CLIMATE CHANGE, CHEMICALS, AND HEALTH: KEY FACTS AND IMPLICATIONS

Toxics Link
for a toxics-free world

India is at the frontline of the intersecting climate and chemical crises. Rising temperatures, extreme weather events, and rapid industrial transitions are intensifying exposure to hazardous chemicals through air, water, food, and consumer products. These risks disproportionately affect vulnerable communities—including farmers, informal waste workers, coastal populations, and women. With over two decades of experience in chemical safety and toxics, Toxics Link underscores that chemical safety must be systematically integrated into India's climate policies, adaptation strategies, and public health planning to safeguard people and ecosystems.

INTRODUCTION

Climate change, biodiversity loss, and pollution have been identified as three interconnected global environmental crises, collectively referred to as the "Triple Planetary Crises" (21). Among these, climate change and chemical pollution are deeply intertwined, with each amplifying the impacts of the other on human health, ecosystems, and society. While the consequences of global warming—such as heat stress, food insecurity, and extreme weather events—are increasingly well documented, the bidirectional linkages between climate change and chemical pollution pathways remain comparatively underexplored.

Emerging research highlights how rising temperatures, altered precipitation patterns, extreme weather events, and glacial melt influence the transport, persistence, transformation, and human and ecological exposure pathways of hazardous chemicals [17]. Climate change not only accelerates the release, dispersion, and toxicity of chemicals already present in the environment, but also triggers secondary releases from environmental reservoirs such as soils, sediments, and glaciers [15].

Understanding these complex interlinkages is essential for developing integrated and effective strategies that simultaneously address climate change and chemical pollution, rather than treating them as separate challenges.

Interlinkages between Climate Change and hazardous waste and chemicals

- Climate change leads to an increase in the release of chemicals into the environment.
- Chemicals production, usage, and disposal lead to the release of greenhouse gases (GHGs) into the environment.

CLIMATE CHANGE

- Climate change refers to long-term shifts in temperature, precipitation patterns, and the frequency and intensity of extreme weather events.
- Human activities—particularly fossil fuel combustion, industrial processes, and land-use change—have already caused approximately 1.1 °C of global warming above pre-industrial levels [10].
- Recent observations indicate that global temperatures are approaching, and in some cases exceeding, the 1.5 °C threshold.

HOW THIS MATTERS NOW?

Without urgent action, emissions from chemicals and plastics could undermine Paris Agreement goals, while climate change is already remobilising toxic legacies that threaten health and ecosystems worldwide

- According to the World Meteorological Organization (WMO), 2024 was the warmest year on record, with a global mean surface temperature of 1.55 °C ± 0.13 °C above pre-industrial levels, likely marking the first calendar year to cross the 1.5 °C threshold.

The consequences are increasingly visible:

- record-breaking heatwaves,
- melting Arctic ice,
- stronger hurricanes, and
- Devastating floods.

These events not only disrupt ecosystems and livelihoods but also release toxic chemicals long stored in soils, water, and waste sites—creating a dangerous, double burden of climate and chemical risks [14,10].

According to World Meteorological Organization, 2024 was the warmest year in the 175-year observational record.

CHEMICALS AS DRIVERS OF CLIMATE CHANGE

1. Climate impacts from chemicals extend across their entire life cycle:
    - Extraction and refining of oil and gas
    - Chemical and plastic production
    - Product use
    - End-of-life disposal, including incineration and open burning
2. Plastics, produced almost entirely from petrochemicals, are a major driver:
    - Plastic production already accounts for 3–4% of global emissions and could rise to 15% by 2050 [7, 8].
    - Under business-as-usual scenarios, plastics could consume a significant share of the remaining carbon budget compatible with the 1.5°C goal [22].
3. End-of-life practices worsen both pollution and climate impacts:
    - Open burning of plastics and e-waste releases dioxins, furans, heavy metals: lead and mercury, and flame retardants
    - These practices emit both toxic pollutants and climate-forcing gases
    - Some chemical manufacturing processes emit extremely potent greenhouse gases
4. Certain fluorochemical by-products have global warming potentials thousands of times higher than CO_2
5. PFAS manufacturing can release HFC-23, a by-product of HCFC-22 production. While it does not directly deplete ozone, HFC-23 is a super-potent greenhouse gas (GWP_{100} ≈ 14,600 in IPCC AR6), showing how chemicals developed to protect the ozone layer can still drive climate change. [15,13].
6. Global demand for plastics production has doubled since 2000 and is projected to double again by 2030, driving fossil fuel demand [7].

KEY CLIMATE-DRIVEN PATHWAYS OF CHEMICAL RELEASE AND EXPOSURES:

- **Melting glaciers and permafrost:** Polar ice and high-altitude glaciers are releasing stored pollutants like PFAS and mercury into water bodies [14,15].
- **Rising temperatures and chemical release:** Hotter conditions increase volatilisation of pesticides and POPs, such as PCBs used as plasticisers in paints and joint sealants, and PBDEs used as flame retardants spreading them into air and water [15]. Warmer temperatures also enhance chemical volatilisation and atmospheric transport, extending the reach of toxic substances far beyond their point of origin.
- **Increased pest outbreaks:** Higher temperatures drive greater pesticide use, raising chemical exposure [15].

One study in China highlighted that pesticide usage as a result of both increased temperature and precipitation could rise by 1.1 to 2.5% by 2040 and 2.4 to 9.1% by 2070, despite current efforts to reduce pesticide usage [20]

- **Disasters trigger large-scale chemical releases from industrial sites and landfills [1,3]:** In India, a study concluded that reduced river flows from climate change will intensify industrial pollution in the Ganges at Kanpur, concentrating tannery effluents and worsening health and ecological risks [3].

GENDERED IMPACTS

- Biological and social vulnerability: Pregnancy, lactation, household roles, caregiving, occupational rotes and limited access to healthcare increase susceptibility and risk.
- Women in agriculture: Handle Highly Hazardous Pesticides (HHPs) without protection, increasing exposure, especially while caring for children [15].
- Informal sector workers, especially women in recycling, textiles, and tanning, face a triple burden of chemical exposure, heat stress, and poor occupational protections, increasing risks of respiratory, reproductive, and endocrine disorders.
- Maternal and child health: POPs and mercury released by floods or melting ice can cross the placenta and enter breast milk, causing adverse birth outcomes and affecting development [12].
- Women in textiles, plastics, tanneries: Face chemical exposure, heat stress, and poor occupational protection [12].
- Water, food, and mental health: Climate-driven contamination and caregiving burdens intensify exposure and stress.

- **The rising temp can interfere with the Micro plastic fragments (~5 μ)** found in the oceans and can impact the carbon sink capacity of the ocean to absorb and sequester carbon dioxide from the atmosphere.
- **Sea-level rise:** Coastal landfills and contaminated sites are increasingly at risk of inundation, releasing toxic substances into marine and coastal ecosystems [15].
- **Wildfires:** As fires intensify, they spread flame-retardant chemicals and release toxins stored in soils and vegetation into the air [15].
- **Vulnerable Communities:** Climate-driven chemical exposures interact with malnutrition, infectious diseases, and heat stress, increasing vulnerability in communities.
- **Healthcare systems:** Combined impacts can strain healthcare systems, particularly in low-resource or highly exposed regions.

CHEMICALS IN PLASTICS AND CLIMATE CHANGE

- Over 98% of single-use plastics are produced from virgin fossil resources
- Plastic production accounts for 3–4% of global greenhouse gas emissions, a share projected to double by 2040 if current trends persist
- Climate impacts occur at every stage of the plastic life cycle:
  - Extraction and refining of oil and gas release large quantities of CO_2 and methane.
  - Polymerisation and conversion processes are highly energy-intensive.
  - Use and disposal release micro- and nano plastics, volatile organic compounds (VOCs), and greenhouse gases when plastics degrade under sunlight or are burned in open dumps and incinerators.
- Plastics act as chemical carriers, leaching additives such as bisphenols, phthalates, flame retardants, and UV stabilisers.
- Newer chemicals from emerging industrial processes may also be mobilised or altered by climate stress, adding further

CHEMICAL EXPOSURE AND HUMAN HEALTH IN A CHANGING CLIMATE

- Climate stressors can worsen chemical-related health impacts by increasing exposure, altering toxic kinetics, and weakening physiological resilience to heat, disease, and environmental stress
- Animal studies show that EDC exposure can impair thermoregulation and reduce an organism's ability to cope with heat, increasing sensitivity to temperature extremes [24]
- PFAS (Per- and polyfluoroalkyl substances) persist in the environment and bio accumulate in humans and wildlife may be aggravated under climate stressors such as heat waves and infectious disease outbreaks

SHARED SOLUTIONS

- Strengthen chemical and waste management
- Phase out persistent chemicals
- Address mixtures and endocrine disruptors
- Reduce plastics production and use
- Promote Circular Economy
- Remediate contaminated sites
- Improving end-of-life management of plastics
- Developing integrated inventories
- Mobilise finance and research

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For more information please contact,

Toxics Link

H-2, Jangpura Extension
New Delhi- 110014
info@toxicslink.org

Supervised by

Piyush Mohapatra; piyush@toxicslink.org

Researched and Compiled by

Tripti Arora; tripti@toxicslink.org