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BIODIVERSITY MAINSTREAMING IN THE MANUFACTURING AND PROCESSING SECTOR

*Note by the Executive Secretary***

INTRODUCTION

1. In decision XIII/3, paragraph 103, the Conference of the Parties decided to consider, at its fourteenth meeting, the mainstreaming of biodiversity into the sectors of energy and mining, infrastructure, manufacturing and processing, and health. The present document focuses on the key dimensions of mainstreaming biodiversity into manufacturing and processing industries,[1] briefly presenting this sector and its trends, why it matters for biodiversity conservation and sustainable use, what mainstreaming approaches have been used to date and what gaps need to be addressed.

2. The present document is complemented by an information document (CBD/SBI/2/INF/31) which provides more in-depth information on: (a) the definition of the manufacturing industries, their global status and trends; (b) the interactions between manufacturing and biodiversity,[2] explaining the main impacts and dependencies of various manufacturing industries and identifying the risk areas for biodiversity; and (c) the biodiversity mainstreaming approaches in the manufacturing and processing sector, highlighting best practices, challenges and opportunities.

3. It is important to note that mainstreaming in the manufacturing sector must not be considered in a vacuum; various drivers of projected global trends, as well as linkages with other sectors, will be highly relevant.

I. THE MANUFACTURING SECTOR: STATUS AND TRENDS

4. According to the United Nations Statistics Division, manufacturing "includes the physical or chemical transformation of materials, substances, or components into new products."[3] This involves facilities (plants, factories or mills) that typically use power-driven machines and materials-handling equipment, small scale/artisanal transformation of materials or substances into new products, and businesses that sell directly to the general public their products made on the same premises from which they are sold (e.g., bakeries and custom tailors). The output of a manufacturing process may be finished, i.e. ready for utilization or consumption, or semi-finished, as an input for further manufacturing.

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* CBD/SBI/2/1.

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[1] Hereinafter referred to as "manufacturing industries". Manufacturing includes the processing of the products of various raw material producers into diversified goods, including the products of agriculture, forestry and fishing.

[2] The Convention on Biological Diversity defines biological diversity as "the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems".

[3] United Nations Statistics Division (2017). *International Standard Industrial Classification of All Economic Activities*, Rev.4. https://unstats.un.org/unsd/cr/registry/regcst.asp?Cl=27, accessed on 5 January 2018.

5. Manufacturing is at the heart of modern economies. It is critical to satisfy the ever growing demands of consumers worldwide. Technological and organizational innovations have allowed the sector to diversify, and it now includes the following industries: manufacture of food products; beverages; tobacco products; textiles; wearing apparel; leather and related products; wood and products of wood and cork; articles of straw and plaiting materials; paper and paper products; printing and reproduction of recorded media; coke and refined petroleum products; chemicals and chemical products; basic pharmaceutical products and pharmaceutical preparations; rubber and plastics products; basic metals; non-metallic mineral products; fabricated metal products; computer, electronic and optical products; electrical equipment; machinery and equipment; motor vehicles, trailers and semi-trailers; furniture.

6. According to the World Bank,[4] manufacturing accounted for approximately 15 per cent of global gross domestic product (GDP) in 2016. The main manufacturing nations are, in decreasing order of global share in manufacturing GDP: China; United States of America; Japan; Germany; and Republic of Korea (more than 50 per cent of global manufacturing GDP combined).[5] The manufacturing GDP of China rose from about US$ 385 billion in 2000 to US$ 3,250 billion in 2015.[6] The growth of manufacturing industries in the members of the Organization for Economic Cooperation and Development (OECD) lies in high-end technologies, which often directly relies on inputs of raw material from countries with major emerging national economies and developing economies. Manufacturing accounted for 23 per cent of total employment worldwide in 2012, and the International Labour Organization (ILO)[7] projects that manufacturing jobs in 2018 will amount to 24 per cent of the global workforce.

7. During the last decade, several large developing economies joined the group of leading manufacturing nations (for example Brazil, China and India), a severe recession severely impacted demand,[8] and manufacturing employment fell at an accelerated rate in developed economies.[9] The manufacturing sector is now looking for growth opportunities, by notably putting significant investment into research and development and new markets.[10] While global value chains remain concentrated among a relatively small number of countries, there is room for various developing nations to attract more manufacturing companies as they become more engaged in the globalized economy.

8. Several megatrends are affecting the "advanced manufacturing"[11] industries, including, but not limited to: continued ageing of the workforce in some developed countries; the need for a change in manufacturing skills; growing demand for customized products and services according to consumers' individual specifications; increasing demand for manufactured goods in cities and increased efforts to support reshoring[12] to developed countries. In addition, new global manufacturing trends, such as The Internet of Things (IoT), advanced robotics and three-dimensional printing, are shifting the criteria that make locations attractive for production and are threatening significant disruptions in employment, particularly for low-

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[4] URL: http://wdi.worldbank.org/table/4.2#, accessed on 9 November 2017.

[5] Levinson, M. (2017). U.S. manufacturing in international perspective. Congressional Research Service, R42135, 19 pp.

[6] URL: http://wdi.worldbank.org/table/4.3#, accessed on 6 January 2018.

[7] URL: http://www.ilo.org/global/research/global-reports/global-employment-trends/2014/WCMS_234879/lang--en/index.htm, accessed on 9 November 2017.

[8] Global economic growth grew at a rate below 2.5 per cent. Global trade slowed down dramatically to around 1.5% in 2015 and 2016, compared to 7% before the crisis; UNCTAD (2016). The Trade and Development Report (TDR) 2016. URL: http://unctad.org/en/pages/PublicationWebflyer.aspx?publicationid=1610, accessed on 9 November 2017.

[9] McKinsey (2012). Manufacturing the future: The next era of global growth and innovation. URL: https://www.mckinsey.com/business-functions/operations/our-insights/the-future-of-manufacturing, accessed on 7 November 2017.

[10] KPMG International's 2016 Global Manufacturing Outlook; URL: https://home.kpmg.com/xx/en/home/campaigns/2016/05/kpmg-internationals-2016-global-manufacturing-outlook-competing-for-growth.html, accessed on 7 November 2017.

[11] Advanced manufacturing technology is defined as computer-controlled or micro-electronics-based equipment used in the design, manufacture or handling of a product. *OECD Frascati Manual*, Sixth edition, 2012; URL: https://stats.oecd.org/glossary/detail.asp?ID=52, accessed on 9 November 2017.

[12] Reshoring is the act of bringing outsourced personnel and services back to the location from which they were originally outsourced.

skilled labour.[13] For instance, an increasing number of companies process materials and manufacture finished products at the site of final use, which has major implications for logistical networks.

II. THE BIODIVERSITY DEPENDENCIES OF MANUFACTURING INDUSTRIES

9. The manufacturing sector relies directly and indirectly on various ecosystem services.[14] Some industries rely primarily on renewable and non-renewable resources (provisioning ecosystem services), typically on raw material inputs into various manufacturing processes, and some regulating ecosystem services, such as water flow regulation and purification services. Ecosystems also provide services in absorbing and mitigating air and water emissions, which is particularly relevant for several manufacturing industries in which significant emissions occur at the factory level (e.g., stack emissions).

10. Manufacturing industries have multiple dependencies on ecosystems; e.g., water extraction from an aquifer or river at a factory, ecosystems acting as recipients of air, water and soil pollution, as mentioned above. Some manufacturers rely on the supply of renewable, biological raw/transformed materials (e.g., fibres, foods) while others use genetic resources and associated traditional knowledge, including the pharmaceutical, agriculture, industrial biotechnology, cosmetics, botanicals, and food and beverage sectors.[15] These dependencies on ecosystems can be diverse and complex, contingent on the type of raw material extracted or produced for manufacturing transformation by raw material extractors and producers. To fully understand such dependencies would require looking at the interactions between raw material extractors/producers (e.g., crop producers, mining) and ecosystems.

11. The globalized nature of supply chains involved in the manufacturing of goods can create challenges in tracking which ecosystem services matter the most to specific manufacturers, especially when a company knows very little about the activities of its suppliers (e.g., material inputs purchased from wholesalers on global markets), and where dependencies on such services are indirect. Yet, dependencies on biodiversity and ecosystem services can become strategic business issues for many manufacturing industries. Manufacturing industries with heavy reliance on provisioning ecosystem services (e.g., food and beverages, textiles) are more likely to suffer first from any increased resource scarcity, while high-tech industries rely on more on intermediate goods which involve more complex supply chains. For instance, securing sustainable supply chains — due to the concerns/needs of retailers and consumers — has become a critical issue for many manufacturers of textiles (e.g., securing the supply of specific skins for luxury leather manufacturing), cosmetics (e.g., securing the supply of specific plant materials), foods (e.g., securing oils that are deforestation-free and fish from sustainably managed fish stocks) and furniture (e.g., deforestation-free supply chains).

III. THE BIODIVERSITY IMPACTS OF MANUFACTURING INDUSTRIES

12. Impacts on biodiversity vary across manufacturing industries, and are driven by the specifics of their production inputs (e.g., renewable and non-renewable resource use) and non-product outputs (e.g., air and water emissions, solid waste).[16] Manufacturing companies generate both direct (e.g., factory location

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[13] Hallward-Driemeier, M., Nayyar, G. (2018). Trouble in the making? The future of manufacturing-led development. Washington, DC: World Bank. doi:10.1596/978-1-4648-1174-6.

[14] Through the understanding of the relationships between biodiversity and ecosystem services is far from comprehensive, various species, their interactions and the associated ecosystem functions and processes contribute to the supply of most ecosystem services (e.g., see results of the European Union's Openness research project, URL: http://www.openness-project.eu/library/reference-book/sp-link-between-biodiversity-and-ecosystem-services).

[15] A series of briefs and factsheets on these sectors have been prepared by the Secretariat in the Series "Bioscience at a Crossroads"; URL: https://www.cbd.int/abs/resources/factsheets.shtml; accessed on 9 November 2017.

[16] Distinguishing between an impact driver and an actual impact is critical to understanding the environmental impacts of manufacturing industries. An impact driver can be: A measurable quantity of an ecosystem component used as an input to production (e.g., volume of water used for cooling in a factory) or a measurable non-product output of a business activity (e.g., tons of greenhouse gas emissions). An impact is a change in the quantity or quality of an ecosystem component or attribute, which occurs as a consequence of an impact driver, and may lead to changes in human well-being or organizational viability/profitability. All impact drivers interact with ecosystems (e.g., greenhouse gas emissions leading to climate change and hence changes in ecosystem processes and dynamics) and can lead to indirect changes in biodiversity patterns (e.g., climate change leading to changes in the spatial distribution of species). Some impact drivers (e.g., resource extraction, land use change) lead to direct, immediate changes in biodiversity (i.e. loss of habitats and species).

and its direct pollution) and indirect (e.g., through the supply chain) biodiversity impacts and dependencies, across globalized value chains from raw material extraction/production to manufactured goods consumption.

13. Most manufacturing processes cause, to varying degrees, air, water and soil pollution, which all can have significant impacts on ecosystems and human health. For instance, the cost of air pollution from 14 000 industrial facilities in Europe amounted to at least EUR 59 billion and up to EUR 189 billion in 2012, with industries outside of the power generation sector responsible for 30 per cent of these total costs.[17] Experience from the consumer electronics industry, where products have increasingly short life cycles, shows the growing problem of e-waste,[18] which results in heavy metals and organic contaminants ending up in freshwater and coastal areas, and often in the food chain.

14. Manufacturing is responsible for about 35 per cent of global electricity use, over 20 per cent of CO_2 emissions and up to 17 per cent of air pollution-related health damage, with estimates of gross air pollution damage ranging from 1 to 5 per cent of global GDP.[19] More specifically, manufacturing industries account for one third of global energy use and 25 per cent (6.7 Gt) of total world emissions, 30 per cent of which comes from the iron and steel industry, 27 per cent from non-metallic minerals (mainly cement) and 16 per cent from chemicals and petrochemicals production. CO_2 emissions from fossil-fuel combustion in the industrial sector totalled 3.8 Gt in 2007, a 30 per cent increase since 1970.[20] In addition, the world generated approximately 41.8 million metric tons of e-waste in 2014.[18]

15. Key indirect biodiversity impact drivers of manufacturing industries can be linked to manufacturing inputs and thus suppliers of raw materials (e.g., extraction of rare minerals and basic metals). Indeed, raw material producers or extractors are responsible for significant biodiversity impacts,[21] including those related to habitat loss/degradation (e.g., deforestation due to agricultural supply chains, which is the largest single source of pressure on biodiversity worldwide).[22,23] For terrestrial ecosystems, habitat loss is largely accounted for by conversion of natural habitats to agriculture, which amounts to some 30 per cent of land globally. This can also be coupled with the overexploitation of biological resources (e.g., overfishing,[24] deforestation[25]) which remains a major challenge in many countries. This means that industries that manufacture food products, beverages, textiles/leather,[26] paper, rubber, wood products and tobacco products are indirectly responsible for a significant proportion of existing and future habitat loss worldwide due to the land-intensive needs of their underlying resource production systems. In

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[17] European Environment Agency (2014). Costs of air pollution from European industrial facilities 2008–2012 — an updated assessment. EEA Technical Report, No 20/2014, 76 pp.

[18] Smith, C. (2015). The Economics of E-Waste and the cost to the environment. *Natural Resources & Environment* 30 (2), 1-4.

[19] United Nations Environment Programme (2011). Manufacturing: Investing in energy and resource efficiency. Pp. 242-285. URL: https://www.unenvironment.org/resources/report/towards-green-economy-pathways-sustainable-development-and-poverty-eradication-0, accessed on 25 February 2018.

[20] Ibid.

[21] For Puma, a sport and lifestyle brand, the majority of environmental impacts (57%) occur at the level of tier 4 suppliers (i.e. raw material producers, such as cotton farmers). Manufacturers (tier 1 – manufacturers, tier 2 – outsourced processors and tier 3 – raw material processors) involved in Puma's supply chains account for a lower but significant share of environmental impacts (about 37%); while Puma's direct operations (offices, shops) only account for 6% of impacts. Source: Chartered Global Management Accountant (2014). Rethinking the value chain. Accounting for natural capital in the value chain. CGMA briefing, 16 pp.

[22] Chaudhary, A., Verones, F., de Baan, L., Hellweg, S. (2015). Quantifying land use impacts on biodiversity: Combining species–area models and vulnerability indicators. *Environ. Sci. Technol.* 49(16), 9987–9995.

[23] Secretariat of the Convention on Biological Diversity (2010). *Global Biodiversity Outlook* 3. Montreal, Canada, 94 pp.

[24] E.g. Pauly. D., Watson, R., Alder, J. (2005). Global trends in world fisheries: Impacts on marine ecosystems and food security. Phil. Trans. R. Soc. B 360, 5-12; Srinivasan, U.T., Cheung, W.W.L., Watson, R., Sumaila, U.R. (2010). Food security implications of global marine catch losses due to overfishing. *Journal of Bioeconomics* 12(3), 183-200.

[25] Bianchi, C.A., Haig, S.M., (2013). Deforestation trends of tropical dry forests in central Brazil. Biotropica 45: 395–400; Meyfroidt, P., Rudel, T.K., Lambin, E.F. (2010). Forest transitions, trade, and the global displacement of land use. *Proceedings of the National Academy of Sciences* 107(49), 20917-20922.

[26] See, for example, Aiama, D., Carbone, G., Cator, D., Challender, D. (2016). Biodiversity risks and opportunities in the apparel sector. IUCN, Gland, 41 pp.

some areas, habitat loss has also recently been partly driven by the demand for agro-fuels,[27] thus indirectly implicating the chemical industry.

16. Diffuse/non-point pollution sources, typically linked to commercial agriculture (including fish farming[28]) also pose concerns. They also present major risks to freshwater and marine ecosystems, and can be correlated with the global supply chains of various manufacturing industries (e.g., food, beverages, furniture, textiles).

17. In the foreseeable future, major risks for biodiversity linked to the activities and growth of manufacturing industries include: (a) the siting/design of factories as well as point-source pollution from manufacturing processes; (b) land use changes linked to the supply of various manufacturing inputs (e.g., foods, beverages, textiles, rubber); and (c) the over-harvesting of biological resources (e.g., fish, wood, natural and genetic materials). Biodiversity loss can occur over the whole value chains of manufactured goods, due to the activities of retailers, manufacturers and/or raw material producers. However, the most significant land use changes might occur at a specific step of the value chain, for instance at the level of raw material producers. Demand for land (leading to habitat destruction) may be correlated to the need for specific raw materials, as required by manufacturers to produce goods in response to the needs of retailers, the ones in direct contact with consumers (e.g., expansion of palm oil plantations or agro-fuel farms in response to rising global demand). Yet, while manufacturers put pressure on raw material producers to supply volumes of inputs as per their needs, retailers influence the demands for specific products according to the needs of consumers. Retailers can thus play a role in alleviating pressures on biodiversity by educating their clients (i.e. helping them to change their consumption patterns) while manufacturers can do the same by engaging with their suppliers (i.e. to improve/change their practices) or seeking others which are more responsible.

18. Under the OECD Environmental Outlook Baseline,[29] despite sizeable energy-efficiency gains, energy and industry-related emissions are projected to more than double to 2050 compared to 1990 levels. Moreover, e-waste is projected to grow to 50 million metric tons per year by 2018.[18] From the perspective of the impacts of raw material suppliers, while net emissions from land-use change are projected to decrease rapidly,[29] some land use change projections[30] show higher rates of cropland expansion in sub-Saharan Africa (up to 72%), Canada (up to 26%) and Middle East/North Africa (>20%) at the end of the twenty-second century.

IV. CURRENT APPROACHES TO MAINSTREAMING IN THE MANUFACTURING SECTOR

A. Initiatives at the international level

19. There are a number of international initiatives that are related to mainstreaming in the manufacturing sector. First, the 2030 Agenda for Sustainable Development[31] includes a number of Sustainable Development Goals related to manufacturing. These included Goal 9 (calling for sustainable industrialization, and the retrofit of industries to make them sustainable, with increased resource-use efficiency and greater adoption of clean and environmentally sound technologies and industrial processes), and Goal 12 (sustainable consumption and production). The 10-year framework of programmes on sustainable consumption and production is another important global initiative, adopted at the United Nations Conference on Sustainable Development in 2012. Numerous other United Nations entities are

[27] See, for example, Gao, Y., Skutsch, M., Masera, O and Pacheco, P. (2011) A global analysis of deforestation due to biofuel development. Working Paper 68. CIFOR, Bogor, Indonesia, 100 pp.

[28] e.g., Handy, R.D., Poxton, M.G., 1993. Nitrogen pollution in mariculture: Toxicity and excretion of nitrogenous compounds by marine fish. Reviews in Fish Biology and Fisheries 3(3), 205-241.

[29] OECD 2011. *Environmental Outlook to 2050*. Climate Change Chapter. 39p., URL: http://www.oecd.org/env/cc/49082173.pdf, accessed on 9 May 2018.

[30] Prestele, R., Alexander, P., Rounsevell, M.D.A., Arneth, A., Calvin, K., Doelman, J., Eitelberg, D.A., Engström, K., Fujimori, S., Hasegawa, T., Havlik, P., Humpenöder, F., Jain, A.K., Krisztin, T., Kyle, P., Meiyappan, P., Popp, A., Sands, R.D., Schaldach, R., Schüngel, J., Stehfest, E., Tabeau, A., Van Meijl, H., Van Vliet, J. and Verburg, P.H. (2016). Hotspots of uncertainty in land-use and land-cover change projections: A global-scale model comparison. Glob. Change Biol. 22: 3967–3983. doi:10.1111/gcb.13337

[31] See General Assembly resolution 70/1 of 25 September 2015.

engaged in relevant efforts, including the United Nations Industrial Development Organization and the United Nations Environment Programme. Additional information on these initiatives is provided in an information document.

B. National policies and business sector initiatives and tools

20. Mainstreaming related to biodiversity and other environmental concerns involving the manufacturing sector has taken many forms. Typical policy interventions have included direct regulation (command and control) where a standard, procedure or process is specified, such as hazardous waste or air emissions regulations. Other measures include (a) market-based instruments such as taxes/subsidies and trading schemes which help internalize negative environmental externalities (e.g. landfill taxes, greenhouse gas trading schemes), (b) removal, phase-out or reform of incentives, including subsidies, harmful to the environment, (c) various positive incentives encouraging more environment-friendly practices, such as investment grants and subsidies to encourage innovation and investment in cleaner technology (e.g., support for energy efficiency, resource efficiency); (d) information provision (to increase environmental awareness) and public engagement programmes (to encourage more pro-environmental attitudes by consumers); (e) public procurement supporting or discouraging specific behaviours or products with significant environmental impacts; (f) disclosure requirements requiring companies above certain thresholds to report annually on their environmental risks, impacts and performance; (g) international funding/financing instruments (targeting the manufacturing sector or specific companies) and trade agreements with environmental safeguards.

21. An important element for mainstreaming is reliable data. Significant efforts have been made on monitoring and tracking air and water emissions, as well as solid waste, from individual manufacturing plants and the life-cycle of manufactured goods (e.g., car emissions). In some regions, precise statistics are available. For instance, 50 per cent of total damage costs of air emissions in Europe can be attributed to only 147 facilities and 90 per cent of these costs to only 1,529 facilities,[32] though not all belong to the manufacturing sector (e.g., power plants).

22. Significant efforts have also been made in reducing emissions and waste. Efforts have also been made to reduce raw material/resource needs through various complementary approaches, such as recycling (including improving the recyclability of products), product eco-design (e.g., shifting to less polluting or harmful components), as well as industrial ecology[33] circular economy[34] initiatives. Yet, in most countries, much more needs to be done.

23. Moreover, several key environmental approaches and/or tools are progressively integrating biodiversity considerations, such as environmental management systems, environmental and social impact assessments, life-cycle impact assessments, environmental management accounting and reporting/-disclosure, or externality valuation and disclosure. These are detailed below.

24. *Environmental management systems*: There has been significant advancements in embedding biodiversity considerations in environmental management systems (e.g., ISO 14001, European Union Eco-Management and Audit Scheme (EMAS));[35] typically with targets and key performance indicators for monitoring selected biodiversity attributes at sites owned or leased by multinational companies. This can be correlated to a large extent with efforts made to improve the surface area and condition of habitats (as well as populations of threatened species) at the level of manufacturing plants.

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[32] European Environment Agency (2014). Costs of air pollution from European industrial facilities 2008–2012 — an updated assessment. EEA Technical Report, No. 20/2014, 76 pp.

[33] Gibbs, G., Deutz, P. (2007). Reflections on implementing industrial ecology through eco-industrial park development. *Journal of Cleaner Production* 15(17), 1683-1695; Homas, V.M. (1997) Industrial ecology: Towards closing the materials cycle. *Journal of Industrial Ecology* 1: 149-151.

[34] Tukker, A. (2015). Product services for a resource-efficient and circular economy – a review. *Journal of Cleaner Production* 97, 76-91; Yuan, Z., Bi, j., Moriguichi, Y. (2006). The circular economy: A new development strategy in China. *Journal of Industrial Ecology*, 10: 4-8.

[35] E.g., Hammerl, M., Hormann, S. (2016). The ISO management system and the protection of biological diversity. Lake Constance Foundation (LCF) and Global Nature Fund (GNF), Germany, 72 pp.

25. Moreover, various other sectoral initiatives have developed useful site level guidelines and best practices that could be adapted to various manufacturing sectors to improve biodiversity management of factory sites (e.g., the Cross-Sector Biodiversity Initiative,[36] the Energy and Biodiversity Initiative.[37]

26. *Environmental and social impact assessments and the impact mitigation hierarchy*: An increasing number of companies are adopting and/or applying no-net-loss/net-positive impact[38] approached or policies based on the full implementation of the Impact Mitigation Hierarchy (from avoidance to offset measures), though no high-profile example from the manufacturing sector has been identified to date. This may be done voluntarily or in response to specific legislative contexts. While existing regulations are more likely than not to have affected projects involving manufacturing businesses (e.g., construction of a new factory), for instance in the context of the various wetland and species offset programmes in the United States or the European Union, many widely publicized examples relate to mining, oil/gas and infrastructure projects in non-OECD countries (e.g. Business and Biodiversity Offset Programme case studies[39]) in response to environmental safeguards from financial institutions (e.g., IFC Performance Standard 6).[40] Nevertheless, there is potential for manufacturing industries to further explore no-net-loss/net-positive impact approaches throughout their value chains (e.g., for the commercial agriculture and forestry sectors; e.g. Aiama *et al*., 2015[41]), not just at the level of their factories. This may become part of the discussions for supplier/commodity selection as well as the definitions of terms and conditions in contractual agreements. No-net-loss/net-positive impact approaches are consistent with achieving no (net) deforestation as understood by Parties to the New York Declaration on Forests (2014) or the Amsterdam declarations on "imported deforestation" (2015).

27. *Supply chain management and life-cycle assessments*: Beyond site level approaches, some companies have started to embrace environmental considerations in supply chain management. This often involves whole value chain approaches dealing with resource efficiency (e.g., reducing water use and energy consumption) and emissions reduction (e.g., minimizing waste), from the retailer to the raw material producer. This often involves undertaking product life cycle assessments, which sometimes include biodiversity impacts.[42] This sometimes has also been coupled with the support of labelling and certification schemes used for various commodities used in industrial production processes.[43,44,45] For

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[36] The Cross-Sector Biodiversity Initiative is a partnership between IPIECA, the International Council on Mining and Metals (ICMM) and the Equator Principles Association, the European Bank for Reconstruction and Development (EBRD), the International Finance Corporation (IFC) and the Inter-American Development Bank (IDB) to develop and share good practices related to biodiversity and ecosystem services in the extractive industries. URL: http://www.csbi.org.uk/, accessed on 5 January 2018.

[37] http://www.theebi.org/, accessed on 5 January 2018.

[38] No-Net-Loss ("NNL") refers to the point where biodiversity gains from targeted conservation activities (impact mitigation, restoration / restoration and offset measures) match the losses of biodiversity due to the impacts of a business activity or project. The type, amount and condition (or quality) of biodiversity need to be taken account. A net gain means that biodiversity gains exceed a specific set of losses.

[39] URL: http://bbop.forest-trends.org/pages/pilot_projects, accessed on 9 January 2018; Business and Biodiversity Offsets Programme (BBOP) (2013). To no net loss and beyond: An overview of the Business and Biodiversity Offsets Programme (BBOP). BBOP: Washington, D.C., United States of America.

[40] Rainey, H. J., Pollard, E. H., Dutson, G., Ekstrom, J. M., Livingstone, S. R., Temple, H. J., Pilgrim, J. D. (2015). A review of corporate goals of No Net Loss and Net Positive Impact on biodiversity. Oryx, 49(2), 232-238; Sahley, C.T., Vildoso, B., Casaretto, C., Taborga, P., Ledesma, K., Linares-Palomino, R., Mamani, G., Dallmeier, F., Alonso, A., 2017. Quantifying impact reduction due to avoidance, minimization and restoration for a natural gas pipeline in the Peruvian Andes. Environmental Impact Assessment Review 66, 53-65.

[41] Aiama, D., Edwards, S., Bos, G., Ekstrom, J., Krueger, L., Quétier, F., Savy, C., Semroc, B., Sneary, M., Bennun, L. (2015). No net loss and net positive impact approaches for biodiversity: exploring the potential application of these approaches in the commercial agriculture and forestry sectors. IUCN: Gland, Switzerland.

[42] See, for example, Souza, D.M., Teixeira, R.F., Ostermann, O.P. (2015). Assessing biodiversity loss due to land use with Life Cycle Assessment: are we there yet? *Glob Chang Biol.* 21(1):32-47.

[43] See, for example, The Aluminium Stewardship Initiative (ASI) is a global, multi-stakeholder, non-profit standards setting and certification organisation. It is the result of producers, users and stakeholders in the aluminium value chain coming together with a commitment to maximising the contribution of aluminium to a sustainable society. URL: https://aluminium-stewardship.org/about-asi/, accessed on 15 January 2018.

instance, the Roundtable on Sustainable Palm Oil, which manages a certification scheme[46] to ensure the credibility of palm oil sustainability claims, has a membership of several hundred companies, including consumer goods manufacturers, processors and/or traders, retailers and producers.

28. *Environmental management accounting and reporting/disclosure*: Environmental management accounting,[47] in particular greenhouse gas accounting and reporting, has largely become mainstreamed in many countries. For instance, thousands of companies, including many manufacturing businesses, participate voluntarily in the Climate Disclosure Project,[48] which has led to significant changes in their climate change policies and strategies so as to demonstrate improved climate performance over time. However, corporate biodiversity risk, measurement and performance is currently very limited:[49] i.e. focused on high-level principles and management approach disclosures. Building a standardized biodiversity measurement protocol, which would include supply chain impacts, and supporting the disclosure of biodiversity performance, would go a long way in mainstreaming biodiversity in business strategies, as recently advocated at the 2017 Biodiversity and Business Indaba of the South African National Biodiversity and Business Network.[50] In this context, it would be important to develop science-based targets to drive meaningful biodiversity, measurement, accounting and disclosure.[51]

29. *Externality[52]/natural capital valuation*: There is a growing number of companies measuring and valuing their natural capital[53] impacts and dependencies,[54] such as valuing and disclosing negative environmental externalities (including land use change as an impact driver) throughout global supply chains. Such efforts demonstrate that doing so can (a) be disclosed regularly, (b) contribute to the improvement of the value of brands, (c) drive sustainable innovation in product design, and (c) help secure raw material supply through direct engagement with key raw material suppliers (e.g., to improve the sustainability of production processes and avoid unexpected costs due to resource shortages or changes in legislations in source countries). In that context, the Natural Capital Coalition has recently launched the Natural Capital Protocol (2016), a standardized framework for measuring and valuing natural capital which was designed to help generate trusted, credible and actionable information that business managers need for internal decision-making. The Natural Capital Coalition has also developed sectoral guidelines, including for the food and beverage sector,[55] and is now working on a biodiversity supplement.[56]

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[44] See, for example, KPMG (2012). Certification and biodiversity. Exploring improvements in the effectiveness of certification schemes on biodiversity. 59 pp.

[45] See, for example, United Nations Environment Programme – World Conservation Monitoring Centre (2011). Review of the biodiversity requirements of standards and certification schemes: A snapshot of current practices. Secretariat of the Convention on Biological Diversity, Montreal, Canada. Technical Series No. 63, 30 pp.

[46] URL: https://www.rspo.org/certification, accessed on 5 March 2018.

[47] International Federation of Accountants (IFAC) (2005). Environmental Management Accounting International Guidance Document. New York, 92 pp.

[48] URL: https://www.cdp.net/en, accessed on 5 January 2018.

[49] CBD/SBI/2/4/Add.2.

[50] URL: https://www.ewt.org.za/BUSINESSDEVELOPMENT/business.html, accessed 12 January 2018.

[51] Putt del Pino, S., Cummis, C., Lake, S., Rabinovitch, K., Reig, P. (2016). From doing better to doing enough: Anchoring corporate sustainability targets in science. Working Paper. Washington, DC: World Resources Institute and Mars Incorporated. URL: http://www.wri.org/publications/doing-enough-corporate-targets, accessed on 9 April 2018.

[52] In economics, an externality is the cost or benefit that affects a party that did not choose to incur that cost or benefit.

[53] Natural capital is defined as "the stock of renewable and non-renewable natural resources (e.g., plants, animals, air, water, soils, minerals) that combine to yield a flow of benefits to people" by the Natural Capital Coalition; URL: https://naturalcapitalcoalition.org/natural-capital/, accessed on 9 April 2018.

[54] See case studies on the Natural Capital Hub at URL: https://naturalcapitalcoalition.org/hub/, accessed on 9 April 2018.

[55] URL: https://naturalcapitalcoalition.org/protocol/sector-guides/food-and-beverage/, accessed on 9 April 2018.

[56] URL: https://naturalcapitalcoalition.org/projects/biodiversity/, accessed on 9 April 2018.

V. CURRENT CHALLENGES AND GAPS IN MAINSTREAMING IN THE MANUFACTURING SECTOR

30. Building the business case is often highlighted as a prerequisite for business to recognize biodiversity as a material (important) issue. This involves the framing of value propositions, such as reputational and brand risks, compliance and liability risks, cost savings and new business opportunities, according to the expected values and needs of the target business audience (e.g., a company executive versus an environmental manager). Yet, making the business case requires appropriate information.

31. This is why there has been increasing interest worldwide in the measurement and valuation of ecosystems, and environmental impacts more broadly, including but not limited to, in the context of natural capital concepts[57,58] and non-market approaches.[59] These have been marketed as a key vehicle for integrating ecological understanding and economic considerations to redress the traditional neglect of business dependencies and impacts on ecosystem services in both private and public policy, decision-making and operations.[60] Indeed, a good understanding of biodiversity and ecosystem services, their benefits and trade-offs in development pathways has been advocated to be prerequisite for win–win–win situations for people, business and nature.[61] This is argued to be the case because a lack of knowledge can lead to wrong decisions and even conflicts or catastrophes. Companies are often not aware of the benefits they receive from biodiversity and ecosystem services and do now quantify the full extent of their environmental impacts. This has been argued to prevent them from integrating the values of nature into policy and decision-making as well as strategic planning and operational routines.[62] Humans do not protect or sustainably manage what they do not value. Humans cannot value what they do not measure. And humans do not measure what they cannot or do not see or touch.

32. There is limited knowledge of biodiversity impacts and dependencies across the whole value chains of manufactured goods. While key environmental impacts are monitored in many countries, very little is known about the supply chain and end-of-life impacts of goods produced by individual manufacturing companies. Linking supply chain end-of-life impacts of goods to their manufacturing process/location could explain which manufacturing companies and facilities are contributing to the primary drivers of biodiversity loss worldwide. Besides, more efforts should be made in assessing and monitoring biodiversity impacts *per se* (e.g., decrease in population of a species, percentage loss of a specific habitat type), not just impact drivers (e.g., air emissions, water use). This is why recently there have been calls for the development of a standardized biodiversity measurement protocol for business, which would include global value chain dimensions.[50]

33. A key challenge in biodiversity valuation for the private sector is linked to existing misunderstandings about values, valuation processes, their uses and applications in real world settings. Monistic valuation approaches (i.e. a single currency/indicator/value type is used to convince people), by definition, do not reflect the diversity of values that people adhere to and the associated valuation

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[57] Waage, S. (2014). Making sense of new approaches to business risk and opportunity assessment. BSR.

[58] Natural Capital Coalition (2016). Natural Capital Protocol. (Online) Available at: www.naturalcapitalcoalition.org/protocol, accessed 9 November 2017.

[59] Amy R. Poteete, A.R., Janssen, M.A., Ostrom, E. (2010). Working together collective action, the commons, and multiple methods in practice. Princeton University Press.

[60] TEEB (2012). The Economics of Ecosystems and Biodiversity in Business and Enterprise. Edited by Joshua Bishop. Earthscan, London and New York.

[61] See, for example, Cadman, M., Petersen, C., Driver, A., Sekhran, N., Maze, K., Munzhedzi, S. (2010). Biodiversity for Development: South Africa's landscape approach to conserving biodiversity and promoting ecosystem resilience. South African National Biodiversity Institute, Pretoria; TEEB, 2010. The Economics of Ecosystems and Biodiversity: Ecological and Economic Foundations. UNEP/Earthprint: London.

[62] See, for example, Houdet, J., Trommetter, M., Weber, J. (2012). Understanding changes in business strategies regarding biodiversity and ecosystem services. *Ecological Economics* 73: 37-46.

approaches and methods.[63] In particular, overreliance on monetary valuation (as a concrete and prominent example of a single, monistic value framing perspective) may raise the concern of stakeholders with incompatible world views on values and appropriate approaches to valuation and, as a result, may not be a particularly compelling way to convince private sector actors, including company management and employees, of the importance of biodiversity and its conservation/sustainable use. Four key points are worth highlighting in this context.

34. First, the well-researched limitations of economic valuation methods[64] make them best suitable for assessing changes in tangible provisioning and some regulating services. Second, whenever the monetary value of ecosystem services lost is smaller than the benefits of proposed industrial projects in trade-off analysis, and other, less tangible types of ecosystem services and benefits are present,[65] this approach would need to be complemented by other tools in order to capture the full range of relevant values. Third, monetary values do not equate to financial values (i.e. actual business revenues, expenses, assets and liabilities). Highly valuable ecosystem services, even when expressed in economic terms, may not necessarily be captured by business due to the lack of existing markets and/or enabling regulatory environments.[66] This implies that business does not readily change its viewpoints or practices on the basis of the results of monetary valuation studies alone. Companies require tangible, demonstrable proof that revenue can be generated and captured for their own purposes. Finally, the business case can be made through multiple value framing perspectives,[67] which can all contribute to changing social norms that may eventually lead to changes in (what is considered acceptable) business practices. This view is supported by the relatively recent call, by the scientific community of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) for integrating the multiple values of biodiversity and ecosystem services as the basis for informed deliberation, agreement and decisions.[68]

35. Effective biodiversity mainstreaming in the manufacturing sector also requires supportive/enabling policy environments that reward pro-biodiversity behaviour and discourage practices leading to biodiversity loss. Acknowledging the importance of globalized value chains calls for multi-sectoral and jurisdictional approaches to mainstreaming. As indicated in the note by the Executive Secretary on mainstreaming issued for the first meeting of the Subsidiary Body, "globalization, trade and displacement effects remain weakly covered in national strategies. Progress in improved sustainability at the national level can be offset (globally) by increasing external footprints arising from increasing reliance on imported commodities. An example is the increasing dependency of domestic livestock production on imported feedstock in some countries. Attention to sustainability measures in supply chains for major commodities will contribute to addressing this problem" (UNEP/CBD/SBI/1/5/Add.1, para. 29).

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[63] For more than a decade, the literature on ecosystem services valuation has stressed the importance of integrating social, ecological and monetary aspects of the values of ecosystem services and biodiversity in decision-making, rather than relying only on monistic approaches dominated by a single worldview. For example: Gómez-Baggethun, E., Martín Lopez, B., Barton, D., Braat, L., Saarikoski, H., Kelemen, M., García-Llorente, E., van den Bergh, J., Arias, P., Berry, P., Potschin, L.M., Keene, H., Dunford. R.. Schröter-Schlaack. C.. Harrison. P. (2014). State-of-the-art report on integrated valuation of ecosystem services. European Commission FP7 FP7 OpenNESS Project Deliverable 4.1., 33 pp.

[64] See, for example, TEEB, 2010. The Economics of Ecosystems and Biodiversity: Ecological and Economic Foundations. UNEP/Earthprint: London.

[65] See, for example, Houdet, J., Chikozho, C. (2015). The Valuation of ecosystem services in South African Environmental Impact Assessments. Review of selected mining case studies and implications for policy. *The Journal of Corporate Citizenship* Issue 60, 58-79.

[66] Ruhl, J.B., Kant, S.E., Lant, C.L. (2007). The law and policy of ecosystem services. Island Press, 360 pp.

[67] See, for example, Maze, K., Barnett, M., Botts, E.A., Stephens, A., Freedman, M., Guenther, L. (2016). Making the case for biodiversity in South Africa: Re-framing biodiversity communications. Bothalia 46(1), a2039. http://dx.doi.org/10.4102/abc.v46i1.2039

[68] Pascual, U., Balvanera, P., Diaz, D., Pataki, P., Roth, E., Stenseke, M., Watson, R.T., Dessane, E.B., Islar, M., Kelemen, E., Maris, V., Quaas, M., Subramanian, S.M., Wittmer, H., Adlan, A., Ahn, S., Al-Hafedh, Y.S., Amankwah, E., Asah, S.T., Berry, P., Bilgin, A., Breslow, S.J., Bullock, C., Caceres, D., Daly-Hassen, H., Figueroa, E., Golden, C.D., Gomez-Baggethun, E., Gonzalez-Jimenez, D., Houdet, J., Keune, H., Kumar, R., Ma, K., May, P.H., Mead, A., O'Farrell, P., Pandit, R., Pengue, W., Pichis-Madruga, R., Popa, F., Preston, S., Pacheco-Balanza, D., Saarikoski, H., Strassburg, B.B., van den Belt, M., Verma, M., Wickson, F., Yag, N., (2017). The value of nature's contributions to people: the IPBES approach. Current Opinion in Environmental Sustainability 26: 7–16.

36. The effective mainstreaming of biodiversity with respect to manufactured goods would thus involve managing biodiversity dependencies and impacts at each step of their life cycles, from the production/extraction of raw materials upstream to their end-of-life (e.g., disposal and recycling practices). Several countries and industries (e.g., manufacturers, retailers, raw material producers, logistic companies, wholesalers, waste management industries, etc.) in the value chains of manufactured goods thus hold a shared responsibility over biodiversity impacts and dependencies. However, each country or company, individually, would have variable levels of influence over the behaviour of other companies/countries involved in the globalized value chains of manufactured goods. Depending on power relations (among other factors), one or more players along such value chains could hold the key to more effective biodiversity mainstreaming at each step of value addition. Accordingly, mainstreaming solutions need to take into account the costs and benefits of proposed mainstreaming changes at each step of globalized value chains (i.e. to avoid impact leakage). This calls for mainstreaming approaches based on multi-stakeholder consultations and agreements so that policies, strategies, rules, incentives and disincentives apply to the whole value chain of manufactured goods, not only within the boundaries of single nations.

37. From this perspective, reframing or specifying how the private sector, including each manufacturing industry, can contribute, in practice, to each Aichi Biodiversity Target would actively support the business case for biodiversity mainstreaming. Most of the Aichi Targets are relevant to the private sector in general, and some particularly to manufacturing industries (e.g., Aichi Targets 4, 5 and 8). The development of industry-specific targets and key performance indicators for inclusion in future national biodiversity strategies and action plans as well as the associated national reporting initiatives under the Convention should drive more effective engagement by Parties and the Secretariat with the key actors in the manufacturing sector.

VI. CONCLUSIONS

38. The importance of biodiversity for the manufacturing sector cannot be overemphasized. All manufacturing industries rely on some ecosystem services directly, at the factory level, and indirectly, through their supply chains. At the same time, manufacturing industries generate significant biodiversity impacts, which occur across the life cycle of manufactured products. These impacts are expected to rise over the coming decades.

39. Significant efforts have been made by Parties to reduce the environmental impacts from manufactured goods that are of relevance to biodiversity (e.g., air emissions, solid waste). To that end, a variety of policy interventions have been mobilized, from direct regulations and market-based instruments to greener public procurement, with greater support needed for some developing nations to improve monitoring, compliance and enforcement.

40. Significant efforts have also been made by some manufacturing companies to mainstream biodiversity considerations through the use of various environmental tools, such as environmental management systems, environmental and social impact assessments, life-cycle impact assessments, environmental management accounting and reporting/disclosure, or externality/natural capital valuation. Companies going beyond mere compliance should be recognized, supported and rewarded.

41. In order to further support manufacturing companies in biodiversity mainstreaming, strengthening global and sectorial partnerships and information sharing and collaboration among Parties, relevant organizations and initiatives would be required. Particularly, more support is needed to help manufacturing companies better recognize, measure, value, manage responsively and make disclosures concerning their performance related to their direct and indirect dependencies and impacts on ecosystems and biodiversity. In addition, innovative governance and management models would be required to address biodiversity challenges across entire value chains of manufactured goods.

42. Parties may wish to consider designing, adopting and implementing enabling policy and legislative environments and incentive measures, or providing guidance with a view to supporting manufacturing companies in recognizing, measuring, valuing, managing sustainably, and making disclosures concerning their performance related to their direct and indirect dependencies and impacts on biodiversity, including across their value chains, and in particular:

(a) Support the development of, or co-develop, key biodiversity performance indicators with stakeholders, on direct and indirect biodiversity impacts and dependencies, including their socioeconomic consequences for affected stakeholders, as well as associated disclosure guidance and requirements above certain thresholds (e.g., as part of listing requirements on stock exchanges or in the context of public procurement);

(b) Support or strengthen, as appropriate, the inclusion of biodiversity in national accounting, having regard to the United Nations System of Environmental Economic Accounting (SEEA) and its guidance on experimental ecosystem accounting;

(c) Include supply chain dimensions of biodiversity-related dependencies and impacts in national guidance on environmental and social impact assessments, including strategic impact assessments;

(d) Develop or strengthen biodiversity safeguard requirements, taking into account relevant international guidance and good practices, and their inclusion in public procurement policies that are in line with the objectives of the Convention, and in approaches that promote science-based information on biodiversity in the decisions of consumers and producers ("eco-labelling", consistent and in harmony with the Convention and other relevant international obligations;

(e) Intensify their efforts to implement Aichi Biodiversity Target 3.

43. Manufacturing industries and companies should:

(a) Continue improving their environmental mainstreaming activities, from product eco-design efforts to resource efficiency, recycling and/or emission reduction initiatives;

(b) Continue improving measurement of their biodiversity impacts, beyond the measurement of impact drivers towards actual biodiversity losses (or gains), and biodiversity dependencies, with a focus on their indirect impacts and dependencies throughout their supply chains;

(c) Initiate or continue and deepen engagement with their value chains with a view to developing open-source biodiversity data sets and biodiversity-friendly technological solutions for rapid diffusion and uptake, and to promoting the full implementation of the impact mitigation hierarchy across their supply chains;

(d) Initiate or continue improving their regular disclosure of their direct and indirect biodiversity impacts and dependencies, including their socio-economic consequences for affected stakeholders, including by cross-referencing relevant Aichi Targets, as appropriate.

40. Finally, the Executive Secretary, while facilitating the work towards the post-2020 global biodiversity framework, should take into account the potential contribution of businesses in implementing the post-2020 framework, notably:

(a) By supporting relevant organizations and initiatives in their work towards common biodiversity measurements and indicators that are applicable to businesses, including value chain dimensions;

(b) By supporting, or continuing support for, relevant organizations and initiatives in the development of more diverse and integrated value-framing perspectives and initiatives on the importance of biodiversity and the need for its effective conservation and sustainable use;

(c) By collaborating with, and supporting the work of, relevant organizations and initiatives, including multi-stakeholder initiatives, industry leaders, and international and national industry bodies and professional associations, in order to raise the profile of biodiversity in manufacturing, to help develop the business case for each manufacturing industry and promote industry best practices, and to include biodiversity safeguards in the pertinent activities of the financial sector, including in terms of project finance, business finance and insurance products.

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