoplankton and other benthic life. Are we gravely interfering with marine biogeochemical processes associated with phytoplankton and other forms of life that gave birth to the current “oxygen-rich” planet ~3 billion years ago? Recent data suggest that it is the case. The extent of damage to the life is so enormous that it became a major impediment to recovery efforts of several marine endangered species as well. The linking of Monk Seal entanglements in northwestern Hawaiian Islands to marine-borne plastic debris is yet another grave concern.<sup>1</sup>

The large plastic items thrown into the ocean eventually disintegrate into thousands of tiny pieces of plastic that form a large cloud of “plastic gunk/soup” beneath the ocean surface across the pelagic water column. This human-made condition is severely compounded by natural disasters resulting in large-scale destruction (including recent 2011 tsunami in Japan). The latest tsunami in Japan dumped ca. 3 million metric tons of human-made debris (~80% is plastic) into Pacific Ocean. The huge pile of marine-borne trash from the tsunami is going to

meet North Pacific Subtropical Convergence Zone and will hit other areas in Hawaii and shores in California in few months to come, causing a monumental but enormous policy challenge in the United States. There is no doubt if recurring tsunamis continue; it will pose a dangerous threat to the marine life at alarming rate; that could result in multilevel, cascading effects on ocean biology and chemistry.

Considerable (but not enough!) resources are directed toward source identification, fluxes, compounding El Nino effects, and other impacts (such as ingestion, entanglement, ecological trap, role of artificial vector transportation, community displacement, and alterations in organism ability to magnetically navigate) on a diverse species of animals, phytoplankton, coral reef, and benthic communities. Some of the bigger issues are the formation and effects of micro- and nanocolloids of plastic on the ocean life. The large threat posed to entire food chain from the reactive species of micro- and nanocolloids and intermediate products of plastic, extent and rates of preferential accumulation in phytoplankton, in fish, and eventually to humans is not known yet. The *ES&T* community needs to be engaged (more so than ever) in research associated with marine plastic monitoring, fate and transport, prevention, cleanup activities, and identifying future research needs. Strategic integration of multiple scientific disciplines (biology, toxicology, microbiology, chemistry, geography, oceanography, global policy, etc.) is the need of the hour to leverage on a global network of sustainable ocean observation and security systems.

There need to be a serious focus on socio-economic impacts, awareness, and education programs. Accentuated levels of marine plastic often correlated to tourism, visitor density, and communities with lower economical standards and literacy.<sup>2</sup> It must be realized at all levels from the individuals, local bodies, to global networks that the human behavior is the ultimate cause of marine-borne plastic generation and must be addressed at the root-cause level. The current data indicate that measures taken so far in reducing marine plastic is inadequate and must be dealt with more rigorous practices based on the goal of zero-tolerance to plastic in marine environment. Scientifically robust metrics and local-to-global feed-back mechanisms need to be implemented to support policy, regulatory and management decisions. NOAA's marine debris program (in the United States) in partnership with local and state agencies has been making steady progress toward implementing some of the critical aspects of teaming-up, monitoring, prevention, and cleanup efforts. One of the key challenges is the identifying

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**Figure 1.** An artistic rendition of marine plastic debris (courtesy: creative art by Ferdi Rizkiyanto).

partners, bridging right collaborations across the globe to develop a framework to implement a long-lasting ocean stewardship. In this direction, United Nations Environment Program can facilitate support and networking capabilities from other nations across the globe.

Given the unsustainable status-quo and scale of the impact, there need to be an aggressive effort on imposing multipronged “zero-plastic-ocean” policy. The focus needs to be on (1) identifying and eliminating routes of plastic transport to oceans; (2) aggressively supporting global networks to fund plastic cleanup efforts in oceans; and (3) developing cleaner technologies that produce nature-friendly plastics. The identification, tracking, and elimination of source are the critical backbone elements to prevention, mitigation, and remediation tasks. Global-scale modeling with the help of remote sensing and GIS applications must be incorporated into mechanistic predictions.<sup>3</sup> The ultimate goal of elimination of source requires far more collaborative team work than science-based solutions; that recognize and address cultural sensitivity in tackling and elimination of plastics at global level. Long-term educational and financial inputs (such as paid educational workshops and litter buyback incentive programs) will lead to rather target-driven and timely outcomes. With involvement from private sector in funding and participating on own-the-ocean and payback programs, the overall ocean stewardship can be more effective, responsible, and rewarding. Last but not least, the transformation of plastic industry to more of a clean but eventually to green-tech applications incorporating life-cycle assessments and “cradle-to-cradle” approaches need to be fast-tracked. The plastics from recycled biological materials with appropriate chemical linkers (quick to degrade and nature-friendly) such as plant/bacteria/fungi biomass, food wastes, and agricultural wastes need to be swiftly developed. All of the above components of “zero-plastic-oceans” policy need to be implemented on war-footing basis to be able to show any sign of relief from being put us close on the verge of “digging our own grave” under the oceans.

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## Notes

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