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A safer, cleaner environmental future

University of South Australia

Centre for Environmental Risk Assessment and Remediation

Global Contamination Initiative

A proposal for a new global initiative addressing one of the most serious threats to our planet and our future

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1 Background

Contamination by the chemical products and byproducts of human activity is one of the most pervasive and far-reaching impacts that we have upon the Earth and upon our own health and wellbeing. Traces of anthropogenic contamination are now found from the stratosphere to the deep oceans, from pole to pole, in many forms of wildlife, in all modern societies, in the food chain, and in most individuals, including newborns. It is estimated that there are over 3 million contaminated sites worldwide, chiefly in urban areas, of which the vast majority are un-remediated. Many such sites are contaminated with hydrocarbons that release toxic volatiles that pose significant risk to people in residential and commercial areas. In addition, modern homes and offices may themselves emit toxic vapours which harm their inhabitants every day.

Rockstrom et al (Nature 461, 2009) identified chemical contamination as one of the ten 'planetary boundaries' that humanity, for its own sake, ought not to transgress. However, owing to a lack of data, they were unable to quantify the extent of global contamination, its effects or where to set the boundary:

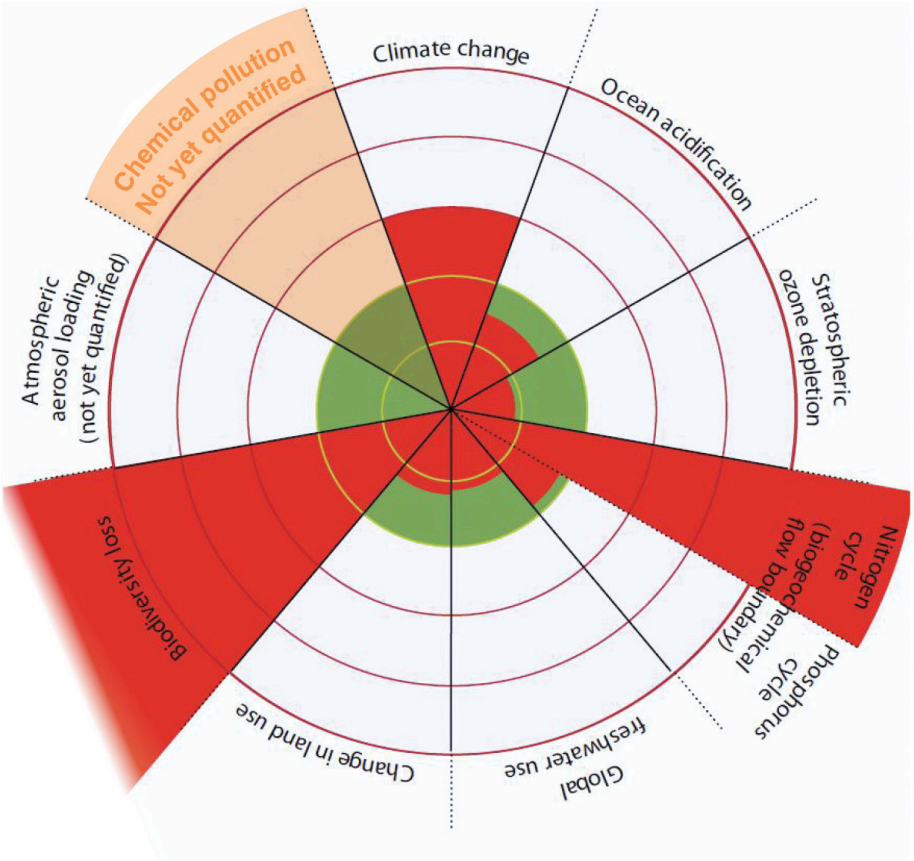

Figure 1. The ten plantary boundaries, including yet-to-be-quantified chemical pollution. Green shading represents the 'safe operating space'; red shading represents the current status of each boundary. From Rockstrom *et al* (*Nature* 461, 2009).

In the argument of Rockstrom et al, chemical contamination is as significant as climate change, nutrient pollution, biodiversity loss, or any of the other major impacts of human population growth and development upon the Earth's biosphere, human health and wellbeing. Furthermore, it is likely that the effects of chemical contamination on the biosphere are exacerbated by these other impacts.

The six main pathways by which toxic substances now travel around the planet are:

- water (rivers, lakes, groundwater, oceans and airborne droplets)
- soil (and thence into crops, pastures, livestock and the food chain)
- the atmosphere (as gases, dusts and aerosols)
- people (most humans now carry a lifelong burden of contaminants)
- trade of manufactured goods and food, both legal and illegal
- wildlife, including birds, fish, animals, insects, plants and microbes.

The UN Environment Programme estimates current world chemical output at 20 million metric tonnes, about a third of which is thought to be toxic or carcinogenic. This is growing at a rate of about 3% per year. In addition, the mining, construction and energy sectors produce in total hundreds of millions of tonnes of tailings and waste, which is often toxic.

Much has been achieved by individual countries in defining the effects and limits for individual compounds or substances in food, drinking water, air and the human environment, as well as in the regulation of these. However, there remain significant gaps in our understanding of the compounding effect of the combined chemical assault on human health in particular and on biology generally, and of its growing dispersal throughout the Earth System.

Furthermore, many manufacturing countries either lack effective regulations or do not enforce them, yet their products are traded globally. And even in the best-run jurisdictions, both knowledge and regulation lag far behind the generation of novel chemical compounds, nanoproducts and electronic waste, and their release into the biosphere. The rate of clean-up of polluted sites remains far below what is needed to protect environmental and human health.

Earth System Science

A relatively new scientific discipline, Earth System Science aims to provide the knowledge needed to reach a balance between the needs of the people on Earth and the physical and biological limits of our planet. Intrinsic to this is the need to understand with precision exactly what the main human impacts are, any adverse consequences and, if so, how they may be best mitigated. Chemical contamination forms a very real and significant part of those impacts.

2 The proposal

The Global Contamination Initiative (GCI) is a global scientific initiative to define, quantify, set limits to, help clean up and devise new ways to curb the growing chemical assault on human health and the biosphere. We envisage this as an international alliance of leading scientific, government, industry and community organisations and individuals dedicated to making ours a cleaner, healthier and safer world.

The initiative seeks not only to define the extent of contamination at international scales, but also to develop cost-effective, workable solutions that can be readily adopted by industry, governments and the community. These include further developing and disseminating the concept of 'green production' – the production of goods and services without any accompanying risk of contamination.

GCI is a worldwide knowledge network that will perform new scientific research, aggregate existing knowledge, develop novel assessment and clean-up technologies, advise governments and industry on ways to improve existing regulation or industry practices, train high-level experts, and share information about ways to reduce anthropogenic contamination in all facets of human society and the natural environment.

Crucially, GCI will raise the profile of this critical issue. A key reason that the fight against environmental contamination lags behind issues of similar (or lesser) importance is that it simply has not yet entered the public consciousness to a sufficient level. With the right people, structure and governance, a high-level global network such as GCI will ensure that all stakeholders – from international and national decision-makers to the general public – develop the awareness and knowledge required to make genuine progress. Such a profile is required if we are to achieve a critical mass of policy, research and behaviour.

GCI will also forge important, and previously absent, linkages between human health and biodiversity protection. Biodiversity is a critical element of nature's clean-up processes. The healthier the Earth's biodiversity, the more capable it is of performing 'natural' remediation – in turn maintaining and improving its own health. This positive feedback loop has served the planet well for millennia, but in recent centuries human activity has interrupted this process to reverse the loop – the more polluted our environment becomes, the less able the planet is to clean itself up. As such, biodiversity must be protected from human activity, including anthropogenic contamination.

Above all GCI will take a global perspective. It will develop a 'stocks and flows' model of global contamination; seek to establish safe boundaries; prioritise the most urgent substances, issues and areas for action; investigate the combined effects of contamination on human health and the environment; and propose and disseminate solutions.

3 Discussion

Attempts to control pollution go back as far as the construction of the sewers of ancient Rome (600 BC) and early urban clean-air regulations in 13th century Britain. Research into the impact of industrial contamination is almost as old as industry itself, but today's scientific approach to the issue became established around 70 years ago. In the ensuing decades, the research has focused on human health and environmental impacts of heavy metals and metalloids such as arsenic, mercury, lead and cadmium; toxic substances such as chlorine and bromine compounds; pesticides and volatiles (POPs, PAHs, TCE, PBDE); carcinogens such as benzene and other hydrocarbon products; and the movement and fate of these substances in the environment.

Modern contaminant science has raised awareness that pollution is rarely a simple effect caused by a single substance, but commonly involves a suite of hazardous chemicals and metals, which can circulate in the environment via ground and surface water, the atmosphere, dust and sediments, and can concentrate in wildlife, the human food chain, and even move from mother to infant. International awareness has been greatly enhanced by the World Health Organization and the Stockholm Convention (1995) with its 'dirty dozen' list of banned volatile chemicals.

However, it is likely that less than 1 per cent of the world's estimated 3–5 million potentially contaminated sites have been properly assessed or remediated – while humanity continues to produce and dispose of an estimated 400 million tonnes of hazardous waste each year, most of it unsafely.

GCI considers that contamination is an issue as urgent as climate change, pandemic disease, ozone depletion, or any issue that profoundly affects human health, the safety of millions and the world ecosystem. Despire this, contamination receives lower priority, both in terms of support for the science and in the development and implementation of public policy and practical solutions.

4 Causes of the problem

The reasons for this neglect of an issue so central to human and planetary health, safety and wellbeing include:

1. A widespread lack of awareness among governments and societies about the current scale, pervasiveness and risk to billions of people from contamination in the Earth System
2. The complex nature of the threat, consisting as it does of more than 83,000 different human-made chemicals, with differing impacts on human and environmental health, and whose synergies remain poorly understood
3. The wide variation in regulation and enforcement between countries, and the reluctance of some industries to comply unless compelled to do so
4. A lack of international institutions dedicated to reducing the human and environmental risks of hazardous chemicals and waste
5. The multidisciplinary nature of assessment and clean-up, requiring that complex and costly teams of experts must be assembled to deal with a single site or issue
6. The fact that the production of potential new contaminants is far outrunning the ability of regulators to assess and control them
7. Lack of scientific data on the genetic impacts of exposure to multiple contaminants, either short or long term
8. The very wide variance of standards and technical skills in dealing with contamination from country to country, and even within countries
9. Lack of effective control over the international trade and transport of contaminated products, food and wastes
10. Frequent attempts to dispose of contaminated waste in oceans and other water bodies, from where it may be recirculated into the biosphere and food chain.

Global Contamination Initiative

Vision

Minimise the exposure of all humans and the Earth's biosphere to anthropogenic chemical contamination from all sources

Goals

1. Better understand the contemporary nature, extent, circulation and impact of Earth System contamination on human and environmental health and wellbeing
2. Assemble global data for international, national, industry and health bodies engaged in reducing the impact of contamination
3. Develop and assist the adoption of cost-efficient technologies to assess and clean up or prevent contamination
4. Share scientific knowledge and technologies for assessing, cleaning up and preventing contamination, locally and globally
5. Educate consumers, industry and governments about contamination, its pervasiveness, its adverse effects and how to prevent them
6. Create value by developing beneficial uses for contaminated land
7. Prevent disease by fostering cleaner industry and contamination-free food

5 Structure of the Initiative

GCI is an international partnership involving governments, industry, scientific organisations and community bodies. An analogous body is the Stockholm International Water Institute.

This partnership approach will strengthen networking and collaboration among scientists, regulators, engineers and industry managers. But it will also reach out to the community, to the consumers who influence demand for industry products, and to taxpayers who generally pay for the consequences of pollution. This recognises that the responsibility for cleaning up and preventing future contamination is society-wide, and does not depend on one group any more than another. It is a shared responsibility, and one we owe to future generations.

GCI's funding is envisaged as a mix of international scientific research funds from participating governments, resources from contributing scientific and regulatory agencies and industry bodies, philanthropic contributions, and contract research for industry and government.

Key areas of GCI scientific research may include:

1. Extent and circulation of anthropogenic contaminants in the Earth System
2. Establishment of scientifically credible 'boundaries' to limit release of certain key contaminants
3. Impact of contaminant mixtures on human and environmental and human health
4. Extent of contamination of the global food chain, resulting risks and options for prevention
5. New methods for assessing and remediating contamination and bioavailability, especially in cases where pollutants cross national borders
6. Green production, green manufacturing and new ways to prevent future contamination
7. Better ways to engage society, industry and governments in understanding and sharing responsibility for global clean-up.

One of the most important features of GCI will be the substantial value it will add to existing – but often piecemeal – efforts to overcome the contamination challenge. The initiative is in a unique position to assemble and resource international taskforces – including scientists, industry and regulators – to address global contamination problems and opportunities. The initiative will both minimise duplication and maximise collaboration of research among (and within) countries, leading a global approach to a truly global problem.

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