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Navigating Pollution:
A Blueprint for the Banking Sector

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Acronyms

AMD	Acid mine drainage
AMR	Anti-microbial resistance
APIs	Active pharmaceutical ingredients
APIs	Active pharmaceutical ingredients
ARM	Alliance for Responsible Mining
ASGM	Artisanal and small-scale gold mining
ASM	Artisanal and small-scale mining
B2B	Business to business
B2C	Business to consumer
BBP	Butyl benzyl phthalate
BenMAP-CE	Environmental Benefits Mapping and Analysis Program—Community Edition
BFS	Bankable feasibility studies
CAF	Clean Air Fund
CAGR	Compound annual growth rate
CCAC	Climate and Clean Air Coalition
CDP	Carbon Disclosure Project
CECs	Contaminant of emerging concern
CEPN	Clean Electronics Production Network
CFP	Chemical Footprint Project
CFCs	Chlorofluorocarbons
CIPs	Chemicals in product
CSOs	Civil society organisations
CSRD	Corporate Sustainability Reporting Directive
DBP	Dibutyl phthalate
DEPH	Bis(2-ethylhexyl) phthalate
DIBP	Diisobutyl phthalate
DMA	Double materiality assessment
EDCs	Endocrine-disrupting chemicals
ECs	Emerging contaminants
EIBs	Environmental impact bonds
EITI	Extractive Industry Transparency Initiative
EMF	Ellen MacArthur Foundation
ENCORE	Exploring Natural Capital Opportunities, Risks and Exposure
EPA	Environmental Protection Agency
EPPPs	Environmentally persistent pharmaceutical pollutants

EPR	Extended producer responsibility
ERA	Environmental risk assessment
ESG	Environmental, social and governance
ESRS	European Sustainability Reporting Standards
ESIA	Environmental and social impact assessment
FARM	Financing Agrochemical Reduction and Management
GAINS	Greenhouse Gas and Air Pollution Interactions and Synergies
GBF	Kunming-Montreal Global Biodiversity Framework
GDP	Gross domestic product
GEF	Global Environment Facility
GFC	Global Framework on Chemicals
GHG	Greenhouse gas
GHS	Globally Harmonized System of Classification and Labelling of Chemicals
GISTM	Global Industry Standard on Tailings Management
GRI	Global Reporting Initiative
GSC	Green and sustainable chemistry
HAPs	Hazardous air pollutants
HCFCs	Hydrochlorofluorocarbons
HHPs	Highly hazardous pesticides
HSLEEPs	Hazardous substances in the life cycle of electrical and electronic products
ICCM	International Conference on Chemicals Management
ICMM	International Council on Mining and Metals
IEA	International Energy Agency
IEC	International Electrotechnical Commission
IFC	International Finance Corporation
IFOAM	International Federation of Organic Agriculture Movements
IFRS	International Financial Reporting Standards Foundation
IOMC	Inter-Organization Programme for the Sound Management of Chemicals
IPBES	Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services
IRMA	Initiative for Responsible Mining Assurance
IRP	International Resource Panel
ISSB	International Sustainability Standards Board
ITU	International Telecommunications Union
LCA	Life cycle analysis
LEAP-IBC	Long-Range Energy Alternatives Planning System —Integrated Benefits Calculator
LMICs	Low-to-middle income countries
MEA	Multilateral environmental agreement
MMDA	Model mining development agreement
MSGs	Multi-stakeholder groups
NAPs	National action plans
NDCs	Nationally Determined Contributions

NGFS	Network for Greening the Financial System
NGO	Non-governmental organisation
OECD	Organisation for Economic Co-operation and Development
OEMs	Original equipment manufacturers
PAHs	Polycyclic aromatic hydrocarbons
PBBs	Polybrominated biphenyls
PBDEs	Polybrominated diphenyl ethers
PCBs	Polychlorinated biphenyls
PFASs	Per- and polyfluoroalkyl substances
PhACs	Pharmaceutical active ingredients
PiE	Pharmaceuticals in the environment
PIC	Pesticides and industrial chemicals
PM	Particulate matter
POPs	Persistent organic pollutants
PRB	Principles for Responsible Banking
PRTRs	Pollutant Release and Transfer Registers
PSAF	Principles for Sustainable Agriculture Finance
RAINS	Regional Air Pollution Information and Simulation
REACH	Registration, Evaluation, Authorisation and Restriction of Chemicals
RoHS	Restriction of hazardous substances
SASB	Sustainability Accounting Standards Board
SBMG	Sustainable Bauxite Mining Guidelines
SFSP	Sustainable Food Systems Programme
SLCPs	Short-lived climate pollutants
SDG	Sustainable Development Goals
SEI	Stockholm Environment Institute
SVHCs	Substances of very high concern
TBBPA	Tetrabromobisphenol A
TCFD	Task Force on Climate-related Financial Disclosures
TNFD	Taskforce on Nature-related Financial Disclosures
TSFs	Tailings storage facilities
UNCTAD	UN Trade and Development
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNEP FI	United Nations Environment Programme Finance Initiative
UNITAR	United Nations Institute for Training and Research
VOCs	Volatile organic compounds
UNFCCC	United Nations Framework Convention on Climate Change
WEEE	Waste electrical and electronic equipment
WEF	World Economic Forum
WTO	World Trade Organization
WHO	World Health Organization

Executive summary

Humanity is facing a triple planetary crisis of climate change, biodiversity loss and pollution. The causes of these crises overlap and exacerbate one another, creating a complex web of challenges that must be addressed in a coordinated manner. Failure to do so threatens the social, economic and environmental viability of all human endeavour.

The degradation and collapse of ecosystems caused by pollution of air, soils, fresh water and oceans imposes a substantial cost on society, hinders the achievement of many Sustainable Development Goals (SDG) targets and has serious economic consequences.

Addressing pollution requires a comprehensive and coordinated response, with financial institutions playing a key role in protecting our environment and ensuring a sustainable future. Banks and other financial institutions provide the capital that supports businesses and industries, including those that contribute to pollution. At the same time, banks and other financial institutions may also finance pollution prevention and control efforts and technologies, and therefore can be a driver for less polluting practices and the development of sustainable alternatives.

This paper serves as a primer for banks navigating the issue of pollution. It first explores the current economic and societal costs of pollution, highlights the double materiality of pollution—namely, both its impacts on society and the environment and the financial risk to companies and financial institutions– and explores the benefits that a transition towards an economy with low levels of pollution represents. While some banks have embraced progressive practices there remains a gap between widely practiced avoidance of banned and highly hazardous chemicals and the elimination of pollution from financing activities across the global banking sector.

There is a growing realisation that profitability and sustainability are not mutually exclusive. Indeed, they can be mutually reinforcing. Supporting companies that implement resource-efficient practices and reduce pollution presents banks with a significant opportunity to improve the financial performance of their clients, which can translate into tangible benefits for the banks themselves. Furthermore, sustainable finance, particularly investments in companies, technologies or projects that contribute to environmental sustainability, can potentially generate superior financial returns.

This paper provides pollution-related guidance on possible actions by banks under each of the six Principles for Responsible Banking (PRB). The guidelines in the UNEP FI Impact Protocol provide a step-by-step guide for analysing and managing bank portfolio impacts, following UNEP FI's holistic impact approach and in conformity with the requirements of the PRB and other voluntary frameworks and mandatory regulations.

Banks can proactively address pollution within operations, portfolios and client engagements. By integrating pollution considerations into their strategic frameworks, banks can not only mitigate risks but also seize opportunities to contribute to a healthier, more resilient planet and society. Through actions including active client engagement, banks can manage pollutants and address emerging issues of concern, based on scientific and technical reports from international organisations and local or regional information.

To manage impact effectively in their institutional portfolios, banks need a sector-based approach. Sectors share common challenges in addressing pollution across the life cycle of supply chain activities encompassing design, production, distribution, consumption and end-of-life phases. Moreover, the specific pollution impacts (and hence the solutions) vary widely across sectors, necessitating tailored approaches. This paper examines five high-impact sectors—mining, textiles, electronics, pharmaceuticals and agriculture—providing banks with greater detail on the sectoral-specific impacts, risks and opportunities, including tools and resources that they can apply to tackling pollution.

The strategies outlined in this paper serve as a starting point for banks to engage in meaningful change, ensuring that their contributions to pollution reduction are impactful and lasting. As the world continues to grapple with environmental challenges, the banking sector's action to address pollution will be essential in shaping a sustainable path forward. UNEP FI and its partners will develop more detailed guidance on pollution for banks in 2025, further supporting the sector's journey to align with the Principles for Responsible Banking and enhance their positive impact on society and the environment.

1. Introduction

Pollution is the introduction of harmful substances into the environment that have adverse effects on living organisms, ecosystems, human health and economic activity. It damages the health, functionality, productivity and resilience of terrestrial, freshwater and ocean ecosystems and organisms on which we depend. As a ubiquitous environmental problem, pollution has far-reaching consequences. From persistent and highly toxic pesticides and industrial chemicals to microplastics, the pervasive and escalating impacts of pollution if left unchecked could lead to a cascading effect of environmental degradation, loss of critical ecosystem function, morbidity and mortality, economic disruption and social unrest. The cumulative effects of pollution, coupled with other interlinked global challenges such as climate change and biodiversity loss, could push ecosystems and societies beyond their tipping points, resulting in irreversible damage and widespread suffering. Addressing pollution requires a comprehensive and coordinated response, with financial institutions playing a key role in protecting our environment and ensuring a sustainable future.

This paper explores the current economic and societal costs of pollution, highlights the double materiality—namely the risks and impacts—of pollution, and explores the opportunities that a transition towards an economy with low levels of pollution represents. It then provides pollution-related guidance on possible actions by banks under each of the six Principles for Responsible Banking (PRB). Finally, the paper takes a first sectoral look to provide banks with greater detail on the sectoral-specific impacts, risks and opportunities including tools and resources that can assist them in tackling the issue of pollution in selected high impact sectors.

2. Relevance of pollution for the banking sector

Human existence relies on nature's services—from clean air and water to food production, climate regulation and biodiversity—that sustain life and underpin economic and social stability. More than half of global economic value generation (approximately USD 58 trillion) is moderately or highly dependent on natural systems (PWC 2024; WEF 2024a, 2024b). Banks are increasingly aware of their role in contributing to the elimination of pollution. A United Nations Environment Programme Finance Initiative (UNEP FI) consultation with banks in the agricultural sector[1] showed unanimous acceptance of responsibility in contributing to the global pollution crisis, commitment to manage waste within their own operations and keen awareness of the diverse collaborative roles and activities required to combat pollution. The survey highlighted a consensus that banks could adopt a more proactive role to address pollution challenges beyond internal operations but identified a divergence on what the priority actions should be, influenced by disparities in regional context experienced by each bank.

Industries and businesses are a significant source of pollution. The International Energy Agency (IEA) estimates that globally, industry (including state-owned companies) was responsible for approximately one quarter of particulate matter (PM2.5) and nitrogen oxide (NO_x) emissions and 46% of sulphur dioxide (SO_2) emissions (Clean Air and Climate Coalition 2024). Large companies can have a similar air pollution footprint to countries. A 2008 study estimated that 54% of outdoor air pollution (SO_x, NO_x, PM, volatile organic compounds (VOCs) and mercury) was caused by the world's 3,000 largest companies (UNEP-PRI 2011).

2.1 The costs of pollution to economy and society

The degradation and collapse of ecosystems caused by pollution of air, soils, fresh water and oceans imposes a substantial cost on society, hinders the achievement of many Sustainable Development Goals (SDG) targets and has serious economic consequences. A growing body of evidence shows that the health impacts of pollution are much greater than previously thought, connecting pollution exposure to respiratory diseases, cardiovascular disorders, neurological damage and increased mortality rates. Globally pollution is the largest single cause of disease and premature death, being responsible for

1 Consultation run in 2022 with 69 banks from Europe, North America, Latin America, the Caribbean, North Africa, Asia and the Middle East.

approximately 9 million deaths per year, or one in six deaths worldwide.[2] Air pollution alone accounted for 8.1 million deaths globally in 2021, becoming the second leading global risk factor for death (Fuller et al 2022).

Chemicals are a major contributor to pollution due to their widespread use, persistence in the environment, and potential toxicity. Chemical classifications categorise compounds based on their hazards, aiding in pollution assessment. In instances where specific chemicals may pose significant hazards, specialised classification systems have been established to expedite hazard identification. For example, the Globally Harmonized System of Classification and Labelling of Chemicals (GHS) offers a general framework, which has been adapted in many countries. These classifications categorise chemicals based on, for example carcinogenic, mutagenic, reproductive, or long-term and repeat exposure health effects (WHO 2020).

National or regional regulations have also adapted other chemical classification systems, such as the European Union's REACH, which further adapts chemical classification by identifying "substances of very high concern" (SVHCs). These substances, known to cause cancer or persist in the environment, are subject to strict controls, including eventual bans ("sunset dates"). The Global Framework on Chemicals (GFC) is considering a list of the eight issues of concern (Table 1). The range of issues related to industrial economies and the complexity of each issue is cause for alarm. Note the issues listed in Table 1 were adopted on an interim basis by the GFC, following resolution V/5 made at the fifth meeting of the International Conference on Chemicals Management (ICCM).

The 2019 Global Chemicals Outlook II (GCO-II) (UNEP 2019) has identified 11 additional issues with emerging evidence of risks to human health and the environment that were further assessed in UNEP's Assessment Report on Issues of Concern (UNEP 2020).

Table 1: Issues of concern

Issue	Examples of concern	Examples of products/sectors
Chemicals in products (CIP)	Potential adverse human and environment effect due to releases along products' life cycles. Limit the potential for recycling and other safe end-of-life treatments and pose a risk to end users of products.	Toys, electronic devices, textiles, toiletries, cosmetics building products
Endocrine disrupting chemicals (EDCs)	Complex and wide-ranging health effects that are not well understood, with studies suggesting associations with reproductive dysfunctions, cancers, neurodevelopmental disorders, diabetes and metabolic disorders, and endocrine disrupting effects on wildlife (UNEP 2020).	Toys, plastics, cleaning products, waterproof fabrics, non-stick pans, electronics, drinking water, pharmaceuticals

2 The human health impact of pollution is still largely underestimated. This estimated impact only covers air pollution, lead exposure and occupational exposure to 12 chemicals/chemical groups.

Environmentally persistent pharmaceutical pollutants (EPPPs)	Active in humans and animals by design at low concentrations, accumulating in waste streams on excretion and released to the environment from different sources with long-term impacts on the environment and adverse effects on human health due to toxicity, endocrine disruption and antimicrobial resistance.	Drinking water, wastewater treatment, health sector, agriculture, aquaculture
Hazardous substances in the life cycle of electrical and electronic products (HSLEEP)	Possible adverse effects from environmental and human exposure to hazardous chemicals such as heavy metals, flame retardants and phthalates released during production, use and disposal.	Extractive industries, manufacture and disposal of electronic devices and infrastructure
Highly hazardous pesticides (HHPs)	Known to cause acute and chronic adverse impacts on human health and the environment.	Agriculture, aquaculture, forestry, food, drinking water
Per- and polyfluoroalkyl substances (PFASs)	Human-made chemicals that are extremely persistent and widely used in many industrial applications. Their persistence exacerbates significant concerns about their potential health and environmental impacts.	Cleaning products, textiles, leather, paper and paints, fire-fighting foams, wire insulation
Lead in paint	Growing global demand for lead for paint is still a major source of lead exposure for children in low- and middle-income countries.	Paint decoration, construction
Nanomaterials	Anthropogenic nanoparticles from dissipative losses from many uses.	Chemical engineering, manufacturing, healthcare, construction, energy technologies and agri-chemicals and food packaging

One in two children in low-to-middle income countries (LMICs) and one in three globally is lead poisoned. It is not just lead in paint that is a major source of lead exposures. Other sources include lead in cookware, cosmetics, spices and used lead-acid battery recycling (UNICEF 2020).

Air quality represents another fundamental aspect to health. There is now a much stronger body of evidence showing that air pollution affects different aspects of health at even lower concentrations than previously understood. It is estimated that 99% of the global population lives in areas where the air pollution is above World Health Organization (WHO) air quality guidelines, and 4.2 million deaths can annually be attributed to ambient air pollution (WHO 2024a). While air pollution results from similar processes such as incomplete combustion of fuels or chemical reactions between gases, pollutants can come from various sources, including extractive industries, energy production, transport, manufacture, construction and demolition, agriculture and households. Air pollutants with the strongest evidence for public health concern include particulate matter (PM), carbon monoxide (CO), ozone (O_3), nitrogen dioxide

(NO_2) and sulphur dioxide (SO_2).[3] Health problems can occur as a result of both short- and long-term exposure to these pollutants.

Globally, the impacts of pollution are unevenly distributed, often disproportionately affecting the most vulnerable and disadvantaged communities. Populations from low- and middle-income countries are exposed to 1.3–4 times higher levels of ambient PM2.5. In 2021, more than 700,000 deaths in children under five years were linked to air pollution, representing 15% of all global deaths in children under five (Health Effects Institute 2024). While reductions in the number of deaths attributable to household air and water pollution associated with extreme poverty have fallen in the last two decades, deaths from so-called modern pollution risks such as ambient air and toxic chemical pollution have risen by 66%, having an estimated welfare economic loss greater than 6% of global gross domestic product (GDP) (Fuller *et al.* 2022).

Box 1: Direct and indirect economic costs

Direct economic costs can be directly attributed to a specific cause or activity. They are often tangible and easily quantifiable. Examples include cleanup costs after a pollution incident, medical expenses for illness caused by pollution, or loss of property value.

Indirect economic costs are more difficult to quantify or attribute to a single cause, as they are the result of a sequence of events and are often referred to as externalities. Pollution is a classic example of a negative externality, where the costs of the pollution are borne by society, rather than being reflected in the price of the product-service. Examples include loss of ecosystem services that are unpriced largely in the formal economy.

3 WHO global air quality guidelines: particulate matter (PM2.5 and PM10), ozone, nitrogen dioxide, sulfur dioxide and carbon monoxide provides details specific to each air pollutant.

The global direct (private and production) and indirect economic costs (Box 1) associated with pollution from air, water and soils are considerable and challenging to calculate (Table 2). The groundbreaking 2013 UNEP report *Costs of Inaction on the Sound Management of Chemicals*, soon to be updated,[4] highlights the large costs of inaction and the specific challenges of estimating the costs and benefits reliably (United Nations Environmental Programme [UNEP] 2013). More recent studies project the welfare economic costs of air pollution will exceed USD 6 trillion annually, while the value of soil ecosystem services lost because of soil degradation are expected to range between a staggering USD 6.3 to 10.7 trillion (Economics of Land Degradation Initiative [ELD] 2015).

Estimates of the loss of ecosystem services from the marine environment from plastic pollution range from USD 0.5 to 2.5 trillion annually (Beaumont *et al.* 2019). The World Bank calculates that poor sanitation and water supply alone result in costs of approximately USD 260 billion annually in developing countries. It also estimates that the health damage caused by air pollution costs USD 8.1 trillion a year, equivalent to 6.1% of global GDP, while recent UNEP-supported studies put the cost of inaction of tackling air pollution in Cambodia, Indonesia and Thailand at between 1.6% and 2.1% of each country's GDP by 2030 (International Institute for Applied Systems Analysis [IIASA] 2023).

Developing nations often bear a disproportionate burden of pollution-related cost, with the Lancet Commission on pollution and health estimating that the greatest burden of pollution's economic losses—and more than 90% of pollution-related deaths—occur in low- and middle-income countries, due to both higher exposure levels and limited access to healthcare (Fuller *et al.* 2022).

4 Resolution V/3 of the Global Framework on Chemicals—For a Planet Free of Harm from Chemicals and Waste invites relevant participating organizations of the Inter-Organization Programme for the Sound Management of Chemicals to update the existing costs of inaction report, considering quality-assured new research and the latest information relating to economic and social costs of unsound management of chemicals and waste at the national, regional and international levels.

Table 2: Economic losses from pollution

Media	Direct economic costs	Indirect economic costs/losses	Annual loss (USD)
Air	▪ Medical expenses for pollution-related illnesses ▪ Agricultural losses ▪ Reduced property values ▪ Control and cleanup measures	▪ Reduced labour productivity ▪ Loss of tourism revenue ▪ Yield decline from soil acidification ▪ Damage to infrastructure	8.1 trillion (World Bank 2022)
Soil	▪ Reduced crop yields ▪ Increased production costs ▪ Loss of property value ▪ Soil remediation costs	▪ Health care costs ▪ Loss of ecosystem services ▪ Loss of biodiversity ▪ Loss of amenity value	6.3–10.6 trillion (ELD 2015)
Fresh water	▪ Increased water treatment costs ▪ Reduced agricultural productivity ▪ Loss of fisheries revenue ▪ Property value decline	▪ Health care costs ▪ Industrial losses ▪ Loss of ecosystem services ▪ Loss of amenity value	0.5 trillion (UNDP 2016)
Oceans	▪ Fisheries decline ▪ Coastal property damage ▪ Cleanup costs ▪ Loss of fisheries revenue	▪ Loss of ecosystem services ▪ Increased costs for industries ▪ Impact on food security ▪ Amenity value decline	3.7 trillion (plastics only) (WWF 2021)

2.2 The double materiality of pollution

Pollution is a pervasive byproduct of human economic activity and varies widely in scale and intensity. Banks, as key economic actors, significantly influence production and consumption patterns through financing decisions. Table 3 outlines this influence can be understood by considering how a bank's financing decisions affect the environment, people and society (environmental, social and socioeconomic impact materiality).

Table 3: Pollution-related impact materiality

Impact materiality (environmental, social and economic): the banks' portfolio composition and overall business practices that contribute to pollution affecting the environment and people	
Environmental impacts	**Degradation of air, water and soil quality:** Pollutants contaminate air, water and soil, leading to a range of environmental problems. **Habitat destruction and biodiversity loss:** Pollution can destroy habitats, disrupt ecosystems, and contribute to the loss of biodiversity. **Climate change:** Certain pollutants, such as greenhouse gases, contribute to climate change, leading to rising temperatures, sea level rise, and more extreme weather events.

Social impacts	**Negative health effects:** Exposure to pollution can lead to a variety of health problems, including respiratory diseases, cardiovascular disease, cancer and neurological disorders. These health issues can result in lost productivity, increased healthcare costs and premature death. **Socioeconomic losses:** Pollution-related closures of industries or businesses can disrupt economic activities, leading to brain drain of skilled workers migrating to cities with less pollution (particularly the case for air pollution), job losses, reduced productivity, increased costs related to financial compensation for workers, and increased costs related to healthcare and absenteeism due to illnesses linked to air pollution. **Inequity and social justice:** Pollution often disproportionately affects marginalised communities, developing countries, women and children and can exacerbate existing social inequalities. This can lead to violations of human rights, such as the right to health, a clean environment and adequate housing.
Economic impacts	**Economic costs:** Pollution can lead to significant economic costs, including the costs of cleaning up pollution, treating health problems, and mitigating the impacts of climate change. **Economic opportunities:** Not achieving a just transition to a cleaner economy could stifle the creation of new economic opportunities in sectors such as renewable energy, green technology and pollution control. **Convergence issues:** The economic impacts of pollution can vary across regions and countries, leading to convergence issues and potential (waste) trade tensions.

Reported *impact* materiality serves as the basis for companies to determine which of these impacts, at what point in time could affect the financial health and value creation of the company (Table 4). Double materiality recognises that both impacts on people and planet, and financial risk and opportunity are interconnected and that these ideally should be managed as one holistic process (GRI 2024a).

Table 4: Pollution-related financial materiality

Financial materiality: how external factors related to pollution affect banks' financial health.	
Credit risk	Borrowers may default on debt obligations as pollution-related incidents cause financial losses, assets used as collateral are devalued or become stranded and polluting companies face regulatory fines, legal liabilities and reputational damage that can increase their default risk.
Market risk	Pollution-related incidents can increase market risk for banks by leading to fluctuations in asset prices, changes in investor sentiment, and shifts in market demand. Environmental regulations and consumer preferences can shift towards sustainability and low pollution, impacting asset values and investment opportunities.
Underwriting risk	Pollution-related impacts can increase insured losses, create insurance gaps and cause insurance costs to increase.
Operational risk	Banks exposed to polluting industries face operational risks from accidents, spills and regulatory breaches that impact supply chains and operational facilities.
Liquidity risk	Inability to meet funding needs or obligations due to pollution-related impacts can lead to increased demand for liquidity. Banks may need to raise additional funds to cover losses or meet increased cleanup costs, which can be very significant.

Liability risk	Direct responsibility for failure to conduct due diligence, direct liability from knowingly financing harmful or polluting activities, lawsuits from shareholders, those impacted and activists, and fines through involvement with polluting industries can damage a bank's reputation and customer relationships.

From impact materiality to financial materiality

Figure I shows the non-exhaustive transmission channels from pollution-related risks to financial risks. Assessing pollution-related financial risks requires evaluating direct and indirect costs, borrower creditworthiness, regulatory compliance, reputational damage, and long-term business implications. The higher these costs, the more severe the pollution-related risk for the bank. However, accurately quantifying these costs can be challenging due to complexities in attributing specific financial losses to pollution events. Hence, the costs of environmental pollution and immediate relevance to the banking sector are often underestimated due to non-trivial challenges in accounting for the economic costs of pollution and ascribing them to a specific lending or investment activity (NGFS 2020 Table 5). Please refer to Table 5 for challenges accounting for financial costs of pollution.

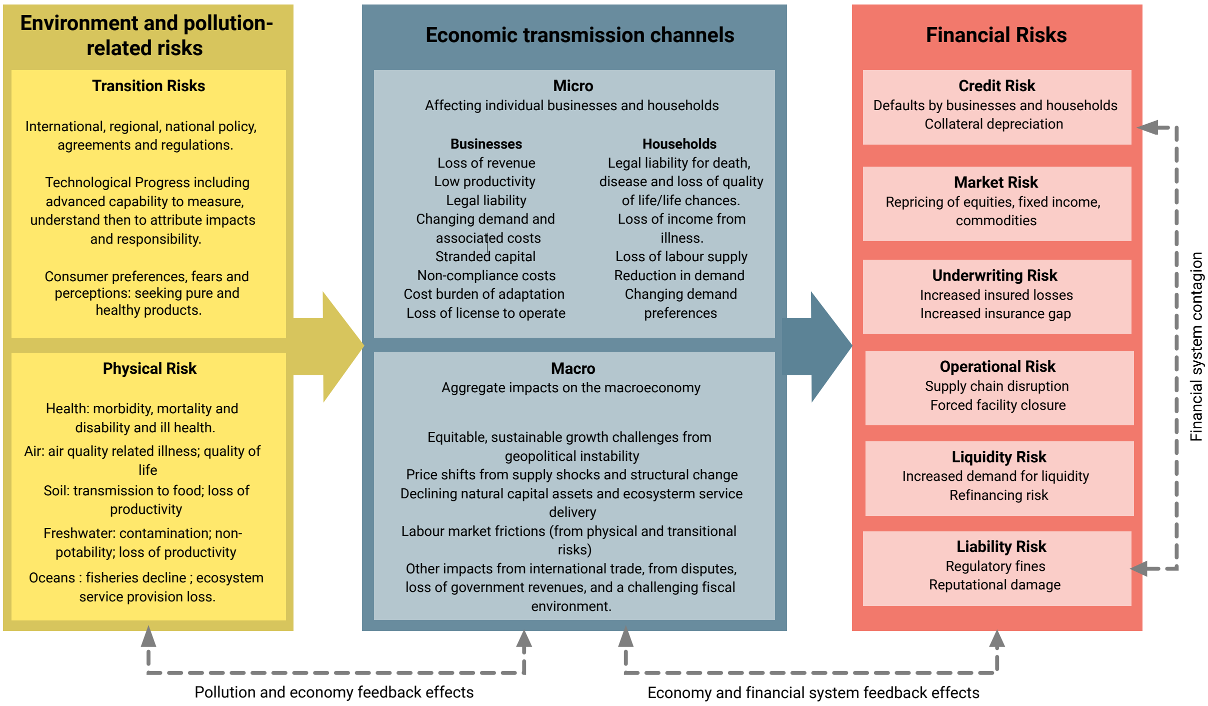


Figure I: Transmission channels—Pollution-related risks to financial risks (adapted from NGFS 2020)

Table 5: Challenges accounting for financial costs of pollution

Complexity of pollution and its impacts	
Ubiquity, diversity, pervasive and persistent	There is a vast diversity of chemical pollutants that are produced from every sector of economic activity that can be found in air, soil, water and living tissues. Many of these chemicals, such as those found in cosmetics, food, and paint, can directly contaminate environments and pose significant risks to human health. Additionally, many of these chemicals persist in the environment for long periods of time, making them difficult to remediate and control.
Chemical interactions	Biotic interactions: Many pollutants can bioaccumulate in organisms, moving through food chains and affecting ecosystems. Abiotic interactions: Pollutants can interact with soil, water and air, creating new pollutants or altering environmental conditions.
Delayed effects	Some pollution impacts, such as long-term health effects or ecosystem damage, may take years or decades to manifest, complicating cost estimation.
Spatiotemporal and population variations	Pollution levels and impacts can vary significantly across regions and over time, requiring complex modelling and data analysis. Where people live or whether they can accesss healthcare, the vulnerability of communities or individuals, based on various factors (eg. age, previous illness etc.) will also make a difference.
Data limitations and measurement challenges	
Incomplete data	Information on pollution sources, emissions and environmental concentrations is often limited or unreliable, or clients are unwilling to share.
Valuation difficulties	Assigning monetary values to environmental damage, such as loss of biodiversity or human health impacts, is subjective and challenging. However, a growing body of court cases and compensations awarded is clearly connecting polluting activities to costs and damages associated with impacts.
Attribution challenges	Determining the specific contribution of pollution to specific economic losses can be complex due to multiple contributing factors.
Lack of markets and cost reflecting market prices	
Non-market goods	Many environmental benefits, such as clean air and water, are not traded in markets, making it difficult to assign a monetary value.
Externalities	Pollution often generates negative externalities, costs borne by society but not reflected in market prices.

Complexity of economic systems	
Indirect effects	Pollution can have ripple effects throughout the economy, making it difficult to trace all associated costs.
Discounting future costs	Determining the present value of future pollution costs involves making assumptions about discount rates, which can significantly affect results.
Global complex value chains	Tracking the sources of pollution across complex global supply chains is extremely challenging, but increasingly possible through application of advanced technologies.

Banks operate within a dynamic risk landscape shaped by evolving technological capabilities, societal preferences and policy interventions. The concept of transition risk underscores this dynamism, highlighting the "silent selection" occurring within the business environment (Pecorari *et al.* 2020). As public awareness grows around pollution's detrimental effects, societal expectations and demands for sustainable practices intensify. Consequently, policymakers implement regulatory frameworks and market-based incentives to encourage pollution reduction and resource efficiency. These combined forces are driving banks and the businesses they finance to internalise environmental externalities and adopt innovative sustainability strategies (Horbach *et al*. 2012).

The Network for Greening the Financial System (NGFS) report provides valuable insights on integrating these approaches for effective environmental risk management (NGFS 2020). Traditional credit risk models can be complemented by geospatial biophysical and societal modelling tools, such as life cycle assessments, chemical exposure modelling, real options and climate scenario analysis.

2.3 Opportunities for pollution reduction and management in the banking sector

Banks play a vital role in supporting the transition to an economy that avoids and minimises pollution. Although some banks have embraced progressive practices there remains a gap between widely practiced avoidance of banned and highly hazardous chemicals and the elimination of pollution from financing activities across the global banking sector. Findings from the UNEP FI survey of banks on plastics and agricultural pollution can explain this market failure. Banks mentioned the lack of a clear business case, and the lack of data, as a major obstacle to advance an agenda aimed at avoiding and minimising pollution in their lending and investment portfolios. Banks articulated a lack of clarity on how to position themselves to leverage the positive impacts of reduced pollution and the circular economy agenda within their customer base, beyond the elimination of banned substances. However, it is increasingly understood that the costs of inaction—continuing to finance polluting activities—far outweigh the costs of the necessary transition to a pollution-free economy (UNEP 2013).

Supporting companies that implement resource-efficient practices and reduce pollution presents banks with a significant opportunity to improve the financial performance of their clients, which can translate into tangible benefits for the banks themselves. Businesses that reduce pollution often experience lower operational costs, enhanced risk management and reduced liability exposure, leading to stronger financial results and, ultimately, higher loan repayment rates. By financing companies that prioritise pollution reduction, banks can secure more stable returns while minimising their risk exposure to environmental liabilities. Moreover, as the demand for green finance products grows, banks are well positioned to support innovative companies that are developing pollution-reducing technologies, further expanding their client base in this emerging market.

Although banks have highlighted the need for a stronger business case, there is a growing realisation that profitability and sustainability are not mutually exclusive. Indeed, they can be mutually reinforcing. Sustainable finance, particularly investments in companies, technologies or projects that contribute to environmental sustainability, can potentially generate superior financial returns. Early stage and strategic lending and investments in environmentally sustainable businesses enable banks to capture new growth opportunities, reduce future risks and align with shifting market dynamics that prioritise sustainability. For example, the global investment gap to achieve the SDGs by 2030 is estimated at USD 30 trillion (UNCTAD, 2023), highlighting the vast untapped potential for banks to channel finance into sustainable projects, including those addressing pollution. New research by the Clean Air Fund highlights that only 1% of international development funding (USD 2.5 billion per year) and 2% of international public climate finance (USD 1.66 billion per year) was committed to targeting air pollution between 2015 and 2021 (Clean Air Fund, 2023).

The scale of opportunity is further emphasised by the progress of banks that are signatories to the PRB, which by 2023 had collectively mobilised USD 2.3 trillion of sustainable finance. However, a UNEP FI survey revealed that pollution—distinct from climate change or biodiversity loss—remains an underprioritised area of impact for these banks. This gap suggests that many banks have yet to fully recognise the significant opportunities associated with addressing pollution. Examples of opportunities in high-impact sectors are presented in Section 4.

Addressing pollution has positive interlinkages with other sustainability topics. This multiplier effect creates opportunities for banks to make progress on their other sustainability commitments. For example, pollution is one of the five main drivers of nature loss, as identified by the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES, 2024), and tackling it offers banks a chance to support nature preservation and restoration efforts, in addition to delivering on broader sustainability objectives. Furthermore, reducing air pollution not only improves biodiversity and ecosystem health, but also directly contributes to better human health outcomes and climate change mitigation. Additionally, efforts to reduce water and soil pollution can enhance food security, improve access to clean water and support sustainable agriculture practices, aligning with multiple SDGs.

Box 2: Sustainable practices can yield multiple benefits

An example of the positive spillover effects of pollution reduction can be seen in projects such as the Selva Shrimp initiative in Indonesia, which demonstrates how addressing pollution and promoting sustainable practices can yield benefits for biodiversity, climate and local communities. This initiative combines small-scale shrimp farming, which tends to have a higher level of female participation, with active measures to protect and restore mangrove forests. To achieve certification farmers must have 40% of their ponds covered in mangrove. The ecosystem services provided by the mangrove enables farmers to eliminate use of supplementary feed, medicine and fertilisers that can represent a persistent toxic hazard. The project incentivises farmers to adopt sustainable practices by offering higher prices for premium products and increasing harvest sizes through improved farming methods (Global Center on Adaptation 2020). Such projects illustrate that addressing pollution presents opportunities for banks to align with multiple sustainability objectives while delivering measurable environmental, social and financial returns.

It is important that banks understand the interlinkages between pollution and sustainability objectives to leverage opportunities for positive outcomes and avoid unintended consequences (UNEP FI 2024b). The extract from UNEP FI Interlinkages Mapping (Table 6) shows how acting on pollution by reducing resource intensity and associated pollutants emission, or waste generation and related waste management, can have both positive and negative interlinkages with other topics. It also shows how impacting and impacted topics relate to one another, for example how reducing negative pollutant impacts on soil health can help mitigate climate change, through maintenance of soil microbial communities and soil organic carbon; or how reducing pollutants to waterbodies positively impacts species and habitats and avoids the need to extract and exploit new water resources (such as deepwater aquifers).

Table 6 also demonstrates how pollution reduction can create synergistic benefits across various sustainability topics, further strengthening the business case for banks to prioritise financing that avoids or minimises pollution. Figure II shows positive interlinkages between various pollution-related impact areas listed in Table 6.

The circular economy concept underscores the opportunity for banks to enhance impact and risk management by financing circular activities, projects and clients. By shifting from linear "take-make-waste" business models to circular models that emphasise resource efficiency, waste reduction and resource recovery, banks can de-risk their portfolios. Circular economy principles offer banks the ability to manage their portfolios more proactively, reducing their exposure to risks associated with resource scarcity, supply chain disruptions and volatile resource prices. By transitioning from linear portfolios—where assets are increasingly prone to becoming stranded—to circular portfolios, banks can hedge against future risks and capture new growth opportunities.

Financing the circular economy not only mitigates environmental risks but also positions banks to capitalise on the emerging market for sustainable, pollution-mitigating and pollution reduction solutions that are integral to the future of finance (UNEP FI 2024b, 2024a). This approach can help banks build a more resilient, diversified portfolio that delivers long-term value for both the bank and its clients while contributing to the global transition toward an economy where pollution is minimised.

Transitioning to sustainable pollution control, if guided by just transition principles, can promote inclusivity while reshaping workforce needs. Pollution reduction demands new skills in pollution management, digital tracking and eco-friendly materials, calling for reskilling and upskilling to support workforce adaptability and prevent job displacement. At the same time, pollution control can drive job creation, particularly in waste management, water purification and air quality sectors, enhancing working conditions and income resilience. However, this shift may bring trade-offs, especially in traditional pollutant-heavy industries, requiring equitable training, skill development and inclusive policies to ensure no communities are left behind.

Table 6: Non-exhaustive interlinkages table between Air, Soil, Water Pollution, Waste and other topics, derived from the updated UNEP FI Interlinkages Mapping (UNEP FI 2024g)

Strong positive interlinkage | Moderate positive interlinkage | Strong negative interlinkage | Moderate negative interlinkage

Acting on Air, Soil, Waterbodies pollution or on Waste impacts…		Due to…
Air	**Health & Safety**	Reducing air-pollution diseases and conditions, and overall contributing to a healthier population.
	Climate Stability	Reducing GHG emissions and pollutants like black carbon and methane, which enhance atmospheric conditions and helps in slowing global warming.
	Species	Reducing exposure to harmful pollutants and contributing to healthier ecosystems and increased wildlife survival rates.
Soil	**Health & safety**	Reducing soil pollution from harmful chemicals and heavy metals which can leach into water sources and the air.
	Food	Enhancing food health and preserving food quality and the production of safe and sufficient food.
	Climate stability	Decreasing GHG emissions by enhancing soil carbon sequestration and reducing practices such as tillage and improper fertiliser use.
	Waterbodies	Reducing erosion and runoff of sediment, nutrients, and pollutants into rivers, lakes, and streams, thereby preserving water quality and aquatic habitats.
	Species	Fostering healthier plant growth, better habitats and food sources for wildlife, thus promoting biodiversity and ecosystem stability.
	Habitat	Enhancing the fertility and resilience of soils, which contributes to provide vital habitats for various species to thrive.
Waterbodies	**Health & safety**	Preventing the spread of noxious diseases and decreasing microplastics and pollutants in the food chain.
	Water	Enhancing the safety and clean water availability for consumption.
	Food	Increasing food production and availability by ensuring healthier aquatic ecosystems.
	Energy	Enhancing access to energy by ensuring cleaner water for all stages of energy production.
	Culture & heritage	Helping preserve natural heritage by maintaining pristine aquatic environments.

	Infrastructure	Extending water management systems lifespan and reducing maintenance costs by reducing corrosion and damage.
	Species	Support species conservation by providing a healthier environment for aquatic life.
	Habitat	Promoting healthier ecosystems and supporting biodiversity by reducing pollutants and toxins that harm aquatic life.
	Resource intensity	Supporting long-term water resources security and availability.
Waste	**Health & Safety**	Contributing to healthier environment and population, through waste reduction and improved management, especially for hazardous waste.
	Water	Enhancing water quality and availability for communities by reducing pollution and contamination of water sources.
	Food	Reducing food waste and enhancing food quality by preventing hazardous components dissemination.
	Healthcare & sanitation	Improving sanitation through better wastewater management practices.
	Employment	Creating jobs in waste collection, recycling, and materials recovery industries.
	Sector diversity	Creating new markets and opportunities in recycling, waste-to-energy, and upcycling industries, thereby diversifying economic activities.
	Flourishing MSMEs	Negatively affecting MSMEs by imposing higher compliance costs, such as adhering to stricter waste disposal regulations or investing in more sustainable technologies.
	Climate stability	Reducing GHG emissions by minimising landfill use, promoting recycling and composting, and preventing methane emissions from organic waste decomposition.
	Waterbodies	Improving water quality in waterbodies by reducing the discharge of untreated or poorly treated wastewater and solid waste.
	Air	Improving air quality by reducing the emission of air pollutants from waste disposal sites.
	Soil	Preserving soil quality through reduced soil pollution resulting from waste.
	Species	Contribute to species preservation by reducing the negative impacts of pollution on wildlife and ecosystems resulting from waste.
	Habitat	Preventing habitat degradation caused by improper disposal of waste through effective waste management systems reducing pollutants release into the environment.
	Resource intensity	Reducing resource intensity by recycling and reusing materials, decreasing the need for raw resource extraction and lowering the overall consumption of energy and materials in production processes.

Figure II: Positive interlinkages between various pollution-related impact areas (adapted from UNEP FI 2024b, 2022)

Box 3: Pollution and human rights

The transition to economies where pollution is minimised is closely tied to human rights, as recognised in the 2021 United Nations Human Rights Council resolution and the July 2022 United Nations General Assembly decision,[5] which affirmed the right to a healthy environment as a fundamental human right. This resolution underscores the need to address pollution not only as an environmental imperative but also as a critical obligation to protect human well-being, dignity and equality. Pollution adversely impacts air quality, water sources, soil health and food safety, all of which are essential to secure a healthy and safe environment for communities worldwide. Consequently, tackling pollution from a human rights perspective is essential, as it aligns with commitments to uphold fair working conditions, protect communities disproportionately affected by pollution, and ensure that economic transitions prioritise health, equity and inclusivity. The recognition of a healthy environment as a human right reinforces the urgency of creating policies and economic structures that prevent pollution, promote clean technologies and support vulnerable populations in achieving environmental and economic security.

5 Official Records of the General Assembly, Seventy-sixth Session, Agenda item 74 (b), A/RES/76/300

3. Actions by the banking sector to address pollution

Financial institutions play a vital and powerful role in shaping the dominant systems of production and consumption throughout the global economy. Recognising societal pressure to address the pollution crisis, over the past decade the banking sector has increasingly engaged in a range of activities that, while not necessarily directly focused on pollution, can help mitigate its impacts. These include:

Own operations

- **Supply chain management:** Collaborate with suppliers to reduce environmental impacts throughout the value chain.

Lending and investment portfolios

- **Environmental risk assessment:** Incorporate climate, biodiversity and pollution risks into risk management processes.
- **Sector-specific standards:** Adopt standards for high-pollution sectors such as oil and gas, mining and agriculture. Examples include:
  - **Oil and gas:** Equator Principles, International Finance Corporation (IFC) Performance Standards
  - **Mining:** Global Reporting Initiative (GRI) Mining Sector Supplement, International Council on Mining and Metals (ICMM)
  - **Agriculture:** Principles for Sustainable Agriculture Finance (PSAF)
- **ESG integration:** Embed environmental, social, and governance factors into lending and investment decisions.
- Specialised lending:
  - **Circular economy initiatives:** Finance businesses focused on resource efficiency and waste reduction.
  - **Green loan products:** Develop sustainable finance taxonomies to finance environmentally benign and positive projects.

Sustainability reporting

- **Adoption of frameworks:** Adopt frameworks like GRI, Sustainability Accounting Standards Board (SASB), Task Force on Climate-related Financial Disclosures (TCFD), and Taskforce on Nature-related Financial Disclosures (TNFD) to disclose environmental impacts.

These activities can contribute to align banking practices with SDGs and contribute to a lower carbon, less polluting future. This section describes how banks can take further action to address pollution under each of the six Principles for Responsible Banking (PRB).

The guidelines in the UNEP FI Impact Protocol provide a step-by-step guide for analysing and managing bank portfolio impacts, following UNEP FI's holistic impact approach and in conformity with the requirements of the PRB and other voluntary frameworks and mandatory regulations.

3.1 Principle 1: Alignment

Principle 1 requires banks to align their business strategy to be consistent with and contribute to individuals' needs and society's goals as expressed in international, regional and national interventions, protocols and frameworks and by implication to align their pollution abatement strategy.

The landmark decision made by the United Nations General Assembly in 2022[6] to recognise access to a clean, healthy, and sustainable environment as a fundamental human right signifies a global shift towards recognising the critical importance of environmental protection for human well-being and the need for equitable access to environmental resources. Tackling pollution is essential to upholding this human right. The negative impacts of pollution intersect with all Sustainable Development Goals but are of highest direct relevance to SDG 2 (Zero Hunger), SDG 3 (Good Health and Well-Being), SDG 5 (Gender Equality), SDG 6 (Clean Water and Sanitation), SDG 11 (Sustainable Cities and Communities), SDG 12 (Responsible Consumption and Production), SDG 13 (Climate Action), SDG 14 (Life Below Water), and SDG 15 (Life on Land). These SDGs are interconnected, and pollution can undermine the achievement of each, especially by contributing to biodiversity loss and the degradation of ecosystem services. Specifically SDG 12 (Responsible Production and Consumption) (Table 7) and associated SDG target 12.4 aims to achieve the environmentally sound management of chemicals and all wastes throughout their life cycle.

Table 7: Relevance of pollution to the SDGs (non-exhaustive)

SDG	Priority dependencies
	Pollutants such as heavy metals, pesticides and microplastics can accumulate in soil and water, reducing crop yields and compromising the safety of food supplies. Contaminants in the food chain can lead to health issues in humans and animals, while degraded soils and polluted water sources reduce land productivity and biodiversity, making it harder to sustainably feed a growing population. Addressing pollution is therefore essential to achieving sustainable and resilient food systems.
	Toxic pollutants can negatively impact human health and well-being by causing a range of adverse effects, including respiratory problems, neurological disorders, reproductive issues including birth defects, and cancer. These impacts are not distributed equally among populations, with variables such as gender, ethnicity, socioeconomic status and age playing a crucial role in determining exposure, health consequences and access to healthcare.

6 Official Records of the General Assembly, Seventy-sixth Session, Agenda item 74 (b), A/RES/76/300

5 GENDER EQUALITY	Gender plays a significant role in shaping the impact of pollution on populations. In many contexts, pollution disproportionately affects women, particularly those in marginalised communities, exacerbating gender inequality and hindering access to resources, opportunities and quality of life.
6 CLEAN WATER AND SANITATION	Pollution poses a major barrier by contaminating freshwater sources, making safe and clean water less accessible. Industrial discharges, agricultural runoff, and plastic waste introduce toxins, pathogens and chemicals into rivers, lakes, and groundwater, threatening human health and ecosystems. Reducing pollution and investing in water sanitation infrastructure can help protect water quality, improve public health and safeguard ecosystems.
11 SUSTAINABLE CITIES AND COMMUNITIES	Urban populations rely heavily on clean water, food, and air, while urban industrial systems consume significant quantities of natural resources and generate substantial waste. These urban systems exert a profound influence on and depend upon surrounding ecosystems and populations.
12 RESPONSIBLE CONSUMPTION AND PRODUCTION	Responsible production and consumption practices can significantly reduce pollution by minimising waste, promoting efficient resource use and supporting sustainable supply chains. Irresponsible production practices are increasingly being regulated and punished. Consumers' growing preference for non-polluting goods and services is driving businesses towards more sustainable practices.
13 CLIMATE ACTION	Greenhouse gases from fossil fuel combustion and chemicals such as chlorofluorocarbons (CFCs) and hydrochlorofluorocarbons (HCFCs), are potent greenhouse gas pollutants and a cause of anthropogenic climate change. The production, use and poor waste management of substances derived from the extraction and use of fossil fuels also contribute to pollution of soil, water and air, for example nitrous oxide from degradation products of synthetic fertilisers.
14 LIFE BELOW WATER	Pollution is a major driver of biodiversity loss in aquatic ecosystems. Plastics, chemicals and excess nutrients can contaminate marine ecosystems, harming aquatic life, destroying habitats and disrupting marine food chains. These impacts can have cascading effects on coastal communities that rely on marine resources for livelihoods and subsequently on global food security.
15 LIFE ON LAND	Wildlife is exposed to multiple forms of pollution: the degradation of freshwater sources, poor air quality and soil contamination degrade the conditions necessary for the survival of species, both terrestrial and soil-dwelling. These complex threats modify and damage the ecology of terrestrial ecosystems and jeopardise much of the ecosystem services that sustain human life.

International agreements on pollution have direct implications for the banking sector. The Kunming-Montreal Global Biodiversity Framework (GBF) and the Global Framework on Chemicals (GFC) are the newest global instruments implying the need to strengthen the global banking system by setting targets and enhancing risk and impact management practices.

The Kunming-Montreal Global Biodiversity Framework

The Kunming-Montreal Global Biodiversity Framework (GBF) is a comprehensive plan adopted in 2022 by nearly 200 countries to halt and reverse biodiversity loss by 2030. It sets out ambitious targets to protect and restore ecosystems, ensure the sustainable use of biodiversity, and share the benefits of genetic resources equitably. Recognising that pollution is a major driver of biodiversity loss, GBF target 7 calls for the financial sector to work with other sectors of the global economy to reduce pollution risks to levels that are not harmful to biodiversity and ecosystem functions by 2030. This includes reducing excess nutrients, pesticides and hazardous chemicals, as well as plastic pollution.

The GBF primarily focuses on biodiversity conservation and the sustainable use of natural resources. While the GBF does not directly address pollution management, it recognises that pollution is a key driver of biodiversity loss and ecosystem degradation. Pollution, including air, water and soil pollution, can negatively impact biodiversity by contaminating habitats, disrupting ecological processes and threatening the survival of species. Therefore, the GBF indirectly acknowledges the importance of addressing pollution across various environmental compartments to safeguard ecosystems and promote sustainable development. Banks can use GBF target 7 to operationalise the nexus between pollution, nature and climate by engaging with clients, reducing exposure to clients in high-polluting sectors without a transition plan and increasing financing for pollution-free transition.

The Global Framework on Chemicals—for a planet free of harm from chemicals and waste

The Global Framework on Chemicals (GFC) is another recent, relevant, comprehensive and multi-stakeholder global framework for pollution. It was adopted as an outcome of the 5th session of the International Conference on Chemicals Management (ICCM5) held in Bonn, Germany, in September 2023. The GFC is a non-binding agreement that provides a framework for countries and other relevant stakeholders to work together to reduce the risks posed by chemicals to human health and the environment. While the GFC does not impose specific legal obligations, it does encourage countries to adopt and implement national laws and regulations that align with its principles and goals. The GFC outlines a set of targets that provide a useful context for establishing firm-level strategy (Table 8).

The GFC defines targets for the safe and sustainable management of chemicals, with strategic objectives focusing on legal frameworks, data accessibility, issue prioritisation, innovation and sustainable practices. For banks and the financial sector, the GFC is highly relevant as it sets targets to integrate responsible chemical management into the operations of customers, which banks can use for their financing decisions. The GFC primarily addresses the management of chemicals throughout their life cycle, including their production, use and disposal. The GFC encompasses all areas where chemicals and waste may pose risks to human health and the environment, including pollution of air, water bodies and soil, as well as impacts on human health and biodiversity (Table 8).

Table 8: The Global Framework for Chemicals (GFC) relevance to banks

Strategic Objective	Target	Description	Relevance for banks	PRB action category*
A Legal and institutional foundations	**A3**	By 2030, implement measures to prevent or minimise adverse effects from chemicals throughout their life cycle.	Banks need to consider how sustainable financing can support businesses in achieving strong chemical management practices	Internal policies and processes, Client engagement
	A5	By 2030, work towards notifying or regulating chemical exports they have prohibited nationally.	Banks need to ensure clients comply with export regulations to mitigate risks.	Internal policies and processes, Client engagement
B Informed decision-making and accountability	**B2**	By 2030, make available reliable information on chemicals throughout the value chain.	Banks can access, collate and analyse chemical information from portfolios for risk assessment and portfolio management.	Internal policies and processes
D Innovation and sustainable practices	**D1**	By 2030, increase finance for sustainable chemistry innovations.	Banks can support innovative companies and sustainable chemical and resource efficiency practices.	Portfolio composition and financial flows
	D3	By 2030, incorporate chemical management into finance approaches.	Banks can integrate chemical management into their business models and reporting.	Internal policies and processes, Client engagement
	D7	By 2030, implement occupational health and safety practices.	Banks can engage with clients to ensure supply chain sustainability and worker safety.	Client engagement
E Partnerships and resource mobilisation	**E2**	By 2030, strengthen partnerships for chemical management.	Banks can participate in industry initiatives and collaborate on sustainable finance solutions.	Advocacy and partnerships
	E3	Mobilise financial resources for chemical management.	Banks can play a crucial role in financing sustainable chemical projects and innovations.	Portfolio composition and financial flows

* Four action categories for impact management by banks according to the UNEP FI Impact Protocol are policies and processes, client engagement, portfolio composition and financial flows, and advocacy and partnerships.

Other relevant frameworks

The Organisation for Economic Co-operation and Development (OECD) Environmental Framework requires member countries to support the development of public policies on environmental performance. It is therefore a reference for banks operating in these countries. OECD topics on pollution include air pollution, chemical safety, circular economy, consumption and innovation, green growth, green transport, oceans, plastics, resource and waste productivity, and water. The Montreal Protocol, the Basel Convention, the Rotterdam Convention, the Stockholm Convention, the Minamata Convention, and the Convention on Long Range Transboundary Air Pollution are other important global and regional multilateral environmental agreements (MEAs) to address pollution at various levels. MEAs operate at a global level (multilateral agreements negotiated under the auspices of the UN), at regional level (for example in the context of the UN Economic Commission for Europe or the Council of Europe), and at sub-regional level (for instance for the management of seas or transboundary rivers). They highlight the interconnectedness of pollution issues and the need for coordinated global action to protect human health and the environment. They address specific pollution-related concerns and aim to safeguard the environment and human well-being through international cooperation and regulation. Specifically, these frameworks:

- Focus on managing the production, use and disposal of highly hazardous chemicals, ozone-depleting substances, mercury and other pollutants or toxic substances, and regulating various aspects of chemicals, pollutants and their impacts on the environment and human health.
- Foster a shared objective to reduce risks associated with chemicals and pollutants through measures such as bans, restrictions, labelling and promoting the use of safer alternatives.
- Provide a framework for member countries to develop and implement regulations, policies, and strategies to achieve the goals outlined in these agreements, fostering a systematic approach to managing environmental and health risks associated with chemicals and pollutants.

Table 9 provides an overview of international agreements and frameworks on pollution.

While internationally agreed frameworks can help deliver alignment, banks can go further to support unrepresented and marginalised communities impacted by their investments. For example, pollution can have significant gender-specific impacts. Women often lack representation and are often disproportionately exposed to pollutants and face unique health risks that can also exacerbate gender inequality by limiting women's access to resources and opportunities, particularly in developing countries and marginalised communities. Engaging effectively with these communities requires banks to conduct gender-sensitive research, integrate gender considerations into policy development, empower women, support women-led initiatives and ensure strong alignment with these most affected communities.

Table 9: An overview of international agreements and frameworks on pollution

Agreement	Date	Focus	Goal	Content	Relevance to banking
Montreal Protocol	1987	Ozone-depleting substances	Protecting the ozone layer	Phase-out of ozone-depleting substances and phase-down use of hydrofluorocarbons	Impacts industries using or producing ozone-depleting substances and some alternatives
Basel Convention	1992	Transboundary movement of hazardous waste	Protecting human health and the environment from the adverse effects of hazardous wastes	Controlling the transboundary movement of hazardous and other wastes	Impacts banks financing waste management industries
UN Framework Convention on Climate Change (UNFCCC)	1992	GHG emissions	Stabilising greenhouse gas concentrations	Provides an overarching framework for climate action	Provides an overarching framework for climate action, influencing banking sector
Stockholm Convention	2001	Persistent organic pollutants	Eliminating or restricting POPs	Bans and restrictions on POPs	Impacts industries using or producing POPs, indirectly affecting banks
Rotterdam Convention	2004	Prior informed consent for hazardous chemicals	Protecting human health and environment	Regulation of highly hazardous chemical trade	Affects trade finance and supply chain management
Minamata Convention on Mercury	2013	Mercury	Protecting human health and environment	Measures on mercury supply and trade, mining, emissions, disposal and products containing mercury	Encourages financial institutions to assess and limit financing to projects that contribute to mercury pollution
(UNFCC) Paris Agreement	2015	GHG emissions	Protecting human health and environment	Nationally Determined Contributions (NDCs) for GHG reduction plans	Drives transition to low-carbon economy, impacting various sectors
Kunming-Montreal Global Biodiversity Framework (GBF)	2022	Biodiversity conservation and pollution reduction	Halting and reversing biodiversity loss	Sets out 23 targets and four overarching goals, aiming to halt biodiversity loss, promote ecosystem restoration, ensure sustainable use of natural resources, and enhance the equitable sharing of benefits from biodiversity, especially for Indigenous Peoples	Emphasises financing sustainable activities and avoiding polluting industries
Global Framework on Chemicals (GFC)	2023	Sound management of chemicals	Protecting human health and environment	Sound management of chemicals and waste throughout life cycle	Promotes financing sustainable chemical management practices

3.2 Principle 2: Impact and Target Setting

Principle 2 requires banks to undertake an analysis of their impacts on society, the environment and the economy, to identify their most significant impacts and to set a minimum of two targets that address at least two of the identified significant impacts. There are a variety of pollution-related resources, including tools and case studies, guidance and sources of data available to banks (Table 10).

The UNEP FI Impact Protocol provides a step-by-step process for managing impact, from identifying significant impact topics to setting targets and defining action plans, in line with PRB requirements. The Impact Protocol is complemented by the UNEP FI Impact Mappings and Impact Analysis Tool, which includes tools for context analysis, impact identification, impact assessment and target setting. The protocol, mappings and tool can be used for all impact topics, including pollution. The needs mapping and identification module helps banks understand pollution within their operating areas. The sector mappings and the identification module can help banks identify their potential impacts based on the bank's sector exposures, and the interlinkages map and assessment module supports setting pollution-related impact targets.

As part of target-setting, banks may engage with their clients to obtain the appropriate operational data. This can be sparse where disclosure is not mandatory or commonplace, as is common in the chemicals sector. Banks may also engage with deep-domain experts and scientists to help set priorities across a potentially large suite of chemicals and transformation products, point and diffuse sources and environmental (air, soil, water) pathways and interactions. Based on these inputs, banks can set achievable targets to reduce their pollution-related negative impacts and increase their positive contributions to nature conservation. These targets should be aligned with international frameworks like the Global Biodiversity Framework and national biodiversity strategies, or the Global Framework on Chemicals. To achieve their targets, banks need to integrate them into their organisational strategies, develop action plans, and regularly monitor progress.

Table 10: Resources for pollution impact assessment

Impact management resources specifically designed for banks		
Name	**Focus**	**Relevance for banks**
UNEP FI Impact Mappings and Impact Analysis Tools	Management of positive and negative portfolio impacts across environmental, social and socio-economic pillars.	In keeping with the UNEP FI holistic impact approach and the Principles for Responsible Banking, these tools enable banks to identify and assess impacts across their portfolio.
World Bank: Environmental, Health, and Safety Guidelines	Support financial institutions operating primarily in countries with limited pollution standards, including acceptable limits for some classes of pollutants.	The World Bank Group Guidelines (which complement International Finance Corporation (IFC) standards) provide environmental, health and safety components that relate largely to potential sources of pollution and managing hazardous substances. Guidance documents cover air and (waste)water emissions/quality, hazardous materials management, waste management, noise, land pollution, chemical/biological hazards and special hazard environments, and transport of dangerous goods. It also provides specific sectoral guides.
Data & benchmarking on companies' management of pollution		
Name	**Focus**	**Relevance for banks**
CDP (formerly Carbon Disclosure Project)	The CDP focuses primarily on environmental disclosures, with emphasis on climate change, deforestation, water security, waste management and plastics-related impacts.	The CDP provides data on how companies are responding to some aspects of pollution—plastics, water and substances of concern. Banks can utilise CDP data to develop financial products and services that support environmentally responsible businesses and better manage their own portfolio risk. The CDP data and platform offer valuable tools for assessing clients, engaging in dialogue, managing risks, and developing sustainable finance solutions. The core element of the CDP is its annual questionnaire. This questionnaire asks companies to disclose comprehensive data on their environmental impact, governance and strategies. It also provides resources and guidance to help companies prepare for and complete the questionnaire. The CDP maintains a public database of submitted responses, allowing stakeholders to access and analyse the environmental performance of companies.

Chemical Footprint Project (CFP)	A programme of Clean Production Action, a 501(c)(3) non-profit organization. Its mission is to transform global chemical use by measuring and disclosing data on business progress to safer chemicals.	The CFP provides a tool for benchmarking companies as they select safer alternatives and reduce their use of chemicals of high concern. The four pillars of the CFP survey—management strategy, chemical inventory, footprint measurement, and disclosure and verification—are essential to assessing good chemicals management and governance practices. Banks can support CFP and encourage their clients and customers to participate in the survey. By sharing their plans and progress toward safer chemicals, companies can demonstrate leadership and foster a positive dynamic of understanding and progress with banks.
UNEP Global Waste Management Outlook	The Global Waste Management Outlook offers an updated assessment of global waste management and an analysis of data concerning municipal solid waste management worldwide.	The analysis uses life cycle assessments to explore what the world could gain or lose through continuing business-as-usual, adopting halfway measures, or committing fully to zero waste and circular economy societies. The report also evaluates three potential scenarios of municipal waste generation and management, examining their impacts on society, the environment and the global economy. Furthermore, it presents potential strategies for waste reduction and enhanced management, following the waste hierarchy, to treat all waste materials as valuable resources.
Impact management resources for the private sector overall		
Name	**Focus**	**Relevance for banks**
ENCORE	Nature-related risk assessment for sectors, subsectors and production processes	ENCORE (Exploring Natural Capital Opportunities, Risks and Exposure) is a free online tool that helps organisations explore their exposure to nature-related risk and take the first steps to understand their dependencies and impacts on nature.
A Practical Guide for Business: Air Pollutant Emission Assessment	A first-of-its-kind guide for businesses to measure air pollutant emissions across their value chain	Developed by Climate and Clean Air Coalition (CCAC), Stockholm Environment Institute (SEI), and IKEA Group, this guide helps companies measure air pollution emissions across their value chains. This overview helps companies understand their air pollution emissions and take action to reduce them. It also allows companies to undertake health or other impact assessment analyses. SEI intends to develop methods to estimate the local impacts of air pollution emitted down a company's supply chain.
Environmental Benefits Mapping and Analysis Program—Community Edition (BenMAP-CE)	Open-source computer program that calculates the number and economic value of air pollution-related deaths and illnesses	Developed by the Environmental Protection Agency (EPA), BenMAP-CE is an open-source software tool that quantifies the health and economic impacts of changes in air quality, particularly focusing on ground-level ozone and fine particulate matter (PM2.5). Users can estimate the number and economic value of air pollution-related deaths and illnesses across various geographic scales.

Greenhouse Gas and Air Pollution Interactions and Synergies (GAINS)	Model to assess emission and pollution reduction strategies that combat both air pollution and climate change	GAINS provides an authoritative framework for assessing strategies that reduce emissions of multiple air pollutants and greenhouse gases for the least cost, and minimise their negative effects on human health, ecosystems and climate change. It was launched in 2006 as an extension to the Regional Air Pollution Information and Simulation (RAINS) model which is used to assess cost-effective response strategies for combating air pollution, such as fine particles and ground-level ozone.
Long Range Energy Alternatives Planning System–Integrated Benefits Calculator (LEAP-IBC)	Tool to calculate human health, vegetation and climate benefits for a target country resulting from addressing short-lived climate pollutants (SLCPs)	The LEAP-IBC model uses activity data and emissions factors to first calculate emission inventories for current and future years and to then use these emissions to estimate the resultant atmospheric concentrations of fine particulate matter (PM2.5) and ozone (O3) in the target country. Finally, the impacts on human health (e.g. change in premature mortality), vegetation (crop yield loss), and climate (temperature change in four latitudinal bands) are calculated.
WHO global air quality guidelines	Normative guideline values for all major air pollutants	To help countries improve air quality for health, WHO has set normative guideline values for all major air pollutants. The 2021 updated air quality guidelines cover recommended levels and interim targets for PM2.5, PM10, ozone, nitrogen dioxide, sulphur dioxide and carbon monoxide. The guideline values represent health-based targets useful for tracking the burden of disease from air pollution, informing national level targets and standards, and monitoring the effectiveness of air quality management efforts designed to improve health.
The Earth Commission	Evidence-based recommendations to ensure a just and sustainable future for humanity and nature	The Earth Commission defines a safe and just Earth system and outlines pathways to achieve it by assessing planetary health and developing strategies to address climate change, biodiversity loss and pollution.
Chemicals management		
Name	**Focus**	**Relevance for banks**
OECD sustainable chemistry	A proactive sustainable chemistry approach for risk management of chemicals, materials and products from their conception that enhances life cycle thinking.	The OECD offers tools and case studies associated with the proper management of chemical substances that serve as a reference for banks in their decision-making processes and delves into sectors and products of interest in their portfolios. Some of the materials available include case studies on plastic food packaging, insulation, *Considerations and Criteria for Sustainable Plastics from a Chemical Perspective, Technical Tools and Approaches in the Design of Sustainable Plastics,* and *Working Paper on Policy Approaches to Incentivise Sustainable Plastics Design,* among others.

The Inter-Organization Programme for The Sound Management of Chemicals (IOMC)	IOMC Toolbox is a problem-solving tool that enables countries to identify the most appropriate and efficient national actions to address specific national problems related to chemicals management	The tools developed under the IOMC provide guidance to public entities and are of relevance to banks in sectors and subsectors where the use of chemical substances represents both financial risks and opportunities. The tools include: ▪ Chemical Accident Prevention, Preparedness and Response ▪ Industrial Chemicals Management Scheme ▪ National Management Scheme for Pesticides ▪ Public Health Management of Chemicals and WHO Chemicals Road Map ▪ Classification and Labelling System Scheme ▪ National Management Scheme for Pollutant Release and Transfer Registers (PRTRs) ▪ Occupational Safety and Health Management Scheme for Chemicals ▪ Best Available Techniques
USEtox	USEtox is a tool for assessing and comparing chemicals in personal care products, toys, building materials and other products.	USEtox is based on scientific consensus providing midpoint and endpoint characterisation factors for human toxicological and freshwater ecotoxicological impacts of chemical emissions in life cycle assessment. It characterises human toxicity and ecotoxicity impacts for thousands of chemical emissions and product applications and provides a scientific foundation for the comparative assessment of chemicals.

3.3 Principle 3: Clients and Customers

Principle 3 states that banks are required to work responsibly with their clients to encourage sustainable practices and enable economic activities that create shared prosperity for current and future generations. Client engagement is identified as one of the four categories of action that banks can take as part of their impact management work, as identified by the UNEP FI Impact Protocol for Banks.

The PRB Guidance on Client Engagement (UNEP FI 2024e) provides step-by-step actions that banks can take, employing tools for banking institutional clients in the UNEP FI Impact Analysis Tools for Banks. It describes how effective client engagement depends on a robust internal setup composed of five activities, namely: (a) implementing the respective governance, policies and processes to oversee and implement the strategy, (b) ensuring adequate data collection and management infrastructure, (c) conducting a portfolio impact analysis, (d) engaging in strategy development, and (e) supporting capacity building for relevant staff.

Impact identification and target-setting work completed to evaluate the banks' portfolio of clients can be used to identify the most significant clients in terms of their pollution impact and relevance to the bank's business, then develop client and sector-specific engagement processes. Pollution impact data from clients can be obtained from mandatory disclosures and from client adoption of voluntary disclosure frameworks and standards. Sustainable finance taxonomies are being designed to provide a clear and consistent framework for identifying and classifying "green" economic activities (Box 3). Banks can encourage clients to adopt international performance standards that provide guidance, benchmarks, management systems and disclosure frameworks to assess pollution-related impact (and financial materiality) and stimulate adoption of safer chemical alternatives and practices. The data collected from clients with support from the bank can be used to refine impact assessment and target setting within the bank, and programme work with clients to identify data gaps and processes to complete them.

Box 4: Sustainable finance taxonomies

Sustainable finance taxonomies provide a clear and consistent framework for identifying and classifying green economic activities. By classifying economic activities based on their environmental impact, these taxonomies guide banks towards sustainable lending and investment opportunities (IFC, 2024). While they do not directly address the intricate complexities of chemical interactions, they offer a structured approach for banks to identify opportunities to support environmental goals across sectors and supply chains. Taxonomies apply a precautionary principle, highlighting potential risks from substances that may be widely used and approved. One of the six environmental objectives of the European Union's sustainable finance taxonomy is pollution prevention and control, covering air, water, soil, noise, and light pollution, as well as waste generation. The taxonomy sets specific technical screening criteria for economic activities to be considered as substantially contributing to pollution reduction, focusing on areas such as: hazardous substance reduction and phase-out, emissions control from industrial processes and transportation, proper waste management and disposal, and promotion of circular economy practices.

Eligible activities include the manufacture of low-emission vehicles, waste treatment and recycling operations, production of environmentally friendly materials, and development of pollution control technologies. While not a formal taxonomy, the United States of America has initiatives such as the Climate-Aligned Financial Products framework. In Asia-Pacific, China and Singapore, and in Latin America, Mexico and Colombia are developing similar taxonomies to support the sustainable economy agenda and catalyse sustainable and transition financing needs for the region and globally.

A strong global-standard-setting momentum is underway with more than forty-seven classifications announced, under development or adopted worldwide (SBSN 2024). While there is a growing push for global standardisation, differences in economic structures, environmental priorities and regulatory frameworks often lead to variations that remain highly relevant.

Banks can provide superior value to their clients while managing their own exposure effectively. The client engagement process is iterative in nature. At each cycle the needs of the client should be assessed, enabling design of support plans, their implementation and ongoing monitoring in relation to specific pollution impact targets, as described in PRB Guidance on Client Engagement (UNEP FI 2024e). Meticulous evaluation of client performance enables banks to refine their service offerings to better meet client needs. Proactive identification of potential challenges enables banks to develop mitigation strategies, protecting both the bank and the client and differentiated pricing structures can be implemented based on assessed risk levels. This holistic approach to client engagement not only protects the bank but also deepens customer trust and loyalty. By fostering strong client relationships, banks can also more effectively identify opportunities to support environmentally and socially responsible financing decisions and develop sustainable finance products that incentivise and reward targeted pollution impact reduction and constitute a core element for implementing their client support plan (Table 11).

Table 11: Examples of sustainable finance products and their relevance for pollution

Sustainable finance product	Key characteristics	Pollution relevance
Green bonds	Debt securities dedicated to green projects	Proceeds can be used to finance pollution control technologies, waste management and remediation projects
Green loans	Debt financing with environmental conditions	Can support investments in pollution prevention and control equipment, technologies and processes
ESG funds	Investment in companies with strong ESG performance	Can invest in companies with effective pollution management practices and low environmental impact
Green revenue bonds	Debt securities financed through project revenues	Can be used to finance public infrastructure projects with pollution reduction benefits (e.g. wastewater treatment plants)
Pollution control bonds	Debt securities specifically dedicated to funding pollution control projects	Directly addresses pollution issues by financing remediation and prevention efforts
Environmental impact bonds	Debt securities with performance-based repayments linked to environmental outcomes	Incentivises investment in projects with measurable pollution reduction targets
Green guarantees	Guarantees issued to support green projects	Can facilitate financing for pollution control projects by reducing lender risk
Green insurance	Insurance products covering environmental liabilities	Can provide financial protection against pollution-related incidents and encourage risk mitigation through higher premium for risky activities

3.4 Principle 4: Stakeholders

Principle 4 requires banks to consult, engage, collaborate and partner with relevant stakeholders. Stakeholder mapping, informed by portfolio impact assessment, can assist in defining which stakeholders, beyond clients, to engage with. Engaging with stakeholders provides banks with valuable insights into the environmental and social challenges associated with identified impacts and enables them to make informed decisions about lending and investment strategies to achieve stated pollution reduction targets. Stakeholder feedback can help identify potential pollution-related impacts (and subsequently associated risks) that may not be apparent through internal assessments. Understanding stakeholder expectations and concerns can help banks comply with evolving pollution-related regulations. It is crucial to be aware of potential conflicts of interest, to avoid facing the risk that some stakeholders may provide biased or misleading information to further their own agendas. Table 12 sets out typical external stakeholders and reasons for engaging with them.

The identification, assessment and management of pollution impacts is a highly technical and technology-driven set of activities that is subject to rapid advances in the development and deployment of measurement devices and science. Academia, research organisations, scientists and affected communities are often the first stakeholders to identify and experience the negative impacts of pollution, even before the banking sector or policy makers and regulators become aware of the issues. Their input is essential to provide necessary forewarning of pending pollution-related issues and define appropriate strategies and financing modalities to address them.

Table 12: Typical external stakeholders

Stakeholder	Reasons for engagement
Policymakers	Advocate for policies that promote sustainable practices and reduce pollution, influence regulatory frameworks and collaborate on policy development to address the negative impacts of pollution from the bank's portfolio.
Regulators	Stay informed about relevant regulations and industry standards, ensure compliance with regulatory requirements related to pollution reduction and provide feedback on regulatory frameworks to minimise the bank's exposure to pollution-related risks.
Industry associations	Collaborate with industry peers to develop common standards and best practices for pollution reduction, advocate for industry-wide changes and share knowledge and experiences on mitigating the negative impacts of pollution from the bank's portfolio.
Sector-specific standard setting institutions	Collaborate with standard-setting bodies to develop and promote industry-specific standards for sustainability and pollution reduction, ensuring that the bank's portfolio aligns with these standards and minimises negative impacts.
Academia/ Scientists/ Research institutions	Access expertise and knowledge on scientific and technical dimensions of environmental issues, support research and innovation in sustainable finance, and collaborate on studies to assess the bank's portfolio's contribution to pollution reduction.
Innovators	Identify and support innovative solutions for pollution reduction that can be applied to the bank's portfolio, such as technologies for sustainable agriculture or clean energy.
Civil society organisations (CSOs)	Collaborate with CSOs to address environmental concerns, gain insights from local communities affected by pollution and support sustainability initiatives that can reduce the negative impacts of the bank's portfolio.
Affected communities	Engage with communities that are affected by pollution from the bank's portfolio, address their concerns and develop strategies to mitigate negative impacts and promote community development.
Representative consumers	Understand consumer preferences and expectations regarding sustainability, incorporate consumer feedback into the bank's sustainability strategies and promote sustainable consumption choices that can reduce the negative impacts of the bank's portfolio.
Peers	Collaborate with other banks and financial institutions to share best practice, learn from each other's experiences and promote industry-wide adoption of sustainable practices.

Stakeholder input can also drive the development of innovative financial products and services that tackle the issue of pollution. Stakeholder engagement is crucial in mitigating the perception of heightened risk associated with innovative, environmentally focused technologies and business models. Having strong engagement with stakeholders can also limit resistance, uncertainty and subsequent restricted uptake of innovative financial products and services offered by banks. By fostering open dialogue with stakeholders, banks can dispel misconceptions, build trust, and create a more level playing field between traditional, potentially polluting investments and emerging sustainable opportunities. This balanced approach is essential for driving the transition towards a less polluting economy while managing financial risk effectively.

3.5 Principle 5: Governance and Culture

Principle 5 requires banks to develop governance structures that enable and support their effective implementation. By embedding pollution-related considerations into governance, culture, and decision-making processes, banks not only mitigate risks but can also identify new business opportunities in the emerging sustainable finance landscape. As defined in UNEP FI's Guidance on Effective Governance (UNEP FI 2024d), sustainability governance from a banking perspective is a system that promotes controlled progress, business integrity and is responsive to stakeholder voices. In line with this guidance, five pillars underpin sustainability governance in a pollution-specific context:

1. **Responsible leadership:** The board and senior management can develop expertise in pollution-related issues, including regulatory trends, technological advancements and stakeholder concerns. This could involve appointing board members with relevant environmental expertise or establishing advisory panels focused on pollution management.
2. **Governance design:** Banks can create clear roles and responsibilities for overseeing pollution-related impacts, risks and opportunities. This might include establishing a dedicated committee or integrating pollution considerations into existing risk management structures. Remuneration policies could be linked to pollution reduction targets or the development of pollution mitigation products.
3. **Pollution integration:** Pollution considerations can be embedded within the bank's core strategy and risk management framework. This could involve developing specific pollution-related risk assessment tools, integrating pollution metrics into credit decision-making processes or setting targets for financing pollution reduction technologies.
4. **Purpose and knowledge:** Banks can foster a culture of environmental responsibility, with a specific focus on pollution prevention and mitigation. This could include developing training programmes on pollution-related risks and opportunities for employees, from front-line staff to risk managers.
5. **Stakeholder engagement:** Banks can actively engage with stakeholders on pollution-related issues. This might involve collaborating with environmental non-governmental organisations (NGOs), participating in industry initiatives on pollution reduction or engaging with clients to support their transition to less polluting practices.

By applying these pillars, banks can create a robust governance framework that not only manages pollution-related risks but also positions them to capitalise on opportunities in the growing market for pollution mitigation and clean technologies.

3.6 Principle 6: Transparency and Accountability

Principle 6 requires banks to provide information on their implementation of the Principles for Responsible Banking. Several frameworks (and associated standards) for disclosure contain pollution-relevant components. Broadly put, the frameworks describe how the information should be reported, while the standards define what information needs to be collated. A comprehensive overview of the key methodological and conceptual trends among the nature-related assessment and disclosure approaches is provided in the recent UNEP FI report, Accountability for Nature (UNEP FI 2024a), whose next version is expected to include an analysis of pollution-related disclosure. They can be grouped into mandatory and voluntary disclosures. They differ largely on their focus being financial or impact materiality, or double materiality.

Mandatory regional reporting frameworks and standards include the Corporate Sustainability Reporting Directive (CSRD) and the European Sustainability Reporting Standards (ESRS). The CSRD sets the obligation for reporting, while the ESRS provide the technical specifications for that reporting, starting with a double materiality assessment that helps identify which topical standards are applicable.[7] Among the topical standards is ESRS E2 Pollution. As per ESRS E2 (European Commission 2023), companies must disclose their pollution impact, including air, water and soil contamination. This involves detailing actions taken to prevent and mitigate pollution, as well as outlining strategies to adapt to a less polluting economy. Financial implications of pollution-related risks and opportunities must also be disclosed, providing an understanding of the company's environmental performance and its potential impact on future profitability.

Most standards are voluntary, for example the Global Reporting Initiative (GRI) that is widely used by organisations worldwide to report on their environmental, social and governance (ESG) performance using a double materiality approach. The GRI is, at the time of writing, developing a new working group to update some of the pollution-related standards (GRI 2024b). Other voluntary standards include the CDP (formerly the Carbon Disclosure Project) which is focused on assessing the financial risks and opportunities associated with climate change (financial materiality), as well as GHG emissions information. The Sustainability Accounting Standards Board (SASB) has an industry-specific focus on environmental, social and governance issues that are most likely to affect a company's financial performance, such as its access to capital, cost of capital and reputation (financial materiality).

7 The impact analysis requirement of PRB Principle 2 and the identification process described in the UNEP FI *Impact Protocol* are equivalent to the impact materiality assessment component of the ESRS double materiality assessment (DMA) requirement. The UNEP FI frameworks and impact management suite of resources can therefore be leveraged for ESRS DMA; this can be facilitated through the dedicated UNEP FI – ESRS Interoperability Package.

Further examples include standards aimed specifically at investors, such as the International Sustainability Standards Board (ISSB). Created by the International Financial Reporting Standards (IFRS) Foundation, the ISSB is tasked with developing a global baseline of sustainability disclosure standards. It has incorporated SASB and TCFD in its IFRS S1 and IFRS S2 Standards:

- **IFRS S1 (General Requirements for Disclosure of Sustainability-related Financial Information)** sets general disclosure requirements designed to enable a company to communicate to investors the sustainability-related risks and opportunities.
- **IFRS S2 (Climate-related Disclosures)** is designed to be used alongside IFRS S1 and requires information specifically about climate-related risks and opportunities.

In April 2024 ISSB announced that it would commence research projects about risks and opportunities related to natural capital.

The Task Force on Climate-related Financial Disclosures (TCFD) was established in 2015, and the Taskforce on Nature-related Financial Disclosures (TNFD) was established in 2021 by a coalition of financial institutions, corporates and market service providers with support from UNEP FI. Both frameworks have gained significant traction and influence in the financial industry. They encourage companies to assess and disclose their dependencies and impacts on climate and nature, including pollution-related risks, impacts and dependencies.

The TCFD focuses primarily on the financial risks and opportunities associated with climate change. While it indirectly touches on pollution through its emphasis on greenhouse gas emissions and their impact on the environment, its scope is broader.

The TNFD, on the other hand, has a direct focus on nature-related risks, impacts and dependencies, and covers all drivers of biodiversity loss (except climate change, covered under the TCFD), including pollution. It recognises that pollution is a significant driver of biodiversity loss and ecosystem degradation, which can have financial implications for businesses and investors, and includes a set of pollution-related metrics (Table 13).

The TNFD uses a “LEAP Approach” to help organisations identify, assess and manage their nature-related risks and opportunities. LEAP stands for locate, evaluate, assess, and prepare:

- **Locate:** Identify direct and indirect dependencies and impacts on nature
- **Evaluate:** Assess the significance of those dependencies and impacts
- **Assess:** Identify and analyse the associated nature-related risks and opportunities
- **Prepare:** Develop strategies to address the identified risks and opportunities, including setting targets and reporting on progress

The LEAP approach is designed to be flexible and adaptable to different organisational contexts, enabling organisations to assess their nature-related issues and inform their disclosure statements in alignment with the TNFD recommendations. It has been adapted to multiple sectors (TNFD 2024a), including the financial sector, for which additional detailed guidance has been provided (TNFD 2024b). Its impact-focused components are aligned with the UNEP FI impact methodology.

Table 13: TNFD and ESRS pollution metrics

Pollution metrics	Description
TNFD	
C2.0—Soil pollutants by type	This metric focuses on the types and quantities of pollutants released into the soil, including chemicals, heavy metals and organic contaminants.
C2.1—Water pollutants by type	The TNFD encourages companies to disclose the volume and quality of wastewater discharged into water bodies, including information on pollutants and treatment processes.
C2.2—Waste generation and disposal	Information describing the quantity, type and methods of management are presented.
C2.3—Plastic pollution	Given the significant environmental impact of plastic waste, the TNFD emphasises the need to disclose plastic usage, recycling rates and efforts to reduce plastic pollution.
C2.4—Non-GHG air pollutants	While not as extensively covered as other pollution types, the TNFD acknowledges the importance of air quality and encourages companies to disclose relevant information, especially in sectors with significant emissions.
ESRS	
Greenhouse gas emissions	Total greenhouse gas emissions, including scope 1, 2, and 3 emissions.
Air pollutant emissions	Emissions of specific air pollutants, such as particulate matter, sulphur oxides and nitrogen oxides.
Water consumption	Total water consumption and water use efficiency.
Wastewater discharge	Volume and quality of wastewater discharged into the environment.
Water pollution incidents	Number and severity of water pollution incidents.
Soil contamination	Levels of contaminants in soil, such as heavy metals, pesticides and organic pollutants.
Land degradation	Extent of land degradation due to pollution or other factors.
Soil remediation efforts	Measures taken to remediate contaminated soil.

4. A first approach to high-priority sectors

To manage impact effectively in their institutional portfolios, banks need a sector-based approach, given that sector-specific factors are what drive their clients' impacts. Sectors share common challenges in addressing pollution across the life cycle of supply chain activities encompassing design, production, distribution, consumption and end-of-life phases. Moreover, the specific pollution impacts (and hence the solutions) vary widely across sectors, necessitating tailored approaches. Sectoral specificity underscores the need for a nuanced understanding of pollution impacts, risks and opportunities when developing sustainable finance strategies. UNEP FI Sectors Mapping (UNEP FI 2024f) identifies agriculture, mining, manufacture (including the manufacture of chemical products and pharmaceuticals, textiles and apparel) as some of the key sectors requiring addressing their potential impact in terms of pollution to air, soil and waterbodies.

This section develops a first approach for banks to five high priority sectors: mining, textiles, agriculture, pharmaceuticals and electronics, due to their significant environmental impact across various stages of production, consumption, and waste management. While advances in technology and regulations aim to mitigate these impacts, the scale and complexity of these industries often contribute substantially to pollution, environmental degradation and negative impacts on human health, especially on the most vulnerable communities. Opportunities for banks to take more sustainable and circular approaches are also outlined for these sectors.

The sectors analysed are not the only relevant sectors globally in terms of (non-GHG) pollution, but all stages of their product/service life cycles and value chains feature many of the issues (and emerging issues) of concern that international bodies have identified as requiring urgent attention. Impacts, risks and opportunities differ by sector, but arguably across all sectors, the design and development phase offers the most important potential for transition shift. Circular economy strategies, which focus on rethinking conventional processes to ensure efficient resource use through cycles of design, production, use and recovery, can play a crucial role in reducing pollution and minimising waste across these sectors—from raw material extraction to end-of-life management.

In the following sections the sectoral insights are made by applying the concepts presented in Table 3 on impact materiality and Figure I on financial materiality. Each sector faces distinct challenges, yet they share commonalities such as transition risks (e.g., regulation, consumer preferences, technology) and physical risks (e.g., declining productivity, human health impacts) that can translate into financial risks. For example, while consumer preferences may initially seem less relevant to sectors like mining, the broader societal trends towards sustainability and ethical consumption will eventually impact demand for certain raw materials and the production methods used to extract them.

4.1 Mining

Global demand for major metals (iron, aluminium, copper, zinc, lead, and nickel) is likely to increase by two to six-fold depending on the metal over the 21st century (Watari *et al.* 2021). Much of this growth in demand, particularly for copper, lead, cobalt, graphite, lithium, nickel and rare-earth elements, will be driven by requirements for clean energy technologies. United Nations Conference on Trade and Development (UNCTAD) projections indicate that by 2050, lithium demand could rise by more than 1,500%, with similar increases for nickel, cobalt and copper (UNCTAD 2024). The annual production of gold from artisanal and small-scale gold mining (ASGM) has increased from 380–450 tons in 2010–2011 to more than 600 tons in 2020 involving more than 20 million people in a sector that is largely not officially recognised or registered, regulated or protected (Prescott *et al.* 2022).

The growing demand for these metals, coupled with increasing pollution risks associated with terrestrial mining, is driving interest in new sources of supply, such as deep-sea mining. However, deep-sea mining also carries significant environmental impacts that are largely unknown, making it a controversial and complex issue. Without urgent and concerted action to change the way resources are used, material resource extraction could increase by almost 60% from 2020 levels by 2060, from 100 to 160 billion tonnes (UNEP FI 2024c). The application of circular economy principles, to recover and re-use elements from wastes from downstream sectors, for example electronics, batteries and construction, offers a real solution to this challenge.

Pollution impacts from the mining sector

Environmental: Terrestrial mining operations can generate a wide range of environmental impacts throughout their life cycle. The primary pollution impact from mining is from contamination of ecosystems (soil, water and air) with heavy metals and toxic compounds released from the materials being processed and materials used in processing. Common toxic/heavy metals and metalloids that can be released into the environment from mining activities include arsenic, cadmium, chromium, copper, lead, mercury and zinc. These heavy metals can contaminate water, soil, and air, impacting the health and integrity of entire ecosystems. The impacts of ASGM are of increasing concern, not only because of its role in driving deforestation, but also because of the largely unregulated use of mercury and other chemicals for extraction of gold. ASGM is the world's largest source of anthropogenic mercury emissions and releases (Prescott *et al.* 2022). The bioaccumulation of methylmercury creates hotspots of contamination in terrestrial and aquatic ecosystems and organisms.

Social: At least 23 million people around the world live on floodplains contaminated by potentially harmful concentrations of toxic waste from metal-mining activity according to a recent study (Macklin *et al.* 2023) Terrestrial mining operations can generate a wide range of environmental impacts throughout their life cycle. The primary pollution impact from mining is from contamination of ecosystems (soil, water and air) with heavy metals and toxic compounds released from the materials being processed and materials used in processing. Common toxic/heavy metals and metalloids that can be released into the environment from mining activities include arsenic, cadmium, chromium, copper, lead, mercury and zinc. These heavy metals can contaminate water, soil, and air, impacting the health and integrity of entire ecosystems (Macklin *et al.* 2023).

Heavy metals can bioaccumulate and biomagnify in food chains, leading to long-term health effects. The consumption of fish, meat and vegetables contaminated with methylmercury, for instance, can result in severe health deterioration, and in some cases results in Minamata disease, a poisoning of the nervous system. Mining pollution disproportionately affects local communities, particularly women, who often bear the brunt of health risks due to their roles as caregivers and their exposure to contaminated resources. Pollution-related health issues, including respiratory problems, reproductive health complications and waterborne diseases, exacerbate existing socioeconomic challenges. Addressing these issues requires recognising and addressing gender disparities, ensuring women's participation in decision-making, and implementing policies that prioritise environmental justice and women's health and well-being.

Economic: The mining sector can be a major driver of economic growth and can support a wide range of development outcomes across the SDGs. However, if adequate safeguards are not taken, it leaves a significant environmental footprint that translates into substantial economic costs. One of the most direct economic consequences is the enormous expense associated with environmental remediation. Mining activities, particularly the disposal of tailings and waste rock, can lead to severe contamination of soil and water resources. The cleanup of these sites is often a complex and costly process, with expenses potentially running into billions of dollars. Abandoned mines and tailings dumps have consequently created extensive environmental liabilities in many countries, requiring significant public and private investment for restoration. For instance, the remediation of the Giant Mine in Canada is projected to cost around USD 4.38 billion, making it one of the most expensive federal environmental cleanups in the country's history (Blake 2022).

Pollution risks in the mining sector

Transition risks

Regulatory/legal: Activities at every stage of the mining value chain may lead to release of potential pollutants that can contaminate surface water, ground water, air and soil at scale, causing enduring negative health impacts and environmental and social repercussions. For these reasons, EY considered "social license-to-operate" the number one business risk for the mining sector over the past five years (EY 2023). Banks also face the risk of being held liable for environmental damages, legal and clean-up costs associated with environmental liabilities caused by their clients engaged in mining activities. Further, regulatory changes or non-compliance penalties can expose banks to financial and reputational risks, and to risks of default if projects encounter environment-related problems that impede their feasibility, their profitability or the long-term sustainability of their portfolios.

The mining industry faces major risks that may be controlled for, as far as is possible, in the design and production phases. However, its exposure to risks during the use phase of refined materials is limited, with risk concentration shifting to downstream sectors such as construction or electronics. Nevertheless, financial institutions are increasingly held accountable for the entire life cycle impacts of the projects they fund, including potential future liabilities arising from the use of mined materials. For instance, regulatory controls on materials such as asbestos due to health concerns have led to stranded assets, illustrating the transitional risks that can impact both the mining sector and its financiers. This evolving landscape of responsibility underscores the critical need for banks to conduct thorough due diligence and ongoing risk assessments throughout the entire life cycle of mining projects they finance, from extraction to end-of-life management.

Technological: Technological progress in mining can create additional risks. For example, the increased use of automation and artificial intelligence can lead to job losses, which can reduce the social benefits of mining and create additional pressures on mines to develop alternative employment opportunities with local communities where they operate. On the other hand, mines who fail to adopt the latest mining technologies, will not benefit from reduced labour and processing costs. At the same time, new mining technologies such as deep-sea mining can introduce new environmental and regulatory risks. Banks can carefully assess these risks and adjust their lending and investment strategies to mitigate potential losses.

Rising prices for scarce minerals also stimulate the development of substitutes, which often occurs more rapidly than the implementation of regulatory controls (Lovins 2021). For instance, many applications that currently rely on permanent-magnet motors and generators can be achieved through alternative technologies that do not require rare earth minerals, providing a potentially more sustainable solution. One example is the development of iron-nitride supermagnets. Similarly, researchers and industry are developing magnet-free induction motors for use in wind turbines and EVs. Efforts are also underway to find alternatives to cobalt, a critical material for electric vehicle batteries.

Physical risks

Health: Mine workers and nearby communities may face direct exposure to hazardous substances, leading to respiratory problems, skin ailments, and neurological disorders. Specific health impacts vary depending on the metals being mined (Macklin *et al.* 2023). For instance, exposure to cobalt and nickel mining is most associated with respiratory toxicity, while manganese mining is linked to neurologic toxicity. Long-term exposure can lead to chronic conditions such as pneumoconiosis (black lung disease) in coal miners. ASGM poses particular risks to local communities, as mining operations are often poorly managed and regulated, and outdated hazardous practices are common. Also, when previously contaminated land is cleared for agricultural use, or to extend mining activities, as hazardous pollutants, for example mercury, can then be transferred to aquatic ecosystems it bioaccumulates and biomagnifies in aquatic food webs and species of importance for local food security.

Air: Mining operations release particulate matter, volatile organic compounds and other pollutants that can cause respiratory issues and reduce air quality in surrounding areas. Fine particles from smelting operations or slag dumps can disperse widely, penetrating deeply into the respiratory system and causing adverse health effects. Mining and metals are also among the world's most carbon-intensive sectors. For example, estimates suggest that steel, aluminium, gold and copper are responsible for 11%, 3%, 0.4%, and 0.2% of global carbon dioxide emissions, respectively (UNEP FI 2024c).

Soil: The soils surrounding mining sites are often severely affected by multiple metal and metalloid contaminants, including arsenic, cadmium, copper, zinc, and lead, and also by salinity, which restrict land use through the degradation of soil structure and horizons, disruption of soil microbial communities' structure, and alteration of nutrient cycles. Even after mining operations cease, tailings ponds left on site continue to be a major source of contamination and disturbance to the surrounding ecosystem. This ongoing pollution can persist for decades, affecting soil fertility and potentially entering the food chain through crops grown in contaminated areas (Leila *et al.* 2020).

Fresh water: Mining activities introduce pollutants like mercury, lead, cadmium, and arsenic into water systems through leaching from tailings, illegal dumping, and improper disposal practices. This contamination can lead to long-term degradation of water quality, affecting both surface water and groundwater, with significant health risks to aquatic ecosystems and communities relying on these water bodies for drinking and agriculture. For example, sulphide-bearing minerals exposed to oxygen and water can generate acid mine drainage, a significant source of pollution containing high concentrations of metals. Ore bodies rich in these minerals are particularly susceptible to this issue, increasing the risk of heavy metal release into ecosystems.

Oceans: Pollutants from mining operations and tailings can reach coastal areas through rivers and groundwater, affecting marine life. In addition, deep-sea mining is an emerging threat, potentially causing widespread and permanent damage to deep-sea ecosystems and biodiversity. These activities also risk disrupting the ocean's crucial role in carbon cycling and storage, as marine sediments are a significant global carbon sink.

Each mining operation is unique in location, scale, ore body characteristics and specific techniques to process the ore, such as heap leaching or flotation. Together, these factors determine the types of chemicals and levels of pollution risks associated with the mining operation, while environmental regulations and economic factors may influence the choice of mining technology and waste management practices. Open-pit mining, compared to underground mining, generates more dust, contributing to air pollution and respiratory problems. It also exposes more ore to oxygen and water, increasing the risk of acid mine drainage and damage to water bodies.

It is therefore crucial to consider the specific social and biophysical context of each project when assessing and mitigating pollution risks, and to understand that these extend beyond the mine facility to the surrounding, mine-connected ecosystem and community. Detailed and comprehensive expert models, comprehensive baseline data collection and continuous monitoring of environmental and social characteristics and performance are an essential part of daily operations. Pollution risks in the mining sector encompass a spectrum of environmental and social issues that can emerge at various stages of the mine's life cycle, from design and development to end-of-life, as illustrated in Figure III.

Lifecycle Stage	Design & Development	Production	Distribution	Use	End-of-Life
Some Priorities	• Ensuring the mine is designed to minimise biodiversity loss and environmental contamination • Achieve net-zero targets • Effective and planned mine closure including remediation, on-going monitoring and post-mining green economic transition	• Reducing air and soil pollution, water use and pollution, land degradation, waste generation affecting local communities and ecosystems in all mine operations	• Reducing emissions, accidents and spills during transportation	• Eliminating hazardous chemicals in products (CIPs) and product-related exposure	• Mine closure, facility decommissioning and subsequent post-closure monitoring, remediation, revegetation and repurposing
Some Sustainable Finance Opportunities	• Advanced resource exploitation techniques to minimise contaminant release on extraction • Ore processing design • Net-zero life-of-mine design • Smelter design and waste management systems • Mine closure design	• Green bonds and escrow services for mine reclamation • Clean technologies • Sustainable supply chain financing	• Sustainable logistics • Low-carbon transportation • Supply chain traceability	• Extended producer responsibility • Take-back programs • Circular economy initiatives	• Financing for mine closure and reclamation • Post-closure monitoring

Figure III: The mining life cycle

Opportunities in the mining sector

Developing a mine can take many years. The average life of a mining project from identification of a viable deposit to production can exceed thirty years (S&P Global 2024). The life of mine can vary from five to more than 70 years. Closure (end-of-mine) and post-closure (post-mine) periods can be far more than 20 years depending on local and regional regulations and the complexity of the project. The long lead times, that involve stakeholder engagement, environmental and social impact assessments, resource qualification, design of operations and bankable feasibility studies (BFS) necessary for permitting and financing, provide an important opportunity for mining companies to design systems that minimise pollution throughout the life of a mine. By adopting a life-of-mine approach in the design phase it is possible to optimise resource extraction to minimise contaminant by-product emissions, to design highly efficient mine processing and waste management systems that eliminate or reduce the adverse pollution and impacts that mining can create, and to prepare technical interventions and financial resources for mine-closure, remediation and post-mining pollution monitoring.

Given the significant capital investment required for mining, banks have a unique opportunity to influence the industry's future. By introducing tailored financial instruments that address issues at each stage of the mining life cycle banks can incentivise mine operators to adhere to sustainability frameworks. These initiatives can surpass current industry standards, promoting more environmentally conscious mining practices:

- **Advanced resource qualification and mine planning:** Resource qualification is a critical step in the mining process as it provides the basis for project feasibility studies, mine planning and investment decisions. Modern geospatial resource qualification and extraction modelling techniques can be used to ensure "optimal" mine design and resource extraction of the primary minerals of concern, with concomitant avoidance of pollutant by-products. This means avoiding those parts of the ore body that have excessive concentrations of potentially harmful pollutants that cannot be addressed effectively through waste management processes.

- **Promoting innovation for waste management:** Mining operations generate polluting waste materials with enduring negative impacts. Banks can support cost-reducing innovations aimed at reducing waste volumes and revenue increasing innovations that enhance metals/mineral recovery.
- **Addressing tailings facility threats with specialised financial tools:** The multitude of tailings storage facilities (TSFs) and the magnitude of the negative impacts and risks to human lives represent a significant latent threat, particularly post-closure, if not effectively managed. Banks can engage with mining clients to ensure they provide adequate timely information on the management of these facilities. Moreover, designing specific financial instruments that align with the Global Industry Standard on Tailings Management can mitigate irreversible environmental impacts, ensuring responsible closure and minimising of long-term risks (ICMM 2020).
- **Supporting artisanal and small-scale mining (ASM) through responsible financing:** Banks can bolster ASM by validating ancestral rights, ensuring legal compliance and recognising their role in regional economies and strategic mineral supply chains. Financing ASM's transition to cleaner technologies and socially responsible practices is pivotal. Initiatives like the PlanetGold Programme offer insights into financing ASM that align with banks' interests in sustainable and responsible investments. The PlanetGOLD programme, led by UNEP, is advancing sustainable practices in the artisanal and small-scale gold mining (ASGM) sector, which supplies around 20% of global gold output but faces environmental and social challenges, such as mercury pollution. Banks have an opportunity to support ASGM through responsible financing—validating ancestral rights, ensuring legal compliance and recognising ASM's role in regional economies and strategic mineral supply chains. By financing the sector's transition to cleaner technologies and socially responsible practices, banks can align their portfolios with sustainable development goals. Insights from the PlanetGOLD programme's work on ASM financing—outlined in resources such as Access to Finance—can guide banks in supporting ASM within a sustainable investment framework. Additionally, the role of central banks in ASGM, particularly through domestic gold purchase programmes as outlined by the World Gold Council's London Principles, is gaining traction. UNEP's collaboration with the World Gold Council is exploring these models, with PlanetGOLD projects in the Philippines, Mongolia, Ecuador and Colombia testing approaches to integrate ASGM into formal, responsible supply chains and advance clean mining practices.
- **Encouraging mineral recovery initiatives for sustainable value chains:** Investing in mineral recovery projects beyond traditional electronic waste recycling presents a compelling opportunity. Banks can support initiatives focused on recycling metallic and non-metallic minerals, fostering a circular economy. This not only enhances business prospects but also reduces the pressure on new mineral extraction.
- **Facilitating responsible mine closure and rehabilitation:** Supporting mining operations' closure and post-closure phases is crucial. Banks can play a pivotal role by ensuring transparency through public disclosure of closure plans and financial liability cost estimates. Introducing diverse tailored financial instruments will aid in securing adequate closure, facilitating land reuse and restoring economic value to intervened areas, benefiting both companies and communities.

To mitigate pollution-related risks and leverage the opportunities to their advantage, banks can employ several measures before financing mining projects. These include:

- Ensuring compliance with environmental regulations
- Incorporating environmental risk assessments into lending criteria and
- Actively engaging with mining companies in the design phase to support and incentivise them to adopt cleaner production technologies and implement effective waste management practices.

Banks can engage with clients to ensure they develop financial plans for mine closure, facility rehabilitation, monitoring and mitigation of environmental pollution and impacts post-mine closure.

Due to its potential for significant environmental and social harm, the mining sector is heavily regulated in some parts of the world. Additionally, a wide range of governance frameworks, voluntary standards, sectoral guidelines and tools exist to promote positive social, environmental and economic outcomes in the mining industry. Table 14 provides an overview of various tools and initiatives that banks can leverage to promote sustainable finance and mitigate environmental risks. These resources offer guidance, frameworks and platforms to support banks in integrating sustainability into their business operations and decision-making processes.

Table 14: Mining sector standards, guidelines, tools and reporting initiatives relevant to the banking sector (non-exhaustive list)

Additional sectoral guidance: Metals and mining (TNFD)
The LEAP approach, a framework for assessing and managing nature-related risks and opportunities, can be applied to the metals and mining life cycle through specific guidance and tools. Core global disclosure metrics tailored to this sector are available, along with sector-specific indicators and metrics to identify potential dependencies and impacts on nature. Dependency and impact matrices can further help organisations in this sector assess their interactions with ecosystems and identify risks and opportunities. Illustrative lists of environmental assets, ecosystem services, impact drivers, risks and response actions specific to the metals and mining sector can provide practical guidance for implementation.
International Council for Mining and Metals (ICMM)
Bringing together 24 major mining companies and 42 mining and metals associations. Pollution principles focused on include health and safety, environmental performance, risk management, biodiversity conservation and responsible production. Tools developed for its members include: ▪ Tools supporting integrated mine closure ▪ Water Reporting: Good Practice Guide ▪ Tailings Reduction Roadmap ▪ Adapting the ICMM Tailings Management Good Practice Guide into Training Materials ▪ Health and Safety Performance Indicators: Guidance ▪ Hazard Assessment of Ores and Concentrates for Marine Transport: Guidance ▪ Working Together: How Large-scale Mining can Engage with ASMs

Sustainability Reporting in the Mining Sector: Current Status and Future Trends (UNEP)
Developed by UNEP in 2020, the report provides a comprehensive overview of the status of sustainability reporting in the large-scale mining sector. It has a specific focus on how governments can further support the efforts of the sector in advancing their sustainability practices and reporting. The report offers recommendations to governments on how to further support the sustainability performance of the mining companies operating in their jurisdictions and more particularly how to support their sustainability reporting efforts. Other recommendations are addressed to mining companies and other stakeholders, including the financial sector.
Managing mining for sustainable development: A sourcebook (UNDP)
Developed by United Nations Development Programme (UNDP) in 2018 the guide provides tools that can be relevant for banks to: i) provide national and local policymakers and international development partners with an introduction to sustainability considerations related to the social, environmental and economic impacts of mining, as well as policy tools and practices for managing mining for sustainable development, and ii) suggest ways for national and local policymakers and development partners to better integrate social and environmental sustainability into their work, thereby strengthening the sustainable management of mineral resources at national and sub-national levels, and enhancing the economic benefits of mining achieving the SDGs.
Alliance for Responsible Mining (ARM)
ARM works with and for artisanal and small-scale miners on economic, social and environmental issues, using tools and developments specific to the contexts of the countries in which they operate. Currently, the project portfolio is focused on Latin America and Africa. It holds significance for banks as it provides an avenue to support sustainable financing and investments that promote responsible mining practices, ethical supply chains and community development, aligning with principles of social responsibility and environmental stewardship.
Environmental, Health and Safety Guidelines for Mining (IFC)
Provides guidance on environmental aspects (including pollution), occupational health and safety, community health and safety, mine closure and post-closure, performance indicators and monitoring, and occupational health and safety performance. It is applicable to underground, open-pit mining, alluvial mining, solution mining and marine dredging.
Mine Closure: A Toolbox for Governments (World Bank)
Provides policymakers, governmental administrators, and lawmakers with the information needed to develop a broad governance framework that reduces the risks of an improperly managed mining industry and helps ensure successful mine closure. It offers crucial insights into establishing robust governance frameworks for mine closure, enabling banks and financial institutions to assess and manage investment risks associated with mining operations while promoting responsible lending practices and sustainable financing within the mining sector.
Environmental Impact of Extractive Industries (EITI)
EITI The Extractive Industries Transparency Initiative Requirement 6.4, Environmental Impact of Extractive Industries, Guidance Note (EITI 2021) provides step-by-step guidance to multi-stakeholder groups (MSGs) on how to disclose information related to management and monitoring of environmental impact across the value chain, offers examples from implementing countries and outlines opportunities to strengthen the dissemination and use of data.

Model Mining Development Agreement (MMDA)
In 2009 the Mining Law Committee of the International Bar Association established a project to prepare a model mining development agreement (MMDA) that mining companies and host governments can use for mining projects. The MMDA project seeks to provide a tool with a specific starting point. It asks what a mining contract might look like if the process started from the precept of a project aiming to contribute to sustainable development. It seeks to provide an agenda for negotiations based on a sustainable development objective that is common to all parties.
Initiative for Responsible Mining Assurance (IRMA)
IRMA provides a suite of resources including: ▪ Standards: IRMA's globally recognised standards set rigorous requirements for environmental protection, social responsibility and governance in mining operations. ▪ Certification: IRMA offers independent, third-party certification to mines that meet its standards, providing a seal of approval for responsible practices. ▪ Training and capacity building: IRMA provides training programmes and resources to help mining companies, communities and civil society organisations build the capacity to implement responsible mining practices. ▪ Research and advocacy: IRMA conducts research and advocacy to promote responsible mining and address challenges faced by the industry. ▪ Knowledge sharing: IRMA facilitates knowledge sharing and collaboration among stakeholders to drive continuous improvement in responsible mining practices.
Global Reporting Initiative, GRI Mining Standard
Developed by a multi-stakeholder expert group, the Standard identifies 25 topics that encapsulate the full range of impacts for mining organisations, including: ▪ Environmental: climate change, greenhouse gas and air emissions, biodiversity, water and waste ▪ Social: community engagement and human rights, including those of Indigenous Peoples, land and resource rights, modern slavery and forced labour ▪ Economic: anti-corruption, procurement and payments to governments ▪ The most recent draft adds new topics to the GRI Standards including: tailings facilities and hazardous waste streams, artisanal and small-scale mining, and operating in conflict zones. The draft Standard aligns with existing ESG and disclosure frameworks for the sector.
Global Industry Standard on Tailings Management (GISTM)
The GISTM requires operators to take responsibility and prioritise the safety of tailings facilities, through all phases of a facility's life cycle, including closure and post-closure. It also requires the disclosure of relevant information to support public accountability. The Standard is supported by conformance protocols that will provide detailed guidance for certification or assurance, as applicable, and for equivalence with other standards.
Sustainable Bauxite Mining Guidelines
Developed by the International Aluminium Institute these guidelines build on the 2018 Sustainable Bauxite Mining Guidelines (SBMG) and provide a practical, attainable guide to improve sustainability. It is bauxite-specific and has theory and examples developed at some mines over 50 years, which provide crucial learnings from past collective experience. Includes a section on how aluminium mining companies can assess and mitigate air pollutant emissions from their mining operations.

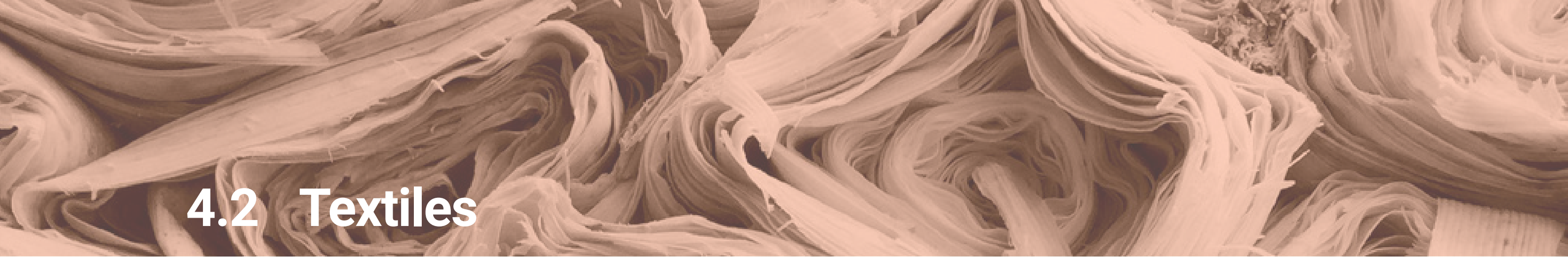
PlanetGOLD Programme for Artisanal and Small-Scale Gold Mining (ASGM): The PlanetGOLD programme, led by UNEP, supports the sustainable transformation of the artisanal and small-scale gold mining (ASGM) sector. ASGM is responsible for around 20% of the world's annual gold production but is often linked to environmental challenges, such as mercury pollution, and adverse social impacts. PlanetGOLD works to reduce and eliminate mercury use in ASGM by supporting countries in implementing best practice, improving access to financing and fostering market demand for responsibly sourced gold. Through targeted projects, the programme addresses the sector's challenges and encourages a responsible transition, promoting healthier communities and cleaner practices across the globe.

National action plans under the Minamata Convention: As part of UNEP's commitment to minimising mercury pollution, it assists parties to the Minamata Convention in developing national action plans (NAPs) for ASGM. The NAPs provide a structured approach for countries to assess the environmental and health impacts of mercury use in ASGM, set goals and implement actions for reducing mercury use and emissions. These plans are essential tools for countries to meet their obligations under the Minamata Convention, helping to ensure that mercury emissions are minimised, worker and community health is safeguarded and environmentally responsible mining practices are promoted in ASGM communities worldwide.

Despite these initiatives, the sector-specific and fragmented nature of current mining governance can be incompatible with the holistic decision-making needed to deliver positive change (IRP 2020). Again, the significant capital investment required for mining means banks have a unique opportunity to influence the industry's future.

To explore how financing mechanisms can support responsible mining, the UN International Resource Panel (IRP) is currently developing a report to guide investors, shareholders and stakeholders on how to drive financial resources towards more sustainable practices. The shift to circular practices in mining aligns with the insights from the upcoming IRP report on critical minerals, which highlights the need for sustainable resource management to meet global demands for low-carbon technologies. The IRP report emphasises that efficient, circular management of critical minerals—through strategies such as recycling, reuse, and reduced material intensity—can significantly reduce environmental and social impacts. For financial institutions, this guidance underscores the importance of supporting circular approaches in mining to foster resilience in supply chains, mitigate environmental degradation and ensure responsible sourcing practices that align with sustainability and climate goals.

The mining sector has always been at the forefront of innovation, and as mentioned, there is a growing interest in the potential for deep sea mining. Given the high level of scientific uncertainty and potentially devastating environmental impacts of deep-sea mineral extraction, UNEP FI has also published a briefing paper to understand the risks and impacts of financing marine extractive industries (UNEP FI 2022a). This briefing paper discusses the significant reputational, regulatory and operational risks associated with deep-sea mining and provides recommendations for financial institutions to respond to the deep-sea mining sector. In addition, the paper sheds light on alternative strategies that reduce the environmental footprint of terrestrial mining and support the transition toward a circular economy.



4.2 Textiles

In 2019 the global textile market was valued at USD 961.5 billion. It is estimated to exhibit a compound annual growth rate (CAGR) of 4.3 per cent to 2027 (Norarmi *et al.*, 2022). The growing consumer advocacy for sustainability in the fashion industry has not been enough to counteract the negative impacts of an increasingly dominant "fast fashion". Despite the "conscious consumer" movement, the prevalence of cheap, mass-produced clothing designed for short-term use continues to drive overconsumption, leading to excessive waste and pollution. This trend has significantly increased waste generation in production and disposal of garments in landfills, open dumps and other uncontrolled circumstances (International Affairs Forum 2024).

Pollution impacts from the textiles sector

Environmental: The textile industry's environmental impact is significant. It extends from the production of raw materials;—natural fibres from agriculture and synthetic fibres from petrochemicals—to end-of-life. As such it is necessary to assess the textiles sector role as driver on natural resource dependencies and pollution impacts of agricultural and raw materials producing sectors. The textile sector is responsible for an annual water consumption of around 215 trillion litres and an estimated 16% of all insecticides and 7% of all herbicides used annually. Water consumption, especially during yarn preparation, bleaching, and dyeing, can cause water stress and chemical pollution. Producing 1 kg of textiles on average requires 0.58 kg of various chemicals (EMF 2017). To date, around 3,500 different chemicals have been identified for their use in the textile industry, with at least 175 considered highly environmentally concerning. Meanwhile, more chemicals may be used in the textile industry and may be environmentally concerning, which remain to be identified, tested and assessed (Šajn 2019). GHG emissions from the textile value chain are estimated to be between 2% and 8% of global annual emissions, depending on the methodology used (Han *et al.* 2017). Waste disposal, particularly the degradation of textiles in soil, contributes to methane emissions, a potent greenhouse gas.

In addition, plastic pollution represents a significant concern. The textile sector is a significant source of plastics-related pollution, as polyester is the most used textile fibre, making up 54% of global fibre production in 2022 (Cañete Vela *et al.* 2022; Textile exchange 2017). The textile sector is responsible for approximately 9% of annual microplastic losses to the oceans, mainly through the release of synthetic fibres during washing (UNEP 2023b). A single laundry load of polyester clothes can discharge 700,000 microplastic fibres that can end up in aquatic systems and ultimately the food chain (Šajn 2019). Polyester continues to be the most used textile fibre, representing 54% of global fibre production in 2022 (Textile Exchange 2023). In addition, heavy metals such as chromium and copper used in dyeing accumulate in soils and threaten soil health and food contamination and subsequent impacts to human health.

Social: The large quantity of toxic chemicals used during fibre production and dyeing pose significant potential health risks from air pollution for workers in factories and communities living in proximity to processing facilities. Workers in the textile sector face health risks from exposure to hazardous chemicals, with poor chemical management costing the industry an estimated EUR 7 billion annually (Natural Resources Defence Council 2021). Communities and workers in low-income countries, particularly where small-scale and informal production is prevalent, are disproportionately affected by pollution from the textile sector. They face higher health risks and exposure to toxic chemicals, due to the concentration of factories in these regions, limited access to healthcare, weaker environmental regulations and lack of oversight. Having specific policies in place to ensure workers' health and safety along the textile supply chain is essential, aligning with global efforts to ensure ethical and responsible business practices. Addressing these challenges requires coordinated policy frameworks, international standards, and enforcement mechanisms to create a level playing field and ensure that pollution mitigation practices are adopted universally.

Economic: Environmental pressures have been estimated to put EUR 110 billion of value at risk (UNEP 2023b), underscoring the significant financial implications for both the industry and its financiers if sustainability challenges are not adequately addressed. Estimates suggest that less than one per cent of materials used during the production of garments are recycled into new clothing and 73% of garments end up in landfills and open dumps releasing hazardous chemicals as they degrade or harmful emissions during incineration. This represents a loss of over USD 100 billion worth of materials each year (EMF 2017).

Pollution risks in the textile sector

Transition risks

Regulatory/legal: Despite widely acknowledged concern over the volume and variety of chemicals used in the textile sector, it is still challenging to identify all industrial chemicals used and emitted due to limited capacity, a lack of transparency and poor tracking systems necessary to verify the environmental practices of suppliers and subcontractors (UNEP 2023a). This opacity is particularly pronounced in countries with less stringent oversight, where many textile manufacturing operations are located. The resulting information gap, exacerbated by insufficient data on the environmental and health impacts of pollution, hinders banks and investors from accurately assessing their exposure to international regulatory and reputational risks.

Governments and regulatory bodies are responding to these challenges with increasingly stringent measures. For instance, the European Union has implemented restrictions on hazardous chemicals in textiles through the REACH Regulation, banning or limiting the use of certain substances classified as carcinogenic, mutagenic or toxic for reproduction. The fast fashion industry, known for its rapid production cycles and low-cost clothing, is particularly vulnerable to these regulatory shifts. As governments impose stricter regulations, including labelling requirements and extended producer responsibility (EPR) laws, fast fashion brands face the challenge of balancing consumer demand for affordable clothing with the need to adopt more sustainable practices. This regulatory pressure is pushing the industry towards circular economy models that prioritise recycling, reuse and repair. Textile companies failing to reduce impacts from pollution throughout their operations and supply chains may face increasing legal risks, resulting from fines, lawsuits, reputational damage and potential liabilities for environmental cleanup or harm to workers and communities. Pollution incidents and supply chain disruptions can expose banks to financial risks, affecting the long-term sustainability of their portfolios and leading to financial losses, asset devaluation and reputational damage.

Technological: The innovation of sustainable materials and technologies, such as recycled textiles and biodegradable fibres can reduce the demand for virgin materials, disrupting traditional supply chains and business models. Additionally, digital textile printing technologies can reduce water consumption and chemical usage, while circular economy models can minimise waste and promote sustainability. However, these advancements can also pose challenges for traditional businesses, as they may require significant investments in new technologies and processes. Other technological advancements in high precision measuring, in supply chain tracking and blockchain could make it easier to trace the origin of pollutants and attribute responsibility to specific manufacturers or suppliers. This increased transparency poses a risk to companies that have historically benefited from the opacity of complex global supply chains. The European Union, for instance is developing a digital product passport, which provides a detailed history of a product's environmental impact throughout its life cycle, potentially exposing companies to greater scrutiny and liability.

Shifting consumer preferences: While affordability remains a priority for most, a growing segment of consumers is becoming more environmentally and socially conscious. They may start to seek out sustainable fashion options, selecting biodegradable or recycled fabrics, items certified for fewer chemicals in dyes and finishes, and favouring brands with transparent, fair labour practices. This shift is forcing brands to reconsider their production methods, material choices, and supply chain practices. Companies that fail to adapt to these changing consumer expectations risk losing market share and facing reputational damage.

Physical risks

Health: Health risks are prevalent due to the exposure of workers, local communities and consumers to toxic chemicals used in textile production. Workers in factories face occupational hazards from prolonged exposure to harmful substances, leading to respiratory problems, skin diseases and increased cancer risks. Local communities near manufacturing sites may suffer from contaminated drinking water and air pollution, resulting in a range of health issues. Consumers are also at risk from residual chemicals in clothing that can cause skin irritation and allergic reactions. These health issues can damage consumer trust and potentially result in product recalls and liability claims. Additionally, microfibres released into the environment can enter the food chain, posing potential long-term health threats.

Air: Textile production releases particulate matter and volatile organic compounds that reduce air quality and cause respiratory issues in surrounding areas. Moreover, is a significant contributor to climate change through the release of carbon and methane resulting from the decomposition of textile waste in landfills.

Soil: The use of pesticides and fertilisers in fibre production such as cotton farming degrades soil quality and disrupts local ecosystems. Textile waste disposed of in landfills can leach harmful chemicals into the soil, affecting its fertility and potentially contaminating nearby agricultural lands.

Fresh water: Freshwater resources are severely impacted by the textile industry, which is responsible for about 20% of global clean water pollution due to dyeing and finishing processes (World Bank 2019). The production process for textiles, particularly cotton, consumes vast amounts of water, exacerbating water scarcity in many regions. Furthermore, untreated wastewater containing toxic substances such as lead, mercury, and arsenic is often discharged directly into rivers, contaminating water sources relied upon by millions of people. The textile industry's reliance on water and energy resources makes it vulnerable to water scarcity, which can limit production capacity and increase costs.

Oceans: Microfibres shed during washing processes enter waterways and eventually reach oceans, where they accumulate and disrupt marine life. This pollution not only threatens biodiversity but also impacts fisheries and marine-based economies.

Pollution risks in the textile sector encompass a spectrum of environmental and social issues that can emerge at various stages of the industry's life cycle, from raw material extraction to manufacturing and disposal, as illustrated in figure IV. Additionally, the textile sector's reliance on agricultural commodities such as cotton exposes it to vulnerabilities from declining agricultural productivity due to extreme weather events, water scarcity and soil degradation, which can lead to higher input costs, supply chain disruptions and price volatility.

Lifecycle Stage	Design & Development	Production	Distribution	Use	End-of-Life
Some Priorities	Designing textiles • with a focus on sustainable / preferred material selection • with minimal chemical use, eliminating chemicals of concern • for reuse and durability (priority), and recyclability	• Minimising water pollution, air pollution and waste generation in yarn and fabric, textile and garment production	• Reducing transportation emissions and packaging waste • Promoting close-loop supply chains and reverse logistics • Scale and promote sustainable and circular business models to be easily accessible and affordable for consumers	• Reducing waste through extending the lifetime of products, including through better product care information • Addressing 'fast fashion' and low utility / short use cycles	• Textile waste management that reduces landfill disposal and incineration in favour of repair, reuse and recycling
Some Sustainable Finance Opportunities	• Sustainable fibre sourcing • Eco-design • Product longevity	• Water-efficient or water-less dyeing processes • Chemical management and phasing out chemicals of concern • Closed-loop production • Techniques that reduce microfiber pollution	• Sustainable logistics • Reduced packaging • Circular economy business models	• Textile repair and reuse • Innovations to reduce microfibre shedding during product care	• Textile collection and recycling • Extended producer responsibility (EPR) programs

Figure IV: The textiles life cycle

Opportunities in the textile sector

The evolution of the textiles sector is fast-paced and to a considerable extent determined by fashion and consumer trends, rather than pragmatism. Here are several strategic opportunities for banks to consider:

- **Improving chemicals management:** The textile industry's poor chemicals management has been estimated to impose significant negative health impacts. Banks can facilitate economic benefits by supporting initiatives aimed at eliminating such impacts, estimated at approximately USD 8 billion per year (UNEP 2019). This could involve financing projects focused on the reduction and responsible management of potentially polluting substances in textile manufacturing processes.

- **Promoting economic and social transformation:** The textile sector is a cornerstone of many developing economies, employing more than 300 million people throughout the value chain (EMF 2017). Banks can be instrumental in supporting the sector's transformation towards more sustainable production and ensuring the protection of workers along the textile value chain.
- **Aligning with global initiatives:** Numerous global initiatives address the reduction of potentially polluting substances in the textile industry. Banks can leverage these initiatives to identify specific investment and financing opportunities. Areas such as substitution of hazardous chemicals, fibre innovation, use of sustainable production technologies, reduction of energy and water consumption and fibre-to-fibre recycling technologies present viable investment avenues for banks committed to sustainability.
- **Responding to regulatory and consumer trends:** Regulatory restrictions, increasing consumer concern, civil society campaigns (e.g. DETOX, Greenpeace) and industry-driven initiatives (e.g. Zero Discharge of Harmful Chemicals) drive innovation in the textile sector. Banks can capitalise on these trends by financing projects that align with evolving regulatory standards and consumer preferences. Supporting textile companies in adopting safer chemistries, shifting to circular business models that decouple revenue generation from volume in products, introducing—and over time fully shifting towards—sustainable collections and embracing preferred fibres are strategic opportunities for banks.
- **Fostering innovation in textile technologies:** Leading brands have introduced sustainable collections without harmful chemicals, and with low water and carbon footprints (EMF 2017). While sustainable textile fibres such as hemp, sisal and jute are also becoming popular, the sustainable fibre market is expected to grow significantly in the upcoming years (Technavio 2018). Besides investing in the development and adoption of sustainable and preferred fibres and materials, other opportunities for innovation include safer textile chemistries, fibre-to-fibre recycling and advanced technologies for chemical recovery from wastewater (UNEP 2023b). Innovations aimed at reducing microfibre shedding from synthetic fabrics can significantly help minimise microplastic pollution in water systems.
- **Life cycle analysis (LCA) and circularity:** A holistic life cycle analysis approach is essential to fully understand the environmental footprint of textiles at every stage, from raw material extraction to end-of-life disposal. Banks can support projects that incorporate LCA to assess environmental impacts across the entire textile production chain. By financing initiatives that integrate LCA and circularity principles—such as recycling, reuse, and designing for durability—banks can help the textile sector reduce pollution, waste and its overall environmental footprint.
- **Supply chain transparency, traceability and reporting:** Supporting improved transparency, traceability and reporting throughout textile supply chains allows banks to help address concerns around ethical sourcing, environmental impact, and labour practices. Financing digital tools and platforms that provide visibility into supply chains can drive accountability and make it easier to identify sustainable practices. Increasing supply chain transparency is critical but challenging, given the fragmentation of

the textile sector and involvement of numerous small and large companies. Engaging with textile companies to publicly disclose their supply chain information helps improve transparency across the sector.

- **Shifting consumption patterns toward slow fashion:** As consumers become more aware of the environmental impact of fast fashion, banks can encourage the shift toward slow fashion by financing brands that prioritise quality, durability and sustainable production practices. This support can foster a more responsible textile sector and contribute to changing consumption habits towards sustainability.

In seizing these opportunities, banks can play a transformative role in steering the textile industry towards more environmentally and socially responsible practices. By conducting thorough environmental and social impact assessments before financing textile projects, ensuring compliance with global sustainability standards, and actively engaging with textile companies to adopt cleaner production technologies and more sustainable and circular business models, banks can protect their own investments from regulatory, reputational, and financial risks. A wide range of standards, guidelines, and tools have been developed to promote sustainable practices and reduce pollution throughout the textile value chain. Numerous organisations work on the implementation of certifications and labels for actors along the textile value chain to support the management and reduction of environmental and social impacts, including the reduction or elimination of polluting substances.

Table 15 provides an overview of various tools and initiatives that can be leveraged by the banking sector to promote sustainable finance and mitigate environmental risks and impacts. These resources offer guidance, frameworks, and platforms to support banks in integrating sustainability into their business operations and decision-making processes.

Table 15: Textile sector reference tools/initiatives and relevance for the banking sector (non-exhaustive list)

Textile Exchange
A global non-profit driving beneficial impacts on climate and nature across the fashion, textile and apparel industry. It takes a supply chain approach to driving sustainability through the sector and provides standards and certification tools specific to a wide range of synthetic and natural materials, with a particular focus on Tier 4/raw material production.
The Fashion Pact
A non-profit organisation forging a nature-positive, net-zero future for fashion, through CEO-led collaboration. They have defined specific targets, namely eliminating problematic and unnecessary plastic in business-to-consumer (B2C) packaging by 2025 and business-to-business (B2B) packaging by 2030, ensuring at least half of all plastic packaging is 100 per cent recycled content, by 2025 for B2C and by 2030 for B2B. Financial and regulatory systems are considered as enablers.
Ellen MacArthur Foundation (EMF)
EMF take a design-focused approach to the elimination of waste and pollution. They have developed textile specific resources, specifically the report A new textiles economy: Redesigning fashion's future, which outlines a vision and sets out ambitions and actions—based on the principles of a circular economy – to design out negative impacts and capture a USD 500 billion economic opportunity by truly transforming the way clothes are designed, sold, and used.

UN Alliance for Sustainable Fashion
Initiative of UN agencies and allied organisations designed to contribute to the SDGs through coordinated action in the fashion sector. It encompasses both social issues, such as improvements in working conditions and remuneration for workers, as well as environmental issues, including the reduction of the industry's waste stream, water pollution and GHG emissions.
Roadmap to Zero Programme (Zero Discharge of Hazardous Chemicals Foundation (ZDHC))
Leads the fashion industry to eliminate harmful chemicals from its global supply chain by building the foundation for more sustainable manufacturing to protect workers, consumers and our planet's ecosystems. It is a multi-stakeholder organisation comprising more than 320 signatories from across the industry, including brands, suppliers, solution providers and chemical suppliers. It provides a series of technical and specific guidelines for pollution-related challenges and industrial wastewater treatment, including a roadmap to achieve the goal that 100% of chemical formulations used in the ZDHC community and 70% of chemical formulations used in the global industry will conform to the ZDHC Manufacturing Restricted Substances List (MRSL) by 2030.
Ethical Fashion Initiative
Flagship programme of the International Trade Centre, a joint agency of the UN and the World Trade Organization (WTO). Its mission is to promote sustainable and inclusive development in emerging economies through increased trade and employment in the creative and cultural industries, fashion and textiles. From a sustainability perspective, the initiative has defined due diligence and reporting processes.
UNEP Textile Initiative
Provides leadership and encourages sector-wide collaboration to accelerate a just transition towards a sustainable and circular textile value chain. The initiative focuses on shifting consumption patterns, improving practices and investing in infrastructure to tackle issues such as overproduction, overconsumption and the use of hazardous chemicals. Through global engagement, policy dialogues and partnerships, UNEP aims to drive changes in policy, practice and behaviour among stakeholders to create a more sustainable and circular textile industry.
Global Fashion Agenda
Provides in-depth analysis and reports based on the latest industry data. It specialises in communicating complex sustainability content in a compelling and actionable manner and is responsible for leading industry publications. The Global Fashion Summit is a multi-stakeholder event renowned as a nexus for agenda-setting discussions on the most critical environmental, ethical and social issues. Its Innovations Forum is a key platform to connect fashion leaders with some of the most promising solution providers.
Cascale (formerly Sustainable Apparel Coalition)
Global, non-profit alliance of 300 leading apparel, footwear, and textile brands, retailers, manufacturers, sourcing agents, service providers, trade associations, NGOs and academic institutions. It has developed a framework to address impact and sustainability at the product, facility, brand and retail levels.

4.3 Electronics

The growth of electronic waste (e-waste) worldwide is staggering and is outpacing formal recycling by a factor of five. Global e-waste generation has surged from 34 billion kilograms in 2010 to 62 billion kilograms in 2022, increasing by an average of 2.3 billion kilograms per year. This makes e-waste the world's fastest-growing domestic waste stream, fuelled mainly by higher consumption rates of electric and electronic equipment, short life cycles and few options for repair.

While e-waste is expected to continue to grow, reaching 82 billion kilograms by 2030, the documented collection and recycling rate has only risen from 8 billion kilograms in 2010 to 13.8 billion kilograms in 2022. Consequently, the gap between e-waste generation and proper recycling is widening. The complex composition of electronic devices and dispersed use of critical raw materials such as indium and germanium require large investments in facilities and costly processes for their recovery (Baldé *et al.* 2024). In addition, the costs of recycling materials are often still higher than using virgin materials, making it difficult to establish a strong business case for recycling.

Hence, e-wastes may end up being "illegally" transported and dumped at locations, often in the developing world, where "cheaper" unregulated informal recycling systems have developed to collect, sort and process waste electronics. Unsound recycling of e-waste can release up to 1,000 different chemical substances into the environment, including known neurotoxicants such as lead (WHO 2024b). To address these issues, it is essential to implement proper e-waste management practices, including collection, sound recycling and disposal mechanisms that minimise environmental and health impacts.

Pollution impacts from the electronics sector

Environmental: Pollution is generated at every stage of the electronics sector life cycle. The extraction and refinement of resources and the subsequent production of electronic devices generate:

- Air pollutants (carbon dioxide (CO_2), sulphur dioxide (SO_2), nitrogen oxides (NO_x), particulate matter (PM), and volatile organic compounds (VOCs) from manufacturing, transportation, and energy use;
- Water pollutants including heavy metals, solvents, acids, and other toxic substances leached from mining, manufacturing, and disposal processes; and
- Soil contaminants, including hazardous chemicals, lead, cadmium, and other toxic elements from mining tailings, manufacturing waste, and e-waste disposal.

The waste quantities generated in the production of electronic equipment dwarf the mass of materials in the final electronic products. In 2002, the fossil fuel and chemical input to a 2-gram microchip were estimated at 1.7kg (Williams, Ayres and Heller 2002). The large ratio of input materials relative to those embodied in the end products is primarily a result of the need for very pure materials in microchips.

While electronic device production and use, and digital service provision generate pollution, much of the environmental concern is on end-of-life issues. Although e-waste accounts for only two to five per cent of the total solid waste volume, it contributes more than 70% of its toxicity. This is due to its high concentration of hazardous chemicals, including halogenated compounds like PCBs, TBBPA, and PBBs, as well as toxic/heavy metals and metalloids such as arsenic, chromium, cadmium, copper and mercury. These toxicants can contaminate food chains through air, water and soil, causing various health problems. The improper disposal of electronic waste can lead to the release of hazardous substances, such as heavy metals, halogenated and organophosphorus flame retardants that can leach into nearby water sources, harming aquatic life and affecting water quality. Soil contamination can occur through the release of heavy metals and other toxins, rendering land unsuitable for various uses and disrupting ecosystems. Incineration of e-waste may produce harmful gases (such as dioxins and furans) that damage air quality and contribute to climate change.

Social: Improper disposal in landfills or through informal recycling practices can release toxic substances into the environment, affecting nearby communities and creating long-term health hazards. Workers involved in the dismantling, recycling, and disposal of electronic devices face direct exposure to hazardous substances, leading to health impacts such as respiratory problems, skin ailments, and neurological disorders. In low- and middle-income countries, where informal e-waste recycling is prevalent, workers face even more severe health risks due to lack of protective equipment and proper regulations. Studies have shown that these informal recyclers experience a range of significant health impacts, including respiratory issues such as cough, chest pain, and asthma, skin disorders, hormonal imbalances, cardiovascular problems such as cardiac arrhythmias and hypertension, and renal dysfunction (Eckhardt and Kaifie 2024). Additionally, these workers face increased risks of physical injuries such as cuts, burns and eye problems due to handling e-waste without proper protection. Children, who are often involved in waste picking and manual dismantling of e-waste, are particularly vulnerable to these health hazards, with potential long-term impacts on their development (WHO 2024b).

Economic: Globally, e-waste is the fastest growing and most valuable waste- stream (Andeobu *et al.* 2023). Yet less than one-quarter (22.3%) of annual e-waste is currently collected and recycled. This rate is expected to decline to 20% by 2030 due to the widening difference in recycling efforts relative to the staggering growth of e-waste generation worldwide. This missed opportunity represents a loss of valuable resources worth approximately USD 62 billion (Baldé *et al.* 2024). In many developing countries, particularly in Africa and Asia, informal e-waste recycling has emerged as a crucial economic activity, providing livelihoods for impoverished communities. However, the economic benefits of informal recycling come with significant environmental and health costs. Unregulated recycling practices, such as open burning of e-waste to extract valuable metals, release toxic substances into the environment. These pollutants have far-reaching economic impacts beyond the recycling sector itself. Contamination of water bodies affects local fishing industries, reducing fish stocks and impacting the livelihoods of fishing communities. Soil pollution from improper e-waste disposal degrades agricultural land, potentially leading to reduced crop yields and economic losses for farming communities (Andeobu *et al.* 2023). Integrating informal e-waste management practices into regulated systems can not only reduce negative environmental impacts, but also create more stable and safer jobs while increasing overall economic productivity in affected regions (International Labour Organization, 2014).

Pollution risks in the electronics sector

Transition risks

Regulatory/legal: The complex landscape of regulations surrounding electronics recycling and e-waste management includes international treaties like the Basel Convention, regional directives such as the EU's Directive on waste electrical and electronic equipment (WEEE) and on the restriction of the use of certain hazardous substances electrical and electronic equipment (RoHS), and country-specific legislation such as the EPA guidelines in the United States of America and China's RoHS. These regulations aim to control hazardous substances, manage e-waste, and promote environmentally sound recycling practices. Improper disposal or handling of electronic waste can lead to environmental contamination and public health issues, which in turn can damage a company's brand value and corporate image. Furthermore, as governments impose stricter regulations on e-waste management, companies may face legal actions, fines, and increased scrutiny from consumers and investors who prioritise sustainability.

Technological: Technological advancements aimed at reducing pollution in the electronics sector can also create transition risks for banks. For example, the shift towards more energy-efficient components and materials, such as power-efficient processors and low-energy display technologies, can disrupt existing supply chains and reduce demand for certain materials. This could impact the profitability of suppliers and manufacturers, potentially affecting their ability to repay loans. Additionally, the increased use of recycled materials and the development of circular economy models can lead to changes in traditional business models, as companies may need to invest in new technologies and processes to adapt to these shifts. This could create uncertainty for banks and increase their credit risk. Other technological advancements in high precision measuring, supply chain tracking and blockchain could make it easier to trace the origin of pollutants and attribute responsibility to specific manufacturers or suppliers. This increased transparency poses a risk to companies that have historically benefited from the opacity of complex global supply chains. The European Union, for instance is developing a digital product passport, which provide a detailed history of a product's environmental impact throughout its life cycle, potentially exposing companies to greater scrutiny and liability.

Physical risks

Health: Workers involved in the production, recycling and disposal of electronic devices face direct exposure to hazardous substances with adverse impacts on their health. In low- and middle-income countries, where informal e-waste recycling is prevalent, these health risks are even more severe. This can lead to increased healthcare costs, reduced productivity and potential legal liabilities for companies involved in the electronics supply chain.

Air: Air quality can be affected by the incineration of e-waste, which produces harmful gases and pollutants. These emissions, including dioxins, furans and particulate matter, can travel long distances from recycling sites, impacting air quality and human health in surrounding areas and even thousands of miles away.

Soil: E-waste poses significant physical risks to soil through the release of toxic substances such as heavy metals (including lead, mercury and cadmium) and flame retardants. When improperly disposed of in landfills or illegal dumping sites, these contaminants can seep directly into the soil, degrading soil quality, reducing fertility, harming microorganisms and potentially entering the food chain through crops grown in contaminated areas (Jain *et al.* 2023). Companies involved in electronics manufacturing or e-waste management may face risks associated with soil remediation costs or decreased land values.

Fresh water: Toxic substances, including heavy metals and chemicals from plastics and coatings, may enter water systems through leaching from landfills, illegal dumping and improper disposal practices of e-waste. This contamination affects both surface water and groundwater, with studies in e-waste recycling areas revealing alarmingly high levels of toxic heavy metals in water samples (Jain *et al.* 2023). The pollution disrupts aquatic ecosystems, leading to decreased biodiversity and habitat alteration, while contaminants bioaccumulate in the food chain, affecting fish and other aquatic life.

Oceans: Heavy metals and complex chemicals from e-waste, such as cadmium, lead, mercury, copper, and brominated flame retardants, make their way into marine systems through run-off water and groundwater contamination with detrimental and long-lasting effects on marine species and marine ecosystems (Sampson 2024).

Pollution risks in the electronics sector encompass a spectrum of environmental and social issues that can emerge at various stages of a product's life cycle, from design and development to recycling e-waste, as illustrated in Figure V.

Lifecycle Stage	Design & Development	Production	Distribution	Use	End-of-Life
Some Priorities	• Avoiding the use of (combinations of) hazardous materials • Eliminating built-in obsolescence • Extending the life-span of devices • Minimising energy inefficiency	• Eliminating air pollution from particulates, gases and water and soil pollution from heavy metals and chemicals use during mining and manufacturing • Eliminating worker exposure related health risks	• Reducing emissions from physical distribution logistics • Reducing emissions from server farms for online software (updates) • Reducing packaging waste	• Improving energy consumption throughout lifespan, and reducing electromagnetic pollution	• Improving recycling rates and reducing large e-waste quantities sent to landfill, incinerated or illegally transported and dumped • Reducing the release of hazardous chemicals to air, water and soil in 'informal' and unregulated recycling facilities • Eliminating exposure related health impacts of informal recycling workers resource scarcity
Some Sustainable Finance Opportunities	• Design for disassembly • Modularity of components for longer lifespan • Use of recycled materials • Energy-efficient components	• Green manufacturing practices • Clean and renewable energy • Pollution prevention technologies	• Sustainable logistics • Reduced packaging • Efficient transportation	• Energy-efficient devices • Extended product lifespans • Take-back programs	• E-waste recycling • Responsible disposal

Figure V: The electronics life cycle

Opportunities in the electronics sector

The growing global population and prevalence of electronic devices and systems in all spheres of life are driving demand for electronic products, leading to rising prices for many primary materials. Some resources, such as indium, are becoming increasingly scarce. As a result, used electronic products containing materials that could be recycled are circulating globally, creating opportunities for effective e-waste management (Hieronymi 2012). Yet, e-waste recycling rates are declining globally, partly due to the lack of investment in facilities. This "financing gap" in end-of-life solutions, combined with sectoral expansion provide opportunities for the banking sector to foster change through financial deepening and sustainable financing. Much attention has been given to end-of-life e-waste, but waste and pollutants are also generated in the production of electronic equipment representing opportunities for pollution impact reduction throughout the life cycle of electronic equipment. These include:

- **Alternative materials and modernised processes:** The growing market represents many opportunities for banks to finance the development or incorporation of new non-polluting products (less polluting, recoverable, reusable, recyclable), as well as the modernisation of processes, machinery and equipment. This becomes particularly relevant given the existing or projected exclusion of some materials used in electrical and electronic equipment manufacturing.
- **Eco-friendly design:** Designing electronics that are more energy-efficient, longer-lasting and easier to recycle.
- **Inclusive integration of informal recycling initiatives:** There is huge potential in the sector to support informal actors in the recovery of e-waste to move towards formality and improve their standards. When informal work is reduced, individuals and businesses gain better access to credit and financial services, fostering entrepreneurship and economic growth. In addition, it helps enforce labour standards and protections as formal workers are more likely to have regulated working hours, fair wages and improved working conditions.
- **Bottom-line impact:** E-waste is an economic source of many metal feedstocks, including gold, silver, copper, platinum, palladium, nickel, lead and tin as well as rare earths, for which demand is rapidly growing with increased electrification and digitisation. In 2019, the World Economic Forum (WEF) predicted the global value of e-waste to be at least USD 62.5 billion a year, while concentrations of some metals are often much higher in e-waste than in mined ores (Lee *et al.* 2023).
- **Improving end-of-life management:** The global e-waste management market is expected to reach USD 108.1 billion by 2027 from USD 59.8 billion in 2022, which corresponds to a compound annual growth rate (CAGR) of 12.6% (BBC Research 2023). The responsible management of e-waste is not only crucial for end-of-life data and equipment security but also represents a strategic financing avenue for banks. Inappropriate disposal of sensitive electronics, including servers, can result in fines and data breaches, posing risks to customer relationships. Financing proper disposal and recycling initiatives mitigates the financial risks associated with grey-market sales, counterfeits, and unauthorised reuse.
- **Increasing customer value:** Banks can play a pivotal role in financing the shift towards circularity targets set by original equipment manufacturers (OEMs) and telecom companies. E-waste recycling aligns with these circularity goals, as demonstrated by Apple's commitment to using 100% recycled and renewable materials by 2030, Vodafone's pledge to reuse, resell, or recycle all network waste by 2025 or HP's target of 7% product and packaging circularity by 2030, including e-waste recycling. Moreover, supporting in-store e-waste drop-off programmes, as adopted by retailers like Best Buy and Lowe's, not only attracts foot traffic but also contributes to customer retention, presenting a viable investment opportunity (Lee *et al.* 2023).

- **Optimise co-benefits for climate and nature:** E-waste recycling emerges as a strategic means for companies to achieve their net-zero goals through the prevention of pollution, the reduction of landfill use and illegal dumping, as well as the conservation of natural resources, energy and water. The inherently lower emissions associated with smelting and recycling secondary metals, in comparison to primary metal extraction, make e-waste recycling an attractive investment with positive implications. For instance, recycled copper's three to five times smaller carbon footprint than virgin copper enhances its financial attractiveness.
- **Mine e-wastes:** Within the paradigm of a circular economy, the mine of e-waste should be considered an important source of secondary raw materials. Due to issues relating to primary mining, market price fluctuations, material scarcity, availability and access to resources, it has become necessary to improve the mining of secondary resources and reduce the pressure on virgin materials. By recycling e-waste, countries could at least secure access to scarce raw materials in a sustainable way.

The evolving landscape of responsible e-waste management opens doors for banks to introduce innovative financial products tailored to the needs of businesses adopting more sustainable practices for e-waste management. Offering specialised financing solutions, such as low-interest loans, can catalyse the adoption of best practices and environmentally friendly technologies within the e-waste recovery sector.

Table 16 provides an overview of various tools and initiatives that can be leveraged by the banking sector to promote sustainable finance and mitigate environmental. These resources offer guidance, frameworks, and platforms to support banks in integrating sustainability into their business operations and decision-making processes.

Table 16: Electronics sector reference tools/initiatives and relevance for the banking sector (non-exhaustive list)

The Strategic Approach to International Chemicals Management (SAICM) platform
The SAICM platform, a precursor to the Global Framework on Chemicals, has provided valuable tools and guidance relevant to the electronics sector, particularly through the Global Environment Facility (GEF)-funded project Global Best Practices on Emerging Chemical Policy Issues of Concern under SAICM. This project developed resources that promote sustainable practices in electronics, including guidance on sustainable public procurement, a supplement to the eco-innovation manual specifically for the electronics industry, and a study on eco-labels. These tools help stakeholders identify and manage hazardous chemicals, promoting safer alternatives and advancing eco-friendly product design and recycling. For the banking sector, the SAICM platform offers insights that can inform financing strategies aligned with sustainable practices in electronics. By supporting clients who adopt these tools and standards, banks can contribute to reducing pollution and fostering a circular economy in the electronics sector.
E-Waste Monitor (UNITAR)
This tool creates a global, regional and national picture of e-waste, the true nature of the e-waste challenge, including collection and recycling rates, national and regional countermeasures, but also transboundary movements. The E-Waste Monitor is developed and supported by United Nations Institute for Training and Research (UNITAR), UNU-ViE (United Nations University Vice-Rectorate in Europe) Sustainable Cycles (SCYCLE) and the International Telecommunication Union (ITU).

The Clean Electronics Production Network CEPN
CEPN addresses complex workplace health and safety challenges in the electronics supply chain. The collaborative multi-stakeholder innovation network launched in 2016 as part of the Center for Sustainability Solutions at Green America and now counts more than 20 member organisations, including electronics brands and suppliers, environmental NGOs, labour and worker representatives, ecolabels and representatives from academia and government agencies.
International Telecommunication Union (ITU)
This specialised UN agency has produced a wide range of reports and publications on WEEE management. ITU is at the forefront of enabling environmentally sustainable digital transformation. Recognising the pivotal role of digital technologies in climate action and sustainable development, ITU is committed to greening the digital transition and minimising its environmental impact. Working with more than 1,000 public and private sector members, ITU is leading the circular economy transition by mitigating the impact of e-waste and leveraging the positive impacts of information and communication technologies (ICTs) in climate change monitoring, adaptation and response.
International Electrotechnical Commission (IEC)
The IEC brings stakeholders from around the world to collaborate and develop technical solutions and best practices to ensure the safety and well-being of citizens and build trust in technology. IEC Standards are the culmination of a consensus-driven process based on clearly defined, transparent rules. More than 20,000 affiliated experts work together to provide the technical foundation for effective solutions that can help mitigate the impact of climate change and build resilience to withstand its consequences. Their work includes a focus on integration of circular economy practices to reduce and eliminate waste through intelligent design, material efficiency and recycling and to support energy efficiency measures by providing globally relevant performance measurements, advocate for the dissemination and promotion of energy efficient technologies and define minimum energy performance requirements.
Restriction of Hazardous Substances in Electrical and Electronic Equipment (RoHS)
EU laws restrict the use of certain hazardous substances in electrical and electronic equipment through the RoHS Directive. The RoHS Directive currently restricts the use of ten substances: lead, cadmium, mercury, hexavalent chromium, polybrominated biphenyls (PBB) and polybrominated diphenyl ethers (PBDE), bis(2-ethylhexyl) phthalate (DEHP), butyl benzyl phthalate (BBP), dibutyl phthalate (DBP) and diisobutyl phthalate (DIBP). It is important to note that many countries have adopted RoHS or RoHS-like rules.
Waste from Electrical and Electronic Equipment (WEEE)
EU rules to address environmental and other issues caused by the growing number of discarded electronics in the EU. The aim is to contribute to sustainable production and consumption by preventing the creation of WEEE as a priority, contributing to the efficient use of resources and the retrieval of secondary raw materials through reuse, recycling and other forms of recovery and improving the environmental performance of everyone involved in the life cycle of electrical and electronic equipment.
Regional e-waste management rules
While there isn’t a single overarching federal law for e-waste management in the United States of America, individual states have enacted laws and regulations to address e-waste disposal and recycling. The Environmental Protection Agency (EPA) regulates hazardous substances, including those found in electronic equipment, and can impose restrictions on their use and disposal. Across Asia (for example in China, India and Japan) there exist national e-waste regulations, licensing requirements and rules to regulate collection, recycling and disposal of e-wastes with penalties for illegal dumping.

Extended producer responsibility (EPR) programmes
EPR programmes place accountability on electronics manufacturers for the entire life cycle of their products, including end-of-life disposal and recycling. By encouraging producers to design with reuse and recyclability in mind, EPR programmes help reduce e-waste and support circular economy practices. Banks can play a role by financing companies that actively participate in or adopt EPR frameworks.
E-waste certification standards
E-waste certification standards, such as R2 (Responsible Recycling) and e-Stewards, establish criteria for responsibly managing discarded electronics. These standards promote safe recycling, pollution control and protection for workers in the e-waste management sector. Banks can support certified e-waste processors or encourage clients to partner with certified facilities, enhancing responsible electronics disposal.
Life cycle assessment (LCA) tools (e.g. UNEP Life Cycle Initiative)
LCA tools, such as those developed by UNEP's Life Cycle Initiative, provide a framework to assess the environmental impacts of electronic products from production through disposal. By identifying areas for pollution reduction and resource efficiency, LCA tools enable more sustainable product design and decision-making. Banks can leverage these insights to finance projects and companies that prioritise sustainability throughout the electronics life cycle.
Right to repair policies
Right to repair policies empower consumers and third parties to repair electronic devices, extending product lifespan and reducing waste. These policies encourage manufacturers to design for durability and repairability, supporting pollution reduction and resource efficiency. Banks can help by financing companies that integrate repairable designs and support the right to repair, aligning with sustainability goals.
Digital passports
Digital passports are digital records embedded in electronic products, detailing information about materials, components and recyclability. They enable easier tracking, repair and recycling at end-of-life. For banks, digital passports provide an opportunity to finance innovative solutions that support traceability and sustainable life cycle management in electronics, promoting transparency and accountability across the supply chain.

4.4 Pharmaceuticals

Pharmaceutical products play a vital role in saving lives and improving the quality of life for people and animals suffering ill health. The benefits of modern pharmaceuticals in treating diseases and improving public health are an undeniable priority. However, the environmental and health impacts associated with pharmaceutical pollution must also be carefully considered because they contain pharmaceutical active compounds (PhACs), hereafter referred to as active pharmaceutical ingredients (APIs), that have been designed to have specific effects on living organisms. Pharmaceuticals are one of the chemical industry's fastest growing segments. The global prescription drug market is forecasted to reach USD 1.7 trillion by 2030, which represents a compound annual growth rate (CAGR) of 7.7% (Evaluate 2024). Due to releases from various sources, pharmaceutical residues are present worldwide in surface water, groundwater, soil and other environmental media (UNEP 2019).

Pollution impacts from the pharmaceutical sector

Environmental: The major source of pharmaceuticals in the environment is by patient excretion following the use of a medicine. Conventional wastewater treatment plants are unable to isolate and remove many of the active pharmaceutical ingredients contained in these products. Effluent from industry during manufacturing of pharmaceuticals and incorrect disposal of unused or expired medicines contributes a comparatively smaller amount to pharmaceuticals in the environment. Veterinary pharmaceuticals used in animal husbandry can also contaminate soil and water, particularly when manure is used as fertiliser. This can lead to the uptake of pharmaceuticals by crops, affecting the food chain and possibly wildlife. It thereby causes various health issues, such as renal failure in vultures and reproductive issues in fish and amphibians and the development of antibiotic-resistant microbes (UNEP 2019). Other sources of pollution from the pharmaceutical industry include GHG emissions during manufacture, with the sector contributing to around 4.4% of global GHG emissions (WEF 2024b).

Social: In a major global study, pharmaceuticals or their transformation products have been detected in the environment of 71 countries covering all five United Nation regions. A total of 631 different pharmaceuticals have been found above the detection limits of the analytical methods employed (Beek *et al.* 2016). A more recent study has extended analysis to 104 countries across all continents, finding that many of the most heavily contaminated samples were obtained from campaigns in low- to middle-income countries (Wilkinson *et al.* 2022). Anti-microbial resistance (AMR) has emerged as a major global threat, primarily driven by the overuse and misuse of antibiotics in healthcare settings and the agricultural industry. It occurs when microorganisms, such as bacteria, viruses, fungi and parasites, develop the ability to resist the effects of antimicrobial medicines. This makes infections caused by these microorganisms more difficult to treat, increasing the risk of severe illness, disability and death. Low-income countries are expected to be disproportionately affected by AMR and drug resistance, potentially pushing more people into extreme poverty (Dadgostar 2019).

Economic: In many regions of the world there is limited post-consumer management of leftover, expired and unused pharmaceutical waste. This leads to substantial financial losses in healthcare systems, with estimates suggesting that unused prescription medications cost the healthcare industry in the United States of America approximately USD 5.4 billion per year for adults taking one prescription medication daily, while the disposal of regulated medical waste, including pharmaceuticals, costs 119% more per pound than regular trash (Karim-Nejad and Pangilinan 2022). In addition, AMR leads to significant economic impacts, primarily through increased healthcare costs and productivity losses. Healthcare expenditures rise due to longer hospital stays, more expensive treatments, and additional medical services. Productivity losses stem from increased sick days, premature deaths, and reduced labour supply, with global economic losses projected to reach trillions of dollars by 2050 (Murray *et al.* 2022).

Pollution risks in the pharmaceutical sector

Transition risks

Regulatory/legal: APIs are often highly persistent and pervasive, with unintended effects on other organisms when they enter into the environment, even at very low concentrations. Although the impacts of such chemicals released from pharmaceutical products remain largely poorly understood—and from an environmental perspective, weakly regulated—they are of increasing concern (Miettinen and Khan 2022). Future regulations could target those for which pollution and negative impact evidence coalesces. Their classification as emerging contaminants (ECs) would represent a transitional risk to the sector (Samal *et al.* 2022).

Technological: The rapid pace of pharmaceutical development is a significant factor contributing to the emergence of new pollution risks associated with novel and existing APIs. Interactions with other pollutants can also create unforeseen consequences. However, technological advancements now enable more precise detection, measurement and analysis of these substances, enhancing the ability to assess risks, understand impacts and trace sources of contamination. These characteristics of innovation within the pharmaceutical sector emphasise the need for “extended” environmental risk assessment that involves identification of potential environmental risks of existing and new APIs and ongoing monitoring and evaluation of pharmaceutical pollution post-authorisation.

Physical risks

Health: There is compelling evidence of widespread contamination from pharmaceuticals and their transformation products in soil and water, with increasing proof of adverse impacts on organisms, including humans. Exposure is typically to a complex mixture of pharmaceuticals, leading to unpredictable, interactive, and often unknown effects on human health (Ginebreda 2010). In addition, growing antimicrobial resistance (AMR) poses serious health risks, making infections harder to treat and increasing the likelihood of treatment failures. A first in-depth analysis of the global health impacts of AMR over time reveals that more than one million people died from AMR globally each year between 1991 and 2021 and estimates that AMR deaths will rise steadily in the coming decades, increasing by almost 70% by 2050 compared to 2022, impacting older people more severely (Naghavi *et al.* 2024). AMR also poses a significant threat to food security, as it can affect the health of animals and plants, reducing productivity in agriculture. In 2015, WHO published the Global Action Plan on AMR, underlining that systematic misuse and overuse of antimicrobials put every nation at risk and AMR is a crisis that must be managed with the utmost urgency (WHO 2015).

Air: Pharmaceutical manufacturing processes release various hazardous air pollutants (HAPs) and volatile organic compounds (VOCs) into the atmosphere. The primary pollutants include methylene chloride, methanol, toluene, and hydrogen chloride. These emissions contribute to air quality degradation, potentially leading to respiratory issues and other health problems in nearby communities (EPA 2024). In addition, the pharmaceutical industry contributes significantly to global carbon emissions.

Soil: Pharmaceutical pollution in soil primarily occurs through the application of biosolids, animal manure, and irrigation with contaminated water. Active pharmaceutical ingredients can persist in soil, affecting its microbial composition and fertility. This persistence can lead to the accumulation of drugs in agricultural soils, potentially entering the food chain through crop uptake. Moreover, soil pollution can contribute to the spread of antimicrobial resistance genes, posing a significant threat to human health by reducing the effectiveness of antibiotics. The sorption of pharmaceuticals to soil particles also affects their mobility and bioavailability, potentially leading to long-term contamination of soil resources.

Fresh water: Pharmaceuticals, including antibiotics enter water bodies through manufacturing discharge, improper disposal and excretion from humans and animals. With the increase in demand, there has been a sharp increase of these pollutants in water bodies. Wastewater treatment plants are often unable to completely remove these compounds, resulting in their release into rivers, lakes, and groundwater, with adverse impacts on aquatic ecosystems and risks to human health. The presence of antibiotics in fresh water can also contribute to the development of antibiotic-resistant bacteria.

Oceans: The persistence of pharmaceuticals and antibiotics may bioaccumulate and biomagnify in marine organisms, leading to potential biomagnification up the food chain. This can affect not only marine life but also human health through the consumption of contaminated seafood.

Pollution risks in the pharmaceuticals sector encompass a spectrum of environmental and social issues that can emerge at various stages of a product's life cycle, from manufacture to pharmaceutical waste management, as illustrated in figure VI.

Lifecycle Stage	Design & Development	Production	Distribution	Use	End-of-Life
Some Priorities	• Chemical development • Waste generation • Environmental impact assessment	• Water pollution • Air pollution • Waste generation • Energy consumption	• Transportation emissions • Packaging waste • Responsible prescription	• Medication adherence • Drug resistance • Waste generation	• Pharmaceutical waste management • Environmental contamination
Some Sustainable Finance Opportunities	• Green chemistry • Waste minimisation • Life cycle assessment	• Energy-efficient manufacturing • Waste management • Pollution prevention	• Sustainable logistics • Reduced packaging • Cold chain management	• Drug disposal programs • Medication return systems • Public awareness campaigns	• Safe disposal, recycling, and recovery of valuable materials

Figure VI: The pharmaceuticals life cycle

Opportunities in the pharmaceutical sector

Several opportunities for pollution prevention innovations along the pharmaceuticals sector life cycle include:

- **Design of medicines that are safe** or have very targeted activity. These may be derived from naturally occurring biocompounds for which natural degradation mechanisms exist.
- **Technologically advanced delivery mechanisms** which render APIs inactive beyond specific “personalised” biological contexts. Indeed, personalised manufacturing or “zero-lag” real-time production for individual demand could lead to a tighter “closed-loop” and reduced pollution and waste (Ding 2018).
- **Supply chain interventions** could reduce the disposal of unused medicines through reverse-loop supply chain management that would enable unused medicines to be inspected, verified, repackaged and redistributed before they expire.
- **Improving equitable access to medicines** such as painkillers for sectors of the global community that are lacking would reduce waste and reduce pollution from poor waste management.
- **Product and supply chain innovations** such as new delivery systems and products with a lower environmental risk, reduced water usage, greener manufacturing methods, recyclable packaging, closed-loop and reverse logistics and waste recycling all represent valuable businesses opportunities in the pharmaceutical sector. Production facility and municipal-level advanced biological, physical and chemical wastewater treatment technologies can address ongoing risks related to the removal of pollutants from manufacturing effluents and end-user excretions. These include advanced membrane, adsorption and biosorption filtration and oxidation processes, also emerging nanotechnologies.

Ultimately, addressing pharmaceutical pollution requires a comprehensive approach that considers both the benefits and risks of pharmaceutical products. This includes finance for measures to reduce pollution at all stages of the pharmaceutical life cycle, starting with the design and development phases, through manufacture to disposal. The Eco-Pharmaco-Stewardship (EPS) initiative of the European Federation of Pharmaceutical Industries (EFPIA) provides a useful framework to identify and address emerging and ongoing environmental concerns arising from the development, production, use and disposal of drugs.

There is a range of other, mostly industry-led standards, guidelines, and tools available to help companies in the pharmaceutical sector reduce their environmental footprint and mitigate pollution risks. These resources can provide guidance on responsible sourcing and manufacturing practices to waste management and end-of-life strategies. By aligning with these standards and participating in relevant initiatives, pharmaceutical companies can demonstrate their commitment to sustainability and mitigate potential financial and reputational risks associated with pollution.

Banks can play an important role to incentivise and support their clients by employing Principle 3 of the PRB and following guidance that will help them engage effectively in this activity (PRB 2024). Table 17 provides an overview of various tools and initiatives that can be leveraged by the banking sector to promote sustainable finance and mitigate environmental risks. These resources offer guidance, frameworks and platforms to support banks in integrating sustainability into their business operations and decision-making processes.

Table 17: Pharmaceutical sector reference tools/initiatives and relevance for the banking sector (non-exhaustive list)

Additional sectoral guidance: Biotechnology and pharmaceuticals (TNFD)
The LEAP approach, a framework for assessing and managing nature-related risks and opportunities, can be applied to the Biotechnology and Pharmaceuticals sector through specific guidance and tools. Core global disclosure metrics tailored to this sector are available, along with sector-specific indicators and metrics to identify potential dependencies and impacts on nature. Dependency and impact matrices can further help organisations in this sector assess their interactions with ecosystems and identify risks and opportunities. Illustrative lists of environmental assets, ecosystem services, impact drivers, risks and response actions specific to the sector can provide practical guidance for implementation.
Global Action Plan on Antimicrobial Resistance (WHO)
Endorsed by the World Health Assembly in May 2015 in resolution WHA67.25. The goal of the plan is to ensure continuity of successful treatment and prevention of infectious diseases with effective and safe medicines that are quality assured, used in a responsible way and accessible to all who need them. The five objectives outlined in the plan are to: ▪ improve awareness and understanding of antimicrobial resistance ▪ strengthen knowledge through surveillance and research ▪ reduce the incidence of infection ▪ optimise the use of antimicrobial agents ▪ ensure sustainable investment in countering antimicrobial resistance. The plan provides a framework for developing national action plans, including key actions that the various actors should take within 5–10 years to combat AMR.
Pharmaceuticals in the Environment (PIE)
An initiative of the European Federation of Pharmaceutical Industries and Associations (EFPIA) to address emerging and ongoing environmental concerns, through the Eco-Pharmaco-Stewardship (EPS) initiative. The EPS uses a life cycle approach to address the roles and responsibilities of public services, industry, environmental experts, doctors, pharmacists and patients. They have identified three pillars for focus: ▪ Pillar 1: identification of potential environmental risks of existing and new active pharmaceutical ingredients through the Innovative Medicines Initiative (IMI). ▪ Pillar 2: manufacturing effluents management that compiles and encourages exchange of best industry practice to identify appropriate methods to reduce risk to the environment. ▪ Pillar 3: extended environmental risk assessment (ERA), which extends beyond market authorisation (i.e. is "beyond compliance") to include provisions for constant revision of exposures and effects of post-authorisation of active pharmaceutical ingredients.

Pharmaceutical Supply Chain Initiative (PSCI)
PSCI is a grouping of pharmaceutical and healthcare companies focused on improved social, health, safety and environmental outcomes. They provide a platform where a range of resources are made available on topics relating to the environment and pollution, including authorisations, spills and releases, waste management, water use, PIE, anti-microbial resistance, decarbonisation and chemical registrations.
AMR Industry Alliance (AMRIA)
The AMRIA is one of the largest private sector coalitions set up to provide sustainable solutions to curb antimicrobial resistance, with more than 100 biotech, diagnostics, generics and research-based pharmaceutical companies and associations joining forces. The Alliance's commitments include: ▪ Review Alliance members' own manufacturing and supply chains to assess best practices for controlling the release of antibiotics into the environment. ▪ Establish a common framework for managing antibiotic release and begin applying it to their own manufacturing and supply chains by 2018. ▪ Work with stakeholders to develop a practical mechanism to transparently demonstrate that Alliance member supply chains meet the standards of the framework. ▪ Work with independent technical experts to establish science-based, risk-based targets for antibiotic discharge concentrations and develop best practices to reduce the environmental impact of manufacturing discharges by 2020.
International Federation of Pharmaceutical Manufacturers and Associations (IFPMA)
IFPMA helps lead the innovative pharmaceutical industry's work on AMR. They raise awareness of the unique challenges in combating AMR and of measures that could establish economic conditions favourable to long-term investment into antibiotic research and development (R&D). The following tools and mechanisms have been developed: ▪ AMR Action Fund ▪ AMR Preparedness Index ▪ Global Principles on Incentivizing Antibiotic R&D
EU taxonomy legislation
Commission Delegated Regulation (EU) 2023/2486, adopted in June 2023, supplements the EU Taxonomy Regulation by establishing technical screening criteria for economic activities contributing to environmental objectives, including pollution prevention and control. For the pharmaceutical industry, the regulation sets specific criteria for manufacturing activities, with a particular focus on addressing antimicrobial resistance and wastewater management. It encourages sustainable production practices, such as the use of green chemistry principles, and requires increased transparency and reporting on environmental impacts.

4.5 Agriculture

The global agricultural sector, including cropping and livestock systems as well as aquaculture, has expanded and intensified to meet the rising food demand for a growing population with changing dietary patterns. It currently covers 38% of the Earth's land surface and provides livelihoods for more than 2 billion people (Zabel *et al.* 2019). Much of "conventional" or "industrial" agriculture relies on inputs of fossil fuel energy, synthetic fertilisers, herbicides, insecticides and fungicides and where necessary irrigation to achieve consistently high yields from monocropping annual production systems. The use of these chemicals causes the release of toxic and environmentally damaging substances to water, soil and air, thereby impacting biodiversity, the health of ecosystems and people, and contributing to climate change.

However, the advance of conventional or industrialised agriculture over the past century has contributed enormously to food security underpinning a period of unprecedented global population growth. Hence, similarly to the pharmaceuticals sector where human health benefits are a priority to evaluate against pollution impacts and risks, such is the case when evaluating critical food security and pressures on the environment.

Pollution impacts from the agricultural sector

Environmental: Agriculture significantly contributes to water, air and soil pollution worldwide. For instance, the sector is responsible for at least 70% of global freshwater withdrawals (Food and Agriculture Organization of the United Nations (FAO 2018)) and discharges large quantities of agrochemicals, sediments, nutrient enriched effluents, waste biosolids, pathogens, pharmaceutical residues and salts into water bodies. The sector also accounts for 13% to 21% of total global anthropogenic GHG emissions and is the leading source of methane (International Panel on Climate Change 2023). A broader value chain definition of agrifood systems, which includes land use change, retail, transport, consumption, fuel production, waste management, industrial processes and packaging emit one-third of all GHG emissions.

Pesticides represent the highest impact substances used in agriculture, given their inherently toxic design and ability to persist in the environment for decades. Since 1990, global pesticide use has doubled (FAO 2023a). Excessive and improper use of pesticides results in contamination of surrounding soil, water and non-target plants and animals, thereby causing negative health and environmental impacts. It also contributes to loss of biodiversity, for example by destroying beneficial insect populations that act as natural enemies of pests and reducing the nutritional value of food (United Nations 2017).

A relatively small number of highly hazardous pesticides (HHPs) cause disproportionate harm to the environment and human health including severe environmental hazards. High acute and chronic toxicity at low and high concentrations can cause various adverse health outcomes including cancers and neurological, immunological and reproductive effects (UNEP 2022; Kaur *et al.* 2024). Despite international bans, smallholder farmers in developing countries continue to use HHPs, due to perceptions of their effectiveness and lack of alternatives (Constantine *et al.* 2020) and driven largely by government subsidies (Tambo *et al.* 2020). HHP use can represent up to 30% of all pesticides used in some low-income countries, due to substantial variation in the regulatory status of HHPs. It is also in these regions with the fastest growth in use of pesticides that epidemiological evidence is most lacking (UNEP 2022).

The widespread use of fertilisers in agriculture also contributes to environmental pollution. Over the past decade agricultural use of synthetic and organic fertilisers accounted for 74% of human-caused nitrous oxide (N2O) emissions, a potent greenhouse gas that has approximately 298 times the global warming potential of carbon dioxide over a 100-year period (Tian *et al.* 2024). Excessive fertiliser use can also cause eutrophication, a process where water bodies become nutrient-rich and oxygen poor. This can harm aquatic life and the productivity of aquatic food production systems. Additionally, excessive fertiliser use can lead to soil salinisation and degradation, reducing soil fertility and agricultural productivity.

Social: Nitrate and phosphate pollution from fertilisers can also contaminate groundwater, posing health risks to local communities and animals. In addition, agricultural open burning, often used to clear crop residues, is a significant source of air pollution globally. By releasing particulate matter (PM 2.5), black carbon, carbon monoxide (CO), methane (CH_4), and other harmful pollutants, it not only contributes to climate change, but also has major impacts on air quality and human health. The impact and prevalence of agricultural burning vary by region, with Asia, Africa, and parts of Latin America experiencing particularly high levels (Cassou 2018). According to the EPA's 2020 U.S. National Emissions Inventory, agricultural field burnings produced 67,309.81 tons, approximately 20% of total PM2.5 emissions (Pinakana *et al.* 2024). Black carbon, a microscopic pollutant found within PM2.5, can penetrate deep into the lungs and bloodstream.

Agricultural pollution often disproportionately affects low-income, rural communities, who live closer to polluted areas or work in hazardous conditions on farms. This environmental injustice is compounded by the fact that these communities typically have limited access to healthcare and resources to mitigate the impacts of pollution, leading to a cycle of health disparities and socioeconomic disadvantage (FAO and UNEP 2021.).

Pesticides represent the highest impact substances used in agriculture, given their inherently toxic design and ability to persist in the environment for decades. Excessive and improper use of pesticides results in contamination of surrounding soil, water and non-target plants and animals, thereby causing negative health and environmental impacts. It also contributes to loss of biodiversity, for example by destroying beneficial insect populations that act as natural enemies of pests and reducing the nutritional value of food (United Nations 2017). A relatively small number of Highly Hazardous Pesticides (HHPs) cause disproportionate harm to the environment and human health including severe environmental hazards, high acute and chronic toxicity at low and high concentrations can cause various adverse health outcomes including cancers and neurological, immunological and reproductive effects (UNEP 2022; Kaur et al. 2024). While global pesticide use has doubled since 1990 (FAO 2023a), HHP use is also growing and can represent up to 30% of all pesticides used in some low-income countries, due to substantial variation in the regulatory status of HHPs. It is also in these regions with the fastest growth in use of pesticides that epidemiological evidence is most lacking (UNEP 2022). While food security is critical, the environmental and health costs of certain practices can be evaluated with an emphasis on developing sustainable and regenerative agricultural methods that protect both food supplies and ecosystems.

Economic: The advance of conventional or industrialised agriculture over the past century has contributed enormously to food security underpinning a period of unprecedented global population growth. However, the economic impacts of pollution from industrialised agriculture are substantial and multifaceted. Besides health costs, one of the most direct economic consequences is the loss in agricultural productivity due to soil degradation and water pollution. A study in Myanmar found that farms affected by industrial wastewater pollution experienced a 40% yield loss in paddy production, with an estimated economic loss of approximately USD 78 per acre (Htwe 2021). This loss includes both reduced yield and lower selling prices due to decreased crop quality. Contrary to misplaced beliefs that burning increases soil fertility, it actually has the opposite effect, reducing water retention and soil fertility by 25 to 30%. As a result, it requires farmers to invest in expensive fertilisers and irrigation systems to compensate. Burnt residues are no longer available for use as fodder, as mulches to protect soils or as feedstocks for other beneficial uses such as biochar.

The decline in biodiversity due to industrial agriculture represents another form of economic cost, often in terms of reduced ecosystem services, such as natural pest control and pollination. While these losses are difficult to quantify, they represent significant long-term economic impacts. The Food and Agriculture Organization (FAO) estimates that USD 10 trillion of environmental, social, and health costs are hidden in current food and farming systems, with environmental costs alone accounting for USD 2.9 trillion (FAO 2023b). The economic costs of pesticide use are likely to exceed tens of billions of dollars each year in the United States of America and European Union alone (UNEP 2022).

Transitioning away from agrochemicals in agriculture, however, is challenging because many intensive monocrop production systems now depend on them to maintain high yields and reliable food production. Overambitious and unsupported transitions to entirely "organic" systems can have very serious unintended consequences for food security and rural livelihoods. Sri Lanka's experience in 2021 highlights the potential challenges of such rapid shifts and the need for proper planning. The nationwide ban on imports of synthetic fertilisers, pesticides without preparation of effective alternatives led to yield declines of up to 60% for key staples such as rice and potatoes, having dramatic impacts on living standards (Harrison-Broninski 2024). While food security remains critical, the focus should be on developing and implementing sustainable and regenerative farming methods that strike a balance between maintaining robust food production and safeguarding ecosystem health.

Pollution risks in the agricultural sector

Transition risks

Regulatory/legal: Lending and investments into potentially hazardous chemicals production and farming systems that are designed with chemical use as an intrinsic component of the system may bring immediate financial and productivity benefits. However, growing toxicological and epidemiological evidence of the health and ecosystem effects at low doses and of mixtures of chemicals and their degradation products, can generate significant liability risks, and also regulatory risks as these chemicals may face restrictions. Both the Global Framework on Chemicals (GFC) and the Kunming-Montreal Global

Biodiversity Framework (GBF) have targets to eliminate HHPs from agriculture by 2035 and 2030 respectively. Of specific relevance to banking sector engagements in agriculture are agreed targets, from:

(i) GFC target A7 stating that by 2035 stakeholders have taken effective measures to phase out highly hazardous pesticides in agriculture where the risks have not been managed and where safer and affordable alternatives are available, and to promote transition to and make available those alternatives, and

(ii) GBF stating that by 2030 pollution risks from all sources should be reduced to levels that are not harmful to biodiversity and ecosystem functions and services. The GBF sets targets for reduction of:

- excess nutrients lost to the environment by at least half
- overall risk from pesticides and highly hazardous chemicals by at least half and
- through continuous efforts to prevent, reduce and eliminate plastic pollution.

While the evidence supporting the complete elimination of HPPs in agriculture is very clear, there are many other pesticides and new methods for introducing these chemicals into the agricultural environment, for which the case is far less clear-cut. The introduction of genetically modified (GM) crops in the 1990s, fuelled by aggressive marketing, corresponded to increased glyphosate usage. Since 1974, overall glyphosate use has increased approximately 200-fold, with agriculture accounting for 90% of this growth (Richmond *et al.* 2018). Many regulatory agencies have determined glyphosate poses little or no risk to health, however concerns about carcinogenic effects of glyphosate have been raised (International Agency for Research on Cancer 2018).

While its carcinogenicity may still be under discussion and risks of consumer exposure through diet are low, significant risks for non-target terrestrial and aquatic plants may exist, particularly when officially designated risk mitigation measures on product labels are not properly implemented (UNEP 2020). Without consensus on this issue, glyphosate remains widely used due to its potential to reduce GHG emissions, support food security, and minimise tillage, erosion and soil carbon loss in fragile soils.

Furthermore, due to the complex nature of disease and the fact that individuals are often exposed to a variety of chemicals daily, establishing a direct causal link between pesticide exposure and specific health effects can be difficult (Ntzani *et al.* 2013; Ockleford *et al*. 2017). This makes it challenging to hold parties accountable and for victims to seek appropriate compensation (HRC 2017). Nevertheless, thousands of lawsuits have been filed against the company by individuals who claim to have developed non-Hodgkin lymphoma after exposure to glyphosate. As of July 2024, disputed settlement agreements totalling USD 11 billion in nearly 100,000 lawsuits have been filed (Lawsuit Information Center 2024).

Technological: Innovation in agricultural technologies, such as GM crops or antibiotics used in livestock farming, can create new and emerging risks. These include unintended consequences for local communities and their environments, including biodiversity loss, reduced food quality and food safety concerns. For instance, innovative modes of pesticide application have developed to replace "imprecise" broadacre spraying techniques. Systemic pesticides, absorbed by plants and moving throughout their tissues, do not require spray to come into direct contact with an insect and can be effective at lower concentrations than non-systemic pesticides.

Another innovative alternative to spraying has been to develop transgenic crops that produce "natural" insecticides within the plant. Bt-modified crops have been modified with genetics from the bacterium Bacillus thuringiensis (Bt) and can produce a protein that is toxic to certain insects. Meta-analyses have shown that systemic pesticides, particularly neonicotinoids in combination with other plant protection products (PPPs) can lead to increased bee mortality and sublethal effects (Vanbergen, 2021). While evidence suggests that the introduction of Bt cotton has reduced the burden of pests, decreasing pesticide use by 37% increasing yields by 22% and farmer profits by 68%, scientists warn of potential unintended impacts, particularly on biodiversity (Zafar *et al.* 2020; Klümper and Quain 2014).

Advancements in measurement technologies and epidemiological science have enabled more precise detection and quantification of low-dose and mixed pollutant exposure, particularly from agrochemicals. This increased precision can lead to stricter regulations and stricter enforcement of existing regulations, potentially exposing companies to greater liability risks. Additionally, as the scientific understanding of the long-term health and environmental impacts of these chemicals evolves, new regulations and standards may be introduced, requiring significant investments to comply. This can lead to increased costs and operational challenges for businesses, potentially impacting their creditworthiness. Moreover, the identification of new health risks associated with low-dose exposure could lead to public health crises and consumer boycotts, damaging the reputation of companies and their associated financial institutions.

Shifting consumer preferences: Recent trends in the organic food market reflect a strong consumer demand driven by heightened health and quality awareness, with a preference for food produced without synthetic insecticides, fertilisers, antibiotics or genetically modified organisms (GMOs). Valued at approximately USD 245 billion in 2023, the global organic food and beverage market is projected to grow at a compound annual growth rate (CAGR) of 13.20% to reach more than USD 785 billion by 2033 (Spherical Insights 2024). The increase and interest in organic food can be observed across the world, with the fastest growth in Asia Pacific.

Physical risks

Health: Industrial agriculture, including the excessive use of agrochemicals and intensive farming, poses significant risks to human health and the environment. These practices contribute to a cascade of interconnected health and ecological challenges through contamination of water sources, air pollution and accumulation of toxins in food crops. The health impacts range from acute effects such as pesticide poisoning to chronic conditions such as respiratory diseases, cancers, and developmental disorders. Vulnerable populations, particularly farmers and agricultural workers in developing nations, are often disproportionately affected.

There remain significant knowledge gaps in systematic reviews, risk assessments and monitoring of the impacts of pesticides and new technologies such as GM crops and use of antibiotics on human, animal and ecosystem health. These gaps include areas such as toxicological assessments of co-formulants and formulated products, evaluation of complex human health outcomes, understanding the combined effects of multiple pesticide exposures, and the lack of disaggregated data for vulnerable populations, specifically farmers and agricultural workers in developing nations (UNEP 2022).

Air: Air quality is compromised by agricultural burning and other practices, releasing particulate matter (PM2.5) and other pollutants that contribute to respiratory issues and long-term health problems. For instance, exposure to PM2.5 is linked to serious health risks, including heart and lung disease, stroke and certain cancers. Millions of people die prematurely each year due to PM2.5 exposure. Children exposed to PM2.5 may experience psychological and behavioural issues, while older adults may be at increased risk of developing Alzheimer's, Parkinson's and dementia (UNEP 2021). Additionally, agricultural practices contribute significantly to climate change through the release of greenhouse gas emissions, including methane from livestock and rice cultivation, nitrous oxide from fertiliser use, and carbon dioxide from land use changes and farm machinery.

Soil: Soil pollution from industrial agriculture reduces crop yields and threatens food safety by allowing contaminants to accumulate in crops. This pollution disrupts ecosystem balances, potentially leading to the emergence of new pests and diseases. The degradation of soil resources also poses a risk to agricultural sector productivity, impacting yields and increasing costs for producers. Declining soil fertility exacerbates these issues, contributing to increased production costs and declining revenues for producers.

Fresh water: Freshwater ecosystems are compromised by agricultural runoff containing pesticides, fertilisers and other agrochemicals. This runoff degrades drinking water quality and harms aquatic habitats, posing risks to both human health and biodiversity. Contaminants such as nitrates from fertilisers can lead to waterborne diseases when they infiltrate drinking water supplies. Eutrophication, a process where water bodies become overly enriched with nutrients, can threaten aquatic life and further deteriorates water quality, making it more difficult and costly to treat water for human consumption.

Oceans: In coastal areas, nutrient pollution from agricultural runoff contributes to harmful algal blooms and dead zones in marine ecosystems. These phenomena disrupt marine life by depleting oxygen levels in the water, severely impacting fisheries and biodiversity. The loss of ocean resources due to such pollution diminishes the provision of ecosystem services critical for maintaining healthy marine environments. This degradation has material risks for banks' lending and investments in sectors reliant on marine resources.

Pollution risks in the agriculture sector encompass a spectrum of environmental and social issues that can emerge at various stages, from design and development to end-of-life, as illustrated in Figure VII.

Lifecycle Stage	Design & Development	Production	Distribution	Use	End-of-Life
Some Priorities	• Avoiding built-in agro-chemical dependence and associated agro-chemical persistence, bioaccumulation, biomagnification, mobility, toxicity, degradability.	• Minimising accidental releases, unintended hazardous by-products, operational errors, fugitive emissions	• Lowering transportation emissions, accidental spills, storage leakages • Ensure agrochemicals are distributed with appropriate health and safety information and training	• Eliminating pesticide, herbicide, insecticide contamination and residues (in air, water, soil and food); • Minimising biodiversity loss; nutrient run-off; salinity from irrigation; GHGs	• Ensuring effective agricultural waste management, land degradation and contamination
Some Sustainable Finance Opportunities	• Low input (high yield) and biodiverse systems design; financial services for low input systems • Integrated pest management (IPM) • Biomimicry • Physical weed management	• Design and operationalisation of sustainable (biodiverse) intensification systems incl. perennialisation, agroforestry, mixed cropping, minimum tillage • Biological alternatives • Precision agriculture (PA)	• Sustainable packaging • Safe biodegradeable materials • Realtime supply chain monitoring IoT	• Integrated Pest Management (IPM) and Precision Agriculture (PA) services • Biological alternatives • Premium markets for certified agri-products • Cleanup and remediation services • Net-zero and carbon negative systems	• Crop residue value addition (bioenergy, soil amendments, biochar) • Microbial processes for decontamination • Safe disposal of unused product and associated plastic containers

Figure VII: The agricultural life cycle

Opportunities in the agricultural sector

Presently, the dominant paradigm in agriculture is one of monocrops, mechanisation, and chemicals use as a matter-of-course in pest and disease prevention, to remove any competition in the field and maximise yields. When an agricultural system is designed around single crop varieties, and that variety requires chemical inputs to survive and yield, then there is a significant technological and supply chain lock-in effect. The greatest portion of current financing for food and agriculture remains locked into this dominant pathway, with commercial banks contributing more than USD 700 billion annually to agricultural financing, making up most investments in the sector (UNCTAD 2019).

Although banks and credit cooperatives are the primary sources of capital for farmers, their lending decisions are often influenced by other players such as insurers, seed and chemical companies, and offtakers. Insurance companies often require farmers to use specific inputs to qualify for coverage. Offtakers involved in buying, processing and distributing agricultural commodities may also dictate certain quality standards or favour specific GMO seeds and associated chemicals. Seed and chemical companies, in turn, develop products tailored to these demands. This network, referred to as the "agro-industrial complex," has a profound influence on farming practices globally, and may lead banks to issue loans tied to specific inputs and crop varieties.

Despite the complex interplay between these players and current lock-in effects, there are considerable opportunities associated with transforming crop management systems and embracing agroecological and sustainable intensification method to create resilient, sustainable, and socially equitable agricultural systems. Sustainable intensification is a strategy to maintain and increase yields while minimising environmental impacts. Agroecology focuses on creating diverse and resilient agricultural systems that mimic natural ecosystems through application of ecological principles. These include promoting biodiversity, closing nutrient cycles, integrating trees into agricultural landscapes, and involving farmers and communities in decision-making. Introducing alternatives to agricultural open burning can bring substantial economic and social benefits, particularly in rural and agricultural communities. For instance, crop residues can be used for bioenergy production or livestock feed or bedding, creating income-generating opportunities for farmers through sales of bioproducts. Alternatives like no-burn soil management, crop residue utilisation, and sustainable land-clearing methods can boost soil health, reduce the need for costly fertilisers, and increase crop yields over time. These alternatives can also help farmers adapt to climate change by improving soil resilience and water retention, supporting food security and economic stability in the long term. Programmes offering financial incentives and technical support for such practices have already shown success in regions such as India and Southeast Asia (Climate and Clean Air Coalition 2024). Strong support to change long-held beliefs and behaviours surrounding crop residue burning remains critical. Specific opportunities for banks to enable the transition to a more sustainable, resilient and less polluting agricultural sector include the following:

- **Innovating sustainable farming practices:** Banks can spearhead innovation in agriculture by introducing dedicated financial instruments that incentivise and support sustainable farming practices. This may involve financing initiatives focused on precision agriculture, agroecology and organic farming, ensuring adherence to environmental and social sustainability standards. These practices not only reduce emissions, but also enhance product value and increase resilience of supply chains, as many commodities are increasingly threatened by climate-related impacts such as extreme weather events.
- **Fostering technology adoption for sustainable agriculture:** Technology plays a crucial role in modernising agriculture and reducing environmental pollution. Banks can support the adoption of innovative technologies—such as precision farming tools, data analytics, smart irrigation systems and sustainable management of agricultural residues to avoid open burning to enhance productivity while minimising the degradation of natural ecosystems and ecosystem services—by enhancing farmers access to these technologies through the use of transition financing instruments for example.
- **Promoting responsible chemicals management:** Given the widespread use of agrochemicals in modern agriculture, banks can take a proactive role in promoting responsible chemical management. This includes supporting farmers in adopting integrated pest management strategies, reducing reliance on synthetic pesticides, and promoting the use of environmentally friendly alternatives, and supporting initiatives for farmer training. For instance, there has been significant growth in the use of biocontrols as alternatives to agrochemicals. A 2023 survey conducted by the International Biocontrol Manufacturers Association (IBMA) indicates that the European biocontrol market is now valued at more than EUR 1.6 billion, accounting for nearly 10% of the total European crop protection market. The European biocontrol market has a compound annual growth rate (CAGR) of nearly 10% whereas the conventional crop protection market has a CAGR of approximately 4%, and since 2016 the market has doubled in size (IBMA 2023).
- **Strengthening alternatives such as biopesticides and organic fertilisers:** Growing consumer awareness of risks associated with pesticides and synthetic fertilisers presents an opportunity for the biopesticides and organic fertilisers market, as the

consumer choice drives many retailers to adopt secondary residue standards in addition to the national ones to which food producers are forced to adhere. While many of the food producers face increasingly stringent pesticide residue standards and agrochemical restrictions, most of biopesticides comply with the maximum allowable concentration of pesticide residues (MRL) and have short PHI, which is the minimum time that must pass between the last pesticide application and the crop's harvest to ensure compliance with safety standards.

- **Facilitating transition to regenerative and organic farming:** Regenerative and organic farming practices are gaining momentum due to their environmental benefits and reduced pollution of ecosystems. Banks can facilitate the transition to regenerative and organic systems by providing financial support to farmers seeking appropriate certifications, investing in supply chains and promoting consumer awareness of the benefits of produce grown with reduced or no synthetic chemicals. For smallholder farmers, reduced reliance on chemical inputs may have further benefits in terms of income security, as prices associated with these inputs tend to rise or supply bottlenecks occur. In addition, farmers can earn a premium on agricultural products sold under regenerative or organic certification.
- **Promoting biodiversity conservation:** Supporting initiatives that promote biodiversity conservation in agriculture is another avenue for banks. This may involve financing projects that prioritise agroecological approaches, less chemical inputs and sustainable land use planning to maintain ecosystem balance.

To capitalise on these opportunities and enhance the resilience of the agricultural sector, banks can **incorporate environmental and social and environmental due diligence into their lending criteria, collaborate with agricultural stakeholders** to develop capacity and promote sustainable practices, **actively engage with clients** and **offer tailored financial products,** including loans with favourable terms for sustainable initiatives. This strategic alignment with sustainable stewardship can significantly enhance the reputation of financial institutions, while allowing them to comply with evolving environmental regulations and mitigate pollution-related impacts and risks. To assess and manage these risks, banks can utilise established frameworks and standards, particularly the IFC Performance Standard 1 (Assessment and Management of Environmental and Social Risks and Impacts), IFC Performance Standard 3 (Resource Efficiency and Pollution Prevention), and IFC Performance Standard 6 (Biodiversity Conservation and Sustainable Management of Living Natural Resources).

Table 18 provides an overview of various tools and initiatives that can be leveraged by the banking sector to promote sustainable finance and mitigate environmental risks. These resources offer guidance, frameworks, and platforms to support banks in integrating sustainability into their business operations and decision-making processes.

Table 18: Agricultural sector reference tools/initiatives and relevance for the banking sector (non-exhaustive list)

Additional sectoral guidance: Food and Agriculture (TNFD)
The LEAP approach, a framework for assessing and managing nature-related risks and opportunities, can be applied to the food and agricultural sector through specific guidance and tools. Core global disclosure metrics tailored to this sector are available, along with sector-specific indicators and metrics to identify potential dependencies and impacts on nature. Dependency and impact matrices can further help organisations in this sector assess their interactions with ecosystems and identify risks and opportunities. Illustrative lists of environmental assets, ecosystem services, impact drivers, risks, and response actions specific to the sector can provide practical guidance for implementation.
Global Alliance on Highly Hazardous Pesticides (HHPs)
The Global Alliance was agreed on 30 September 2023 to facilitate the implementation of target A7 of the Global Framework on Chemicals (GFC), a critical new policy instrument adopted at ICCM5. The target aims to phase out the world's most hazardous pesticides—HHPs. Target A7 and the Global Alliance were arguably the most concrete commitments in the GFC to urgently address the intentional and systematic release of highly toxic chemicals into the environment worldwide. The Global Alliance will be critical to the successful implementation of complementary international commitments on biodiversity and climate change in other global agreements.
International Code of Conduct on Pesticide Management
A voluntary framework on pesticide management for all public and private entities engaged in, or associated with, production, regulation and management of pesticides. It has been endorsed by FAO members and is supported by key pesticide industry associations and civil society organisations. The Code serves to strengthen the capacity of developing countries to regulate, evaluate and enforce effective control over pesticides. It is designed to be used within national legislation and describe amongst other topics the standards of conduct for pesticide management, complementing the legally binding instruments on chemical management. The Code provides standards of conduct, serving as a point of reference in relation to sound pesticide life cycle management practices, in particular for government authorities and the pesticide industry.
International Federation of Organic Agriculture Movements (IFOAM)
Founded in 1972, IFOAM is a membership-based organisation that aims to bring sustainability to agriculture across the world. The IFOAM Norms form the basis of the Organic Guarantee System of IFOAM - Organics International: ▪ The Common Objectives and Requirements of Organic Standards (COROS) – IFOAM Standards Requirements. ▪ The IFOAM Standard for Organic Production and Processing. ▪ The IFOAM Accreditation Requirements for Bodies Certifying Organic Production and Processing
Sustainable Agriculture Initiative (SAI) Platform
SAI Platform is a non-profit network of more than 170 members worldwide. Working together their members are advancing sustainable agricultural practices through pre-competitive collaboration. Some of their tools include: ▪ European Roundtable for Beef Sustainability ▪ Farm Sustainability Assessment ▪ Regenerating Together Programme ▪ Sustainable Dairy Partnership

Sustainable Agriculture and Land Health Initiative (IUCN)
Through evidence-based dialogue between the agriculture and conservation sectors, the International Union for the Conservation of Nature (IUCN) aims to promote agroecological and regenerative approaches that restore and conserve biodiversity on farms and in agricultural landscapes. Their main outcomes include: ▪ International commitments to sustainable agriculture are advanced and monitored through dialogue between conservation and agriculture actors ▪ Communication of scientific evidence of the multiple benefits of sustainable agriculture ▪ An expanded portfolio of sustainable agroecological projects is developed
One Planet Network (Sustainable Food Systems Programme (SFSP))
The SFSP has developed a suite of tools to support the shift towards sustainable food systems. These resources are aimed at encouraging and guiding countries and other stakeholders to expand their knowledge and step up their action in addressing food system challenges to advance on their SDGs commitments. The SFSP provides knowledge, guidance and inspiration for the urgent need to transform food systems, applying a systems perspective.
Financing Agrochemical Reduction and Management (FARM) (GEF)
FARM is a five-year programme that aims to catalyse a framework for regulatory and financial investment to detoxify the agriculture sector by eliminating the use of the most harmful inputs to food production systems. FARM has a particular focus on leveraging finance from public resources and the financial sector, and aims to align policy, enforcement and finance towards the environmentally sustainable management of pesticides and agricultural plastics.

5. Conclusions

The banking sector is uniquely positioned to influence the global response to the triple planetary crisis, which encompasses climate change, biodiversity loss, and pollution. Guided by the PRB, banks can align their strategic actions to support society in achieving a sustainable, inclusive economy. While much attention has been given to climate and biodiversity, pollution remains a critical but often overlooked challenge. This paper provides a blueprint for how banks can proactively address pollution within operations, portfolios and client engagements in line with the PRB. By integrating pollution considerations into their strategic frameworks, banks can not only mitigate risks but also seize opportunities to contribute to a healthier, more resilient planet and society. Through actions including active client engagement, banks can manage pollutants and address emerging issues of concern, based on scientific and technical reports from international organisations and local or regional information.

Principle 1: Alignment

- Banks can stay informed and monitor their own and their clients' compliance with regulatory frameworks and environmental policies governing pollution control at all levels—regional, national, and international—to avoid exposure to legal liabilities, reputational damage and financial penalties.

- Banks can conduct a periodic review and adaptation of pollution strategies in light of new scientific data, technology advancements and regulatory changes to reflect the need for an evolving approach as understanding and standards around pollution continue to develop.

- Banks can operationalise the nexus between pollution, nature and climate, for instance through aligning their portfolios with GBF target 7, by reducing exposure to clients in high polluting sectors without a transition plan and increasing financing for pollution reduction and management.

Principle 2: Impact and Target Setting

- Banks can integrate pollution into their risk management practices and their lending and investment strategies. This includes assessing the sources of pollutants across portfolio sectors that have environmental consequences, such as ecosystem damage, biodiversity loss and the impact on human health, especially for vulnerable populations.

- Banks can enhance their impact by developing new business opportunities for portfolios to finance pollution mitigation in high-impact sectors and value chains and to address pollution through client engagement. This approach allows for targeted actions that meet the challenges posed by pollution in the current global context.

- Banks can explore incentivising investments in pollution prevention by promoting clean energy, waste management, sustainable infrastructure and green and circular finance, thereby contributing to pollution reduction and environmental conservation efforts.
- Banks can hedge against future risks, capture new growth opportunities and improve their portfolios' impact by transitioning from linear portfolios—where assets are increasingly prone to becoming stranded—to circular portfolios.

Principle 3: Clients and Customers

- Banks can identify the most significant clients in terms of their pollution impact and relevance to the bank's business and develop client and sector specific engagement processes for pollution, based on meticulous evaluation of client performance to refine service offerings to better meet client needs.
- Banks need to recognise the financial risks of inaction (such as potential regulatory penalties, stranded assets or lost market share), alongside the potential economic benefits of proactive pollution management.
- Banks can leverage opportunities in emerging markets that focus on the substitution of hazardous materials. By developing products and services that support innovation and scale-up financing for SMEs providing solutions, banks can drive the adoption of safer alternatives.
- Banks can factor in the social implications of pollution reduction—especially for vulnerable communities affected by industrial pollution—toward supporting a just transition, ensuring pollution mitigation efforts do not disproportionately impact marginalised populations.

Principle 4: Stakeholders

- Banks can develop partnerships with key stakeholders such as governments, environmental organisations and academia to amplify impact and address pollution challenges effectively.
- Banks can support research institutions by financing studies on financial risks and opportunities to address the impacts of pollutants and understanding business models and technologies driving change in the ability to identify, understand, and reduce impacts.
- Banks can contribute to prioritising pollution reduction lending and investment that supports gender equality, marginalised communities, minorities and others who can be shown to suffer the worst impacts of pollution. Collaborating with diverse stakeholders aligns with the PRB's stakeholder engagement goal and strengthens the capacity to tackle pollution on a larger scale.

Principle 5: Governance and Culture

- Banks can embed pollution-related considerations into governance, culture, and decision-making processes, across five pillars of: responsible leadership, governance design, integrating pollution within the bank's core strategy and risk management framework, fostering a culture of environmental responsibility with a specific focus on pollution prevention and mitigation, and stakeholder engagement on pollution-related issues.

- In addition, investing in employee training to ensure staff across departments are informed on pollution risks and impacts and are aligned with sustainable finance goals is essential to build the necessary internal expertise for reducing and managing pollution.

Principle 6: Transparency and Accountability

- Banks can use pollution-related disclosure frameworks and foster transparency and accountability. They can also engage in international discussions and policy and framework development to reduce pollution, ensuring their actions are informed by the latest scientific evidence and contributing to financing solutions in high-impact sectors and value chains. Demonstrating and encouraging transparency and accountability in such actions can further strengthen banks' credibility as key drivers of positive change.

In conclusion, the banking sector's role in combating pollution is both a responsibility and an opportunity. By taking decisive actions and aligning with global efforts to address pollution, banks can play a critical role in creating a more sustainable and resilient future. The strategies outlined in this paper serve as a starting point for banks to engage in meaningful change, ensuring that their contributions to pollution reduction are impactful and lasting. As the world continues to grapple with environmental challenges, the banking sector's action to address pollution will be essential in shaping a sustainable path forward. UNEP FI and its partners will develop more detailed guidance on pollution for banks in 2025, further supporting the sector's journey to align with the Principles for Responsible Banking and enhance their positive impact on society and the environment.

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