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for a toxics-free world

Minutes of the Meeting

"Stakeholders Meeting on Chemicals Management: Persistent Organic Pollutants and Plastics"

February 24, 2026 | Hotel Aketa

Dehradun, Uttarakhand

Stakeholder Consultation on Chemicals Management: Persistent Organic Pollutants and Plastics

Date: 24 February, 2026
Venue: Hotel Aketa, Dehradun, Uttarakhand

The Indian-Norwegian Cooperation project is a collaborative project led by the Norwegian Institute for Water Research (NIVA), Mu Gamma Consultants, SRM Institute of Science and Technology, Central Institute of Petrochemicals Engineering and Technology, and Toxics Link. Established in 2019 under the Norway-India Marine Pollution Initiative and the Norwegian Development Programme to Combat Marine Litter and Microplastics, the project is dedicated to strengthening international cooperation, scientific knowledge exchange, and building institutional and technical capacity to address plastic and POPs pollution in India. The project also supports national efforts to implement the Persistent Organic Pollutants Rules, 2019, which entered into force the same year.

Phase I of INOPOL (2019–2022) was implemented in Gujarat, where comprehensive investigations around the Tapi and Daman Ganga river systems generated critical insights into the presence and impacts of plastic waste and POPs. The findings informed key action points for improving monitoring, management, and regulatory interventions.

Building on this foundation, Phase II of the project focuses on reducing plastic pollution and POPs in Tamil Nadu and Uttarakhand, with an expanded emphasis on generating scientific evidence, supporting regulatory compliance, and strengthening stakeholder capacities.

In this context, Toxics Link, NIVA, SRM, and Mugamma Consultancy Pvt. Ltd. are jointly developing a policy note that identifies the key gaps, concerns, and challenges faced by implementing agencies and stakeholders in enforcing POPs regulations and managing plastic pollution in India. The findings and reports shared in the process aim to support and complement the Government of India's efforts to strengthen POPs management and fulfil its obligations under the Stockholm Convention.

As part of this initiative, a stakeholder consultation meeting was organized in Dehradun, Uttrakhand in collaboration with the State Pollution Control Board with participation from government bodies, researchers, civil society organisations, academia with an to aim to build awareness and create conversation among various stakeholders on the pressing regulatory and implementation challenges in POPs and plastic pollution management.

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<u>The stakeholder meeting intends to:</u>

- Present findings from INOPOL's research on POPs and plastic pollution, including experiences with data collection, laboratory analysis, and environmental modelling in Gujarat and Tamil Nadu;
- Discuss the broader policy and societal relevance of this work, including implications for gender, health, and the ongoing global plastics treaty negotiations;
- Introduce tools, methods, for inventorisation of POPs point sources and protocols for environmental monitoring and laboratory assessment;
- Facilitate dialogue to identify local needs, knowledge gaps, and opportunities for stronger science– policy collaboration in POPs and plastic waste management

(I) Inaugural Session

Welcome Address

Mr. Satish Sinha, Associate Director, Toxics Link, welcomed the participants and emphasised the importance of multi-stakeholder engagement in addressing chemical pollution. He also emphasised the impacts of such complex chemicals on the fragile ecosystem of the state and home to most critical resources like glaciers and river systems and the Himalayas that potentially attract such chemicals due to cooler weather systems in the region.

He highlighted that POPs are among the most hazardous chemicals globally due to their persistence, toxicity, and ability to travel long distances across ecosystems with far-reaching impacts on the environment and human health, stressing further on the need for the country to recognise and act on all such chemicals listed under the Stockholm Convention. Plastics were also highlighted as a growing concern because they can act as carriers for POPs and other toxic additives, facilitating environmental diffusion.

Mr. Sinha referred to Toxics Link's years of research on POPs and plastic pollution, including studies on river systems and ecosystems in Gujarat and Tamil Nadu as a part of the INOPOL consortium project, which was initiated in 2020. He emphasised the need for evidence-based policy interventions and stronger monitoring systems.

Providing historical context, he referenced Rachel Carson's "Silent Spring", which first highlighted the ecological impacts of pesticides, and noted that India ratified the Stockholm Convention on Persistent Organic Pollutants in 2006. He emphasised that the development and implementation of National Implementation Plans (NIP) are crucial for fulfilling India's international commitments and the critical need for all stakeholders to engage collaboratively on this complex issue in the interest of the environment and public health.

Introductory Address

Dr. Hans Nikolai Adam, Senior Research Scientist, Norwegian Institute for Water Research (NIVA), Norway, introduced the work of the Norwegian Institute for Water Research (NIVA), highlighting its long-standing experience in applied environmental research and monitoring.

He explained that the India–Norway Cooperation Project for Plastic and Chemical Pollution Reduction aim to strengthen scientific knowledge and monitoring systems to address chemical pollution.

Dr. Adam shared examples of NIVA's collaborative research in India, including monitoring studies conducted in the Daman Ganga and Tapi river basins in Gujarat and river catchments in Tamil Nadu, thus bridging the most critical gaps of data inadequacy on the subject in India.

He emphasised the importance of linking local environmental management with national and international policy frameworks and highlighted the need for capacity building, scientific monitoring, and international collaboration.

He also appreciated Toxics Link's research report on POPs in Uttarakhand and stated that such studies help identify knowledge gaps and guide policy decisions.

Inaugural Address

Dr. Parag Madhukar Dhakate, Member Secretary, Uttarakhand Pollution Control Board (UKPCB) welcomed all participants and noted that Uttarakhand plays a crucial role in India's environmental landscape as the source of several major rivers and glacier systems, making it particularly vulnerable to environmental contamination.

He explained that Persistent Organic Pollutants (POPs) are hazardous carbon-based chemicals characterised by persistence in the environment, toxicity, bioaccumulation, and long-range atmospheric transport.

Dr. Dhakate noted that India has established regulatory frameworks to manage POPs, including the Regulation of Persistent Organic Pollutants Rules, 2018, which prohibit or regulate several hazardous chemicals.

He emphasised that multi-stakeholder collaboration is essential to effectively address chemical pollution and highlighted the importance of data generation, research, and awareness. He encouraged academic institutions, research organisations, and civil society groups to actively contribute to knowledge generation and environmental protection efforts.

Address on Indo-Norway Partnership

Mr. Andreas B. Schei, Counsellor for Climate and Environment, Royal Norwegian Embassy, New Delhi highlighted the importance of international collaboration in addressing environmental challenges such as plastic pollution and hazardous chemicals.

He noted that Uttarakhand has exceptionally rich biodiversity, including diverse forest ecosystems and wildlife sanctuaries, making environmental protection particularly important.

He spoke about Norway's collaboration with India in areas such as marine pollution, circular economy, and chemical management. Norway has been actively supporting initiatives to strengthen monitoring systems and promote scientific research.

Mr. Schei also shared Norway's experience in regulating POPs under the Stockholm Convention and European Union chemical regulations, emphasising the importance of strong monitoring systems, scientific data, and stakeholder engagement.

Vote of Thanks

Mr. Nathaniel Dkhar, Associate Director, Mu Gamma Consultants Pvt. Ltd. thanked all speakers, institutions, and participants for their valuable contributions. He acknowledged the collaborative efforts of the organisers, supporting partners, and participants in making the stakeholders' meeting successful.

Technical Session I: POPs Management in India

Chair: Mr. Piyush Mohapatra, Senior Program Coordinator, Toxics Link

Progress of the National Implementation Plan (NIP-2)

Dr. Ramesh Kumar, Principal Scientist, CSIR-NEERI, explained that Persistent Organic Pollutants are organo-halogen (fluorine, chlorine, bromine) compounds containing elements such as chlorine, fluorine, or bromine.

He described the defining characteristics of POPs, such as Persistence (they resist degradation in the environment), bioaccumulation (the ability to accumulate in organisms and food chains), toxicity (causes serious health impacts such as endocrine disruption, cancers, and neurological disorders), and long-range transport (ability to travel across continents and accumulate in remote regions such as the Arctic and Himalayan ecosystems). He explained that such chemicals may be intentionally produced chemicals (such as pesticides and industrial compounds) or unintentionally produced by-products, giving the example of waste incineration or industrial processes as activities.

Dr. Kumar explained the global response to POPs through the Stockholm Convention (2001), which requires signatory countries to eliminate or restrict the production and use of listed chemicals. Currently, 37 chemicals are listed globally, while India has ratified 19 chemicals. Additional chemicals are under consideration based on industrial, economic and socio-economic factors.

He also outlined the importance of a National Implementation Plan (NIP) that serves as India's roadmap for fulfilling its obligations under the Convention. Key elements of the NIP include comprehensive data on chemical inventories, sector-wise usage, import/export data, contaminated sites, human health implications, safer alternatives, best available technologies and practices to reduce emissions, and its integration with sustainable development goals.

Dr. Kumar also explained the institutional framework for POPs management, involving departments such as the MoEF&CC, CPCB, State Pollution Control Boards and international partners such as UNEP and funding organisations such as the Global Environment Facility (GEF).

Updating on the second National Implementation Plan, he explained that the project has progressed to approximately 70% completion since its inception in February 2023. During the project period, the project has been successfully map chemical-producing industries, electronics, textiles, transformer oils and other consumer products, etc though he did highlight some degree of difficulty in obtaining credible data on production and usage of these chemicals from various agencies.

Role of the State Pollution Control Board (Uttarakhand)

Dr. Ankur Kansal, Environmental Engineer, UKPCB, explained that POPs reach the Himalayan region due to long-range atmospheric transport, commonly referred to as the "grasshopper effect."

He explained the 'PBTL' criteria of classification of POPs – **P**ersistent, **B**ioaccumulative, **T**oxic, **L**ong-range transportation. Furthermore, he outlined the potential industrial sources of POPs, namely, Chemical manufacturing, Metallurgical industries and Industrial combustion processes (Industrial), and non-industrial sources like domestic waste burning, Household chemical usage, and agricultural inputs.

Emphasising the environment and public health implications, Dr. Kansal highlighted the various case studies illustrating the impacts of POPs, such as the 2011 Endosulfan tragedy in Kerala, and the Oriental Whiteback Vulture population decline due to persistent pharmaceutical compounds such as Diclofenac. He further explained its pervasiveness by giving examples of DDT residues found in mothers' milk and POPs found in arctic and Himalayan regions.

Dr Kansal explained the role of international conventions such as Stockholm, Basel and other global environmental frameworks and their influence on the domestic policy framework, including financial assistance through GEF and Environmental Relief Fund. While concluding his session, he also informed that the monitoring programs, such as the Global POPs Monitoring Program, are being implemented to track these chemicals in environmental matrices, including air, water, milk, and wildlife.

Perspective of the Industry

Dr. Ashutosh Gautam, Head – Environment, Indian Glycols Limited, began his talk by summarising the understanding of POPs, both in India and globally, India's progress under the Stockholm Convention and the critical role of collaborations across sectors.

He shared the perspective of the industry on environmental compliance and chemical management by emphasising that industries are increasingly adopting environmentally responsible practices, including waste minimisation, improved treatment systems and safer chemical substitutions. He also highlighted the importance of collaboration between industry, regulators and researchers to ensure effective implementation of environmental policies while maintaining economic sustainability.

Q&A session

The first question was raised by the regional head of the Uttarakhand Pollution Control Board in Roorkee, enquiring how chemicals, usually identified by their trade name rather than their chemical name in practice, should be managed or addressed within the environmental framework.

Dr Ramesh Kumar says that the answer lies with the government of India. He provided examples of existing frameworks, such as the United Nations-proposed Classical label and Packaging of Chemicals, or the HSN code. While the government has not accepted such a framework yet, he proposes recommending the addition of policies addressing this issue.

Anil Gautam from the People's Sciences Institute enquired if coal burning in thermal power plants and plastic manufacturing plants are possible sources of POPs release?

Dr Ramesh Kumar stated that India is primarily dependent on coal (thermal energy) for its energy production. It is also a prominent fluoride, particulate matter, sulphur and mercury release into the environment and the pollutants in the emissions are regulated under international conventions and domestic regulations. While India possesses the technology to control such emissions, it has not been able to implement it uniformly throughout the country. This is despite the irregularities being flagged by the Supreme Court multiple times.

Aman Bhatia from Axis consultants asked Dr. Kansal, representative of the Uttarakhand Pollution

Control Board, if the government plans to incentivise mechanical-PET recycling-dominant industries to shift to chemical recycling?

Dr. Kansal informed that the government weren't currently providing incentives, focusing on replacing chemical recycling with mechanical recycling, to the industries. However, he pointed out that despite the lack of such incentives, the product quality and profits from producing chemically recycled PET were higher. Given this trend, he predicted that the market shift is imminent.

Mr Satish Sinha asked Dr. Kumar questions on the validity and quality of data produced by the NIP 2.0, given the lack of supporting data on POPs usage and import/export data, the lack of inclusion of diverse stakeholders in the process of the NIP, also flagged by the Stockholm Convention and the concerns on PBDE.

Dr. Ramesh Kumar acknowledged the data gap on POPs in India and pointed towards the absence of regulation on reporting, e.g. REACH, as a barrier to obtaining quality data. He attributes the herculean task of approaching industries and regulatory agencies, individually, throughout the country, as a means for collecting quality data. He admits that although the data might not be one hundred per cent accurate, it is adequate for devising implementation strategies in the absence of reported data.

One the involvement of diverse stakeholders in the formulation of the NIP, Dr. Kumar states that committees are formed by the Ministry of Environment, Forrest and Climate Change and cannot comment further, but acknowledges that the involvement of all stakeholders is also key for the development of the NIP.

He further informs Mr. Sinha that he has been in continuous contact with the Society of Indian Automobile Manufacturers (SIAM) and that the majority of POPs currently in use occur as flame retardants and plasticisers in the vehicles. However, given the availability of funds, SIAM is aiming to phase out hazardous chemicals in the manufacture of automobiles soon.

Technical Session II: Monitoring of POPs

Chair: Dr. A. Ramesh Kumar, CSIR-NEERI

PFAS – A Contaminant of Emerging Global Concern

Dr. Sissel Brit Ranneklev, Senior Research Scientist, NIVA introduced the topic of Per- and Polyfluoroalkyl Substances (PFAS), often referred to as "forever chemicals" due to their extremely stable carbon-fluorine bonds. Unlike traditional POPs, PFAS binds to proteins rather than fatty tissues, which changes their environmental behaviour and human exposure pathways. She went on to explain the molecular structure that make them highly mobile in soil and water systems and difficult to remove using conventional water treatment methods.

Dr. Ranneklev highlighted major sources of PFAS, such as firefighting foams used at airports and military bases, in industrial applications such as textiles and coatings, consumer products, including cosmetics and non-stick cookware and wastewater sludge applied in agriculture. She provided additional information such as the fate and transport of PFAS in drinking water, routes of exposure (food, drinking water, household dust, occupational exposure and consumer products) and health implications such as liver and kidney cancers, endocrine disruption, and weakened immune responses in children.

She went on to contextualise the information by explaining the global status of PFAS monitoring in drinking water – methodology of assessment and high and widespread contamination across the globe. Furthermore, she highlighted the challenges in PFAS monitoring, such as a wide range of substances, analytical and infrastructural challenges. The Indian context was provided by acknowledging India's rapid industrial growth, the high levels of PFAS in surface and groundwater, the lack of a regulatory framework for managing PFAS in drinking water, and the absence of a permissible limit in drinking water.

Dr. Ranneklev emphasised the need for improved monitoring, analytical and infrastructural capacity, safer alternatives and regulatory frameworks to address PFAS contamination.

Polyurethane Foam-based passive air sampling: A cost-effective monitoring technique for atmospheric POPs

Dr. Paromita Chakraborty, Professor & Head, REACH, SRM Institute of Science and Technology, presented Polyurethane Foam (PUF)-based passive air sampling, a cost-effective technique for monitoring atmospheric POPs.

She commenced the presentation by highlighting legacy and emerging contaminations in the environments, such as pesticides, plastic additives, industrial chemicals and personal care products, their long-range transportation, routes of exposure and their ecological impact, such as birth defects and fertility issues.

To provide a cost-effective monitoring technique for such chemicals, Dr. Chakraborty introduced Polyurethane Foam (PUF)-based passive air sampling. The method allows simultaneous collection of both gaseous and particulate pollutants and can be deployed across multiple sites due to its low cost. Seasonal variations significantly influence pollutant distribution. For example, winter conditions allow more stable monitoring due to slower atmospheric movement, and summer and monsoon seasons affect volatilisation, dispersion, and deposition patterns.

On POPs monitoring in Uttarakhand, Dr Chakraborty talked about her study that detected alpha-HCH, beta- endosulfan, Dioxins, PCBs, etc., indicating the persistence of legacy pesticides in the environment.

Dr Chakraborty emphasised the importance of monitoring multiple matrices, including air, water, soil, and biological samples such as fish and milk, to understand exposure pathways.

Q&A session

A question was raised to Dr. Chakraborty enquiring about the timeline of her study in Uttarakhand.

Dr. Chakraborty informed that the study took place in December when the contaminants are lofted in the air. She further recommends keeping the results as the baseline, and studies can be done to understand the seasonal changes and the effect of temperature on the density of the contaminants in the air, especially in colder regions.

Another question was raised on the need to perform seasonal studies, as the changing concentration relative to seasonal changes is expected.

Dr. Chakraborty explains that the concentration of contaminants can be measured in the winter if the aim is to monitor once. However, seasonal studies are performed for two reasons: to study exposure levels owing to changing residual time limit, relative to the movement of air and seasonal anthropogenic activity (e.g. crop burning); and the movement of contaminants throughout different environmental matrices (e.g. monsoons). She recommends restricting the open burning of waste, even in a personal capacity, to reduce emissions.

Ayush from Ideal Foundation, what are the current solutions to incinerators that are probable sources of POPs release?

Dr Chakraborty recommends that steps be taken at the source. She acknowledges that incineration can be a challenge; however, improved recycling should be a major source.

When asked about the perspective of biodegradable sanitary pads. She states that "biodegradable sanitary pads" carry more challenges, as the chemicals involved are even more complicated.

Technical Session III: Plastics and Chemicals

Chair: Dr. Paromita Chakraborty, SRM Institute of Science and Technology

Laboratory Analysis of Microplastics

Dr. Smita Mohanty, Director, LARPM, CIPET Bhubaneswar, discussed the baseline findings of the INOPOL study in Tamil Nadu on microplastics, management challenges faced and the way forward.

She began her talk by highlighting India as a prominent producer of plastic waste, after China and the United States of America. She substantiates the need for projects like INOPOL by presenting the dichotomy of increasing plastic waste in India with the substantial decline in recycling rates in the country, and the need for monitoring studies that help illustrate the existing burden of plastic waste on the riverine system.

She briefly introduced the audience to the different phases of the INOPOL studies that were carried out in Gujarat, Tamil Nadu and Dehradun. Some of the key challenges identified by the team during the projects were high littering rates, a lack of recycling infrastructure, prevalent informal recycling practices and consumer behaviour as recurring issues. She noted that the policy framework on plastic waste is continuously evolving; however, the basic practices of collection, treatment, and recycling remain constant.

Talking about the microplastic monitoring during the first phase of the INOPOL, Dr.

Mohanty highlighted that the project in Gujarat quantified 3.53 pieces/litre of microplastics in Damanganga, 2.83 pieces/litre in Tapti and 0.77 pieces/litre in Dumas beech. Twelve sites were sampled, all of which contained varying concentrations of microplastics. The majority of microplastics obtained belonged to the olefin groups - Polyethylene (PE) 48.68%, Polypropylene (PP) – 35%, PET – 11.18%, and Polystyrene – 5.93 %. This also indicated that microplastics in the sites came from macroplastics like food packaging materials. The samples contained fibres, fragments, beads, or films and varied colours like blue, white, black, yellow, green etc.

During the second phase of the INOPOL study in Tamil Nadu, 13 sites were identified in the Kaveri river basin. Sampling was done to analyse seasonal differences, different times of the day and the type of micro- and macroplastics in the river system. Additionally, passive sampling was done along with sampling along the banks and sediments. MICRO FTR was used to analyse the microplastic fragments, which were composed of mainly of PE, PP, polystyrene and PET. Raman Spectroscopy revealed PE, PET, whereas GC-MS, done to study decomposition, revealed polypropylene and Acrylonitrile Butadiene Styrene. Most of the samples contained mostly polyolefins (PE, PP) and PET. Results were further validated with help from international labs. Aside from testing and monitoring, the project also involved workshops and training programs to build domestic capacity.

Concluding the presentation, Dr. Mohanty talked about how Indian plastic waste management is comparable to many other developing nations; however, she expressed the need to expand on existing frameworks, such as the Extended Producer Responsibility (EPR) and introduce policies such as a credit-to-credit system. Furthermore, she proposed the development of a natural ecosystem that can be utilised to carry out disposals.

Macroplastic Monitoring

Dr Rachel Hurley, Research Scientist at NIVA, presented research on macroplastic monitoring in river systems.

She begins the presentation by listing macroplastics, the scientific name for large plastic items often used in day-to-day lives, as an important source of microplastics in the aquatic system, and explains the fate of their pollution. She emphasised that although microplastics are most often associated with the marine ecosystem, they originate from land, where rivers act as a conduit to the sea. There are various hydrological processes taking place in different riverine system that determines the ultimate plastic that gets deposited in the sea.

Acknowledging that every river system is different, she goes on to discuss various monitoring approaches adopted in the INOPOL project - visual observation of floating macroplastics (for large floating plastic on the surface), Net sampling for submerged macroplastics (for plastic at the subsurface level), and the riverbank survey of stranded macroplastics (for plastic that gets stranded to changing water levels). A series of surveys was conducted across six sites of the Kaveri Basin in Tamil Nadu across different seasons.

In the case of Tamil Nadu, the majority of the plastic waste observed belonged to food packaging, followed by bottles, lids, labels and personal care packaging. Overall, 19.3% of the observed macroplastics were composed of single-use plastic-banned items. The proportion of SUPs with total plastic waste was 2.4%, implying good compliance with the SUP rules in India.

A small-scale study, involving the visual observation method, was also conducted in Uttarakhand, where five sites were surveyed across Dehradun (3) and Rishikesh (2). In Dehradun, the survey was done on streams that drained on the left-hand side of the city, another that drained the right-hand side and the third, after the confluence of these two streams, which then forms a branch of the Song River. In Rishikesh, one survey was done from a bridge on the North edge of the city and another upstream of the urban environment.

Dr. Hurley and her team observed different levels of plastic waste at these sites, compared with the average results from each site in the Cauvery River. The levels were slightly higher in Uttarakhand, compared to Tamil Nadu, but it was mostly attributable to low data points in Uttarakhand and more urban sites than in Tamil Nadu. She further added that the city levels in the UK were in fact broadly comparable with the level observed in Trichy on the Cauvery.

In Dehradun, the highest concentration of macroplastic loads was observed in the confluence region of the Song River, followed by the rivers on the left side and then the right side of Dehradun. Comparatively, Rishikesh had lower levels of macroplastic but a higher diversity of macroplastic types. Dehradun macroplastics were mostly comprised of food packaging (69%), such as chip packets and candy wrappers.

Concluding her presentation, Dr. Hurley pointed out that high macroplastic levels were strongly correlated with urban environments, where there are high densities of both people and waste streams. Hence, more action should concentrate on cities to more effectively reduce plastic pollution. She recommended a robust assessment of macroplastics, which includes seasonal and time changes supplemented by a higher number of sites.

Q&A session

A question was asked about how the macroplastics were quantified.

Dr. Hurley explained the monitoring aspect in the context of Uttarakhand. She recommends dividing the stream into smaller regions, if it is big, to effectively calculate the number of macroplastics. Furthermore, to use a net from a bridge to catch plastic in the water, and to collect and categorise. Additionally, plastic on the edges of the river can be collected to a good estimate of old and new.

Another question was asked on the possible solutions to multilayer plastic waste used for food packaging, which was found in Uttarakhand, given that EPR exists primarily for PET waste.

Dr. Hurley states it would be difficult to estimate the impact of EPR given the lack of prior data on macroplastic waste, but recommends the use of alternatives, implementing waste collection strategies or different EPR schemes that are suitable or tailored to the demands and sensibilities of the people and regulators in Uttarakhand.

Session IV: Panel Discussion – Way Forward

Moderator: Mr. Satish Sinha, Toxics Link
Panelists:

- Dr. P.K. Joshi, Environmental Engineer, UKPCB
- Dr. P.C. Padhi, Director & Head, CIPET Dehradun
- Dr. A. Ramesh Kumar, Principal Scientist, CSIR-NEERI

The panel discussion commenced with Mr. Satish Sinha summarising the events of the meeting. He spotlights existing issues with regard to POPs and microplastic management in India, such as the lack of stringent data, such as that for stockpiles, hotspots and contaminated sites, health effects, etc., that can be utilised by the state and central pollution control board for effective management.

He invites the panellists to give suggestions to the Uttarakhand Pollution Control Board for effective management of both plastic and POPs.

Dr. Ramesh Kumar points out that POPs exposure is dependent on seasonal changes as well as temperature changes; therefore, synthesis of data on POPs and POPs monitoring throughout India is very important. He presses on the need for effective data sharing with policymakers and regulators, such as the Ministry of Environment, Forrest and Climate Change and the CPCB, and the need for more studies linking POPs and their health and ecological impact.

Talking about the National Implementation Plan, he also talks about the need to generate more industrial data and promises to raise the issue during the NIP workshop to improve the reporting mechanism.

Dr. P.K. Joshi from the Uttarakhand Pollution Control Board applauded Toxics Links for conducting the workshop on POPs and plastic management, acknowledging that it was a necessity, as many participating stakeholders (industrial sector, etc.) were unaware of such a class of chemicals. He accepts that UKPCB has an important role to play in the creation of data coming from the industries and states that monitoring needs to start by incorporating hazardous chemical monitoring with usual hazardous waste monitoring.

Furthermore, he expressed the need for stringent monitoring of microplastics and dioxins released from manually operated recycling units, waste-to-energy plants, RDF-based incinerators and the paper and pulp industry. He promises to take action on regulatory aspects and ensure full compliance.

Dr. P.C. Padhi commenced his session by talking about the role of CIPET Dehradun in providing skilled manpower to plastic and plastic-associated industries. He acknowledged that the central government has taken a lot of steps to improve recycling to safeguard our health and environment from microplastics. However, due to the expanding nature of the Indian industrial sector, the number of industries flouting regulations has also increased. He recommends CIPET and UKPCB to work together to organise training for unskilled workers who handle hazardous waste and chemicals. Plastic and allied industries should be trained on recycling and working with hazardous chemicals across the line to ensure the protection of all workers.

He recommends investment in research and development to develop technologies and methodologies to deal with the by-products of the plastic industries. He laments that industrialisation is inevitable and that technologies and awareness need to be created to not only protect public health and the environment, but also to generate more employment in support of "waste" to "wealth".

Mr Sinha opens the panel to the audience and asks for additional recommendations for the pollution control board.

Dr Das from CIPET asks Dr Joshi about possible solutions to plastic littering, given that Uttarakhand is also a prominent tourist hub.

Dr. Joshi informs the audience that the state pollution control board is currently working on a Deposit Refund System Scheme in Uttarakhand and is awaiting final approval. It was piloted in major tourist hubs such as Badrinath, Kedarnath, and other routes of Char Dham, and met with great success. It is expected to curb littering and help rag pickers and small vendors in the collection of plastic waste and PET bottles for further recycling and collection.

Mr. Sinha added that many Indian states have successfully managed to control the issue of littering with full participation from residents, giving the example of Sikkim, and that there needs to be a meaningful exchange of learnings and experiences to effectively tackle the growing issue of littering.

Dr. Rajendra Singh from the Regional office of the UKPCB points out that five to six paper mills had been given consent to operate in his region. Compounded with the push towards RDF and the absence of established monitoring infrastructure for POPs, the release of Dioxins and Furans might be inevitable. He emphasises the need to pay attention to air pollution, building laboratory capacity and the need to standardise air pollution control devices.

Dr. Joshi explains that dioxins and furans are released from incinerators and RDF boilers when the temperature is below the certified temperature. Therefore, he recommends creating a monitoring protocol for exhaust temperature, which could determine the incinerator temperature and, in turn, help reduce emissions of dioxins and furans. He further recommends expanding monitoring studies to lower invertebrates such as zooplankton and macrozoobenthos, in order to better understand the impact of POPs on the aquatic ecosystem.

Mr. Sinha suggests UKPCB expand their testing capabilities by working with either government-affiliated labs, such as CPCB, in order to conduct regular testing. Alternatively, he suggested that the industries conduct these monitoring tests themselves from accredited labs under the supervision of the regulators .

While concluding the session, Mr. Sinha appreciated the acknowledgement made by the UKPCB regarding their limited understanding of POPs and their enthusiasm in addressing and mitigating these issues. He emphasised the importance of building workers' skills as a key priority, alongside strengthening technological capacities. Furthermore, he highlighted the need for robust data generation and greater transparency in policy-making and implementation. In his closing remarks, he also underscored the urgency of minimising the use of single-use plastics also upstream changes by regulating select chemicals.

Key Recommendations

1. Strengthen monitoring systems for POPs, PFAS, and plastics in environmental matrices.
2. Improve laboratory infrastructure and analytical capacity across India.
3. Promote safer chemical alternatives and green chemistry solutions.
4. Encourage industry participation in pollution reduction and waste management initiatives.
5. Strengthen public awareness programs and community participation.
6. Support scientific research and data generation to guide policy decisions.
7. Promote circular economy approaches to reduce plastic pollution.

Photos of the meeting

(I) Inaugural Session

Mr. Satish Sinha, Associate Director, Toxics Link

Dr. Hans Nikolai Adam, Senior Research Scientist, Norwegian Institute for Water Research (NIVA), Norway

Dr. Parag Madhukar Dhakate, Member Secretary, Uttarakhand Pollution Control Board (UKPCB)

Mr. Andreas B. Schei, Counsellor for Climate and Environment, Royal Norwegian Embassy, New Delhi

Mr. Nathaniel Dkhar, Associate Director, Mu Gamma Consultants Pvt. Ltd.

Technical Session I: POPs Management in India

Chair: Mr. Piyush Mohapatra, Senior Programme Coordinator, Toxics Link

Dr. Ramesh Kumar, Principal Scientist, CSIR-NEERI

Dr. Ankur Kansal, Environmental Engineer, UKPCB

Dr. Ashutosh Gautam, Head – Environment, Indian Glycols Limited

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Technical Session II: Monitoring of POPs

Chair: Dr. A. Ramesh Kumar, CSIR-NEERI

Dr. Sissel Brit Ranneklev, Senior Research Scientist,

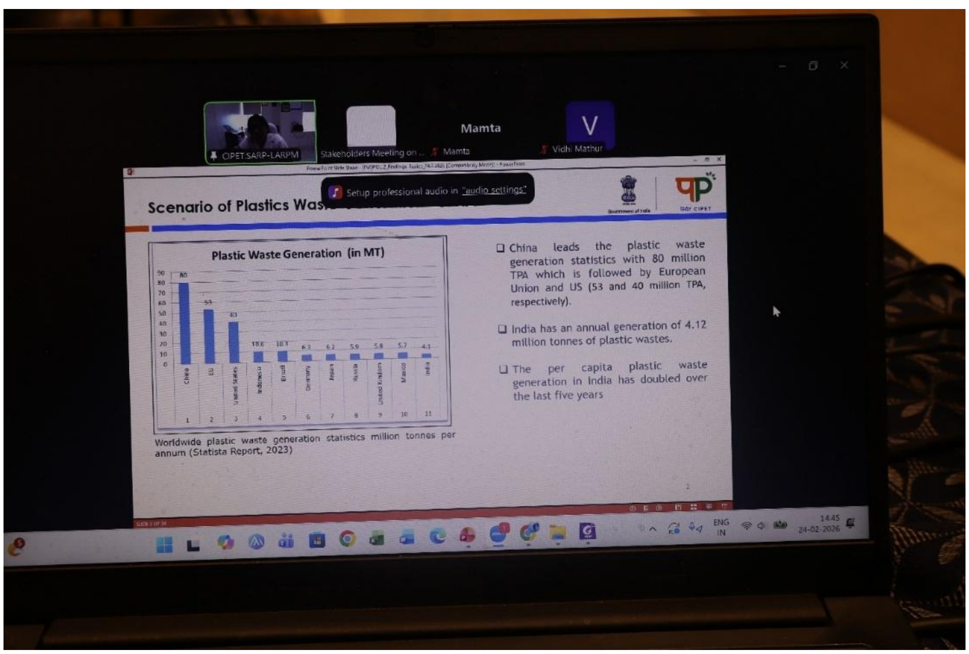
Dr. Paromita Chakraborty, Professor & Head, REACH, SRM Institute of Science and

Technical Session III: Plastics and Chemicals

Chair: Dr. Paromita Chakraborty, SRM Institute of Science and Technology

Dr. Smita Mohanty, Director, LARPM, CIPET Bhubaneswar

Dr. Rachel Hurley, Research Scientist, NIVA



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- Dr. P.C. Padhi, Director & Head, CIPET Dehradun
- Dr. A. Ramesh Kumar, Principal Scientist, CSIR-NEERI

Presentations

(i)

GEF-UNEP funded Project

"Review and update of National Implementation Plan on Persistent Organic Pollutants"

Dr. A. Ramesh Kumar
Principal Scientist
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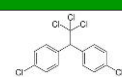
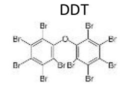
What Are "POPs" ?

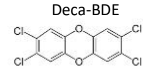
- ❖Synthetic organohalogen compounds
- ❖Persistent in environment
- ❖Lipophilic (i.e. fat soluble), hence bioaccumulative
- ❖Accumulate in food chain
- ❖High levels in fish and marine mammals
- ❖ POPs are toxic to humans and wildlife
- ❖Can be transported to remote areas such as Arctic and Antarctica
- ❖Undergo long-range atmospheric transport and leads to global pollution (Characteristic of semi-volatile compounds)
- ❖Regulated under the Stockholm Convention



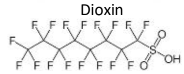
DDT



Deca-BDE



Dioxin



PFAS

2

Stockholm Convention on Persistent Organic Pollutants: An Overview

- Objective: "Protection of Human Health and Environment from Persistent Organic Pollutants"
- Stockholm Convention, adopted in 2001 and entered into force in 2004, requires parties to take measures to eliminate/ reduce the release of POPs into the environment.
- No of parties: 187 (2025)
- Chemicals are listed in in three categories Annex-A (Elimination), Annex-B (Restriction), and Annex-C (minimization of unintentional POPs)
- Initially, the Convention listed 12 chemicals as POPs
  Pesticides (8), industrial chemicals (2), unintentional POPs/by-products (2)
- No of POPs as on 2025: 37
- No. of POPs ratified by India: 19
- India may ratify more chemicals based on the findings of this project

3

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37 POPs listed in the Stockholm Convention (2025)

Chemical	Pesticides	Industrial chemicals	Unintentional production	Annex
DDT, Aldrine, Dieldrine, Endrine	+			B
Chlordane, Chlordecone, Toxaphene,	+			A
Alpha-, Beta-, Gamma-HCH, Endosulfan,	+		By-product of lindane	A
Heptachlor, Mirex , Dicofol, Methoxychlor,	+			A
Chlorpyrifos	+			A
Pentachlorophenol (PCP), and its salts	+	+		A
Commercial PentaBDE, Commercial		+		A
OctaBDE (Hexa/HeptaBDE), Commercial		+		A
DecaBDE, Hexabromobiphenyl (HBB)		+		A
Hexabromocyclododecane (HBCD)		+		A
Perfluorooctane sulfonic acid (PFOS),		+		A
its salts and PFOSF	+	+		B
PFOA & PFHxS and related chemicals				
LC-Perfluoroalkyl acids		+		A
Short chain chlorinated paraffins (SCCP),		+		A
Medium chain CPs(MCCP)				A
UV328, Dechlorane Plus				A
PCB, PeCBz, HCB, PCN, HCBD	+	+	+	A/C
PCDD, PCDF			+	C

4

Courtesy: Roland Weber

Stockholm Convention on Persistent Organic Pollutants: Country Position

STOCKHOLM CONVENTION

Ministry of Environment, Forest & Climate Change

- MoEFCC is the focal point of all multilateral environmental conventions
- India signed SC in 2004 and ratified it in 2006. Submitted its initial NIP in 2011.
- India ratified 19 chemicals (12 (initial) +7 (2018)
- Ratified 7 chemicals under the “Regulation of Persistent Organic Pollutants Rules, 2018” under the provisions of Environment (Protection) Act, 1986.
    1. Chlordecone
    2. Hexabromobiphenyl
    3. Hexabromodiphenyl ether and Hepta Bromodiphenyl Ether (Commercial octa-BDE),
    4. Tetrabromodiphenyl ether and Pentabromodiphenyl ether (Commercial penta-BDE),
    5. Pentachlorobenzene,
    6. Hexabromocyclododecane, and
    7. Hexachlorobutadiene.

5

National Implementation Plans (NIPs) under the Stockholm Convention on POPs

- India signed the convention in 2004 and ratified it in 2006.
- Submitted its initial NIP in 2011.
- Article 7 of the Stockholm Convention, mandates each Party to

Prepare a National Implementation Plan (NIP) for the management of POPs, implement the obligations under the Convention and make efforts to put such a plan into action.

- NIP is not a standalone document but should be closely tied to the Environmental protection rules and national sustainable development strategies
- Shall be submitted within 2 years of the date on which the Convention enters into force
- Review and update, as appropriate, its NIP on a periodic basis and in a manner to be specific by a decision of the Conference of the Parties (COP).
- This is the first updation of NIP for India

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Content/Data Requirement of the National Implementation Plan

- Production, import/export details, use, stockpiles
- Concentrations in environmental compartments, products and waste
- Sector-wise consumption of POPs e.g., Agriculture, Construction, Automotive, Textile, Plastic, Electric and Electronic, Waste incineration, Rubber, Paint, Leather etc.
- Contaminated sites
- Human health implications
- Assessment of alternatives
- Management/action plan to reduce emissions (BAT/BEP)
- Socioeconomic impacts
- Synergies with Basel, Rotterdam, Minamata and SAICM conventions/treaties
- Integration with National developmental policies, SDG, etc.
- Prioritized action plans for POP management

7

Work Distribution

- Overall Coordination, guidance/monitoring: MoEFCC, NCC and UNEP
- POP Pesticides (16 Chemicals): CSIR-NEERI
- Industrial Chemicals (8 Chemicals/groups): CSIR-NEERI
- Industrial Chemicals (PFAS group*): CSIR-IITR, Lucknow
- Un-intentional POPs (7 chemicals): CSIR-NIIST, Trivandrum
- Coordination for sampling/Industry visit: CPCB and SPCBs

*Perfluoro alkyl substances (PFAS) >10,000 isomers(e.g. PFOA, PFOS, and their salts and related compounds)

8

National Coordination Committee (NCC)

- Constituted by MoEFCC vide 22-19/2016/HSMD dated 23/01/2023

- Ministry of Environment, Forest and Climate Change
- Ministry of Chemicals and Fertilizers
- Ministry of Agriculture and Farmers Welfare
- Ministry of Health and Family Welfare
- Ministry of Finance
- Ministry of Statistics and Programme Implementation
- Ministry of Textiles
- Ministry of External Affairs
- Ministry of Small, Medium and Micro Enterprises
- Ministry of Commerce and Industry
- Ministry of Road Transport and Highways
- Ministry of Heavy Engineering and Pubic Enterprises
- Central Pollution Control Board and State Pollution Control Boards/Committees
- Directorate General of Foreign Trade (DGFT)
- CII, FIICI, Indian Chemical Council
- UNEP Country Office

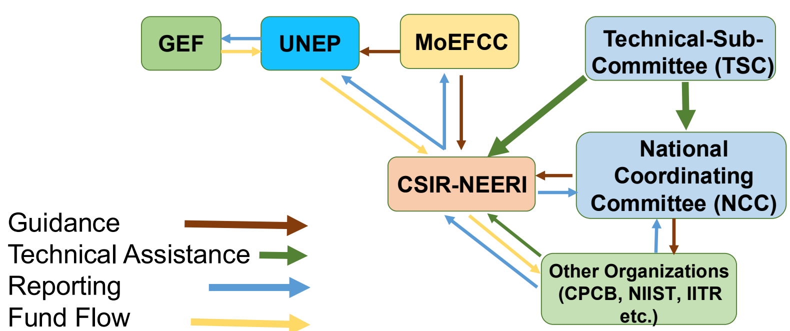
9

Technical Sub- Committee

(Constituted by MoEFCC vide 22-19/2016/HSMD dated 15/02/2023)

1. The Director, CSIR-NEERI
2. The Member Secretary, Central Pollution Control Board
3. The Director, CSIR-NIIST, Trivandrum
4. The Director, CSIR-IITR, Lucknow
5. The Director, ICAR-IARI
6. The Director, ICMR-National Institute of Occupational Health (NIOH), Ahmedabad.
7. The Director, ICMR-National Institute of Nutrition (NIN), Hyderabad
8. The Member Secretary, Gujarat Pollution Control Board
9. The Member Secretary, Maharashtra Pollution Control Board
10. The Member Secretary, Tamil Nadu Pollution Control Board
11. The Member Secretary, Punjab Pollution Control Board
12. The Member Secretary, Rajasthan State Pollution Control Board
13. The Director, Directorate General of Foreign Trade (DGFT), Delhi
14. The Director/Nominee, Directorate of Chemicals and Petrochemicals (DCPC),
15. The Chairman / Nominee, Central Insecticide Board Registration Committee (CIB RC)
16. The Chairman, Textile Committee, Ministry of Textiles, Mumbai,
17. The Director, Central Revenue Control Laboratories
18. The Director General/Nominee, Directorate General of Commercial Intelligence and Statistics, Kolkatta
19. The Director General, Central Power Research Institute, Bangalore
20. The Chief Executive Officer, Food Safety and Standards Authority of India
21. The Director General, CIPET, Chennai
22. The Director General, Bureau of Indian Standards
23. President Society of Indian Automobile Manufacturers (SIAM)
24. Representative, Confederation of India Industries (CII)
25. Representative, Indian Chemical Council (ICC), Mumbai

Institutional Framework for Project Implementation at the National Level



The NIP Development and Update Process

- The three-tier methodology

• Tier 1: Initial assessment

- This is carried out to obtain an overview of the relevant uses of POPs and stakeholders to be contacted in the key sector(s) under investigation. Tier I methods usually rely on available literature and statistics in combination with calculations based on already existing information. Developing countries often develop initial assessments that are not sufficiently detailed and precise to plan the SC implementation or to identify global environmental benefits for the development of future GEF projects to support in-country implementation of NIPs.

• Tier II: Main inventory

- The objective is to generate data on the main sectors through interviews and questionnaires to the national stakeholders, and further identify missing information. The poor rate and quality of answers to questionnaires from key stakeholders is usually the main obstacle to developing the Tier II inventory.

• Tier III: In-depth inventory

- This includes sampling and analysis. In most cases, developing countries have limited or no capacity to conduct in-depth inventories of POPs.

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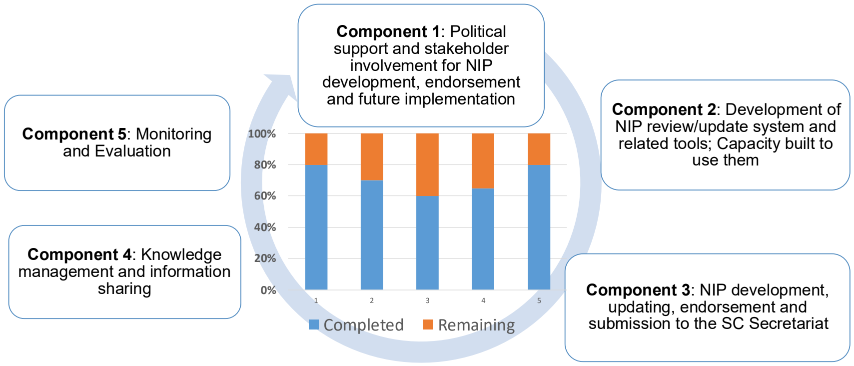
NIP Update Project
Components, Activities, and Outcomes

(Based on 31 December 2025)



Progress of Activities Since 2023

- Inception Workshop held at MoEFCC, on 21 February 2023. About 125 people participated
- Establishment of National Coordination Committee (NCC) and Technical Sub-committee (TSC): Completed. NCC meeting needs to be convened once/year (Last meeting held on 28/07/2025).
- Awareness raising workshops in 2023: 5 Nos (Kolkata, Chennai, Gandhinagar, Trivandrum and Mumbai)
- Awareness raising webinars: 5 completed, participation: about 80-120/ webinar
- Workshops/Awareness programs on PFAS by IITR, Lucknow: 5 Nos
- Training on POPs monitoring for CPCB/SPCB personal completed on 1-5 Sep. 2025
- Training on National Implemention Plan POPs
- POPs data compilation: completed in 2023, being updated regularly
- Analytical method development, sampling and analysis of industrial POPs in various matrices is in progress.
- 12 Quarterly progress reports have been submitted to UNEP, cc to MoEFCC since 2023.
- Technical sub-committee meeting held on 02/02/2026.
- Tier I and Tier II assessments have been completed; Tier III assessments are ongoing.
- Overall progress: 70 %

Workshops/Meetings Planned in 2026

- Awareness-raising workshop on PFAS for PPCB and UP PCB officials (by IITR) during February and March 2026.
- One day training for Customs Officials on “SC listed Chemicals, trade, POPs analysis” in May 2026.
- Training on “Chemicals in Products” to BIS Officials in April/May 2026
- Workshop on “POPs” to Karnataka PCB officials in June/July 2026
- Technical Sub-Committee meeting in September 2026 at NEERI, Nagpur

Inception Workshop at MoEFCC, 21 Feb 2023





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Political Support and Stakeholder Involvement

Workshop at Kolkatta, 23/06/2023

Workshop at Chennai, 07/07/2023

Workshop at Gandhinagar, 12/09/2023

Workshop at Mumbai, 14/09/2023

Workshop at Trivandrum, 23/11/2023

Webinars (5 Nos)

17

"Monitoring and Assessment of Persistent Organic Pollutants (POPs) in the Environment", 01st -05th September 2025




1. Training for CPCB/SPCB officials
2. Participants: 25 Nos



Training Program on “Stockholm Convention on Persistent Organic Pollutants” 11th – 13th December, 2025

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- Training for newly joined CPCB Scientists
- Participants: 85 (55 physical+25 online)

Basic Information/Data on POPs

Sl. No	Name of the Chemical	CAS No*	HSN Number/s*	Common/Trade / Commercial Names	Physical Properties including POPs Screening Criteria**	Uses	Industrial Sectors in which the chemical is used	Manufacturing in India, Quantity/Year	Details of Contaminated sites/Hot spots	Concentrations in environmental, biological samples from India#	Any other information/Remarks
1											

* In case of certain industrial chemicals that exist as isomers, multiple CAS, HSN numbers are possible.

** Physcial state, melting and boiling point, vapour pressure, Log Kow, BCF, t1/2 in air, water, soil/sediment

\# Indicate Author (year). Full reference may be given in separate sheet.

Instructions

1. Separate excel sheet is to be prepared for each chemical.
2. In case of industrial chemical isomers/congeners, data is to be given in the same sheet.
3. Please use wrap text option to adjust the data within the cell.

20

Industrial POPs: Data Collection, Sampling and Monitoring – Progress till Jan 2026

Inventory of Chlorinated Paraffin (CPs)

No. of CPs manufacturing Industries surveyed: 40
Total no. of Industries: ≈ 40

Pulp and Paper Industries

No. of pulp and paper Industries surveyed: 10
Total no. of Industries: ≈ 25

POPs in Automobile Sector


No. of vehicle scrapping facilities surveyed: 15
Total no. of RVSFs: ≈ 100, Informal: ≈ 25

POPs in Textile Sector


No. of Textile Industries surveyed: 40
Total no. of technical textile Industries: ≈ 500

POPs in Waste Electric and Electronic Equipment (WEEE)

No. of WEEE recycling units surveyed: 35
Total no. of Industries: ≈ 400

POPs in Construction and Demolition Activities

No. of Construction material industries visited: 7
(Polystyrene, PUF, PVC, Adhesives, Sealants etc)

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Pesticides Inventory

- Total pesticides in POPs list: 17
- Aldrin and Dieldrin stockpiles have been reported by Regional plant quarantine stations (RPQS) of Gujarat, Manipur, Rajasthan and Maharastra in NIP (2011).
- These pesticides were meant for locust control, as per discussions with CIBRC.
- Informal sources indicated that these stocks were already disposed by incineration.
- Plant Protection Advisor, Faridabad informed that updated status will be shared soon.
- Assessment of POPs contaminated sites: Lucknow, Renukoot (BHC contaminated): Eloor-Edayar (Cochin): DDT contamination, completed.
- Kasarkode District, Kerala: Endosulphan stockpiles reported in Kasarkode (1150 L, and 10 kg) and Pallakad Dists (304 L). Efforts are on for the disposal as per NGT judgement.
- India Pesticides Ltd (IPL) produces Lindane for head lice treatment (Exempted COP 4(2009) Pharma grade); 9 T in 2024. But the exemptions expired in 2019. India has not yet ratified Lindane.
- Comments: Only one industry is manufacturing Lindane, and alternatives are available for head lice treatment.
- MoEFCC, CPCB and UPPCB may look into this for possible ratification of lindane and phaseout.
- Chlorpyrifos: Listed in COP 2025, India has not ratified. Current production: 25 MT/yr.

DDT Inventory

- India is the only manufacturer of DDT (HIL, Rasayani, Maharashtra)
- HIL has shared DDT production and domestic usage details; 2023-24 (till Dec.23): Nil
- For 2022-23: DDT (Technical: 280 MT; DDT 50%: 569 MT, DDT 75%: 18.01 MT
- NCVBDC is the nodal agency for DDT procurement to the states
- As per NIP (2011), DDT stockpiles were reported from the following states
  - Himachal Pradesh, Mizoram, West Bengal, Chhattisgarh, Assam, Meghalaya, Tripura
- It is mandatory to update the stockpile/contamination information in the updated NIP.
- As per NCVBDC communication, DDT stockpiles amount to 245 MT across 8 states.
- Needs disposal in a Hazardous waste incinerator

Pentachlorophenol and its Salts

- India opposed listing of PCP in 2015 COP. India has not ratified PCP.
- Only one industry viz. Excel Industries Ltd, Mumbai is manufacturing 1780 T/year of Sodium Pentachlorophenate (Na-PCP)
- **Uses of Na-PCP in India:**
- Industrial sectors that use PCP and Na-PCP include-
- Wood/Timber and laminate Industry as a preservative
- Paints & coating , Textile, Water treatment (consumption: Plywood: 1.6-2. kg/T; Decorative paint: 0.5-5 g/kg)
- Exported to Nepal, Bangladesh, and African countries
- IS-401 and IS-12120 methods suggest the use of PCP and/or Na-PCP for the treatment of Plywood and wood-based products. Phase out plan, if any needs modification of BIS standard.
- Dr. C N Pandey (**Technical Advisor FIPPI & Century Plyboard India Ltd., former Director, Indian Plywood Industries Research & Training Institute (IPIRTI), MoEFCC,** suggested that manufacturing of Na-PCP may be banned after December 2025 and use of Na-PCP may be banned in Plywood industry after December 2026 and for medium density fibrewood (MDF) industry after 2027 or till usage of existing stockpile whichever is earlier.

Progress: PCBs Inventory

- PCB oils are mainly lying with state electricity boards, thermal power and steel plants.
- Visited Bhilai steel plant during December 2023, and collected soil samples from PCB oil, transformers storage areas identified in NIP (2011).
- PCB contaminated site (Alang ship breaking yard, Gujarat) has been completed in May 2025.
- Currently, CPRI (targeting state electricity boards), and BSP (Steel plants under SAIL) are implementing PCB oil destruction as per the GEF –funded project. “Environmentally sound management and final disposal of PCBs”.
- Updated inventory will be obtained closer to the end of the project.
- MoEFCC may take a note considering the 2025 and 2028 deadlines for the complete destruction of PCBs.


Sl. No	PCB Concentration	Total Tonnes	PCB destructed so far	Balance PCB (to be destroyed)
1	Pure PCBs (100%)	3000.03	125 (BSP)	2875
2	Contaminated PCBs Above 500ppm	6717.632	798 (CPRI)+31 (BSP)=829	5888
3	Stockpiles	120.00		120
	Total	**9837.662**		**8883**

Sector-wise POPs consumption Inventory

- To estimate the use pattern/consumption of POPs
- Principle: (Production+Import)- (Export)= Domestic consumption, the quantity used in various products
- Very challenging due to the complexity of chemical trade, use pattern, etc
- UNEP guidelines on sectoral inventory of POPs
- Sectors such as the automotive sector may be simple to estimate, but others are complex.
- Major POPs using sectors
  - Automotive
  - Plastics
  - Electric and electronics
  - Construction
  - Textiles

POPs Usage: Sector-wise Inventory of Industrial POPs

Industrial Sectors	Products	POPs	Indicative Matrixes to be studied
Construction Sector	Construction, PUF, Adhesives, sealants, paints, coatings	Hexabromobiphenyl (HBB) Hexabromocyclododecane (HBCD), Dechlorane plus, PBDEs, SCCPs, MCCPs, PCBs	PUF, Wall coatings, paints, EPS, XPS (Thermocol), electrical items, water proofing materials etc. Raw materials and finished products
	Leather	SCCPs, MCCPs,	Fat liquor, finished leather, tannery waste
Electric and Electronics Sector	Electric and Electronics	PBDEs, SCCPs, MCCPs, Dechlorane plus (DP), Hexabromocyclododecane (HBCD), Dechlorane plus, Hexabromobiphenyl (HBB)	Electric and Electronic products and waste
Automobiles	All non-metallic parts	PBDEs, HBB, UV-328,	Plastic/Fibre parts, PUF, electric and electronic parts
Textile Sector	Textiles	PBDEs, SCCPs, MCCPs, UV-328	Raw materials, textiles i.e. carpets, upholsteries, water proof, fire-proof textiles etc.
Plastics	Plastics (All polymers/All articles)	PBDEs, SCCPs, MCCPs, UV-328	Raw materials, Plastic products, and waste

Flammability Standards for Automobile Interiors

- All polymers are inherently flammable except fluoropolymers.
- European Union: EU Directive 95/28/EC3 and ISO 3795 materials used in the interior of the car
- Annex A: horizontal burning rate of materials; Annex B: vertical burning rate of materials: 100 mm/min
- Annex C,: melting behaviour of materials
- USA: Federal Motor Vehicle Safety Standard (FMVSS) 302, "Flammability of Interior Materials," **102 mm/min or slower**; ASTM D5132-04 standard
- IS 15061: 2022 Automotive Vehicles - Flammability Requirements
- AIS-180/D1: Automotive Industry Standard
- China GB/T8410
- **Flame Penetration Resistance for Hazardous Packaging:** Packaging and containers used for the transportation of hazardous materials in commerce
- **Smoke Density Test:** Aircraft and passenger train

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Ban/Restrictions on Chemicals used in Automobile Parts

Chemical	Convention/Treaty/Rules	Remarks
C-Penta BDE, C-Octa BDE, C-Deca BDE, Hexabromobiphenyl (HBB) Hexabromocyclododecane (HBCD), Dechorane Plus, Short Chain Chlorinated Paraffins (SCCPs), UV-328	Stockholm Convention on POPs	• C-Deca BDE exemption up to 2036 for spare parts of vehicles. • Textiles • Polyurethane foam for building insulation • India ratified C-Penta BDE, C-Octa BDE, HBB, and HBCD, only.
	Basel Convention: Plastics containing any of these POPs>1000 mg/kg is a POPs waste (low POP content), and cannot be recycled.	
	E-waste, 2022 (ROHS): PBDEs, PBB, Pb, Hg, Cr (VI) should not be >0.1% (1000 mg/kg), Cd should not be >0.01% (100 mg/kg).	

- Global Automotive Stakeholder Group publishes the Global Automotive Declarable Substance List (GADSL)/ International Material Data System (IMDS). (https://www.gadsl.org)
- Include country-wise banned/restricted/SVHC/ list of chemicals used in automobile parts.
- Facilitate identification of chemicals used.

Textile Sector

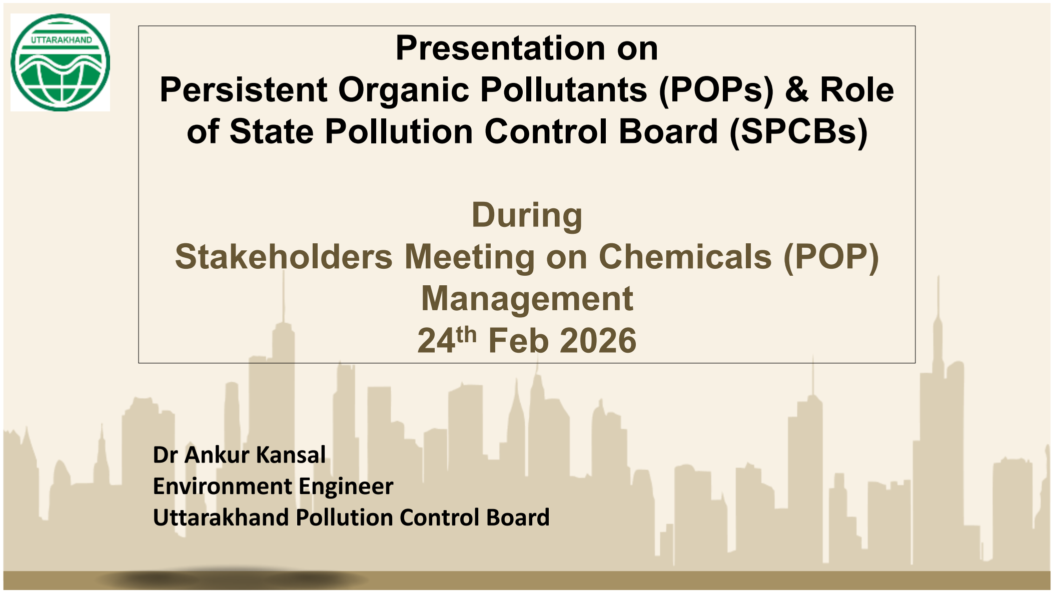
- Technical textiles i.e. special-purpose textiles are likely to contain POPs
- Carpets, floor mats, curtains, etc require flame retardancy
- Sportswear, outdoor clothes, tarpaulins etc: UV 328
- Raincoats, water repellent cloths: PFAS chemicals
- Visited 25 technical textile mills and collected samples
- Collected about 150 samples from the market (sportswear, technical textiles)
- Visited Textile Committee, Mumbai and collected details about chemicals used in textiles.
- Held discussion with industry associations viz. SITRA, ATIRA, BTRA etc, about POPs consumption in textiles, but no data is available.
- Estimation to be done on textile sample analysis.

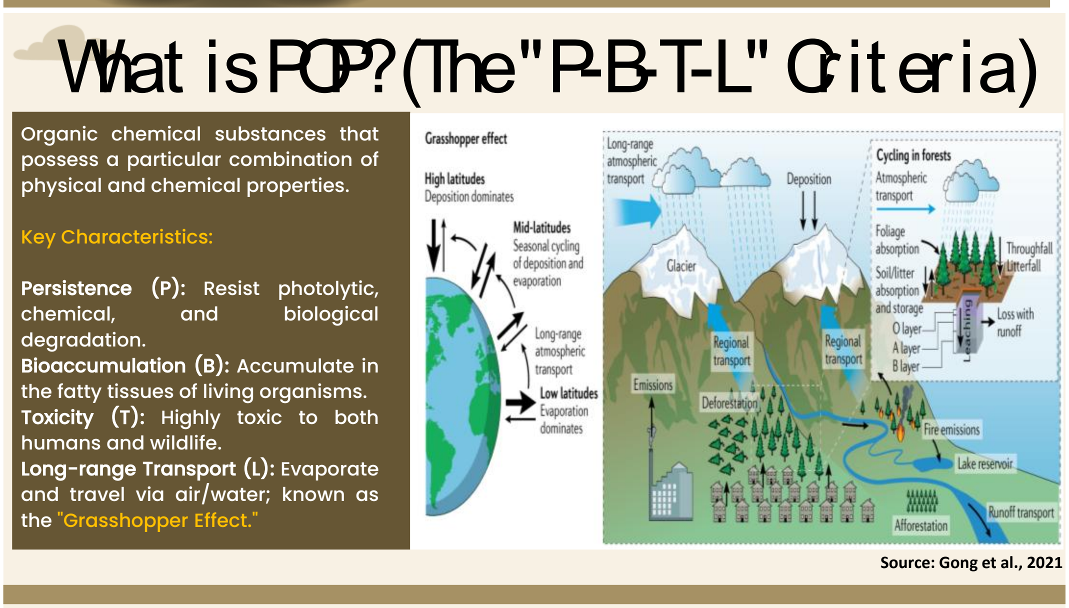
Challenges

- Most SPCBs are cooperating for industry visits, but some are very reluctant to give the list of industries. Few did not respond at all.
- No SPCBs respond to letters, mail, only personal visits work.
- Most Industries, esp. PFAS manufacturing and using, do not disclose data.
- Currently, Import/export data of POPs chemicals are retrieved from the Ministry of Commerce (DGFT) site based on HSN codes. Sometimes, HSN codes are common to several chemicals, resulting in overreporting.
- POPs in products (imported electronics, textiles, plastics etc) are very difficult to estimate due to the complex nature of supply chains.
- POPs chemicals in products e. g. textiles, plastics, electric and electronic goods, paint, consumer goods etc. –Industry apprehension/non-cooperation.
- All laboratory work on POPs analysis requires imported chemicals. Due to restrictions by the GoI for the procurement of imported chemicals/instruments, work is going slowly.
- For industrial POPs, analysis of products i.e. plastics, textiles, personal care products etc. takes more time as it is new to us.

Thanks for your attention…

(ii)


UTTARAKHAND
Presentation on
Persistent Organic Pollutants (POPs) & Role of State Pollution Control Board (SPCBs)
During
Stakeholders Meeting on Chemicals (POP) Management
24th Feb 2026
Dr Ankur Kansal
Environment Engineer
Uttarakhand Pollution Control Board


What is POP? (The "P-B-T-L" Criteria)
Organic chemical substances that possess a particular combination of physical and chemical properties.
Key Characteristics:
Persistence (P): Resist photolytic, chemical, and biological degradation.
Bioaccumulation (B): Accumulate in the fatty tissues of living organisms.
Toxicity (T): Highly toxic to both humans and wildlife.
Long-range Transport (L): Evaporate and travel via air/water; known as the "Grasshopper Effect."
Grasshopper effect
High latitudes
Deposition dominates
Mid-latitudes
Seasonal cycling of deposition and evaporation
Long-range atmospheric transport
Low latitudes
Evaporation dominates
Long-range atmospheric transport
Deposition
Glacier
Regional transport
Regional transport
Emissions
Deforestation
Cycling in forests
Atmospheric transport
Foliage absorption
Soil/litter absorption and storage
O layer
A layer
B layer
Leaching
Throughfall
Litterfall
Loss with runoff
Fire emissions
Lake reservoir
Afforestation
Runoff transport
Source: Gong et al., 2021

TYPES OF POP

POPs are generally categorized into three groups:

1. Pesticides
2. Industrial chemicals
3. Unintentional by-products

Unintentional POPs

Produced accidentally during combustion or chemical processes

Examples: Dioxins, Furans, PAHs (Polycyclic Aromatic Hydrocarbons)

Pesticides

Chemicals used to control pests/weeds (e.g., DDT, Mirex, Heptachlor).

Industrial Chemicals

Chemicals used in manufacturing processes (e.g., PCBs, Hexachlorobenzene).

Industrial Sources

Manufacturing Use of Polychlorinated Biphenyls (PCBs) in electrical transformers, capacitors, and paints.

Waste Incineration Improper burning of hazardous, medical, or municipal waste.

Metal Production Sintering plants in the iron and steel industry.

Chemical Synthesis Production of certain chlorinated solvents and pesticides.

DOMESTIC (HOUSEHOLD) SOURCES

Upholstered Furniture: Flame retardants (polybrominatd diphenyl ethers-PBDEs) found in foams, textiles, and electronics.

Open Burning: Back-yard burning of household trash, especially plastics and PVC.

Household Chemicals: Old paints, floor waxes, and older cleaning agents containing POPs.

Food Chain: Primary human exposure occurs through consuming contaminated fish, meat, and dairy products.

Why We Need to Address POPs (I

Source: Vasseghian et al., 2021

"POPs don't just stay where they are released; they travel and grow more toxic as they move up the food chain."

Human Health:

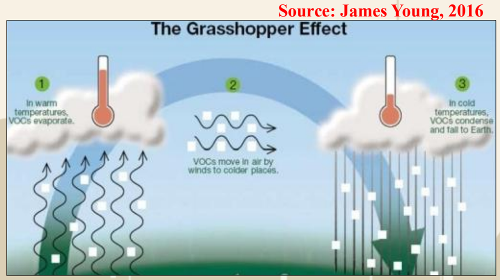
- Cancers and tumors.
- Endocrine disruption (hormonal imbalance).
- Reproductive system failure and birth defects.
- Neurobehavioral disorders (especially in children).

Environmental:

Population decline in wildlife (e.g., thinning eggshells in birds).

- Contamination of remote "pristine" areas like the Arctic.

Source: James Young, 2016



CASE STUDIES OF INDIA

Case 1: Endosulfan Tragedy – Kasaragod, Kerala

1. Large-scale aerial spraying of Endosulfan on cashew plantations (1970s–2000s)
2. Caused Birth defects, Cancer, Neurological disorders, Reproductive problems
3. Affected thousands of villagers
4. Led to nationwide ban of Endosulfan in 2011

Case 2: Decline of Oriental White-backed Vulture (Gyps bengalensis)

1. Residues of DDT and other organochlorines detected in dead vultures and eggs
2. DDT acted as a chronic stressor along with other pollutants
3. Weakened reproductive success and immunity

Case 3: DDT Residues in Human Milk (All India Network Project)

DDT detected in: Breast milk, Blood samples, Food grains, Found even in urban populations. Shows biomagnification through food chain

Case 4: Arctic & Himalayan POP Detection (Grasshopper Effect)

POPs detected in Himalayan glaciers and Remote mountain regions

Even though never used there

GLOBAL INTERVENTIONS TO CONTROL AND ELIMINATE POP

The Rotterdam Convention (1998):

Promotes shared responsibility in the international trade of hazardous chemicals.

Aarhus Protocol (1998):

Specifically focuses on reducing POP emissions in the UNECE region.

The Basel Convention (1989):

Hazardous waste, including POPs cannot be exported without the prior written consent of the receiving country and any transit countries.

Stockholm Convention on POPs (2001)

International treaty to:

- Eliminate or restrict production and use of POPs
- Reduce unintentional release (dioxins, furans)
- Ensure safe disposal of stockpiled POPs

Initially targeted the "Dirty Dozen" POPs (DDT, Aldrin, PCBs, etc.) Now includes many more chemicals

Global Environment Facility (GEF, 2001)

Provides funding to developing countries for:

- POP elimination projects
- Safe disposal of obsolete pesticides
- Cleaner industrial technologies

Global POPs Monitoring Programme (GMP) – 2004

Worldwide monitoring of POPs in air, water, human milk, and wildlife

EFFORTS BY THE GOVERNMENT OF INDIA

Ratification of the Stockholm Convention (2006)

India ratified the Stockholm Convention on Persistent Organic Pollutants in 2006. India committed to:

- Monitoring POP levels in air, water, soil, and biota.
- Promoting safer chemical alternatives.

Regulation of POPs Rules, 2018 (Legal Ban on POPs)

In 2018, the MoEF&CC notified regulation of Persistent Organic Pollutants Rules, 2018 under the Environment (Protection) Act, 1986. These rules prohibited the manufacture, trade, import, and use of 7 major POPs.

Restriction on DDT (Agriculture Ban + Vector Control Use)

DDT is banned for agricultural use in India since 1989. A phase-out plan is in place to completely eliminate DDT once suitable alternatives are available.

MoU and Projects with GEF & UNIDO (PCB Disposal)

India has partnered with international agencies such as Global Environment Facility (GEF) & United Nations Industrial Development Organization (UNIDO)

Under these collaborations:
Projects were launched for Environmentally Sound Management (ESM) of PCB-contaminated transformers and equipment.

CONTINUED

National Implementation Plan (NIP) on Persistent Organic Pollutants (POPs) – India

1. Prepared under the Stockholm Convention
2. Nodal Ministry: Ministry of Environment, Forest and Climate Change (MoEF&CC)
   First NIP: 2011
   Updated NIP: 2018

The National Implementation Plan (NIP) is India's official roadmap to:

- Identify and manage POPs
- Reduce and eliminate their release
- Protect human health and environment

Mandatory obligation for countries that ratified the Stockholm Convention

Objectives of India's NIP

Covers:

- Pesticides
- Industrial chemicals
- Unintentional by-products (dioxins & furans)

Inventory and assess POPs stockpiles, Contaminated sites, and PCB-containing equipment

Develop policies for Elimination of banned POPs, Restriction of controlled POPs (like DDT), and Promote safer alternatives and technologies

Strengthen Monitoring systems, Institutional capacity, and Public awareness

INDIA'S REGULATORY FRAMEWORK & BANNED POPS

In 2018, the Government of India notified Regulation of Persistent Organic Pollutants Rules, 2018.

Nodal Authority: Ministry of Environment, Forest and Climate Change (MoEF&CC)

Supported by:
- Central Pollution Control Board (CPCB)
- State Pollution Control Boards (SPCBs) / PCCs

Responsibilities:
- Granting permissions (if any exemptions)
- Maintaining national inventory of POPs
- Monitoring compliance
- Reporting to Stockholm Convention Secretariat

Under the Regulation of Persistent Organic Pollutants Rules, 2018, India prohibited the manufacture, trade, and use of these 7 chemicals:

Chemical	Category
Chlordecone	Pesticide
Hexabromobiphenyl	Flame retardant
Hexabromocyclododecane (HBCD)	Flame retardant
Hexabromodiphenyl ether & Heptabromodiphenyl ether	Commercial Octa-BDE
Tetrabromodiphenyl ether & Pentabromodiphenyl ether	Commercial Penta-BDE
Pentachloro benzene	Industrial chemical / by-product
Hexachlorobutadiene	Solvent / coolant

REGULATION OF POPS UNDER HWM RULES, 2016

The Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016 (HWM Rules) govern the handling of POPs as toxic waste.

Schedule VI: Strictly prohibits the import of waste containing PCBs, PBBs, and PCTs (Polychlorinated Terphenyls).

Disposal Standards: Mandates specific Destruction and Removal Efficiency (DRE) of 99.99% for incineration of POP-contaminated waste.

Storage & Transport: Requires mandatory "Manifest Systems" and GPS tracking for the movement of hazardous wastes like old transformers containing PCB oils.

Category Key Activity Primary Legal Lever

Monitoring Lab Testing & Sampling Section 11 & 12, EP Act 1986

Enforcement Closure of polluting units Section 5, EP Act 1986

Tracking Manifests & Inventory Rule 3 (POP Rules) / Rule 19 (HOWM)

Regulation Licensing (CTE/CTO) Rule 2, POP Rules 2018

Disposal 99.99% Destruction Rule 16, HOWM Rules 2016

CATEGORICAL ROLE OF SPCBS IN POP MANAGEMENT

Monitoring and Protocol Development

Implementing CPCB-approved protocols for sampling air, water, and soil near "Hotspots" (industrial clusters, landfills, and old power plants).

Lab Strengthening: Upgrading State Environmental Laboratories to analyse complex POPs like Dioxins, Furans, and PCBs (which require high-end GC-MS equipment).

Baseline Data: Developing a state-specific inventory of POPs to feed into the National Implementation Plan (NIP).

Tracking & Source Identification

Fingerprinting Pollutants: Using chemical tracking to identify whether POPs in the environment are from current industrial leakage, old stockpiles, or unintentional by-products of waste burning.

Inventory of Equipment: Mapping all old electrical transformers and capacitors in the state to track PCB oils before they are illegally dumped.

Regulatory & Enforcement Actions

Consent Management: Strictly including POP-specific conditions in the Consent to Establish (CTE) and Consent to Operate (CTO) for chemical and waste industries.

Strict Vigilance: Conducting surprise inspections and audits of "Red Category" industries (high pollution potential) to ensure no banned substances are in use.

Legal Measures: Issuing closure notices, environmental compensation fines, and legal prosecution under the POP Rules, 2018 and HWM Rules, 2016.

Support for R&D and Public Awareness

R&D Collaboration: Partnering with state universities and institutes (like IITs or NEERI) to find safer alternatives to POPs used in local industries (e.g., flame retardants in textiles).

Stakeholder Training: Educating industrial workers on Best Available Techniques (BAT) and Best Environmental Practices (BEP) to minimize unintentional POP emissions.

Mass Awareness: Conducting campaigns to stop the open burning of plastic waste and teaching the public about safe e-waste disposal to prevent Dioxin release.

OPERATIONAL ROLE OF SPCB IN POP MANAGEMENT (BASED ON POP RULES, 2018 AND RELATED HWM GUIDELINES)

01 Authorization & Regulation

SPCBs are responsible for granting, suspending, or cancelling authorization for the handling, collection, reception, treatment, storage, and disposal of hazardous waste, which includes POPs.

02 Inventory Management

They are mandated to prepare and maintain an inventory of POPs stockpiles, wastes, and contaminated sites, and submit this information to the Central Pollution Control Board (CPCB) every two years.

03 Compliance Monitoring

SPCBs conduct inspections and audits of industrial units, common treatment, storage, and disposal facilities (TSDFs), and captive treatment facilities to ensure compliance with POP management standards.

04 Regulation of Utilization

Any utilization of hazardous waste (including co-processing or recycling) involving POPs requires authorization from the SPCB based on CPCB guidelines.

05 Contaminated Site Management

They initiate measures to contain and clean up contaminated sites, particularly in industrial hotspots (e.g., ship-breaking, chemical manufacturing).

06 Accident Reporting

They receive and process information regarding any accidents or spills involving POPs from handlers and operators.

07 Enforcement Actions

In case of non-compliance, SPCBs have the power to issue directions, close down polluting units, or initiate legal action to prevent environmental degradation from POPs.

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COMPLIANCE CHECKLIST FOR POP (SPCB & INDUSTRY)

Administrative & Legal Documentation

Valid CTO/CCA: Does the unit have a valid Consent to Operate or Consolidated Consent & Authorization?

POP Declaration (Form 1): Has the occupier submitted the mandatory declaration of POP stockpiles to the MoEF&CC/CPCB? (Rule 3, POP Rules 2018).

Hazardous Waste Authorization: Is there a valid authorization for handling hazardous waste? (Rule 6, HOWM Rules 2016).

Annual Returns (Form 4): Are hazardous waste annual returns submitted to the SPCB by June 30th every year?

Operational Compliance (Manufacturing/Use)

Prohibited Chemicals:
Are any of the 7 banned POPs (like Chlordecone or Hexabromobiphenyl) present in the raw material inventory?

End-Use Verification:
If DDT is stored, is it used only for vector control by government agencies?

SDS Availability:
Are Safety Data Sheets (SDS) maintained for all chemicals to identify hidden POP content (e.g., flame retardants)?

Storage & Waste Management

Labelling & Marking:
Are storage areas for POP-laden waste (like PCB oils) clearly marked with "Hazardous Waste" labels?

Storage Duration:
Is waste stored for no more than 90 days without specific SPCB permission? (Rule 8, HOWM Rules 2016).

Discharge Prohibition:
Is there zero discharge of POP-contaminated effluent into public sewers or land? (Rule 4, POP Rules 2018).

Transportation & Disposal

Manifest System (Form 10): Is every shipment of POP waste accompanied by a color-coded manifest?

Authorized TSDF: Is the waste being sent only to a SPCB-authorized Treatment, Storage, and Disposal Facility?

Destruction Efficiency: Does the disposal facility provide certification of 99.99% Destruction and Removal Efficiency (DRE)?

Action Plan for Industry Managers "If it's not documented, it didn't happen." Conduct a Chemical Audit of your warehouse today.

Replace old electrical transformers (pre-1980s) that likely contain PCB oils. Transition to Green Chemistry alternatives for flame retardants and pesticides.

CONCLUSION & THE WAY FORWARD

01 Promoting Alternatives

Investing in "Green Chemistry" and non-chemical pest control.

02 Strengthening Legislation

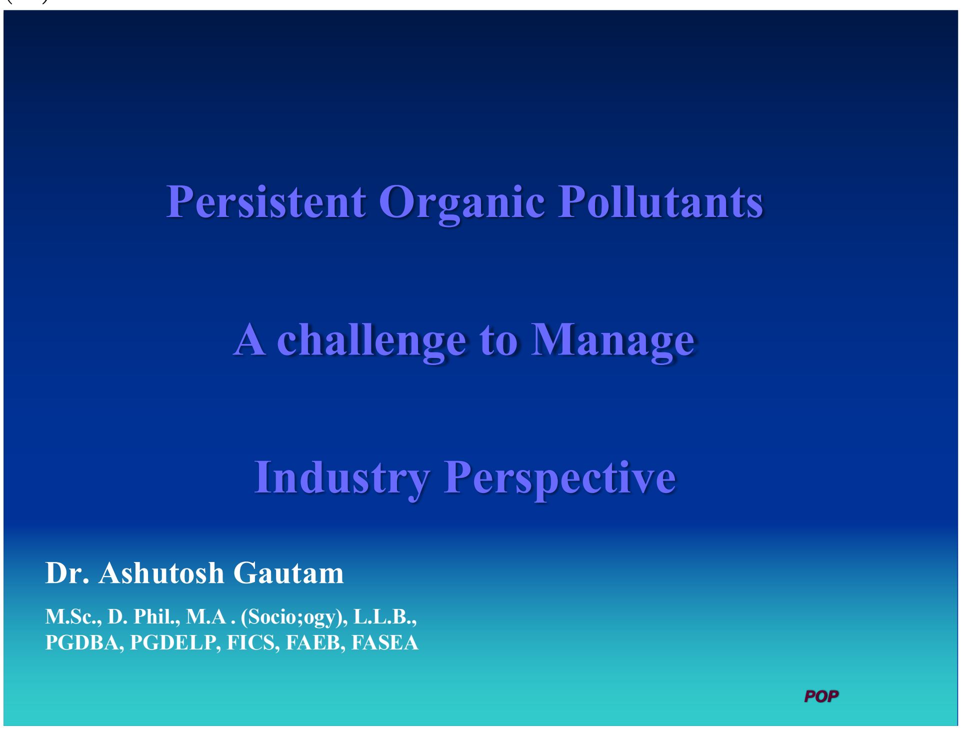
Stricter monitoring of industrial emissions.

03 Public Awareness

Educating citizens on the dangers of open-air trash burning and the importance of recycling electronics safely.


THANK YOU

(III)


Persistent Organic Pollutants
A challenge to Manage
Industry Perspective
Dr. Ashutosh Gautam
M.Sc., D. Phil., M.A . (Socio;ogy), L.L.B.,
PGDBA, PGDELP, FICS, FAEB, FASEA
POP

Persistent Organic Pollutants

POPs are a set of toxic chemicals that are persistent in the environment and able to last for several years before breaking down (UNEP/GPA 2006a). POPs circulate globally and chemicals released in one part of the world can be deposited at far distances from their original source through a repeated process of evaporation and deposition

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Persistent Organic Pollutants

- Due to repeated process of evaporation and deposition, it is very hard to trace the original source of the chemical (http://web.worldbank.org/).
- POPs are lipophilic, which means that they accumulate in the fatty tissue of living animals and human beings (http://www.unece.org/spot/s01.htm).
- In fatty tissue, the concentrations can become magnified by up to 70 000 times higher than the background levels (http://web.worldbank.org/).
- As we move up the food chain, concentrations of POPs tend to increase so that animals at the top of the food chain such as fish, predatory birds, mammals, and humans tend to have the greatest concentrations of these chemicals, and therefore are also at the highest risk from acute and chronic toxic effects.

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Persistent Organic Pollutants

POPs which may be Associated to Industries in Uttarakhand

- Polychlorinated Dibenzo-p-Dioxins (PCDD)
- Polychlorinated Dibenzofurans (PCDF)
- Polychlorinated Dibenzo-p-Dioxins (PCDD)
- Fire Retardants
- Fire Fighting Foams
- Poly Chlorinated Biphenyles (PCBs)

Persistent Organic Pollutants

POPs Sources

- Intentional : Deliberated release
- Unintentional : Unknowingly or Accidental

POPs Sources -

Intentional :

- Use of banned POPs
- Unregulated release of POPs during manufacturing of POPs due to leakages, through effluent or through vents.

Persistent Organic Pollutants

POPs Sources

Unintentional

- Produced unintentionally due to incomplete combustion, as well as during the manufacture of Pesticides and other chlorinated substances.
- They are emitted mostly from the burning of hospital waste, municipal waste, and hazardous waste
- and may also from automobile emissions, peat, coal, and wood, recycling of steel scraps, recycling of plastic.

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Persistent Organic Pollutants

POPs Sources

Unintentional

- POPs emitted mostly from the burning of hospital waste, municipal waste, and hazardous waste are

Polychlorinated Dibenzo-p-Dioxins (PCDD)

Polychlorinated Dibenzofurans (PCDF)

Polychlorinated Dibenzo-p-Dioxins (PCDD)

Commonly termed as Dioxins and Furans

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Persistent Organic Pollutants

Interlinkages between Plastics and POPs

- Plastics and POPs share certain common traits such as persistence, resistance to biological degradation, and the ability to get transported over long distances.
- Throughout the processes of Plastic production, consumption, and disposal, plastics interact with and accumulate POPs by several mechanisms and end up co-existing in the environment.
- Plastic waste can undergo long-range transport through rivers and the oceans, break down into microplastics and get transported through the air, or remain locked in waste dump yards and landfills

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Interlinkages between Plastics and POPs

- Over time, ecological processes lead to the leaching and release of accumulated POPs f.rom these plastic wastes.
- Some of the chemical additives added to plastics during production are POPs which may contributing to unintentional release of POPs.
- During their usage, plastics can also come in contact with POPs and can adsorb them onto their surface, acting as a transmitter.

Persistent Organic Pollutants

Interlinkages between Plastics and POPs

- The smaller the plastic particle, the larger the surface area, thereby leading to increased potential for accumulation of POPs

Release of POPs from Plastic recycling Process.

- Plastic recycling in the informal sector includes shredding, washing, heating and cutting to make granules. This process of recycling is also a potential major POPs source that demands further investigation. The presence of POPs in plastic waste and their fate in the plastic recycling process have not yet been elucidated. By enhancing our understanding of these processes

Persistent Organic Pollutants

POPs Management Challenges : Industrial Perspectives

Data and Awareness Deficit:

- There is a limited awareness and data availability among stakeholders about the POPs
- Regarding banned POPs and POPs long-term health risks, including cancer, endocrine disruption, and reproductive disorders.
- The Release, Management and Control of POPs during various manufacturing processes, Waste incinerations including Biomedical, Hazardous, MSW- RDF.

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POPs Management Challenges : Industrial Perspectives

Economic and Competing Priorities:

- High cost of implementation of advanced remediation technologies.
- Industries often fight to balance compliance of environmental regulation with economic growth and manufacturing efficiency.

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Persistent Organic Pollutants

POPs Management Challenges : Industrial Perspectives

Infrastructure and Technical Gaps:

There is a deficiency of advanced infrastructure, knowledge and expertise available to Industries for the specialized treatment, destruction, disposal of POPs contaminated material.

Legacy Contamination and Waste Management:

Industrial sites often hold significant, unidentified stockpiles of POPs. Poorly managed waste from sectors like power (PCBs in transformers) and chemicals leads to environmental leakage.

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Persistent Organic Pollutants

POPs Management Challenges : Industrial Perspectives

Monitoring of POPs:

Due to limited technical infrastructure, expertise, and resources. Industries, especially in developing regions, struggle with detection & monitoring of POPs

Circular Economy Integration with waste:

POPs embedded in products (e.g., e-waste or plastics) can re-enter the economy through recycling.

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Persistent Organic Pollutants

POPs Management Challenges : Industrial Perspectives

Way Forward

- Data & Knowledge sharing amongst the Stakeholders.
- Industries must ensure recycled materials do not exceed strict POP concentration limits, which adds cost and monitoring burdens to the supply chain.
- Economical Support to Industrial Sector who invest in management of POPs
- Technological support from the Government for POPs Management.

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Persistent Organic Pollutants

POPs Management Challenges : Industrial Perspectives

Way Forward

- **Development of Monitoring and Analytical Facilities** : Detection & monitoring of POPs requires high-precision equipment like **Gas Chromatography-Mass Spectrometry (GC-MS)** to detect thse substances at very low concentrations. Many industries lack the specialized expertise and laboratory capacity for such rigorous monitoring.

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Thanks
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Bio-composting Technology

(IV)


Funded by:
Norway
PFAS in drinking water in India – A review
Avanti Roy-Basu, et al. 2025
INOPOL
India-Norway Cooperation Project on Capacity Building for Reducing Plastic and Chemical Pollution in India (INOPOL)
PFAS – A Contaminant of High International Concern
Sissel Brit Ranneklev* (NIVA)
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SRM UNIVERSITY
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Introduction to PFAS


Environmental Science & Technology

A New OECD Definition for Per- and Polyfluoroalkyl Substances

Zhanyun Wang,* Andreas M. Buser, Ian T. Cousins, Silvia Dematto, Wiebke Drost, Olof Johansson, Koichi Ohno, Grace Patlewicz, Ann M. Richard, Glen W. Walker, Graham S. White, and Eeva Leinala

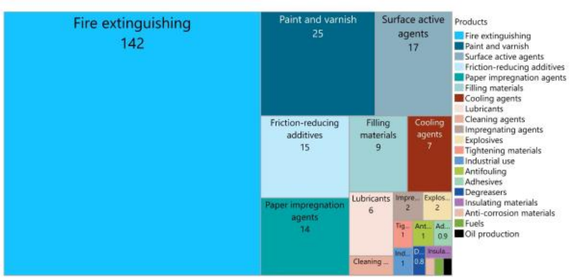
- Produced since late 1930s
- > 14 000 different PFAS
- Persistent – Forever chemicals
- Bioaccumulative and biomagnifying - binds to proteins not fat
- Toxic - Humans and ecosystem
- Mobile pollutant - In air, water, and soil
- Hydrophobic tail and hydrophilic tail
- Degraded into shorter PFAS
- PFAS precursors → degrading into PFOS, PFOA and other PFAS

PFOS

Sources of PFAS

- PFAS are widely used due to their unique desirable properties – persistent towards degradation, water/grease repellent and amphiphilic structure
- **Primary manufacturing facilities:** PFAS are synthesized or used as processing aids in making fluoropolymers (e.g., Teflon).
- **Secondary manufacturing facilities:** Use PFAS-containing materials in products like coatings, electronics, textiles, metal plating/finishing, semiconductors, and photo lithographic industries.
- **Firefighting foams:** Training/exercises in aviation, military, and industry
- **Wastewater and waste management:** Wastewater treatment plants, biosolids, and landfills
- **Consumer commercial products:** Textiles, leather, paper products, paint, cookware, cleaning agent, cosmetics, and personal care products
- **Atmospheric transport:** Emitted from industrial stacks and depositing in soil and water far from the sources

Industrial use of PFAS in Norway (2009-2017)*



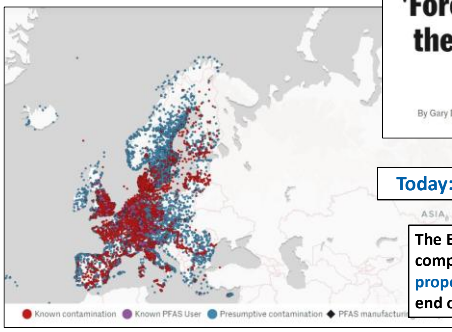
*Norwegian Environmental Agency - The Product Register – Import/use /produce > 100 kg/year

PFAS status in Europe

LES DÉCODEURS · PFAS

'Forever pollution': Explore the map of Europe's PFAS contamination

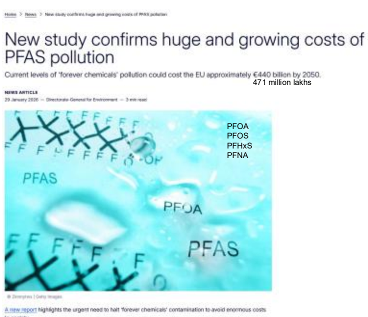
By Gary Dagorn, Raphaëlle Aubert, Stéphane Horel, Luc Martinon and Thomas Steffen (design)



Today: Widespread environmental presence

The European Chemicals Agency aims to complete its scientific evaluation of the proposed EU-wide restriction on PFAS by the end of 2026.

Cost of PFAS pollution in EU



New study confirms huge and growing costs of PFAS pollution

Current levels of 'forever chemicals' pollution could cost the EU approximately €440 billion by 2050.

471 million lakhs

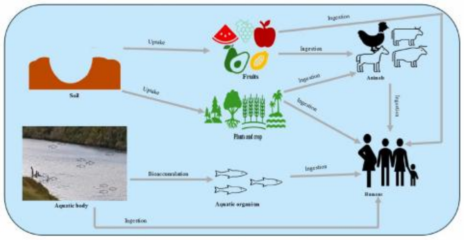
A new report highlights the urgent need to halt 'forever chemicals' contamination to avoid enormous costs to society.

Fate and transport of PFAS in drinking water

- Surface water ↔ Ground water
- Urban run-off
- Industry
- Effluent from WWTP
- Landfill leachate
- Atmospheric depositions
- Land/soil

Gautam et al., 2025 (doi/10.1016/j.hazardv.2025.100748)

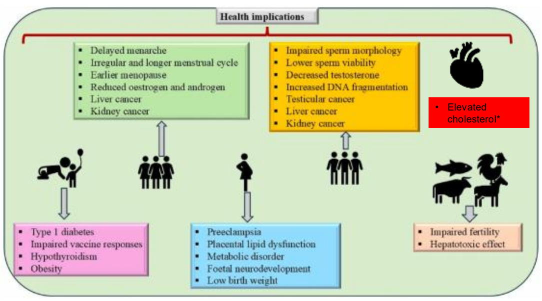
Route of exposure



Ohro & Ngole-Jeme, 2026 (doi.org/j.foodcont.2025.111611)

- Major routes:
- **Food**
- **Drinking water**
- Use of PFAS-product
- Household dust
- Occupational exposure

Health implications of PFAS



Ohro & Ngole-Jeme, 2026 (doi.org/j.foodcont.2025.111611)

Maximum contaminant level/Parametric value

Country	PFAS	MCL* (ng/L)
North America		
USA	PFOA	4
	PFOS	4
	PFHxS	10
	PFNA	10
Canada	Sum of 25 specific PFAS	30
European Union (EU)/Member States		
EU	PFAS	500
	Sum of 20 PFAS	100
Sweden	PFAS-4 (PFOA, PFNA, PFOS and PFHxS)	4
	PFAS-21 (20 PFAS specified in EU)	100
Denmark	Sum of four PFAS (PFOA, PFOS, PFNA and PFHxS)	2
Germany	Sum of 20 PFAS	100
	Sum of four PFAS (PFHxS, PFOS, PFOA, and PFNA)	20
United Kingdom (UK)	PFAS	100
Asia-Pacific (APAC) Region		
Japan	PFOS and PFOA	50
China	PFOS	40
	PFOA	80
South Korea	Sum of PFOS and PFOA	70
	PFHxS	480
Australia	PFOA	560
	PFOS	70

** MCL or maximum contaminant level, is the maximum level of a contaminant allowed in water that is delivered to a public water system user*

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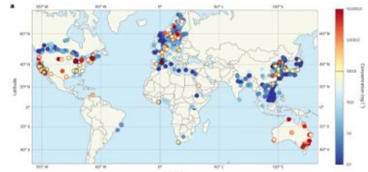
Global status of PFAS monitoring in drinking water

- Widespread contamination – hot spot areas and WWTPs
- Levels above limits in several countries



Grunfeld et al., 2024 (doi.org/10.1038/s41561-024-01402-8)

- Analytical methods and technology
- LC-MS/MS/QTOF LC-MS/TOP
- Challenges in PFAS monitoring
– Wide range of substances – Data gaps – Analytical challenges – Infrastructure limits

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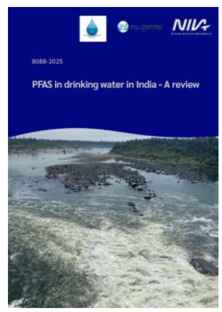
What about India?

- India's rapid industrial growth
- Detected at elevated concentrations in surface and ground water
- Regulatory framework for managing PFAS in drinking water is missing
- Permissible limits in drinking water are needed
- Monitoring network is missing
- Analytical capacity is limited



Avanti Roy-Basu, et al. 2025

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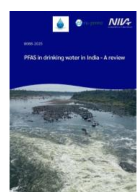
Way forward



Avanti RoyBasu, et al. 2025

- Develop specific regulatory guidelines for PFAS in drinking water
- Develop national monitoring network
- Infrastructure for analysing and water treatment
- Substitution of PFAS
- Policy makers and expert should oversee the PFAS monitoring

Thank you for your attention!

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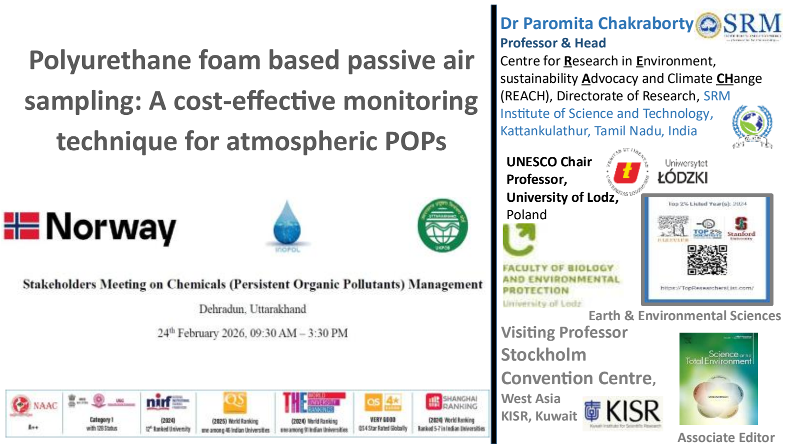
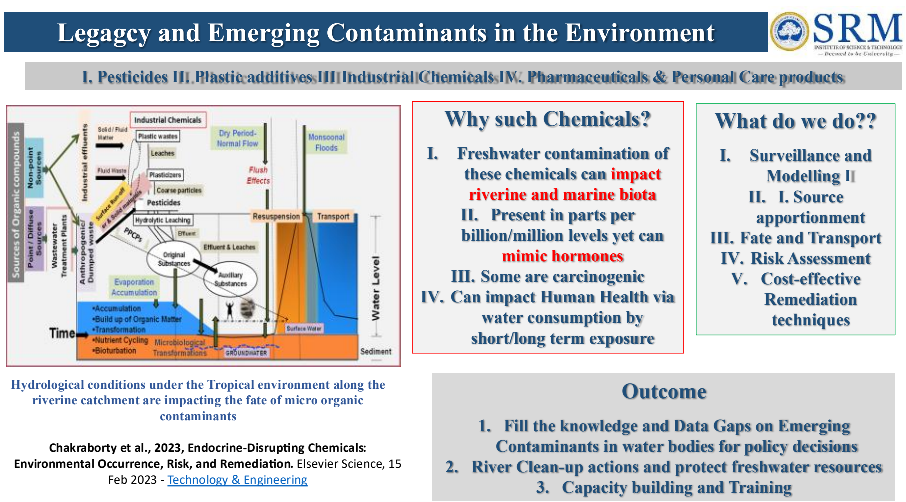
(V)


Polyurethane foam based passive air sampling: A cost-effective monitoring technique for atmospheric POPs
Norway
Stakeholders Meeting on Chemicals (Persistent Organic Pollutants) Management
Dehradun, Uttarakhand
24th February 2026, 09:30 AM – 3:30 PM
Dr Paromita Chakraborty
Professor & Head
Centre for Research in Environment, sustainability Advocacy and Climate CHange (REACH), Directorate of Research, SRM Institute of Science and Technology, Kattankulathur, Tamil Nadu, India
UNESCO Chair Professor, University of Lodz, Poland
Uniwersytet ŁÓDZKI
FACULTY OF BIOLOGY AND ENVIRONMENTAL PROTECTION
Earth & Environmental Sciences
Visiting Professor
Stockholm Convention Centre, West Asia
KISR, Kuwait
KISR
Associate Editor


Concerns about micro-pollutants
Around 1000 chemicals have been identified as endocrine disrupting chemicals globally (WHO/UNEP)
The globe is a closed system.
Any input of contaminants can lead to
• long-range transport,
• transformation(biotic/abiotic)
• bioaccumulation and effects.
Pollutants do not merely go away, they continue to stay in the closed system globe.
Over the past two decades, deaths caused by the modern forms of pollution (eg, ambient air pollution and toxic chemical pollution) have increased by 66%, driven by industrialisation, uncontrolled urbanisation, population growth, fossil fuel combustion, and an absence of adequate national or international chemical policy
Fuller et al., Lancet., 2022
MPs
Source: UNEP


Legagcy and Emerging Contaminants in the Environment
SRM
I. Pesticides II. Plastic additives III Industrial Chemicals IV. Pharmaceuticals & Personal Care products
Hydrological conditions under the Tropical environment along the riverine catchment are impacting the fate of micro organic contaminants
Chakraborty et al., 2023, Endocrine-Disrupting Chemicals: Environmental Occurrence, Risk, and Remediation. Elsevier Science, 15 Feb 2023 - Technology & Engineering
Why such Chemicals?
I. Freshwater contamination of these chemicals can impact riverine and marine biota
II. Present in parts per billion/million levels yet can mimic hormones
III. Some are carcinogenic
IV. Can impact Human Health via water consumption by short/long term exposure
What do we do??
I. Surveillance and Modelling
II. I. Source apportionment
III. Fate and Transport
IV. Risk Assessment
V. Cost-effective Remediation techniques
Outcome
1. Fill the knowledge and Data Gaps on Emerging Contaminants in water bodies for policy decisions
2. River Clean-up actions and protect freshwater resources
3. Capacity building and Training

Toxics Link
for a toxics-free world

Chemicals…Plastics…Transport

Persistent

Birth defects

Dysfunctional immune, development, and reproductive systems

Fertility problems


Environmental Science & Technology

ES&T, 2011

Are Reductions in Industrial Organic Con… Countries Achieved Partly by Export of T…

Knut Breivik, Rosalinda Gioia, Paromita Chakraborty, Ga…

Norwegian Institute for Air Research, P.O. Box 100, NO-2027 Kjeller, Norway…
Department of Chemistry, University of Oslo, P.O. Box 1033, NO-0315 Oslo…
Lancaster Environment Centre, Lancaster University, Lancaster, LA1 4YQ, U…
Guangzhou Institute of Geochemistry, The Chinese Academy of Sciences, Gu…

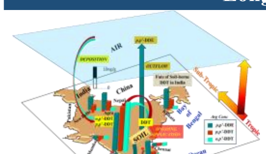
Chakraborty et al., Env Pol, 2016; Khuman and Chakraborty Chemo 2020

Open burning of electronic waste ending in municipal solid waste stream

Areas showing elevated potential for volatilization of semi-volatile organic substances largely coincides with major e-waste regions (Breivik et al., 2011)

Open dumps and informal e-waste sectors are potential sources for dioxin like PCBs in South Asia (Chakraborty et al., 2016a; 2016b, 2021)

Long Range Atmospheric Transport

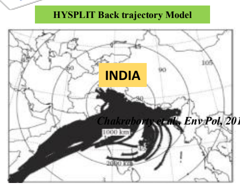


Chakraborty et al., Env Pol, 2016

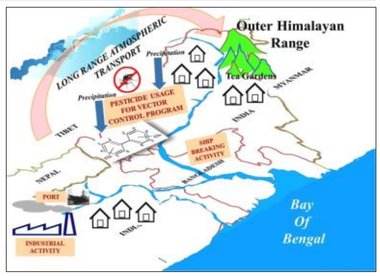
Tri and Tetra PCB congeners were observed in the surface water of Brahmaputra along the outer Himalayan.

Atmospheric transport from the source regions in the eastern India is the possible reason for such observation.

HYSPLIT Back trajectory Model



Sources include electronic scrap recycling and industrial activity apart from the port activities in the suburbs of Kolkata

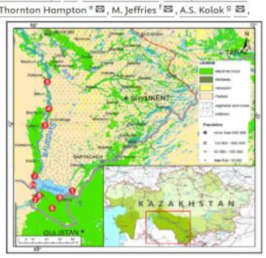



Water Research
Volume 184, 1 October 2020, 116141

Legacy and current pesticide residues in Syr Darya, Kazakhstan: Contamination status, seasonal variation and preliminary ecological risk assessment

D.D. Snow, P. Chakraborty, B. Uralbekov, B. Satybaldiev, J.B. Sallach, L.M. Thornton Hampton, M. Jeffries, A.S. Kolok, S.B. Bartelt-Hunt

Meltwater : Major Source of Pesticides in Syr Darya




Journal of Environmental Chemical Engineering
Volume 13, Issue 3, June 2025, 116968

Baseline investigation, GIS-based sediment transport index and risk assessment for microplastics and pesticides profiling in the inter- fjord Arctic systems

S.S. Kirthiga, R. Dhinesh, Anu Gopinath, Muhammed Nayeem Mullungal, S.S. Shaju, Resmi P. Murali, Jijo Lukose, Paromita Chakraborty

Glacial meltwater and hydrodynamic forces influenced pesticides distribution in Arctic fjords.


Environmental Pollution
Volume 321, 15 March 2023, 121206

Distribution of organochlorine pesticides in surface and deep waters of the Southern Indian Ocean and coastal Antarctic waters

Krushna Vudamala, Paromita Chakraborty, Ramesh Chatragadda, Anoop Kumar Tiwari, Asif Qureshi

Toxics Link
for a toxics-free world

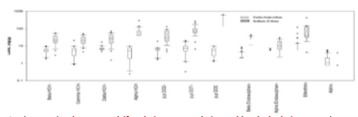
Risk for human health

Contents lists available at ScienceDirect
Environmental Pollution
journal homepage: www.elsevier.com/locate/envpol

Human exposure to organochlorine, pyrethroid and neonicotinoid pesticides: Comparison between urban and semi-urban regions of India

Niharika Anand [a], Paromita Chakraborty [b], Sujata Ray [a,*]

81 human milk samples collected in urban Kolkata and semi-urban Nadia in West Bengal, India. Legacy & new **organochlorines** and **pyrethroids (Bifenthrin) were dominant**



In the **semi-urban area, bifenthrin, permethrin and l-cyhalothrin** were detected

In urban regions, Bifenthrin was 5 fold higher than the TDI (15 mg kg1 bw day1) (FAO and WHO, 2005; odex Alimentarius., 2005).

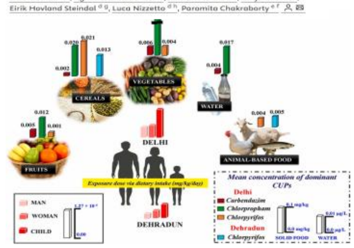
In over **95% of the urban samples** the EDI of HCH and DDT exceeded the TDI of 5 and 10 mg kg^{-1} bw day^{-1} respectively (odex Alimentarius., 2005)

In 12% of the samples from the urban region, the EDI for ***β*-endosulfan** exceeded the TDI (6 mg kg^{-1} bw day^{-1} (odex Alimentarius., 2005)

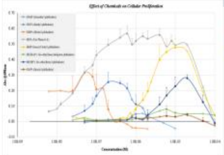
Environmental Research
Volume 242, 1 February 2024, 117543

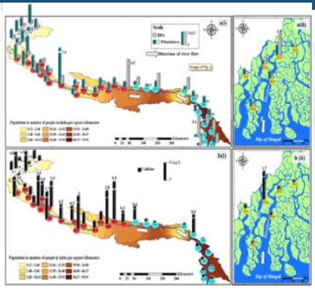
An updated status of currently used pesticides in India: Human dietary exposure from an Indian food basket

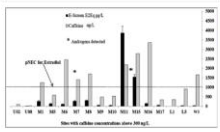
Sidhi Soman [a,e], Agnethe Christiansen [b], Roman Florinski [b], Girija Bharat [c], Eirik Hovland Steindal [d,g], Luca Nizzetto [d,h], Paromita Chakraborty [e,f]



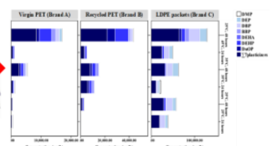
Chemicals via wastewater to water…???



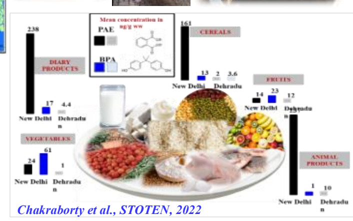




Chakraborty et al., Wat Res., 2021



Mukhopadhyay et al., BECT, 2022



Chakraborty et al., STOTEN, 2022

Outline

Background---

- What are POPs
- Stockholm Convention
- Indian Scenario
- Why monitor POPs in Atmosphere ?

PUF-PAS ---

- Monitoring of POPs in Atmosphere
- PUF-PAS-Design
- **Global Scenario**
- **Indian Cities-***Problem Statement*

Completed and Ongoing Research-Case studies----------------------

- Hypothesis
- Sampling Design
- **Methodology**
- **Research Highlights**

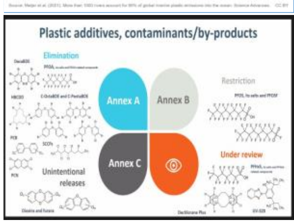
Acknowledgement------------------------

Problem Statement

The U.N. estimated that global sales of disposable face masks will increase 200 times from a year ago to $160 billion this year, and around 75% of the used masks and other pandemic-related plastic waste will end up in landfills or floating on the seas.

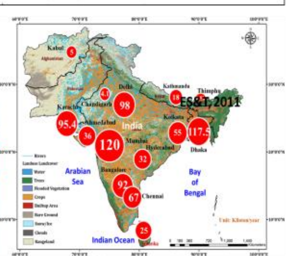
Plastic and biomedical waste, flowing through open drainage systems from hospitals, litter on the beaches in South Asia

UN News
Global perspective Human stories



Open dumping of plastic waste

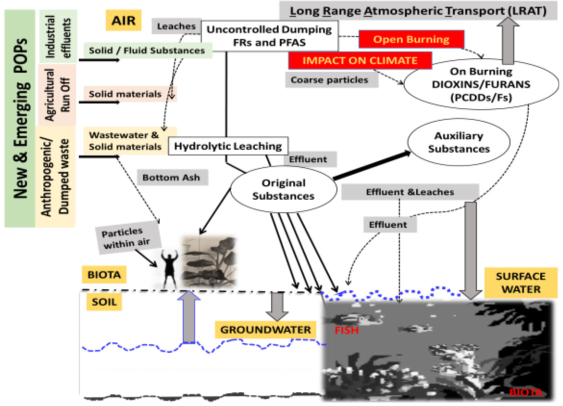
Udhendran et al., JHM Adv, 2025

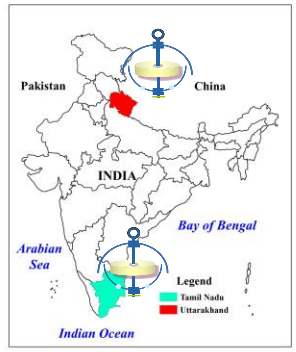


Chakraborty et al., JHM Adv, 2025

Toxics Link
for a toxics-free world

INOPOL Research Design





Research Objectives

Objective 1: Baseline surveillance

- Elucidate spatial and temporal variation of targeted POPs along urban-sub-urban-rural transects of Tamil Nadu & Uttarakhand
- Compare dry & wet concentrations with model outputs
- Atmospheric POPs in Uttarakhand?

Objective 2: Plastic and POPs interlinkage???

-Is Open burning a prominent source-can it impact climate change

Objective 3: Identify 3 major rivers ending in the open ocean to understand the fate of POPs

- Air-water exchange #Atmospheric transport
- Fluxes/net movement

Objective 4: Assess the potential risk

- pNEC-water #Dermal exposure-soil #Inhalation exposure-air
- Impact on Biota-fish-mussels-bovine milk

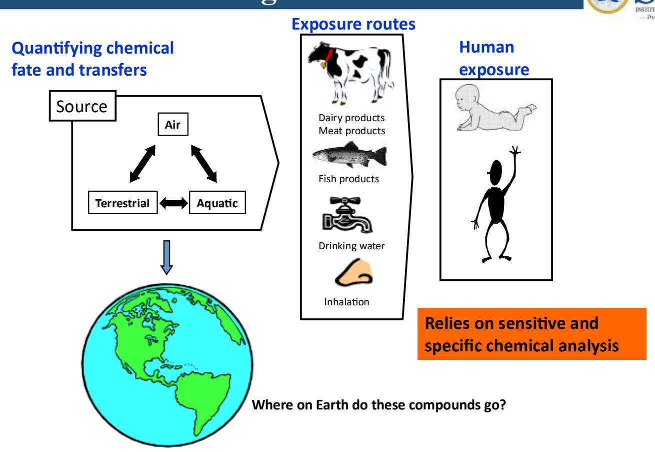
A. Surveillance and Modelling
Matrices: Air , surface water, Bovine milk, Fish etc

B. Training & Capacity Building Programs:
waste plastic recycling to control pollution sources

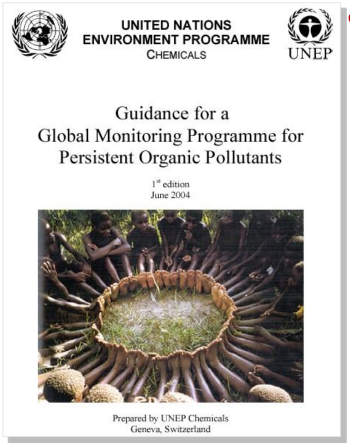
C. Outreach-Community Outreach and Clean-up drives

Where on earth will POPs go?

SRM Institute of Science & Technology — Deemed to be University —



How to evaluate the effectiveness of the Convention?


UNITED NATIONS
ENVIRONMENT PROGRAMME
CHEMICALS
UNEP

Guidance for a
Global Monitoring Programme for
Persistent Organic Pollutants

1st edition
June 2004

Prepared by UNEP Chemicals
Geneva, Switzerland

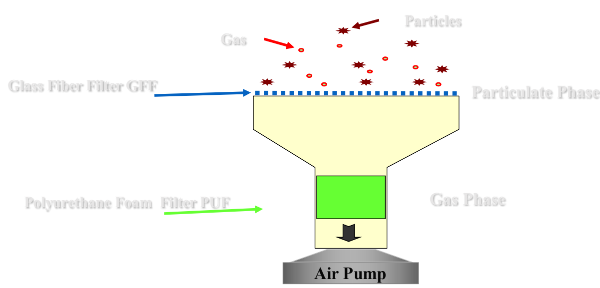
☞ **Global/regional monitoring of POPs**

- to show source reduction and develop and improve National Implementation Plans (NIPs) for the Convention

Potential media for POP monitoring?

- ***Air***
- ***Bivalves (Mussel Watch)***
- ***Other biota (fish, plant etc.)***
- ***Human breast milk***

Sampling Techniques



High-Volume sampler

Passive atmospheric samplers for POPs. . .

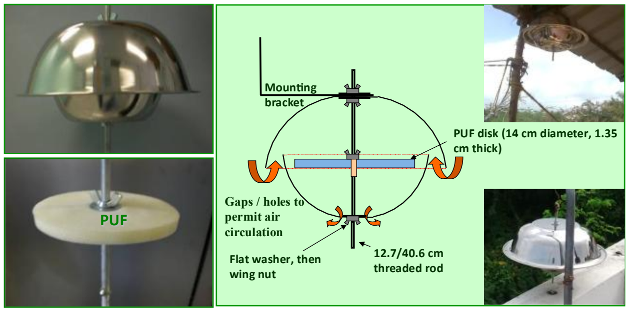
- **Semi-Permeable Membrane Device (SPMD): months-year**
  - *Ockenden et al., 1998, 2001, EST*
  - *Soderström et al., 2003, EST*
- **XAD resin: year**
  - *Wania et al., 2003*
  - *Shen et al., 2004*
- **Polyurethane Foam (PUF): weeks**
  - *Shoeib et al., 2002, EST*
  - *Jaward et al., 2004, EST (Europe)*
  - *Wild et al., 2005, EST (Indoor)*
  - *Pozo et al., 2005, EST (Chile, South America)*
- **Polymer-Coated Glass (POG): days-week**
  - *Shoeib et al., 2002, EST*
  - *Harner et al., 2003, EST*
  - *Farrar et al., 2005, EST*

- cost-effective
- meaningful information
- highly time resolved data

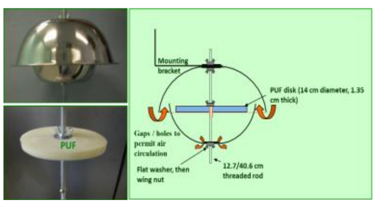
? AIR

Structure of PUF-Disk Passive Air Samplers

Very simple-simple to use-ideal for large scale



Understanding uptake in PAS medium



Diffusive uptake as described by Fick's law

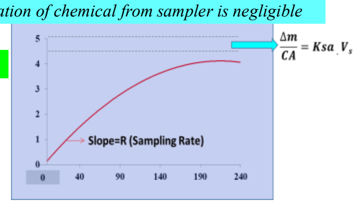
$$\frac{\Delta m}{\Delta t} = k\,A\left(CA - \frac{C_s}{K_{sa}}\right)$$

- Δm = Amount of chemical sequestered in PAS
- k = mass transfer co-efficient quantifying kinetics of uptake
- C = concentration in the atmospheric gas phase
- A = Concentration gradient driving diffusion between atmospheric gas phase and sampling medium
- C_s = Concentration in the Sampling medium
- K_{sa} = Sorption coefficient to the sampling medium from the gas phase
- Δt = Deployment Time
- A = Area across which uptake occurs

If Ksa is large and C_s is small then C_s/K_{sa} can be neglected i.e., volatilisation of chemical from sampler is negligible

$$\frac{\Delta m}{\Delta t} = k\,A\,(CA) = R\,CA$$

R=Sampling Rate in m^3/day



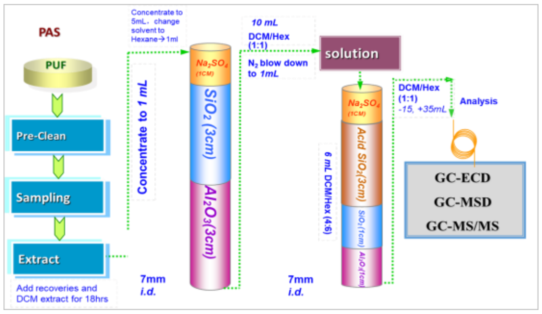
Therefore equilibrium occurs faster when:

1. K_{sa} is small (e.g., at high temperature or with a medium with small sorptive capacity or for a volatile chemical).
2. V_s is small (i.e., when there is little sampling medium or only part of it is accessible)

(Shoeib and Harner, Env Sci Technol., 2002; Bartkow, Env Pol, 2006)

Methodology

Extraction and Analysis



HYSPLIT: The Hybrid Single Particle Lagrangian Integrated Trajectory

FLEXPART: Flexible Particle Trajectory

PMF: Source-Receptor Modelling

The Positive Matrix Factorization (PMF) model developed by the USEPA was used for source apportionment of PCBs.

(EPA, E. Positive Matrix Factorization (PMF) 5.0-Fundamentals and User Guide. 2014)

Fate & Trajectory Models

Aqueous – Particulate – DOC Partitioning

Log transformation followed by correlation analysis with dissolved organic carbon

Hybrid Single Particle Langrangian Integrated Trajectory (HYSPLIT) Model

- 5 days back trajectory simulated over one-hour intervals
- Meteorological data obtained from the Global Assimilation Data System (GDAS) archives
- Data Source: National Oceanic and Atmospheric Administration (NOAA) servers

Air Water Exchange Fluxes

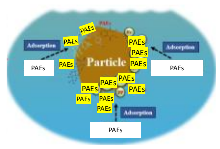
- Two film theory approach
- Fugacity approach

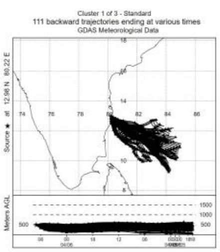
Riverine Discharge Fluxes

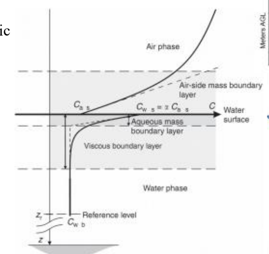
$$Flux\ of\ PAEs\left(\frac{kg}{year}\right) = Q \times C_d \times 10^{12}$$

Annual discharge rate (Q) of river (litres/year)

Average concentration in the dissolved phase (C_d) (ng/L)







HYSPLIT
Air Resources Laboratory

Toxics Link
for a toxics-free world

Environmental Science Processes & Impa[cts]

CRITICAL REVIEW

Check for updates

Cite this: Environ. Sci.: Processes Impacts, 2020, 22, 1925

552 papers

Environmental significance

Over the past 25 years, numerous passive air … initially focused on recording the variabilit… inhalation exposure to SVOCs, probing the e… monitoring interannual trends in SVOC air … their strength and limitations and may hav… curates the current knowledge on this topic i… a direction that will overcome their largest …

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Environmental Science & Technology

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Environmental News

Prev.

Inexpensive passive samplers capture POPs data in developing countries

Kellyn Betts

Abstract

Full Text HTML

Environ. Sci. Technol., Article ASAP
DOI: 10.1021/es803265k
Publication Date (Web): December 10, 2008
Copyright © 2008 American Chemical Society

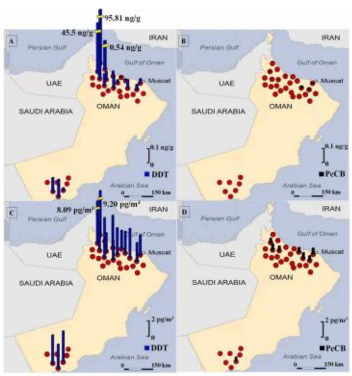
The first year's worth of global-scale data on nine important, airborne, persistent organic pollutants (POPs) is published in *ES&T* (DOI 10.1021/es802106a). Some of these data will play an important role in the inaugural global-monitoring report presented at the international meeting for the Stockholm Convention on POPs treaty in Geneva in May 2009. The humble passive samplers used to collect the data are widely expected to generate vast amounts of global air data on POPs.

Challenges with PUF…

Use of Depuration compounds; More field Blanks

Wania and Shunthirasingham., ESPI, 2020

Possibility for atmospheric transport??

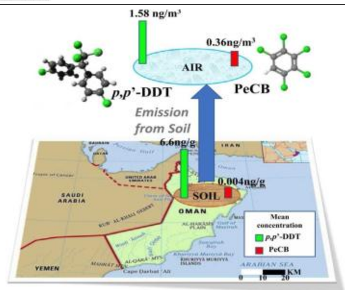


Spatial distribution of OCPs in the Sultanate of Oman (A) DDTs in soil (B) PeCB in soil (C) DDTs in air (D) PeCBs in air.

Journal of Hazardous Materials
Volume 459, 5 October 2023, 132205

New and legacy pesticidal persistent organic pollutants in the agricultural region of the Sultanate of Oman

Hassan Alshemmari [a,b], Mohammed M. Al-Kasbi [c], Yasar N. Kavil [b,d], Mohammed I. Orif [d], Ebtesam K. Al-Hulwani [c], Rawya J. Al-Darii [c], Suleiman M. Al-Shukaili [c], Fawaz A.A. Al-Balushi [c], Paromita Chakraborty [e]

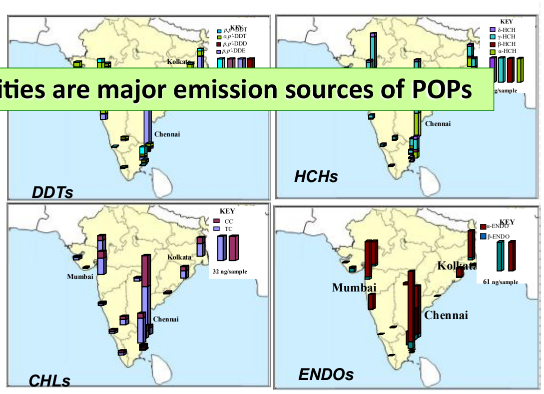


OCPs along the coastal length of India

"Urban tilt" observed for OCPs

urban > rural sites > background sites

Metro-cities are major emission sources of POPs



"Urban tilt"
Env Sci Technol, 2008

Passive Atmospheric Sampling of Organochlorine Pesticides, Polychlorinated Biphenyls, and Polybrominated Diphenyl Ethers in Urban, Rural, and Wetland Sites along the Coastal Length of India

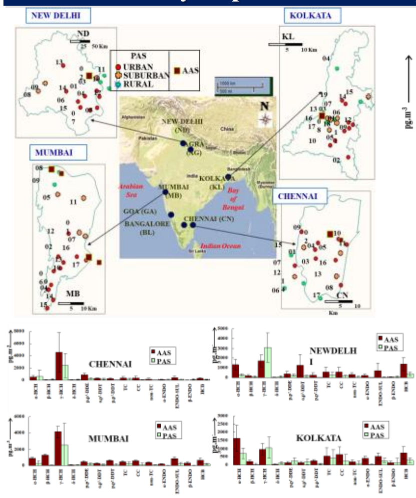
GAN ZHANG, PAROMITA CHAKRABORTY, JUN LI, PICHAI SAMPATHKUMAR, THANGAVEL BALASUBRAMANIAN, KANDASAMY KATHIRESAN, SHIN TAKAHASHI, ANNAMALAI SUBRAMANIAN, SHINSUKE TANABE, AND KEVIN C. JONES

"Urban tilt" in Torronto

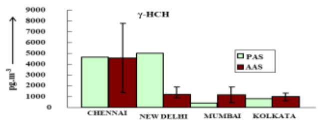
Using Passive Air Samplers To Assess Urban−Rural Trends for Persistent Organic Pollutants. 1. Polychlorinated Biphenyls and Organochlorine Pesticides

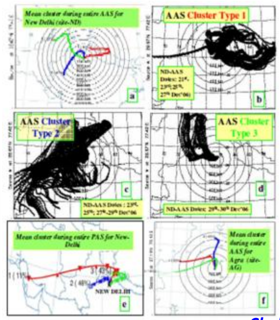
TOM HARNER, MAHIBA SHOEIB, MIRIAM DIAMOND, GARY STERN, AND BRUNO ROSENBERG
Meteorological Service of Canada, Environment Canada, 4905 Dufferin Street, Toronto, Ontario, Canada M3H 5T4, Department of Geography, University of Toronto, Toronto, Ontario, Canada M5S 3G3, and Freshwater Institute, Fisheries and Oceans Canada, Winnipeg, Manitoba, Canada R3T 2N6

Efficacy of passive air sampling in major Indian cities



68 sites selected (28 days)





Selected Organochlorine Pesticides in the Atmosphere of Major Indian Cities: Levels, Regional versus Local Variations, and Sources

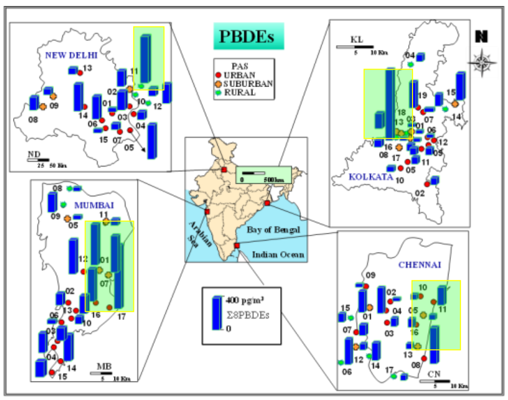
PAROMITA CHAKRABORTY,†,‡ GAN ZHANG,*,† JUN LI,† YUE XU,† XIANG LIU,† SHINSUKE TANABE,§ AND KEVIN C. JONES||

***Environ. Sci. Technol.* 2010, *44*, 8038–8043**

- **Passive and active sampling data were within a factor of 1-3**

Chakraborty et al., Env Sc Technol, 2010

PBDEs in metro cities of India using PUF-PAS



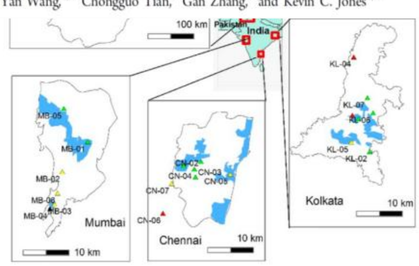
Ratio between maximum and minimum concentrations of PBDEs within each city exceeded 20 fold

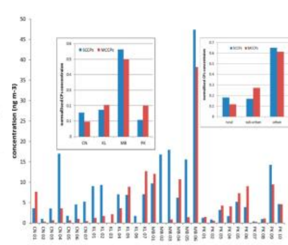
Chakraborty et al , Env Pol, 2017

Environmental Science & Technology — Article — pubs.acs.org/est

Screening of Atmospheric Short- and Medium-Chain Chlorinated Paraffins in India and Pakistan using Polyurethane Foam Based Passive Air Sampler

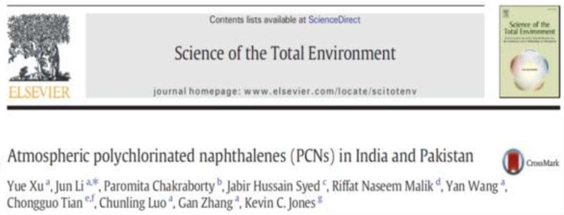
Chakra Chaemfa,*,† Yue Xu,† Jun Li,† Paromita Chakraborty,‡ Jabir Hussain Syed,† Riffat Naseem Malik,§ Yan Wang,†,⊥ Chongguo Tian,# Gan Zhang,† and Kevin C. Jones†,∇





- Concentrations of SCCPs and MCCPs ranged from not detected (ND) to 47.4 and 0 to 38.2 ng/m³ with means of 8.11 and 4.83 ng/m³ in India and Pakistan
- Indian concentrations showed higher average levels of both SCCPs and MCCPs India (10.2 ng/m³ and 3.62 ng m−3 than the samples from Pakistan (5.13 ng/m³ and 4.21 ng/m³

(Chaemfa et al., Env Sci Technol2014)

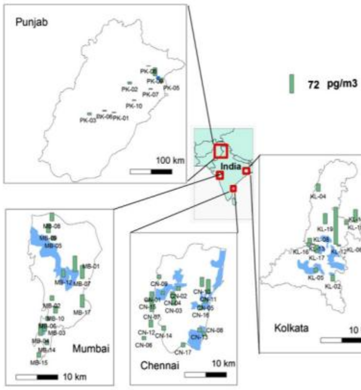

Contents lists available at ScienceDirect

Science of the Total Environment

journal homepage: www.elsevier.com/locate/scitotenv

Atmospheric polychlorinated naphthalenes (PCNs) in India and Pakistan

Yue Xu [a], Jun Li [a,*], Paromita Chakraborty [b], Jabir Hussain Syed [c], Riffat Naseem Malik [d], Yan Wang [a], Chongguo Tian [e,f], Chunling Luo [a], Gan Zhang [a], Kevin C. Jones [g]



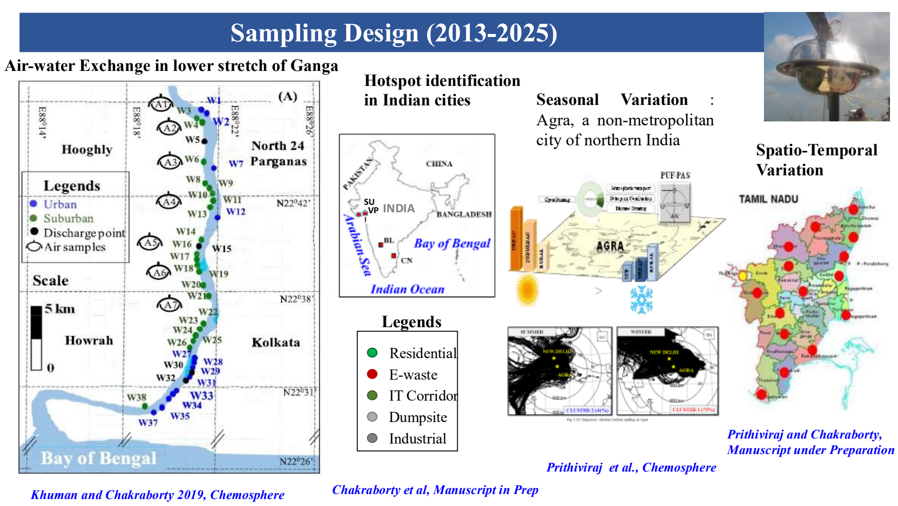
Spatial distributions of atmospheric ΣPCNs at sampling sites in India and Pakistan.

Blue areas represent the industrial clusters in the Punjab Province in Pakistan and Mumbai, Chennai and Kolkata in India

- The average concentrations were 29 pg/m3 and 7.7 pg/m3 in the Indian and Pakistani samples, respectively

(Xu., et al 2014)

Uttarakhand PUF-PAS sampling campaign



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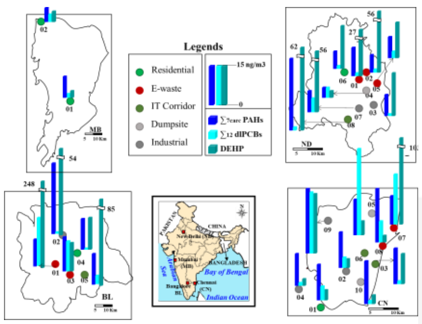
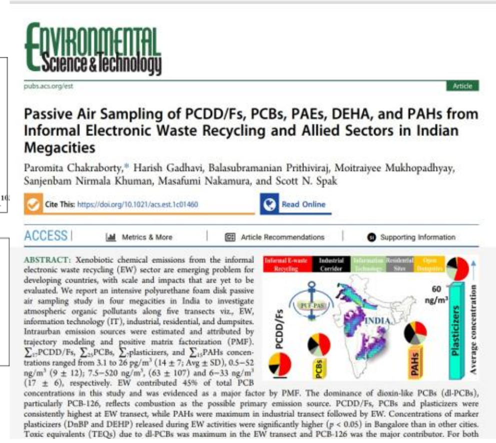
Cost-effective way of Tracking hotspots



Chakraborty et al., Env Sc Technol, 2021


Environmental Science & Technology

pubs.acs.org/est — Article

Passive Air Sampling of PCDD/Fs, PCBs, PAEs, DEHA, and PAHs from Informal Electronic Waste Recycling and Allied Sectors in Indian Megacities

Paromita Chakraborty,* Harish Gadhavi, Balasubramanian Prithiviraj, Moitraiyee Mukhopadhyay, Sanjenbam Nirmala Khuman, Masafumi Nakamura, and Scott N. Spak

Cite This: https://doi.org/10.1021/acs.est.1c01460 Read Online

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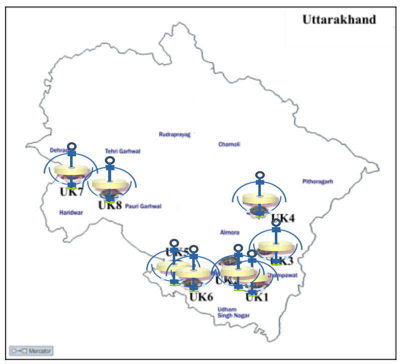
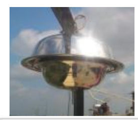
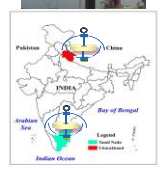
ABSTRACT: Xenobiotic chemical emissions from the informal electronic waste recycling (EW) sector are emerging problem for developing countries, with scale and impacts that are yet to be evaluated. We report an intensive polyurethane foam disk passive air sampling study in four megacities in India to investigate atmospheric organic pollutants along five transects viz., EW, information technology (IT), industrial, residential, and dumpsites. Intraurban emission sources were estimated and attributed by trajectory modeling and positive matrix factorization (PMF). $\sum_{17}$PCDD/Fs, $\sum_{25}$PCBs, $\sum_{7}$plasticizers, and $\sum_{15}$PAHs concentrations ranged from 3.1 to 26 pg/m^3 (14 ± 7; Avg ± SD), 0.5–52 ng/m^3 (9 ± 12); 7.5–520 ng/m^3, (63 ± 107) and 6–33 ng/m^3 (17 ± 6), respectively. EW contributed 45% of total PCB concentrations in this study and was evidenced as a major factor by PMF. The dominance of dioxin-like PCBs (dl-PCBs), particularly PCB-126, reflects combustion as the possible primary emission source. PCDD/Fs, PCBs and plasticizers were consistently highest at EW transect, while PAHs were maximum in industrial transect followed by EW. Concentrations of marker plasticizers (DnBP and DEHP) released during EW activities were significantly higher ($p < 0.05$) in Bangalore than in other cities. Toxic equivalents (TEQs) due to dl-PCBs was maximum in the EW transect and PCB-126 was the major contributor. For both

Cost-effective way of Tracking POPs in Uttarakhand

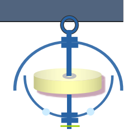


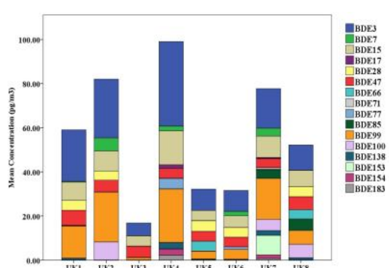




Atmospheric POPs in Uttarakhand

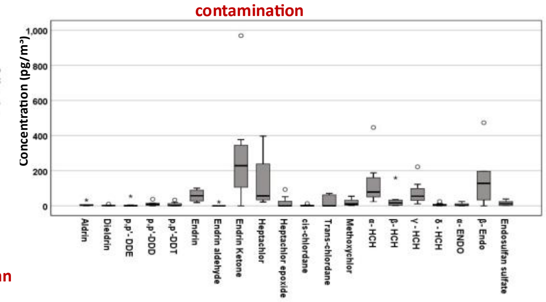
Dominance of lighter BDE- Congeners. **BDE-3 is frequently detected in air samples, with elevated concentrations found near e-waste, industrial, and highly urbanized areas**





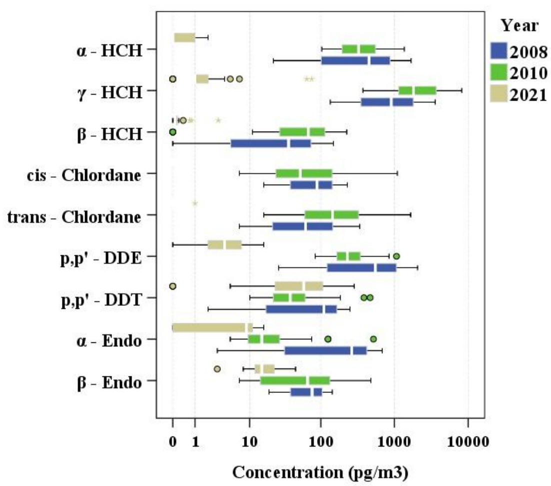
This ratio is indicative of relatively fresh contamination from commercial or electronic products, as BDE-99 is typically more prevalent than BDE-47 in commercial penta-BDE mixtures

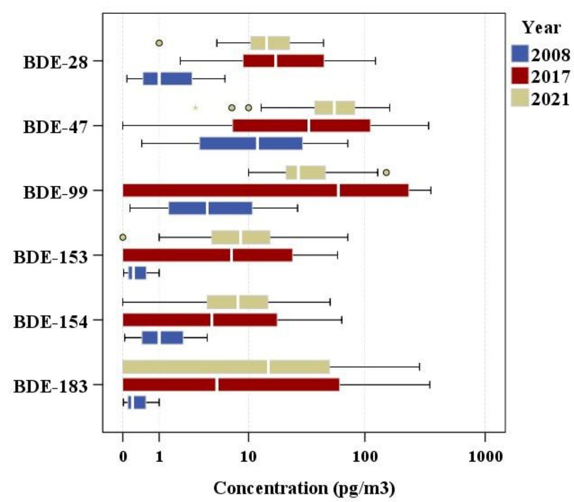
- **Higher alpha-HCH reflect some usage of Technical Formulation**
- **Higher Beta-Endosulfan suggest re-emission from older contamination**



Box and whisker plot showing the range of PBDEs OCPs in the atmosphere of Uttarakhand

Time trend of selected OCPs and PBDEs in 2008, 2010, 2017 & 2021 in urban regions of India



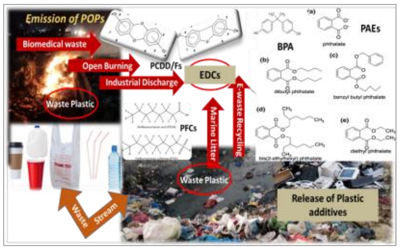


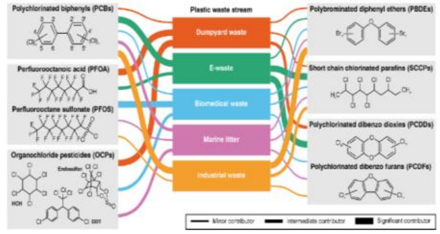
Chakraborty et al., Manuscript in Preparation

Plastics-Chemicals Interlinkages

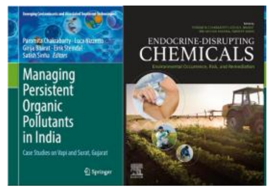
Major Factors for Chemicals release

- ❑ Leaching from Plastic Litter
- ❑ Open burning



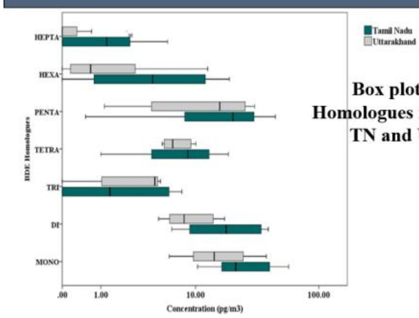


Plastic additives
Flame retardants
By-products

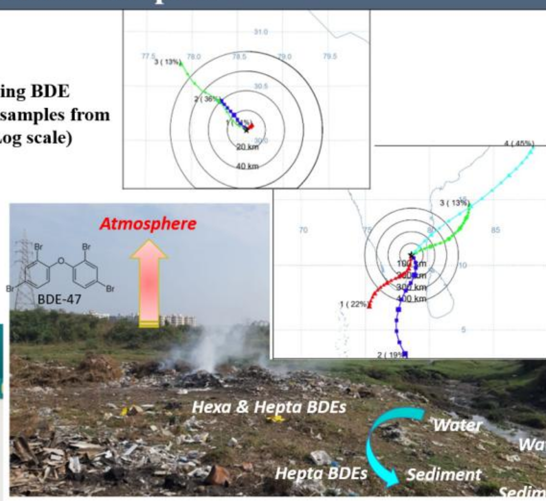


Chakraborty et al., BECT, 2022

Atmospheric transport



Box plot showing BDE Homologues in air samples from TN and UK (Log scale)



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https://doi.org/10.5812/ijhls.106015

Discard Plastic Burning: A Serious Risk Factor in Dehradun, India

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*Corresponding Author: Department of Biochemistry and Biotechnology, Sardar Bhagwan Singh University, Balawala, Dehradun, India. Email: santoshkarn@gmail.com

Image Credit: Int J Health Lif

❑Oceanic air mass had a cleansing effect on Tamil Nadu

Acknowledgement to our Our Fellows

Target POPs
Poly Brominated Diphenyl Ethers(PBDEs)

Sarath Chandra J
Dept. of Civil Engg. & REACH
Research Scientist

Target POPs
Per- and polyfluoroalkyl Substances (PFASs)

Pavithra K
CSIR-SRF,
Dept of Civil Engg. & REACH

Target POPs
Poly Chlorinated Biphenyls(PCBs), Poly Brominated Diphenyl Ethers (PBDEs)

Mithun K
Senior Research Fellow, Dept of Chemistry & REACH, SRMIST,
WARI Intern, UNL , USA

Target POPs
Organochlorine Pesticides (OCPs)

Sidhi Soman
DST-Inspire Fellow,
Dept. of Chemistry & REACH

Yuvanesh J
Junior Research Fellow
Dept. of Chemistry, REACH
Target POPs: PBDEs

Irshana Shahjahan,
Dept. of Chemical Engg. & REACH
SRMIST Fellow
Target POPs: OCPs

Sujith
Target POPs
Per-and polyfluoroalkyl Substances (PFASs)

Acknowledgement

Norwegian Embassy
New Delhi

(VI)

Funded by:
Norway

INOPOL

India-Norway Cooperation Project on Capacity Building for Reducing Plastic and Chemical Pollution in India (INOPOL)

Stakeholder Meeting on Chemicals Management, Dehradun, Uttarakhand, India
24th of February 2026

Toxics Link · SRM UNIVERSITY · NIVA Norwegian Institute for water research · mμ gamma · सिपेट CIPET

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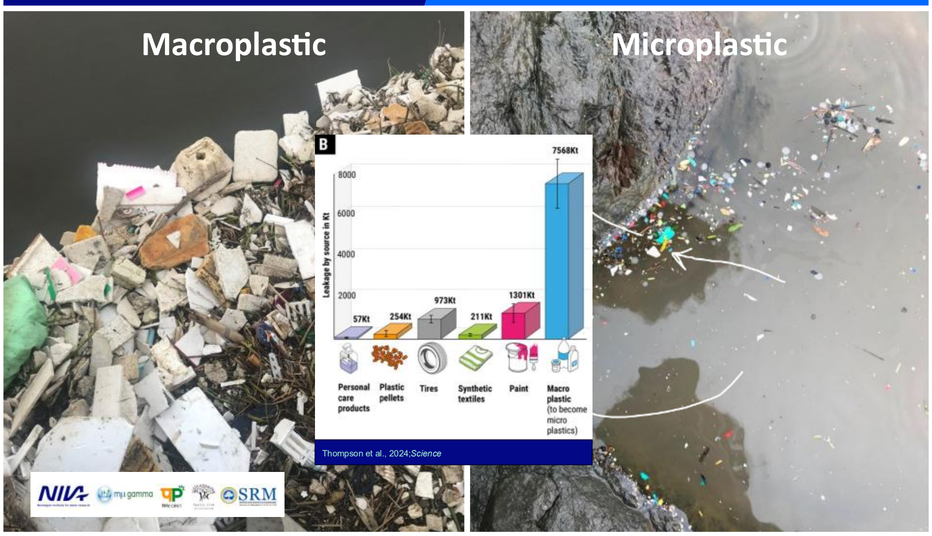
Monitoring riverine macroplastic pollution

Rachel Hurley
Norwegian Institute for Water Research (NIVA)

NIVA



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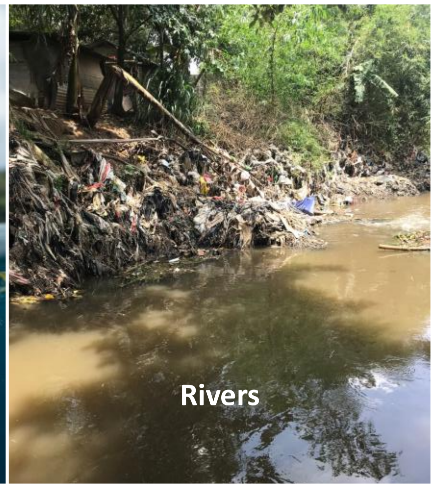
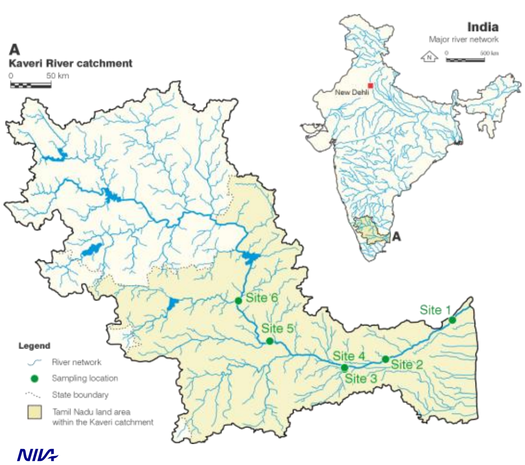
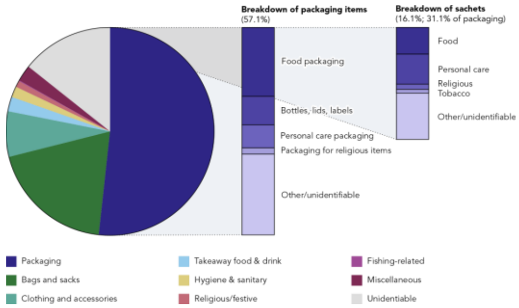
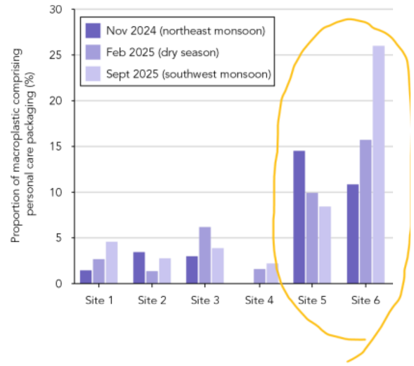
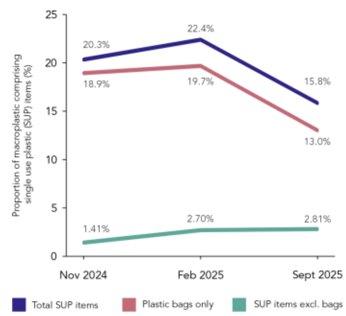








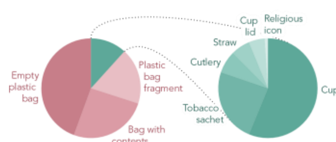


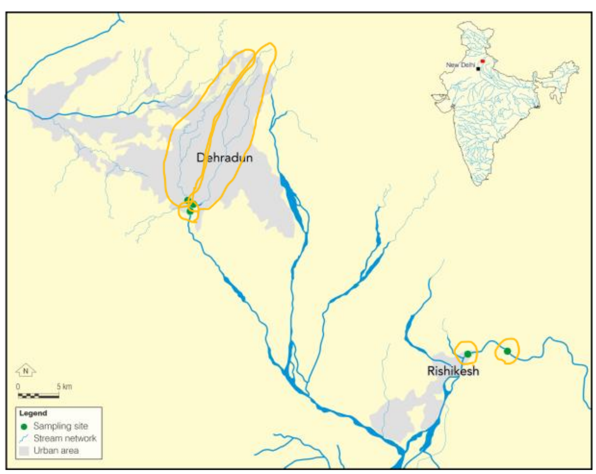
Overal all, 19.3% of observed macroplastics were composed of SUP banned items

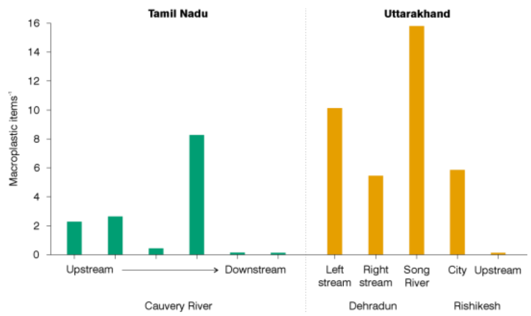
Plastic bags with thicknesses lower than 75 µm and 120 µm were banned in 2021 and 2022, respectively

Small survey of plastic bag thickness measured with a micrometer conducted in September 2025, where **100% were below 75 µm thick**

Proportion of "certain" SUP items was 2.4%







Higher levels observed in UK **but**:
- One data point per site
- More urban sites sampled

UK city levels broadly comparable with TN city level (Trichy)

More rural sites have lower concentrations

Slightly higher macroplastic loads flowing from the left side of Dehradun, highest levels seen when the two Dehradun streams combine

Lower levels in Rishikesh city, but more diverse macroplastic types

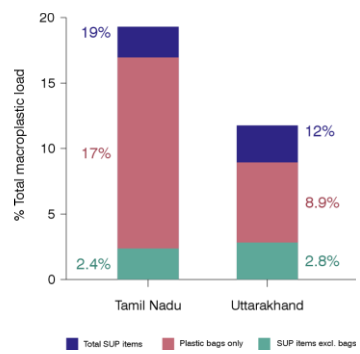
Dehradun macroplastic largely composed of food packaging (69%)

Similar proportion of “certain” SUP items in TN and UK
- Mostly composed of cups in both states

More plastic bags observed in TN than in UK

This contributes to a higher total proportion of SUP items in TN compared to UK

*Plastic bag thickness not measured in UK due to the single method used



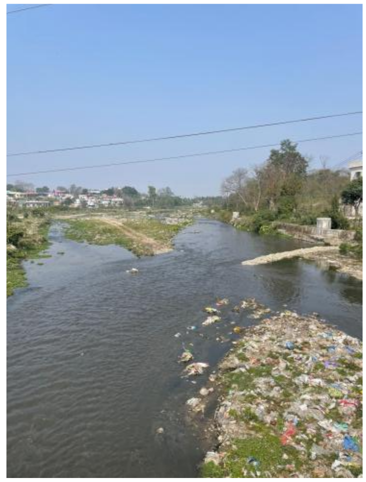
Similar dominance of packaging items, in particular food packaging

Fewer plastic bags with contents observed – indicates efficacy of anti-dumping infrastructure along bridges

Smaller proportion of personal care items, linked to the urban locations with lower prevalence of bathing and clothes washing in the river

Macroplastic assemblages observed in TN and UK suggests municipal solid waste as a potentially important source

What can further monitoring in UK tell us?:
- More robust assessment of macroplastic loads
- Seasonal spatiotemporality
- Additional sites can point to spatial sources
- Riverbank surveys and net sampling would provide a more complete picture of macroplastic in the river



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Thank you for your attention!

rachel.hurley@niva.no

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(VII)

Government of India | सिपेट CIPET

Findings of INOPOL Project - *Baselines, regulatory perspectives, key challenges identified, and way forward*

Presentation by:

DR. SMITA MOHANTY
Pr. Director & Head (Sr. Pr Scientist)

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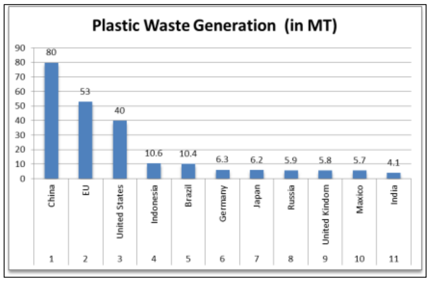
website: www.cipet.gov.in

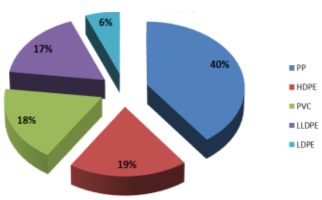
Scenario of Plastics Waste Generation -Global



Worldwide plastic waste generation statistics million tonnes per annum (Statista Report, 2023)

- China leads the plastic waste generation statistics with 80 million TPA which is followed by European Union and US (53 and 40 million TPA, respectively).
- India has an annual generation of 4.12 million tonnes of plastic wastes.
- The per capita plastic waste generation in India has doubled over the last five years

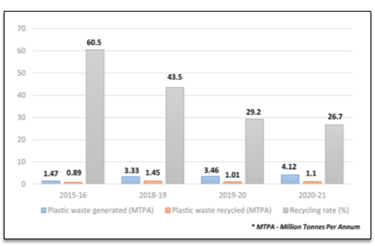
Demand based on Plastics Type – INDIAN PERSPECTIVE



Demands for various types of plastics in India (2021-22)

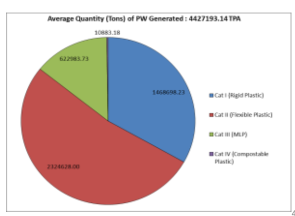
- Indian plastic demand accounts 40% of polypropylene (PP),
- 19 % of high density polyethylene (HDPE)
- 18 % of polyvinyl chloride (PVC)
- 17% of Linear low density polyethylene (LLDPE) and 6 % of low density polyethylene (LDPE
- Based on Study of undertaken by Central Pollution Control Board (CPCB), 2021 the average annual increase observed in generation of hazardous waste is 2%, which is 5.8% in case of bio-medical waste (BMW),and 0.1 and 21.8 % for solid and plastics waste

Plastics Waste Generation and Recycling Rate – INDIAN PERSPECTIVE



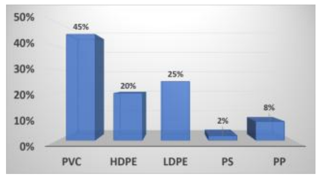
Plastic waste generation, Plastic Waste Recycled and Average plastics recycling rates in India between 2015 to 2021

- The consumption of plastics in India has shown a significant increase from 13.7 million tonnes per year in 2015-16
- 15 million tonnes per year in 2018-19
- 21 million tonnes by 2020-21



Brief Overview of Tamil Nadu (TN)

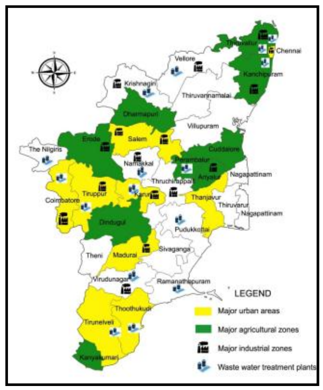
- The state of Tamil Nadu consists of 15 corporations, 121 municipalities and 528 town panchayats.
- A total of 4,30,107 tons per annum or 1178 tons per day of plastic waste is generated from the state.
- 96.4% waste is collected and segregated by urban bodies.
- 2,95,482 TPA of plastic waste are recycled.
- The State has 49 Registered Recyclers & 61 Unregistered Recycling Units in the State
- EOL includes Mechanical recycling - 96, Co-processing in cements - 11,Waste to energy Plants-1, Waste to Oil -1 & Industrial Composting – 2
- Recycling Capacity - 1,33,135 TPA



Recycling rates of different types of Plastics in India

Overview of Tamil Nadu (TN) : SOURCES OF WASTE

- The amount solid waste generated includes horticulture waste, agriculture and dairy waste solid, semi-solid domestic waste, sanitary waste, commercial waste, institutional waste, catering and market waste and other non residential wastes amounts:
  - ✓ *14228 tonnes per day from which 13955 tonnes per day are collected, 6650 tonnes are treated and rest are landfilled according to annual report 2019-2020.*
- The hazardous waste generated in Tamil Nadu are mainly from 4199 industries present in the state.
  - ✓ *During the period 2020-21, about 7,95,000 tons of hazardous waste is generated, in which 85,000 tons (10.69%) is landfillable, 1,24,000 tons (15.59%) is recyclable, 5,76,000 tones (72.45%) is utilizable and 9,500 tons (1.19%) is incinerable.*



Macroplastics Monitoring

- As many as 217 countries will release 3,153,813 tonnes of microplastics into the world's waterways by the end of 2024.
- China, India, the United States and Japan will account for 51% of this volume, according to the 2024 Plastic Overshoot Day (POD) Report.
- India will release 391,879 tonnes of microplastics and will be the second leading polluter of the waterbodies after China (787,069 tonnes) in the world, the analysis by Swiss non-profit EA Earth Action showed.

https://www.e-a.earth/plastic-overshoot-day-report-2024/

Key Challenges Identified

Inadequate Waste

Limited access to waste collection services, particularly in rural areas, areas, leads to indiscriminate dumping dumping and littering.

Lack of Recycling Infrastructure

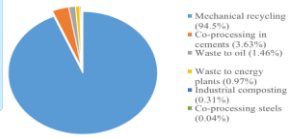
Limited capacity and inefficiency in recycling facilities result in inadequate processing and recycling of plastic waste.

Informal Recycling Practices

The prevalence of informal recycling, often involving unsafe and environmentally harmful practices, further complicates waste management.

Consumer Behavior

Insufficient awareness and behavioral changes among consumers regarding waste management practices, especially plastic waste reduction, hinder progress.



(Source: CPCB EPR Portal)

8

Regulatory Perspectives

National Laws

The Plastic Waste Management Rules, Rules, 2016, are the central government's regulations aimed at reducing plastic waste

State Regulations

TN has implemented its own regulations, building upon the national framework, such as bans on certain types of plastic bags and mandatory extended producer responsibility

Municipal Ordinances

Municipal corporations in have enacted local enforce waste segregation, collection, and disposal within their jurisdictions.

Existing Waste Management Practices

1. **Waste Collection**

   Municipal authorities and private companies collect waste from households and commercial establishments, with varying levels of efficiency and coverage.

2. **Waste Sorting**

   Waste is often sorted manually at designated collection centers, separating recyclable and non - recyclable materials, including plastic.

3. **Waste Treatment**

   Waste is disposed of through various methods, including landfills, incineration, and composting, with plastic waste often posing challenges for efficient processing.

4. **Recycling**

   Formal and informal recycling operations exist, with varying levels of technology, efficiency, and environmental compliance, contributing to the recovery of plastic waste.

Challenges in Plastic Waste Reduction

1 Consumer Dependence

Consumers heavily rely on plastic packaging for various products, making it challenging to transition to alternative materials.

2 Limited Alternatives

The availability and affordability of eco-friendly alternatives to plastic packaging and products remain limited.

3 Enforcement Challenges

Effective enforcement of regulations, including bans on single-use plastics and extended producer responsibility, faces challenges.

4 Behavioral Change

Promoting a culture of plastic waste reduction and encouraging responsible consumer behavior requires sustained efforts and awareness campaigns.

Initiatives and Policies by the Government

Awareness Campaigns

Government agencies conduct awareness campaigns to educate the public on the importance of plastic waste reduction and proper disposal.

Waste Collection Drives

Government initiatives and NGOs organize regular plastic waste collection drives to clean up public spaces and promote responsible disposal.

Support for Recycling

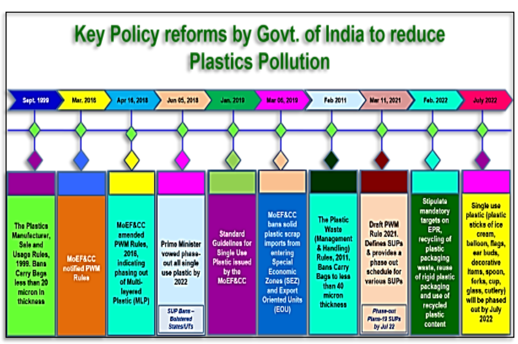
The government provides financial and technical support to promote the development of recycling infrastructure and industries.

Incentives for Sustainability

The government offers incentives for businesses and individuals to adopt sustainable practices and use eco-friendly alternatives to plastic.

Key Policy Reforms: PWM 2016 & its amendment & EPR

Government of India | सिपेट CIPET



Category I
Rigid plastic packaging

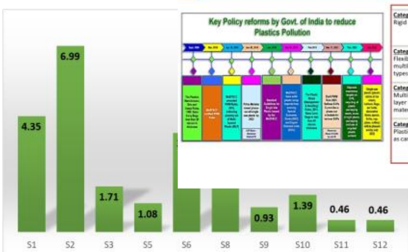
Category II
Flexible plastic packaging of single layer or multilayer (more than one layer with different types of plastic)

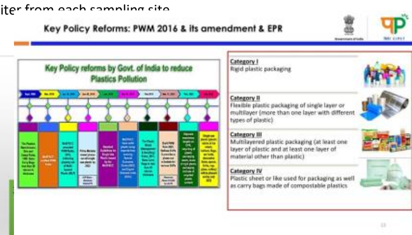
Category III
Multilayered plastic packaging (at least one layer of plastic and at least one layer of material other than plastic)

Category IV
Plastic sheet or like used for packaging as well as carry bags made of compostable plastics

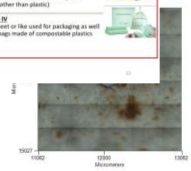
FINDINGS (INOPOL 1)

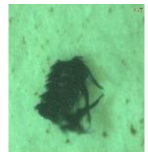
Microplastic pieces per liter from each sampling site



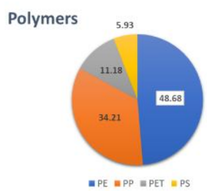


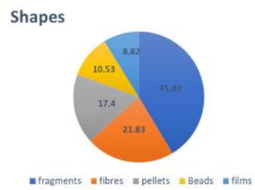
Mean concentration of microplastics
3.53 pieces/L
2.38 pieces/L
0.77 pieces/L

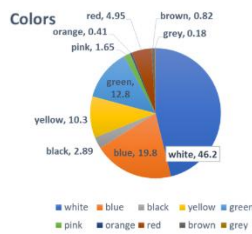




QUANTIFICATION RESULTS

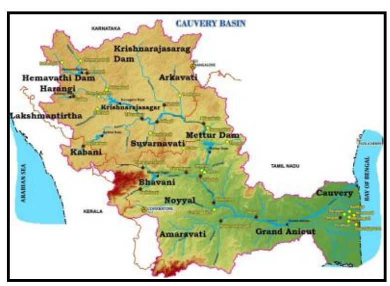






IDENTIFIED SITES FOR INOPOL 2

- ✓ Cauvery river river has a number of tributaries on its left and right bank such as Harangi, Hemavati, Shimsha and Arkavati on its left bank and Lakshmantirtha, Kabbani, Suvarnvati, Bhavani, Noyyal and Amarvati on its right.
- ✓ Adyar River
- ✓ Other sites @ Tuticurin:
  - **Vembar** (9⁰4'35.3994''N 78°10' 16.22''E
  - **Vellapatti** (08°51'28.52'' N-78°10'1.62''E
  - **Threspuram** (08° 48' 59.9''N – 78° 09' 59.9''E)
  - **Punnakayal** (8°29'35.76''N – 78°7'40.16''E): It receives a large amount of marine litter as a result of anthropogenic activities and river runoff from major cities such as Thirunelveli and Thoothukudi;
  - **Thrichendur** (8°29'35.76''N – 78°7'40.16''E): It is well-known for pilgrimage and tourist activities.



Source: https://indiawris.gov.in

SAMPLING COORDINATES of 1st SAMPLING CAMPAIGN (INOPOL 2)

Location	Sampling area	Google Co-ordinates
Location 1	Tiruppur	11°07'07.8"N 77°23'41.0"E
Location -2	Tiruppur	11°06'17.9"N 77°18'50.6"E
Location - 3	Erode	11°21'36.7"N 77°44'32.3"E
Location - 4	Erode	11°19'53.2"N 77°45'29.7"E
Location - 5	Nagamanaickenpalayam	11°03'42.1"N 77°55'46.0"E
Location-6	Manmangalam	11°05'38.7"N 78°00'13.4"E
Location -7	Srirangam	10°50'02.9"N 78°48'56.0"E
Location – 8	Tiruchinampoondi	10°51'04.0"N 78°54'40.3"E
Location – 9	Andanallur	10°52'57.9"N 78°34'42.0"E
Location – 10	Tiruchirappalli	10°50'15.1"N 78°41'42.1"E
Location – 11	Melaiyur	11°08'55.7"N 79°48'16.9"E
Location - 12	Vanagiri	11°08'21.9"N 79°50'22.0"E
Location-13	Keelaiyur	11°08'13.1"N 79°51'22.4"E

GLIMPSES OF 1ST SAMPLING CAMPAIGN FOR INOPOL 2

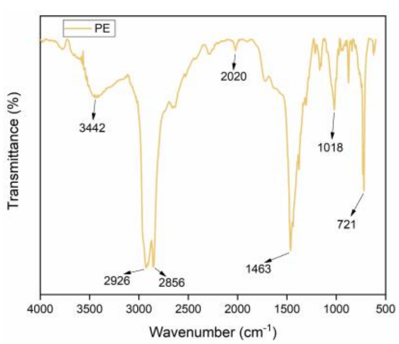
SAMPLING OF MICROPLASTICS IN RIVER WATER

- Passive sampling: Visual observation from bridge
- Sampling through Amber glass bottles (500ml) from the surface water.

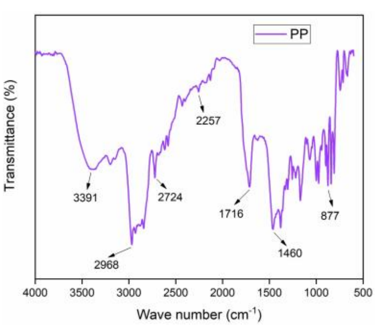
MICRO-FTIR ANALYSIS

- The analysis was done through Perkin Elmer Spectrum 2 attached with Spectrum 200i microscope.
- It was performed within the wavelength 4000-600 cm-1 with 4 cm-1 resolution.
- The analysis was done with 64 scans per spectrum in reflectance mode in Spectrum IR software.
- Before the analysis , background was taken on a gold plate and the analysis was done in single point analysis.

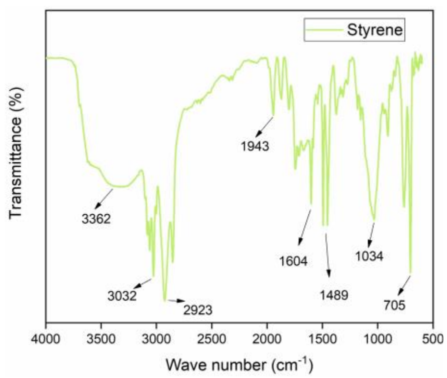
MICRO-FTIR RESULTS



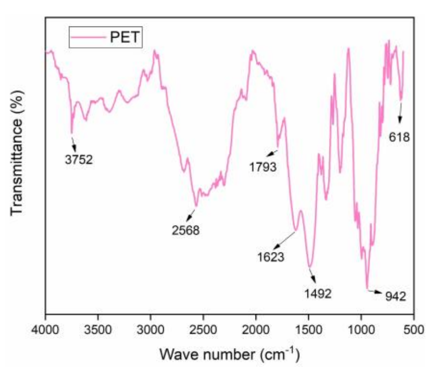
Wavenumbers	Functional groups
3442	O-H stretching
2926-2856	C-H stretching
1463	C-H bending
1018	C-O stretching
721	=C-H bending



Wavenumbers	Functional Groups
2968-2724	C-H stretching
1716	C=O stretching
1460	C-H bending
1376	C-H bending
877	C-O stretching



Wavenumbers	Functional Group
3362-3032	O-H stretching
2923	C-H stretching
1489	C-H bending
1034	C-O-C bending
705	Ar C-H bending

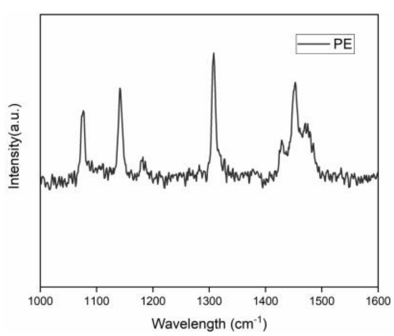


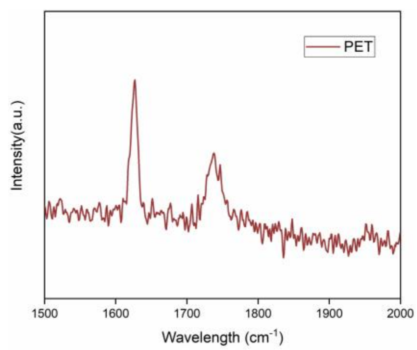
Wavenumbers	Functional Group
3752	O-H stretching
1793	-C-N stretching
149	C-O stretching
942	C=C bending
618	C-H bending

RAMAN SPECTROSCOPY ANALYSIS

- Raman spectroscopic detection and mapping of microplastics were carried out using a INDIRAM CTR-300C Raman spectrometer.
- The slides were cleaned in ultrapure water and ethanol. Silicon wafers were ultrasonically cleaned with acetone and ethanol to remove the grease adhering to the silicon wafer surface.
- The large size microplastic particles were placed on a slide and flattened with another cleaned slide so that they were evenly distributed without overlap for detection.
- Small particle-size microplastic particles were mixed with CTAB to make them uniformly dispersed, and the mixed solution was dripped onto a silicon wafer and dried for testing.

RAMAN SPECTROSCOPY RESULTS

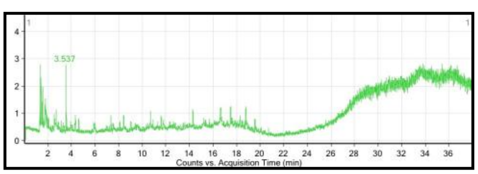




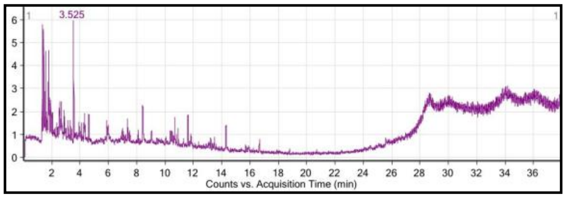
PYROLYSIS GC-MS ANALYSIS

- The MPs analysis using Pyrolysis GC-MS were performed through single-shot 3030S pyrolyzer (Frontier Lab, Japan) pyrolyzed at 700^{0}C for 38 minutes attached with Agilent 7890B GC systems and Agilent 7000D GC/MS Triple Quad by M/S Agilent Technologies, USA.

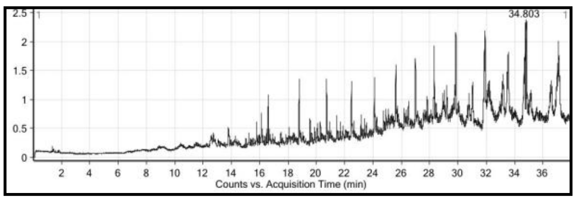
PYROLYSIS GC-MS RESULTS



Polypropylene
2,3,3- Trimethylpent-1-ene
2,4- dimethylhex-3-ene
2,4-dimethylhept-1-ene
Propylene
1,1,3,5-tetramethylcyclohexane
2,4,6,8,10-pentamethyltridec-1-ene
4,6,8-trimethylundecane
2,4,6,8,10,12-hexamethylpentadec-1-ene



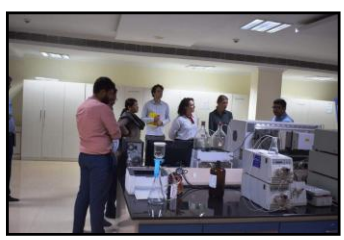
Polystyrene	ABS
Toluene	1,3-Butadiene
Benzene	Acrylonitrile
Ethylbenzene	Benzene
Styrene trimer	Toluene
	Ethylbenzene



PVC	ABS
Benzene	Benzene
Toluene	Toluene
Propene	1,3-Butadiene
Indene	
Naphthalene	
2-Ethyl-1-hexene	

WORKSHOPS, TRAININGS AND LAB VISITS

The capacity-building program: Insights and practices for reducing plastic pollution and POPs in India wrapped up successfully on Sep 30 and Oct 1, 2024.

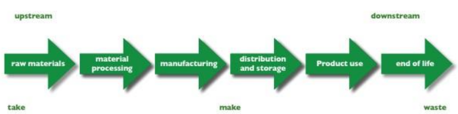


NIVA visit to CIPET:SARP-LARPM

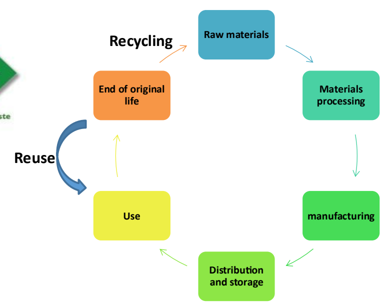
CIPET visit to NIVA at Oslo for microplastics training programme along with other Indian partners and Tamil Nadu Pollution Control Board (TNPCB) on October 2024

WAY FORWARD

- Rather than the linear 'cradle to grave' process above, where a product has no use at the end of its life, we must think in cycles: 'cradle to cradle'.
- At the end of the original life of a product, it should be used to begin as another product - just like our natural eco-systems.



Current Linear Process (source 'Towards Zero Waste – Brisbane City Council)



Future Cyclic Process towards Resource Efficient and Zero Waste Society

THANKS!

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