BANGLADESH MATERIAL FOOTPRINT AND DOMESTIC MATERIAL CONSUMPTION ACCOUNTS

Bangladesh Bureau of Statistics
Statistics and Informatics Division
Ministry of Planning

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March 2025

বাংলাদেশ পরিসংখ্যান ব্যুরো
পরিসংখ্যান ও তথ্য ব্যবস্থাপনা বিভাগ
পরিকল্পনা মন্ত্রণালয়

Bangladesh Bureau of Statistics
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Report
on
BANGLADESH MATERIAL FOOTPRINT AND DOMESTIC MATERIAL CONSUMPTION ACCOUNTS

Prepared by

Strengthening Environment, Climate Change and Disaster Statistics (ECDS) Project
Bangladesh Bureau of Statistics

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Director General
Bangladesh Bureau of Statistics

Preface

Material footprint measures the number of raw materials extracted to meet the consumption demands of a nation. Similarly, Domestic Material Consumption (DMC) measures the total amount of raw materials used within a country. It includes materials extracted domestically and imports, minus exports, providing an indicator of a nation's resource use and sustainability. This comprehensive measure provides a holistic perspective on the environmental impacts of economic activities and the status of natural resources. The report 'Bangladesh Material Footprint & Domestic Material Consumption Accounts' offers a detailed analysis of these indicators, shedding light on the sustainability of current practices and highlighting opportunities for improvement.

As the National Statistics Office (NSO), the Bangladesh Bureau of Statistics (BBS) aims to enhance access to policy-relevant information for researchers, policymakers, and citizens by providing comprehensive statistics to support decision-making. BBS has prepared this report, which is the first of its kind in Bangladesh, with the target of fulfilling its objective to meet user needs and priorities. This report will facilitate the status of Natural resources and way forward to use these resources efficiently that leads to achieve the Sustainable Development Goals (SDGs).

I would like to extend my deepest gratitude to respected Secretary of the Statistics and Informatics Division (SID), for his prudent guidance and tireless effort throughout the entire process of preparing this innovative report. My sincere thanks to Project Director of the Strengthening Environment, Climate Change and Disaster Statistics (ECDS) Project, BBS and his team for their dedication and outstanding efforts towards the preparation of this report.

Mohammed Mizanur Rahman

Dhaka
March 2025

Project Director
ECDS project
Bangladesh Bureau of Statistics

Acknowledgement

The Report title 'Bangladesh Material Footprint and Domestic Material Consumption (MF & DMC)' is one of the most innovative reports under the **Strengthening Environment, Climate Change and Disaster Statistics (ECDS) project** of Bangladesh Bureau of Statistics (BBS). The data and information of the report has been obtained from the secondary sources in particular different international publications and articles. The findings available from this report will assist in the formulation of new policies to promote in achieving sustainable development goals (SDG's) focusing to measure the status of natural resources and address to use it in efficient manner. I strongly believe that the findings of the publication will stir up strong interest regarding these issues among the policy-makers, researchers, academics, students, and other stakeholders.

I would like to start by expressing my sincere gratitude to Ms. Aleya Akter, Secretary, Statistics and Informatics Division (SID), Ministry of Planning who gave us necessary support and advice to accomplish this report successfully. My sincere thanks and gratitude to Mr. Mohammed Mizanur Rahman, Director General, BBS for his perseverance, passion, insightful comments and suggestions were crucial in enabling us to complete this publication on time. I offer my deep sense of gratitude to Dr. SM Shakil Akhter, Additional Secretary (Informatics), and Dr. Dipankar Roy, Joint Secretary, Statistics and Informatics Division and Mr. Md. Rafiqul Islam, Director, National Accounting Wing, BBS for their outstanding support and continuous guidance for preparing the publication on time. I would like to thank the Chairperson and all members of the different committees to implement this as well as their prudent feedback to enrich this publication.

I also express my gratitude to all the Directors of BBS. Special thanks to ECDS project team mentioning Mr. Surangit Kumar Ghosh, Deputy Director; Mr. Aminur Rahman Khan, Statistical Officer; Ms. Atia Bilkis, Statistical Officer and Mr. Md. Ahsan Habib, Statistical Officer who have worked hard to compile and review the report. The consultant Dr. Bazlul Haque Khondker, deserves special thanks as because he provided the main theme and ideas to organize the whole report and overall findings.

Comments and suggestions for further improvement of the report will be highly appreciated.

Dhaka
March 2025

Mohammad Saddam Hossain Khan

Key Findings

Sl. No.	Description	Measurement unit	Value (2021-22) (in '000)	Value (2022-23) (in '000)
1	2	3	4	5
01.	**Domestic Extraction Scenario in Bangladesh**			
	Biomass	Ton	112,438.3	114,181.1
	Metal Ores	Ton	-	-
	Non-Metallic Minerals	Ton	643,525.8	693,602.1
	Fossil Fuel	Ton	240,21.9	22,433.7
	Total	Ton	**779,986.0**	**830,216.9**
02.	**Physical Trade Balance**			
	Imports	Ton	76,228.6	78,024.8
	Exports	Ton	2,211.7	2,248.9
	Physical Trade Balance	Ton	**74,016.9**	**75,775.9**
03.	**Domestic Material Consumption (DMC)**			
	Biomass & Biomass Products	Ton	139,127.8	141,649.9
	Metal Ores	Ton	9,209.0	9,713.9
	Non-Metallic Minerals	Ton	668,609.9	718,884.9
	Fossil Fuel	Ton	37,046.8	35,731.5
	Waste for Treatment	Ton	85.9	89.9
	Mixed & Complex Products	Ton	-76.5	-77.3
	Total Domestic Material Consumption	Ton	**854,002.9**	**905,992.8**
	Total DMC Per Capita	**Ton**	**5.03**	**5.30**

Material Footprint in ’000 Ton for 2022-23					
Description	**Domestic Extraction**	**Imports (RME)**	**Exports (RME)**	**Material Footprint (MF)**	**MF per capita**
1	2	3	4	5	6
Biomass	114,181.10	28,795.20	6,750.20	136,226.10	0.797
Metal Ores		31,350.40	0.00	31,350.40	0.183
Non-Metallic Minerals	693,602.10	93,178.75	6,679.60	780,101.25	4.5762
Fossil Fuel	22,433.70	43,677.35	1,409.40	64,701.65	0.378
Total	**830,216.90**	**197,001.70**	**14,839.20**	**1,012,379.40**	**5.920**

SDG Indicators

Sl. No.	Indicators	SDG Indicator	Value in 2021-22	Value in 2022-23
1	2	3	4	5
1.	Material Footprint	8.4.1; 12.2.1	959.43 Million Tons	1,012.38 Million Tons
2.	Material Footprint per Capita	8.4.1; 12.2.1	5.649 Tons/person	5.920 Tons/ person
3.	Material Footprint per GDP	8.4.1; 12.2.1	2.08 kg/$	2.24 kg/$
4.	Domestic Material Consumption	8.4.2; 12.2.2	854.00 Million Tons	905.99 Million Tons
5.	Domestic Material Consumption per Capita	8.4.2; 12.2.2	5.03 Tons/person	5.30 Tons/ person
6.	Domestic Material Consumption per GDP (Material Intensity)	8.4.2; 12.2.2	1.86 kg/$	2.01 kg/$

Acronyms

APD: Assistant Project Director

BBS: Bangladesh Bureau of Statistics

BDP: Bangladesh Delta Plan

CO_2: Carbon Dioxide

DE: Domestic Extraction

DMC: Domestic Material consumption

DMI: Direct Material Input

DPO: Domestic Processed Output

DRC: Domestic Resource Consumption

DTA: Domestic Technology Assumption

ECDS: Environment, Climate Change and Disaster Statistics

EEA: European Environment Agency

EPB: Export Promotion Bureau

EW-MFA: Economy-Wide Material Flow Accounts

FAO: Food and Agriculture Organization

GDP: Gross Domestic Product

GHGs: Greenhouse Gases

HIES: Household Income and Expenditure Survey

IO: Input-Output

LCA: Life Cycle Assessment

LCA-IO: Life Cycle Assessment-Input-Output

MAC: Middle Class and Affluent

MF: Material Footprint

MFA-RME: Material flow accounts in raw material equivalents

MRIO: Multi-Regional Input-Output

MT: Metric Tons

N_2O: Nitrous Oxide

NAS: Net Addition to Stock

NDC: Nationally Determined Contribution

NIS: National Innovation System

NSO: National Statistical Organization

PIC: Project Implementation Committee

PSC: Project Steering Committee

PTC: Project Technical Committee

RMC: Raw Material Consumption

RMTB: Raw Material Trade Balance

SDGs: Sustainable Development Goals

SEEA: System of Environmental Economic Accounting

SID: Statistics and Informatics Division

SLR: Sea Level Rise

UK: United Kingdom

Executive Summary

Executive summary

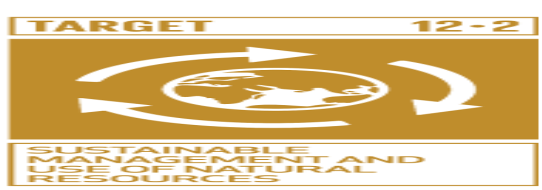
Rising global temperatures and heatwaves, driven by human activities, have increased significantly, threatening livelihoods worldwide. The past decade was the warmest on record, leading to intensified heatwaves, glacial melt, sea level rise, and extreme weather events. These changes exacerbate risks to human health, agriculture, freshwater resources, and coastal communities, particularly in vulnerable regions.

Bangladesh's deltaic landscape makes it highly susceptible to flooding, with 80% of its area as floodplains. Riverine and coastal flooding inundate up to 60% of the country during extreme events, worsened by sea level rise, storm surges, and intense cyclones. Rising sea levels threaten 17% of the land, displacing millions by 2050. Saltwater intrusion, intensified cyclones, and severe monsoon floods jeopardize agriculture, freshwater availability, and infrastructure. Climate change exacerbates health risks, with increasing vector-borne diseases, waterborne illnesses, and heat stress. These impacts threaten food security, health, and livelihoods across Bangladesh, particularly affecting its exposed coastal communities.

The overuse of natural resources drives climate change, causing greenhouse gas emissions, deforestation, and environmental degradation. This strain depletes resources and harms air, water, and soil. In response to global climate challenges, sustainability and resource efficiency are essential, balancing economic growth with environmental preservation and reducing waste and environmental impacts. As we venture into this resource-efficient paradigm, our understanding of resource consumption and its environmental ramifications becomes the cornerstone of evidence-based policymaking.

The material footprint (MF) refers to the total amount of raw materials extracted to meet the consumption demands of a country. It accounts for the global extraction of resources required to produce the goods and services consumed by a nation, irrespective of where the extraction occurs. It provides a comprehensive indication of the pressures placed on the environment to support economic growth and to satisfy the material needs of people, and stands as a critical gauge of our collective responsibility to understand, manage, and mitigate our impact on the planet's finite resources. Material Footprint, material footprint per capita, and material footprint per GDP are important indicators, applicable to 2 SDG targets.

Domestic material consumption (DMC) measures the total amount of materials directly used by an economy. It considers physical trade balance (Materials extracted for exports are deducted, and those imported are added into DMC), along with domestic extractions of materials. DMC reflects the direct use of materials in the domestic economy, highlighting the resource dependency and efficiency within national borders. It is a crucial indicator for understanding the sustainability of a country's resource use and its impact on the environment.

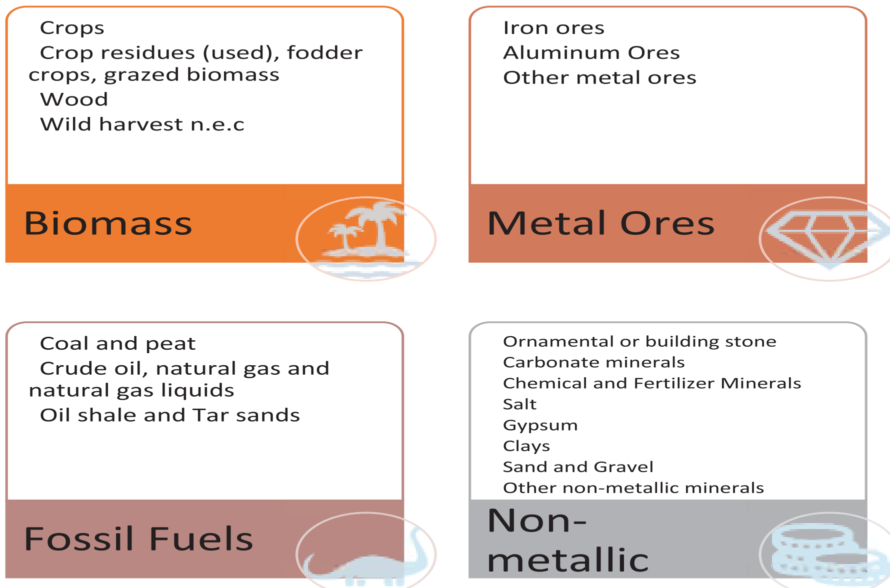


Material footprint is on the rise globally, increasing faster than population and economic output. The global material footprint rose from 43 billion metric tons in 1990 to 92 billion in 2017—an increase of 113 per cent since 1990. The rate of natural resource extraction has accelerated since 2000. Without concerted political action, it is projected to grow to 190 billion metric tons by 2060.

Measuring Material Footprint of Bangladesh

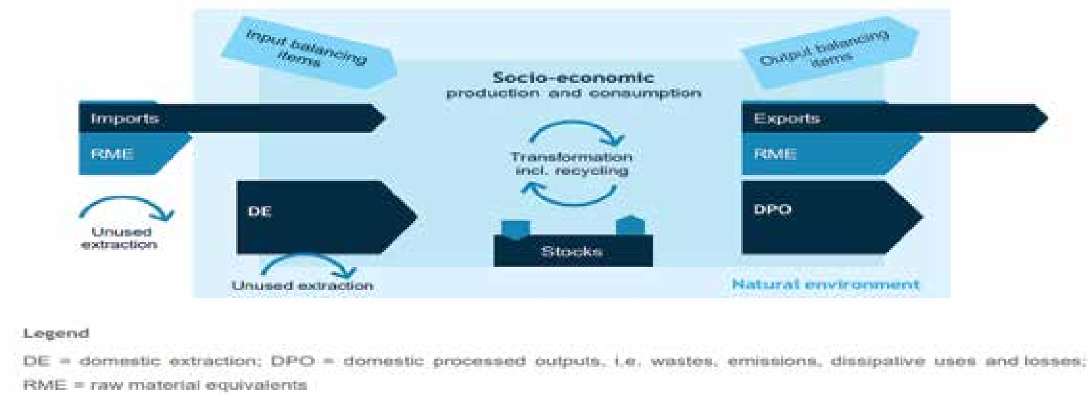
In Bangladesh, the material footprint is calculated using a comprehensive approach aligned with Eurostat's methodology, integrating input-output modeling with material flow accounts. This process analyzes domestic material extraction, imports, and exports, deriving key indicators like Physical Trade Balance (PTB) and Domestic Material Consumption (DMC). The approach provides a holistic view of material usage, supporting evidence-based policies for sustainable growth and resource management aligned with global sustainability goals.

Different Material Categories considered



To establish a comprehensive Material Flow Analysis (MFA) approach tailored to Bangladesh's context, structured process is employed. It encompasses a meticulous examination of various material categories, each playing a distinct role in our resource consumption. It begins with data collection and compilation of Biomass including crops, wood, and wild harvests, and fossil fuels like coal, oil, and natural gas. Metal ores such as iron and aluminum are crucial for industrial processes and construction, and non-metallic minerals like stone, salt, gypsum, and sand which serve myriad purposes in construction, agriculture, and manufacturing.

Data on material extraction and use in Bangladesh was collected through desk research and consultations, coordinated by Bangladesh Bureau of Statistics (BBS). Relevant publications were reviewed, but gaps in data, especially on mineral extraction and fish capture, led to a two-part consultation event. Agencies were tasked with filling these gaps, and their inputs were incorporated into the analysis.



Next, Resource Flow Analysis examines the journey of resources from extraction to consumption and waste generation, identifying key hotspots. It investigates national material flows, including inputs (domestic extraction, imports, and hidden flows) and outputs (emissions, waste, and exports). This analysis enables calculation of various material flow indicators, some of which are outlined in the report.

Issues and Challenges

The analysis reveals differences between our material footprint calculations and those from international sources (UNEP IRP Global Material Flows Database). These discrepancies stem from variations in data sources, local adjustments, and methodologies, including how secondary data and indirect material flows are treated. Furthermore, data availability and validity are crucial to ensuring the robustness of environmental accounting.

Addressing data availability and validity challenges is crucial for accurate material footprint analysis in Bangladesh. Incomplete data on biomass, such as straw, crop residues, wild fish, and aquatic plants, leads to underestimation. Non-metallic minerals data gaps, including specialty clays, construction materials, and carbonate minerals, hinder accurate assessment. Additionally, waste generation and emissions data, particularly for air and water emissions and hidden flows, are incomplete, complicating the full understanding of environmental impacts. Ensuring the validity of data is equally important. Some data estimates are questionable, leading to inconsistencies and potentially misleading conclusions.

Issues in Data Availability and validity

Incomplete Biomass Data:

- *Straw and Crop Residues:* Significant gaps exist in data, leading to underestimation of domestic extraction and material footprint.
- *Wild Fish and Aquatic Plant Harvest:* Lack of comprehensive data on wild fish and aquatic plants underrepresents biomass extraction, affecting sustainability assessments.

Non-Metallic Minerals Data Gaps:

- *Specialty Clays:* Missing data hampers accounting for their industrial contribution.
- *Construction Materials:* Lack of data on sand and gravel impacts understanding of construction's environmental effects.
- *Carbonate Minerals:* Absence of data on chalk, dolomite, and limestone underestimates the material footprint.

Waste Generation and Emissions:

- *Complex Data Collection:* Challenges in obtaining accurate data due to complex parameters.
- *Gaps in Emissions Data:* Missing data on key emissions categories and compounds limits environmental impact assessments.
- *Hidden Flows:* Inadequate data collection on secondary and tertiary material flows hampers comprehensive analysis.

Data Validity

- *Exaggerated estimates:* The estimate of 688.5 million tonnes of industrial sand and gravel, representing 99% of all minerals, suggests potential data errors.

Recommendations

Addressing these issues requires a concerted effort to improve data collection methodologies, ensure comprehensive coverage of all relevant material flows, and adopt standardized practices as exemplified by international benchmarks. Developing a comprehensive data collection system is crucial, integrating data from various sectors such as agriculture, fisheries, mining, construction, and waste management.

Targeted Surveys and Collaborations: Address data gaps by conducting targeted surveys and partnering with academic institutions, following international data standards.

Institutional Collaboration: Promote multi-stakeholder engagement and form a national task force to facilitate data sharing and joint efforts.

Advanced Technologies: Implement real-time data systems using satellite imagery, remote sensing, and IoT devices.

Analytical Tools: Use big data analytics, machine learning, and lifecycle assessment for enhanced data analysis.

Training and Capacity-Building: Equip analysts with skills through training programs to ensure data consistency.

Data Validity: Regularly cross-check estimates with industry reports and benchmarks; establish a validation task force.

Transparency: Ensure data accessibility through open platforms and user-friendly online portals to support informed policymaking.

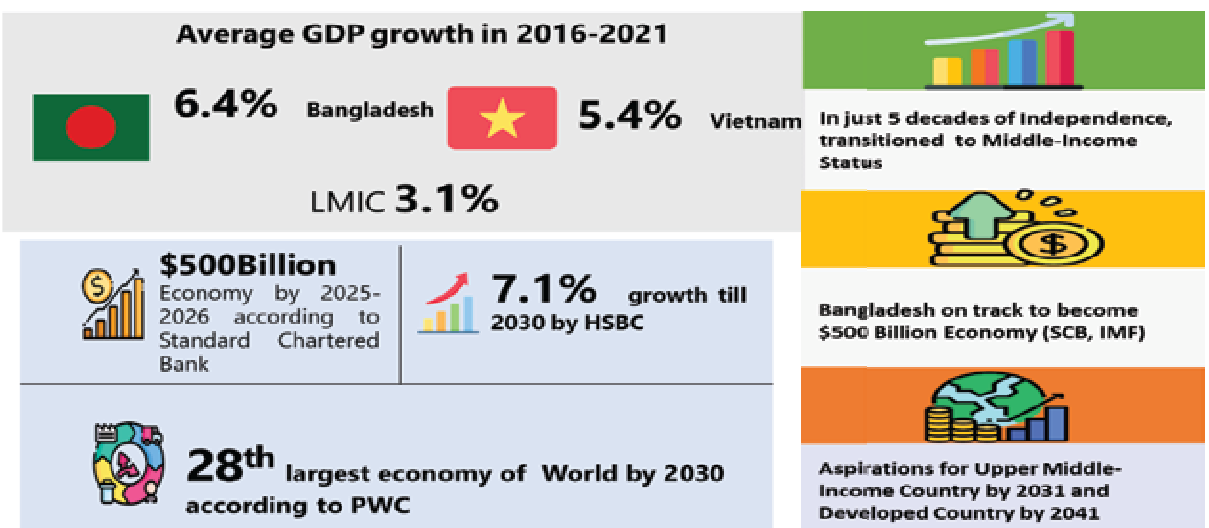
Chapter I
Introduction

1.1 Bangladesh Development Context

In just five decades since gaining independence, Bangladesh has transformed from fragility to middle-income status. Bangladesh's developmental narrative is a blend of resilience, determination, and progress. The nation's Gross Domestic Product (GDP) growth rate has been consistent, averaging around 6% over the last two decades. Reaching over 8 percent in fiscal year 2019, Bangladesh showcased economic resilience during the COVID-19 pandemic – achieving a growth rate of 5.2 percent in fiscal year 2020, surpassing comparable economies like India, Bhutan, and Vietnam[1].

Additionally, efforts to improve human development indicators have borne fruit, with significant strides made in reducing poverty and improving social indicators. With extreme poverty rate plummeting to 5.6 % in 2022 from 46.0 % in 1991[2] with remarkable achievements in human development, Bangladesh has taken significant steps toward reaching the first Sustainable Development Goal (SDG) target of eradicating extreme poverty by 2030. The increase in per capita GDP from US$418.1 in 2000 to US$2234 in 2020 coincides with a substantial reduction in poverty rates from 48.9 percent in 2000 to 18.7 percent in 2022[3].

Figure 1: Bangladesh's Impressive Growth and Development Performance



[1] Federation of Bangladesh Chambers of Commerce & Industries (2023). Bangladesh Business Summit 2023 Outcome Report [Online]. Available at: mofa.portal.gov.bd/sites/default/files/files/mofa.portal.gov.bd/page/c82bf223_4735_4288_a73a_28df1fb2c6cb/Bangladesh Business Summit 2023 Outcome Report.pdf. [Accessed: April 3rd, 2024]

[2] Bangladesh Bureau of Statistics (BBS) (2023). Key Findings: HOUSEHOLD INCOME AND EXPENDITURE SURVEY HIES 2022 [Online]. Available at: https://bbs.portal.gov.bd/sites/default/files/files/bbs.portal.gov.bd/page/57def76a_aa3c_46e3_9f80_53732eb94a83/2023-04-13-09-35-ee41d2a35dcc47a94a595c88328458f4.pdf [Accessed: April 3rd, 2024]

[3] Bangladesh Bureau of Statistics (BBS) (2023). Key Findings: HOUSEHOLD INCOME AND EXPENDITURE SURVEY HIES 2022 [Online]. Available at: https://bbs.portal.gov.bd/sites/default/files/files/bbs.portal.gov.bd/page/57def76a_aa3c_46e3_9f80_53732eb94a83/2023-04-13-09-35-ee41d2a35dcc47a94a595c88328458f4.pdf [Accessed: April 2, 2024]

The manufacturing sector, a key driver, played a pivotal variable, generating millions of low-skilled jobs. Despite initially having the world's second-lowest per capita income, the nation achieved lower middle-income status in under fifty years. The RMG industry has played a pivotal role in this export expansion, emerging as a flagship product and contributing significantly with export earnings reaching $42.6 billion in 2021-22. Domestic consumption, fueled by remittances and a growing middle class, further propelled economic growth and helped create millions of jobs. Projections indicate a substantial rise in individuals earning $5,000 or more annually, reaching a Middle Class and Affluent (MAC) category of 34 million people by 2025 according to the Boston Consulting Group.

Climate change is a pervasive and existential challenge confronting the global community. It manifests in the form of rising temperatures, changing precipitation patterns, increased frequency of extreme weather events, and sea level rise. These changes threaten natural ecosystems, human health, food security, water resources, and economic stability. Bangladesh, being one of the most vulnerable nations to climate change, experiences these impacts acutely due to its geographical, socio-economic, and demographic characteristics.

Bangladesh is one of the most vulnerable countries to climate change. The country continues to face increasing climate risks, with sudden temperature drops in winter, frequent heatwaves, poor rainfall during monsoon and multiple cyclones and severe floods hampering livelihoods. On average, an estimated 20-25% of the country becomes inundated due to river spilling and drainage congestion. Extreme situation arises when the three major rivers (Ganges, Brahmaputra and Meghna) reach their flood peak at same time, when 55-60% of the country is inundated[4]. Projected GDP losses range from 2% to 9% (in case of severe flood) with substantial declines in rice and wheat production[5].

The costs of environmental degradation and natural disasters are predicted to rise over time. The annual economic toll from tropical cyclones alone amounts to $1 billion on average, underscoring the urgency of addressing climate-related risks. The costs of environmental degradation and natural disasters are predicted to rise over time, compounded by higher heat, humidity, and health impacts. By 2050, climate variability and extreme events could result in the loss of one-third of agricultural GDP and trigger significant internal migration, particularly affecting women[6]. Projections suggest that the flood extent will increase for all areas of the country by mid-century (2050) based on the extreme scenario. Sea level rise (SLR) and consequently, salinity intrusion are also prominent issues now in the Bangladesh delta for its complex geographical position. Intergovernmental Panel on Climate Change (IPCC) 2013 predicts sea level rise between 0.2 to 1m for low to high emission scenarios in 2100 for the Bay of Bengal[7].

The pervasive threat of climate change poses a significant risk to Bangladesh's development aspirations and trajectory. Rising temperatures, erratic precipitation patterns, and the increasing frequency of extreme weather events jeopardize infrastructure, agricultural productivity, and overall economic stability. Such disruptions not only undermine the impressive GDP growth and human development gains achieved over the past decades but also threaten to exacerbate poverty and inequality. In this context, emphasis should be placed on increasing material utilization and Sustainable management must give importance.

Embracing resource efficiency is essential for minimizing environmental degradation and ensuring

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[4] Planning Commission (2017). Bangladesh Delta Plan 2100

[5] UN Environmental Programme (2023). The Intergovernmental Panel on Climate Change [Online]. Available at: https://www.ipcc.ch/. [Accessed: April 4, 2024]

[6] The World Bank (2022). Key Highlights: Country Climate and Development Report for Bangladesh [Online]. Available at: https://www.worldbank.org/en/news/feature/2022/10/31/key-highlights-country-climate-and-development-report-for-bangladesh. [Accessed: April 4, 2024]

[7] Planning Commission (2017). Bangladesh Delta Plan 2100

that economic activities do not compromise the natural systems on which the nation depends. By optimizing the use of materials, reducing waste, and promoting recycling system, Bangladesh can support its economic growth while preserving vital ecosystems. Moreover, measuring the material footprint—a comprehensive assessment of the total resources used throughout the lifecycle of products—enables policymakers and businesses to identify inefficiencies and implement strategies for sustainable resource management. This approach not only aligns with the Sustainable Development Goals but also fortifies Bangladesh's resilience against climate change, safeguarding the country's long-term developmental objectives.

1.2 Climate Change Realities and Vulnerabilities

Rising temperatures and heatwaves threaten livelihoods all over the globe. The Earth's average surface temperature has increased by approximately 1.1°C since the late 19th century, driven predominantly by human activities such as the burning of fossil fuels, deforestation, and industrial processes. This warming trend has been accelerating in recent decades, with the last decade (2010-2019) being the warmest on record. Heatwaves have become more frequent, intense, and prolonged, posing severe risks to human health, agriculture, and biodiversity. For instance, the 2019 European heatwave resulted in thousands of deaths and substantial agricultural losses.

The warming climate has led to significant melting of glaciers and polar ice sheets. The Greenland Ice Sheet and the Antarctic Ice Sheet have been losing mass at an alarming rate, contributing to global sea level rise. Glacial retreat is not only a sign of climate change but also affects freshwater availability for millions of people dependent on glacial meltwater, such as in the Himalayas and the Andes.

Global mean sea level has risen by about 20 centimeters since the late 19th century, with the rate of increase accelerating in recent years. This rise is due to thermal expansion of seawater and the melting of ice sheets and glaciers. Sea level rise exacerbates coastal erosion, increases the frequency and severity of coastal flooding, and threatens low-lying coastal communities and ecosystems. Small island nations and densely populated delta regions are particularly at risk.

Climate change affects precipitation patterns, leading to more intense and irregular rainfall. Some regions experience increased rainfall and flooding, while others face prolonged droughts. These changes have profound implications for water resources, agriculture, and food security. For instance, the Horn of Africa has suffered from recurrent droughts, contributing to food shortages and humanitarian crises.

The frequency and intensity of extreme weather events, such as hurricanes, typhoons, and cyclones, have increased. These events cause widespread destruction, economic losses, and loss of life. The 2017 Atlantic hurricane season, with devastating hurricanes like Harvey, Irma, and Maria, underscored the increasing destructiveness of such storms, influenced by warmer ocean temperatures and higher atmospheric moisture content.

Bangladesh’s deltaic features make it highly vulnerable to floods. Bangladesh is a low-lying deltaic country crisscrossed by a dense network of rivers and bordered by the Bay of Bengal. Approximately 80% of the country consists of floodplains, making it susceptible to riverine and coastal flooding. On average, an estimated 20-25% of the country becomes inundated due to river spilling and drainage congestion, which can go up to 55-60% during extreme flood events[8]. The country's topography and hydrology amplify the impacts of sea level rise, storm surges, and extreme weather events.

Bangladesh's coastline is already experiencing the effects of sea level rise. Even a modest rise in sea level can have severe consequences due to the flat and low-lying nature of the coastal regions. The

[8] Planning Commission (2017). Bangladesh Delta Plan 2100

Southern part of Bangladesh being a delta in formation, is extremely flat. One meter sea level rise will affect 17% of the country area covering the flat coastal zone. Climate experts predict that by 2050, rising sea levels will submerge some 17 percent of the nation's land and displace about 20 million people[9]. Saltwater intrusion from rising sea levels also affects freshwater resources and soil salinity, impacting agriculture and drinking water availability. Water borne diseases, such as diarrheal diseases, increase with floods as well as sharper summers and heat stress while vector borne disease such as malaria and dengue are also on the increase. Saltwater intrusion has forced many communities to be more dependent of higher salt and sodium content in their intake. This is likely to increase blood pressure in local communities, particularly women and excepting mothers[10].

Bangladesh is frequently hit by tropical cyclones originating in the Bay of Bengal. These cyclones bring heavy rainfall, storm surges, and high winds, causing widespread damage to infrastructure, agriculture, and human settlements. The increasing intensity of cyclones due to warmer sea surface temperatures exacerbates the vulnerability of coastal communities. Cyclone SIDR (November 2007) had a maximum wind velocity of over 250 km/hour, while cyclone Aila (March 2009) has forced a huge amount of saltwater breaching protecting hydrological barriers and devastating communities in the coastal area of Bangladesh[11]. They are stark reminders of the destructive potential of such events.

Riverine flooding in Bangladesh is expected to increase with monsoon rain intensifying. The country experiences seasonal flooding due to monsoon rains and the overflow of major rivers such as the Ganges, Brahmaputra, and Meghna. Both intensity and frequency of flooding is reported to be increasing in the last 2 decades. Climate change is expected to intensify the monsoon rains and increase the frequency of extreme rainfall events, leading to more severe and prolonged flooding. This exacerbates the challenges of managing water resources, protecting infrastructure, and ensuring food security.

Agriculture sector and food security are expected to be highly impacted due to harsh climate conditions. Agriculture is a critical sector in Bangladesh, employing nearly half of the workforce and contributing significantly to the country's GDP. Climate change poses multiple threats to agricultural productivity, including erratic rainfall, increased temperatures, and soil salinity. It is estimated that under a moderate climate change scenario, Aus's production would decline by 27% while wheat production would be reduced to 61%. Under a severe climate change scenario (with 60% moisture stress), yield of Boro might reduce by 55-62%[12]. The changing climate affects crop yields, reduces arable land, and increases the prevalence of pests and diseases. These factors threaten food security and the livelihoods of millions of farmers.

The health impacts of climate change in Bangladesh are profound. Increased temperatures and humidity create conducive conditions for the spread of vector-borne diseases such as malaria and dengue fever. Flooding and extreme weather events exacerbate waterborne diseases by contaminating drinking water sources. Heatwaves pose direct health risks, particularly to vulnerable populations such as the elderly, children, and outdoor workers.

1.3 Imperative of Resource Efficiency for Sustainable Development

The overuse of natural resources has been a fundamental driver of climate change, contributing to

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[9] Bangladesh Centre for Advanced Studies (2012). Regional Cooperation to Combat Climate Change: The Way Forward. Available at: https://www.bcas.net/article-full-desc.php?article_id=11

[10] Bangladesh Centre for Advanced Studies (2012). Regional Cooperation to Combat Climate Change: The Way Forward. Available at: https://www.bcas.net/article-full-desc.php?article_id=11

[11] Bangladesh Centre for Advanced Studies (2012). Regional Cooperation to Combat Climate Change: The Way Forward. Available at: https://www.bcas.net/article-full-desc.php?article_id=11

[12] Planning Commission (2017). Bangladesh Delta Plan 2100

greenhouse gas emissions, deforestation, and environmental degradation. The mounting demand for goods and services has exerted immense strain on our natural resources, resulting in their rapid depletion and the exacerbation of environmental degradation. Our extensive utilization of natural resources and emissions have cast a profound impact on our air, water, and soil. The global economy relies on extensive use of natural resources and emits substances into the environment, impacting air, water, and soil. Various economic activities, such as agriculture, mining, power generation, transportation, and consumption, contribute to this impact.

In an era marked by pressing global climate challenges, the urgency of sustainability has never been more pronounced. In the face of global climate challenges, sustainability has become a critical imperative, necessitating a balance between economic growth and environmental preservation. At the heart of this complex equation lies resource efficiency – a cornerstone in our quest to achieve the Sustainable Development Goals (SDGs) and transition towards green economies. Embracing resource efficiency is not merely a choice but a necessity. It promises a reduction in waste, a curtailment of environmental footprints, and a maximization of economic growth.

1.4 Overuse of Resources and Climate Change

Fossil Fuels and Greenhouse Gas Emissions

The over-reliance on fossil fuels—coal, oil, and natural gas—for energy production and industrial processes is the principal cause of anthropogenic climate change. Burning fossil fuels releases significant amounts of carbon dioxide (CO_2) and other greenhouse gases (GHGs) into the atmosphere. Since the Industrial Revolution, CO_2 levels have increased by more than 40%, reaching unprecedented levels. The combustion of fossil fuels for electricity, heat, and transportation accounts for nearly 75% of global GHG emissions, driving the warming of the planet and contributing to extreme weather events.

Deforestation and Land Use Change

Deforestation and land use change are major contributors to climate change, primarily through the release of stored carbon. Forests act as carbon sinks, absorbing CO_2 from the atmosphere. However, extensive deforestation for agriculture, logging, and urban development has significantly reduced forest cover. The Food and Agriculture Organization (FAO) estimates that the world loses about 10 million hectares of forest annually. This not only releases large amounts of CO_2 but also reduces the planet's capacity to absorb future emissions. In tropical regions, deforestation is particularly impactful, as these forests contain large amounts of carbon in both biomass and soil.

Agricultural Practices

Agricultural practices, particularly intensive farming, contribute to climate change through emissions of CO_2, methane (CH_4), and nitrous oxide (N_2O). Methane is produced by livestock digestion (enteric fermentation) and rice paddies, while nitrous oxide is released from soil management practices, including the application of synthetic fertilizers. These gases are potent, with methane being over 25 times more effective than CO_2 in trapping heat in the atmosphere over a 100-year period, and nitrous oxide being nearly 300 times more effective.

Industrial Processes

The industrial sector is a significant consumer of natural resources and a major source of GHG emissions. Processes such as cement production, steel manufacturing, and chemical synthesis release large amounts of CO_2 and other pollutants. For instance, cement production alone is responsible for about 8% of global CO_2 emissions. Additionally, the extraction and processing of raw materials, including metals and minerals, contribute to environmental degradation and energy consumption, exacerbating climate change.

Overexploitation of Water Resources

Water resources are also overexploited, leading to the depletion of aquifers, reduction of river flows, and deterioration of water quality. The energy required for water extraction, treatment, and distribution further adds to GHG emissions. In regions where water is scarce, such as the Middle East and North Africa, the energy-intensive process of desalination is increasingly used, contributing to the carbon footprint. Furthermore, inefficient water use in agriculture, industry, and households exacerbates the stress on water resources and increases vulnerability to climate impacts.

The overuse of natural resources has been a significant driver of climate change, contributing to rising greenhouse gas emissions, deforestation, and environmental degradation. Addressing this challenge requires a multifaceted approach that enhances resource efficiency across all sectors. Transitioning to renewable energy, promoting sustainable land use and agricultural practices, adopting circular economy principles, and improving water management are essential imperatives for sustainable development and limiting the impact on climate. Through coordinated efforts, innovative solutions, and supportive policies, it is possible to create a resilient and sustainable future for all.

As we venture into this resource-efficient paradigm, our understanding of resource consumption and its environmental ramifications becomes the cornerstone of evidence-based policymaking. Measuring resource use empowers us to craft comprehensive strategies and monitor our progress towards sustainable growth, climate mitigation, and adaptation. It enables us to set meaningful targets aimed at the reduction of waste, pollution, and the unsustainable consumption of our natural treasures. Although some countries can efficiently monitor their resource extraction and emissions, understanding the interconnections between production and consumption is crucial. It is important to remember that monitoring resource extraction and emissions alone falls short of the holistic perspective we need. To truly comprehend our environmental impact, we must delve into the intricate interconnections between production and consumption. Only through this comprehensive view can we forge a path that not only sustains our economic prosperity but safeguards the planet's future for generations to come.

Chapter II

Concepts, Definitions and Implication

In the quest for sustainable development, understanding and managing the material footprint and domestic resource consumption are critical. These metrics provide insight into the extent of resource use and its environmental implications, thereby guiding policy and behavioral changes towards sustainability. This chapter delves into the definitions, current data, trends, and the broader implications of material footprint and domestic resource consumption, emphasizing the need for efficient resource use.

Domestic Material Consumption (DMC)

Domestic material consumption (DMC) measures the total amount of materials directly used by an economy. It considers physical trade balance (Materials extracted for exports deducted, and those imported are added into DMC) along with domestic extractions of materials. DMC reflects the direct use of materials in the domestic economy, highlighting the resource dependency and efficiency within national borders. It is a crucial indicator for understanding the sustainability of a country's resource use and its impact on the environment.

DMC = Annual quantity of raw materials extracted from the domestic territory+ physical imports (in tons) – physical exports (in tons)

The DMC indicator provides an assessment of the absolute level of the use of resources and allows to distinguish consumption driven by domestic demand from consumption driven by the export market. It is important to note that the term "consumption" as used in DMC denotes apparent consumption and not final consumption. DMC does not include upstream "hidden" flows related to imports and exports of raw materials and products.

Material Footprint

The material footprint (MF) refers to the total amount of raw materials directly & indirectly extracted to meet the consumption demands of a country. Material footprint captures the full upstream raw material inputs across supply chains for the goods and services we consume, capturing all resources used in product's lifecycle. This includes biomass, fossil fuels, metal ores, and non-metallic minerals. Unlike traditional metrics, such as direct material input (DMI), the material footprint accounts for the global extraction of resources required to produce the goods and services consumed by a nation, irrespective of where the extraction occurs. It provides a comprehensive measure of the environmental pressure exerted by consumption patterns.

Material Footprint = Domestic Extraction + Raw materials in Import – Raw materials in Export

The material footprint is a comprehensive metric that offers profound insights into our intricate relationship with the environment and resource utilization**.** At its core, it quantifies the total volume of raw materials extracted to fulfill the demands of final consumption. This measure extends beyond the mere sum of materials consumed, as it encompasses the entire spectrum of upstream raw material inputs. It considers the complex and often international supply chains that support the production of the goods and services that we utilize in our daily lives. The UK Government defines Material Footprint as "a measure of the global primary raw material extraction attributable to final domestic demand for goods and services by the residents of an institutional unit, typically a nation."

In essence, the material footprint embodies the environmental pressures exerted to sustain economic growth and meet the material needs of a nation's residents. Material footprints quantify the worldwide demand for material extractions (biomass, metal ores, non-metallic minerals, and fossil energy materials/carriers) triggered by consumption and investment by households, governments, and businesses in the respective economy. It refers to the total amount of raw materials extracted to meet final consumption demands of an economy and is one indication of the pressures placed on the environment to support economic growth and to satisfy the material needs of people. It stands as a critical gauge of our collective responsibility to understand, manage, and mitigate our impact on the planet's finite resources.

2.1 Definition of Material Footprint Categories: Biomass, Metal ores, Non-metallic minerals, and Fossil Fuel

Biomass

Biomass is organic, non-fossil material derived from biological sources, encompassing a wide range of natural resources that all countries utilize. Primarily used as food for humans and feed for livestock—roles where it is irreplaceable—biomass also serves as fuel (e.g., fuelwood) and as a raw material for products like textiles, paper, and construction wood. Historically dominant in material resources, biomass's share in industrialized economies has declined since industrialization, although global extraction and usage have surged, driven by population growth, changing diets, biofuel production, and climate-friendly bio-economy initiatives. Biomass includes all vegetable matter extracted by humans, wild fish captures, and hunted animal biomass, with livestock products flowing within economic systems rather than classified as direct biomass extraction.

Metal Ores

Metal ores, as defined within Material Footprint accounting, are economically viable deposits of metal compounds located within the Earth's crust. Metals in pure form are elements that typically exhibit high conductivity, ductility, malleability, and strength, making them essential for diverse technological applications. Most metals occur naturally as compounds combined with other elements, necessitating capital- and energy-intensive processing to extract them in usable forms. An ore's economic value depends on the market, meaning a rock's concentration of metal can qualify it as "ore" if extraction costs align with market prices. Metal ores are selectively mined for processing, with surrounding rock or soil that is merely moved for access classified as "overburden" and excluded from material footprint calculations. In classification, ores are generally divided into categories based on the primary metals they yield, such as iron and aluminum, and other metal ores, while polymetallic ores are recognized for their co-product potential.

Non-Metallic Minerals

Non-metallic minerals, as defined by the OECD, include resources such as stone from quarries, clay, sand, chemical and fertilizer minerals, salt, gypsum, natural gemstones, asphalt, bitumen, and peat, excluding coal and petroleum. These materials are generally abundant and locally sourced, with the largest share by mass consisting of sand, gravel, and clay for construction. The remainder serves various uses, including decoration, chemical, and agricultural applications. The lack of a strict distinction between industrial and construction purposes reflects the versatile application of many non-metallic minerals. Over the past four decades, this category has expanded significantly and now represents many materials extracted globally, although it remains underreported. Given their low economic value but high mass and volume, it is assumed that non-metallic minerals extracted domestically are consumed domestically, except in densely populated regions like Monaco, Singapore, and Hong Kong, where imports may be necessary.

Fossil Fuels

Fossil fuels, derived from ancient biomass, are the primary global energy carriers, available in solid, liquid, and gaseous forms. They play a critical role in supporting economies by powering households, businesses, and industries. Coal, the largest fossil fuel by volume, is primarily burned for electricity, while petroleum serves both as an energy source and a base material for industrial processes like synthetic materials production. Natural gas is widely used for heating, cooking, electricity, vehicle fuel, and manufacturing essential chemicals and plastics. In 2016, fossil fuels represented about 17% of global material extraction, with coal, natural gas, and oil accounting for the bulk. Peat, though less common, remains significant in specific regions, including Canada and parts of Europe (UNEP 2017).

2.2 Implications of Material Footprint and Domestic Material Consumption

2.2.1 Environmental Impact

The rising material footprint and domestic material consumption have significant environmental impacts, including:

Resource Depletion: Over-extraction of resources can lead to the depletion of critical natural reserves, undermining the availability of materials for future generations.

Biodiversity Loss: Resource extraction and land use changes disrupt ecosystems and habitats, contributing to biodiversity loss.

Pollution: The extraction, processing, and disposal of materials generate pollutants that contaminate air, water, and soil, affecting human health and the environment.

Climate Change: The use of fossil fuels and land use changes associated with resource extraction contribute to greenhouse gas emissions, driving climate change.

2.2.2 Economic and Social Implications

Resource Dependency: Countries heavily reliant on resource extraction face economic vulnerabilities due to fluctuations in global commodity prices and the finite nature of resources.

Inequality: The distribution of resources and consumption patterns can exacerbate inequalities within and between countries, with wealthier nations and populations consuming a disproportionate share of resources.

Sustainable Development: Efficient resource use is essential for sustainable development, ensuring that economic growth does not come at the expense of environmental health and social equity.

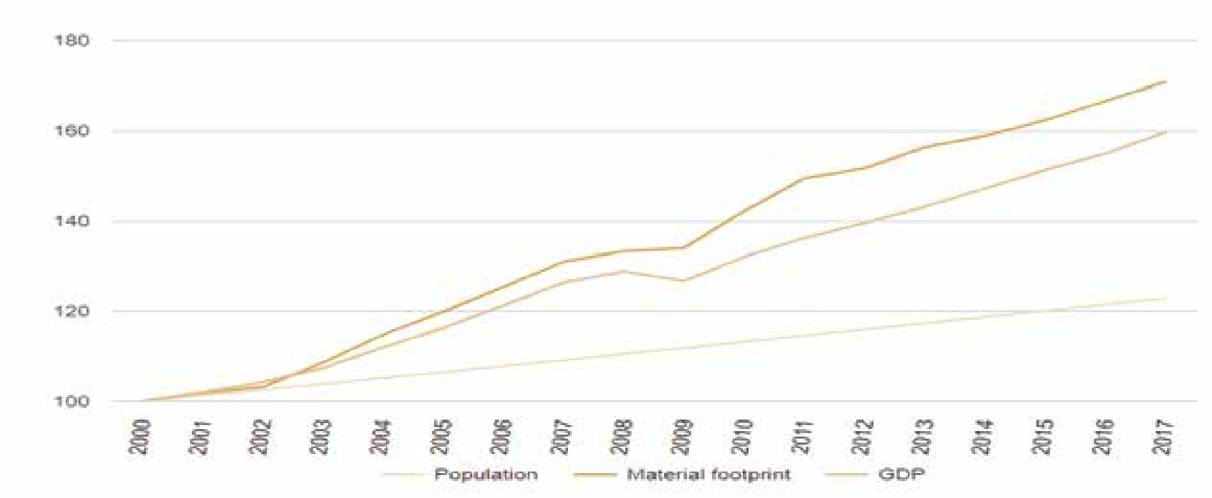
Chapter III

Global Trend & SDGs

3.1 Global Trends in Material Footprint

The global material footprint is increasing at a faster rate than both population and economic output. The global material footprint rose from 43 billion metric tons in 1990 to 54 billion in 2000, and 92 billion in 2017—an increase of 70 per cent since 2000, and 113 per cent since 1990.[13] The rate of natural resource extraction has accelerated since 2000. At the global level, there has been no decoupling of material footprint growth from either population growth or GDP growth. It is imperative that we reverse that trend. Without concerted political action, it is projected to grow to 190 billion metric tons by 2060.

Figure 2: Growth of Material Footprint in line with Population and GDP Growth Index 2000=2017 (baseline 2000=100)



The EU's material footprint refers to the amount of material extracted from nature, both inside and outside the EU, to manufacture or provide the goods and services consumed by EU citizens**.** The material footprint provides a comprehensive measure of all materials extracted to satisfy consumption demand in the EU, including materials extracted outside the EU and imported. The demand for metals and fossil fuels is met mainly by imports, while the demand for biomass and non-metallic minerals is met mainly by domestic extraction. The EU's total material footprint is above the global average and much above those of low- and middle-income countries[14]. This level of resource consumption exceeds the planet's 'safe operating space' for resource extraction. The Eighth Environment Action Program calls for a significant decrease in the EU's material footprint to safeguard precious natural resources and because the extraction and processing of these resources has significant environmental and climate impacts, such as climate change and biodiversity loss[15].

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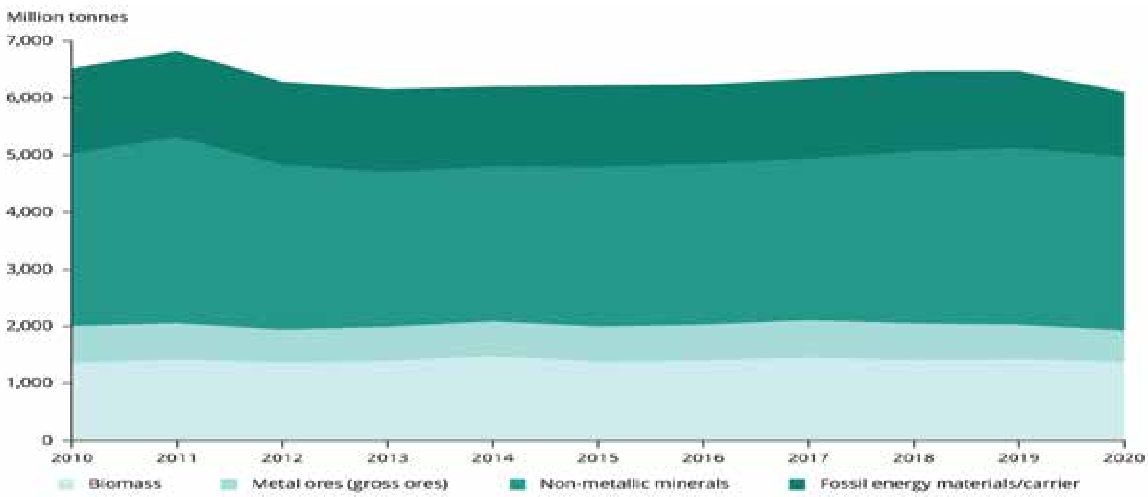
[13] United Nations Statistics Division. Available at https://unstats.un.org/sdgs/report/2019/goal-12/#:~:text=Shrinking%20our%20material%20footprint%20is%20a%20global%20imperative&text=The%20global%20material%20footprint%20rose,extraction%20has%20accelerated%20since%202000.

[14] European Environment Agency (2023). Europe's material footprint. Available at: https://www.eea.europa.eu/en/analysis/indicators/europes-material-footprint

[15] IRP, 2019, *Global Resources Outlook 2019: Natural Resources for the Future We Want*, International Resource Panel, Nairobi, Kenya.

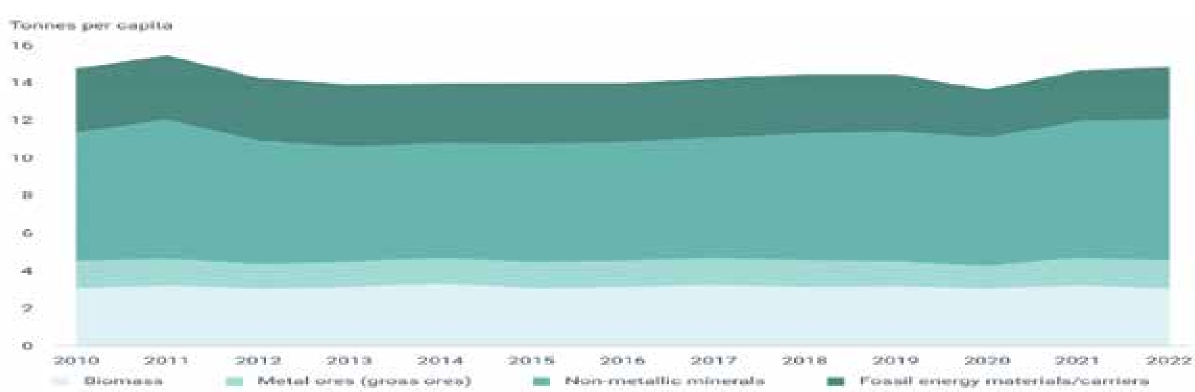
Figure 3a: EU Material Footprint, in million tons of raw material equivalent



Source: 8th Environment Action Program, European Environment Agency

From 2010 to 2020, the EU's material footprint remained relatively stable: it fell by 7% from 2010 to 2016 and increased by 5% from 2016 to 2019. In 2020 the material footprint fell by 5% to 6.1 billion tons, but the 2020 data is heavily influenced by the economic slowdown due to the COVID-19 pandemic, which is considered as a temporary phenomenon. Of the various material groups, consumption of non-metallic minerals is the highest, accounting for 50% of the footprint in 2020; changes in consumption in this group were largely responsible for the overall trend. Biomass was the next largest group (23%), followed by fossil fuels (19%) and metals (9%). Although non-metallic minerals account for a large part of the total material footprint, they have less of an impact on the environment and climate than metals and fossil fuels, relative to their shares of the material footprint.

Figure 3b: EU Material Footprint, in tons per capita of raw material equivalent



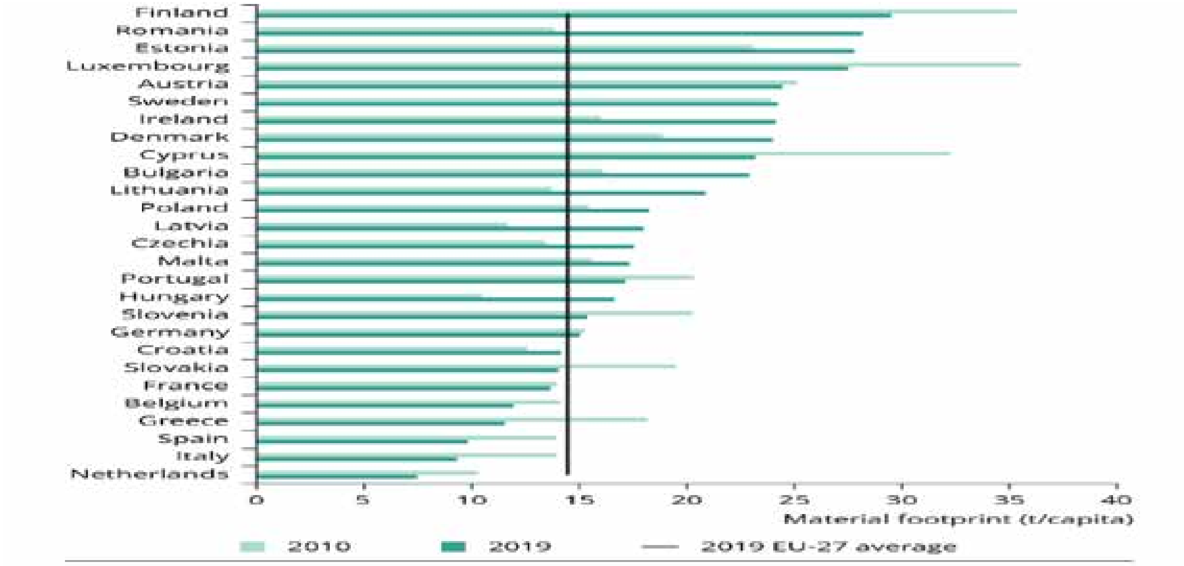
Between 2010 and 2022, the European Union's per capita material footprint remained relatively constant. In 2020, the material footprint per capita saw a significant reduction of 5.7%, dropping to 13.7 tons, primarily due to the economic downturn caused by the COVID-19 pandemic. However, it rebounded by 7.2% in 2021[16]. Among the different material categories, non-metallic minerals had the highest consumption, constituting 51% of the material footprint in 2022. Changes in the consumption of this group were the main driver behind the overall trend.

Biomass was the second largest category, making up 21% of the footprint, followed by fossil fuels at

[16] European Environment Agency (2023). Europe's material footprint. Available at: https://www.eea.europa.eu/en/analysis/indicators/europes-material-footprint

18% and metals at 10%. The proportion of fossil fuels has been declining (from 23% in 2010), while the share of non-metallic minerals has increased from 46% in 2010. Despite the significant contribution of non-metallic minerals to the total material footprint, their environmental and climate impacts are relatively lower compared to metals and fossil fuels. This is because non-metallic minerals primarily consist of relatively inert materials like gravel and limestone[17].

Figure 4: EU States' Material footprint, 2010 and 2019



Source: European Environment Agency (2023). Europe's material footprint

Material footprints vary substantially across EU countries, from 7.5 tons/capital in the Netherlands to 29.5 tons/capita in Finland. Since 2010, 14 of the 27 Member States have reduced their material footprints, with Greece and Italy reducing their footprints by more than 30%. On the other hand, Romania, Hungary and Ireland's material footprints have increased by more than 50%.

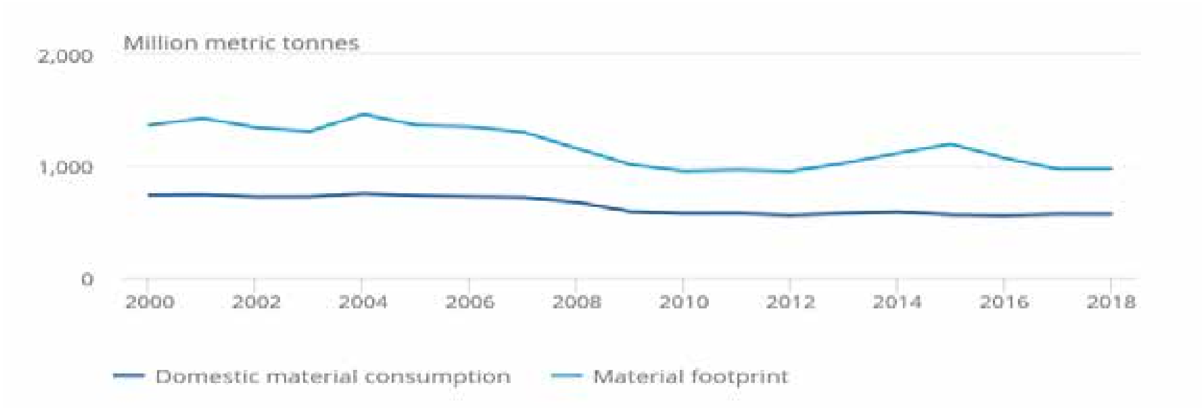
3.2 United Kingdom

In 2018, the UK's domestic material consumption (DMC) stood at 569 million metric tons. DMC is a metric that quantifies the total volume of materials directly utilized by an economy. It is calculated by combining domestic extraction with imports and then subtracting exports. Notably, the UK's DMC has demonstrated relative stability since 2000, with a notable decline in 2008, attributable to the economic recession.

While DMC focuses on the materials needed for primary production processes, the material footprint offers a more comprehensive perspective. It encompasses the additional materials essential to satisfy consumption demands, effectively capturing both domestic and foreign material extraction required to manufacture the goods and services consumed by households, government entities, and charities within the UK over a single year. In situations where a country exhibits low levels of primary production but high demand for consumer goods and services, the material footprint can significantly exceed the DMC, highlighting the intricate relationship between consumption patterns and resource utilization. The case for UK is shown below.

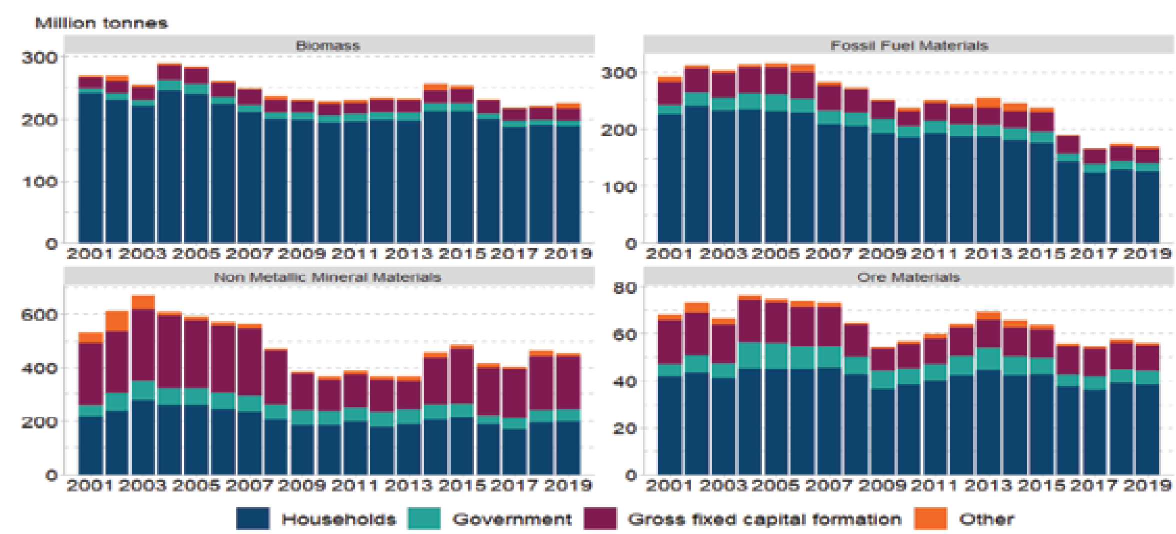
[17] IRP, 2019, 'Global Resources Outlook 2019: Natural Resources for the Future We Want', (https://www.resourcepanel.org/reports/global-resources-outlook) accessed June 4, 2024.

Figure 5: Domestic Material Consumption and Material Footprint in UK, 2000 to 2018



In 2019, England's material footprint totaled approximately 902 million tons, representing a substantial 84% share of the entire UK's material footprint. Interestingly, this material footprint had decreased by about a third (31%) since its peak in 2003. The composition of England's material footprint in 2019 was predominantly composed of non-metallic minerals, accounting for half (50%), while biomass constituted a significant quarter (25%). Furthermore, the driving forces behind England's material footprint were primarily attributed to household consumption, comprising 61%, followed by gross fixed capital formation at 28%, and government services expenditure at 9%. Notably, the contribution of household consumption to England's material footprint varied depending on the material type. In 2019, a substantial 84% of biomass extraction and harvesting could be attributed to households, while only 43% of non-metallic mineral extraction had a household origin. An intriguing trend emerged between 2001 and 2019, where a considerable portion of global material extraction driven by England's final domestic demand occurred outside of the UK.

Figure 6: Trends in annual raw material consumption by material group, split by end use; England, 2001-2019 (in million tons)



3.3 Portugal

In the year 2021, Portugal reported a domestic material consumption (DMC) of approximately 163.9 million tons, marking a 7.1% increase compared to the previous year, 2020. However, when viewed through a longer-term lens, this figure was notably 12.9% lower than the DMC recorded in 2011. An intriguing aspect of Portugal's material consumption was the composition of materials involved. Non-metallic minerals took the lead as the most significant category, accounting for a substantial 63.2% of the country's DMC in 2021. Following closely behind, biomass constituted 21.1% of the total, while fossil energy materials and metallic ores contributed 7.3% and 6.8%, respectively. These figures provide a valuable snapshot of Portugal's resource utilization patterns, reflecting both short-term changes and a decade-long trajectory in material consumption.

Figure 7: Domestic Material Consumption trends in Portugal

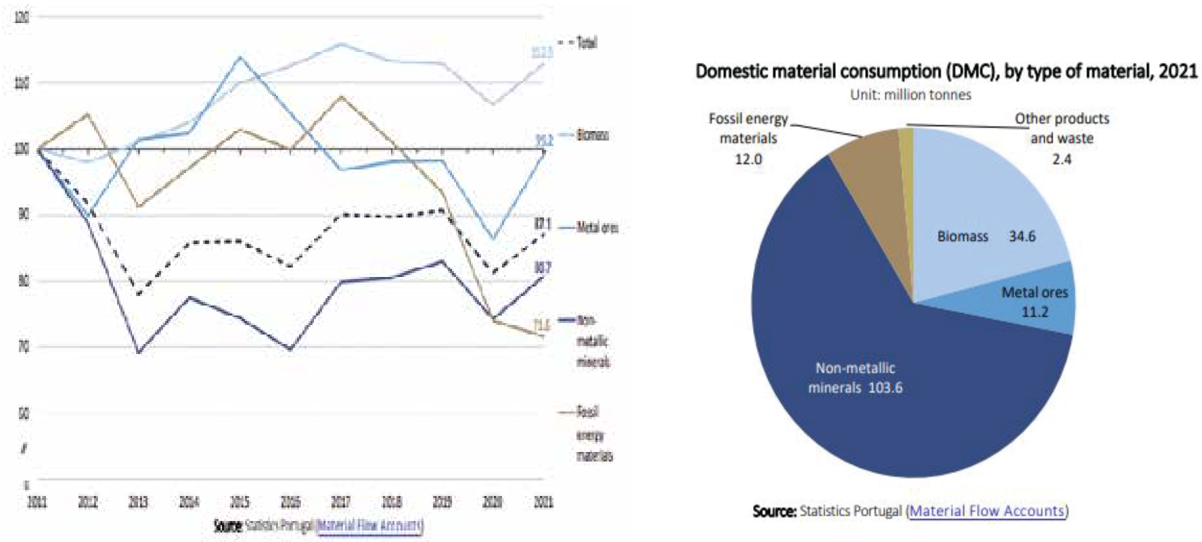


Figure 8: Material Footprint in Netherlands, 2017

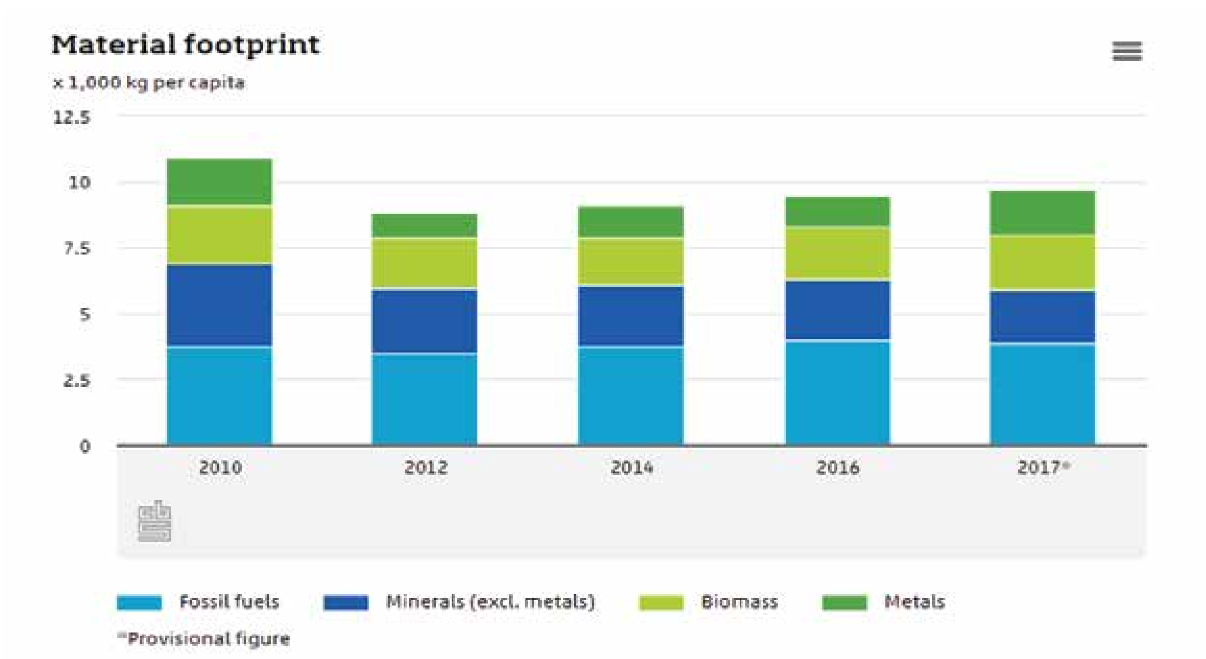
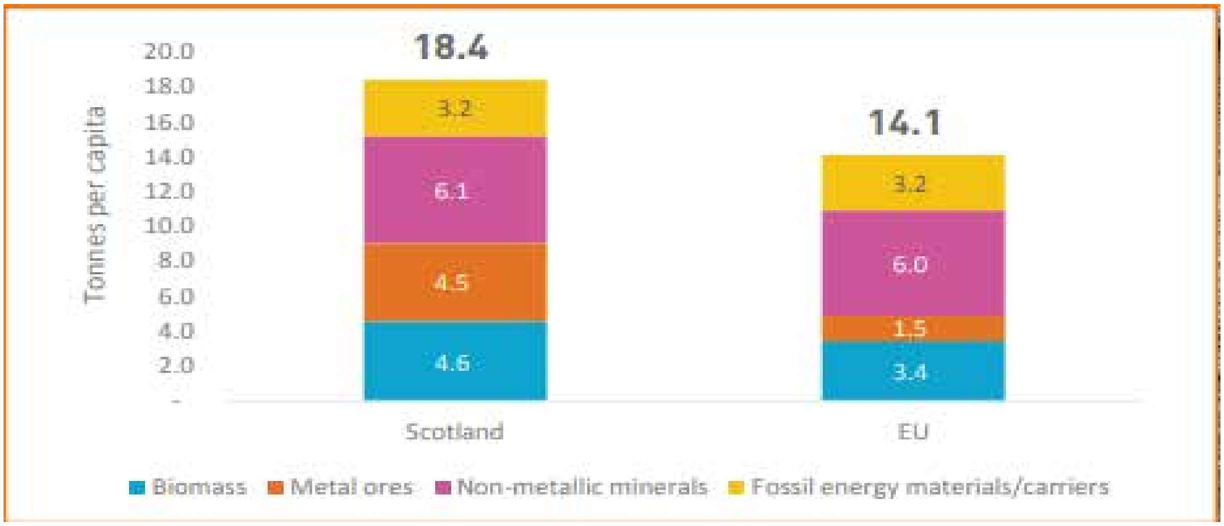


Figure 9: Material Footprint in Scotland and EU Average, 2017



3.4 SDG and Material Footprint

Material Footprint, material footprint per capita, and material footprint per GDP are important indicators, applicable to 2 SDG targets-

SDG Target 12.2: "By 2030, achieve the sustainable management and efficient use of natural resources"

SDG Target 8.4: "Improve progressively, through 2030, global resource efficiency in consumption and production and endeavor to decouple economic growth from environmental degradation, in accordance with the 10-Year Framework of Programs on Sustainable Consumption and Production, with developed countries taking the lead"

Chapter IV
Methodology

4.1 Measuring Material Footprint: Approach and Methods

Material footprints are estimated, using data from national accounts and material flow accounts. With production chains now global, environmental impacts are felt across borders. Merely monitoring national resource extraction and emissions is insufficient to grasp the true impact, as production of emission-intensive goods may have shifted elsewhere. An environmental accounting system is needed to reveal these interrelations between production and consumption, enabling a global understanding of their impact.

Material Flow Accounts in Raw Material Equivalents (MFA-RME) complement Economy-Wide Material Flow Accounts (EW-MFA). MFA-RME accounts for products in terms of the amount of domestic extraction necessary to produce them, irrespective of where the material was extracted. Producing those estimates is closely related to input-output techniques, which is one of the elements in the SEEA CF research agenda. The main MFA-RME indicator, Raw Material Consumption (RMC), is also referred to as a 'material footprint', as it captures the amount of extraction of materials needed to meet the country's consumption and investment demand.

EW-MFA represents a framework for describing the interaction of a domestic economy with the natural environment and the economy of the rest of the world in terms of flows of materials, waste and emissions**.** EW-MFA based accounts and indicators deliver a very comprehensive overview of natural resource extraction, trade in natural resources, waste disposal and emissions. They measure environmental pressures of natural resource use, and EW-MFA based headline indicators have been used as a proxy for overall environmental pressure and impact of a national economy. For this reason, indicators based on EW-MFA data sets have been adopted for monitoring progress of the 2030 sustainable development agenda and the SDG targets for resource productivity (SDG 8.4) and sustainable use of natural resources (SDG 12.2).

Economy-wide material flow accounts (EW-MFA) consider all material inputs and outputs of a national economy.

It accounts for many resources within four main categories: fossil fuels, metals, minerals, and biomass. Provides an overview of annual material inputs and outputs of an economy. These include inputs (extractions) and outputs (emissions, waste) from and to the domestic environment as well as trade flows. The difference between inputs and outputs is classified into two categories: either domestic waste and emissions, or net addition to stock.

Material flow accounts in raw material equivalents (MFA-RME) complement EW-MFA.

The EW-MFA is supposed to form a physical complement to the monetary national economic accounts (System of National Accounts) in the System of Environmental Economic Accounting (SEEA) (UN, 2016). MFA-RME accounts for products in terms of the amount of domestic extraction necessary to produce them, irrespective of where the material was extracted. Producing those estimates is closely related to input-output techniques, which is one of the elements in the SEEA CF research agenda. The main MFA-RME indicator, raw material consumption (RMC), is also referred to as a 'material footprint'.

EW-MFA is consistent with the principles and system boundaries of the system of national accounts (SEEA; UN 2017). Only flows that cross the system boundary on the input side or on the output side are counted. Material flows within the economy are not represented in EW-MFA and balances. This means that the national economy is treated as a black box in EW-MFA and, for example, inter-industry deliveries of products are not described.

In EW-MFA two types of material flows across system boundaries are relevant:

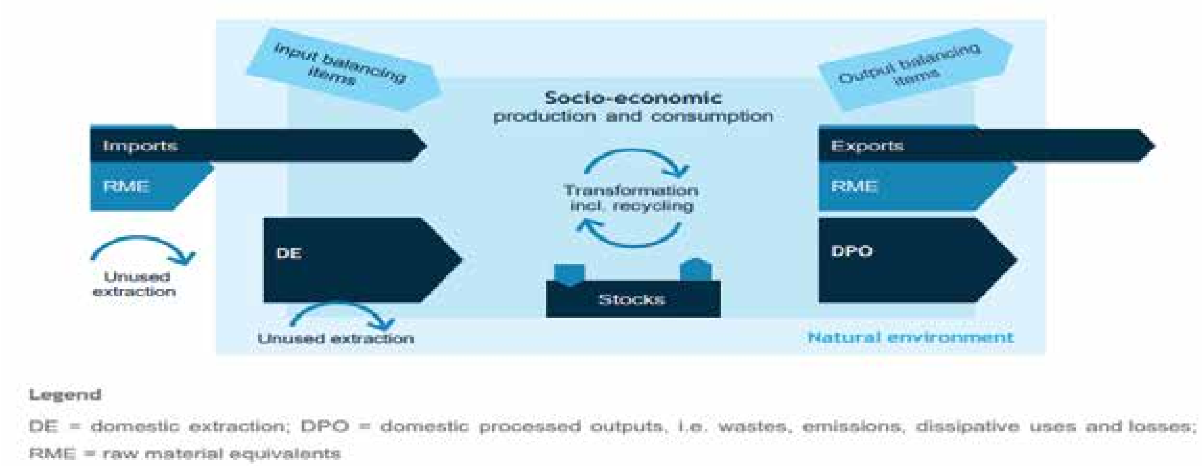
Material flows between the national economy and the natural environment: This consists of the extraction of primary (i.e. raw, crude or virgin) materials from and the discharge of materials to the natural environment (wastes

Material flows between the national economy and the ROW. This encompasses imports and

The EW-MFA framework consists of six integral modules, each designed to meticulously capture and quantify the complex interplay between economic activities and natural resource utilization. The initial module is dedicated to Domestic Extraction (DE), Direct Physical Imports (IM), and Exports (EX) of materials, forming the foundational basis of the accounting process. The second module delves into the indirect flows linked to imports and exports, specifically focusing on Raw Material Equivalents of Imports (RMEIM) and Exports (RMEEX). Progressing further, the third module examines the output dimension of material flow accounts, reporting on domestic processed output (DPO) alongside the intricate pathways through which waste and emissions exit the economy and interact with the environment.

Module four tracks net additions to stocks, while the next one examines unused extraction and focuses on specific industries. Module four is a pivotal component that quantifies Net Additions to Stocks (NAS) and often integrates a stock account of in-use stock (Stock). It serves the vital function of reconciling input and output flows while introducing essential balancing items. The fifth module scrutinizes unused extraction within the context of domestic extraction or raw material extraction associated with imports and exports abroad. Lastly, a potential sixth module specializes in the material flows of distinct industries, culminating in the creation of a comprehensive material flow satellite account intricately linked to physical supply and use tables, offering a holistic view of resource utilization across various sectors.

Figure 10: Simplified Representation of EW-MFA



Source: The use of natural resources in the economy – A Global Manual on Economy-Wide Material Flow Accounting

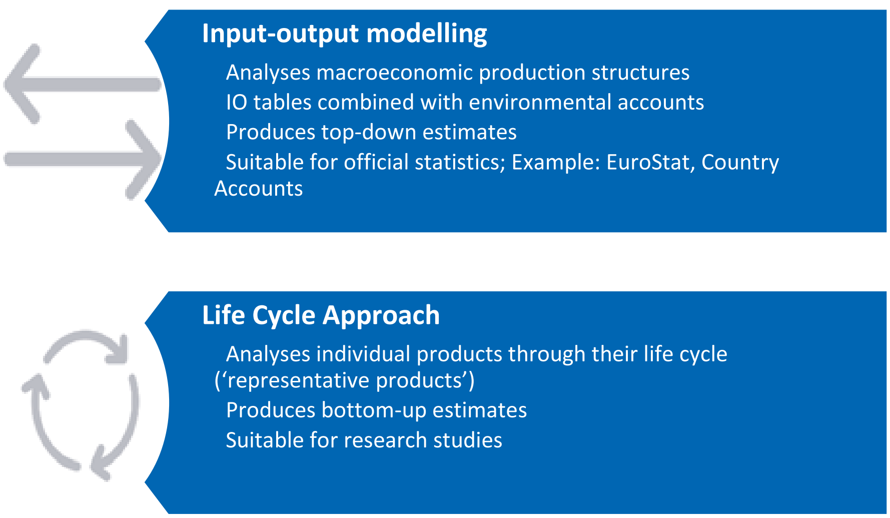
Material footprint is typically calculated using two primary methods: Input-output modeling and the Life cycle approach.

Input-output modeling examines the macroeconomic production structures within a country. It combines input-output (IO) tables with environmental accounts, providing a top-down estimate of a country's material footprint. This method is particularly suitable for official statistics and is often used by organizations like Eurostat and for country-level accounts. It allows for a comprehensive view of how various sectors of the economy contribute to material use.

Life cycle approach, on the other hand, delves into the life cycle of individual products, often referred to as 'representative products.' It takes a bottom-up approach, analyzing the materials and resources used at every stage of a product's life, from production to disposal. This method is well-suited for research studies, as it offers detailed insights into the material footprint of specific products or processes.

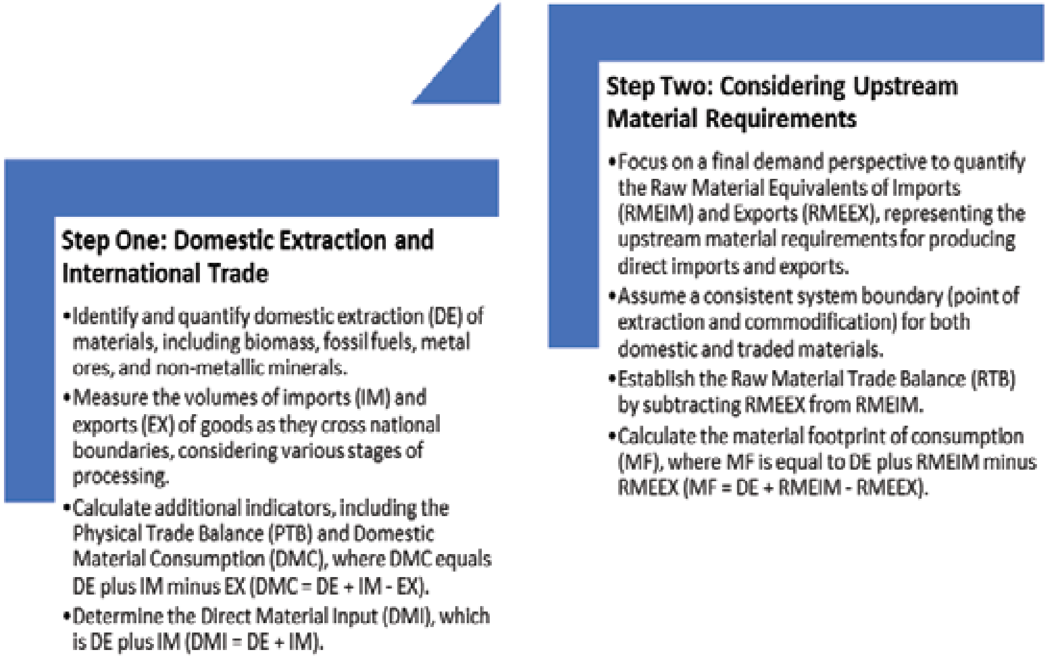
These two approaches, while distinctly, complement each other in providing a comprehensive understanding of a country's material footprint. While input-output modeling offers a broader perspective on the entire economy, the life cycle approach allows for in-depth scrutiny of specific products or processes, making them valuable tools for both official statistics and research endeavors in the quest for sustainable resource management.

Figure 11: Different ways of calculating material footprint



The calculation of material footprint in the EW-MFA, using an input-output model, is done in two key steps/ modules. Step one focuses on the core data set, covering the domestic extraction (DE) of materials used in economic processes, including biomass, fossil fuels, metal ores, and non-metallic minerals. It also includes the measurement of imports (IM) and exports (EX) of goods as they cross national boundaries, encompassing various stages of processing. This module enables the derivation of important indicators such as the Physical Trade Balance (PTB) and Domestic Material Consumption (DMC), where DMC is the sum of DE, IM, and EX. Step two adopts a final demand perspective, quantifying the upstream material requirements (RMEIM and RMEEX) to produce direct imports and exports. The Raw Material Trade Balance (RMTB) is determined by subtracting RMEEX from RMEIM, and it serves as a crucial component in calculating the material footprint of consumption (MF). This indicator attributes global material extraction to a country's final demand, providing valuable insights into resource utilization.

Figure 12: Material footprint in the EW-MFA using 2 step analysis



With consideration of upstream material use, global raw material extraction associated with final demand in a particular country, or Material Footprint (MF), can be calculated. This indicator is also called Raw Material Consumption (RMC)[18]. To denote the upstream requirements of used extraction associated with imports or exports the term RME was coined (Eurostat 2001). Methods to account for RME have developed fast in the past few years and can be grouped into three different approaches: (1) single-region approaches, which apply material use patterns of domestic production (termed as Domestic Technology Assumption, DTA) to imports; (2) Multi-Regional Input-Output models (MRIO)[19], which integrate national IO models into one world model; (3) hybrid Life Cycle Assessment-Input-Output model(LCA-IO) approaches[20], which use the DTA approach but apply Life Cycle Assessment (LCA) coefficients to those imports that are not, or not sufficiently, represented by domestic IO structures.

Figure 13: Various ways to calculate raw material equivalent:

Different ways to calculate Raw Material Equivalent:

Single-Region Approach: This method looks at material use patterns of domestic production (Domestic Technology Assumption, DTA) and applies them to imports

Multi-Regional Input-Output Models (MRIO): MRIO combines information from different countries to create a big picture. It integrates national IO models into one world model

Hybrid Life Cycle Assessment-Input-Output model (LCA-IO) Approach: This method is a mix of the first two. It uses the DTA method but also considers Life cycle assessment coefficients to imports that are not represented by domestic patterns. This gives a more detailed view.

[18] Eisenmenger, Fischer-Kowalski and Weisz 2007; Muñoz, Giljum and Roca 2009; Schaffartzik et al. 2014a; Schoer et al. 2012
[19] Bruckner et al. 2012; Tukker et al. 2014; Wiebe et al. 2012; Wiedmann et al. 2015
[20] Schaffartzik et al. 2014a; Schoer et al. 2012; Weinzettel and Kovanda 2009

Systematic Calculation of Material Footprint through Material Flow Accounts is important

MFA, as an accounting framework, relies on a consistent database, serving multiple policy-oriented analyses of economy-environment interactions. MFA-based indicators provide aggregated insights into the physical structure of socioeconomic systems. By aligning a country's GDP with its material use, nations can track their progress in decoupling resource use from economic growth. Time series data facilitate historical analyses of environmental pressures at both national and global levels. Notably, economic growth correlates with increased use of materials, often shifting from renewable to nonrenewable resources. MFA enables monitoring of metabolic transitions and their links to socioeconomic changes. Moreover, MFA data finds application in economic models, incorporating environmental aspects in trade and employment evaluations. It also allows investigating national material consumption within a global context, revealing world resource supply, demand, and dependencies. Additionally, MFA combines material use data with other natural resource usage, emissions to air, water, and waste, to gauge environmental interlinkages effectively.

4.2 Approach to Measuring Material Footprint for Bangladesh

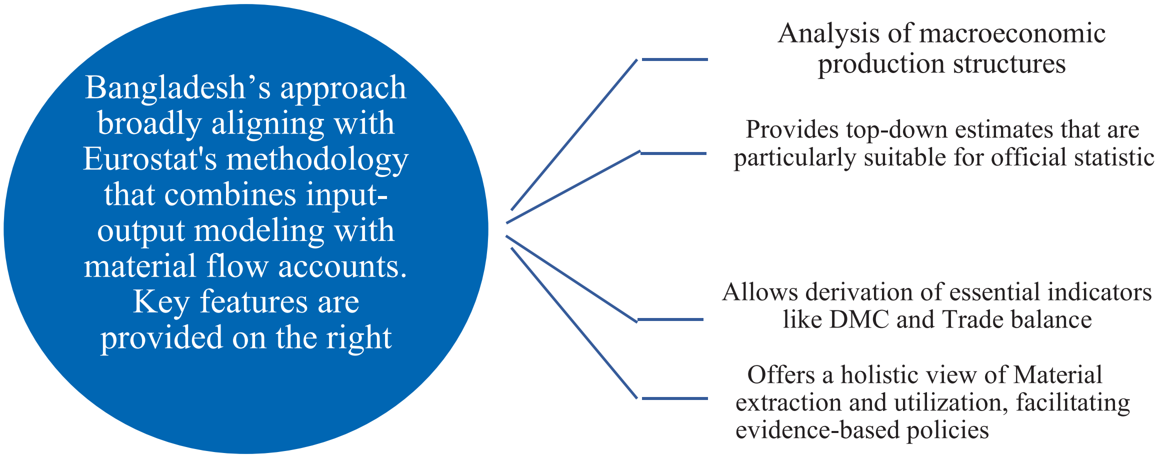
Measuring the domestic material consumption and material footprint is crucial for identifying inefficiencies and the scale of resource use. By doing so, we can set meaningful targets to reduce waste, pollution, and the excessive consumption of natural resources. Moreover, it provides a comprehensive understanding of the environmental impacts of resource use, allowing evidence-based policies to be formulated for a transition towards a more circular and resource-efficient economy.

With the urgency of climate action and the necessity of resource efficiency, Bangladesh's commitment to addressing these challenges is evident through national plans and strategies. The Bangladesh Delta Plan 2100 (BDP 2100), and the Nationally Determined Contribution (NDC) outline priority areas for adaptation and mitigation. These plans present a comprehensive set of potential climate investments, requiring significant financial resources. Tracking the material footprint will be vital to assess progress, identify areas for improvement, and mobilize resources effectively. By tracking domestic material consumption and material footprint, Bangladesh can improve resource efficiency and contribute to mitigating climate change while ensuring continued economic progress.

Given Bangladesh's aspirations for sustainable growth and resource management, the adoption of such an approach could offer valuable insights and guidance for its policy framework and resource-efficient practices. Economy-Wide Material Flow Analysis (EW-MFA) serves as a powerful tool with multifaceted applications, providing substantial support for government policies related to resources, their use, and resource efficiency. This approach encompasses a broad scope, offering a comprehensive database that captures data on material input, output, and net utilization within national economies. Domestic extraction data, for instance, plays a crucial role in shaping national resource conservation policies. Simultaneously, insights into imports and exports help evaluate a nation's physical trade balance and its degree of self-sufficiency in resource management. Additionally, EW-MFA enables the characterization of countries based on their economic orientation, distinguishing between those primarily involved in resource production and consumption. It also assesses their state of development, often referred to as their metabolic profile. Aggregated mass indicators derived from this analysis, such as resource productivity (€/kg) and resource intensity (kg/€), hold significance for organizations like the European Environment Agency (EEA) and Eurostat. Furthermore, MFA methodology plays a vital role in monitoring decoupling, signifying the separation of the physical system from the monetary system, a critical aspect of sustainable development. While the use of MFA indicators as proxy for environmental pressure is debated, they nevertheless shed light on the intricate relationship between economic development and its environmental consequences.

To estimate the material flow accounts and Material Footprint in Bangladesh, Euro Stat's approach has been adopted. In Bangladesh, the calculation of the country's material footprint relies on a comprehensive approach, broadly aligning with Eurostat's methodology that combines input-output modeling with material flow accounts. This systematic process involves the meticulous analysis of macroeconomic production structures, integrating these data with environmental accounts. It results in top-down estimates that are particularly suitable for official statistics and national reporting. The calculation encompasses various facets, including domestic extraction of materials, imports, and exports, allowing for the derivation of essential indicators like Physical Trade Balance (PTB) and Domestic Material Consumption (DMC). Material Footprint is a critical metric, representing the total materials directly used by the economy, covering both domestic extraction and the net effect of imports and exports. Bangladesh's approach is designed to offer a holistic view of its material utilization, thereby facilitating evidence-based policies and strategies for sustainable growth and resource management in line with global sustainability goals.

Figure 14: Bangladesh's approach broadly aligning with Eurostat's methodology



A. Data Collection:

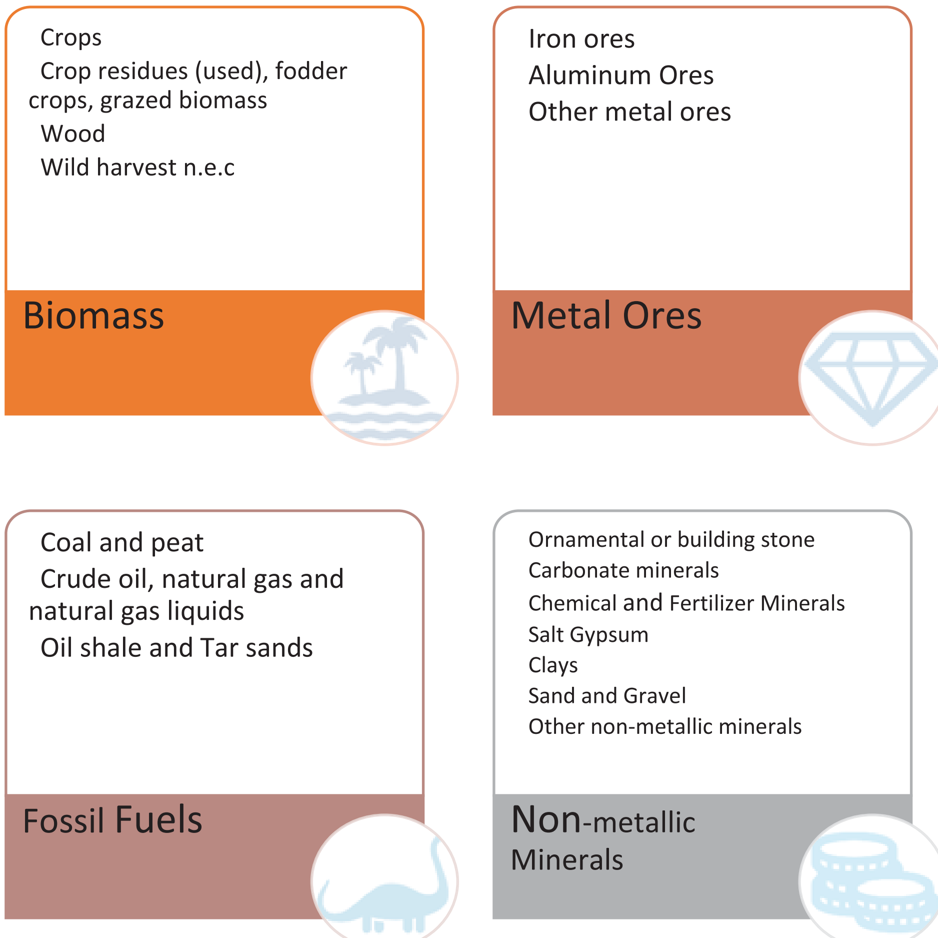
To establish a comprehensive Material Flow Analysis (MFA) approach tailored to Bangladesh's context, a structured process was employed. It began with Data Collection and Compilation, where data on domestic resource extraction, imports, and exports are meticulously gathered. This process extends to collecting data on resource consumption by distinct economic sectors, such as agriculture, industry, and services, providing a holistic understanding of resource utilization.

Categories of Materials considered

MFA encompasses a meticulous examination of various material categories, each playing a distinct role in our resource consumption. Within the realm of Biomass, this includes a diverse array of materials, ranging from crops and crop residues to vital fodder crops and grazed biomass. It also extends to wood, a fundamental resource, as well as the often-overlooked wild harvest. Fossil fuels, an integral part of our energy landscape, comprises Coal and peat, which have fueled industrial revolutions, Crude oil, natural gas, and natural gas liquids that power our transportation and homes, and unconventional sources like Oil shale and Tar sands, playing an increasingly vital role in energy production.

Moving to Metal Ores, the focus narrows down to the earth's riches, including Iron ores, crucial for industrial processes, Aluminum ores, powering the aerospace and construction industries, and a category encompassing various other metal ores, each contributing to the production of numerous products. Finally, under Non-metallic Minerals, a wide spectrum of materials finds its place. This includes ornamental or building stone, adorning our architecture, Carbonate minerals, integral in industrial processes, Chemical and Fertilizer Minerals, essential for agriculture, and common substances like Salt, Gypsum, Clays, Sand, and Gravel, which serve myriad purposes in construction, agriculture, and manufacturing. All these material categories are meticulously examined in Material Flow Analysis to understand their production, consumption, and impact on our economies and environments.

Figure 15: Different Material Categories considered



Data Collection Mechanism

Data of material extraction and use was gathered using a mix of desk research and consultation with relevant agencies, with BBS playing a central role in coordination. First, available secondary sources, including BBS Publications (Statistical Yearbook, Yearbook of Agricultural Statistics, Municipal Waste Management Report) and publications of relevant ministries (Ministry of Agriculture, Ministry of Environment, Forest & Climate Change, Ministry of Industries etc.) were thoroughly reviewed to collect relevant inputs. While some of the data was regularly collected and published by the relevant agencies, there remained gaps in data for other critical elements such as mineral extraction and aquatic fish capture. A two-part consultation event was thus organized by BBS with the related agencies and departments to first discuss the progress, challenges and the gaps in data, and secondly, map the responsible agencies and receive their inputs to some of the existing gaps in data and guidance on how the other missing elements can be found/ estimated. Few selected agencies responsible for associated data were then tasked to provide specific inputs to the data template that was sent to them by BBS, and the responses were later incorporated into our analysis.

The table below shows the responsible agencies for some of the data that were not otherwise available in secondary publications. Table 1b then tries to portray the quality of some of the data that were identified and used in our analysis.

Table 1a: Data inputs from relevant agencies

Sl No.	Data type	Ministry/ Agency/ Department
1	Minerals	Data was not available
2	Natural gas & coal	Petro Bangla
3	River water	Data was not available
4	Air Quality & Emissions Data	Department of Environment
5	Material Import	Bangladesh Bank
6	Biomass	Bangladesh Agricultural Development Corporation
7	Other relevant Data	BBS

Table 1b: Quality of Data Collected and Used

Category	Product Class	Quality (Green= solid; Grey= issues; Red= no data)
Biomass	Crop	
	Wood	
	Wild Harvest	
Metal	Iron Ore	Not Applicable for Bangladesh
	Aluminum Ore	Not Applicable for Bangladesh
Fossil Fuels	Coal & Peat	
	Crude Oil & Natural Gas	
	Oil shale & Tar Sands	
Non-Metallic Minerals	Ornamental or building stone	
	Carbonate minerals	
	Chemical and Fertilizer Minerals	
	Salt	
	Gypsum	
	Clays	
	Sand and Gravel	

B. Resource Flow Analysis

The next step is Resource Flow Analysis, where the intricate journey of resources, from extraction to final consumption and waste generation, is scrutinized. This analysis unveils critical hotspots of resource use and waste generation across sectors, shedding light on areas that require immediate attention.

Inputs: Materials from the natural environment and material imports from other national economies (ROW).

Used domestic extraction: Raw material extractions from the domestic environment which are directly used in subsequent economic processing.

Unused domestic extraction (domestic hidden flows): Those primary material inputs associated with the above-mentioned used domestic extraction which are not directly used in economic processing and hence are not valued economically. Examples are mining overburden, harvest losses and soil erosion.

Imports: The materials in goods imported to the national economy.

Indirect flows associated with imports (foreign hidden flows): i.e. the 'hidden' cradle−to−border primary resource extractions (used and unused) that have been required to produce the imported good (often referred to as 'ecological rucksacks').

Outputs: Materials to the environment and material exports to other economies.

Processed outputs to nature: i.e. the emissions and waste flows of production or consumption processes.

Exports: i.e. the materials of exported goods

Unprocessed outputs: This equals the unused domestic extraction (domestic hidden flows)

Indirect flows associated with exports i.e. the 'hidden' lifecycle−wide primary resource extraction that had been required to produce the exported good (often referred to as 'ecological rucksacks').

The difference between inputs and outputs is labelled "Net Addition to Stock" (NAS).

However, it should be noted that there were severe data limitations for outputs at this stage, as the standard requirements for processed and unprocessed outputs to nature, and indirect flows associated with exports could not be met by the available data. We were thus unable to calculate Net Addition to Stock and reach a balance between output & input due to such restrictions. Export data is, however, widely available, and routinely updated by the Export Promotion Bureau (EPB). It was collected and used in our analysis to calculate material footprint.

C. Systematic Calculation of Material Footprint

Moving forward, the Material Footprint Calculation takes center stage. Utilizing indicators like Raw Material Consumption (RMC) or Raw Material Equivalents (RME), this step quantifies the Material Footprint. The results are expressed in physical terms, such as tons or kilograms, and in some case monetary terms (GDP contribution of material use), reflecting the economic value associated with these resources. Other indicators to be considered include:

Domestic Extraction (DE): Annual raw materials extracted from the natural environment for economic processing.

Direct Physical Imports and Exports: Traded commodities imported or exported in tons.

Net Additions to Stock (NAS): Measures physical growth of the economy with new construction materials and stock accumulation.

Domestic Processed Output (DPO): Total weight of materials used in the national economy before flowing to the environment.

Input and Output Balancing Items: Estimations of flows involved in processing, affecting mass balance.

National Material Balance Equation: DE + Imports + Input

Balancing Items = Exports + DPO + Output Balancing Items + NAS.

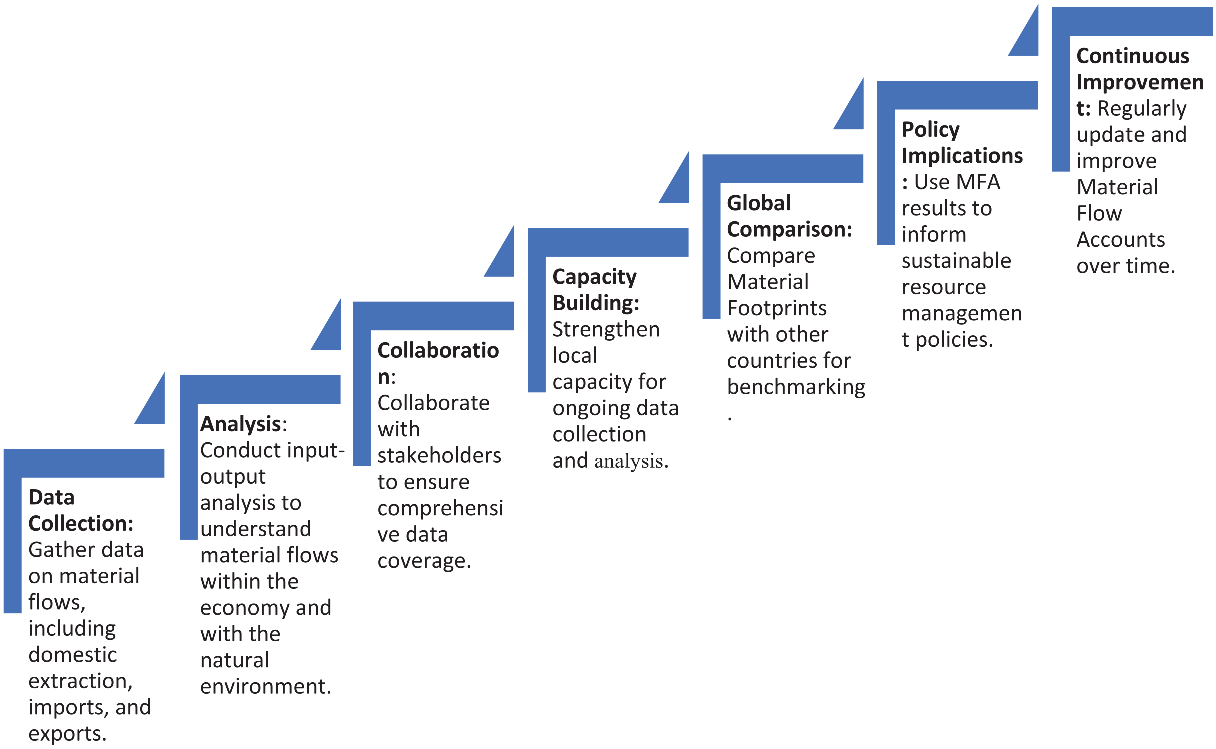
Unused Extraction: Materials associated with direct extraction activities.

Upstream Material Use: Associated with imports and exports, calculated to estimate Material Footprint (MF) or Raw Material Consumption (RMC).

D. Sectoral Analysis and Global Comparisons

Finally, Sectoral Analysis comes into play. Different sectors' contributions to the Material Footprint were meticulously examined. This granular analysis will not only identify sectors with high resource consumption but also highlights their potential for improvement. By following this systematic approach, Bangladesh can gain invaluable insights into its resource management, paving the way for informed policy decisions and sustainable resource use.

Figure 16: Approach for Bangladesh in the medium-long term



Chapter V
Estimating Material Footprint for Bangladesh

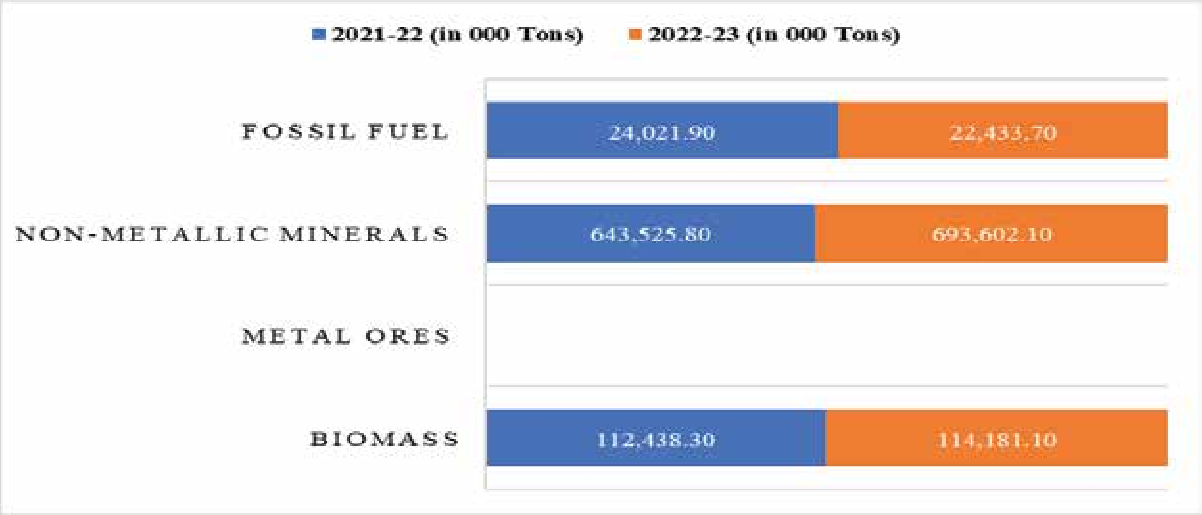
5.1 Measuring Domestic Extraction

Domestic Extraction, which refers to the total amount of resources extracted from the nature within national boundary, was found to be around 830 million tons in FY 2022-23. It went up from around 780 million tons in FY 2021-22, showing a notable increase of approximately 6.44%. This growth can be attributed to variations in the extraction of different categories of resources, each contributing uniquely to the overall change as highlighted in the table below.

Table 2: Domestic Extraction Scenario in Bangladesh

Category/ Production	2021-22 (in 000 Tons)	2022-23 (in 000 Tons)	Growth (%)
Biomass	112,438.3	114,181.1	1.55
Metal Ores	-	-	-
Non-Metallic Minerals	643,525.8	693,602.1	7.78
Fossil Fuel	24,021.9	22,433.7	-6.61
Total	**779,986.0**	**830,216.9**	**6.44**

Figure17: The graphical representation of Domestic Extraction Scenario in Bangladesh



The overall increase in domestic extraction is primarily driven by the significant rise in non-metallic mineral extraction and to a lesser extent, the growth in biomass. The increase in biomass extraction suggests a rise in activities such as agriculture, forestry, and possibly bioenergy production. This growth might be driven by higher demand for food, timber, and biofuels, reflecting economic and population growth. The extraction of non-metallic minerals increased by 50,076 thousand tons (approximately 7.78%). Non-metallic minerals, including sand, gravel, and limestone, are primarily used in construction. The significant increase in this category indicates a robust growth in construction and infrastructure development activities. This trend is often associated with urbanization, economic expansion, and large-scale public and private projects. Despite the reduction in fossil fuel extraction, the net effect observed is an upward trend in total extraction, reflecting broader economic and developmental activities.

Figure 18: Domestic Extraction of Bangladesh (830 million tons) and other countries

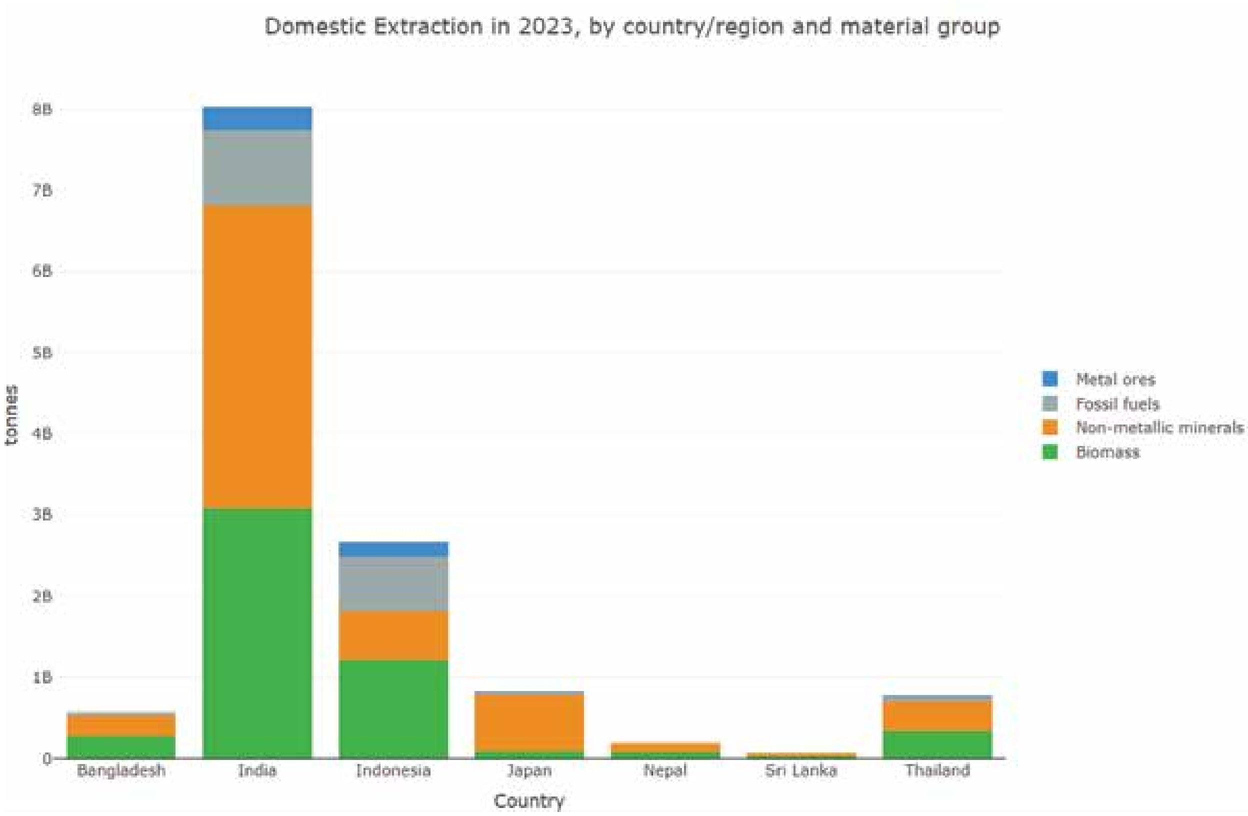
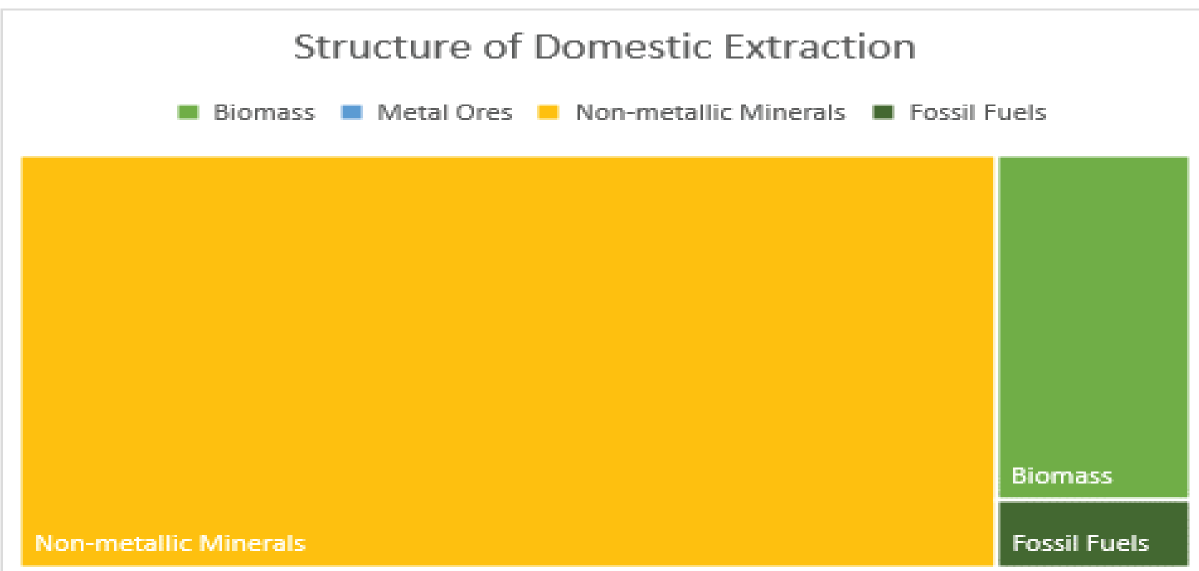


Figure 19: Structure of Domestic Extraction for Bangladesh



5.1.1 Biomass

The total biomass extraction data highlights the substantial contribution of crops, which constitute approximately 75% of the total biomass extraction. Wood follows with 21%, while animal harvest and catch n.e.c. make up 3%. Crop residues (used), fodder crops, and grazed biomass represent around 1%. This detailed analysis reveals the dominance of cereals within crops, the significant role of timber in the wood category, and the growing importance of aquaculture within animal harvest and catch. Annex A details the extraction data for the biomass sector, categorized into four main groups: Crops, Crop Residues, Wood, and Animal Harvest/Catch.

5.1.2 Metal Ores

No metal ore extraction data was found for Bangladesh, largely because the country depends on imports due to the limited availability of such resources for mining. Bangladesh's geological landscape is primarily composed of sedimentary formations, which are not conducive to the formation of substantial metal ore deposits. Unlike countries with rich mineral resources, Bangladesh does not have significant reserves of metals such as iron, copper, or bauxite that can be economically extracted. Consequently, the nation relies heavily on imported metal ores to meet its industrial and manufacturing needs. This dependency on imports is reflected in the absence of domestic extraction data for metal ores in material footprint analyses

The reliance on imports can be attributed to the geological and environmental characteristics of Bangladesh. The country's terrain is predominantly deltaic, formed by the confluence of major rivers such as the Ganges, Brahmaputra, and Meghna. This landscape is more suited to agricultural activities and alluvial mineral deposits rather than the hard rock mining required for metal ores. Additionally, the potential for metal ore mining is further limited by environmental and land-use considerations, given the high population density and the extensive use of land for agriculture and habitation.

5.1.3 Non-Metallic Minerals

The total extraction volume for non-metallic minerals is 693.6 million metric tons (mT). According to data received from various line ministries, departments and agencies, the non-metallic minerals sector is predominantly driven by the extraction of industrial sand and gravel, which accounts for the vast majority (99.26%) of the total extraction volume. Other categories, such as ornamental or building stone, chemical fertilizer minerals, salt, and various other non-metallic minerals, contribute smaller proportions, each below 0.25% of the total. This distribution highlights the essential role of sand and gravel in industrial and construction activities, but also somewhat undermines the specialized and diverse applications of other non-metallic minerals such as stones and various salts. More information on extraction of minerals of various categories is provided in Annex B.

5.1.4 Fossil Fuels

The total domestic extraction volume identified for fossil fuels is 22.4 million metric tons (mT). It was observed that the fossil fuel extraction sector is overwhelmingly dominated by natural gas and gaseous petroleum products, which account for 94.02% of the total extraction volume. This high percentage underscores the importance of natural gas as a major energy source. Crude oil and liquid petroleum products, along with brown coal, contribute smaller proportions of 2.01% and 3.97%, respectively. Further information on domestic extraction of fossil fuel can be found in Annex C. Overall, the findings are in line with Bangladesh’s energy mix (52.27 MTons of Oil Equivalent), which heavily relies on natural gas (44%) and imports for primary energy[21]. The absence of data for hard coal, peat, coal-derived products, natural gas liquids, oil shale, tar sands, and mixed fossil fuel products highlights potential areas for further data collection and reporting. This distribution emphasizes the critical role of natural gas in the energy mix, driven by its efficiency and relatively

[21] Energy & Mineral Resource Division & Petro Bangla

lower environmental impact compared to other fossil fuels.

5.2 Trade of Materials

An essential part of identifying Domestic Material Consumption and calculating Material Footprint is to understand the cross-border trade of materials, as it has direct implications on the number of materials attributable to a country. Material Imports, although extracted elsewhere, needs to be factored in as it caters to domestic demand. Similarly, exports would be applicable for the exporting nation and thus needs to be disregarded from the extracting nation.

Whie Export Promotion Bureau (EPB) and Bangladesh Customs regularly publishes data for exports and imports respectively monthly, the data is usually in monetary value, rather than quantity. The official data in dollar and BDT terms, are further segregated in terms of HS Codes, which do not readily align with Material footprint categories. Thus, for the sake of establishing a baseline, trade quantity data from International Resource Panel (IRP) was used. The IRP of United Nations Environmental Programmer (UNEP) regularly estimates trade quantity data, in Metric Tons, to track Material flow. The data obtained was then calibrated to estimate the total import & export for fiscal year. The total import of materials in FY 2022-23 was about 78.0 million tons, which is 2.36% higher compared to FY 2021-22. Biomass and biomass products recorded the largest proportion of imports, with around 28.5 million tons, closely followed by non-metallic minerals and related products at 25.6 million tons. Then we have fossil fuel and products from fossil at around 13.8 million tons. Around 9.8 million tons of metal ores and products from metal were imported in FY 2022-23. Around 0.22 million of waste and mixed/ complex products were also imported, that while not significant, needs to be considered in calculations for Domestic Material Input (DMI) and Domestic Material Consumption (DMC).

Table 3: Imports of materials by category [22]

Category /Production	2021-22 (in ’000 Ton)	2022-23 (in ’000 Ton)	Growth (in %)
Biomass & Biomass Products	27,744.3	28,547.8	2.90
Metal Ores & Products from Metal	9,296.5	9,801.4	5.43
Non-Metallic Minerals & products	25,439.8	25,649.3	0.82
Fossil Fuel & products	13,533.1	13,806.0	2.02
Waste for treatment	213.8	219.1	2.46
Mixed & complex products	1.1	1.2	3.60
Total Imports	**76,228.6**	**78,024.8**	**2.36**

Exports of materials in FY 2023 was estimated to be around 2.25 million tons, which is 1.68% higher compared to FY 2022, mainly due to rise in biomass and non-metallic minerals. Export of non-metallic minerals and products from such minerals increased by around 3.06% in FY 2023, while

[22] Except for the physical import and export data, all data refer to fiscal years (i.e. July to June). Since there were no physical import and export data from domestic sources, data from international sources have been used. International sources use calendar year.

biomass and biomass products exports increased by around 2.29% in FY 2022-23.

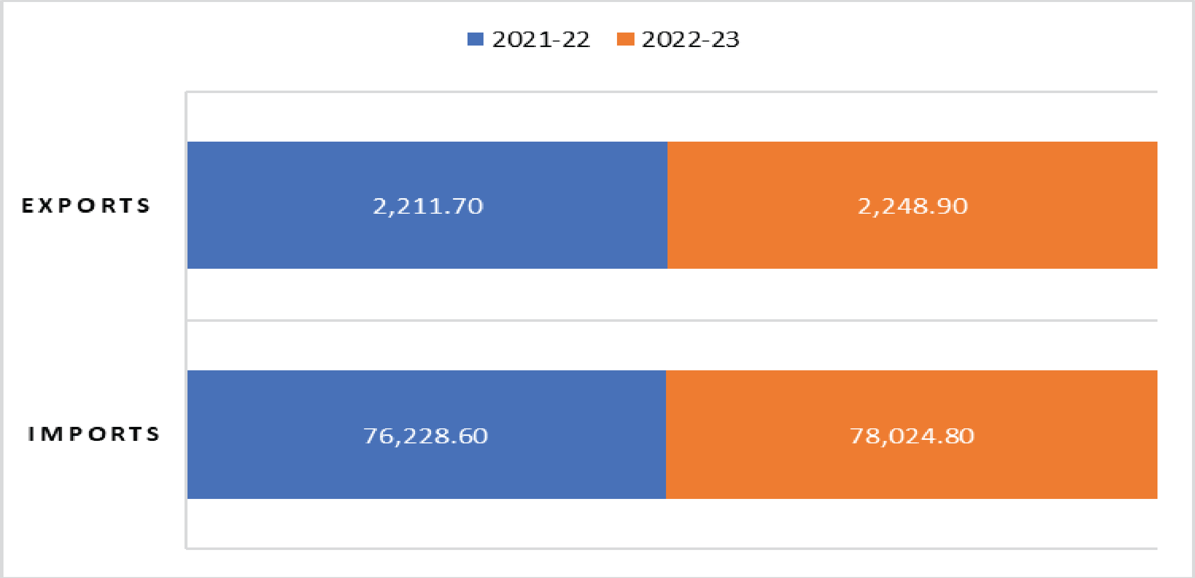
Table 4: Exports of materials by category

Category / Production	2021-22 (in 000 Tons)	2022-23 (in 000 Tons)	Growth (%)
Biomass & Biomass Products	1,054.8	1,079.0	2.29
Metal Ores & Products from Metal	87.5	87.5	-0.02
Non-Metallic Minerals and Products	355.7	366.6	3.06
Fossil Fuel & Products	508.2	508.2	0.00
Waste for final treatment	127.9	129.3	1.06
Mixed & Complex Products	77.6	78.4	1.02
Total Exports	**2,211.7**	**2,248.9**	**1.68**

Table 5: Physical Trade Balance (in 000 tons)

Year	2021-22	2022-23	Growth (%)
Imports	76,228.6	78,024.8	2.36
Exports	2,211.7	2,248.9	1.68
Physical Trade Balance (Import- Export)	**74,016.9**	**75,775.9**	**2.38**

Figure 20: The Graphical Representation Physical Trade Balance (in 000 tons)



5.3. Domestic Material consumption (DMC) and Material Footprint

5.3.1 Domestic Material Input (DMI)

DMI is calculated as the sum of domestic extraction of natural resources and imports of materials. DMI for Bangladesh for FY 2022-23 stands at 908.2 million tons.

Table 6: Domestic Material Input calculations for 2022-23 (in '000 tons)

Category /Production	Domestic Material Input (2021-22)	Domestic Extraction (DE)	Import	Domestic Material Input (DE + Import)
Biomass & Biomass Products	140,182.6	114,181.1	28,547.8	142,728.9
Metal Ores	9,296.5	-	9,801.4	9,801.4
Non-Metallic Minerals	668,965.6	693,602.1	25,649.3	719,251.4
Fossil Fuel	37,555.0	22,433.7	13,806.0	36,239.7
Waste for Treatment	213.8	-	219.1	219.1
Mixed & Complex Products	1.1	-	1.2	1.2
Total	**856,214.6**	**830,216.9**	**78,024.8**	**908,241.7**

5.3.2 Material Import Dependency

The table below shows the material import dependency, which is the ratio of imports over domestic material inputs (DMI) in the Bangladesh economy. In 2022-23, Metal ores and metal concentrate materials had the highest material import dependency, with about 100%, followed by fossil fuel at 38.1%. Biomass and Biomass products had an import dependency of 20.00%. On the other hand, the lowest material import dependency was reached for non-metallic minerals with 3.57%. The overall material import dependency for Bangladesh for 2022-23 was 8.59%.

Table 7: Material import dependency for Bangladesh (in %)

Category /Production	2021-22	2022-23
Biomass & Biomass Products	19.79	20.00
Metal Ores	100.00	100.00
Non-Metallic Minerals	3.80	3.57
Fossil Fuel	36.04	38.10
Overall Import Dependency	**8.90**	**8.59**

5.3.3. Domestic Material Consumption

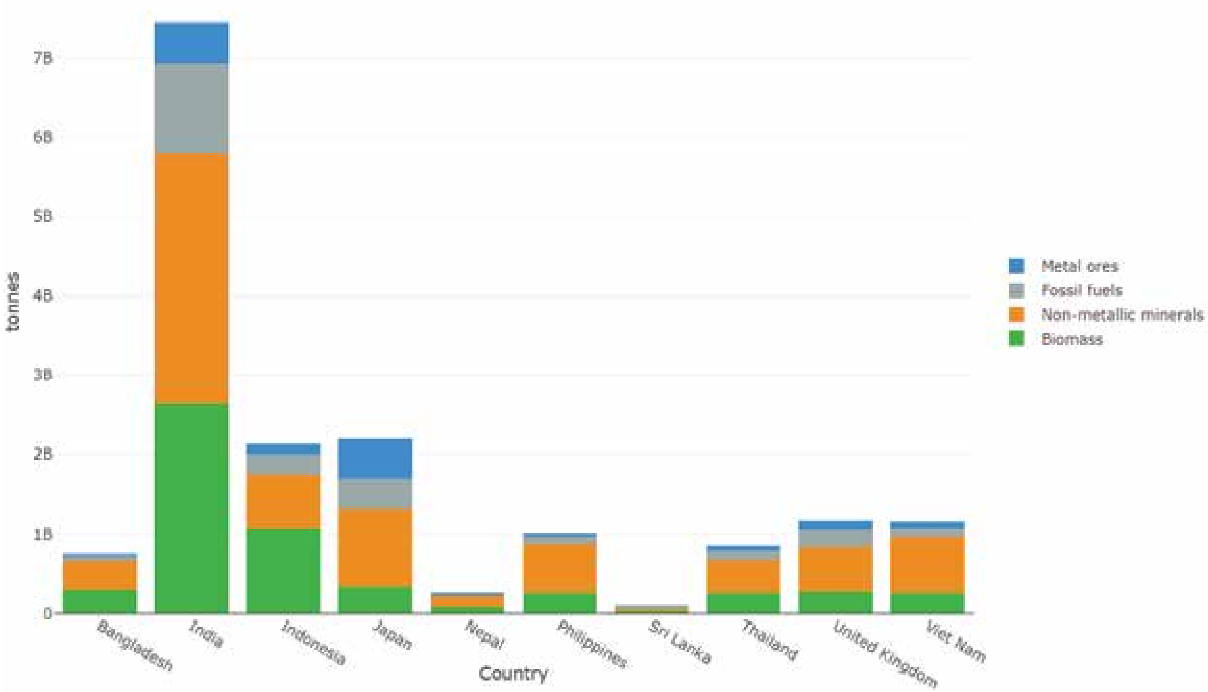
The domestic material consumption (DMC) measures the total amount of materials directly extracted and used from the environment, considering the physical trade balance. In FY 2022-23 the DMC reached about 906 million tons, 6.09% higher compared to FY 2021-22. Domestic material consumption is dominated by non-metallic minerals, followed by biomass & biomass products.

Table 8: Domestic Material Consumption (DMC) in 000 Tons

	2021-22			2022-23		
Category /Production	**DMI**	**Export**	**DMC (DMI-Export)**	**DMI**	**Export**	**DMC (DMI-Export)**
Biomass & Biomass Products	140,182.6	1,054.8	139,127.8	142,728.9	1,079.0	141,649.9
Metal Ores & products	9,296.5	87.5	9,209.0	9,801.4	87.5	9,713.9
Non-Metallic Minerals & products	668,965.6	355.7	668,609.9	719,251.4	366.6	718,884.9
Fossil Fuel & products	37,555.0	508.2	37,046.8	36,239.7	508.2	35,731.5
Waste	213.8	127.9	85.9	219.1	129.3	89.9
Mixed & Complex Products	1.1	77.6	-76.5	1.2	78.4	-77.3
Total	**856,214.6**	**2,211.7**	**854,002.9**	**908,241.7**	**2,248.9**	**905,992.8**

The figure below illustrates the DMC across several countries, segmented into four material categories: biomass, non-metallic minerals, fossil fuels, and metal ores. India stands out with the highest DMC, exceeding 7 billion tons, driven largely by non-metallic minerals and biomass, indicating significant construction activities and agricultural output. Indonesia and Japan follow, each consuming over 2 billion tons, with a balanced mix of materials. Bangladesh, in contrast, shows a relatively lower DMC of approximately 906 million tons, with biomass being the dominant material, reflecting its agrarian economy. Countries like Nepal and Sri Lanka display lower material consumption, while Thailand, Vietnam, and the United Kingdom show moderate levels, with variations in material composition reflecting diverse economic activities.

Figure 21: Domestic Material Consumption of Bangladesh and comparators



Domestic Material Consumption (DMC) per Capita: The domestic material consumption per capita in FY 2022-23 was about 5.3 tons, showing an increase of approximately 0.27 tons per capita compared to FY 2021-22. This indicates a person have roughly used 5,300 kg of materials in FY 2022-23.

Table 9: Domestic Material Consumption (DMC) per Capita

Category /Production	2021-22	2022-23
Biomass & Biomass Products	0.82	0.83
Metal Ores	0.05	0.06
Non-Metallic Minerals	3.94	4.20
Fossil Fuel	0.22	0.21
Total Material Footprint per Capita	**5.03**	**5.30**

5.3.4. Material Footprint

The Material Footprint measures the total amount of raw materials extracted globally to meet a country's consumption demands, including the materials embedded in imported goods. It assesses the global impact of a country's consumption, considering all stages of the production chain, not just within national borders. The Material footprint for Bangladesh for FY2023 was calculated to be 1.01 billion tons.

Table 10: Material Footprint in '000 Tons

	2021-22	2022-23			
Category /Production	**Material Footprint**	**Domestic Extraction**	**Imports (RME)**	**Exports (RME)**	**Material Footprint (DE+Im-Ex)**
Biomass	134,713.52	114,181.1	28,795.20	6,750.20	136,226.10
Metal Ores	31,429.65		31,350.40	0.00	31,350.40
Non-Metallic Minerals	726,655.05	693,602.1	93,178.75	6,679.60	780,101.25
Fossil Fuel	66,634.55	22,433.7	43,677.35	1,409.40	64,701.65
Total	**959,432.77**	**830,216.9**	**197,001.70**	**14,839.20**	**1,012,379.40**

Material Footprint per Capita is an indicator that measures the number of raw materials extracted globally to meet the consumption demands of an individual in a particular country. It provides insight into the resource consumption patterns at an individual level, reflecting the environmental impact of personal consumption. This indicator is crucial for assessing sustainable consumption and resource efficiency in relation to population size. By examining material footprint per capita, policymakers can identify the resource intensity of consumption patterns and target measures to promote more sustainable and efficient resource use at the individual level.

Table 11: Material Footprint per Capita (in metric tons per capita)

Category /Production	2021-22	2022-23
Biomass	0.793	0.797
Metal Ores	0.185	0.183
Non-Metallic Minerals	4.278	4.562
Fossil Fuel	0.392	0.378
Total	**5.649**	**5.920**

The indicator helps assess how individual consumption contributes to global resource depletion and environmental pressures. High values indicate higher resource consumption per person, which may imply unsustainable consumption patterns. Material Footprint per Capita for Bangladesh in FY 2022-23 was measured to be 5.920 metric tons per capita. It increased by around 271 kilograms of materials per person from the previous fiscal year, indicating a surge in resource use.

Global comparison shows that Bangladesh's Material Footprint per capita is lower than most comparator countries including Indonesia, Vietnam, and Thailand. However, it recorded higher values when compared to India and Sri Lanka, indicating opportunities for striving for greater resource efficiency and more sustainable consumption patterns.

5.3.5. Resource Productivity & Material Intensity

Resource productivity is calculated as the ratio between the gross domestic product and domestic material consumption. This represents the amount (in USD) generated by the economy of the country for each unit of material consumed. In FY 2022-23, the resource productivity for Bangladesh economy reached the value $498.37 /ton.

Material intensity describes the national economy's dependency on natural resources[23]. It can be measured as the ratio of domestic material consumption to GDP. Material intensity for FY 2022-23 in Bangladesh was recorded at 0.00201 tons/$. This suggests that around 2.01 kgs of material was consumed to generate 1 USD. As material intensity decreases, the aim is to reach a situation where the state of the environment does not deteriorate as the economy grows. This is also known as decoupling of economic growth and environmental impacts.

Domestic material consumption in relation to GDP (Material Intensity and Resource Productivity) are two of the sustainable development indicators (SDG). They are related to indicator 8.4.2, and measure the total amount of materials directly used by an economy, reflecting the level of material use relative to economic output. The table below highlights the different SDG indicators that were calculated as part of the analysis.

Table 12: SDG indicators

Sl No.	Indicators	SDG Indicator	Value in 2022-23	Value in 2022-23
1	Material Footprint	8.4.1; 12.2.1	959.43 million Tons	1,012.38 million Tons
2	Material Footprint per Capita	8.4.1; 12.2.1	5.649 Tons/person	5.920 Tons/ person
3	Material Footprint per GDP	8.4.1; 12.2.1	2.08 kg/$	2.24 kg/$
4	Domestic Material Consumption	8.4.2; 12.2.2	854.00 million Tons	905.99 million Tons
5	Domestic Material Consumption per Capita	8.4.2; 12.2.2	5.03 Tons/person	5.30 Tons/ person
6	Domestic Material Consumption per GDP (Material Intensity)	8.4.2; 12.2.2	1.86 kg/$	2.01 kg/$

[23] https://stat.fi/meta/kas/materiaali_inte_en.html

Chapter V I
Comparison with International Findings

The table below compares the results of our material footprint analysis with those from the UNEP IRP Global Material Flows Database. A substantial variance is observed across all categories: biomass and biomass products, metal ores, non-metallic minerals, and fossil fuels.

Table 13: Material Footprint of Bangladesh in FY 2022-2023 (in '000 Tons)

Category /Production	Authors calculation	UNEP IRP Global Material Flows Database
Biomass & Biomass Products	136,226.10	302,650.5
Metal Ores	31,350.40	31,208.7
Non-Metallic Minerals	780,101.25	353,767.8
Fossil Fuel	64,701.65	63,279.4
Total Material Footprint	**1,012,379.40**	**750,906.4**

Source: United Nations Environment Program, International Resource Panel, Global Material Flows Database

Biomass and Biomass Products

Our estimates of biomass and biomass products are at 136,226.1 thousand tons, whereas the UNEP IRP database reports a significantly higher figure of 302,650.5 thousand tons. This discrepancy might arise from possible data gaps in the extraction values of straw and other crop residues, including sugar and fodder beet leaves, wild fish catch and aquatic plant harvest which caused the underestimation. Additionally, differences in categorization, data collection methods, or temporal coverage might also have led to the difference. Biomass includes a variety of materials such as crops, wood, and other plant-based resources. Variations in accounting for subcategories or using different conversion factors can lead to such differences.

Metal Ores

For metal ores, the calculation of 31,350.4 thousand tons is like UNEP IRP's figure. Metal ores include valuable materials such as iron, copper, and aluminum, which Bangladesh do not extract from nature or export, and relies solely on imports, which are public data and thus recorded similar values.

Non-Metallic Minerals

The estimate for non-metallic minerals is 780,101.25 thousand tons, significantly higher than UNEP IRP's 353,767.8 thousand tons. Non-metallic minerals include construction materials like sand, gravel, and limestone. The higher estimate in the analysis could be due to differences in scope or accounting for additional materials not considered by UNEP IRP. Another possibility is the inclusion of more extensive or recent construction activity data in our calculations. Besides, there were some cases of missing data, particularly for specialty clays, chalk, dolomite & limestones. The data for industrial sand & gravel, which is unusually high also indicate potential errors in data collection or estimation methodologies.

Fossil Fuels

In fossil fuels, the calculation is 64,701.65 thousand tons compared to UNEP IRP's 63,279.4 thousand tons. Fossil fuels encompass coal, oil, and natural gas. The little variance might result from different reporting standards, extraction methods, or energy content considerations. UNEP IRP likely uses a comprehensive global approach, possibly accounting for indirect consumption and upstream processes.

Total Material Footprint

The total material footprint from our analysis is 1,012,379.4 thousand tons, while the UNEP IRP database reports 750,906.4 thousand tons. This overall difference indicates that the estimates are generally higher, except for metal ores and fossil fuels. The discrepancy underscores the importance of consistent methodologies and comprehensive data collection in environmental accounting.

Methodological Insights

The UNEP IRP Global Material Flows Database employs a comprehensive and standardized methodology to estimate material footprints. This includes:

Data Collection: UNEP IRP gathers data from a variety of national and international sources, ensuring a broad and inclusive dataset.

Standardization: The database uses standardized units and conversion factors to harmonize data from different regions and sectors.

Scope and Coverage: It includes direct material inputs, domestic extraction and processed materials to provide a holistic view of material flows.

Temporal and Spatial Resolution: UNEP IRP often incorporates long-term datasets and spatially disaggregated data to capture regional variations and trends over time.

The analysis reveals notable differences between our material footprint calculations and those from the UNEP IRP Global Material Flows Database**.** The analysis may differ due to variations in data sources, local adjustments and data gaps. Differences in methodologies and how secondary data is treated or how indirect material flows are accounted for can also contribute to the observed discrepancies. Understanding and reconciling these differences is crucial for accurate environmental accounting and informed policy making.

Chapter VII
Limitation and Challenges

In the pursuit of accurately calculating the Material Footprint for Bangladesh, several critical issues and challenges must be addressed to ensure the data's accuracy and comprehensiveness. The primary concerns revolve around data availability and data validity, both of which are fundamental to the robustness of environmental accounting endeavors. Addressing these concerns is essential for developing a reliable material footprint analysis that can guide sustainable resource management and policy making.

7.1 Data Availability

Data availability forms the cornerstone of material footprint analysis. The required datasets encompass a broad spectrum of factors, including data on imports, exports, domestic resource extractions, emissions, and waste. The following outlines the specific challenges encountered in data collection:

7.1.1 Incomplete Biomass Data

Straw and Crop Residues: Significant gaps exist in the extraction values of straw and other crop residues, including sugar and fodder beet leaves. This incomplete data leads to an underestimation of domestic extraction and consequently, a lower material footprint value compared to international sources such as the UNEP IRP Global Material Flows Database. Accurate data on these residues is crucial as they play a significant role in agricultural ecosystems and resource recovery processes.

Wild Fish and Aquatic Plant Harvest: The absence of comprehensive data on wild fish catch and wild aquatic plant harvest further contributes to the underrepresentation of biomass extraction figures. These components are vital for assessing the sustainability of fisheries and aquatic ecosystems.

7.1.2 Non-Metallic Minerals Data Gaps

Specialty Clays: No data was found for specialty clays, which are crucial in various industrial applications, including ceramics and refractory materials. The lack of data on these clays hampers the ability to fully account for their contribution to the material footprint.

Construction Materials: Data on sand and gravel for construction is lacking[24], which is essential given the booming construction industry in Bangladesh. Accurate data on these materials is necessary to understand the environmental impact of construction activities.

Carbonate Minerals: The absence of data on carbonate minerals such as chalk, dolomite, and limestone present a significant gap. These minerals are vital for cement production and other industrial processes, and their omission can lead to an underestimation of the material footprint.

7.1.3 Waste Generation and Emissions

Complex Data Collection: Acquiring accurate data on waste generation and emissions is challenging due to the complex nature of these parameters. Rigorous collection and assessment processes are required, which are often not fully implemented or standardized.

Gaps in Emissions Data: There are significant gaps in most required categories of waste generation and emissions, such as emissions to air, emissions to water, and dissipative use of products. Apart from carbon monoxide, sulfur dioxide, and dust particles, measurements of most gaseous and liquid emissions to air and water are missing. In the case of emissions to air, the standard methodology

[24] It appears that data on sand and gravel has been an imputed one using old coefficient. As mentioned above the large value of sand and gravel is a major reason for Bangladesh's high share on non-metallic component.

considers far more compounds, such as methane, ammonia, persistent organic pollutants, HFCs, PFCs, and SF6. No data was found for emissions to water and dissipative use of products, which are essential for understanding the full environmental impact of industrial sectors and waste management practices.

Hidden Flows: Data related to hidden flows, which are integral to our analysis, are not routinely or uniformly collected. These hidden flows include secondary and tertiary material flows that are often overlooked in primary data collection processes. Ensuring comprehensive data on hidden flows is crucial for capturing the full extent of material usage and environmental impact.

7.2 Data Validity

Ensuring the validity of data is equally important. Some data estimates are questionable, leading to inconsistencies and potentially misleading conclusions.

7.2.1. Industrial Sand and Gravel Extraction

Exaggerated Estimates: The extraction of industrial sand and gravel was estimated at 688.5 million tons, which is alarmingly high and constitutes 99% of all minerals extracted. This figure is inconsistent with global cases and other minerals extracted in Bangladesh. Such discrepancies indicate potential errors in data collection or estimation methodologies. It is essential to verify and cross-check these estimates with industry reports and international benchmarks to ensure their accuracy.

The challenges of data availability and validity significantly impact the accuracy of material footprint analysis for Bangladesh. Addressing these issues requires a concerted effort to improve data collection methodologies, ensure comprehensive coverage of all relevant material flows, and adopt standardized practices as exemplified by international benchmarks. By doing so, we can enhance the reliability of our environmental accounting and support informed policymaking for sustainable development. Ensuring accurate and comprehensive data will enable better tracking of resource use, improve environmental impact assessments, and aid in the development of sustainable resource management strategies. Addressing these data challenges is imperative for fostering a sustainable future and achieving national and global environmental goals.

Chapter VIII
Conclusion

In the pursuit of accurately calculating the Material Footprint for Bangladesh, several critical issues and challenges must be addressed to ensure the data's accuracy and comprehensiveness. The primary concerns revolve around data availability and data validity, both of which are fundamental to the robustness of environmental accounting endeavors.

Data availability forms the foundation of material footprint analysis. The required datasets encompass a broad spectrum of factors, including data on import and export quantity, domestic resource extractions, emissions, and waste. There are specific challenges encountered in data collection. For instance, significant gaps exist in the extraction values of straw and other crop residues, including sugar and fodder beet leaves. This incomplete data leads to an underestimation of domestic extraction and consequently, a lower material footprint value compared to international sources such as the UNEP IRP Global Material Flows Database. Additionally, the absence of comprehensive data on wild fish-catch and wild aquatic plant harvest further contributes to the underrepresentation of biomass extraction figures.

In the domain of non-metallic minerals, data gaps are prevalent. No data was found for specialty clays, which are crucial in various industrial applications. Similarly, the lack of data on sand and gravel for construction, essential given the booming construction industry in Bangladesh, presents a significant shortfall. The absence of data on carbonate minerals such as chalk, dolomite, and limestone, which are vital for cement production and other industrial processes, further exacerbates the challenge.

Acquiring accurate data on waste generation and emissions is another critical challenge due to the complex nature of these parameters**.** Rigorous collection and assessment processes are required, which are often not fully implemented or standardized. There are significant gaps in most required categories of waste generation and emissions, such as emissions to air, emissions to water, and dissipative use of products. Apart from carbon monoxide, sulfur dioxide, and dust particles, measurements of most gaseous and liquid emissions to air and water are missing. In the case of emissions to air, the standard methodology considers far more compounds, such as methane, ammonia, persistent organic pollutants, HFCs, PFCs, and SF6. No data was found for emissions to water and dissipative use of products. Furthermore, data related to hidden flows, which are integral to our analysis, are not routinely or uniformly collected. These hidden flows include secondary and tertiary material flows that are often overlooked in primary data collection processes.

Ensuring the validity of data is equally important. Some data estimates are questionable, leading to inconsistencies and potentially misleading conclusions. For instance, the extraction of industrial sand and gravel was estimated at 688.5 million tons, which is alarmingly high and constitutes 99% of all minerals extracted. This figure is inconsistent with global cases and other minerals extracted in Bangladesh. Such discrepancies indicate potential errors in data collection or estimation methodologies.

Addressing these issues requires a concerted effort to improve data collection methodologies, ensure comprehensive coverage of all relevant material flows, and adopt standardized practices as exemplified by international benchmarks. Developing a comprehensive data collection system is crucial, integrating data from various sectors such as agriculture, fisheries, mining, construction, and waste management.

Targeted surveys, field studies, and collaborations with academic and research institutions: Filling specific data gaps, such as those related to biomass extraction, non-metallic minerals, and waste generation and emissions, will require targeted surveys, field studies, and collaborations with academic and research institutions. Adopting international standards for data collection and reporting is essential.

Fostering institutional collaboration is vital. Promoting multi-stakeholder engagement, involving government agencies, private sector entities, academic institutions, and international organizations, will facilitate data sharing and joint initiatives. Forming a national task force/committee on material footprint analysis with representatives from all relevant sectors will support this collaborative effort.

Applying advanced technologies: A comprehensive system should be capable of capturing data on domestic resource extractions, emissions, and waste generation in real-time, utilizing advanced technology like satellite imagery, remote sensing, and IoT devices.

Applying advanced analytical tools for analyzing the real-time data: Utilizing advanced analytical tools such as big data analytics, machine learning, and lifecycle assessment methodologies will enhance the analysis and interpretation of material footprint data.

Investing in training and capacity-building programs to equip analysts with the necessary skills will be instrumental. Training data collectors and analysts in standards and best practices will ensure consistency and comparability of data.

Improving data validity involves regularly cross-checking data estimates with industry reports, academic studies, and international benchmarks. Establishing a data validation task force to oversee the accuracy and reliability of collected data will help address anomalies and ensure the robustness of the analysis.

Finally, ensuring transparency and accessibility of data through open data platforms and public reporting will promote accountability and support informed policymaking. Developing user-friendly online portals for data access and visualization will enable stakeholders to explore and utilize the data effectively.

By implementing these recommendations, Bangladesh can significantly improve the accuracy and comprehensiveness of its material footprint calculations. Enhanced data collection infrastructure, standardized methods, targeted efforts to fill data gaps, improved data validity, institutional collaboration, advanced analytical tools, and increased transparency will collectively contribute to a more robust and reliable material footprint analysis. This, in turn, will support informed policymaking, sustainable resource management, and the achievement of national and global environmental goals.

Annex

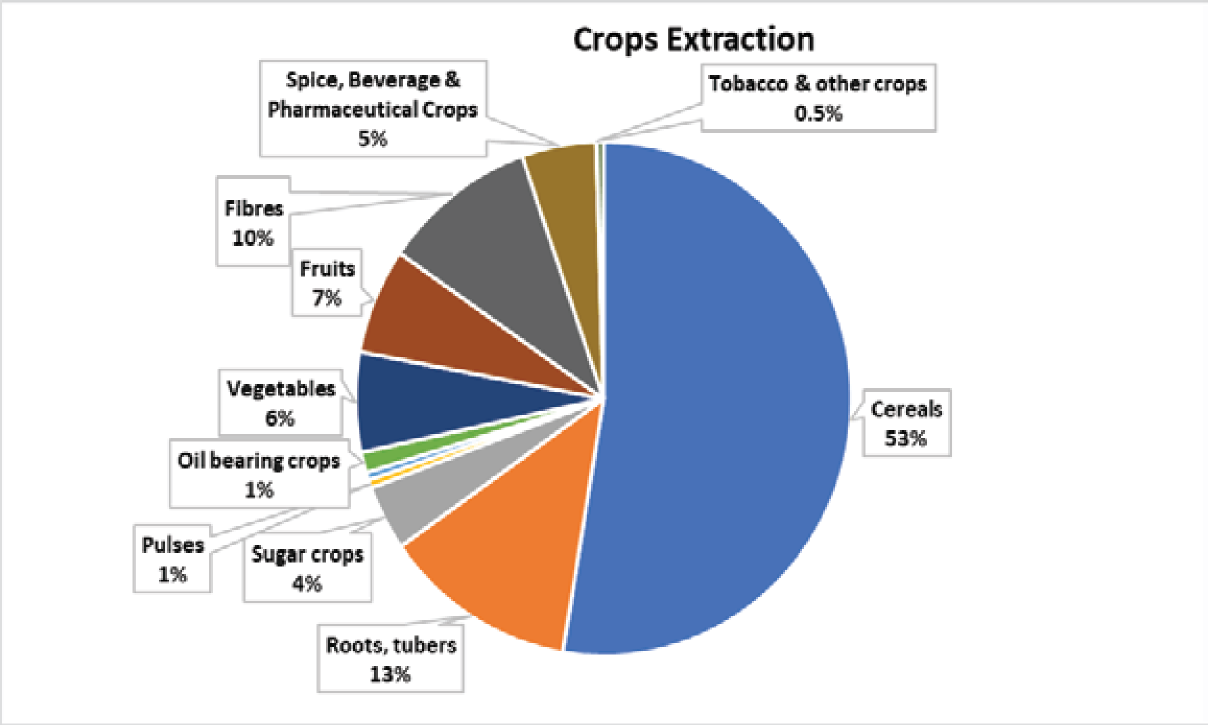
Annex-01: Detailed Tables

Annex A: Domestic Extraction: Biomass

2 DIGITS	3 DIGITS	Value in '000 Tons
Crops	Cereals	44828.7
	Roots, tubers	10729.3
	Sugar crops	3504.1
	Pulses	439.2
	Nuts	416.6
	Oil bearing crops	1096.3
	Vegetables	5364.0
	Fruits	5694.0
	Fibers	8554.6
	Spice, Beverage & Pharmaceutical Crops	4116.7
	Tobacco	86.6
	Other crops n.e.c.	335.8
Crop residues (used), fodder crops, grazed biomass	Straw	
	Other crop residues (sugar and fodder beet leaves, other	
	Fodder crops (incl. biomass harvest from grassland)	424.2
	Grazed biomass	713.6
Wood	Timber (Industrial roundwood)	22226.8
	Wood fuel and other extraction	2062.7
Animal harvest and catch n.e.c.	Wild fish catch	
	All other wild aquatic animals catch	
	Wild aquatic plant harvest	
	Wild terrestrial plant harvest n.e.c. (incl. gathering)	
	Wild terrestrial animal catch (incl. hunting)	735.9
	Aquaculture	2852.0

Crops

The crops category is the largest, with a total extraction volume of 85,166 thousand tonnes. Cereals dominate this category, making up 52.6% of the total crop extraction and accounting for 44,828.68 thousand tonnes. Roots and tubers follow, contributing 12.6 % with 10,729.32 thousand tonnes. Sugar crops represent 4.1%, with an extraction of 3,504.09 thousand tonnes. Pulses and nuts are smaller segments, contributing 0.54% (439.22 thousand tonnes) and 0.51% (416.62 thousand tonnes), respectively. Oil bearing crops make up 1.28%, totaling 1,096.31 thousand tonnes. Vegetables and fruits are significant as well, with vegetables at 6.3% (5,364.03 thousand tonnes) and fruits at 6.7% (5,693.98 thousand tonnes). Fibers constitute around 10% with 8,554.60 thousand tonnes. Spice, beverage, and pharmaceutical crops account for 4.8% of 4,116.69 thousand tonnes. Tobacco and other crops N.E.C. are minor contributors, with 0.1% (86.58 thousand tonnes) and 0.4% (335.82 thousand tonnes), respectively. Overall, crops constitute a substantial portion of the total biomass extraction.

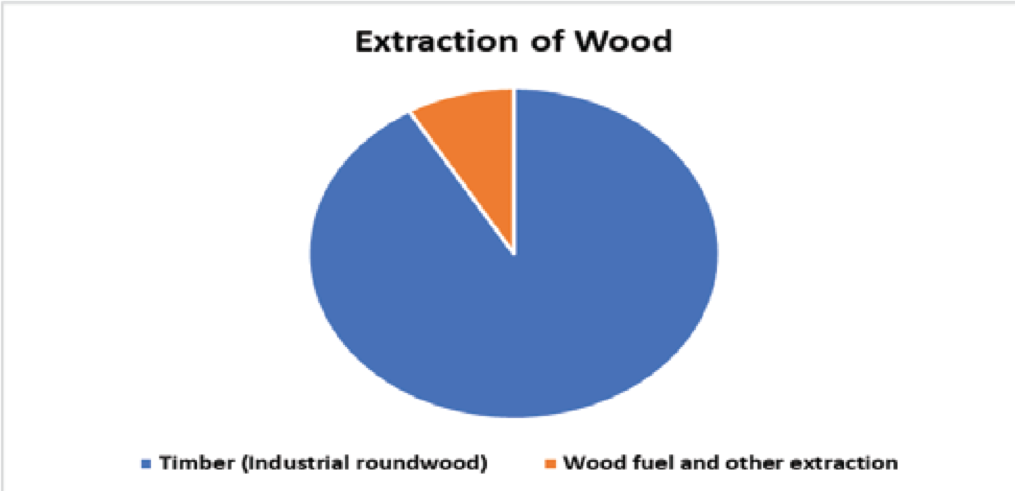


Crop Residues (Used), Fodder Crops, and Grazed Biomass

This category includes important by-products and secondary uses of crops, totaling 1,137.74 thousand tonnes. Fodder crops, including biomass harvested from grassland, account for 37.28% of this category with 424.17 thousand tonnes. Grazed biomass represents 62.72%, with 713.57 thousand tonnes. These residues are crucial for livestock feed and soil health, emphasizing their role in agricultural sustainability.

Wood

The wood category is divided into timber and wood fuel, with a total extraction volume of 24,289.47 thousand tonnes. Timber (industrial roundwood) is the dominant subcategory, making up 91.51% with 22,226.80 thousand tonnes. Wood fuel and other extractions account for 8.49%, totaling 2,062.67 thousand tonnes. This data underscores the significant role of wood in both industrial and energy sectors.



Animal Harvest and Catch n.e.c.

This category, which includes various types of wild harvest and aquaculture, totals 3,587.95 thousand tonnes. Aquaculture is the largest subcategory, representing 79.50% with 2,852.05 thousand tonnes. Wild terrestrial plant harvest, including gathering, makes up 20.50% with 735.90 thousand tonnes. The extraction volumes for other subcategories like wild fish catch, all other wild aquatic animals catch, wild aquatic plant harvest, and wild terrestrial animal catch are not specified, indicating the need for more comprehensive data collection in these areas.

Annex B: Domestic Extraction: Non-Metallic Minerals

The table below provides a detailed breakdown of non-metallic minerals extraction, categorized into several subcategories and specific products.

1 DIGIT	2 DIGITS	3 DIGITS	Value in '000 mT	% of total
A3. NON-METALLIC MINERALS	Ornamental or building stone		662.3	0.096
	Carbonate minerals important in cement	Chalk		
		Dolomite		
		Limestone		
	Chemical fertilizer minerals		1227.9	0.177
	Salt (Sea salt (crude)		1532.4	0.221
	Clays	Structural clays	14.56	0.002
		Specialty clays		
	Sand and gravel	Industrial sand and gravel	688445	99.256
		Sand and gravel for construction		
	Other non-metallic minerals n.e.c.		1720	0.2479

The total extraction volume for non-metallic minerals is 693,602.1 thousand metric tonnes (mT). The non-metallic minerals sector is predominantly driven by the extraction of industrial sand and gravel, which accounts for the vast majority (99.3%) of the total extraction volume. Other categories, such as ornamental or building stone, chemical fertilizer minerals, salt, and various other non-metallic minerals, contribute smaller proportions, each below 0.25% of the total. This distribution highlights the essential role of sand and gravel in industrial and construction activities, while also recognizing the specialized and diverse applications of other non-metallic minerals. Sustainable extraction and management practices are crucial to balance the economic benefits with environmental and resource conservation considerations.

Industrial sand and gravel dominate the non-metallic minerals category, making up an overwhelming 99.3% of the total extraction volume. This category's dominance underscores its critical role in construction, glass production, and various industrial processes. The absence of data for construction-specific sand and gravel might indicate either a data gap or categorization within industrial uses.

Ornamental or building stone constitutes a small fraction of the total non-metallic mineral's extraction. Despite its relatively low percentage, this category is significant for the construction and decorative stone industries. Structural clays are essential for ceramics, bricks, and construction materials. The extraction volume is relatively low, representing only 0.0021% of the total, reflecting specialized and limited usage. No data is available for specialty clays

Chemical fertilizer minerals play a crucial role in agriculture by providing essential nutrients for crop growth. This category represents a small but important part of the overall non-metallic minerals sector.

Salt extraction, particularly sea salt, is vital for various uses, including food preservation, industrial processes, and de-icing. It constitutes 0.2209% of the total non-metallic mineral's extraction, indicating its diverse applications and importance.

Other non-metallic minerals category includes various non-metallic minerals not elsewhere classified. These minerals, although diverse, collectively represent 0.2480% of the total extraction volume, highlighting their niche but significant applications.

No extraction data is provided for chalk, dolomite, or limestone in this table. These minerals are typically important for cement production and other industrial applications. Their absence of the data may suggest either a lack of extraction or missing data.

Annex C: Domestic Extraction- Fossil Fuel

<table>
<tr><th>2 DIGITS</th><th>3 DIGITS</th><th>Value in '000 Ton</th></tr>
<tr><td rowspan="4">Coal and peat</td><td>Brown coal</td><td rowspan="4">890.64</td></tr>
<tr><td>Hard coal</td></tr>
<tr><td>Peat</td></tr>
<tr><td>Coal derived products N.E.C.</td></tr>
<tr><td rowspan="2">Crude oil, natural gas and natural gas liquids</td><td>Crude oil & liquid petroleum products</td><td>450</td></tr>
<tr><td>Natural gas & gaseous petroleum products</td><td>21093.1</td></tr>
</table>

	Natural gas liquids	
Oil shale and tar sands		
Mixed / compounded products mainly from fossil fuels		

Coal and Peat

- **Brown Coal**: 890.64 thousand MT
- **Percentage of Total**: 3.97%

The extraction of brown coal constitutes 3.97% of the total fossil fuel extraction. This category is significant for its use in electricity generation and as a raw material in various industrial processes. No data is provided for hard coal, peat, and coal-derived products N.E.C. in this table, which might indicate either a lack of extraction or unreported data.

Crude Oil, Natural Gas, and Natural Gas Liquids

- **Crude Oil & Liquid Petroleum Products**: 450 thousand MT
- **Percentage of Total**: 2.01%

Crude oil and liquid petroleum products account for 2.01% of the total fossil fuel extraction. These products are critical for transportation, heating, and as feedstocks for petrochemical industries.

- **Natural Gas & Gaseous Petroleum Products**: 21,093.1 thousand MT
- **Percentage of Total**: 94.02%

Natural gas and gaseous petroleum products dominate the fossil fuel extraction sector, comprising 94.02% of the total. This high percentage underscores the importance of natural gas as a major energy source for electricity generation, heating, and as a cleaner alternative to coal and oil.

- **Natural Gas Liquids**: No extraction data found

No extraction data is available for natural gas liquids. These liquids are valuable as they are used as feedstock in petrochemical plants, in heating, and for enhancing oil recovery.

Oil Shale and Tar Sands

No extraction data was also found for oil shale and tar sands in this table. These resources are typically used for producing synthetic crude oil and other hydrocarbons, but their extraction and processing can be environmentally intensive.

Mixed/Compounded Products Mainly from Fossil Fuels

No extraction data was found for mixed or compounded products derived from fossil fuels. These products usually involve blends or combinations of various fossil fuels for specific applications, such as in certain industrial processes or specialized fuel formulations.

Annex 02: All Committee

01. Project Steering Committee (PSC)

SL. No.	Name, Designation and Office (Not according to seniority)	Designation in the Committee
1.	**Ms. Aleya Akter**, **Secretary**, Statistics and Informatics Division, Ministry of Planning	**Chairperson**
2.	**Mr. Mohammed Mizanur Rahman,** Director General (Additional Secretary), Bangladesh Bureau of Statistics (BBS)	Member
3.	**Dr. Nurun Nahar,** Additional Secretary, Programming Division, Planning Commission	Member
4.	**Mr. Md. Younus Mian,** Additional Secretary, NEC-ECNEC and Coordination, Planning Division	Member
5.	**Ms. Rahima Begum,** Joint Secretary, Finance Division, Ministry of Finance	Member
6.	**Dr. Dipankar Roy,** Joint Secretary, Development and Planning Wing, Statistics and Informatics Division, Ministry of Planning	Member
7.	**Dr. Md. Rafiqul Islam,** Joint Secretary, Energy & Mineral Resources Division, Ministry of Power, Energy and Mineral Resources	Member
8.	**Ms. Mazeda Yasmin,** Joint Secretary, NEC & Coordination, Planning Division	Member
9.	**Ms. Zakia Afroz**, Joint Secretary, Ministry of Environment, Forest and Climate Change (MoEFCC)	Member
10.	**Ms. Lutfun Nahar,** Joint Secretary, Ministry of Disaster Management and Relief (MoDMR)	Member
11.	**Ms. Shusoma Sultana,** Deputy Secretary, Planning-8 Branch, Ministry of Agriculture	Member
12.	**Ms. Tahsina Begum,** Deputy Chief, Socio Economic Infrastructure Division, Planning Commission	Member
13.	**Mr. Kamal Hossain Talukder,** Director, Implementation Monitoring and Evaluation Division (IMED), Ministry of Planning	Member
14.	**Dr. Munira Begum,** Joint Chief, General Economic Division (GED), Planning Commission	Member
15.	**Mr. Shah Eyamin-Ul Islam,** Deputy Secretary, Development-1, Ministry of Water Resource (MoWR)	Member
16.	**Mr. SK Shamsur Rahman,** Deputy Secretary, Planning Section, Statistics and Informatics Division (SID)	Member
17.	**Mr. Md. Rafiqul Islam,** Director (IC), National Accounting Wing, Bangladesh Bureau of Statistics (BBS)	Member
18.	**Mr. Mohammad Saddam Hossain Khan,** Project Director, ECDS Project, Bangladesh Bureau of Statistics (BBS)	Member
19.	**Mr. Md. Mostafizur Rahman,** Deputy Secretary, Development-1 Section, Statistics and Informatics Division (SID)	**Member-Secretary**

02. Project Implementation Committee (PIC)

Sl. No.	Name, Designation and Office (Not according to seniority)	Designation in the Committee
1.	**Mr. Mohammed Mizanur Rahman,** Director General (DG), Bangladesh Bureau of Statistics (BBS)	**Chairman**
2.	**Dr. Nurun Nahar,** Additional Secretary, Programming Division, Planning Commission	Member
3.	**Mr. Mohammad Obaidul Islam,** Deputy Director General (Joint Secretary), Bangladesh Bureau of Statistics (BBS)	Member
4.	**Dr. Dipankar Roy,** Joint Secretary (Development), Statistics and Informatics Division	Member
5.	**Ms. Zakia Afroz,** Joint Secretary, Ministry of Environment, Forest and Climate Change (MoEFCC)	Member
6.	**Ms. Lutfun Nahar,** Joint Secretary, Ministry of Disaster Management and Relief (MoDMR)	Member
7.	**Dr. Munira Begum,** Joint Chief (Joint Secretary), General Economic Division (GED), Planning Commission	Member
8.	**Ms. Mazeda Yasmin,** Joint Secretary, NEC & Coordination, Planning Division	Member
9.	**Mr. Md. Mostafizur Rahman,** Deputy Secretary (Development), Statistics and Informatics Division	Member
10.	**Ms. Tahsina Begum,** Deputy Chief, Socio Economic Infrastructure Division, Planning Commission	Member
11.	**Mr. Md. Mosharaf Hossain,** Director, Implementation Monitoring and Evaluation Division (IMED)	Member
12.	**Mr. Muhammad Ali Prince,** Deputy Secretary, Finance Division, Ministry of Finance.	Member
13.	**Mr. Md. Emdadul Haque,** Director, Demography and Health Wing, Bangladesh Bureau of Statistics (BBS)	Member
14.	**Mr. Md. Rafiqul Islam,** Director (IC), National Accounting Wing, Bangladesh Bureau of Statistics (BBS)	Member
15.	**Mr. Mohammad Saddam Hossain Khan,** Project Director, ECDS Project, Bangladesh Bureau of Statistics (BBS)	**Member-Secretary**

3. Project Technical Committee (PTC)

SL. No.	Name, Designation and Office (Not according to seniority)	Designation in the Committee
1)	**Mr. Mohammed Mizanur Rahman,** Director General (Additional Secretary), Bangladesh Bureau of Statistics (BBS)	**Chairperson**
2)	**Mr. Mohammad Obaidul Islam,** Deputy Director General (Joint Secretary), Bangladesh Bureau of Statistics (BBS)	Member
3)	**Dr. Dipankar Roy,** Joint Secretary (Development), Statistics and Informatics Division	Member

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15)	**Ms. Dilruba Karim,** Principal Scientific Officer, Soil Resource Development Institute (SRDI), Farmgate, Dhaka.	Member
16)	**Mr. Md. Mostafizur Rahman,** Deputy Secretary (Development), Statistics and Informatics Division	Member
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18)	**Mr. Md. Bazlur Rashid,** Meteorologist, Bangladesh Meteorological Department (BMD), Ministry of Defense, Agargaon, Dhaka.	Member
19)	**Dr. Dilara Zahid,** Director, Institute of Disaster Management and Vulnerabilities Studies, University of Dhaka.	Member
20)	**Mr. Netai Chandra Dey Sarker,** Director (MIM), Department of Disaster Management, Mohakhali, Dhaka	Member
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22)	**Dr. Hossan Md. Salim,** Livestock Statistical Officer, Department of Livestock Services, Khamarbari, Dhaka.	Member
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24)	**Mr. Alauddin Al Azad,** Director, Agriculture Wing, Bangladesh Bureau of Statistics (BBS)	Member
25)	**Mr. Md. Emdadul Haque,** Director, Demography and Health Wing, Bangladesh Bureau of Statistics (BBS)	Member
26)	**Mr. Mohammad Abdul Kadir Miah,** Director, Census Wing, Bangladesh Bureau of Statistics (BBS)	Member
27)	**Mr. Md. Rafiqul Islam,** Director (IC), National Accounting Wing, Bangladesh Bureau of Statistics (BBS)	Member
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29)	**Mr. Md. Jahangir Alam,** Deputy Director, ECDS Project, Bangladesh Bureau of Statistics (BBS)	Member
30)	**Mr. Surangit Kumar Ghosh,** Assistant Project Director (APD), ECDS Project, Bangladesh Bureau of Statistics (BBS)	Member
31)	**Mr. Aminur Rahman Khan,** Statistical Officer, ECDS Project, Bangladesh Bureau of Statistics (BBS)	Member
32)	**Mr. Mohammad Saddam Hossain Khan,** Project Director, ECDS Project, Bangladesh Bureau of Statistics (BBS)	**Member-Secretary**

4. Project Sample Design Committee (PSDC)

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5. Report Review Committee of SID

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3.	**Mr. Md. Emdadul Haque,** Director, Demography and Health Wing, Bangladesh Bureau of Statistics (BBS)	Member

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5.	**Mr. Mohammad Abdul Kadir Miah**, Director, Census Wing, Bangladesh Bureau of Statistics (BBS)	Member
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11.	**Mr. Tufail Ahmed,** Deputy Director, National Accounting Wing, Bangladesh Bureau of Statistics (BBS)	Member
12.	**Mr. Mohammad Anamul Haque,** Maintenance Engineer, Computer Wing, Bangladesh Bureau of Statistics (BBS)	Member
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14.	**Mr. Aminur Rahman Khan,** Statistical Officer, National Accounting Wing & ECDS Project, BBS	Member
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