



Micro-plastics : An Emerging Contaminant - with Potential Threat to Aquatic Systems - less studied in India

E.V. Ramasamy

School of Environmental Sciences, Mahatma Gandhi University
Kottayam, Kerala, India-686 560

E-mail: evramasamy@mgu.ac.in Mobile: 09447095935

Plastics are the most versatile synthetic materials invented by human and being used extensively in daily life. Global production of plastics has increased drastically in the past 50 years and reached around 300 million tons (Cressey, 2016). Higher level of plastic consumption proportionately increases the generation of plastic wastes. Plastic wastes unlike other human-generated garbage doesn't rot or rust away, but persists in the environment for years, polluting the environment and killing organisms. Much of the plastic wastes discarded ultimately end up in the ocean through streams, rivers and runoff. The plastic debris break down due to the sun light or the mechanical action of wind / waves or biological means to some extent, into tiny particles of microscopic sizes now referred as 'micro plastics' (often referred to particles of < 5 mm in size). The micro plastic particles (MPs) derived through mechanical/ biological breakdown of larger plastic debris are classified as 'secondary micro plastics', while they are manufactured as microbeads / pellets used in personal care products such as face scrubs and in air-blast media are termed as 'primary micro plastics' ; after use when discarded they reach the water bodies through drains. Research on these 'micro plastics' is growing since 2004 when Richard Thompson who does research on ocean plastics at Plymouth University in UK, coined the term (Cressey, 2016).

The impact of micro plastics pollution on the environment and biota is being researched globally. Due to their small size, they are bioavailable to organisms throughout the food-web in an aquatic environment. Due to their large surface to volume ratio and chemical composition, micro plastic particles (MPs) accumulate waterborne contaminants such as heavy metals (Cole et al., 2011) and Persistent, Bio-accumulative and Toxic (PBT) compounds. Plastics contain a huge number of chemical additives which in turn affects adsorption of organic contaminants. Pesticides and organic pollutants have also been reported on plastic debris at harmful concentrations (Barnes et al., 2009), 100 times more than their concentration found in sediments. Besides this, many of the chemical components of plastics such as dyes are listed as

priority pollutants by United States Environmental Protection Agency (USEPA) (Lithner et al., 2011). Ingestion of MPs with adsorbed pollutants by aquatic organisms may lead to contamination of the food web of the aquatic system (Rochman et al., 2013). Considering these harmful impacts UNEP recently passed a resolution stating 'the presence of plastic litter and microplastics in the marine environment is rapidly increasing serious issue of global concern that needs an urgent global response' (Cressey, 2016).

Studies on MPs began in early 2000 and a wealth of information is available on MPs in the marine environment (Thompson et al., 2004; Cole et al., 2011) whereas freshwater and estuarine systems have received less attention (Free et al., 2014). A recent review on micro plastics (Eerkes-Medrano et al., 2015) listed twelve studies on the occurrence of MPs in freshwater systems of which five studies were exclusively on freshwater sediments. From India, there are only two reports on MPs: one is on the occurrence of small plastic debris (81 mg/kg) such as polyurethane, nylon, polystyrene, polyester particles in the marine sediments of Gujarat coast (Reddy et al., 2006). The other study is on assessing plastic debris in the beaches of Mumbai (Jayasiri et al., 2013).

India is among the major plastic consumers in the world and generates approximately 5.6 million tons of plastic waste annually. Kerala is a small densely populated state located on the south-western tip of Indian subcontinent, with the Arabian Sea coast to the west and the Western Ghats mountain range to the east. Kerala is bestowed with a network of rivers, streams and lakes. This densely populated (819 people per km²) state of Kerala generates huge quantities of plastic discards; approximately 4-6% of the municipal solid waste (MSW) is plastic. Like many states in India, Kerala also lacks sufficient waste management facilities resulting in the accumulation of waste piles. In addition, a prolonged monsoon (4-6 months) brings ample rain to Kerala every year leading to the washout of plastic debris from the waste piles into the network of rivers,



streams, lakes and ultimately to the Arabian Sea (Sruthy and Ramasamy 2016).

Vembanad Lake a freshwater/estuarine system is the largest lake in Kerala and forms a part of the Vembanad wetland system which has been recognized as a Ramsar site. The lake receives discharge from seven major rivers plus many streams and canals, and is a sink for many contaminants including heavy metals (Ramasamy et al., 2012). As these rivers and streams flow through densely populated urban stretches, the possibility of occurrence of MPs in the lake is high. Local population largely depends on this lake for their livelihood such as agriculture, farming and fishing, hence it is highly relevant to investigate the occurrence of MPs in Vembanad Lake.

Despite that, 80% of the marine litter originate from land sources and riverine systems conduit most of the plastic litter into the marine environment, no study, to date, has addressed the presence of MPs in the Indian freshwater/estuarine water or sediment. A pioneering study conducted by the author's research team (Sruthy and Ramasamy 2016) recently accepted for publication – to the best of our knowledge – is the first report of the presence and distribution of micro plastics in the sediments of Vembanad Lake, in India.

In this context, the first ever report on microplastics in the Vembanad Lake water – a part of the study conducted by the research team of this author – is presented for this symposium. Water samples were collected from ten sites and processed for microplastic extraction. Identification of the polymer components of MPs was done using micro Raman spectroscopy. MPs were recovered from all samples, indicating their extensive distribution in the lake. The abundance of MPs recorded from the water samples is in the range of 23800 to 244000 particles km⁻² with a mean abundance of 60,650 particles km⁻². Low density polyethylene has been identified as the dominant type of polymer component of the MPs. As clams and fishes are the major source of protein to the local population, the presence of MPs in the lake becomes critically important, posing a severe threat of contaminating the food web of this lake. This study, being the first report from India on MPs in a lake, provide impetus for further research on the distribution and impact of this emerging pollutant on the biota of many aquatic systems spread across India.

References

- 1) Barnes, D.K., Galgani, F., Thompson, R.C., Barlaz, M., 2009. Accumulation and

fragmentation of plastic debris in global environments. *Phil. Trans. R. Soc. B* 364. 1985-1998.

- 2) Cole, M., Lindeque, P., Halsband, C., Galloway, T.S., 2011. Microplastics as contaminants in the marine environment: a review. *Mar. Pollut. Bul.* 62(12). 2588-97.
- 3) Cressey, D., 2016. The plastic ocean, *Nature*, 536, 263-265.
- 4) Eerkes-Medrano, D., Thompson, R.C., Aldridge, D.C., 2015. Microplastics in freshwater systems: a review of the emerging threats, identification of knowledge gaps and prioritization of research needs, *Water Res.* 75. 63-82.
- 5) Free, C.M., Jensen, O.P., Mason, S.A., Eriksen, M., Williamson, N.J., Boldgiv, B., 2014. High-levels of microplastic pollution in a large, remote, mountain lake. *Mar. Pollut. Bull.* 85. 156-163.
- 6) Jayasiri, H.B., Purushothaman, C.S., Vennila, A., 2013. Plastic litter accumulation on high-water strandline of urban beaches in Mumbai, India. *Environ. Monit. Assess.*, 185 (9). 7709-7719.
- 7) Lithner, D., Larsson, A., Dave, G., 2011. Environmental and health hazard ranking and assessment of plastic polymers based on chemical composition. *Sci. Total Environ.* 409. 3309-3324.
- 8) Ramasamy, E.V., Toms, A., Shylesh, C.M.S., Jayasooryn, K.K., Mahesh, M., 2012. Mercury fractionation in the sediments of Vembanad wetland, west coast of India. *Environ. Geochem. Hlth.*, 34(5). 575-86.
- 9) Reddy, S.M., Basha, S., Adimurthy, S., Ramachandriah, G., 2006. Description of small plastics fragments in marine sediments along the Alang-Sosiya ship-breaking yard, India. *Estuar. Coast. Shelf Sci.* 68. 656-660.
- 10) Rochman, C. M., Hoh, E., Hentschel, B. T., Kaye, S., 2013. Long-term field measurement of sorption of organic contaminants to five types of plastic pellets: Implications for plastic marine debris. *Environ. Sci. Technol.* 47. 1646-1654.
- 11) Sruthy, S and Ramasamy, E.V., 2016. Microplastic pollution in Vembanad Lake, Kerala, India: The first report of microplastics in lake and estuarine sediments in India. *Environ. Pollut. (In press)*.
- 12) Thompson, R.C., Olsen, Y., Mitchell, R.P., Davis, A., Rowland, S.J., John, A.W.G., McGonigle, D., Russell, A.E., 2004. Lost at sea: where is all the plastic? *Science*. 304, 838.

ENVIRONMENTAL EDUCATION AND SUSTAINABLE DEVELOPMENT

Vidyadhar Durgekar

Author & Lead Auditor and Assessor

Website: www.vidyadhardurgekar.com; E-mail: durgekar@hotmail.com,

Mobile: +919632715093

Sustainable development is the imperative of the 21 Century said Mr Ban Moon, Secretary General United Nations². The indiscriminate use of the resources is a threat than the legitimate use of the same. The Global warming is a serious issue for the world. This paper tries

to highlight who is contributing to this global warming and what they are doing it to control. It also evaluates the reason for the unsustainable development and its impact. It concludes with the solutions to educate the youth to ensure the mitigation of the issue permanently.

Keywords: Sustainable Development, *Environment, Poverty alleviation, Environment Education*

SUSTAINABLE DEVELOPMENT

India as country, did not see much development during the colonial rule of the British. Post- independence, the first five year plan emphasised on the industrialisation giving priority to heavy and infrastructure development projects. The agriculture industry was on the back foot giving way to the mega infrastructural projects. Without much exposure to the planned sustainable disciplined industrialisation the country headed ahead limping, which resulted in the present mess of un- sustainable development. The best democracy of the world ensured the unlimited freedom to damage and escape the law. Even though the state control on the industries was ensured to control the environmental and economic violations, they miserably failed to implement because of the lack of accountability and discipline which has further aggravated in all these years. The excessive control gave rise to excessive corruption leading to the compromise of all the sustainable requirement. Everyone used their discretion to deviate from the requirement and to promote an unhealthy development projects. The industries went into competition amongst themselves to deviate and have last laugh on the compliance industries. Bhopal Gas tragedy was a living example to the systemic disaster. We seem to have forgotten all that and heading in the same way. The example of the real estate industry in Bengaluru is a live example where the lakes were dried and acquired by builders. Also all over India, the agricultural lands were acquired for the industries which were sold to the builders after two decades to make more money instead of job creating industries.

the resources is a threat than the legitimate use of the same. Therefore understating the need, the United Nations world commission on Environment & Development Commission in 1987 defined the phrase 'Sustainable development' as the 'meeting needs of the poor while not increasing environmental problems'. Etymologically of the phrase 'sustainable development' leads to the Brundtland Report in 1987. It is the policy of the world population to exploit the natural resources to a level that it can rejuvenate itself. Sustainable development is the imperative of the 21 Century said Mr. Ban Ki Moon, Secretary General United Nations³. It is also the use of the natural resources to a level without jeopardising the capacity of the future generation's requirements. The present generation, not being the owners, have no right to destroy it. They need to protect it as trustees and handover the nature and its resources as it is the next generation. It was a path breaking move to take forward the whole concept of bringing together the two opposite forces needed for existence of mankind. The developmental activities should be so much that they should not be impacting the nature to a non-irreversible process.



Picture courtesy: <http://thesustainableleader.org>

It is a fact that the humans need the nature and there is enough for the need of everyone. The challenge is the greed of the people. The indiscriminate use of



This is also called the Triple Bottom Line comprising the Social, Environment and Economical aspects, The development is an artificial man made process towards liberating the poor from their curse of poverty. Since it is human intervention to alter the nature to increase the resources, it interacts with nature, which when uncontrolled has an adverse impact on nature. Environment is a gift of creation to facilitate the healthy living of the living beings which are interdependent and interacting in existence. This conflict between the development and the environment has given rise to the theory of 'Doom and gloom'. The freedom of development should limit itself to a level of the reversible state so as to

ENVIRONMET

The environment is the creations in which we live and interact every day. It is the land, air, and water we need every day. The indiscriminate intervention with the nature to alter it to suit the human greed has many places showed its draconian impact. The famous botanist Ms Rachael Carson had warned us about the use of pesticides in her book 'Silent spring'. She had found that the evidence to prove the relation between the pesticides being carcinogenetic leading to human cancer⁵. The world did take note of it, but ignored it to suit the greed of our society. One glaring example is the Punjab agricultural success story. The sixty years of the increased productivity achieved by using the chemicals has resulted in slow accumulation of In the case of the Tirupur textile industrial growth in the last two decades, there was an indiscriminate development improving the social and economic issues but leaving behind the environment circle. This circle pulled down the growth when it went beyond control. The effluent discharged into the ground without the proper use of technology and slack respect to the laws led to the closure of many plants. As per the Tamil Nadu Agricultural University and the Loss of Ecology Authority report the thousands of hectares of agricultural lands have been damaged leading to the reduction of the agricultural production. In 14.07.2005 The Hon'ble High Court of Tamil Nadu expressed its displeasure on the conduct of the industrial units in not installing the Reverse Osmosis Plants as agreed to reach Zero Discharge status and recorded.

not to impact the regenerative capacity of the nature. To ensure this the society needs to consider the triple issues comprising of environment, economics, and social needs. The point where they align is the sustainable part of the whole development scenario. This needs to be understood by everyone so that the nature is taken care and at the same time the poverty also is eradicated by the development. Emphasis on either of them in slight excess is detrimental to the human sustenance because of which the term Sustainable development takes its importance.

the toxins within water, soil, and entering food chain of the region. It is available on the internet that the considerable population of the state of Punjab has been suffering with cancer but we try to push it under the carpet to introspect our mistakes.

| S.No | Total cases reported | Count | % |
|------|-----------------------------|-------|------|
| 1 | Total malignancies reported | 5,737 | 100 |
| 2 | Female | 3,257 | 56.8 |
| 3 | Male | 2,480 | 43.2 |

Table 1. Total and frequently reported cancers, stratified by gender and age-group (Jan. 1, 2014- Dec. 2014)

Positive environmentalism is a word which refers to a pro-technology, pro-progress perspective of protecting the world's environment. There are fundamentally two approaches to environmental action. One is negative environmentalism, full of doom and gloom, and another one is positive environmentalism which means that, while representing the project in any way, everyone should avoid criticisms or negativity but instead just be a supporter of positive environmental initiatives wherever they come from on all sides in the community. This approach seeks to influence the issue as partners -- and not as adversaries⁷

All the people of this country have the same right on all the natural resources. All the people should have the same right to exploit till there is an equitable sharing of the resources. One poor man has his per capita carbon foot print in double digit decimal and the rich has his in double digit. Therefore it is necessary to develop till this per capita carbon foot is almost reached to a sustainable level.



| 1 | Country | Per Capita Carbon Emissions |
|---|---------|-----------------------------|
| 2 | India | 1.64 |
| 3 | USA | 17.5 |
| 4 | UK | 7.96 |
| 5 | France | 5.75 |

| | | |
|----|---------|-------|
| 6 | Japan | 9.25 |
| 7 | China | 6.18 |
| 8 | Kuwait | 34.24 |
| 9 | Iran | 7.73 |
| 11 | Vietnam | 1.71 |

1. https://www.unglobalcompact.org/Silent_Spring, Rachael Carson
2. http://www.punjabcancerregistry.org.pk/reports/PCR2_2014.pdf

3. https://en.wikipedia.org/wiki/Positive_environmentalism

Courtesy-

<http://mdgs.un.org/unsd/mdg/SeriesDetail.aspx?srid=751>

The Global warming is a serious issue for the world. Who is contributing to this global warming and what they are doing it to control. The authors in Hot Topic say that the Asian monsoon is likely to get gradually wetter which could also result in flooding, which needs to be seen even after so many years.⁸

Carbon credit is a term used as the quantitative measure to trade the permit representing the right to emit one tons of carbon dioxide or the other greenhouse gas with a carbon dioxide equivalent to one tons of carbon dioxide. Carbon credits and carbon markets are a component of national and international attempts to mitigate the growth in concentrations of greenhouse gases. One carbon credit is equal to one tons of carbon dioxide, or in some markets, carbon dioxide equivalent gases. However this process called off in 2013. However the Paris agreement in the year Dec 2015 has revived the whole process again. It was opened for the signature on 22 April 2016 in New York City. As of October 2016, 192 UNFCCC members have signed the treaty, 87 of which have ratified it. After the European Union ratified the agreement in October 2016, there were enough countries that had ratified the agreement that produce enough of the world's greenhouse gases for the agreement to enter into force

By October 2016, 191 states and the European Union have signed the Agreement. 87 of those parties have ratified or acceded to the Agreement. China, United States, and India, the countries with three of the largest greenhouse gas emissions of the signatories totalling to 42%.

The Dr. Karthikeyan report of the high level working group on Western Ghats are a very good example of the research texts. The exploitation of the Western Ghats by the rich, need to be stopped immediately; without affecting the livelihood of the poor and tribal.

As per the analysis of the High Level Working Group headed by Dr Karthikeyan, revealed that close to 60 per cent of the Western Ghats region is under cultural landscape which is human dominated land use of settlements, agriculture and plantations (other than forest plantations) and only 41 per cent of the land area can be currently classified as natural landscape. Of the natural landscape, the biologically rich area, with some measure of contiguity is roughly 37 per cent of the Western Ghats which is alarming.⁹ But till now the will to ensure the effective measure is lacking from the administration.

The subject of environment has been included as part of the curriculum from the last decade in under graduation levels. However the poetry on this subject was there from many years. However the focus on the development was missing in the student's curriculum. The emphasis on the environment, blinded the students and the teachers against the requirement of the development to ensure social justice to the poor. It is true that the students are overloaded with the inclusion of many subjects.

We should evaluate and understand, what exactly needs to be taught to the children and how. In this regard the western education system can show us the way in which they have been doing effectively. The society needs better human beings than the qualified human beings. Whatever they become, first they should try to become good human beings. With this objective in mind we should frame our education system so that the children can acquire qualities to develop himself as a good citizen from whom the society can benefit. They should be trained to teach themselves whatever they need to become good people.

One major difference between the Indian education and the western education is the word 'Why'. The west teaches them to ask the question why, whereas we snub them from asking why. The word why allows them explore the reasons behind the question which can clarify them further and change with

time. Every succeeding generation comes with the exposure to the fresh thinking and inventions which should be harnessed and developed in a forward thinking approach instead of looking back and hold on to those. They should be facilitated with the skill to survive in this imperfect world for which they need to be taught with human values of sharing and caring. The sharing and caring is an element of the sustainable development wherein all the people poor or rich share the same environment viz, air, water, and land.

CONCLUSION

It is a fact that the humans need the environment and there is enough for the need of everyone. Along with the environment they also need the development. The challenge is the greed of the people. The indiscriminate use of the resources is a threat; than

the legitimate use of the same. Considering the dramatic rise in the population, there is no other way other practical way other than the industrialisation, through which employment can be generated to feed the poor of the world. If you ask me, I would say the focus on Positive Environmentalism is fundamental to our development. Always face the sunshine and your shadows will fall behind you. It is true that uncontrolled industrialization will create havoc with all sorts of pollution around making it unfit for living. However, it can be controlled to the limit of human tolerance until a balance is achieved between growth and environment, neither of the parties should take advantage of each other¹⁰

Therefore it is imperative that the society adopts the principle of sustainable development to ensure uniform growth for the betterment of the future generation



Courtesy:<http://topenglishlessons.blogspot.in/2015/03/sustainable-development.html>

The principles of Sustainable Development includes mainly other things

- Strategy and policy
- Review and assessment of policies
- Living with Environment and sustainable development
- Ecology and sustainability
- Social aspects of sustainability
- Political Dimensions of sustainability
- Economic, Social and natural resources
- Good governance, Control and regulations
- Future visions and scenarios

We have lost considerable number of years, to understand and implement the sustainable way of development. It can only be done through the effective knowledge sharing with the future

generation. There is an immediate necessity of the sustainable environmental education to be more focussed on the scientific approach with the commitment to the people around. The education



Lake 2016: Conference on Conservation and Sustainable Management of Ecologically Sensitive Regions in Western Ghats [THE 10TH BIENNIAL LAKE CONFERENCE]

Date: 28-30th December 2016, <http://ces.iisc.ernet.in/energy>

Venue: V.S. Acharya Auditorium, Alva's Education Foundation, Sundari Ananda Alva Campus, Vidyagiri, Moodbidri, D.K. Dist., Karnataka, India – 574227

needs to be more rational than emotional in nature without any bias towards the subject nor the research. The assessment reports needs to be authenticated or the authors need to be accountable for the lapse in the report. The honesty is essential in promoting the environmental issues which have direct impact on the eradication of poverty.

The Corporates and the industrial houses needs to be more ethical and accountable to the society failing which serious action to be taken by the government. It is only possible if the society as a whole is valuing the ethical practices. Which is again the factor of value education system.

There are enough or more legislations in India but poor application because of the slackened justice delivery system. Need to strengthen the effective monitoring and implementation machinery. The youth has to be educated to understand both the sides of the issues instead of relying on sided education. They should be taught to reason everything given to them before accepting it. The education needs to be based more on their own study and field study rather than lecturing.

REFERENCES

1. King, Gabrielle Walker and Sir David. *The Hot Topic*. London: Bllomsburry, 2008.
2. Kolbert Elizaeth. *The Sixth Extinction*, New York, Picador, 2015
3. Yunus Mohammad. *Building Social Business*, New York, 2010.,
4. Carson Rachael. *The Silent Spring*, New York, Penguin Books, 2000
5. Sen Amartya. *Development as freedom*, New Delhi, Oxford University Press, 2013
6. Sen Amartya. *Employment, Technology and Development*, Oxford University Press, 2011
7. Guha Ramachandra. *Environmentalism A Global History*, Gurgaon, Penguin Books, 2014
8. Durgekar Vidyadhar. *Sale of souls, Bengaluru*, Leadstart Publications, 2013
9. Dr K. Karthikeyan, *The High Level Working Group on Western Ghats*, New Delhi, MOEF, 2013
10. Secretary-General Ban Ki-moon addresses world leaders on the 66th General Assembly Session, UN News, www.un.org/apps/news/story.asp?NewsID=39647#.WBfsLvI97IU
11. The contribution of early childhood education in sustainable Society, Paris, UNESCO, 2008 www.unesdoc.unesco.org/images/0015/001593/159355E.pdf