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CHEMICALS AND HUMAN AND ENVIRONMENTAL HEALTH

The need for an international panel on chemical pollution

Joan O. Grimalt

A key element in the improvement of human living conditions brought about by the Industrial Revolution was the synthesis of new chemical compounds, such as dichlorodiphenyltrichloroethane (DDT). These innovations had positive effects on humans and, indirectly, on some ecosystems, such as wetlands. However, many of these compounds also had harmful effects on both humans and wildlife, which were only discovered decades after they were first used. Now, an international group of scientists has proposed the creation of a body similar to the International Panel on Climate Change to study the compounds being produced and to provide social and political managers with the information required to avoid these problems. The United Nations Environment Assembly has decided to create this body.

Keywords: **science and policy**, **DDT**, **wetland preservation**, **chemical compound governance**, **international management bodies**.

The history of chemistry, like the history of humankind, is a succession of trials, errors, corrections, and new attempts. The use of chemical compounds to control agricultural pests is a good example of this paradigm. A large area of land devoted to a monoculture creates an ideal ecosystem for the development of insects or other specialised pests. Preventing this is not easy and the battle has evolved as our knowledge of chemical compounds and their properties has progressed.

In the past, an effective way to control some pests was to treat certain plants with copper or iron sulphate. This was such a common practice that the word *sulfatar* is sometimes used in Catalan as a generic term for any treatment with insecticidal or fungicidal compounds. As you can imagine, these compounds are not always as effective as they should be, and copper is also toxic. Faced with the need to use other compounds, even arsenic was used in many cases. Can you imagine consuming a product treated with arsenic? Incorrect treatment and cleaning of the compound can represent a big risk for consumers as well as for farm employees.

«Chemical pollution can cause a wide range of adverse effects on human health and ecosystems»

In this context, an innovative product appeared, popularly known as DDT (dichlorodiphenyltrichloroethane), which is a specific neurotoxicant for organisms with a relatively simple nervous system and thought to be non-toxic to warm-blooded animals (birds and mammals). This compound was used extensively in the 1950s and 1960s and was an essential element in the elimination of *Anopheles* mosquitoes in many areas. Thus, it

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Courtesy of the Science History Institute

Cruz Verde

On the left, advertisement for DDT by the American company Pennsalt, published in *Time* on 30 June 1947, before the harmful effects on human and animal health were known. DDT also became popular in Spain, even in products intended for children, as seen in the image above advertising hair cologne to kill lice and other insects.

was also important in the eradication of malaria, a disease caused by eukaryotes of the genus *Plasmodium*, specifically *P. falciparum*, transmitted by female *Anopheles* sp. mosquitoes when they bite another organism. By eliminating these mosquitoes, the chain of infection was broken and malaria was eradicated almost everywhere in Europe. For example, in Spain, malaria was considered eradicated in 1964. In addition to malaria, plasmodia transmitted other diseases such as tertian fever (*P. vivax*) and quartan fever (*P. malariae*) – common among agricultural workers – which also disappeared with the elimination of *Anopheles*. In 1948, the Nobel Prize for Medicine was awarded to Paul H. Müller for proposing the use of DDT to eliminate *Anopheles* mosquitoes and malaria and it is clear that DDT has saved many millions of lives. As of 2005, the World Health Organization still recommends its use to control malaria in countries where it remains endemic, mainly in tropical Africa.

This compound also had a positive effect on wetlands, as people no longer considered them unhygienic and dangerous to their health, because the risk of contracting malaria from living near them had been eliminated. Today, these ecosystems are considered wonderful places because of their rich wildlife, especially in terms of bird species. Despite this, in the 19th century, every effort was made to dry them up and use them for agriculture. Indeed, the Catalan word *paludisme* means malaria and refers explicitly to wetlands (it comes from the Latin word *palus*, meaning 'swamp' or 'marsh'). In Europe today, the largest bird reservoirs are found in river deltas: Guadalquivir (Doñana National Park, Spain), the Ebro and Danube, and coastal lagoons (such as the Albufera Natural Park in Valencia, Spain). In other words, wetlands that could not be dried out because they received too much water. In the 19th century, living in these areas meant being exposed to malaria and the other fevers mentioned above. Hence, if people lived there, it was because they had nowhere else to live.

In 1962, Rachel Carson published *Silent spring*, in which she argued that the indiscriminate use of DDT and other pesticides would lead to a day when all birds would disappear and spring would be silent. This book had a huge impact, despite the fact that many people went to great lengths to discredit the author. But she was right. It was not true that DDT had no effect on warm-blooded organisms. In the case of birds, exposure to DDT made eggshells thinner, and so many eggs were lost (Hellou et al., 2012). Later, many more health problems associated with DDT were observed, including in humans (Bravo et al., 2019; Longnecker et al., 2001), leading to its inclusion on lists of banned compounds (such as the Stockholm Convention), except in areas where malaria is still endemic. In these cases, it can still be used for health rather than agricultural purposes.

«DDT is one of the clearest examples of a chemical compound that has had very important advantages and disadvantages»

One of the problems with DDT is its persistence in the environment once used, which is very strong in the case of its main metabolite, popularly known as DDE (dichlorodiphenyldichloroethylene). In fact, almost everyone in the world has some concentration of DDE in their bloodstream and in most cases, it is the most abundant organochlorine compound found (Beard, 2006; Longnecker et al., 1997; Vizcaino et al., 2011). The compound can travel long distances through the

atmosphere without being degraded, so it is present in all humans, not just those who have lived near rural areas (Arellano et al., 2015; Grimalt et al., 2001; Wania & Mackay, 1993).

DDT is one of the clearest examples of a chemical compound that has had very important advantages and disadvantages, as illustrated by the trial and error sequence we mentioned above. Replacing DDT with other insecticides, which we will not go into here, may have saved many birds from extinction, but we now face a very real problem: the decline of flying insects everywhere as a result of the massive use of these new compounds. Think of how many insects hit your windscreen while driving 20 years ago and how many do now. This reduction can cause a lot of problems with crop fertilisation because many of these insects are pollinators.

There are many other cases, unrelated to pesticides, where a compound has shown interesting properties but has had to be banned because of adverse health effects. Moreover, the problems are not only limited to the use of compounds, but also to their presence in our waste products. When chemicals and waste are mismanaged, not only are valuable resources lost, but chemical pollution can cause a wide range of adverse effects on human health and ecosystems at the local, regional, and global scales.

Smithsonian Institution

In 1962 the biologist Rachel Carson published *Silent spring*, in which she argued that the indiscriminate use of DDT and other pesticides would lead to a day when all birds would disappear and spring would be silent.

HOW CAN WE BREAK THE CYCLE OF TRIAL AND ERROR WITH CHEMICAL COMPOUNDS?

The first step is to formulate the problem. The number of synthetic chemical compounds in use today exceeds 600,000. Growth has been exponential, from around 3,000 compounds in 1900 to the current figure. Conversely, the global sales of chemical products exceeded US$5.6 billion in 2017, and this figure is expected to double by 2030 (Llanos et al., 2019). In terms of waste generation, the contribution of plastic materials to the oceans was around 5–13 million tonnes in 2010 and is expected to reach around 100–250 million tonnes by 2025 (United Nations Environment Programme, 2019). The challenge is significant.

Consortia of many countries, such as the European Union, have established regulatory and policy frameworks to properly manage chemicals and the waste associated with human activities and to minimise adverse effects on human health and the environment. These frameworks are being complemented and extended by joint international action, particularly in relation to pollutants that can be transported over long distances through air, water, and biota, and those that cross national borders through international trade in resources, products and waste.

Other important international actions include the Vienna Convention for the Protection of the Ozone Layer and its Montreal Protocol; the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal; the Stockholm Convention on Persistent Organic Pollutants; the Minamata Convention on Mercury; the Convention on Long-Range Transboundary Air Pollution; and the Arctic Monitoring and Assessment Programme. The activities of international organisations such as the United Nations Environment Programme (UNEP), the World Health Organization (WHO), and the Food and Agriculture Organization (FAO) must also be considered. In addition, certain international consortia, such as the European Union, have also

CDC

This image shows the disinfection of an American soldier with DDT. This compound was not considered harmful to warm-blooded animals, so why not use it to kill parasites on troops?

started initiatives such as the Registration, Evaluation, Authorisation, and Restriction of Chemicals (REACH) to prevent toxic effects. The European Food Safety Authority (EFSA) and the European Chemicals Agency (ECHA) are also worth mentioning. As far as the US is concerned, the Environmental Protection Agency (EPA) is a well-recognised body, and we could mention several others whose activities are very positive, but not sufficiently extensive.

KEY ISSUES NOT ADEQUATELY ADDRESSED

The global reach of existing management bodies is inadequate and fragmented compared to the large and growing universe of chemicals and waste. There is still a need for generic organisations that will allow us to address the problem of pollution in a holistic way. The lack of scientific and policy coverage of many issues related to chemicals and waste limits the ability of the international community to identify and address important issues in a timely and informed manner (Scheringer et al., 2006). In some cases, the lack of thorough scientific assessments has also led to deliberate misrepresentation of scientific information because of conflicts of interest (Karlsson, 2019; Lawrence, 2020).

Monitoring and early warning mechanisms are also needed. Most existing bodies are not responsible for regularly monitoring scientific developments and responding to early information on chemical and waste-related risks. For example, the Persistent Organic Pollutants Review Committee (POPRC) of the Stockholm Convention only begins its assessments after a Party to the Convention nominates a particular chemical for potential monitoring. There are also no mechanisms for drawing attention to alerts from interested parties on specific issues. As a result, the ability of the international community to identify emerging problems is limited. In contrast, the increase and rapid diversification of chemicals, both in terms of its use and as waste, requires continuous monitoring and proactive assessment.

There is also a lack of two-way communication. Policy makers are informed about scientific evidence on specific issues, but there is no mechanism for this to happen the other way round. This means that policy needs for specific scientific information are often scattered across numerous documents from different organisations, which are usually not read or even accessible to the scientific community. Thus, this lack of communication between policy and science makes it difficult for the scientific community to respond to societal needs with timely research.

The participation of scientists and professionals (e.g., lawyers or doctors), especially academics, in science-policy interactions on chemicals and waste is limited. This is partly because of the specific areas of responsibility of chemical institutions, the roles they play, and the lack of opportunities for scientists and practitioners to work together. Inadequate engagement and participation reduces the visibility and importance of collaborative work between scientists, policymakers, and the international governance of chemicals and waste in general. In the case of researchers, this collaborative work on chemicals and waste is often not recognised or rewarded compared to the time spent authoring scientific papers. This further discourages participation. Conversely, industry lobbies often interact with policy makers.

In many cases, waste is not properly managed and both solids and liquids end up in ecosystems and often, in the sea. Moreover, processes are not regularly

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The electrochemical plant in Flix (Tarragona) synthesised the highest amounts of DDT in Spain. The picture shows the double sheet pile wall used to prevent the downstream transport of waste at the start of the excavation in a programme to recover the river bed that has now been completed.

designed to deal with the composition of the waste. Furthermore, the transfer of waste from developed to developing countries exacerbates the problem. The latter do not have the necessary technology to treat it and their environmental regulations are usually laxer. In the European context, waste has also been imported, ostensibly to be treated. Instead, profits have been made by burying it inadequately. In addition to local pollution, poorly managed waste can become a source of regional or global pollution.

SOLUTIONS

Faced with these shortcomings, scientists from the Swiss Federal Institute of Technology in Zurich, the Universities of Aachen, Gothenburg, Antwerp, Toronto, Rhode Island, Boston, and Masaryk, the Spanish Institute of Environmental Assessment and Water Research (IDAEA-CSIC), and the International Panel on Chemical Pollution (IPCP) proposed the creation of an international scientific

«The number of synthetic chemical compounds in use today exceeds 600,000»

assessment organisation for environmental pollutants and waste, equivalent to the International Panel on Climate Change (IPCC) and the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) (Wang et al., 2021).

Although the institutional design of this proposed body should emerge from a process of international negotiation, scientists from the aforementioned institutes have identified four basic features to ensure its scientific credibility, legitimacy, and political relevance.

First, it would need to be established as an intergovernmental body, for example under the joint auspices of organisations such as the UNEP and WHO. Such organisations can ensure the relevance of its work programme and the official status of its scientific assessments. Civil society and industry organisations

could participate as observers, providing experience and knowledge. Second, it should have clearly defined roles and responsibilities, a strict conflict of interest policy and rigorous peer review process. This is essential to develop objective, independent, and transparent work with credibility and legitimacy. Thirdly, it must ensure broad participation of scientists and experts, with a balanced and diverse representation of relevant natural and social science disciplines, as well as gender and geographical equality. This structure would help to break stereotypes and allow for comprehensive, authoritative and widely usable assessments. Finally, there is a need for active communication of their findings to policy makers, the wider scientific community (including funding agencies), stakeholders, and the general public. This would help to increase general awareness and participation in more rational management of chemicals and waste.

The scientific community widely backed the proposal and a supporting website organised by the IPCP collected around 2,000 signatures from most countries. It also received a positive response from the United Nations Environment Assembly (UNEA), which, while hosting in Nairobi from 28 February to 3 March 2022, decided to establish an international organisation for the scientific assessment of environmental pollutants and waste (through Resolution 5/8) and to set up a working group to define its functions and structure.

The outlook is therefore optimistic, given that this body should also 1) identify the issues of most concern to policy makers and, where possible, propose options based on empirical evidence to address them; 2) assess current problems and identify potential solutions, particularly those relevant to developing countries; 3) provide up-to-date and relevant information; identify key knowledge gaps in scientific research; encourage and support communication between scientists and policy-makers; explain and disseminate results to different audiences; and raise public awareness; and 4) facilitate the exchange of information between countries, especially developing countries.

The creation of this international organisation for the scientific assessment of environmental pollutants and waste is very good news and the *political sphere* has responded positively to the demands made by the *scientific sphere*. Indeed, there have been very few examples of this level of agreement to date. It must be hoped that the creation of this body will avoid mistakes like those made with DDT. If proper scientific advice had been available, malaria might have been eradicated using other insecticides that would not have harmed birds as much, and the bioaccumulation of DDT and its metabolites in humans might have been avoided.

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