REPORT

PLASTIC WASTE POISONS INDONESIA'S FOOD CHAIN

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NEXUS3 FOUNDATION

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PLASTIC WASTE POISONS INDONESIA'S FOOD CHAIN

Authors
Jindrich Petrlik, MS, Arnika
Yuyun Ismawati, MSc, Nexus3 Foundation
Joseph DiGangi, PhD, IPEN
Prigi Arisandi, M.Si, Ecoton
Lee Bell, MA (ESD), IPEN
Björn Beeler, MSc, IPEN

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IPEN is a global network of public interest non-governmental organizations (NGOs) forging a toxics-free future. IPEN is comprised of over 550 NGOs in more than 122 countries. Together we work to ensure that toxic chemicals and metals are no longer produced, used, or disposed of in ways that harm human health and the environment. IPEN and its Participating Organizations have become a leading force in chemicals and waste regulation and are catalyzing an international movement to promote chemicals without harm and an end to the production of the world's most hazardous substances.

www.ipen.org

Nexus3 or Nexus for Health, Environment, and Development (formerly known as BaliFokus Foundation) is an organization in Indonesia that works to safeguard the public, especially vulnerable populations, from the impact of development to health and the environment, towards a just, toxics-free, and sustainable future.

www.nexus3foundation.org

Arnika Association is a Czech non-governmental organisation established in 2001. Its mission is to protect nature and a healthy environment for future generations both at home and abroad. Since its beginnings, Arnika has worked on protection of consumers from chemically hazardous products.

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ECOTON works to improve access to information, access to participation and access to justice and fighting for the rights to healthy environment and clean water through investigations, empowering pollution victim groups, and litigations.

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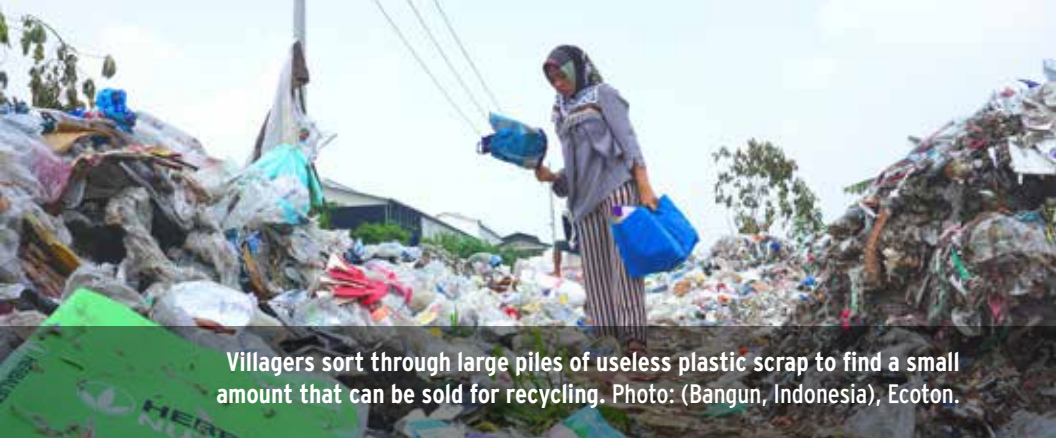
Cover: Bangun, Indonesia (Bottom). Photo: Fulli Syafi Handoko



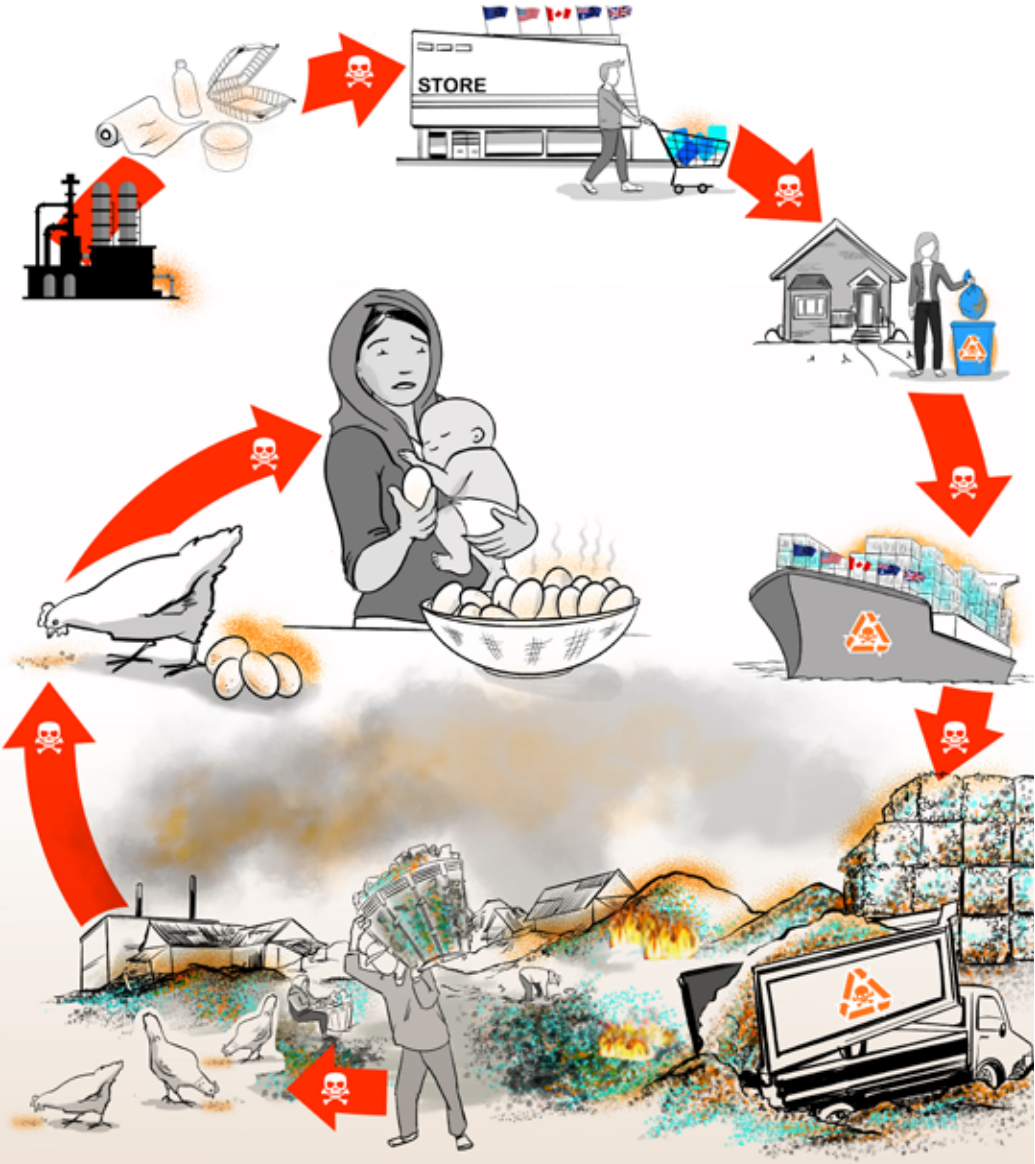
Villagers sort through large piles of useless plastic scrap to find a small amount that can be sold for recycling. Photo: (Bangun, Indonesia), Ecoton.

KEY FINDINGS

Analysis of free-range chicken eggs sampled at two sites in Indonesia where imported plastic wastes are dumped and used for fuel or burned to reduce volume revealed:

- Significant levels of very hazardous chemicals including dioxins, polychlorinated biphenyls (PCBs), polybrominated diphenyl ethers (PBDEs), short-chain chlorinated paraffins (SCCPs) and perfluorooctane sulfonate (PFOS), which are all regulated globally under the Stockholm Convention.
- The second-highest level of dioxins in eggs from Asia ever measured was found in samples collected near a tofu factory in Tropodo that burns plastic wastes for fuel. Dioxin levels were 90-fold higher than the Indonesian regulatory limit.
- The dioxin level in the Tropodo eggs (200 pg TEQ g^{-1} fat) is similar to the highest recorded level of dioxins in eggs from Asia (248 pg TEQ g^{-1} fat), which occurred at the Bien Hoa site in Vietnam, a former US Army airbase where the soil was contaminated by historic Agent Orange use.
- An adult eating just one egg from a free-range chicken foraging in the vicinity of the tofu factory in Tropodo would exceed the European Food Safety Authority (EFSA) tolerable daily intake (TDI) for chlorinated dioxins by 70-fold.
- Eggs collected near a rural plastic waste dump site in Bangun were contaminated by PFOS at levels comparable to highly industrialized areas in Europe. An adult eating just one egg per week from a free-range chicken foraging in the vicinity of the Bangun dump site would exceed the proposed EFSA tolerable weekly intake of PFOS by approximately 1.3-fold.
- Eggs from Tropodo and Bangun contained SCCPs and PBDEs, flame retardant chemicals used in plastics.
- To our knowledge, this is the first study to demonstrate food chain contamination in Southeast Asia with high levels of hazardous chemicals as a consequence of waste mismanagement and poor controls on plastic waste trade.

PLASTIC WASTE POISONS INDONESIA'S FOOD CHAIN



Plastic waste is dumped in communities by paper and plastic recycling importers.

We tested free-range chicken eggs from two communities in Indonesia where imported plastic wastes are used for fuel or burned at waste dumps and found high levels of very hazardous chemicals including dioxins, polychlorinated biphenyl (PCBs), polybrominated diphenyl ethers (PBDEs), short-chain chlorinated paraffins (SCCPs) and perfluorooctane sulfonate (PFOS). All these substances are regulated globally under the Stockholm Convention.

IPEN

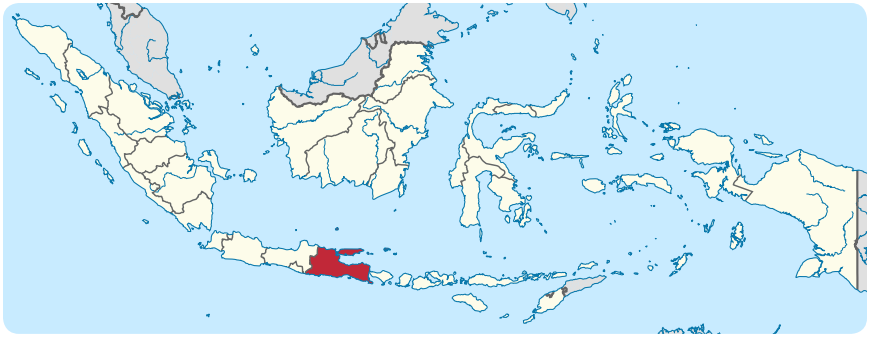
PLASTIC IS A CHEMICAL THREAT

Images of plastic trash on beaches visibly demonstrate widespread pollution, but invisible chemical contamination is a key threat to human health and the environment. For example, most plastics used by consumers contain potentially toxic substances including a variety of additives such as flame retardants, plasticizers, and stabilizers. More than 4000 substances have been identified that are potentially present in plastic packaging or used in manufacturing and at least 148 of them have been identified as hazardous. Toxic chemicals used in plastics can also carry other toxic impurities into products such as children's toys. When plastics are recycled, their toxic chemicals are also recycled into new products including food utensils and children's toys. The export of plastics in e-waste can contaminate the food chain far from where the products were used. As of 2015, approximately 6,300 million metric tons of plastic waste have been produced and only 9% of it was recycled. The industry's response to plastic pollution has been to fight regulation and add to the pollution problem by increasing production. The USD$4 trillion plastics industry currently produces more than 300 million tons of plastic each year and approximately half of it is for single-use items which will quickly become wastes. Vast increases in pollution are likely as the industry sharply increases production with planned investments of USD$164 billion for 264 new plastic production facilities in the USA alone. If these plastic production trends continue, 26 billion tons of plastic waste will be produced by 2050, four times more waste than ever produced historically.

PLASTIC WASTE FLOODS INDONESIA

After China closed the door to plastic waste imports, Southeast Asia became the new destination for developed country exports. For example, in 2018, Indonesia's plastic waste import volume doubled to 320,000 tons compared to 2017, according to UN Comtrade data.[1] The top five exporters of plastic waste to Indonesia in 2018 were Australia, Germany, Marshall Islands, Netherlands, and USA. In addition, Indonesia annually generates ~9 million tons of plastic waste or about 15% of the national waste generated. A World Bank study notes that there is virtually no

1 Rising anger in Southeast Asia over plastic waste dumping has triggered return to sender actions in Cambodia (to Canada, USA); Malaysia (to Australia, Canada, Spain, UK, USA); and Philippines (to Canada, South Korea). Indonesia has returned illegal plastic waste shipments to Australia, New Zealand, Spain, UK, and USA. However, recently Nexus3, BAN, Ecoton, and GAIA revealed that instead of returning wastes to the USA, they were were shipped to India, South Korea, Thailand, and Vietnam.

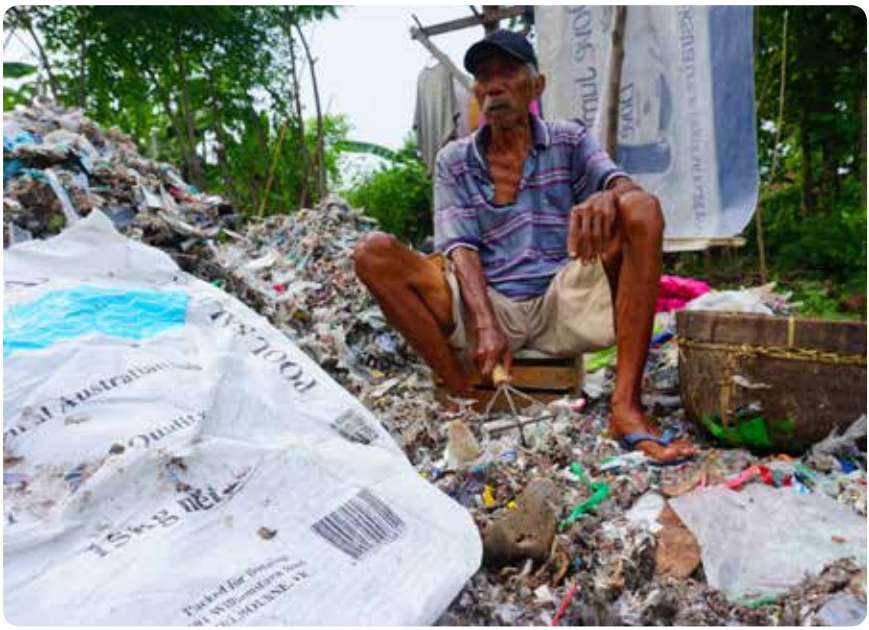


Map of Indonesia showing East Java Province.

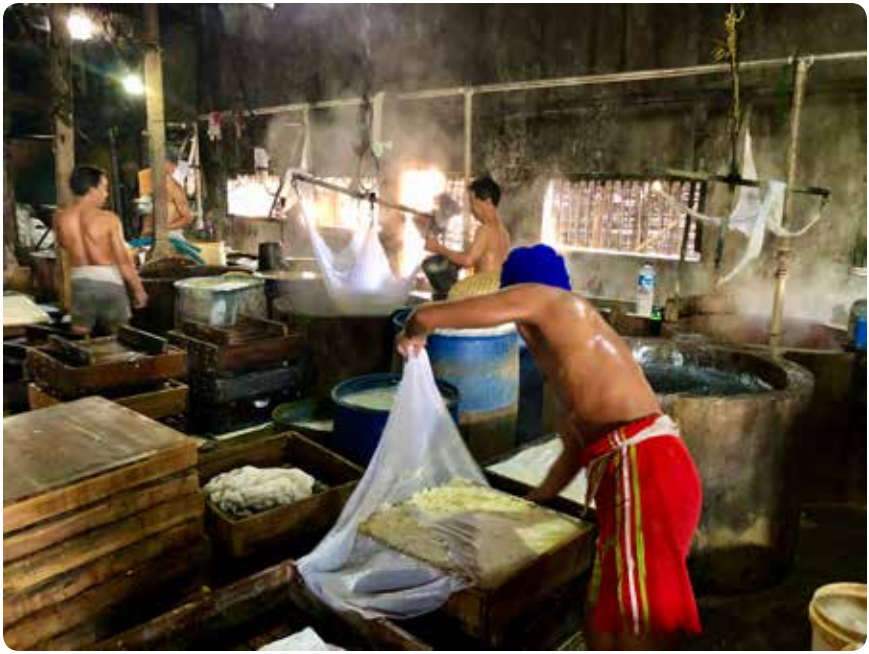
enforcement of solid waste laws and that recycling is largely an informal sector activity (15% of total waste) while formal recycling systems capture less than 5% of the generated waste. Plastic waste ends up in rivers and represents a significant proportion of debris extracted from waterways in all towns, ranging from 20% to 38%.

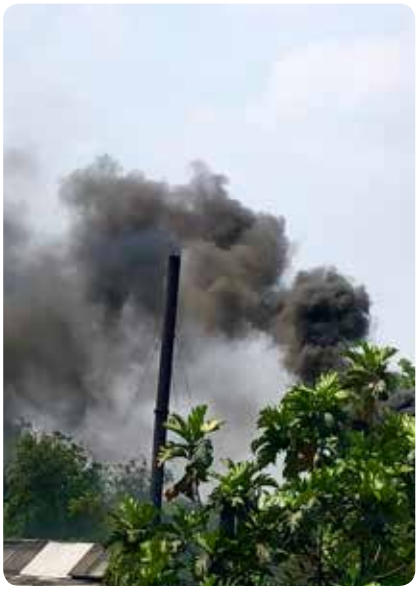
DUMPSITES AND FUEL IN EAST JAVA

Nine paper recycling and manufacturing companies in East Java use about 4 million tons of scrap paper per year as a feedstock to make new sheets of paper for magazines, newspapers, etc. About 63% of this paper scrap is sourced locally and 37% is imported (1.5 million tons). In the past, the imported waste paper materials contained ~2% - 10% plastic scraps. However, in the last 3 years, the proportion of plastic scrap in imported paper bales has sharply increased up to 60% -70%, suggesting that paper scrap is being used to conceal plastic waste dumping. These materials are imported mainly from Australia, Canada, Ireland, Italy, New Zealand, UK and USA. Plastic wastes are either purchased by middle-men and small-scale recyclers, or 'donated' to communities as part of a community development program of the factory. Common destinations for the low-grade plastics are open dumps or tofu factories and chalk/lime processing plants where they are burned for fuel. Bangun and Tropodo are among the impacted villages that are located near the paper companies. They receive more than 50 tons of low-grade plastic every day. In Tropodo, there are 50 tofu factories burning plastic waste for fuel in stoves to create steam. In Bangun, plastic waste is dumped daily and open burning occurs to reduce the volume of plastic wastes.



Villagers live alongside piles of waste. Foreign plastic packaging is commonly found in the piles. Photo: (Bangun, Indonesia), Ecoton





Black smoke billows near villagers' homes from a tofu factory where plastic scrap fuels the furnace to create steam. Photo: (Tropodo, Indonesia), Nexus3

Chickens forage for food, including dried corn and rice husks, in the soil next to a tofu factory where plastic scrap is burned for fuel. Photo: (Tropado, Indonesia), Nexus3.

FREE-RANGE CHICKEN EGGS AS A SIGNAL OF POLLUTION

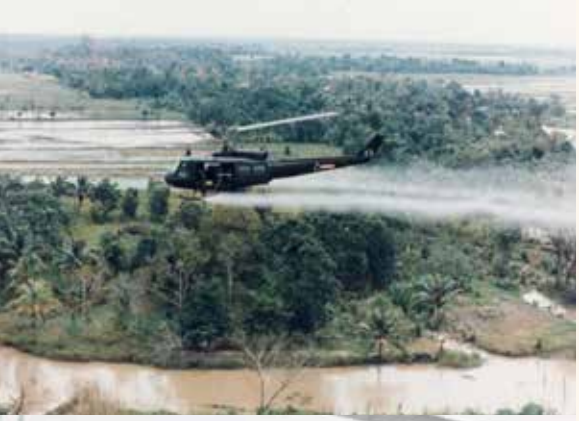
Free-range chickens pick food from among the soil and dust in the local area, ingesting some soil in the process. This makes them active samplers for chemicals present in the soil. Most toxic chemicals known as persistent organic pollutants (POPs) dissolve in fat and accumulate in eggs, which have a significant lipid content. Therefore, free-range chicken eggs can be used to reveal and measure POPs pollution. The chemical content can reveal an important food chain exposure pathway from a pollution source to soil to eggs. To investigate whether plastic waste contaminates the food chain in Indonesia, free-range chicken eggs were collected near sites of plastic waste dumping and burning in Bangun and Tropodo and analyzed for a variety of toxic chemicals.

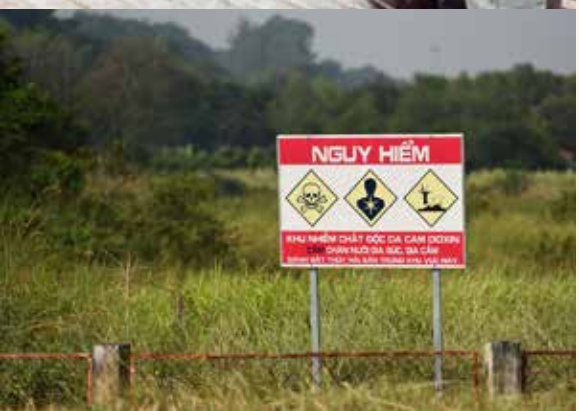
RECORD-SETTING DIOXIN LEVELS

The second-highest level of dioxins in eggs from Asia ever measured was found in samples collected near a tofu factory in Tropodo that burns plastic wastes for fuel. The dioxin level in the Tropodo eggs (200 pg TEQ g^{-1} fat) is similar to the highest level of dioxins in eggs from Asia (248 pg TEQ g^{-1} fat) which occurred at the Bien Hoa site in Vietnam, a former US Army airbase where the soil is contaminated by historic Agent Orange use. An adult eating just one egg from a free-range chicken foraging in the vicinity of the tofu factory in Tropodo would exceed the European Food Safety Authority (EFSA) tolerable daily intake (TDI) for chlorinated dioxins by 70-fold. The typical daily egg consumption per person in Indonesia is less than one egg a day, but even eating 12 grams of egg a day would exceed the EFSA TDI by more than 20-fold. The eggs from Tropodo also exceeded the EU regulatory limit for dioxins by 80-fold and the Indonesian regulatory limits for dioxins and dioxin-like PCBs in eggs by more than 90-fold.

The eggs sampled from the Bangun dump site contained 10.8 pg TEQ g^{-1} dioxins and 13.9 pg TEQ g^{-1} dioxins and dioxin-like PCBs. This is more than four times higher than the EU regulatory limit for dioxins and more than five times higher than the Indonesian regulatory limit for dioxins and dioxin-like PCBs. The difference in dioxin levels at the two sites could reflect the constant plastic burning in tofu factories compared to the more variable situation at the Bangun dump site. Note that the chemical content in the tofu itself was not measured but considering that it is likely that the soil around the factories has become contaminated by airborne emissions it would be sensible for authorities to test the tofu. Indonesia's 2014 National Implementation Plan for the Stockholm Convention recorded that the total release of dioxins and furans in Indonesia reached 9,881 g TEQ (2013) with the highest contribution from open burning (5,547.2 g TEQ). Due to a lack of sampling and analysis capacity, POPs monitoring has never been conducted in Indonesia.[2] The Stockholm Convention requires minimization and, where possible, elimination of dioxins. The treaty has identified dioxin sources including uncontrolled burning (illustrated at the Tropodo and Bangun sites) and waste incinerators. The Indonesian government has proposed building waste incinerators to tackle plastic waste in 12 cities. However, Convention guidelines note that,

2 Note that Ministry of Environment and Forestry Decree No. P.15/2019 only requires monitoring of dioxin and furan emissions from new thermal power plants every five years. However, this regulation requiring infrequent monitoring is not applicable to the tofu factories in Tropodo because it is limited to new power plants.





BIEN HOA'S AGENT ORANGE LEGACY

The US sprayed more than 80 million liters of dioxin-contaminated Agent Orange as a defoliant during the Vietnam war, severely affecting the health of three generations of Vietnamese people. Dioxin contamination resulted in severe birth defects and as many as one million have disabilities that may be attributable to Agent Orange. At the US military base in Bien Hoa, barrels of Agent Orange were loaded onto planes for spraying and thousands of liters leaked from storage tanks or were spilled. In 2019, the US and Vietnam began a 10-year cleanup of the site, one of the biggest and most complicated remediation projects in the world. The dioxin level in the Tropodo, Indonesia eggs is similar to the highest level of dioxins in eggs from Asia, which occurred at the Bien Hoa site in Vietnam.

> *"When considering proposals to construct new waste incinerators, priority consideration should be given to alternatives such as activities to minimize the generation of waste, including resource recovery, reuse, recycling, waste separation and promoting products that generate less waste."*

Numerous epidemiology studies have revealed a variety of human health effects linked to chlorinated dioxin exposure including cardiovascular disease, diabetes, cancer, porphyria, endometriosis, early menopause, alteration of testosterone and thyroid hormones, and altered immune system response, among others.

TOXIC FLAME-RETARDANT CHEMICALS

Eggs from both Tropodo and Bangun contained flame retardant chemicals used in plastics such as SCCPs and PBDEs. A 2017 study of 60 plastic children's products from 10 countries found SCCPs in 45% of them. The same year, governments added SCCPs to the Stockholm Convention for global elimination. SCCPs are toxic to aquatic organisms at low levels, disrupt endocrine function, and are suspected to cause cancer in humans.

PBDEs in plastic products are recycled into new products including food utensils and children's toys. The most common members of the PBDE family have been banned by the Stockholm Convention including commercial mixtures of PentaBDE (2009), OctaBDE (2009) and DecaBDE (2017). PBDEs have adverse effects on reproductive health as well as developmental and neurotoxic effects. DecaBDE and its degradation products may also act as endocrine disruptors.

CANCER-CAUSING "FOREVER CHEMICALS"

Eggs from the rural dump site in Bangun were also contaminated by PFOS and other per- and polyfluoroalkyl substances (PFAS) leaking from wastes at levels comparable to highly industrialized areas in Europe.

A couple in Bangun village collect plastic scraps to sell. The small amount of recyclable plastics are bought by recyclers, low-grade scrap is sold to local factories for fuel. Photo: (Bangun, Indonesia), Nexus3

PFAS is a large class of more than 4,500 very persistent fluorinated chemicals (including PFOS) that have been widely used in packaging, textiles and plastics. EFSA has proposed sharply lowering the permitted intake of PFOS from 150 ng/kg body weight/day to 6 ng/kg body weight/week. An adult eating just one egg from a free-range chicken foraging in the vicinity of the Bangun dump site would exceed the proposed tolerable weekly intake of PFOS by approximately 1.3-fold.

PFOS was added to the Stockholm Convention in 2009 and another member of the chemical family, PFOA, was added to the treaty in 2019. In animal studies, PFOS causes cancer, neonatal mortality, delays in physical development, and endocrine disruption.

Higher maternal levels of PFOS and PFOA are associated with delayed pregnancy and damage to male reproductive health. In humans, PFOA is associated with high cholesterol, ulcerative colitis, thyroid disease, testicular cancer, kidney cancer, pregnancy-induced hypertension, and immune

system effects and it is transferred to the fetus through the placenta and to infants via breast milk. An investigation of PFAS substances in Indonesia found that they are unregulated and contaminate coastal sediments and breast milk.

IMPLEMENTING NEW BASEL CONVENTION CONTROLS

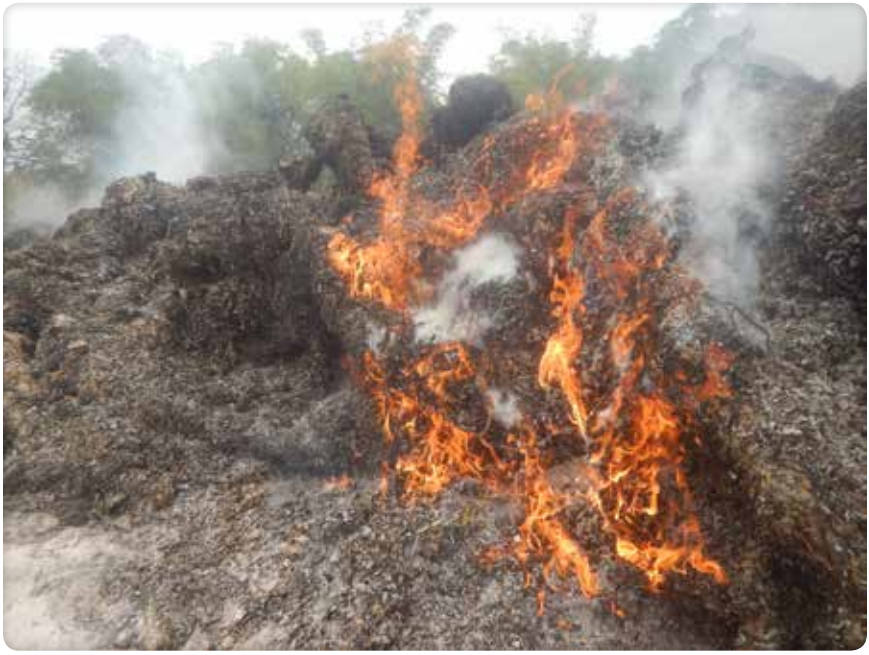
The toxic consequences of plastic waste imports into Indonesia demonstrated in this study provide strong justification for action under the Basel Convention. A complete ban on plastic waste imports is another possible measure. Enforcement will be important for either option.

In May 2019, the Fourteenth Conference of the Parties to the Basel Convention (COP14) agreed by consensus to bring most plastic wastes under the control regime of the treaty. The decision takes effect on 1 January 2021 and is expected to have a major impact on global plastic waste flows and production. First, governments created a listing for hazardous plastic waste which is subject to all treaty control procedures. Second, export of mixed or contaminated plastic wastes (relevant to this study) will require prior informed consent, granting Indonesia and other importing countries the right to refuse the shipment. Only a few narrow exemptions for non-hazardous, non-PVC, clean unmixed and uncontaminated plastic wastes can be exported freely, and only for recycling – not burning or landfilling. However, these exemptions also include fluorinated polymers made with PFAS substances. Growing public health concerns about PFAS substances and the data in this study showing contamination of eggs with PFAS substances indicates that this exemption should be ended. Currently, a Basel Convention Small Intersessional Working Group is examining this issue and will make recommendations to Basel COP15 on the matter.

On 5 December 2019, the Basel Ban Amendment will enter into legal force. This Amendment will help protect Indonesia because it prohibits Parties who are OECD Member Countries, EU Member States, and Liechtenstein from exporting hazardous wastes to the rest of the Parties. In addition, the EU incorporated the treaty annex that will contain most plastic wastes into its Waste Shipment Regulation, meaning that as of 1 January 2021, EU Member States will be prohibited from exporting mixed or contaminated plastic wastes to Indonesia and most other developing and transition countries. Indonesia ratified the Ban Amendment in 2005 and played a key role in establishing it within the treaty.

STRENGTHENING THE STOCKHOLM CONVENTION WASTE PROVISIONS

This study demonstrates the presence of POPs substances in chicken eggs that are regulated under the Stockholm Convention such as dioxins, PCBs, PBDEs, SCCPs, and PFOS. Unintentional production of dioxins and PCBs should be addressed under the treaty by preventing uncontrolled combustion. Provisions under the Stockholm Convention may also allow control of POPs present in plastic and paper waste such as SCCPs, PBDEs, PFOS and PFOA by using stricter limit values to define POPs wastes (known as low POPs content levels). Wastes with levels of these substances over the limit must be destroyed and not exported. However, currently the threshold values are weak, and therefore allow exports of large volumes of POPs in wastes across borders from developed countries.



Villagers in Bangun burn piles of useless plastic scrap to reduce the volume of waste. Photo: (Bangun, Indonesia), Nexus3

RECOMMENDATIONS

This study links waste mismanagement and uncontrolled movement of plastic waste with contamination of the food chain in Indonesia. Bangun and Tropodo are just two examples of many similar sites in Southeast Asia. Measures to address this issue include:

- Inform relevant communities about the results of this study, including a government recommendation against eating or selling free-range chicken eggs until cleanup actions and further testing demonstrate that the eggs are safe to consume.
- Prohibit combustion as a disposal option for plastic waste or as an example of the 'circular economy.' It should not be accepted as a best practice for plastic waste management.
- Prohibit the combustion of plastics as a fuel for industrial operations due to the dioxin and other halogenated pollution generated in emissions and ash.
- Restrict the use of halogen-containing synthetic fuels derived from plastics due to the persistent organic pollutants that would occur in emissions of burning such fuel.
- Remediate sites contaminated with dioxins and other POPs to ensure that human health is protected and food chain contamination cannot occur.
- Increase monitoring of POPs chemicals in compliance with Stockholm Convention provisions along with other pollutants of concern.
- Update the Indonesian Stockholm Convention National Implementation Plan to evaluate the effectiveness of preventive measures and control of POPs in Indonesia.
- Strictly apply the new provisions of the Basel Convention to block hazardous waste imports and control transboundary movement of plastic wastes or enact a ban on plastic waste imports.
- Introduce stricter, more protective limits for POPs in wastes in the Stockholm Convention.
- Enact a stronger international Beyond 2020 chemicals framework that includes work to reduce and eliminate PFAS as a class.
- Reduce and minimize plastic production and use and avoid the use of halogenated plastics or the addition of halogenated compounds in plastic production such as bromine, chlorine and fluorine.

THE DATA

TABLE 1: TOXIC CHEMICALS IN EGGS FROM TROPODO AND BANGUN (ng G^{-1} FAT)

Substance	Tropodo	Bangun	Bangkok super-market control	Indonesia limit	EU standard / limits
Number of eggs in pooled sample	3	3	6		-
Fat content (%)	15	13	11.6		-
PCDD/Fs (pg TEQ g^{-1} fat)	200	10.8	0.1		2.50
DL PCBs (pg TEQ g^{-1} fat)	32	3.1	0.001		-
Total PCDD/F + DL PCBs (pg TEQ g^{-1} fat)	232	13.9	0.1	2.50	5.00
Total PCDD/Fs + DL PCBs - DR CALUX (pg BEQ g^{-1} fat)	560	21	-		-
PBDD/Fs (pg TEQ g^{-1} fat)	< 21.3	< 21.3	< 21.3		-
HCB	5.5	2.7	< 0.2		-
PeCB	1.9	1.1	< 0.4		-
HCBD	< 0.1	< 0.1	< 0.4		-
7 PCB	5.3	15.4	0.22		-
6 PCB	4.4	12.3	0.22		40.00
SCCPs	65	153	-		-
sum HCH	0.8	0.9	2.2		-
sum DDT	10.8	4.3	< LOQ		-
sum of PBDEs	65	91	3.1		-
sum of PFASs (ng g^{-1} of fresh weight)	2.7	26	-		-
L-PFOS (ng g^{-1} of fresh weight)	0.9	15.4	-		-

Pooled samples of 3 egg samples were collected at each of the selected sampling sites in order to obtain more representative samples. Two samples from Indonesia and one pooled sample of commercial eggs (non-free-range) from Bangkok were assessed for polychlorinated dibenzo-p-dioxins and dibenzofurans (PCDD/Fs) and dioxin-like polychlorinated biphenyls (dl-PCBs) using the DR CALUX method. These were sent to a Dutch ISO 17025 certified laboratory (BioDetection Systems B.V., Amster-

dam) performing the cell-based screening analysis DR CALUX according the European Standard EC/644/2017. The DR CALUX bioassay method is proven as cost-efficient semi-quantitative effect-based toxicity screening analyses for all kinds of stable dioxin-like compounds (PCDD/Fs, dl-PCBs, PBDD/Fs, PBBs, chlorinated and brominated polycyclic aromatic hydrocarbons, and N-dioxins).

To allow congener differentiation, all pooled egg samples from Indonesia as well as the pooled eggs sample from the Bangkok supermarket were analyzed for content of individual PCDD/Fs and an extended list of PCB congeners by HRGC-HRMS at the accredited laboratories Münster Analytical Solutions (MAS) Gmbh in Münster, Germany. All samples were also analyzed for content of non-dioxin-like (indicator) PCBs (iPCBs), DDT and its metabolites, hexachlorocyclohexanes (HCHs), hexachlorobutadiene (HCBD), pentachlorobenzene (PeCB) and hexachlorobenzene (HCB) in a Czech certified laboratory (University of Chemistry and Technology in Prague, Department of Food Chemistry and Analysis).

The eggs from Bangun, Tropodo and a Bangkok supermarket were also analyzed for PBDEs, HBCD and short chain chlorinated paraffins (SCCPs). All of these analyses were conducted in a Czech certified laboratory (Institute of Chemical Technology, Department of Food Chemistry and Analysis). The samples of free-range chicken eggs in this report were sampled during April of 2019. The analyses of eggs from Indonesia were conducted in European laboratories in the period between June and September 2019.

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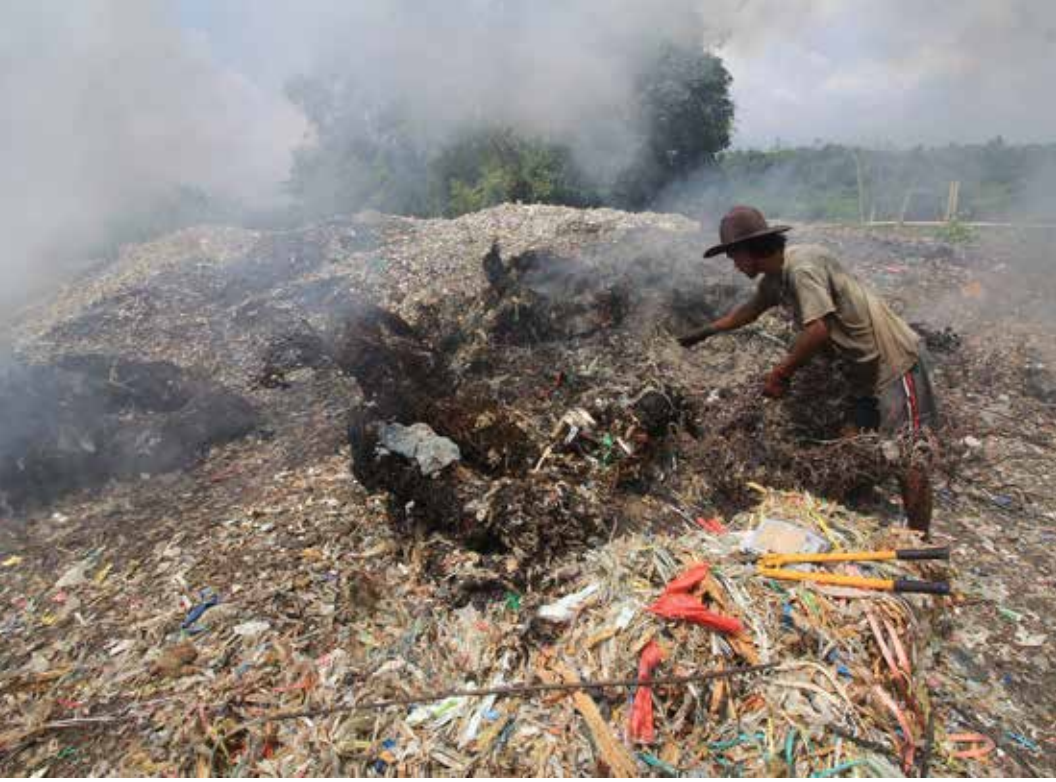

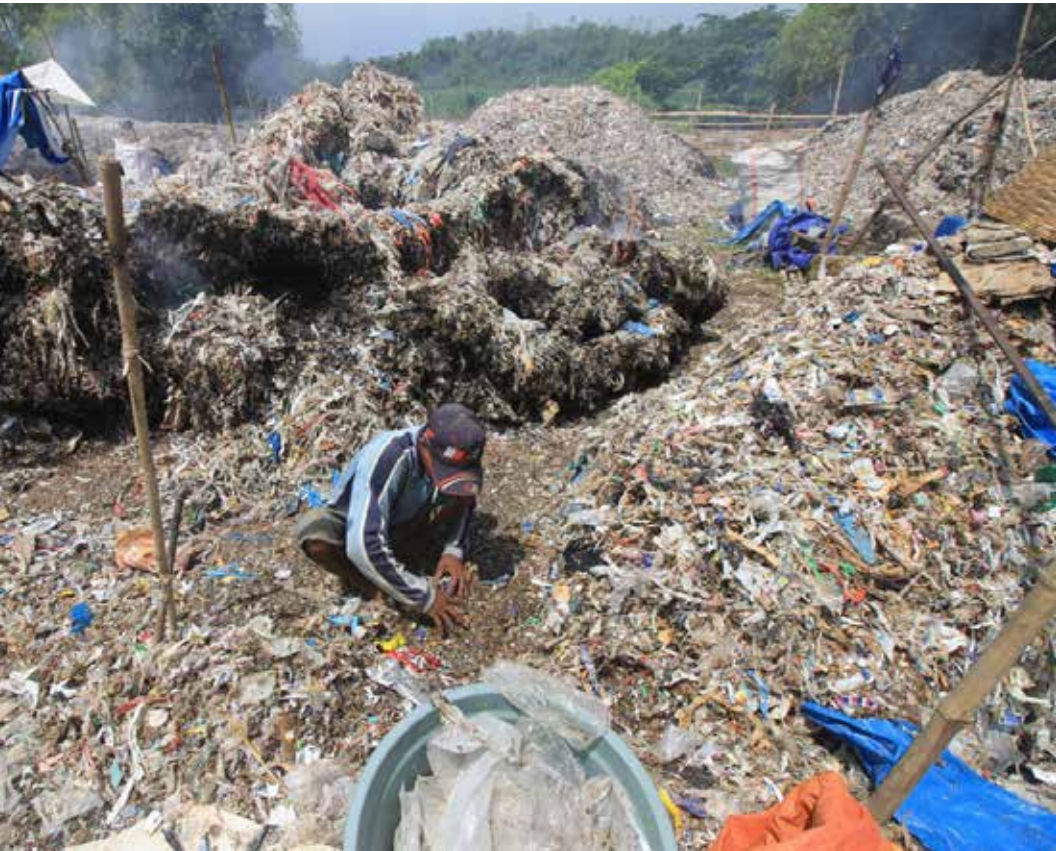

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