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REPURPOSING: SDG 14 MEETS SDG 6

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As the United Nations Environment Programme (UNEP) report titled 'Drowning in Plastics' states, of the 9.2 billion tonnes (Gt) of plastics made in the 67-year period (1950-2017), 14% was incinerated, 10% was recycled, and while a small percentage is in stock (functional or dormant), a significant proportion has languished in landfills and dumpsites on land, and leaked out to the hydrosphere (lakes, rivers and oceans). Microplastics in oceans are like microorganisms are to humans– insidious and treacherous, 'invisible' but destructive. Much has already been written about their freshwater, marine and terrestrial ecotoxicity potentials and human toxicity potentials. This short feature, however, does not dwell on a problem. It is not about the 'what-should-not-have-been', but rather about the 'what-can-must-and-most-probably-will-be'. It will shed a sliver of light on a possibly small solution which can be bracketed under the 'Repurposing-R' of the waste management hierarchy.

One can think in terms of collecting plastic wastes *in-terra*, or for that matter, recovering waste plastics while remediating oceans (or water bodies in general). Now, there are two more Rs there – recovery and remediation – from the '*R-senal*' of a circular economy. It must be remembered that India ranks second, only after the Philippines, as far as the quantities of plastics discharged into the oceans are concerned. The sight of PET (polyethylene terephthalate) bottles being chucked out of moving cars by the *nouveau riche* in India, has always

been a painful one, triggering a sense of helplessness laced with anger.

SDG 14 meets SDG 6

The United Nations' SDG 6 (Sustainable Development Goal # 6) concerns clean water and sanitation, while SDG 14 focuses on 'Life Below Water'- the neustons, nektons, planktons and benthos. SDG 14, or rather the march towards the targets set under SDG 14, is obstructed by the proliferation of microplastics in the hydrosphere. Indeed, these 'micro-villains' wend their way into rivers, lakes and seas, via untreated/partially-treated wastewater. This nexus can be bolstered, and a win-win situation arrived at, if research conducted in Japan and Ireland can pave the way towards commercialisation of a lab-scale test result (if, as and whenever possible).

A decade ago, researchers at the Kyoto Institute of Technology

(Japan) had chanced upon, serendipitously, a new strain of bacteria which degraded PET, by availing of two enzymes (PETase and MHETase). *Ideonella sakaiensis* (I. sakaiensis) as the Japanese christened this bug, is mesophilic and sensitive to high and low pH values. While time and speed are of the essence if this bacterium has to be looked upon as a consumer of PET, the researchers are of the view that genetically modifying this strain will enable it to work much faster, at the optimum conditions of temperature and pH.

I. *sakaiensis* and PET in the WWTP

India grapples with wastewater treatment issues, while on the upstream, water scarcity impacts both society and economy (the agricultural sector, primarily) adversely. Sub-optimal treatment, wherever it exists, leads to deterioration of the quality of water in, and the carrying capacity of the sinks.

One wonders what must and can be done with the plastics recovered from the oceans (once the efforts made at remediation consistently filter/dredge out the floating, sinking, settled and resuspended microplastics). Burn and get rid of them, perhaps? Toxicity reincarnating as global warming, in the process? But can these recovered masses- at least a small proportion of them- be repurposed? There is a lot of PET lying around for that matter, for *I.sakaiensis* to chew on.

In a wastewater treatment plant (WWTP), as the wastewater reaches the denitrification process on the downstream, most of the organics (COD, or chemical oxygen demand, in biological treatment lingo) are already used up in the aerobic proces sesupstream. Denitrification is essential to convert the nitrates in the wastewater to nitrogen (courtesy bacteria which are able to use the oxygen in the nitrate, in lieu of molecular oxygen). Methanol, ethanol or glycerol are often added as carbon sources, for the bacteria to feast on and grow. A part of the carbonaceous compounds is assimilated in the biomass, and the remaining is released as carbon dioxide (CO_2) and water vapour, along with nitrogen (from the reduced nitrate). If recycling the recovered microplastics is ruled out (obviously!), cannot they be repurposed as carbon sources in wastewater treatment? Of course, what would be recovered would be a mixture of different types of microplastics, and at the time of writing, we only know that *I.Saikaensis* has a penchant for PET. Is the bug ‘omnivorous’ enough to find other types of plastics palatable?

Hopefully, there may be new strains or genetically modified *I.sakaiensis* in the near future, capable of eating up a wider range of plastics! Powdered microplastics sold as carbon sources to be added on to denitrification tanks, will end up emitting less CO_2 (compared to if they would simply be burned and gotten rid of), producing more PET-eating bacteria. They will play a role alongwith the other friendly bugs in the tanks, in decreasing eutrophication of the water bodies into which the treated wastewater flows. Perhaps, some of the treated wastewater can also be recirculated and used in a cascade! If it is really a case of problem-shifting from toxicity to global warming (and if yes, to what degree), depends on what the plastics replace as carbon sources.

Destroyer to do-gooder fodder

By dint of concerted research, collaborative efforts (which SDG 17 advises) and lateral thinking, ‘culprit’ plastics may well be reformed into ‘little biodegradable *Messiahs*’, holding aloft the flags of SDG 6 and SDG 14; by becoming fodder for a family of bugs.

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