Nature as a Shock Absorber

A Financial Materiality Assessment of Forestry-linked Sovereign Indicators in Ghana

SUSTAINABLE SOVEREIGN DEBT HUB

Nature as a Shock Absorber

A Financial Materiality Assessment of Forestry-linked Sovereign Indicators in Ghana

Acknowledgements

SUSTAINABLE SOVEREIGN DEBT HUB

The **Sustainable Sovereign Debt Hub** (SDDH) is a convening platform conceived to address the critical sustainability challenges of global sovereign finance. The Hub focuses on embedding sustainability risks and rewards into sovereign debt markets, ensuring that countries' efforts to improve resilience to climate and nature-related challenges are appropriately designed and incentivised. Through this innovative approach and bringing together key players, the Hub helps build a more resilient, sustainable global economy, with a particular focus on supporting emerging markets and vulnerable nations.

For more information, contact: **ssdh@naturefinance.net**

Nature as a Shock Absorber

SUSTAINABLE SOVEREIGN DEBT HUB

A Financial Materiality Assessment of Forestry-linked Sovereign Indicators in Ghana

Table of Contents

Executive Summary

In today's rapidly shifting geopolitical landscape, with cuts to international development aid and rising barriers to cross-border capital flows, many countries of the Global South are in an increasingly precarious financial position. At the same time, the global economy is losing up to US$25 trillion a year because of the interconnected crises in nature, climate and human health (IPBES 2024). More specifically, the twin climate change and nature loss crises are undermining economic resilience, pushing sovereigns into an increasingly perilous fiscal position. The central role played by sovereign credit ratings and debt sustainability analysis in sovereign finance is contributing to this vicious cycle, by influencing perceptions of creditworthiness that in turn curtail investment in climate adaptation and sustainable development at the moment of most critical need.

This report introduces the Financial Materiality Assessment (FIMA) framework as a tool to arrest and potentially reverse this cycle. FIMA takes a given set of sustainability targets and corresponding key performance indicators (KPIs) and models the impact of achieving or missing them on the public finances and the wider economy. In this way, the framework demonstrates and quantifies the potential upside of pursuing financially material and credit relevant performance targets, countering the widespread narrative that overemphasises the nature and climate risk dimensions. Instead, positive impacts can be magnified by embedding the KPIs into public financial management strategies and fiscal frameworks, including via the use of financial instruments such as sustainability-linked bonds (SLBs) and loans (SLL), debt-for-development swaps, nature credits, green budgeting frameworks, among others.

The report considers nature KPIs, yet the FIMA framework can apply to any target or KPI, at the sovereign or sub-sovereign level, tied to a financing arrangement or not. This report's case study takes a forestry KPI in Ghana and uses the FIMA framework to show how nature can strengthen the sovereign's fiscal position both directly via the mechanics of performance-based financial instruments and fiscal frameworks, but also indirectly via the positive macroeconomic effects on key sovereign credit drivers. For example, the latter may include increased agricultural yields from agroforestry and regenerative farming practices, which feed through to exports, external liquidity, the fiscal accounts, and other key sovereign risk metrics. This can trigger a virtuous cycle whereby credible commitments to tackle nature-related credit risks unlock new KPI-linked sovereign financing on favorable terms. This would allow Ghana – a country assessed as being at a 'high' risk of debt distress under the joint IMF-World Bank debt sustainability framework from 2019 onwards – to direct funds towards resilience investments, generating nature- and credit-positive outcomes, and bolstering the sovereign's creditworthiness.

The FIMA framework for Ghana uses deforestation rate as the Headline KPI, assessing how outcomes under baseline, pessimistic, and optimistic deforestation scenarios affect public debt dynamics and sovereign credit ratings. For illustration, our model indicates that the optimistic scenario, when compared to baseline "business as usual" assumptions, boosted growth by up to 1 percentage points (pps) with a cumulative effect of 18% between 2024 and 2050. All else being equal, achieving the performance target all along could decrease Ghana's debt stock by 2.5 pps, save US$500m in interest payments, and lower its interest-to-revenue ratio by 1.7 pps by 2034.

Leveraging Ghana's standing forest to sell carbon credits could add up to 0.5% of GDP to this accounting (depending on the price assumption). Taking all these gains together and feeding them into credit rating models suggests a potential uplift of up to two notches. Ghana's fiscal space would be significantly impacted together with its ability to invest in nature restoration and climate adaptation measures, thus lowering vulnerability to future shocks, debts distress and potential default.

With climate and nature risks increasingly being recognised as core credit factors, this report underscores the growing relevance of tracking credit relevant and financially material KPIs, whether they be nature related or sustainability themed. Within this context, the FIMA framework provides a clear roadmap for countries – especially debt distressed countries – to leverage their natural capital for credit enhancement, arguing that nature can, and should, be understood as a credit-positive asset.

1

Introduction
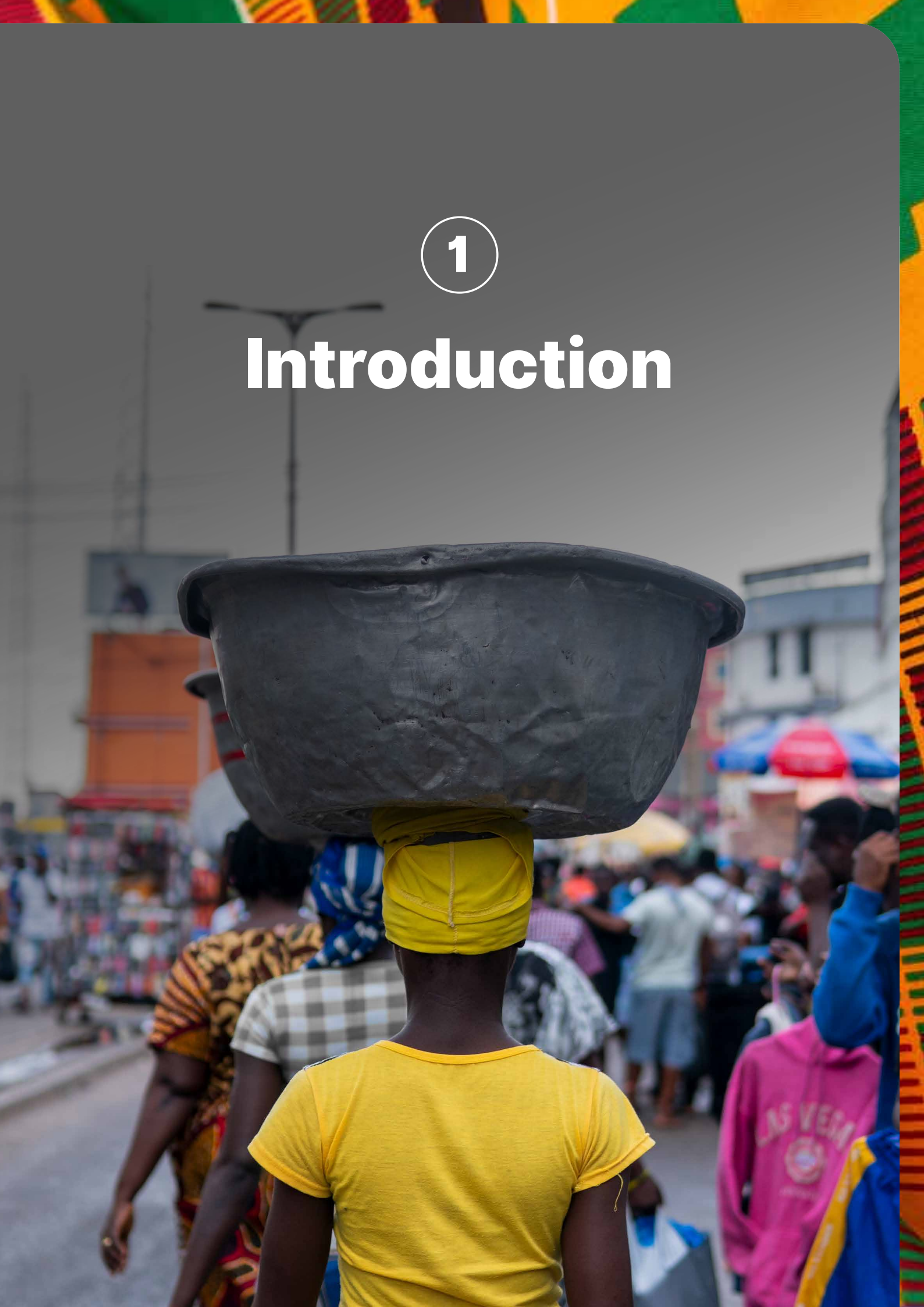
① Introduction

Climate change and nature loss are increasingly relevant and material sovereign credit risks. The most recent landmark study by the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) concluded that the global economy is losing up to US$25 trillion a year because of interconnected crises in nature, climate, and human health (IPBES 2024). The impacts of these crises are felt by governments in their capacity as sovereign borrowers, in the f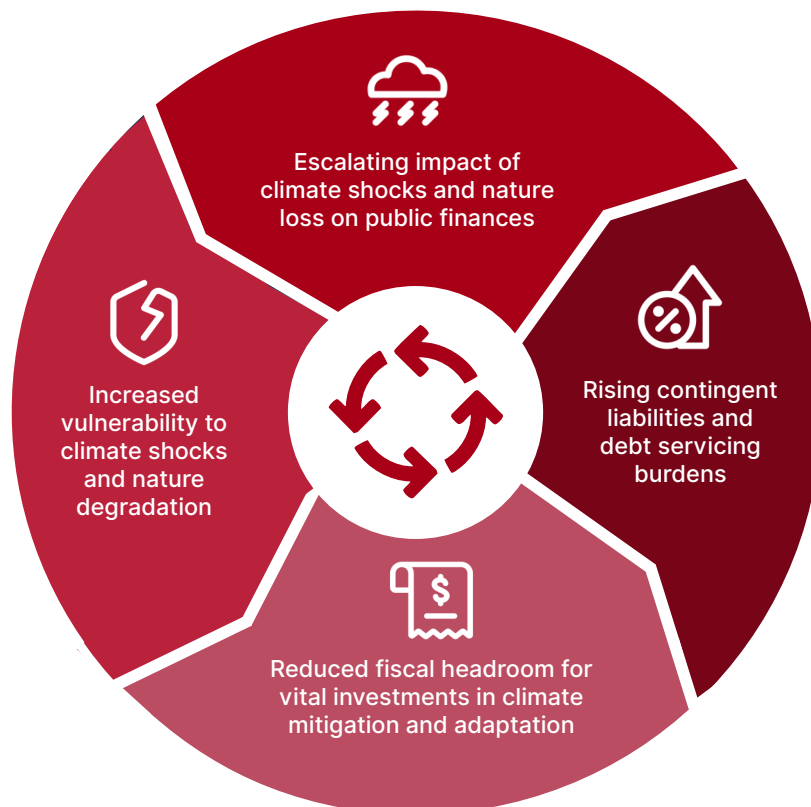orm of intensifying fiscal pressures and deteriorating sovereign credit risks. In other words, the reduced ability to service their public debts and avoid default. A growing body of research has shown the rising correlations between climate/nature shocks, debt sustainability, and sovereign credit ratings (Cevik and Jalles 2020; Cevik and Jalles 2020; Kraemer and Volz 2022; Aggarwala et al. 2022; University of East Anglia 2023; Gardes-Landolfini et al. 2024), and more broadly the high dependence of the economy on natural services (PwC 2023). The connected dependencies between climate, nature and credit create a vicious cycle (depicted in Exhibit 1) where decreasing sovereign creditworthiness, due to climate change and nature loss, reduces the capacity for investment in mitigation and adaptation measures. This then increases a country's vulnerability to future shocks and the likelihood of debt distress and default. Given the limited progress on closing the climate and nature financing gaps, this climate-nature-credit cycle will continue to accelerate, culminating in worsening debt distress and rising default among debt-distressed sovereigns.

Exhibit 1 Climate-Nature-Credit Nexus

- Escalating impact of climate shocks and nature loss on public finances
- Rising contingent liabilities and debt servicing burdens
- Reduced fiscal headroom for vital investments in climate mitigation and adaptation
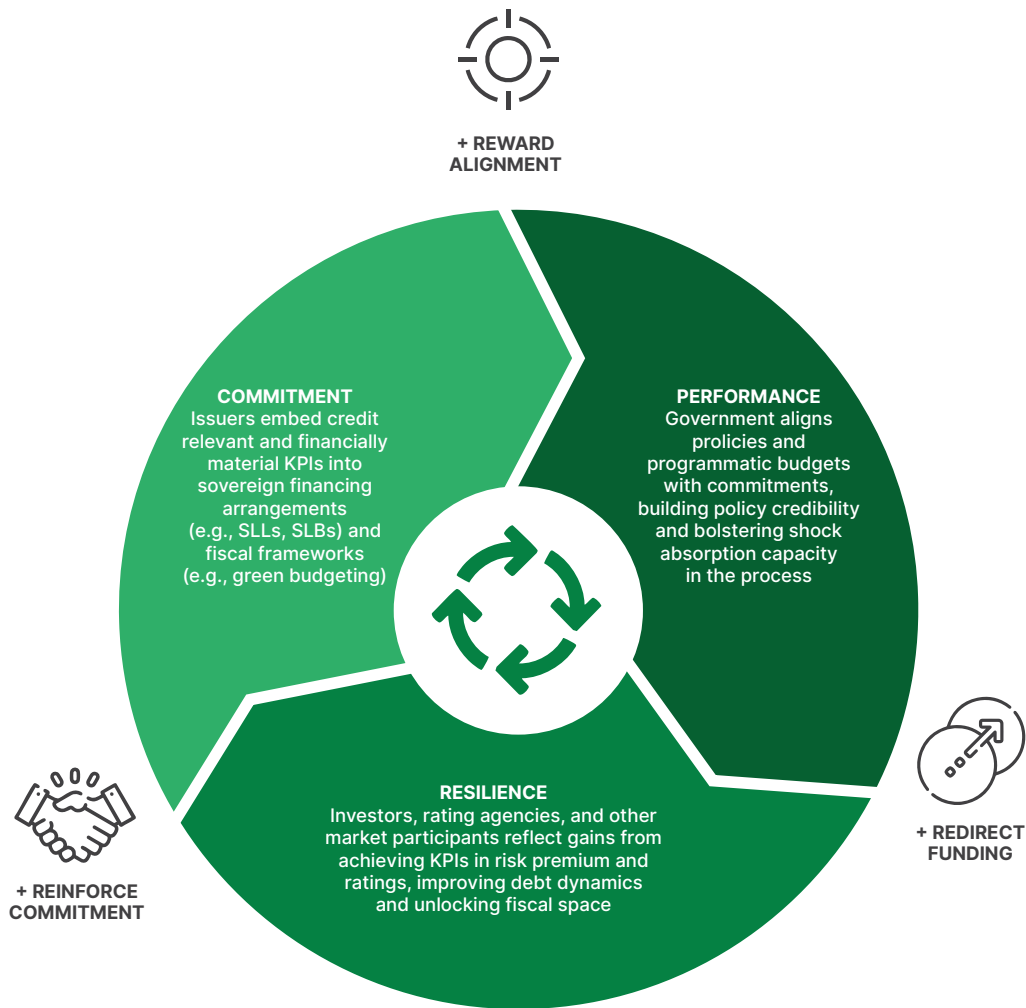- Increased vulnerability to climate shocks and nature degradation

Source: SSDH

Despite the mounting evidence, efforts to systematically incorporate climate and nature into sovereign risk frameworks have been slow. Most of those efforts have focused on climate shocks, not nature loss and related social risks. Similarly, climate and nature risk management frameworks have overwhelmingly focused on corporates, financial institutions, and central banks. More importantly, academic studies on this subject generally fail to provide practical, meaningful, or actionable insights for Ministries of Finance (MOF) and their Debt Management Offices (DMOs) on how to mitigate risks or optimise debt management strategies. The excessive focus on analysing climate and nature through a risk lens has also overlooked or understated the potential gains from climate adaptation/mitigation and nature alignment. In particular, the role of nature as infrastructure, nature as a shock absorber or nature as a credit strength has yet to be clearly articulated as policy recommendations.

Breaking this nexus will require more public financing of adaptation measures and the transformation of public financial management, especially the use of sustainability-linked sovereign financing (SLSF). SLSF consists of performance-based financing instruments that include sustainability-linked bonds (SLBs), loans (SLLs), debt-for-development swaps (DDS) and outcome bonds. They all share the common feature of providing financial incentives in exchange for a sovereign commitment to pursue ambitious sustainability targets and implement strict reporting on material key performance indicators (KPIs). SLSF instruments like SLBs and SLLs differ from thematic instruments (e.g., green and blue bonds) because they do not earmark proceeds for specific projects; instead, they can be used for general budgetary purposes. This feature makes such instruments suitable for refinancing operations, demonstrating the credibility of commitment and signalling the predictability of policies. Furthermore, a sustainability-linking framework can serve as the scaffolding to organise and optimise the selection of use-of-proceed bonds and other project finance instruments into a holistic and coherent sustainable financing strategy.

To ensure that the sustainability targets are appropriately funded and prioritised, the KPIs should extend from the financing to the spending side of the fiscal accounts. Performance-based budgeting, such as "green budgeting", can embed the same targets and KPIs into budget allocation decisions. If the chosen targets and KPIs optimise for both environmental and fiscal sustainability, then achieving them should result in greater resilience as well as gains in sovereign creditworthiness. This outcome is based on the assumption that aligning expenditures with resilience-enhancing targets will feed through improvements in macro-fiscal outcomes and produce gains in policy effectiveness and credibility (key considerations in a sovereign credit rating assessment). The data systems and reporting protocols behind the KPIs can also serve as the basis for creating jurisdictional nature credits, performance-based grants or other fiscal revenue streams to generate additional credit uplift. In other words, pursuing appropriate financially material KPIs should help reverse the climate-nature-credit cycle, since improved financing conditions create fiscal space to invest in resilience-enhancing measures, bolstering creditworthiness and further improving financing terms. This theory of change is encapsulated in Exhibit 2.

Exhibit 2 Virtuous Cycle of Performance-Based Financing

+ REWARD ALIGNMENT

COMMITMENT
Issuers embed credit relevant and financially material KPIs into sovereign financing arrangements (e.g., SLLs, SLBs) and fiscal frameworks (e.g., green budgeting)

PERFORMANCE
Government aligns prolicies and programmatic budgets with commitments, building policy credibility and bolstering shock absorption capacity in the process

+ REDIRECT FUNDING

RESILIENCE
Investors, rating agencies, and other market participants reflect gains from achieving KPIs in risk premium and ratings, improving debt dynamics and unlocking fiscal space

+ REINFORCE COMMITMENT

Source: SSDH

The key to unlocking such a virtuous cycle is the financial materiality assessment (FIMA) framework. FIMA is a conceptual framework that demonstrates the credit relevance and financial materiality of chosen sustainability targets and KPIs in terms of the key drivers of sovereign creditworthiness. It models the potential credit uplift to be obtained from achieving the targets, both directly by the mechanics of the instruments deployed and indirectly via macro-fiscal transmission channels through which the positive impacts propagate. To accomplish this, the framework maps the KPIs to the various parameters used for macroeconomic forecasting, debt sustainability analysis (DSA), and sovereign risk analysis. The overarching aim of FIMA is to demonstrate that tracking and pursuing sustainability targets can be sound public financial management, provided they are financially material and credit relevant.

This report introduces the FIMA framework and applies it to Ghana as a case study. The study simulates the potential for nature-linked targets and corresponding KPIs to arrest the deterioration in creditworthiness due to deforestation and its related spillover effects. It also estimates the macro-fiscal upside from expanding forest cover and generating associated co-benefits. These are quantified in terms of improvements in public debt dynamics and gains in Ghana's credit rating. Specifically, this case study reveals that[1] over the next 10 years 400,000 ha of tree-cover could be saved. It could also, under certain assumptions, and ceteris paribus conditions, translate into a 3-percentage point reduction in the public debt-to-GDP ratio, and a one notch increase in Ghana's credit rating relative to a "business as usual" deforestation scenario. This boost to the credit profile is an addition to the gains from the reduction in interest rates on the KPI-linked debt, as well as the receipts from sales or swaps of nature credits.

Further research is needed to validate and refine the FIMA framework. The Ghana case study is the first empirical test of the framework with one KPI. More work is needed to chart out the various transmission channels and build out the macro-fiscal models to capture other relevant dimensions of chosen sustainability KPIs. In the case of standing forest, for instance, deeper analysis could assess the impact of large-scale investments into agroforestry-based cocoa, which involves intercropping cocoa with shade trees and other fruit trees. This could reverse the decline in production of the vital export crop for Ghana, while also helping to build ecosystem resilience, diversify livelihoods for producers, and mitigate carbon emissions (Ghana Cocoa Board 2024). With more runs of FIMA in other contexts and for other sustainability themes, the value of the framework for selecting and calibrating KPIs will grow. The longer-term vision is to develop a taxonomy of KPIs that specify the linkages to credit drivers for each at a conceptual level, which can be readily adapted and applied to local circumstances and needs through a FIMA approach. This report and case study provide an important first step in that direction.

---

[1] By saving or replanting roughly 37,000 ha/y, while the current deforestation pace is 118,000 Ha/y.
For comparison, the total forest cover in Ghana is 10.4M ha, including 70% of natural forest and 30% of planted trees.

2

Background & Rationale

② Background & Rationale

Sustainability-linked sovereign financing (SLSF) has a central role to play in closing the US$ 1-4 trillion climate, nature, and sustainable development finance gaps (IEG 2023). It mobilises and channels capital from sustainability-oriented investors in exchange for embedding targets into financing contracts that are subject to strict reporting requirements and reinforced by performance-based financial incentives. In addition to signalling seriousness of commitment, the key performance indicators (KPIs) that track progress on selected targets provide an accountability mechanism to galvanise and sustain policy action. KPIs can also serve as an organising framework to rationalise project selection for green, social, and sustainability bonds. Since the targets and KPIs are selected by the borrowers rather than imposed by creditors, they can enjoy greater legitimacy and political buy-in than conditionality-based lending, especially when integrated into homegrown development strategies (e.g., Country Packages). Multilateral development banks (MDBs) and development finance institutions (DFIs) can leverage this fact to improve performance on their lending facilities, for instance, by extending their own sustainability-linked loans (SLLs) or enabling blended finance structures such as debt-for-development swaps. For these and other reasons, SLSF has the potential to catalyse meaningful volumes of sovereign finance for climate, nature, and sustainable development.

However, despite its potential, SLSF has been slow to establish itself as a mainstream financing solution. The volume of sustainability-linked bonds (SLBs), SLLs, and debt-for-development swaps (DDS) has been muted following the initial surge of issuance during the first wave of offerings in 2021-2022 (see Exhibit 3). The causes of this slow uptake in SLSF instruments are numerous and complex. One of these causes was the volatile global macroeconomic and financial conditions in the aftermath of the COVID-19 pandemic. These conditions led to tight credit and heightened risk sensitivity towards low- and middle-income countries (LMICs), which resulted in soft demand and high interest rates for their bonds. During this period, the risk perceptions were partly influenced by sovereign credit ratings and the World Bank-International Monetary Fund's (IMF-WB) debt sustainability analysis (DSA). Both credit ratings and DSA act as a throttle on capital flows when their outlooks turn negative or indicate distress (see Box 1 for an explainer). This was illustrated during the pandemic with a wave of rating downgrades and rising incidence of debt distress across LMICs as measured by the WB-IMF DSA (World Bank 2024). With external financing scarce and costly, issuers had to choose between familiar "plain vanilla" financing and the still experimental sustainability-linked option. Only a few countries opted for the latter, even as the credit cycle turned up and the ratings downtrend bottomed out (as shown in Exhibit 3).

Exhibit 3 EMDE Portfolio Debt Flows (US$ Billion, excluding China)

■ Right Axis: Debt-for-Nature Swaps (USD m)   ■ Right Axis: Sustainability-linked bonds/loans (USD m)
— Left Axis: EM Capital Flows (USD bn)*

*12-month rolling sum

Source: IIF, OECD, Refinitiv, Bloomberg

BOX 1

A Quick Guide to Sovereign Credit Ratings and Debt Sustainability Analysis (DSA)

The case study on Ghana presented in Section 4 simulates the outcomes of deforestation KPIs using sovereign credit rating and debt sustainability models as described here.

Sovereign Credit Ratings

A sovereign credit rating is an opinion by a registered credit rating agency (CRA) that expresses its forward-looking judgment about the ability and willingness of a government to meet its financial obligations in full and on time. CRA analysts assess "ability to pay" by examining whether the sovereign will have access to sufficient financial resources during the rating horizon to honour its debt obligations given projected macroeconomic conditions and policy settings. In analysing "willingness to pay", they assess whether the government demonstrates sufficient political commitment to direct scarce public funds toward debt service.

CRAs use proprietary statistical or scorecard models to determine their ratings. These employ a mix of quantitative and qualitative variables that are chosen based on a combination of credit relevance (e.g., public debt burdens and budget balances), consistency with economic theory (e.g., inflation and exchange rates), and statistical significance (e.g., per capita GDP, history of default). They are organised into broad pillars or risk "factors" under the general rubrics of macroeconomic performance, institutional or structural features, external finances, and public finances (S&P breaks out a fifth factor for monetary factors). The factors, in turn, comprise "sub-factors" containing either quantitative variables (e.g., GDP per capita, debt-to-GDP ratio) or qualitative scores (e.g., banking sector risk, policy effectiveness). The sub-factors are rolled up using different aggregation methods and weights to produce an "indicative" or model-predicted rating (or in the case of Moody's, a rating range).

Qualitative factors play a major role in sovereign credit ratings. The quantitative variables comprise historical data and forecasts drawn from in-house economists and external researchers. Qualitative considerations such as governance and geopolitical risk are estimated using expert judgments and external indicators. The World Bank's Worldwide Governance Indicators (WGIs) feature prominently in the methodologies, whether as reference points in Moody's scorecard or a coefficient in Fitch's sovereign rating model (SRM). All three CRAs also allow for adjustments to the quantitative scores, which can be applied to each rating factor separately (Moody's and S&P) or to the indicative rating via a "qualitative overlay" (QO) (Fitch).

BOX 1

Exhibit 4 Statistical Models

An econometric regression model with an indicative quantitative output, adjusted in a qualitative overlay

Qualitative Model

- Structural Variables
- Structural Variables
- Macro Variables
- Public Finance Variables
- Public Finance Variables
- External Variables

Credit Score

Qualitative Adjustment

Qualitative Adjustment | Qualitative Adjustment

Indicative Rating

Qualitative Adjustment | Qualitative Adjustment

Final Rating
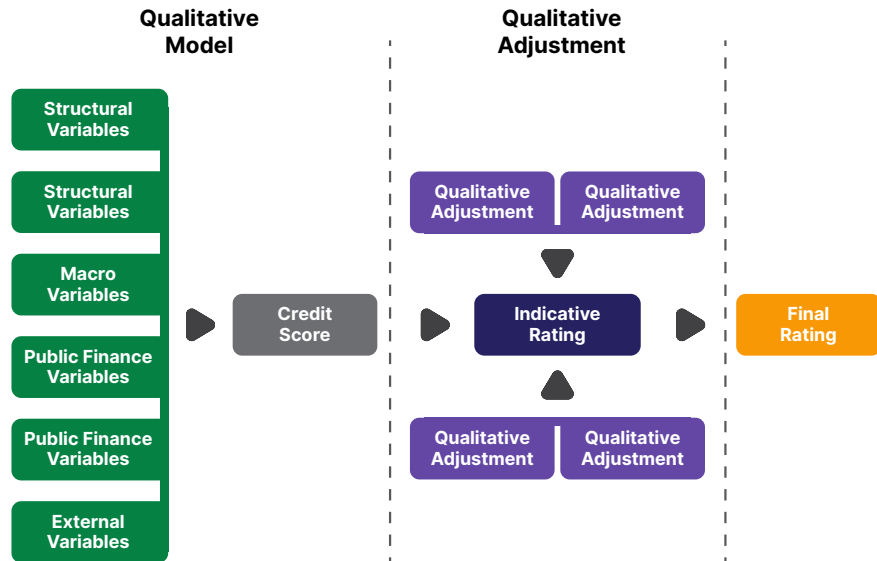
Exhibit 5 Scorecard Models

Quantitative and qualitative factors are aggregated stepwise into an overall indicative outcome

Rating Factor #1

- Quantitative Variable
- Qualitative Score
- Quantitative Variable

Factor Score 1

Rating Factor #2

- Quantitative Variable
- Qualitative Score
- Quantitative Variable

Factor Score 2

- Quantitative Variable
- Qualitative Score
- Quantitative Variable

Factor Score n

Qualitative Adjustment

Indicative Rating

Final Rating
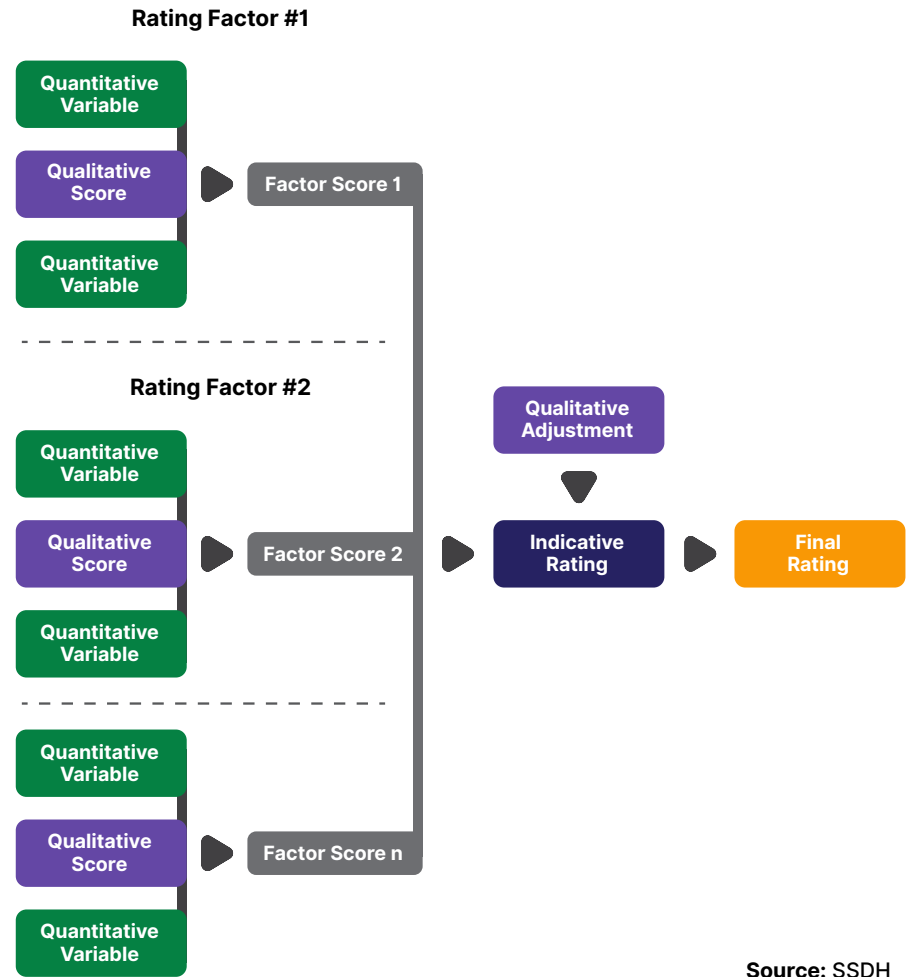
Source: SSDH

BOX 1

The CRAs have developed frameworks for assessing environmental, social, and governance (ESG) risks in sovereign ratings, yet these do not presently constrain their sovereign ratings. Fitch and Moody's have ESG scores that measure the "relevance" and "credit impact" of ESG factors on sovereign ratings, respectively (Fitch 2019, Moody's 2025). S&P does not produce separate scores but instead considers relevant ESG credit factors during the overall credit assessment (S&P 2021).

Debt Sustainability Analysis (DSA):

The Debt Sustainability Analysis (DSA) is a model and analytical framework to determine whether the public debt burden of a given sovereign is sustainable under a range of assumptions and risk scenarios. The DSA is an intertemporal model which calculates gross financing needs over a forecast period to project debt metrics. It involves three key inputs: the macroeconomic assumptions, the existing debt service, and the funding plan. Based on these inputs, the model forecasts debt metrics over a 20-year horizon that indicate levels of stress and vulnerability to shocks in reference to various thresholds.

The World Bank (WB) and International Monetary Fund use the DSA to guide their lending decisions for low-income and market-access countries (LICs and MACs, respectively), which also serves as a critical risk signal for financial market actors. The joint WB-IMF Debt Sustainability Framework (DSF) for LICs applies to its sovereign counterparties to assess debt-carrying capacity and the risk of external and overall debt distress based on three thresholds and benchmarks as per Exhibit 6 (IMF 2017).

Exhibit 6 Debt Burden Thresholds and Benchmarks in the Debt Sustainability Framework

	Present value of external debt (%)		External debt service (%)		Present value of total public debt (%)
	GDP	Exports	Exports	Revenue	GDP
Strong	50	240	21	23	70
Medium	40	180	15	18	55
Weak	30	140	10	14	35

Source: IMF

The trade-off between SLSF and conventional financing is further complicated by institutional constraints on the issuer side. Ministries of Finance (MOF) and their debt management offices (DMOs) are formally responsible for arranging funding to cover financing needs at the lowest possible cost and risk, as well as optimising portfolio structure. They also have to develop domestic capital markets, improve the sovereign credit rating and liaise with the IMF and World Bank on the DSA. The sustainability targets embedded within SLSF are generally not part of the DMO's mandate. Public debt managers, therefore, consider these targets as a lower priority to their core objectives, or even in outright conflict. The tension arises in part because of an inherent principal-agent problem between the DMO that contracts the debt and runs the risk of missed targets, and the line ministries (e.g., the Ministry of Environment) that are responsible for implementing programmes underpinning those targets, yet over which the DMO may have limited oversight or authority. This dynamic between the DMO and line ministries can lead to inefficiencies, misalignment of incentives and suboptimal outcomes. Add to that the extra transaction costs and higher workloads for performance tracking and reporting requirements compared to other funding sources, and the cost-benefit calculus becomes stacked against SLSF.

Given this backdrop, the financial materiality assessment (FIMA) framework can help to tilt the issuer cost-benefit calculus in favour of SLSF and counteract the disincentives faced by public debt managers. FIMA provides a framework for selecting targets and corresponding KPIs based on credit relevance and financial materiality: the extent to which they have a bearing on the perceived willingness and ability to pay outstanding obligations, as assessed by sovereign credit ratings or a debt sustainability analysis (DSA). According to this logic, good outcomes on the KPIs should also translate into stronger credit fundamentals, thereby aligning the sustainability targets with the DMO's core mandate and justifying the higher transaction costs and reporting workloads of SLSF. Concretely, the FIMA framework explains the broader benefits of SLSF beyond the basic mechanics of the instruments (i.e., reduction in interest rates if targets are achieved) by modelling the macro-fiscal impacts of KPIs in terms of improvements in the issuer's credit ratings and public debt dynamics. These results are expressed quantitatively, with the disclaimer that they are based on assumptions and forecasts of headline variables, and therefore subject to significant uncertainty. Furthermore, the impact on qualitative factors of creditworthiness, which comprise a significant part of the credit rating analysis, can "at best" be estimated directionally. Even so, provided the KPI-credit mapping is sound, the FIMA analysis can provide a robust rationale to DMOs for pursuing SLSF and an evidence base on which to select strategically aligned KPIs.

The FIMA framework can also address creditor concerns about the rising exposure of vulnerable sovereigns to climate shocks, nature loss, and other environmental, social, and governance (ESG) issues. Creditors can draw comfort from the knowledge that their funding is simultaneously driving policy action and strengthening the borrower's creditworthiness. Issuers may even be able to entice more traditional sovereign debt investors, as opposed to sustainability-oriented investors, to sustainability-linked offerings if they can convince them that the targets are credit positive. Indeed, investors in conventional instruments are likely to demand more information about sovereigns' exposure to climate and nature risks and other relevant sustainability issues going forward, regardless of whether the issuer is contemplating an SLSF offering or not. This is because risk management frameworks are increasingly treating these factors as core credit risks, rather than ancillary considerations, and because new regulation in certain jurisdictions require disclosure on ESG issues. Sovereigns can — and arguably should — anticipate this trend by implementing data systems and reporting frameworks that track performance across a range of sustainability indicators.

Credit relevance and financial materiality will likely become more salient for KPI selection as climate, nature, and other sustainability-related risks crystalise. The KPIs must remain relevant for the life of an SLSF instrument, which often exceeds a decade, during which time the macroeconomic fundamentals can change dramatically, especially in the context of escalating climate and nature pressures on the economy. Therefore, omitting credit considerations can render carefully calibrated targets obsolete or unattainable. Furthermore, as the IMF-WB DSA and credit rating agencies move to incorporate climate, nature, and other ESG risks into their models, the omission also means a missed opportunity to address these concerns via financially material KPIs.

3

Financial Materiality Assessment (FIMA)

Conceptual Framework

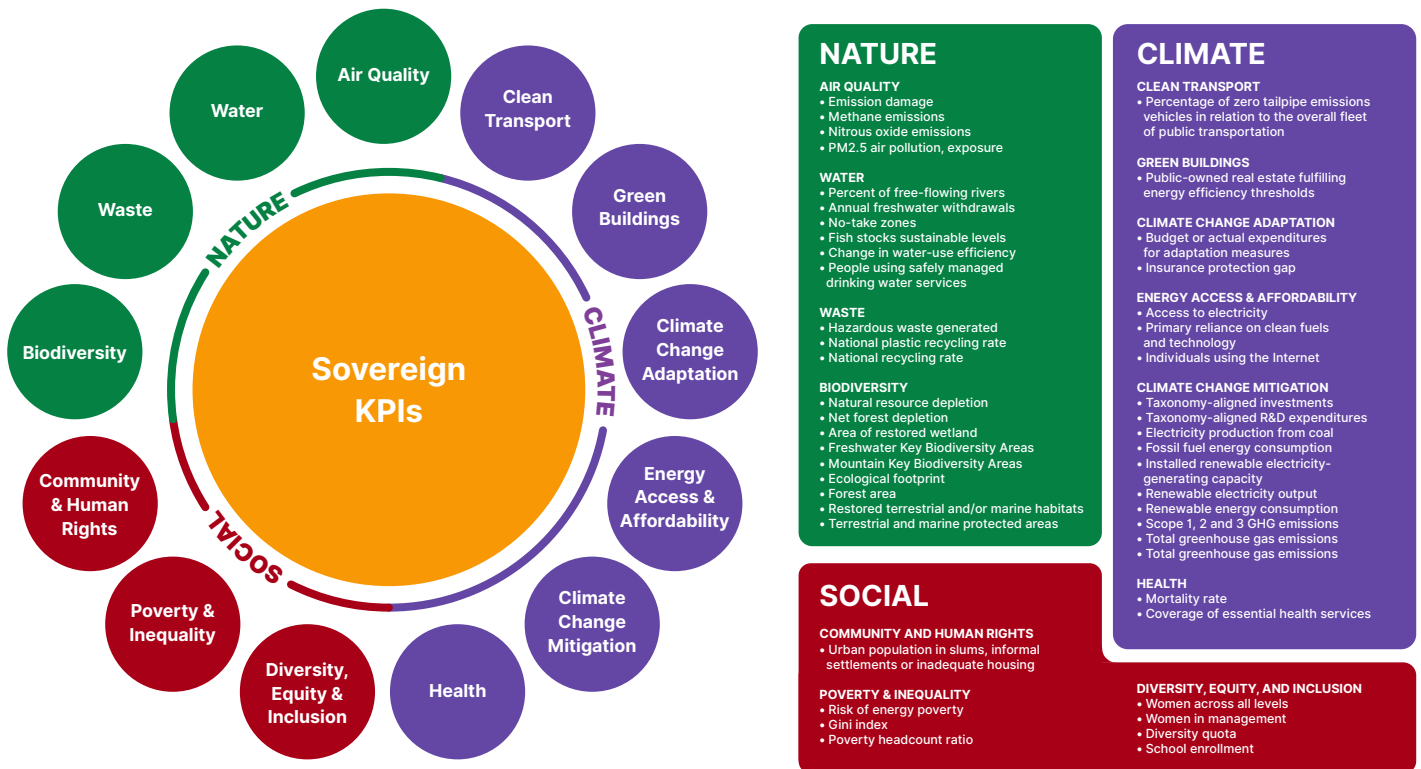# ③ Financial Materiality Assessment (FIMA)
Conceptual Framework

The financial materiality assessment is an analytical framework to assess KPIs on their credit uplift potential. The assessment starts with the selection of one or more 'headline KPIs' under consideration for a sustainability-linked project or transaction such as an sustainability-linked loans (SLLs) or sustainability-linked bonds (SLBs). Each KPI is mapped to 'performance drivers', which are the key factors that will most likely determine the evolution of the indicator, while the 'public financial management (PFM) applications' capture financing and fiscal use cases for the KPI. The headline KPIs, performance drivers, and PFM applications are mapped to macro-fiscal variables based on economic logic or empirical analysis. The focus is on variables that feed directly into credit rating models and debt sustainability analysis. Where possible, the relationships between the KPIs and variables are modelled quantitatively to indicate the degree of "credit uplift" that generating certain KPI outcomes may produce. Identifying the appropriate drivers, applications, and macro-fiscal impacts and specifying the relationships between them may require multiple iterations before a conclusion about financial materiality can be drawn and different KPIs can be compared on that basis.

3.1. Headline KPIs

The process of selecting KPIs for an SLSF operation requires balancing different design criteria, such as ambitiousness, feasibility, integrity, and financial materiality, to maximise the uptake and impact of the KPI-linked instrument. Investors and creditors generally insist that the chosen KPIs and corresponding targets are attainable through plausible policy actions and provide "additionality" over current "business as usual" trends. The International Capital Market Association's (ICMA) Sustainability-linked Bond Principles provide high-level guidelines for KPI selection, stipulating that they should be "relevant, core and material" to the economic, social, and governance policies of the sovereign (ICMA 2024). The Principles also suggest that KPIs should be of high strategic significance and consistent with sustainable development policies and benchmarked against external references or definitions to assess the level of ambition (ICMA 2024).[2] Several frameworks have emerged to aid in the calibration of targets and KPIs, notably the World Bank's feasibility and ambitiousness (FAB) matrix and Relative Evaluation And benCHmarking (REACH) (Wang et al. 2023). Cross-country comparisons are key to these approaches, allowing issuers to assess their projections relative to peers and historical experience. Public resources such as the World Bank's Sovereign ESG Portal and ICMA's KPI Registry provide a ready catalogue of reference KPIs that have been validated to a certain degree by market participants (see Exhibit 7).

---

[2] The Principles also call for the KPIs to be "measurable or quantifiable on a consistent methodological basis" and "externally verifiable" (ICMA 2024).

Exhibit 7 ICMA Illustrative Sovereign KPI Registry

NATURE

AIR QUALITY
• Emission damage
• Methane emissions
• Nitrous oxide emissions
• PM2.5 air pollution, exposure

WATER
• Percent of free-flowing rivers
• Annual freshwater withdrawals
• No-take zones
• Fish stocks sustainable levels
• Change in water-use efficiency
• People using safely managed
  drinking water services

WASTE
• Hazardous waste generated
• National plastic recycling rate
• National recycling rate

BIODIVERSITY
• Natural resource depletion
• Net forest depletion
• Area of restored wetland
• Freshwater Key Biodiversity Areas
• Mountain Key Biodiversity Areas
• Ecological footprint
• Forest area
• Restored terrestrial and/or marine habitats
• Terrestrial and marine protected areas

CLIMATE

CLEAN TRANSPORT
• Percentage of zero tailpipe emissions
  vehicles in relation to the overall fleet
  of public transportation

GREEN BUILDINGS
• Public-owned real estate fulfilling
  energy efficiency thresholds

CLIMATE CHANGE ADAPTATION
• Budget or actual expenditures
  for adaptation measures
• Insurance protection gap

ENERGY ACCESS & AFFORDABILITY
• Access to electricity
• Primary reliance on clean fuels
  and technology
• Individuals using the Internet

CLIMATE CHANGE MITIGATION
• Taxonomy-aligned investments
• Taxonomy-aligned R&D expenditures
• Electricity production from coal
• Fossil fuel energy consumption
• Installed renewable electricity-
  generating capacity
• Renewable electricity output
• Renewable energy consumption
• Scope 1, 2 and 3 GHG emissions
• Total greenhouse gas emissions
• Total greenhouse gas emissions

HEALTH
• Mortality rate
• Coverage of essential health services

SOCIAL

COMMUNITY AND HUMAN RIGHTS
• Urban population in slums, informal
  settlements or inadequate housing

POVERTY & INEQUALITY
• Risk of energy poverty
• Gini index
• Poverty headcount ratio

DIVERSITY, EQUITY, AND INCLUSION
• Women across all levels
• Women in management
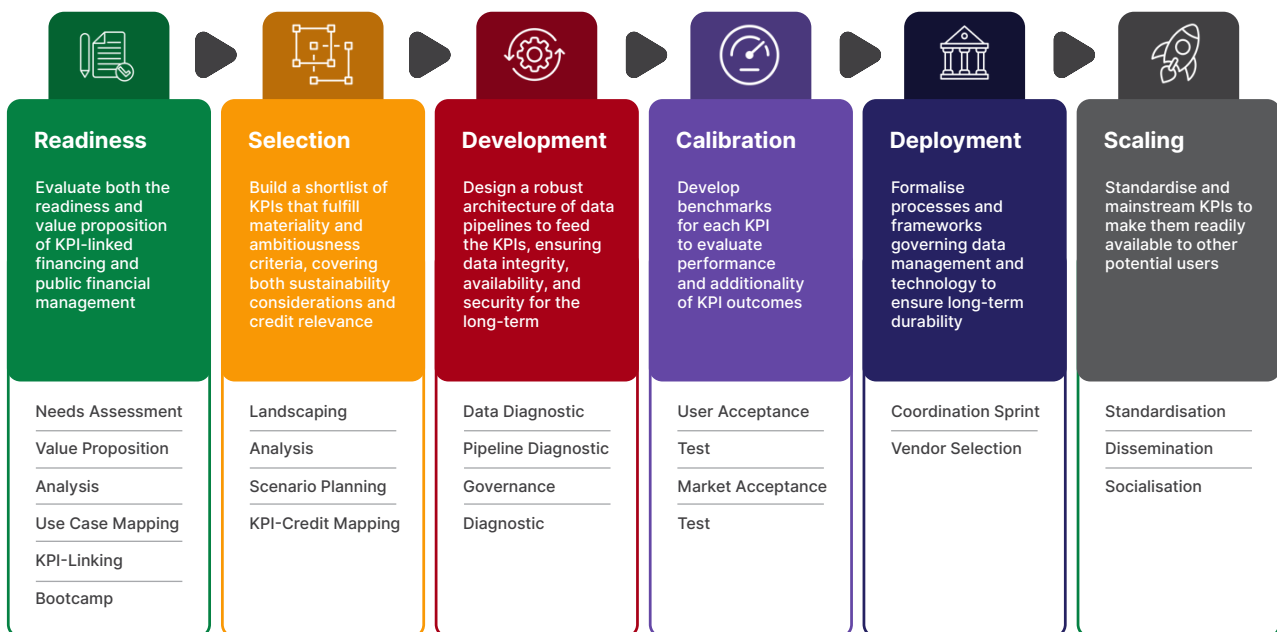• Diversity quota
• School enrollment

Source: ICMA

Integrity refers to the issuer's capacity to deliver consistent, high-quality data to feed the KPIs for the duration of the SLSF operation. Investors and creditors must have confidence in the integrity of the underlying source data and the robustness of reporting protocols since any real or perceived manipulation to avoid an adverse outcome can destroy demand for the offering or result in legal risk for the issuer. Accordingly, the ICMA Principles and best practice specify that an external verifier be contracted to scrutinise the reporting process and provide quality assurance for the duration of the instrument. Even so, many issuers face institutional and technological challenges with handling the data and guaranteeing quality control, especially if they are complex "big" or alternative data sets such as geospatial imagery. Such capacity constraints reduce the pool of data available for compiling KPIs that are up-to-standard and, therefore, limit the range of KPIs available for SLSF. An initial diagnostic of the data architecture undergirding different reporting systems can give an indication of possible sources and states of readiness. If the issuer has identified a desirable KPI but lacks adequate data pipelines and governance frameworks, then interventions are needed to close those gaps and upgrade the data infrastructure. Programmes such as the Sustainable Sovereign Debt Hub's (SSDH) KPI Accelerator help issuers analyse technological readiness and accelerate the operationalisation of data pipelines for KPIs (see Box 2).

BOX 2

SSDH's KPI Accelerator

The Sustainable Sovereign Debt Hub (SSDH), in pursuit of its mission to scale-up KPI-linked financing and debt management, has developed a structured programme of solutions aimed at speeding up the operationalisation of climate, nature, and other sustainability KPIs and tackling the blockages, gaps, and other data-related problems that may hinder timely deployment of KPI-linked frameworks or instruments. The Accelerator leverages techniques and tools from human-centred design and technology innovation disciplines to ensure that the KPIs and underlying enabling technology are developed to meet the needs and preferences of their adopters, while also ensuring high quality and integrity of the data feeding the KPIs. The programme consists of surgical, time-bound, and problem-driven interventions conceived to solve problems quickly and usher the issuers through a series of steps along the KPI development process (See Exhibit 8). The programme can be deployed piecemeal via bite-sized interventions or as a full Accelerator run with the activities bundled into various configurations and sequenced according to the most pressing needs of the sovereign. The Accelerator has been piloted with several sovereigns over the course of 2024 and will be formally launched in 2025.

Exhibit 8 SSDH's KPI Accelerator Programme

| **Readiness**	**Selection**	**Development**	**Calibration**	**Deployment**	**Scaling**
Evaluate both the readiness and value proposition of KPI-linked financing and public financial management	Build a shortlist of KPIs that fulfill materiality and ambitiousness criteria, covering both sustainability considerations and credit relevance	Design a robust architecture of data pipelines to feed the KPIs, ensuring data integrity, availability, and security for the long-term	Develop benchmarks for each KPI to evaluate performance and additionality of KPI outcomes	Formalise processes and frameworks governing data management and technology to ensure long-term durability	Standardise and mainstream KPIs to make them readily available to other potential users
Needs Assessment	Landscaping	Data Diagnostic	User Acceptance	Coordination Sprint	Standardisation
Value Proposition	Analysis	Pipeline Diagnostic	Test	Vendor Selection	Dissemination
Analysis	Scenario Planning	Governance	Market Acceptance		Socialisation
Use Case Mapping	KPI-Credit Mapping	Diagnostic	Test		
KPI-Linking					
Bootcamp					

Although existing KPI frameworks have largely omitted financial materiality considerations, they can be the key to unlocking political buy-in for an SLSF operation. To the extent that financially material targets and KPIs help to coalesce interests and align incentives around SLSF — as argued in the preceding section — it also constitutes a test of practical feasibility, as opposed to the technical feasibility considered by frameworks such as FAB. An initial scan of the sovereign rating profile for noticeable credit weaknesses or rating sensitivities can indicate possible KPI candidates. In the case of Ghana, for example, the credit rating is weighed down by factors including high commodity dependence, elevated inflation, and GDP volatility (see Box 3). Selecting KPIs such as agroforestry production that build resilience to terms-of-trade shocks and lessen export concentration on a few commodities would directly target these perceived weaknesses in Ghana's credit profile.

BOX 3

Ghana Credit Profile Snapshot

Ghana's sovereign credit profile is heavily marked by the country's recent debt default. After a period of strong economic growth and steady debt accumulation, the public burden rose sharply in 2020 amid a series of external shocks — from the global pandemic to a surge in global energy and food prices and global monetary tightening — as well as heavy borrowing to finance expansionary fiscal policy (see Exhibit 11). The government announced a suspension of payments on domestic and external debt in December 2022, after which the three main rating agencies placed the country into default ('restricted default – RD' in the case of Fitch) (see Exhibit 9). The government requested bilateral debt restructuring under the G20 Common Framework, and an agreement with official creditors was reached in January 2024 and finalised in June 2024. The domestic debt exchange programme was completed in September 2023, while an agreement in principle with Eurobond holders was reached in June 2024 and the exchange was completed in October.
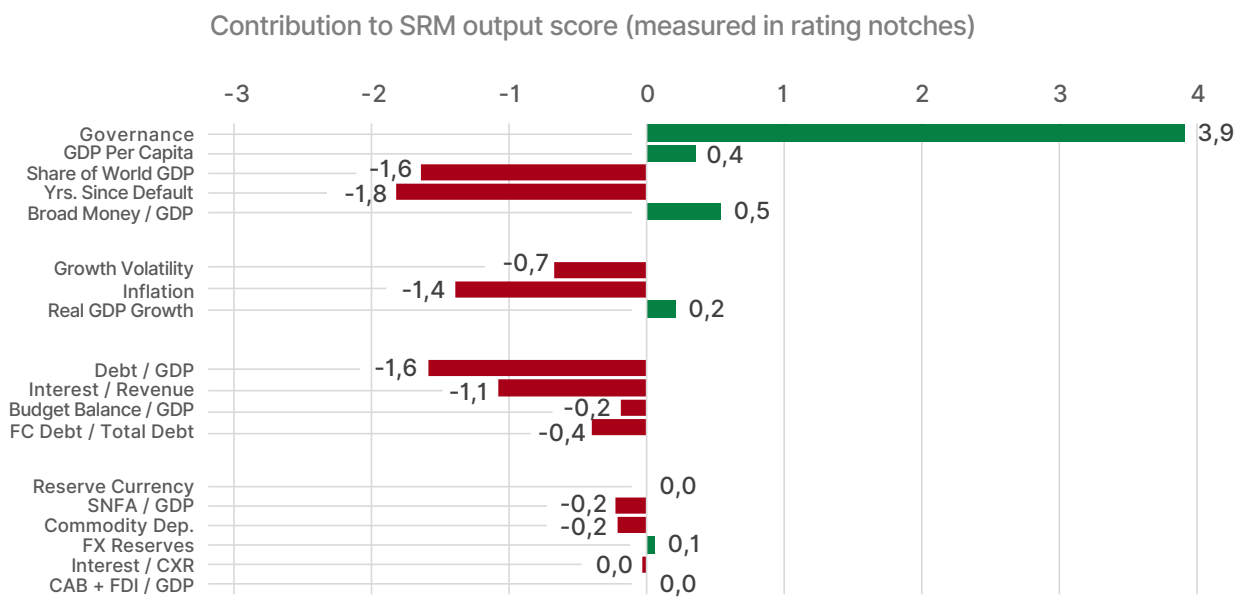
Exhibit 9 Ghana's Sovereign Rating History
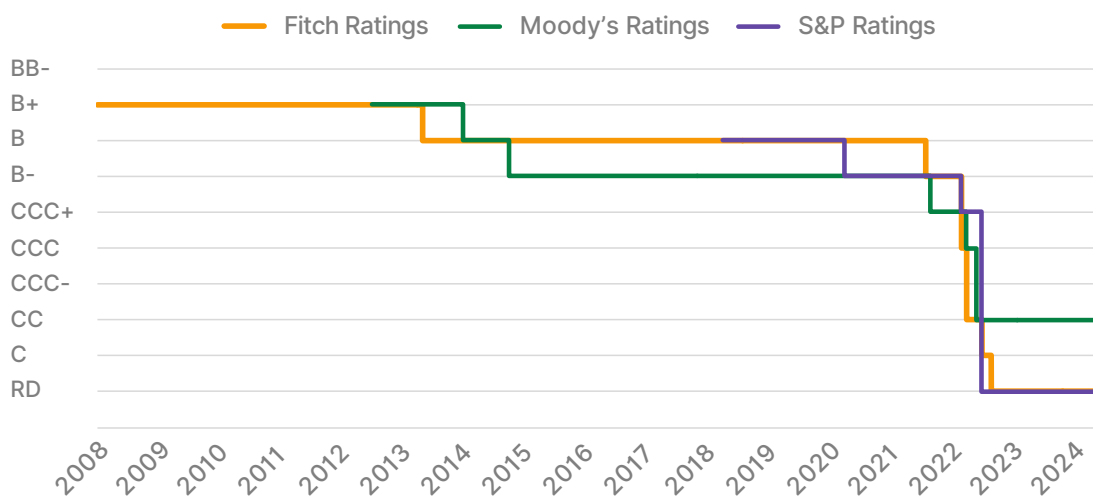
Source: Fitch Ratings, S&P Global, Moody's

BOX 3

The default acts as a heavy drag on Ghana's rating, as can be seen in the breakdown of Ghana's quantitative score in Fitch's sovereign rating model (SRM), which overshadows other credit strengths and weaknesses. Ghana's credit profile balances high governance, strong growth record, and credible fiscal and monetary policies with high inflation and growth volatility, limited external liquidity buffers, commodity dependence and a small economy. Curing the default and rightsising the public finances will be key for Ghana to recover its 'B' rating in the near future while addressing vulnerability to external shocks will be needed to graduate into the 'BB' category.

Exhibit 10 Ghana's in Fitch's Sovereign Rating Model (before qualitative adjustments)

Contribution to SRM output score (measured in rating notches)

	Contribution (notches)
Governance	3,9
GDP Per Capita	0,4
Share of World GDP	-1,6
Yrs. Since Default	-1,8
Broad Money / GDP	0,5
Growth Volatility	-0,7
Inflation	-1,4
Real GDP Growth	0,2
Debt / GDP	-1,6
Interest / Revenue	-1,1
Budget Balance / GDP	-0,2
FC Debt / Total Debt	-0,4
Reserve Currency	0,0
SNFA / GDP	-0,2
Commodity Dep.	-0,2
FX Reserves	0,1
Interest / CXR	0,0
CAB + FDI / GDP	0,0

Source: Fitch Ratings

Ghana was assessed as being at 'high' risk of debt distress under the joint IMF-World Bank debt sustainability framework from 2019 onwards as critical thresholds for debt sustainability were breached. The successful restructuring has since put Ghana's debt trend on a sustainable path (see Exhibit 11) and the IFIs see the country on track to meet DSA targets by 2028 (IMF 2024). However, it remains at 'high' risk of debt distress according to the criteria of the IMF-WB LIC-DSF, and although the latest DSA as part of the IMF extended fund facility review did not consider climate shocks, it highlights the high vulnerability to climate shocks such as flooding and droughts. If these physical hasard and the challenges related to soil erosion continue to weigh on the energy and cocoa sectors, then the projected growth and export earnings under the baseline assumption may seem overly optimistic.

BOX 3

Exhibit 11 Ghana's Public Debt Dynamics – Baseline Scenario

Gross Public Debt (% GDP)

IMF DSA (Dec. 2024 Extended Credit Facility Review) — Fitch DSA (Sept. 2024 Rating Review)
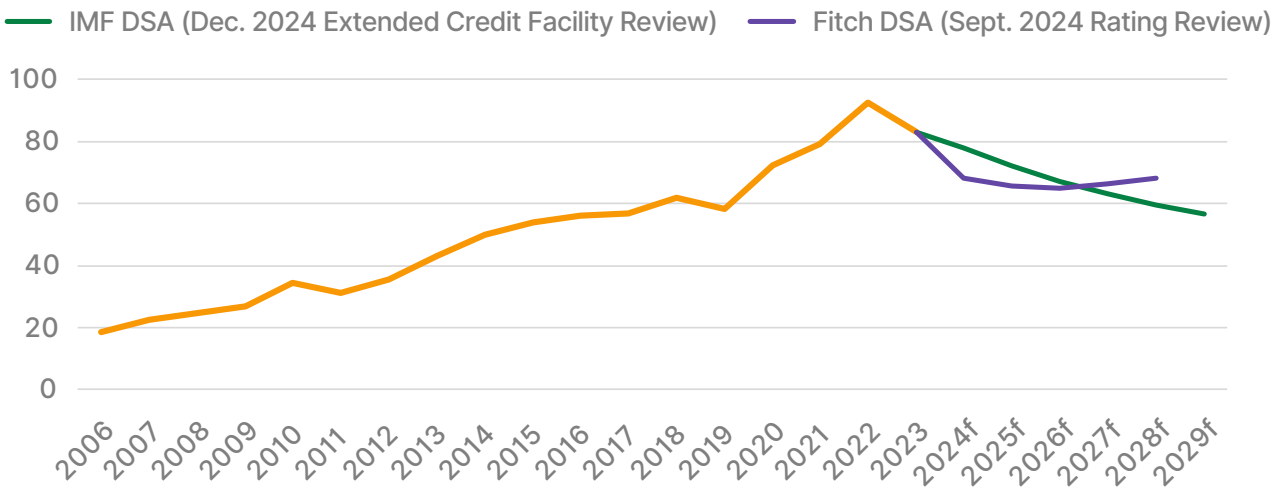
Source: IMF, Fitch Ratings

3.2 Performance Drivers

The next step is to identify the performance drivers that have a significant bearing on the outcome of the headline KPI. There are several reasons for including this component in the FIMA framework:

They enable a more holistic conceptualisation of the target and surrounding issue areas, helping to identify areas for policy intervention to achieve the desired KPI outcomes.

They constitute secondary metrics to measure the target, monitor performance, and establish additionality.

They provide early warning signals for the KPI.

They aid in mapping headline KPIs to macro-fiscal variables, especially where the linkages are unclear or tenuous.

They offer a framework for aligning use-of-proceed bonds and project-level KPIs.

Regarding the last point, FIMA can serve as the conceptual scaffolding for a sovereign financing strategy that combines different models and instruments into a coherent "stack". The headline KPI serves as the thread that ties together KPI-linked and programme-/project-based instruments, with the former providing the overarching policy or programmatic direction and the latter helping to drive implementation. In this way, the FIMA approach makes it possible to transcend the false binary between sustainability-linked and use-of-proceed instruments – as it is often framed within the sustainable sovereign finance discourse – and instead demonstrates how they can work synergistically to an overarching target.

The identification of performance drivers will be context-specific. The choice may reflect both economic logic as well as policy and programmatic priorities. For instance, for the headline forest cover KPI used in Ghana's FIMA (explained in detail in Section 4), the 'performance drivers' were those activities that are chiefly responsible for deforestation in the country: (i) unsustainable cropland expansion, (ii) artisanal and small-scale mining, (iii) illegal logging, and (iv) unsustainable cocoa expansion. Each of these has separate sets of sector-specific KPIs, constituting distinct points of policy and programmatic intervention for the Ghanaian government.

3.3 Public Financial Management (PFM) Applications

The next step in the FIMA process is to identify use cases for the KPIs that extend beyond SLSF operations to other areas of public financial management and public policy more broadly. These can strengthen the value proposition of a prospective SLSF operation for units outside the Ministry of Finance, who may benefit from the data and analytics behind the KPIs, as well as for the debt management office, which can spread the set-up and maintenance costs of the underlying data infrastructure to other agencies. Furthermore, as with the performance drivers, breaking out these downstream applications can surface additional macro-fiscal transmission channels to the DSA and rating profile, amplifying the uplift.

FIMA considers at least three broad areas of application for KPIs: financing, fiscal, and governance. Financing applications encompass any funding arrangement that can incorporate KPIs, whether debt, grants, guarantees or other instruments. Fiscal applications extend the KPIs from the financing to the spending side of the public ledger, for instance, by embedding them into fiscal frameworks and budgeting systems. It also includes KPI-linked revenue sources such as nature credits (i.e., carbon, biodiversity, water, etc.). Governance applications capture the qualitative impacts of KPIs, which are harder to quantify but can have a substantial influence on assessments of 'willingness to pay'. The remainder of the section briefly describes the main KPI applications for each of these clusters and summarises the linkages to the credit profile in Exhibit 13.

Financing Applications

Sovereign sustainability reporting: Sovereigns can track and report on sustainability themes using KPIs and the FIMA framework but without any mechanistic or contractual link to the terms of financing. Reporting on sustainability-linked KPIs, even if they are not part of a financing operation, can assist in improving relations with international financial institutions (IFIs), credit rating agencies, and investors. KPIs can give these groups greater confidence in the credibility and commitment of the issuer to manage credit-relevant risk exposures. Several frameworks have emerged to support such initiatives, including the Assessing Sovereign Climate-related Opportunities and Risks (ASCOR) project or the Taskforce on Climate Related Financial Disclosures (TNFD) (NatureFinance 2023).

Performance-based financing: Going one step further, these arrangements link financing terms to the outcomes of the KPIs in relation to predefined target parameters, thereby embedding a financial incentive for the issuer to pursue the targets. With sustainability-linked bonds and loans, for example, the interest rate "steps-up/-down" if a target is missed/achieved. The corresponding dis-/savings on public debt service are the main impacts on the credit profile, although issuers may also obtain better pricing at issuance (the so-called "greenium"). The proceeds of the instruments may be used for general budgetary purposes and are not typically tied to the targets, which allows them to be used for liability management operations. The range of eligible KPIs is, therefore, quite broad, from economy-wide indicators such as total national carbon emissions to sector-specific targets such as the share of renewables in the energy mix. Examples of such instruments include the first sovereign SLB issued by Chile in 2022, and the sovereign SLL arranged for Uruguay in 2023.

Project-based financing: Thematic use-of-proceed debt instruments ("green", "blue", "social", "sustainable", etc.) disburse funds to specific projects and generally contain reporting requirements covering project selection, allocation and execution. KPIs are not a strict requirement for these instruments, and neither are penalties for non-performance when they are included. ICMA's Green Bond Principles (GBP) recommend the use of KPIs to report on expected or achieved impacts, where feasible (ICMA 2021). In FIMA, the project themes can be aligned with headline KPIs and the project KPIs with the macro-fiscal impacts. This allows the different financing instruments to be "stacked" so that the higher-level policy or programme KPIs in the SLB/SLLs provide the overarching direction, while the programme- and project-level KPIs of UoP instruments help to drive the implementation of the projects.

Debt-for-development swaps (DDS): Debt swaps (also called debt conversions) combine elements of both performance- and project-based financing. Typically, the structures use the proceeds of a thematic bond that is issued by an offshore special purpose vehicle (SPV) for a sustainability-linked loan to the sovereign, which often carries credit enhancement such as a guarantee or political risk insurance to lower the interest rate charged to the borrower. The proceeds of the SLL, in turn, are used to retire outstanding expensive debt, and the savings are channelled via a trust fund into sustainability-linked projects such as nature conservation or climate adaptation. The structure can, therefore contain three interlinked KPI applications: for the UoP bond, for the SLL and for the end projects.

Outcome/Results-based financing (RBF): Unlike performance-based financing (PBF), RBF disburses funds after predefined results have been achieved, which can be outcomes of actions by the borrower or achievement of KPI targets. The distinction between performance and results can be blurry since the latter often require a track record of metrics or because the outcomes are staggered so that they effectively mirror a performance schedule. At the sovereign level, RBF has existed for many decades in the form of policy-based loans from development banks, which tie budget support loans to the enactment of pre-agreed policy actions or reforms. More recently, impact bonds and outcome bonds have emerged whereby philanthropic funds pay the returns on investment – e.g., coupon and interest payments, "success" payments, etc. – if certain outcomes are achieved – e.g., verified carbon removal credits issued, endangered species protected, etc. – although sovereigns have issued none to date. RBF and outcome bonds require credible metrics and robust reporting systems that mirror the role of KPIs in project- and performance-based financing.

Credit enhancement: Credit guarantees, insurance, collateralisation, and other de-risking mechanisms for sovereign debt aim to improve the cost and terms of borrowing by transferring all or part of the credit risk to a higher-rated guarantor. They are critical ingredients in DDS, and development banks and finance institutions have applied them to other sustainability-linked instruments (e.g., a SLB issued by the Development Bank of Rwanda in 2022). Furthermore, policy-based guarantees (PBG) have long been offered by development banks on a similar basis as budget support loans. Targets and KPIs play an important role in unlocking these facilities since guarantors may only provide credit protection in return for credible commitments. Ensuring that they are credit-relevant and financially material is even more salient in this arrangement since achieving the targets in principle reduces the likelihood that the credit enhancement will be triggered.

Grants: As with debt financing, the disbursement of grants can also be linked to KPIs on pay-for-performance or pay-for-results basis, as is the case with "cash-on-delivery" aid for governments where fixed payments are made for each unit of results (Birdsall 2010). Indeed, grants can also be integrated into performance-based debt structures, with philanthropic capital paying grants for KPI outcomes in lieu of interest step-downs.

Fiscal Applications

Sustainability tagging: Budget tagging involves identifying, coding, and classifying public expenditures with the aim of estimating and tracking them against a set of performance targets. Climate Budget Tagging (CBT) has been rolled out across a growing number of governments with the aim of measuring and monitoring alignment with climate targets, with similar initiatives for nature and the sustainable development goals (SDGs) (UNDP 2019; UNDP 2024). These frameworks and tools are being used by a growing number of countries to identify and routinely measure climate-relevant expenditure within the existing budget system.

Sustainability-linked Performance-based budgeting (SPBB): Going one step further than tagging, SPBB links the budgetary allocations for public-sector entities to their performance on predefined indicators. Typically, this entails incremental adjustments to appropriations over multiple budget cycles in ways that channel funding and incentivise action towards predefined targets. With "green budgeting", the targets pertain to sustainability themes and imply redirecting public investment, consumption, and taxation to green priorities and away from harmful subsidies. If this translates into budgetary savings, then the impact on the sovereign credit profile would depend on how the gains are apportioned. For instance, the savings could be used to improve fiscal metrics by paying down debt or to strengthen resilience to climate shocks via investments in adaptation or contingency reserves. Either case would be credit positive in terms of the rating or debt sustainability. Furthermore, to the extent that enhanced performance tracking, transparency, and accountability improve perceptions of policy effectiveness and fiscal discipline, then this should also flatter the qualitative dimensions of the credit analysis (i.e., the factors related to 'willingness to pay').

Ideally, the KPIs in SPBB should be the same or closely aligned with those in the financing side to ensure an optimal correspondence between sustainability-linked financing and the use of proceeds. It also mitigates the principal-agent problem described above since debt managers, who bear the direct consequences of whether the targets are achieved or not (i.e., they are held responsible for the potential coupon step-up or other penalties), can monitor performance in terms of budget appropriations, allocations, and execution. Theoretically, the debt-service savings from a coupon step-down can even be apportioned to those agencies based on their contribution to achieving the target.

Fiscal Applications

Sovereign/Jurisdictional Nature (Carbon, Biodiversity, Pollution, etc.) Credits:[3] Sovereign credits are essentially a KPI-linked revenue source for governments since their creation and enduring value depends on the performance of certain underlying assets or projects, such as standing forests or reforestation initiatives. The measurement, reporting, and verification (MRV) systems that are validating the performance are functionally the same as the data infrastructure underpinning SLSF. They both depend on transparent and robust processes, governance, and controls for buyers of either the credits or the debt to maintain confidence in the value. Indeed, in some instances, they may even be identical, as with KPIs that track deforestation and can be leveraged to develop REDD+ carbon credits.

Sovereign credits can be integrated into public financial management in at least four ways: (i) as direct revenue from credit sales, (ii) as collateral to secure better financing terms on debt transactions; (iii) as a substitute for debt service; (iv) as one of the assets in a swap transaction (see Box 4 for more details). The modelled macro-fiscal impact rests on multiple assumptions, including the projected volume and price of the credits, the valuation and monetisation of the credit, the size of the government's take and the use of proceeds from the credit transaction. Furthermore, the nature credit market remains inchoate, and its development has been hampered by weak demand and low prices. Nevertheless, sovereign credits are an essential instrument in the sustainable financing toolkit and can be valuable sources of fiscal revenue to compensate governments for the economic opportunity cost of forgoing extractive and polluting activities.

Governance Applications

Political risk: Threats to social and political stability, such as food insecurity and violence, are critical sovereign risks. As Fitch states in their sovereign rating criteria, political risks "capture the capacity and willingness of the authorities to mobilise resources to fund debt payments and the risk that this might be disrupted by civil unrest, political instability or conflict" (Fitch 2024). They are also deeply rooted in sustainability-related issues and, therefore, amenable to sustainability-linked solutions. Accordingly, when the selected headline KPIs track such phenomena directly (e.g., childhood nutrition rates) or their underlying causes and catalysts (e.g., deforestation leading to droughts leading to food insecurity), then they can serve as early warning signals of potential credit events such as famines or outbreaks of conflict. If the KPIs are also backed up by measures to foster social and political stability (e.g., school meals and conflict resolution programmes), then embedding them into KPI-linked financing can serve to signal commitment to tackling these risks, while hitting the targets signifies a reduction in susceptibility to such event risks. This capability to anticipate and manage political risks will likely become more important for creditworthiness going forward as the impacts of climate change and natural capital loss (biodiversity, soil health, clean air, and water) intensify.

Qualitative judgements around political risk play a significant role in sovereign credit assessment, especially for 'willingness to pay'. For instance, Fitch considers factors such as 'political stability and capacity', 'legitimacy of the regime', 'conflict and war risk', 'debt payment record', and 'risk to economic policy' as part of their 'qualitative overlay' to the quantitative rating. The agency also relies on the World Bank's Worldwide Governance Indicator (WGI) in its sovereign rating model, where it has the highest weight out of all other variables. Furthermore, political risk influences investor perceptions and, by extension, the cost of borrowing, which in turn feeds through to fiscal metrics and public debt dynamics.

---

[3] Jurisdictional nature credits refer to both credits from projects owned in part or in full by the government and to private-sector credits generated in reference to baselines set by the government and monitored by shared measurement, reporting, and verification (MRV) systems. The baselines and MRV systems cover an entire national or subnational jurisdiction, as opposed to project-based credits that rely on site-specific MRVT therefore, the private-sector credits are effectively "nested" within the jurisdictional programme.

**Governance
Applications**

Government effectiveness: Successfully tracking KPIs and achieving targets can be markers of high government effectiveness, which Fitch defines as "the ability of government and institutions in managing economic activity and absorbing adverse shocks" (Fitch 2024). Moody's defines "policy effectiveness" as "the willingness and capacity of a country's institutions to design and implement policies which foster economic and fiscal strength," especially in terms of debt sustainability (Moody's 2025).

SLSF arrangements can help to bolster policy credibility and predictability since they contain commitment devices and financial incentives and tend to extend through multiple political cycles. In this regard, they function similarly to institutional "fiscal rules" aimed at transparency and policy discipline. Just as these are generally viewed as credit-positive by the rating agencies, so should KPIs that support policy continuity in credit-relevant issue areas. Furthermore, to the extent that the targets enhance resilience, then the gains in shock-absorption capacity should be recognised quantitatively and qualitatively in the credit assessment and DSA.

The applications listed above are not exhaustive, and developing more use cases can enhance the value proposition of SLSF. The enabling data infrastructure and related analytical tools may also have applications in central banking, financial supervision, energy policy, or other issue areas, all of which have material linkages to the credit profile. As the state of the art in measuring and monitoring climate, nature, and other emerging risks advances, the opportunities for developing use cases for KPIs will expand. The larger the user base for KPIs and their enabling technology, the greater the economies of scale and scope in developing a data infrastructure.

BOX 4

Sovereign Nature Credits

Sovereign credits (nature, biodiversity, water, pollution) have the potential to play an important role in sovereign finance. As the market for nature credits achieves scale and the volumes become meaningful from a fiscal standpoint, there will be increasing opportunities to leverage credits for public financial management. At least four mechanisms are possible:

1 **Credit trading:** Governments can create and sell assets generated from a net reduction or removal of greenhouse gas (GHG) emissions (carbon credits) and/or from the protection, regeneration, and stewardship of biodiversity (biodiversity credits, including the provision of ecosystem services), although the latter is still in a nascent stage of development. The assets or credits can be monetised via bilateral result-based payments (e.g., REDD+ Results Units - RRUs), the voluntary carbon markets (VCM), compliance markets such as emissions trading systems (ETS), and the emerging sovereign carbon markets under Article 6 of the Paris Agreement, which include the trading of Internationally Transferred Mitigation Outcomes (ITMOs). At present, several transactions have been finalised, and more pilots are underway for both Jurisdictional REDD+ and Article 6 sovereign credits, although significant work is needed to build the global trading platforms and governance architecture and to operationalise biodiversity credits.

2 **Credit collateral:** Sovereign loans and bonds can be secured with the revenue streams from the issuance and sale of nature credits, with the proceeds channelled into a "sinking fund" that can be drawn down to service the debt in the event of liquidity or solvency problems. Collateralising debt in this manner can improve the credit risk of the instrument and facilitate access to sovereign financing when conventional unsecured sources are not available. Although credit collateral has yet to be piloted, revenue- and asset-backed structures, as well as sinking funds, are relatively common in public finance.

3 **Credit coupon:** The debt service on sovereign bonds and loans can be linked to the issuance of credits, with interest being paid out in credits or their cash equivalent. For instance, credit-linked "outcome bonds", such as the recent issuances by the World Bank in Vietnam, Ghana and Indonesia, and Brazil, typically pay a below-market interest rate that is tied to credits from designated projects. Conceivably, credit-linked outcome bonds can be offered by a sovereign or sub-sovereign, with the added benefit that sovereign credits can be used to service debt rather than general budgetary funds, thereby creating a degree of liquidity relief. They can also be offered at the wholesale or retail level, with the latter offered to small-scale investors.

4 **Credit swaps:** The principal on outstanding bonds or loans can be repaid with sovereign credits of equal or lesser value or exchanged for a new credit-linked instrument such as an outcome bond. This might occur in a distressed situation as part of a sovereign debt restructuring or as a creditor-led initiative to provide climate and nature finance in accordance with the Paris Agreement and Kunming-Montreal Global Biodiversity Framework (GBF). The closest example of such a debt-for-credit swap occurred in 2011 when Spain agreed to exchange US$10 million of bilateral debt in return for Certified Emission Reductions (CERs) aligned with the clean development mechanism of the Kyoto Protocol (see Cassimon et al. 2011). However, as liquidity and solvency pressures on heavily indebted and climate-exposed sovereigns mount, their multilateral and bilateral creditors may become more amenable to receiving sovereign credits in lieu of hard currency. This allows the creditors to tackle the sovereign debt crisis and fulfil their climate/nature financing commitments.

3.4 Macro-Fiscal Impact

Macro-fiscal impacts are the transmission channels through outcomes on the KPIs feed through to the credit rating and public debt dynamics. The variables are generally grouped into four pillars (see Exhibit 12): (i) structural and institutional, (ii) macro/monetary, (iii) fiscal accounts, and (iv) external accounts. Sovereign credit rating incorporates a diverse set of inputs under each of these rubrics, whereas debt sustainability analysis is a function mainly of fiscal and external metrics.

Exhibit 12 Key Macro-Fiscal Variables*

Structural / Institutional Pillar	Macro / Monetary Pillar	Public Finance Pillar	External Finance Pillar
GDP Per Capita 🟡🔵🔴	GDP Growth 🟡🔵🔴🟣	Debt Burden 🟡🔵🔴🟣	Reserve Currency Status 🟡🔴
History of Default 🟡🔵	GDP Volatility 🟡🔵🟣	Interest Bill 🟡🔵🟣	Net Creditor Status 🟡🔴
Board Money Supply 🟡	Inflation / Deflator 🟡🔵🟣	Budget Balance 🟡🔴🟣	Commodity Dependance 🟡🔴
Size of the Economy 🟡🔵	Credit Growth 🔴	Foreign Currency Share 🟡🔵🟣	External Debt Burden 🔴🔴🟣
Policy Effectiveness 🟡🔵🔴		Public Asset 🟡🔴	FX Liquidity 🟡🔵
Political Risk / Stability 🟡🔵🔴		Public Sector Debt Burden 🔵🟣	Net FDI Inflows 🟡
Rule of Law 🟡🔵🔴		Refinancing / Rollover Risk 🔵🔴🟣	
Transparency & Accountability 🟡🔵🔴		Banking Sector Risks 🔵🔴🟣	
Geopolitical Risk 🟡🔵🔴		Climate / Nature Risks 🟡🔵🔴🟣	
		Misc. Contingent Liabilties 🔴🟣	

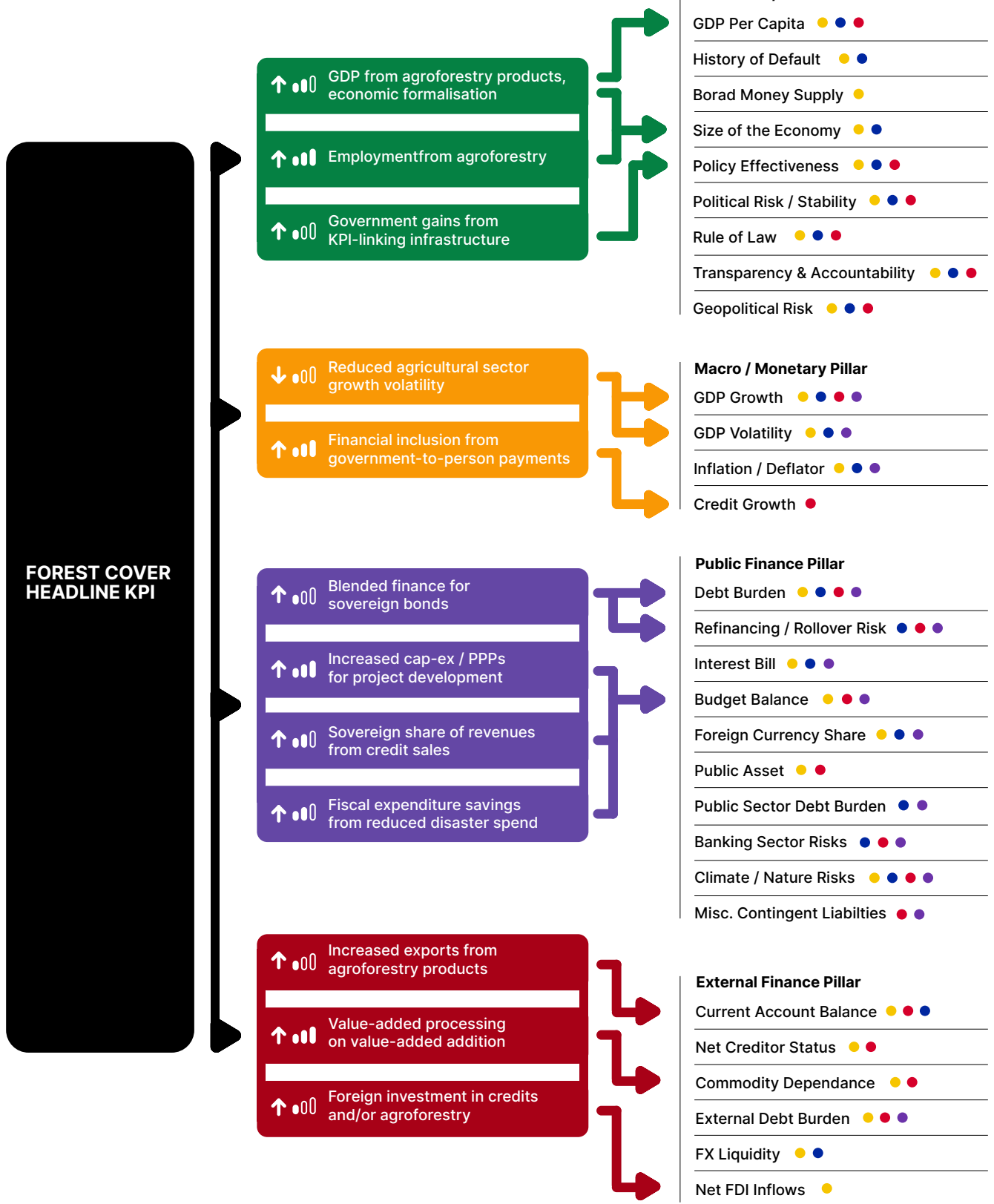🟡 FitchRatings   🔵 Moody's   🔴 S&P Global Ratings   🟣 THE WORLD BANK / INTERNATIONAL MONETARY FUND

*Color-coding corresponds to whether variables is used in the credit rating model or DSA of the institution

Source: SSDH

Specifying and quantifying the relationships between the KPIs, performance drivers, and PFM applications and the macro-fiscal variables that drive ratings and the DSA requires complex, rigorous, and iterative modelling. The first step is to sketch out the linkages between them based on economic theory and existing empirical research, noting the hypothesised direction and intensity of the transmission effects. This sketching is performed on a case-by-case basis, as every country will have idiosyncratic structural features that condition the relationships. The schematic in Exhibit 13 displays the linkages for deforestation KPIs as applied to Ghana. Next, careful statistical analysis is needed to derive and calibrate the coefficients between the variables that provide the best estimates of the quantitative impact of a change in the headline KPI. The results are subject to high degrees of statistical uncertainty, yet they still provide a meaningful indication of the direction and magnitude of impact.

Exhibit 13 Stylised Forest Cover KPI-Credit Mapping

FOREST COVER HEADLINE KPI

↑ GDP from agroforestry products, economic formalisation

↑ Employmentfrom agroforestry

↑ Government gains from KPI-linking infrastructure

Structural / Institutional Pillar

GDP Per Capita 🟡 🔵 🔴
History of Default 🟡 🔵
Borad Money Supply 🟡
Size of the Economy 🔵
Policy Effectiveness 🟡 🔵 🔴
Political Risk / Stability 🟡 🔵 🔴
Rule of Law 🟡 🔵 🔴
Transparency & Accountability 🟡 🔵 🔴
Geopolitical Risk 🟡 🔵 🔴

↓ Reduced agricultural sector growth volatility

↑ Financial inclusion from government-to-person payments

Macro / Monetary Pillar

GDP Growth 🟡 🔵 🔴 🟣
GDP Volatility 🟡 🔵 🟣
Inflation / Deflator 🟡 🔵 🟣
Credit Growth 🔴

↑ Blended finance for sovereign bonds

↑ Increased cap-ex / PPPs for project development

↑ Sovereign share of revenues from credit sales

↑ Fiscal expenditure savings from reduced disaster spend

Public Finance Pillar

Debt Burden 🟡 🔴 🟣
Refinancing / Rollover Risk 🔵 🔴 🟣
Interest Bill 🟡 🔵 🟣
Budget Balance 🟡 🔴 🟣
Foreign Currency Share 🔵 🟣
Public Asset 🔴
Public Sector Debt Burden 🔵 🟣
Banking Sector Risks 🔴 🔴 🟣
Climate / Nature Risks 🟡 🔵 🔴 🟣
Misc. Contingent Liabilties 🔴 🟣

↑ Increased exports from agroforestry products

↑ Value-added processing on value-added addition

↑ Foreign investment in credits and/or agroforestry

External Finance Pillar

Current Account Balance 🟡 🔴 🔵
Net Creditor Status 🟡 🔴
Commodity Dependance 🔴 🟣
External Debt Burden 🟡 🔴 🟣
FX Liquidity 🟡 🔵
Net FDI Inflows 🟡

Direction of impact

↑ Positive
→ Neutral
↓ Negative

Magnitude of impact

▮▮▮ High
▮▮▯ Medium
▮▯▯ Low

Channels of impact*

Credit Ratings

FitchRatings 🟡
Moody's 🔵
S&P Global Ratings 🔴

Debt Sustainability Analysis

THE WORLD BANK
INTERNATIONAL MONETARY FUND 🟣

*Color-coding corresponds to whether variables is used in the credit rating model or DSA of the institution

Source: SSDH

4

FIMA Case Study
Ghana

④ **FIMA Case Study** Ghana

The following case study develops and tests the financial materiality assessment (FIMA) framework on forestry KPIs in Ghana. It simulates how a business-as-usual trend in Ghana's forestry sector can exacerbate the vicious cycle depicted in Exhibit 1, likely keeping its creditworthiness constrained and vulnerable to repeated shocks for the foreseeable future and preventing the country from treading a path out of serial debt distress. On the upside, the FIMA framework shows how reforestation and afforestation efforts can generate macro-fiscal uplift to the sovereign credit rating, including via enhanced policy effectiveness and policy credibility and the issuance of carbon credits. The case study scopes out and quantifies these gains in public financial management in terms of improvements in debt sustainability and positive sovereign rating dynamics. Indeed, part of the rationale for this study is to counter the widespread view among market participants that climate and nature risks will inexorably drag down vulnerable sovereigns such as Ghana, which risks creating a self-fulfilling prophecy by incentivising countries to "double down" on unsustainable but proven extractive growth strategies. The insights and lessons from this case study, which is a theoretical exercise grounded in applied macroeconomics, demonstrate the potential of sustainability-linked financing and performance-based public financial management to arrest and reverse the climate-nature-credit cycle in vulnerable countries.

The choice of targets and KPIs reflects the important role that natural capital, in general, and forestry, in particular, has in Ghana's economy. Ghana is a nature-rich country that has historically relied heavily on natural capital, especially cocoa production – Ghana is the second-largest producer globally after Côte d'Ivoire – to power economic growth (see Exhibit 15). Nature's contribution has diminished gradually in recent decades relative to non-renewable sources, both because of a surge in oil, gas, and gold activities but also because of natural resource depletion and pollution damage. The World Bank estimates the cost of environmental degradation in Ghana at about US$6.3 billion, equivalent to 11% of 2017 GDP (see World Bank 2020). This has had a direct impact on cocoa exports, which have been declining significantly in recent years, from a peak of US$2.8 billion in 2021 to around US$1.5 billion in 2023 despite surging prices in international markets, eroding an important source of foreign exchange and employment (IMF 2024).
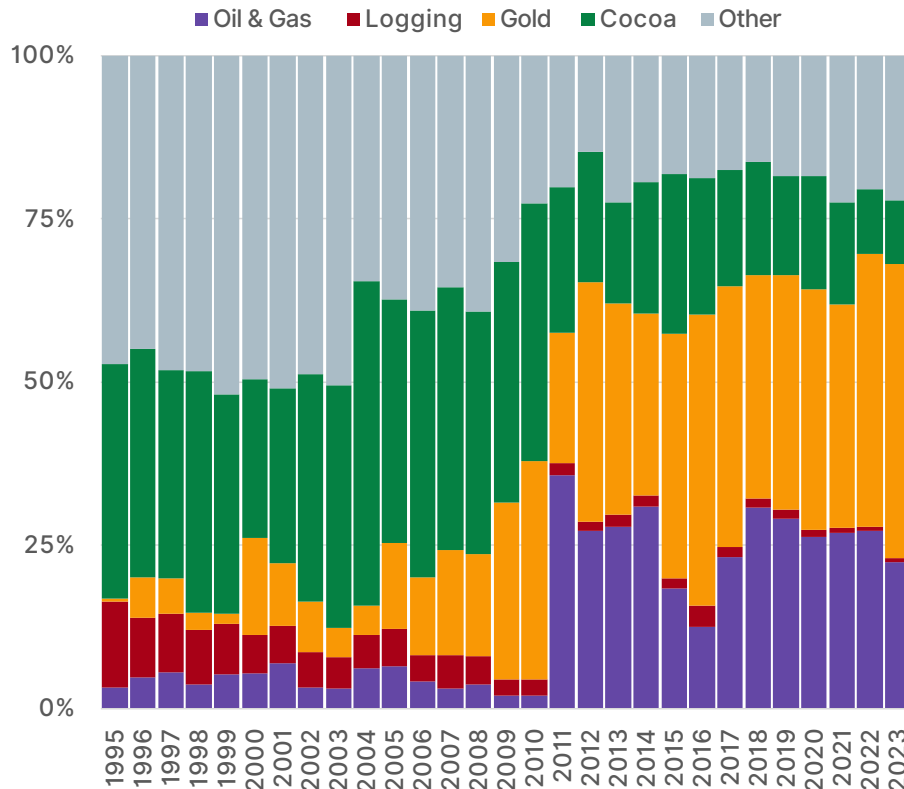
Exhibit 14 / 15 Nature Role in Ghana's Economic Story

Exhibit 14. Resource rents % GDP
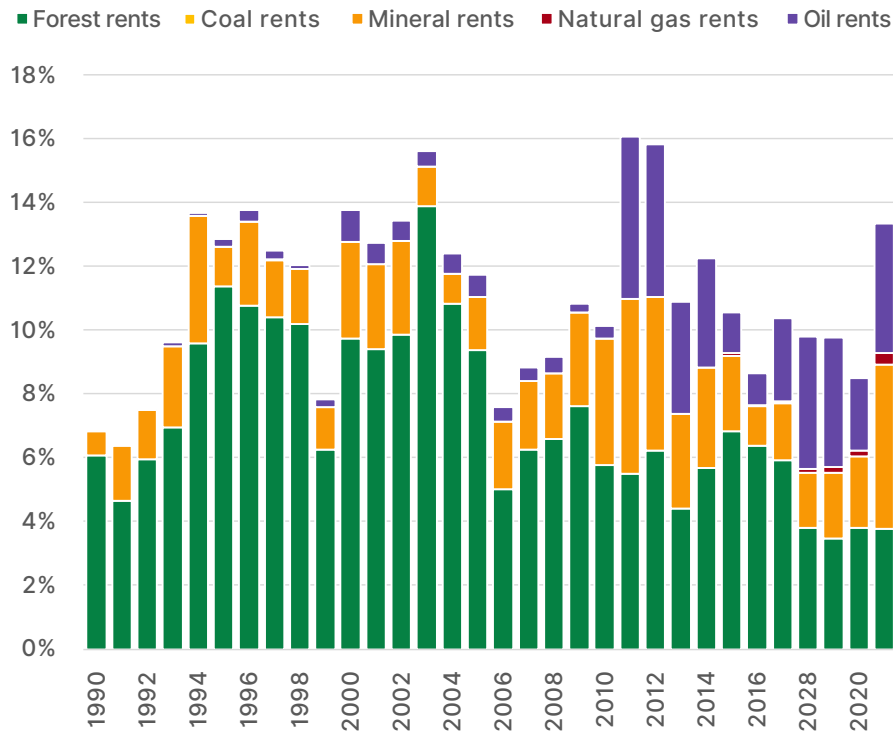
Source: World Bank

Exhibit 15. Goods trade, % total

Source: UNCTAD

The 'headline KPI' chosen for this FIMA case study is the trend in re-/deforestation. The links between deforestation and macroeconomic performance are well documented (Dasgupta 2021; Ranger et al. 2023; Gardes-Landolfini 2024; NGFS 2024). Ghana's economic dependence on the forest sector is especially pronounced — forest rents constituted 3.8% of GDP in 2021, more than double the ratio for Sub-Saharan Africa and 10 times for LMICs. At the same time, the rate of deforestation is also well above peer average — net forest depletion is well above peer levels. Hence, standing forests and deforestation have a significant role to play in Ghana's credit story, this is made clear in the following sections through the lens of the FIMA framework. For the purposes of this analysis, we consider only gross forest surface cover measured in hectares; no distinction is made among forest type or use.

Exhibit 16 Ghana FIMA Mapping

Source: SSDH

4.1 Modeling Macro-Fiscal Impacts of Re-/Deforestation Scenarios

The first steps in the FIMA process were to plug the forestry KPI into a macroeconomic model of Ghana and then to simulate the impact of different deforestation scenarios on headline indicators of growth and fiscal, monetary, financial, and external performance. In the first instance, the effects of deforestation and reforestation on Ghana's economy were assessed through a sectoral approach, focusing specifically on agriculture (the principal staple and industrial crops of cocoa, maize, sorghum, cassava, yam, rice), forest logging, and gold mining. Collectively, these accounted for almost 23% of Ghana's GDP in 2021. Computations of potential effects on sectoral GDP were performed for both negative and positive scenarios of key variables such as area of operations, yields, and illegal share of practice, as summarised in Table 1 of the Appendix.

Exhibit 17 Share of Ghana's 2021 GDP covered by the analysis

Out of scope sectors 77,2%

22,8%

Gold mining 7,1%

Crops other than cocoa 12,0%

Logging 1,5%

Cocoa 2,2%
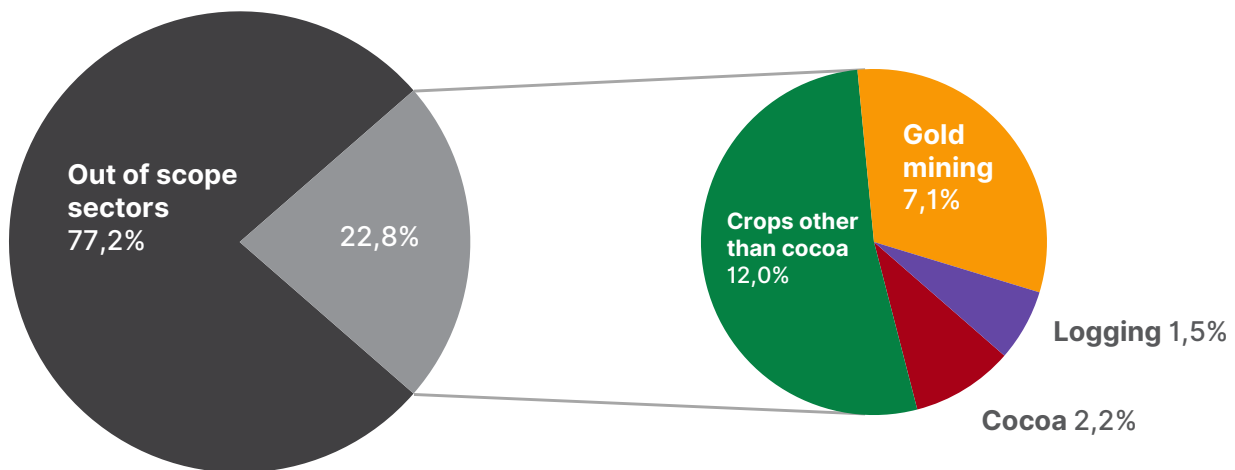
Source: Ghana Statistical Service

For each sector, the impact on output is calculated under baseline, optimistic, and pessimistic assumptions. The impact of reforestation on output is isolated and measured as the change relative to the baseline, keeping the broader macroeconomic conditions unchanged. The changes in production are then translated into impacts on headline GDP growth using the sectoral composition of Ghana's GDP. The three scenarios are summarised as follows, with the impact on total forest surface cover depicted in Exhibit 18:

Baseline scenario

No significant action is taken towards reforestation or to arrest deforestation. In all sectors, production continues to evolve on the same trend as over the past 5-to-10 years. For agricultural sectors, land expansion and yields are both in line with past trends, as with logging and gold mining production.

Scenario 1 – Optimistic

Reforestation targets are met. Agriculture GDP is impacted by the opposite effect of reduction of slowdown in cropland expansion, and of increased yields through interventions such as curbing land depletion and shading crops in some cases.
For logging and gold mining, the impacts stems from a slowdown of production area, offset by a larger formalisation of the activities in these sectors.

Scenario 2 – Pessimistic

Deforestation continues and yields decline due to climate change, as per the past trend observed in recent years. Similarly to the baseline scenario, land expansion and yields are in line with past trends, except for cocoa, where yields drop further, reflecting the absence of countermeasures.

Exhibit 18 Estimates of forest surface preserved optimistic scenario (sectoral breakdown, cumulative kha)

Legend: Cocoa, Maize, Sorghum, Rice, Gold mining
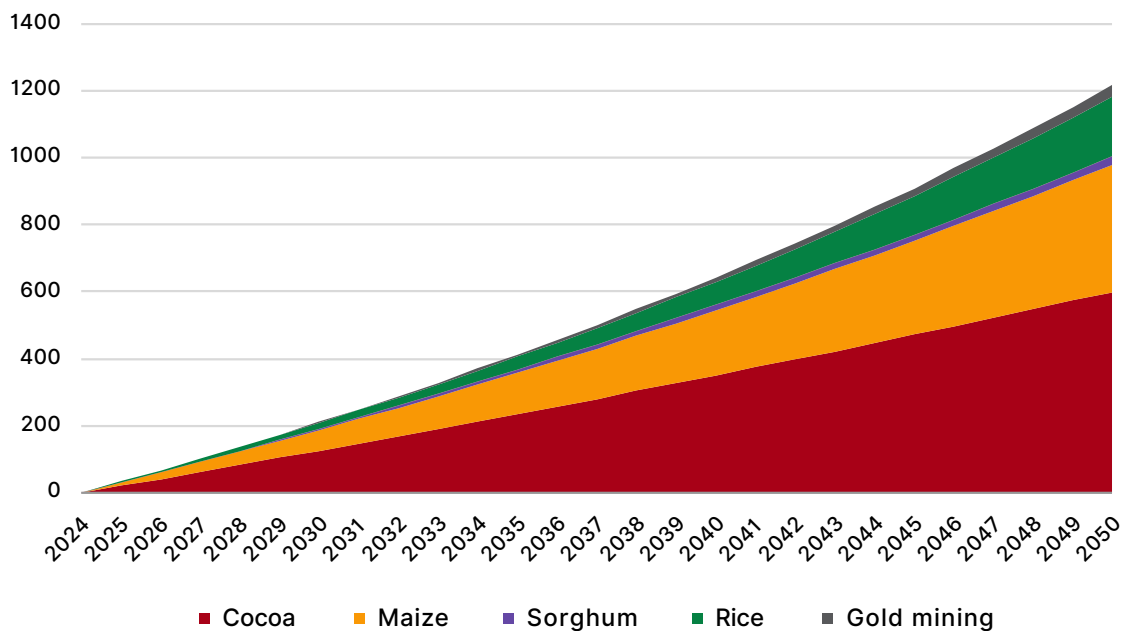
Source: SSDH estimates, based on data from Global Forest Watch, Ghana Ministry of Agriculture.

Note: Agricultural subsectors of cassava, yam crops and logging are also included in the analysis, but they do not contribute significantly to curbing deforestation, thus are not visible in this graph (see assumptions in Appendix).

The positive GDP effects of reforestation are most significant in the agricultural sector, particularly for cocoa, but also for other crops. Productivity gains in the sector exceed the losses related to the reduced expansion of cultivated lands. In contrast, for forest logging, the negative effects related to the slowdown in deforestation are stronger than the gradual formalisation of the sector, leading to a net negative effect on GDP. In the gold sector, the negative and positive effects offset each other, resulting in a net effect close to equilibrium, which is, therefore, less visible in the breakdown (Exhibit 18, above). Cumulatively, these effects peak at around 1% of additional annual GDP by around 2034, before stabilising from 2040 onwards, allowing for a sustainably higher GDP than the Baseline scenario by 0.8% thereafter. At the end of the time horizon, the cumulative effects (in % of GDP for each year they occur) reach +18.3% in the optimistic scenario and -7.0% in the pessimistic scenario.

Exhibit 19 / 20 GDP effects of reforestation across considered sector under Scenario 1 - Optimistic

Exhibit 19 Yearly GDP Gain (GDP % change)
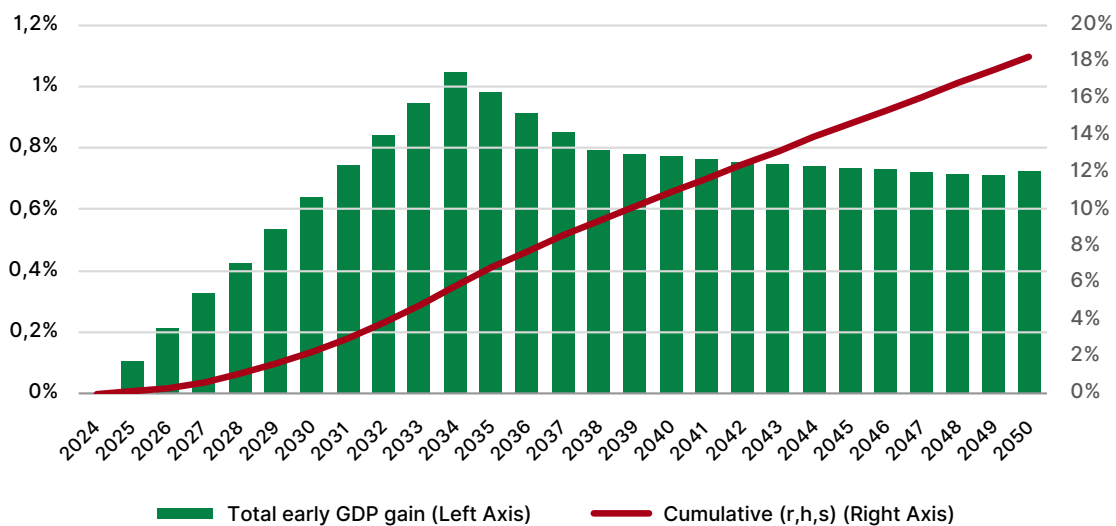
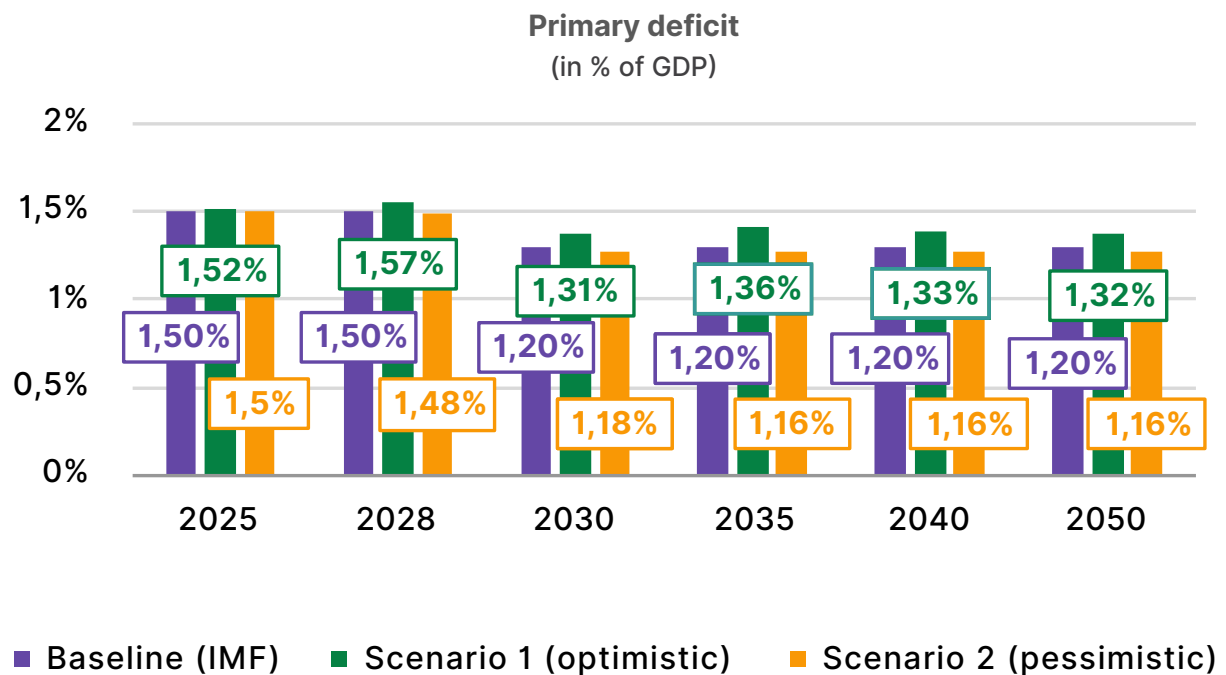**Exhibit 20** GDP gain by sector (GDP % change)
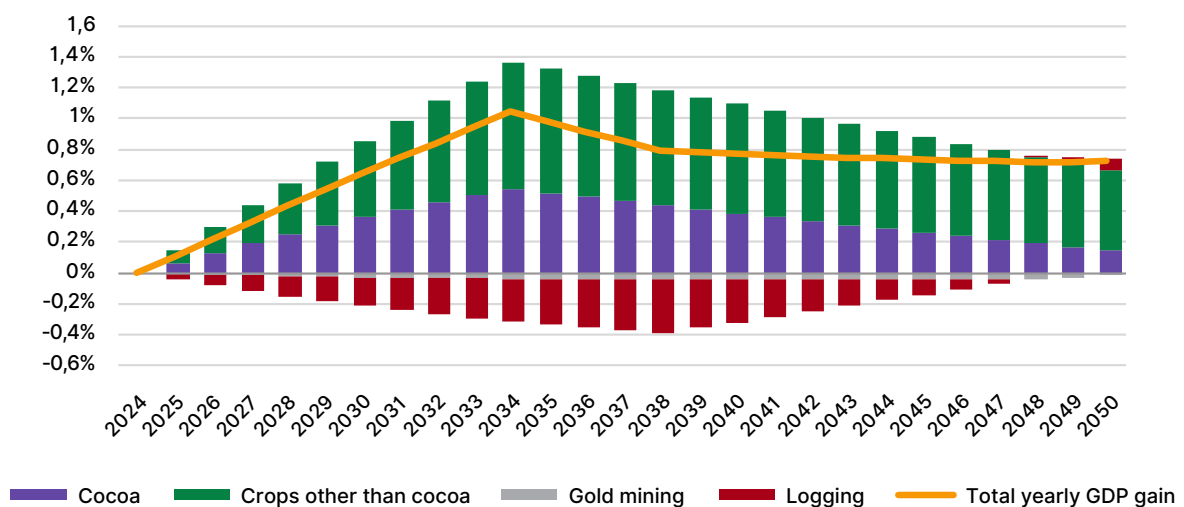
Source: SSDH

Other macroeconomic knock-on effects on headline trade, inflation, exchange rate, and interest rate dynamics show corresponding positive and negative effects for the optimistic and pessimistic assumptions, respectively. The results were derived using a New Keynesian Framework (see Appendix for details) and are summarised in Exhibits A1-A4. In the optimistic scenario, the exchange rate appreciates compared to the baseline on the back of higher exports and GDP, and inflation slightly decreases from the baseline between 2026 and 2034, allowing for a faster reduction of interest rates. The pessimistic scenario shows the same pattern in the opposite direction in similar orders of magnitude.

The combined effect of these macroeconomic forces on the fiscal accounts is modelled as improvement or deterioration in the primary balance (general government budget balance excluding interest payments), with a lower/higher primary deficit over the forecast horizon for the optimistic/ pessimistic scenario. The general government revenue-take as a proportion of GDP is held constant in all scenarios, under the assumption that interventions in the forestry sector do not alter the tax structure. Likewise, on the spending side, most expenditures were kept the same as the baseline scenario except for subsidies, which behave pro-cyclically. Accordingly, with revenue outpacing expenditure growth in all scenarios, the primary balance is set to improve during the forecast period, rising by a greater/lesser amount in the optimistic/pessimistic scenario (see Exhibit 21).

**Exhibit 21** Forecast of primary balance

Primary deficit
(in % of GDP)

Legend: ■ Baseline (IMF) ■ Scenario 1 (optimistic) ■ Scenario 2 (pessimistic)

Year	Baseline (IMF)	Scenario 1 (optimistic)	Scenario 2 (pessimistic)
2025	1,50%	1,52%	1,5%
2028	1,50%	1,57%	1,48%
2030	1,20%	1,31%	1,18%
2035	1,20%	1,36%	1,16%
2040	1,20%	1,33%	1,16%
2050	1,20%	1,32%	1,16%

Source: SSDH

4.2 Debt Sustainability Analysis of Forestry KPIs

Having derived all the variables needed to complete a public debt dynamics equation, it is now possible to draw implications of long-term forestry trends on public debt sustainability. The debt sustainability analysis (DSA) performed for this FIMA is based on the IMF and World Bank's low-income country DSA model. This approach, which is laid out in Exhibit 22 , compares the impact on debt metrics by analysing (1) different macroeconomic scenarios, as outlined in the prior section; (2) the debt service on the existing debt to simulate Ghana's financing needs over the forecast period; and (3) various financing strategies, including the potential use of sustainability-linked bonds (see below).

Exhibit 22 Dynamics of the Debt Sustainability Analysis
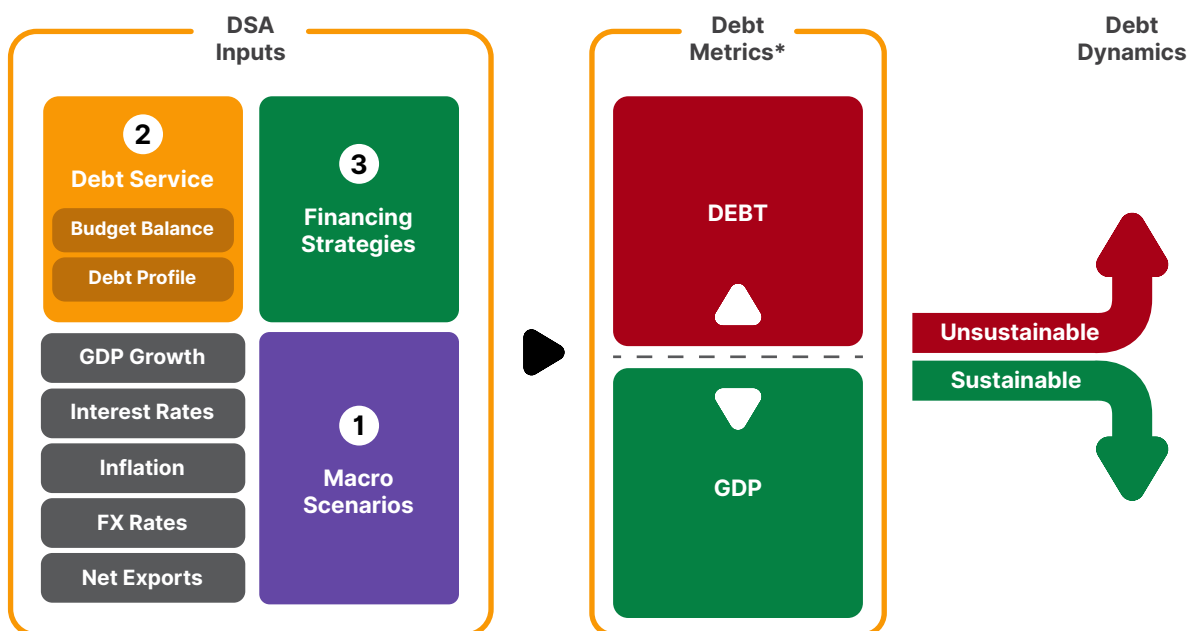
*IMF-WB LIC DSA refers to multiple metrics (see Box 1), only debt-to-GDP used here for illustrative purposes

To forecast the gross financing needs — i.e., the financing to cover any budget deficits and debt service payments — the new debt issuance must be specified. The debt service projection in the scenario analysis is a combination of (i) new official, domestic, and non-bonded commercial financing that remains unchanged across the three scenarios,[4] plus (ii) the new bonded commercial debt that will be issued either in the form of a plain vanilla instrument (in the baseline scenario) or of a sustainability-linked bond (in the optimistic and pessimistic scenarios).[5] Regarding the latter, Ghana is assumed to regain market access from 2027 onwards. At this point, it will start issuing SLBs containing the headline forestry KPI that achieves its reforestation target after five years in the optimistic scenario or fails to in the pessimistic scenario. The outputs of DSA for optimistic scenario are summarised in Table 1.

---

[4] External disbursements include the World Bank, IMF, AfDB and an envelope for bilateral development partners, as detailed by the IMF. An envelope for non-bonded commercial debt is also included. Domestic debt in 2024 is assumed to consist of T-bills issuance only, with interest rates linked to inflation forecasts per the different macroeconomic scenarios, creating a slight difference between scenarios.

[5] The commercial debt issuance will, therefore, be as follows. Baseline scenario: 1bn US$ of plain vanilla bond issued every year between 2027 and 2034, with a maturity of 10y, a bullet payment and a coupon of 10% paid annually. Scenario 1 (optimistic): 1bn USD issued yearly between 2027 and 2034, through a sustainability-linked bond, with a 10% coupon that would step-down to 9.5% (-50bps) after 5 years. This scenario assumes that the KPI triggering the step-down is met. Scenario 2 (pessimistic): 1bn USD issued yearly between 2027 and 2034, through a sustainability-linked bond, with a 10% coupon that would step-up to 10.5% (+50bps) after 5 years. This scenario assumes that the KPI linked to the SLB are not met.

Exhibit 23 Ghana's Debt Dynamics Chart (in % of GDP)

IMF Baseline (December 2024)(1)

Potential trajectory with reforestation
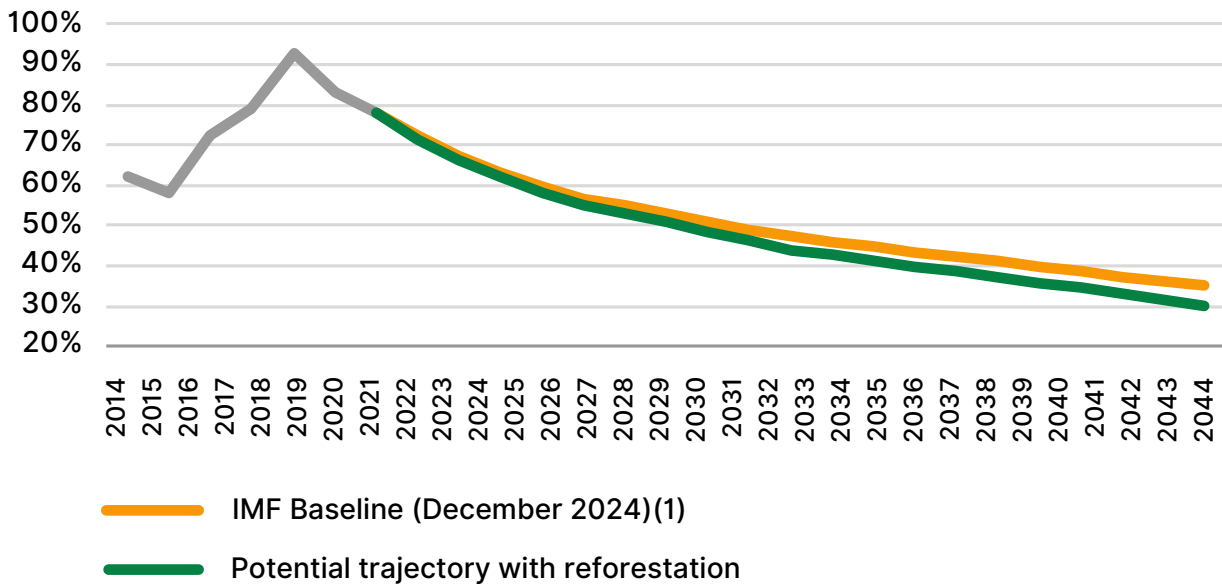
Source: SSDH

Table 1 Model outputs of the optimistic scenario compared to the baseline scenario by 2034

	Between the optimistic scenario and the baseline	Between the pessimistic and the optimistic scenario*
Decrease in the stock of total public debt in percentage point by 2034	-2.5pp	+3.21pp
Interest payments saved between 2024 and 2034 (in GHS bn)	-40.9bn GHS	+55.32bn GHS
Lower interest payments to revenue ratio in percentage points by 2034	-1.7pp	+1.9pp
Key ratios under the IMF DSA Assessment		
PV External Debt / GDP	-0.5pp	+0.7pp
PV External Debt / Exports	-3.7pp	+5.7pp
External Debt Service / Exports	-0.6pp	+1.0pp
External Debt Service / Budgetary Revenues	-0.5pp	+0.6pp
PV public debt / GDP	-2.5pp	+3.1pp

*Due to the exchange rate difference between the various scenarios, the gains are expressed in GHS.

In a scenario where KPIs on SLB are met (Scenario 1 – optimistic), the choice of SLB over ordinary plain vanilla issuances on international capital markets allows for both public debt reduction and interest savings. The resulting step-down in the coupon is assumed to be 50 basis points kicking in five years after issuance (i.e., from 2032 onwards), which amount to savings on interest payments of US$ 500 million between 2024 and 2034, including the effect of the higher exchange rate compared to the baseline scenario.

Table 1 above also illustrates the uplift on the external and public debt ratios that the IMF considers in evaluating the risk of debt distress for a country. In the case of Ghana, two ratios have been particularly important for the IMF are (a) the PV of external debt-to-revenue and (b) the PV of public debt-to-GDP. Both these ratios show improvement in the optimistic scenario.

4.3 Sovereign Credit Rating Analysis of Re-/Deforestation Scenarios

Building on the macroeconomic and DSA results, this section examines how reforestation efforts could affect Ghana's long-term credit rating by the three major rating agencies (Fitch, Moody's, and S&P). The methodological approach for this analysis is described in the Appendix. Important to note is that the impact is measured at the target year 2034, thereby affording enough time for the macroeconomic transmission and SLB coupon ratchet to manifest in the rating inputs. Furthermore, the analysis does not predict the rating per se; instead, it isolates the quantitative variation in ratings that can be attributed directly to reforestation, which reflects differences between the baseline scenario and either the optimistic or pessimistic outcomes.

The rating analysis indicates that Ghana could see an improvement on its sovereign rating of up to 1 notch for each of the agencies because of the macro-fiscal uplift from reforestation activities (optimistic scenario). For illustration, that means if Ghana were to stand at an indicative rating level of 'B-' for rating level of 'B-' for S&P and holding everything else equal, reforestation and attending macroeconomic spillovers alone could lift the sovereign to 'B'. However, this analysis rests on multiple assumptions and complex interaction effects spelt out in the Appendix. It is a conservative estimate based only on a few quantitative variables. Qualitative factors are not considered in these simulations, even though, as argued in Section 3, it is conceivable that improved nature and economic stewardship via sustainability-linked sovereign finance could have a positive bearing on governance consideration in the credit profile. It also omits the potential for new sources of fiscal revenue tied to the KPIs that could further bolster the sovereign credit profile, such as carbon credits.

Table 2 Variables shocked in the simulation

S&P	Moody's	Fitch
Macroeconomic variables		
Real GDP per capita growth	Real GDP growth	Real GDP growth (%)
GDP per capita (USD)	GDP per capita (PPP)	Consumer Price Inflation (annual average %)
	Volatility in Real GDP Growth	Real GDP growth volatility
	Nominal GDP	
Fiscal-related variables		
Gross external financing needs (% of CAR + reserves)	General Government Debt (% of GDP)	Gross General Govt Debt (% of GDP)
Narrow net external debt (% of CAR)	General Government Debt (% of revenue)	General Govt Interest (% of Revenue)
Net general government debt (% of GDP)	General Government Foreign Currency Debt (% of GDP)	General Govt Fiscal Balance (% of GDP)
Change in net general government debt (% of GDP)		FX reserves (months of CXP)
General government interest expenditures (% of GDP)		External Interest Service (% of CXR)
General government interest expenditures (% of revenue)		

4.4 Adding Sovereign Carbon Credits

The FIMA framework accounts for the possibility of generating additional fiscal revenue sources from KPIs, which in this case pertains concretely to carbon credit from avoided deforestation. The sectoral approach employed for the macroeconomic forecasting indicates the potential trajectory of deforestation in terms of forest surface cover under the baseline and upside/downside scenarios. These estimations make it possible to project the total surface of forest preserved over the entire 25-year time horizon, starting from a reduction in deforestation of roughly 30k hectares in 2025 to above 40k hectares per annum in 10 years. This avoided deforestation implies increased sequestration of carbon from the atmosphere, which can be estimated quantitatively using research into the average carbon removal rate of regenerated forests (for instance, see Bernal et al. 2018). On this basis, it is then possible to compute the potential volume of carbon credits that can be issued on the back of this effort to curb deforestation, and when paired with assumptions about the price of carbon, the value of fiscal revenue that can be obtained from selling credits.

Based on these rough estimates, the potential revenue boost from the sale of carbon credits related to decreased deforestation can be computed. These are presented in Exhibits A9 and A10 in the Appendix, which show cumulative earnings over the forecast period under a wide range of carbon price scenarios (from US$10/t to US$100/t). The potential yearly revenue stemming from carbon credits in 2034 ranges from US$ 93 to 935 million, equivalent to 0.05% to 0.5% of GDP in revenue or 0.3% to 3% of Ghana's budget revenue. For reference, the first of Ghana's jurisdictional REDD+ credits sold to the LEAF coalition buyers were priced at US$10/t, yet there is a potential to achieve significantly higher prices in the future. Guyana's sovereign credit transaction with the Hess Corporation commanded the price of US$20/t, with a positive outlook for the new sales. Mombak's credit removal units from the reforestation projects in the Amazon were sold for more than US$50/t in 2023. Tech giants (Meta, Google, Microsoft, Salesforce) have recently formed the Symbiosis Coalition and committed to buying 20 million tons of nature-based carbon removal credits by 2030 (CarbonCredits.com 2024). This could drive the price of high-quality carbon credits further up. Furthermore, if the finalisation of Article 6 of the Paris Agreement opens the door to the integration of jurisdictional carbon credits into the compliance markets, this could represent a landmark development for demand for the jurisdictional REDD+ and other nature-based carbon credits.

Although Ghana's ratings are sensitive to increased revenue mobilisation, the volume projected under these relatively restrictive assumptions suggests that carbon credit income is not sufficient by itself to produce a material rating uplift. Simulations indicate that approximately 1-2 percentage points of GDP in extra fiscal revenue – on top of the 18% of revenue-to-GDP ratio – are needed to generate an additional notch increase in the rating. The 0.5% of GDP in carbon credit revenue on the upper end of the range would not lift the rating by itself. However, it would meaningfully bolster the sovereign credit profile when combined with the other macro-fiscal gains and possible interest savings from sustainability-linked debt. These combinations are presented in Table 3 below. Furthermore, the potential is understated because it only factors in earnings from the KPIs considered in this FIMA study and not Ghana's total potential to harvest carbon credits.

Table 3 Ghana's rating simulations according to various fiscal consolidation scenarios

Description	S&P	Moody's	Fitch
	Gain compared to pessimistic scenario (in notches)		
Optimistic – Ghana's issues an SLB and KPI are reached (Scenario 1 above)	**+1** (+0.49 pts SRM)	**+1**	**+1**
Pessimistic – Ghana's issuances are SLB but KPIs are not reached (Scenario 2 above)	0	0	0
Optimistic – Ghana's issuances are SLB and KPI are reached. And Ghana earns **+1% of GDP in revenue from 2026**	**+1** (+1.38 pts SRM)	**+1**	**+1**
Optimistic – Ghana's issuances are SLB and KPI are reached. And Ghana earns **+2% of GDP in revenue from 2026**	**+2** (+2.12 pts SRM)	**+1**	**+2**

4.5 Summary of findings

A policy to combat deforestation and forestry—could, if combine sectors, contribute to improvir estimate that GDP could increase 2034, with a cumulative effect exports, inflation, the exchange r

The improved macroeconomic fu budget deficits and gross fina instruments, generating additiona gains not captured by this analys lower the public debt-to-GDP rat scenario that excludes a coupon sustainability metrics would also external debt-to-exports ratio u terms, we estimate that the comb (S&P, Fitch, and Moody's) could primarily due to effects on growth

Within the FIMA framework, it is revenue from harvesting carbo estimate that they can reach bet GDP) annually, depending on w respectively. Further analysis ind revenue from carbon credits, wo from 18% in the baseline), could a by an additional notch. This wou pessimistic scenario that does no

5

Conclusion and Next Steps

⑤ Conclusion and Next Steps

The Ghana case study presented here provides an initial validation of the financial materiality assessment (FIMA) framework and its value for advancing several goals. It provides an approach for issuers and market participants to identify and prioritise sustainability KPIs in terms of credit relevance and financial materiality and provides an analytical framework for quantifying the potential macro-fiscal impact and credit uplift. The framework can help prospective debt issuers align sustainability targets with public debt management mandates and strengthen the value proposition of sovereign financing solutions linked to those targets. This is crucial for investors who are concerned with both sustainability objectives but also credit risks. Furthermore, the FIMA framework provides a way to conceptualise nature risks through a sovereign risk lens, making the case that nature in general and standing forests, in particular, can be credit positive.

The next iteration of this FIMA case study should further fine-tune the framework and enrich the simulations. This can be done by bringing in other KPIs, refining the sectoral and macroeconomic models, and adding more macro-fiscal transmission channels. More rigorous analysis of the KPI-credit linkages will strengthen the evidence base for decision-making around sustainability-linked finance and bolster the value proposition for prospective issuers. A few proposed options for further analysis include:

Modelling the impacts of credit enhancement on SLSF, which has the effect of lowering the cost of borrowing and reducing the risk of debt distress and credit rating downgrades.

Building out the macro-fiscal models and refine the calibration of model coefficients.

Drawing out more details on the qualitative linkages between KPIs and governance factors, in particular the relationship between nature and political risk.

Adding in other nature credits, in particular biodiversity credits, and refining the sensitivity analysis to include different credit pricing models.

Demonstrating the role of nature as a shock absorber by building multi-dimensional integrated climate and nature scenarios and simulating the impact of nature-based adaptation measures.

Unpacking further the dimensions of the 'performance drivers', and how targeted interventions can help produce desired KPI outcomes.

The ambition of this work going forward is for market participants and policy practitioners to widely adopt the FIMA framework and apply it in their assessment of sovereign risk, structuring of sustainability-linked financing arrangements, and development of public debt management strategies. To that end, the FIMA framework should be tested and applied in several countries and with various KPIs. These may be used to populate a KPI repository that includes the various credit dimensions captured during the FIMA process. Improving access and accessibility of macro-fiscal and credit rating models will be critical to achieving that goal, which may require the development of open source, streamlined, and user-friendly tools that can quickly run the FIMA process. It will also entail leveraging nudge-type techniques to speed up the adoption of the FIMA framework and related tools, as envisaged by the SSDH Accelerator (see Box 2). Finally, the bigger vision is for the financial community to internalise the notion that, just as nature has been conceptualised as infrastructure, so too should credit strength, and it should be recognised and priced accordingly.

(A) Appendix

A.1 Macroeconomic Model Specification

A semi-structural macroeconomic model was developed to assess short- to medium-term impacts of the anti-deforestation measures on key macroeconomic variables. The model was adapted from the IMF's Quarterly Projection Model (QPM) for the Bank of Ghana (Abradu-Otoo et al. 2022), which uses a semi-structural New Keynesian framework originally introduced by Berg et al. (2006). It focuses on cyclical fluctuations by expressing all real variables as deviations from their long-term potential. The model's behavioural equations are directly specified to capture key dynamics characteristic of standard New Keynesian models, as outlined by Galí (2015). The sectoral assumptions for the model are summarised in Table A1.

Table A1 Sector Assumptions for the Macro-Fiscal Model

		Unit	Baseline	Scenario 1	Scenario 2
Area used	Cocoa	in % YoY (based on data in ha)	1.0%	0.0%	1.0%
	Maize		2.2%	1.5%	2.2%
	Sorghum		0.0%	-0.5%	0.0%
	Cassava		2.1%	2.1%	2.1%
	Yam		2.9%	2.9%	2.9%
	Rice		5.0%	4.5%	5.0%
	Gold mining		2500 ha/year	-100	0 *
	Logging		27 ha/year	-2	0 *
Yields	Cocoa	After 10Y	0.0%	35.0%	-15.0%
	Maize		0.0%	5.0%	0.0%
	Sorghum		0.0%	5.0%	0.0%
	Cassava		0.0%	10.0%	0.0%
	Yam		0.0%	10.0%	0.0%
	Rice		0.0%	5.0%	0.0%
Illegal practice	Gold mining		0.0%	0.5%	0.0% **
	Logging		0.0%	1.0%	0.0% ***

* ha/year_-2 in deforestation deceleration
** Yearly reduction of the illegal share of small-scale mining
*** Yearly reduction of the illegal share logging

The model comprises four key components: aggregate demand, inflation, exchange rate dynamics, and monetary policy. In its simplified form, the model includes an investment-saving (IS) equation for aggregate demand, a Phillips curve for inflation, an uncovered interest parity (UIP) condition for exchange rate dynamics, and a Taylor rule guiding central bank policy rate adjustments. The aggregate demand block is enhanced by breaking it into:

1   Real domestic demand comprising consumption and investment, modelled as a negative function of the real interest rate and a positive function of overall domestic output, primary fiscal spending, and a lag term

2   Real exports as a positive function of their own lag and foreign economic output, and a negative function of the real effective exchange rate

3   Real imports as a positive function of the real effective exchange rate, a lag term, and overall domestic demand.

The model allows estimating the following variables in all scenarios:

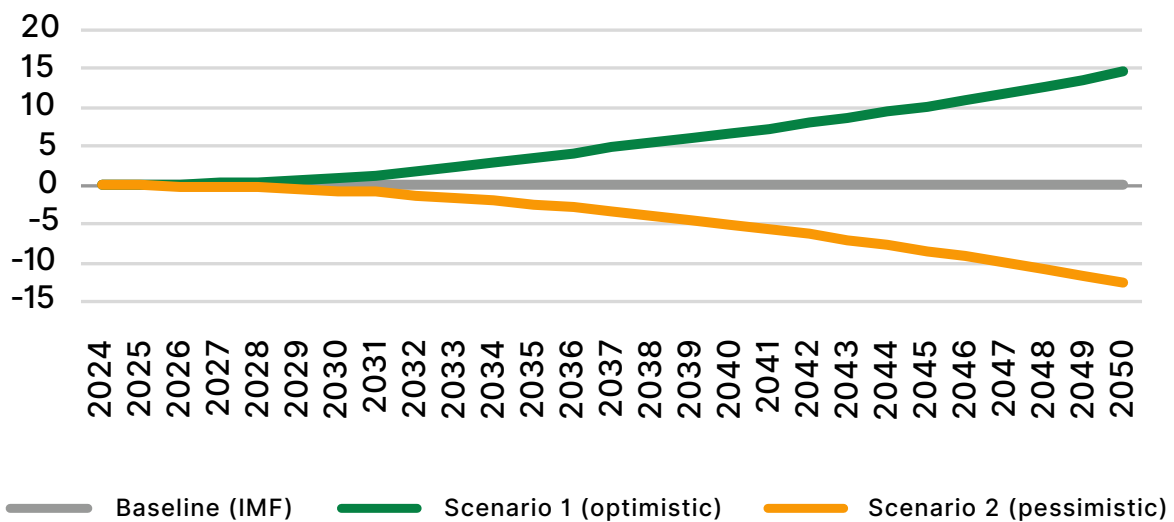**Exhibit A1** Net effect on exports (net improvements of trade balance, cumulative, US$ bn)

Legend: Baseline (IMF) — Scenario 1 (optimistic) — Scenario 2 (pessimistic)

Exhibit A2 Potential level of reserves (months of imports)

Baseline (IMF) ─── Scenario 1 (optimistic) ─── Scenario 2 (pessimistic)
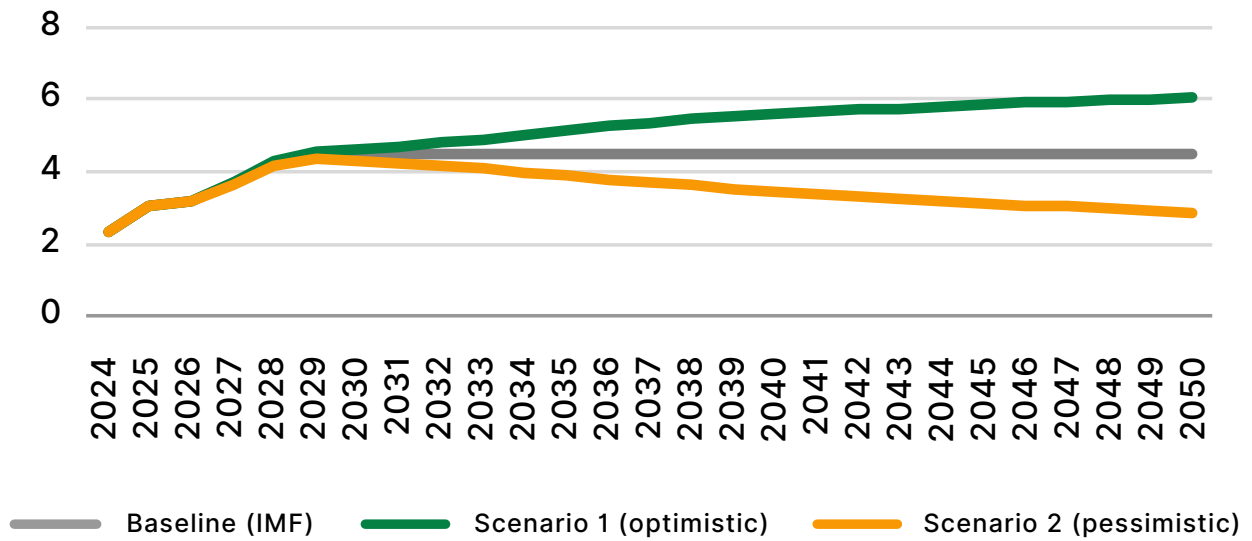
In the upside scenario, net imports improve by US$ 14.7 bn, 2050 (cumulative effects).

Source: IMF 2024

Exhibit A3 Inflation forecasts (in % variation, YoY)

■ Baseline ■ Scenario 1 (optimistic) ■ Scenario 2 (pessimistic)
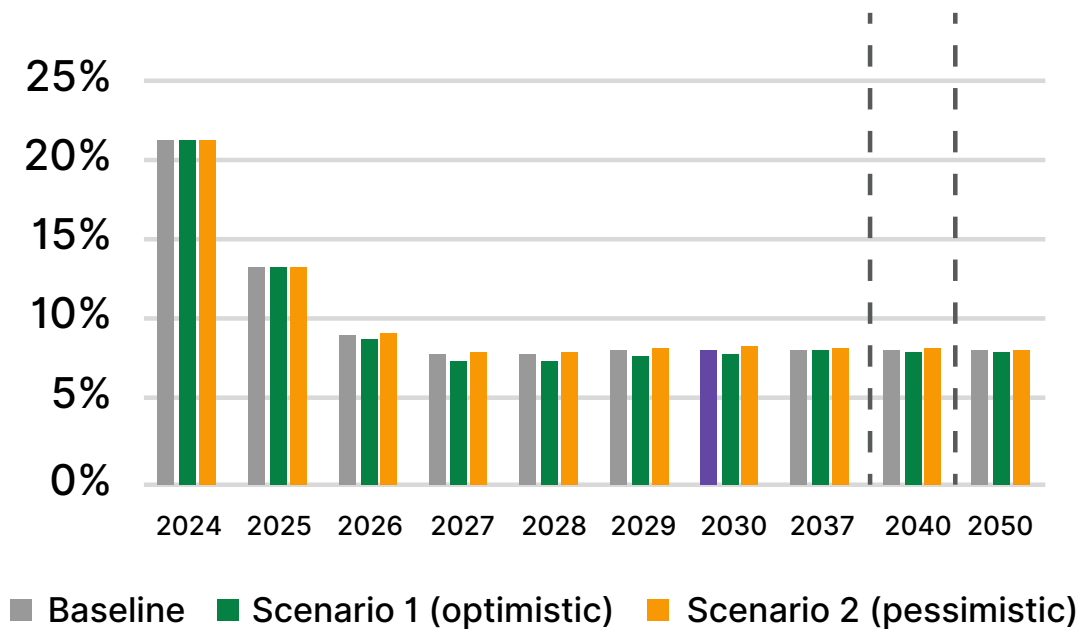
Exhibit A4 Exchange rate forecasts (US$/GHS)

Baseline (IMF)   Scenario 1 (optimistic)

Scenario 2 (pessimistic)
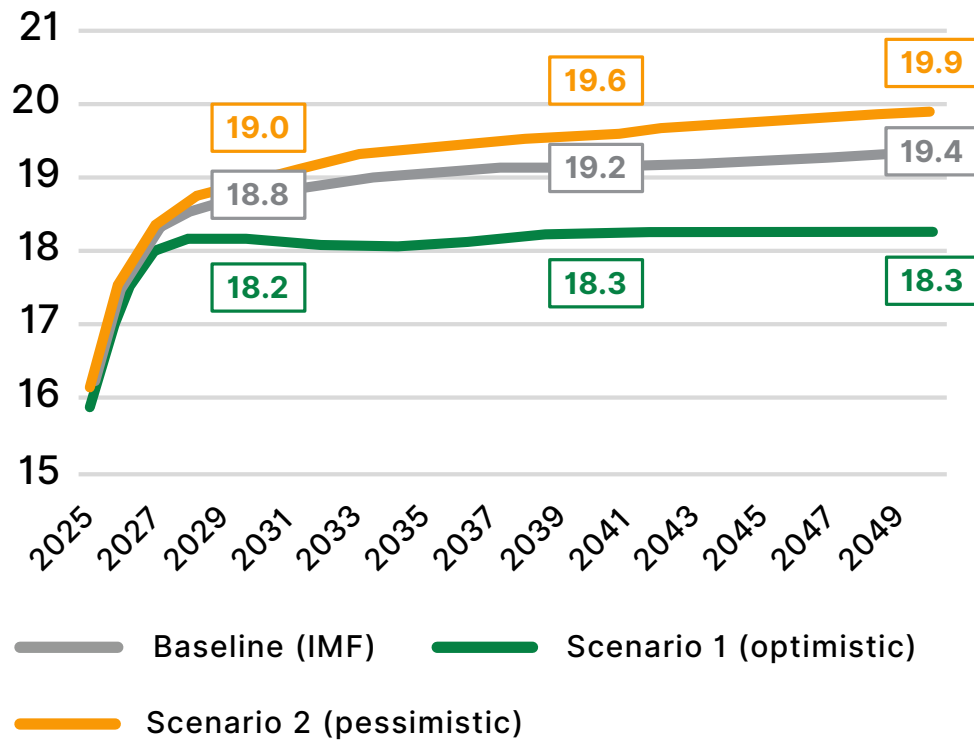
In the optimistic scenario, under the effects of higher exports and GDP, the exchange rate appreciates sustainably compared to the baseline, and inflation slightly decreases from the baseline between 2026 and 2034, allowing for a faster reduction of interest rates.

Exhibit A5 Central bank policy rate (%)

Baseline (IMF)   Scenario 1 (optimistic)

Scenario 2 (pessimistic)
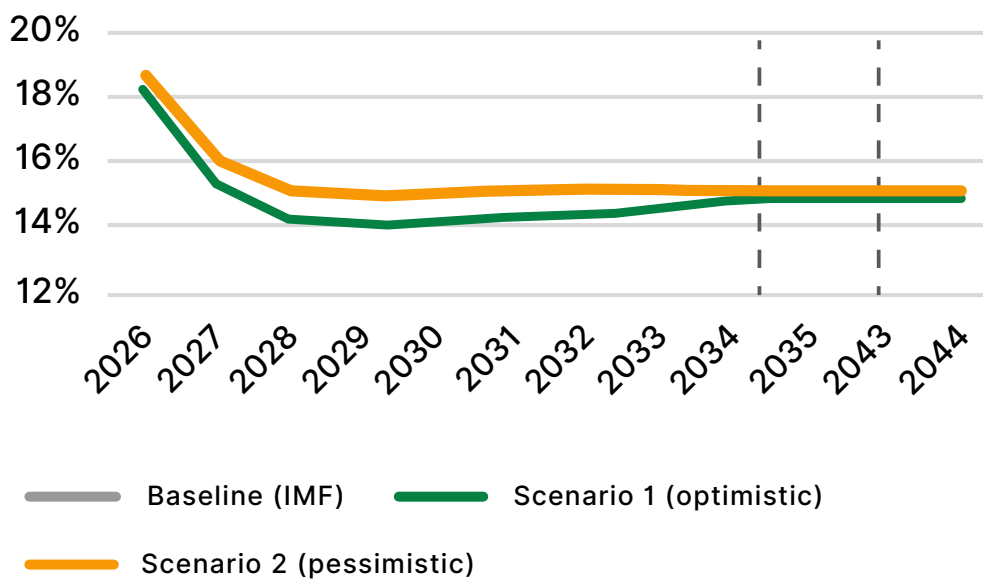
A.2 Macroeconomic Impact of Re-/Deforestation: Fiscal Effects

In all DSA scenarios, the debt service remains fixed, as it reflects historical data up to the end of 2023.
Assumptions are based on the IMF's second review published in July 2024, which provides a detailed
breakdown of Ghana's public debt at end-2023, capturing debt stock prior to external restructuring.
The debt repayment schedule for each creditor category is projected based on estimated loan terms
and IMF data for 2024 and 2025 (see table A1 below). For bilateral and bonded debt that has been
restructured in 2024, the schedule incorporates post-restructuring terms, informed by publicly
available data.

Table A2 Decomposition of Ghana Public Debt at end-2023 ($USD million)

	Debt stock	Debt service	
	2023	2024	2025
External	31.431	2.447	3.816
Multilateral creditors	9.132	533	653
IMF	2.205		
World Bank	5.318		
African Development Bank	1.226		
Other Multilaterals	383		
Bilateral Creditors	5.334	17	22
Paris Club	3.475		
Non-Paris Club	1.859		
Bonds	13.104	1.359	2.524
Commercial creditors	3.861	537	617
Domestic	27.354	6.982	7.036
Short-term bills	5.649	5.649	5.649
Medium-to-long term bonds	15.441	1.303	1.371
Loans	81	30	16
Arrears	5.182		
Other (Overdraft and SDRs on-lent)	1.001		

A.3. Credit Rating Analysis Methodology

To capture the long-term effects of reforestation on credit ratings, the target year has been set to 2034. This timeframe is long enough to allow substantial impacts from reforestation to manifest across key macro-fiscal variables, notably including:

Improvements in nominal GDP level

Higher revenues in the national budget

Reduction in trade deficits, through increased exports

At the same time, this 10-year horizon ensures that projections remain within a relatively foreseeable future for both the macroeconomic and DSA forecasts.
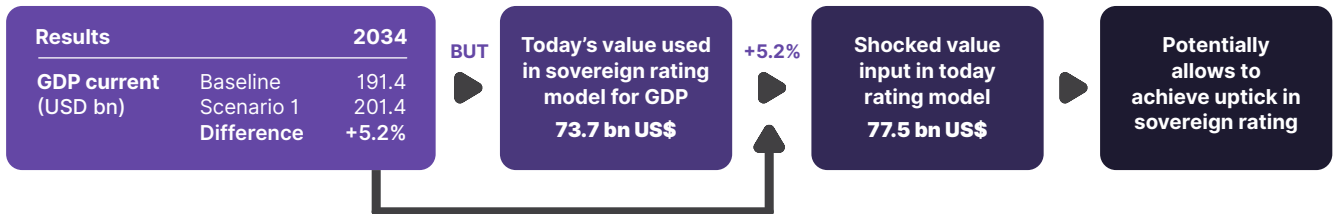
The core objective of the methodology is not to predict Ghana's credit rating in 2034 outright. Instead, it aims to isolate the variation in credit ratings that could specifically result from reforestation. The approach focuses on capturing the differences in rating that might emerge between a baseline scenario and either an optimistic or pessimistic outcome.

A simple approach could have been to directly compare variable forecasts in 2034 from each scenario against the baseline in 2034. However, a key limitation lies in the uncertainty surrounding potential changes in rating agencies' criteria, i.e. how rating agencies will calculate future ratings. Over the next decade, as global economic growth inflates nominal indicators, the benchmarks or thresholds used by agencies (e.g. for Moody's nominal GDP) are likely to be adjusted upward. This means that a given nominal GDP value may not be evaluated in the same way in 2034 as it would be today. Directly comparing the rating stemming from 2034 values could introduce threshold effects that complicate consistent assessment across scenarios.

To account for these uncertainties, we compute the differential for each variable in 2034 between the chosen scenario and the baseline, then add this difference to the last available variable values from 2024. This adjustment enables an assessment of each indicator based on current criteria, reducing potential bias from future methodological changes. This approach is both robust and cautious, as it minimises the uncertainty bias associated with long-term forecasts. It allows for a targeted focus on how reforestation could specifically affect Ghana's long-term rating, by empirically examining how macro-fiscal improvements may enhance scores in certain rating pillars or even the overall rating.

Exhibit A6 Illustration of the Approach

Example of output from
the macro/ DSA modelling

Results		2034
GDP current (USD bn)	Baseline	191.4
	Scenario 1	201.4
	Difference	**+5.2%**

BUT ▶

Today's value used in sovereign rating model for GDP
73.7 bn US$

+5.2% ▶

Shocked value input in today rating model
77.5 bn US$

▶

Potentially allows to achieve uptick in sovereign rating

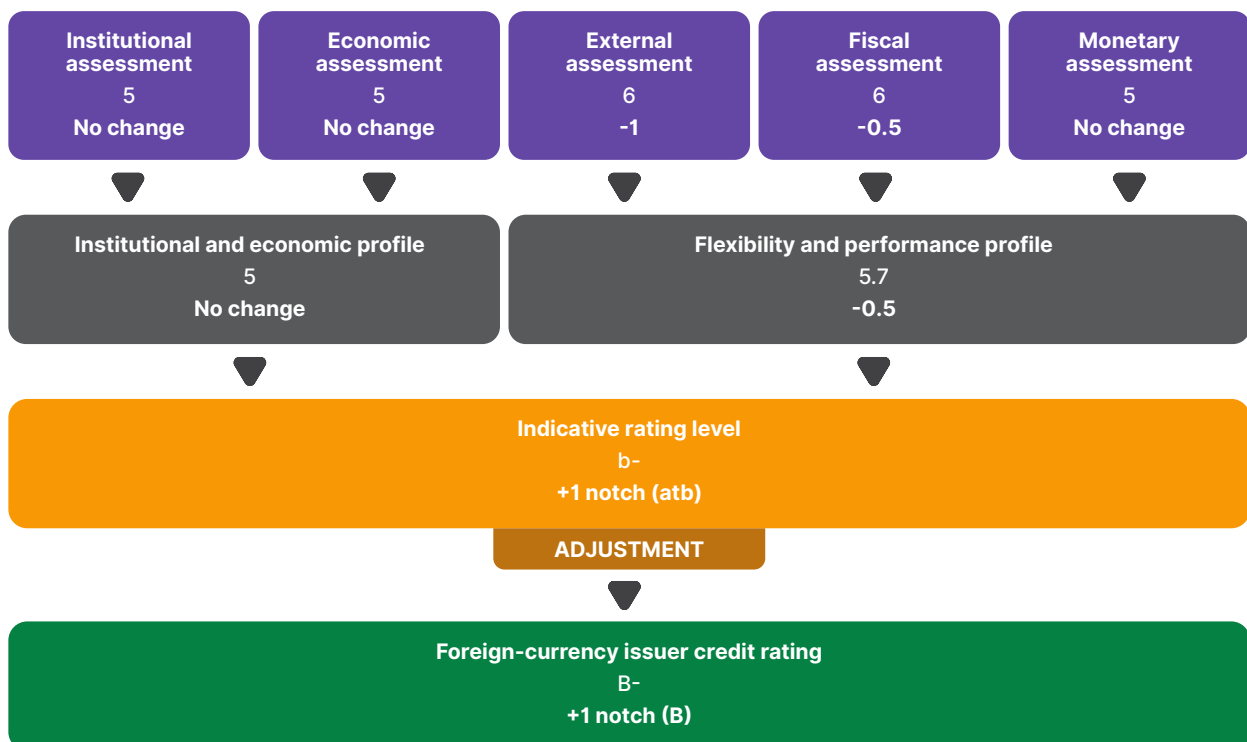Our approach is implemented in several key steps, as outlined below:

1 **Building rating simulation models:** Based on the criteria for Sovereigns of S&P, Moody's and Fitch we rebuild a model allowing to rebuild the indicative ratings of Ghana in the different scenarios. These simulations take into account only the evolution of quantitative metrics, and do not assume any evolution of the qualitative judgement of rating agencies.

2 **Selection of the relevant variables:** Each rating agency evaluates a sovereign credit rating using a set of variables, grouped into different rating pillars. However, only a subset of variables is going to be impacted by reforestation, and we keep the value of other variables constant. In particular, we do not adjust the institutional factors, which have a significant impact on ratings.

3 **Incorporation of each scenario's simulated data into the rating models model, as a differential to the baseline:** In order to isolate the impact of reforestation and to avoid making any assumptions on how rating agencies will adjust the criteria, we do not plug the forecasted data into the rating simulation models. Rather, we calculate a differential between the baseline in 2034 and the optimistic/pessimistic scenario and apply this differential to today's values. For instance, we compute that the GDP in the optimistic scenario will be 5% higher than the baseline, hence shock the variables related to the GDP in rating agencies' model by 5%.

4 **Observing the changes for pillar scores and overall rating between each shocked rating and the 2024 current agency value.** The final step involves assessing how each rating pillar score and the overall rating shifted between the 2024 current value and the shocked scenarios (both optimistic and pessimistic). This comparison offers insights into the specific impact of reforestation and related economic shifts on Ghana's long-term credit profile.

A.3.i. Credit Rating Analysis: S&P

Simulating the macroeconomic uplift from reforestation in S&P scorecard model, the indicative output suggests a one-notch improvement is plausible. The model score reflects an overall improvement of +1 notch for the sovereign credit rating based on the following sensitivities (see Exhibit A6):

Economic Pillar: the scenario projects slight improvements in GDP per capita, but the value remains below S&P's threshold of 7100. Therefore, this factor does not contribute to any notch adjustment.

External Pillar: Enhanced liquidity and reduced indebtedness are observed, resulting in a +1-notch adjustment to the external assessment. This moves the score from a 6 to a 5 in S&P's external assessment rating.

Fiscal Pillar: Slower debt growth leads to a +1 notch increase in fiscal performance. On 'Debt Burden', although there are improvements, they are not sufficient to impact the score (+0 notch). Overall, the fiscal pillar receives a +0.5 notch increase in rating.

Exhibit A7 S&P Scorecard Simulation

| Institutional assessment 5 No change | Economic assessment 5 No change | External assessment 6 -1 | Fiscal assessment 6 -0.5 | Monetary assessment 5 No change |

| Institutional and economic profile 5 No change | Flexibility and performance profile 5.7 -0.5 |

Indicative rating level
b-
+1 notch (atb)

ADJUSTMENT

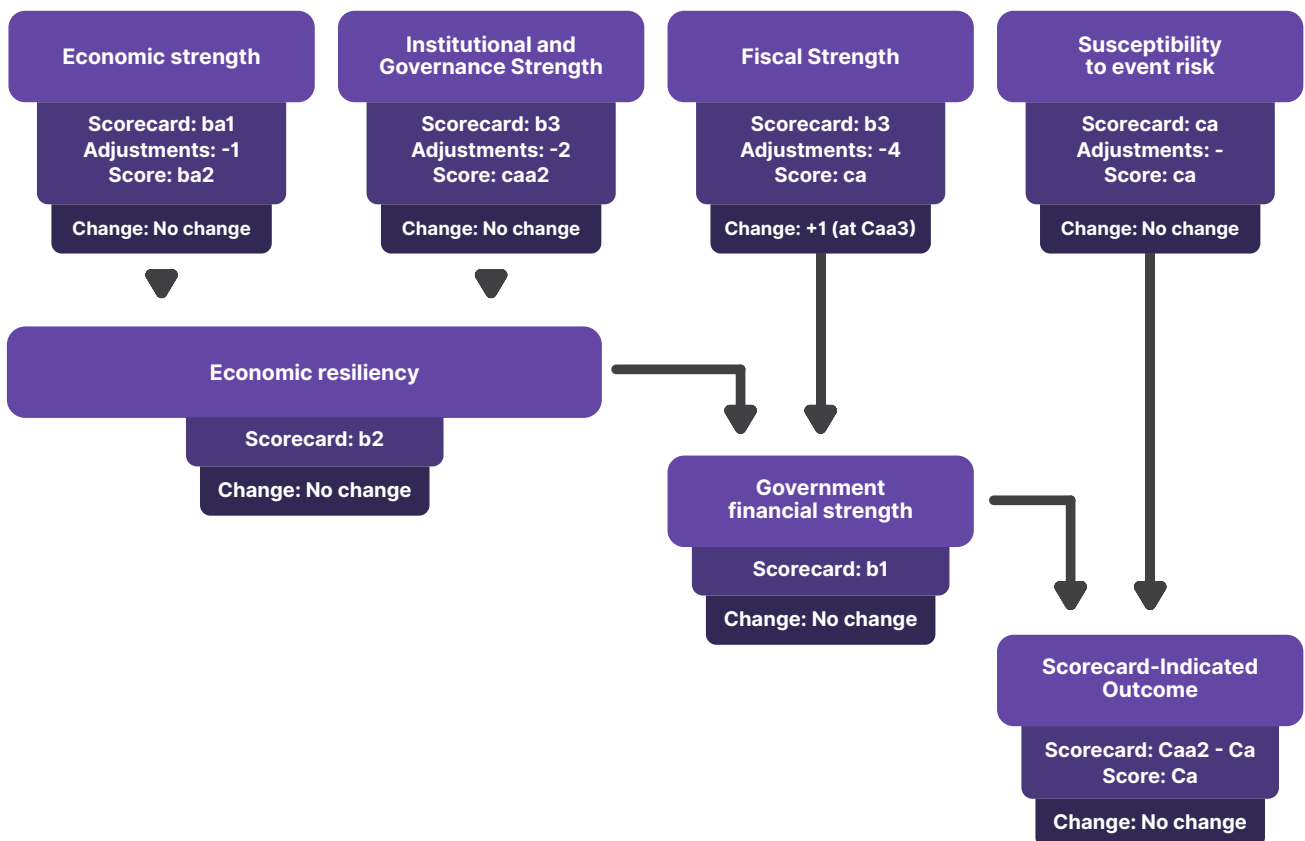Foreign-currency issuer credit rating
B-
+1 notch (B)

A.3.ii. Credit Rating Analysis: Moody's

Applying the same logic to Moody's scorecard also generated rating uplift, especially in the fiscal pillar, albeit not enough to achieve a one-notch improvement in overall rating score, according to our modelling. Changes are observed for the following pillars (see Exhibit A7):

Economic Pillar: GDP growth improvements are noted, but they are insufficient to influence the economic pillar score (+0 notch)

Fiscal Pillar: Improvements in the debt-to-GDP and debt-to-revenue ratios lead to a +1-notch adjustment. This indicates that fiscal health has improved

Exhibit A8 Moody's Scorecard Simulation

Economic strength

Scorecard: ba1
Adjustments: -1
Score: ba2

Change: No change

Institutional and Governance Strength

Scorecard: b3
Adjustments: -2
Score: caa2

Change: No change

Fiscal Strength

Scorecard: b3
Adjustments: -4
Score: ca

Change: +1 (at Caa3)

Susceptibility to event risk

Scorecard: ca
Adjustments: -
Score: ca

Change: No change

Economic resiliency

Scorecard: b2

Change: No change

Government financial strength

Scorecard: b1

Change: No change

Scorecard-Indicated Outcome

Scorecard: Caa2 - Ca
Score: Ca

Change: No change

A.3.iii. Credit Rating Analysis: Fitch

Fitch's sovereign rating model (SRM), which computes an overall quantitative score based on 18 indicators, improved by the equivalent of +0.49 notches (i.e., roughly half a notch) when the macro variables were inputted. Under Scenario optimistic, slight improvements are observed across indicators, with 10 out of 18 indicators reflecting positive changes:

Structural features:
Strengthened GDP growth being faster than the world average, Ghana's share in world GDP slightly increases.

Macroeconomic performances: The boost in GDP, as well the reduced volatility (-20%) and lower inflation contribute to the improvement of the score.

Public finances: Positive effect of lower interest payments, deficits and debt result in a better score.

External finance:
the improvement relies on lower external debt service and enhanced level of reserves.

Rating impact: the improvement yields a +0. 46-point increase in Fitch's score, equivalent to roughly half of a notch. In our simulation, this allow the score to cross the B+ threshold (the +1-notch gain is however dependent on the initial score).

Exhibit A9 Fitch's SRM Simulation
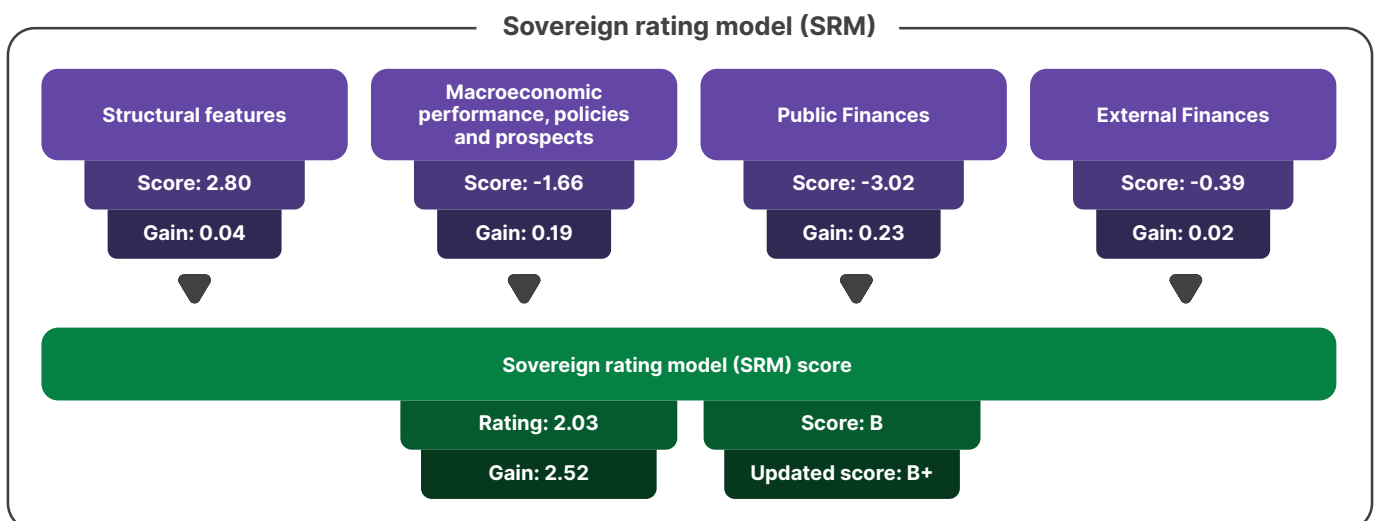
A.3. iv. Carbon Credit Modeling

The potential revenue mobilisation from the issuance of carbon credits is presented in Table A9 and A10.

Exhibit A10 Price sensitivity analysis of revenue from carbon credits in US$ million

	Carbon credit price (US$/t)	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2033
	10	-	8	17	26	35	44	53	63	73	83	93
	20	-	17	34	51	69	87	106	126	146	166	187
	30	-	25	50	77	104	131	159	188	218	249	280
Yearly earnings in US$ millions	40	-	33	67	102	138	175	213	251	291	332	374
	50	-	41	84	128	173	218	266	314	364	415	467
	60	-	50	101	153	207	262	319	377	437	498	561
	70	-	58	118	179	242	306	372	440	509	581	654
	80	-	66	134	204	276	350	425	503	582	664	748
	90	-	75	151	230	311	393	478	565	655	747	841
	100	-	83	168	255	345	437	531	628	728	830	935

Exhibit A11 Price sensitivity analysis of revenue from carbon credits, in % of expected GDP

	Carbon credit price (US$/t)	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2033
	10	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	20	0.0%	0.0%	0.0%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%
	30	0.0%	0.0%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%
Yearly earning in % of expected GDP	40	0.0%	0.0%	0.1%	0.1%	0.1%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%
	50	0.0%	0.1%	0.1%	0.1%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%
	60	0.0%	0.1%	0.1%	0.2%	0.2%	0.2%	0.3%	0.3%	0.3%	0.3%	0.3%
	70	0.0%	0.1%	0.1%	0.2%	0.2%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%
	80	0.0%	0.1%	0.2%	0.2%	0.3%	0.3%	0.3%	0.4%	0.4%	0.4%	0.4%
	90	0.0%	0.1%	0.2%	0.3%	0.3%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%
	100	0.0%	0.1%	0.2%	0.3%	0.4%	0.4%	0.4%	0.5%	0.5%	0.5%	0.5%

Bibliography

Abradu-Otoo, Philip, Ivy Acquaye, Abubakar Addy, et al. 2022. 'Quarterly Projection Model for the Bank of Ghana.'
IMF Working Paper 2022/169
https://www.imf.org/en/Publications/WP/Issues/2022/09/02/Quarterly-Projection-Model-for-the-Bank-of-Ghana-522752

Agarwala, Matthew, Matt Burke, Patrycja Klusak, Moritz Kraemer and Ulrich Volz. 2022.
'Nature Loss and Sovereign Credit Ratings.' Finance for Biodiversity Initiative.
https://www.naturefinance.net/wp-content/uploads/2022/09/NatureLossSovereignCreditRatings.pdf.

Berg, Andrew, Philippe Karam and Douglas Laxton. 2006. 'Practical Model-Based Monetary Policy Analysis—A How-To Guide.'
IMF Working Paper 2006/081. https://www.imf.org/external/pubs/ft/wp/2006/wp0681.pdf

Bernal, Blanca, Lara T. Murray, and Timothy R. H. Pearson. 2018. 'Global Carbon Dioxide Removal Rates from Forest Landscape
Restoration Activities.' Carbon Balance and Management 13: 1-13. https://doi.org/10.1186/s13021-018-0110-8

Birdsall, Nancy and William D. Savedoff. 2010. 'Cash on Delivery: A New Approach to Foreign Aid.' Center for Global
Development. https://www.cgdev.org/publication/9781933286600-cash-delivery-new-approach-foreign-aid

CarbonCredits.com. 2024. 'Google to Buy 50,000 MTs of Nature-Based Carbon Credits from Brazil Startup Mombak.'
https://carboncredits.com/google-to-buy-50000-mts-of-nature-based-carbon-credits-from-brazil-startup-mombak/.

Cassimon, Danny, Martin Prowse and Dennis Essers. 2011. 'Financing the Clean Development Mechanism through
debt-for-efficiency swaps? Case study evidence from a Uruguayan wind farm project.' IOB Working Paper 2011/06.
https://lucris.lub.lu.se/ws/portalfiles/portal/5483569/5218920.pdf

Cevik, Serhan and João Tovar Jalles. 2020. 'Feeling the Heat: Climate Shocks and Credit Ratings.' IMF Working Paper No. 2020/286.
https://www.imf.org/en/Publications/WP/Issues/2020/12/18/Feeling-the-Heat-Climate-Shocks-and-Credit-Ratings-49945

Cevik, Serhan and João Tovar Jalles. 2020. 'This Changes Everything: Climate Shocks and Sovereign Bonds.' IMF Working
Paper 2020/079.
https://www.imf.org/en/Publications/WP/Issues/2020/06/05/This-Changes-Everything-Climate-Shocks-and-Sovereign-Bonds-49476

Dasgupta, Partha. 2021. 'The Economics of Biodiversity: The Dasgupta Review.' HM Treasury.
https://www.gov.uk/government/publications/final-report-the-economics-of-biodiversity-the-dasgupta-review.

Fitch Ratings. 2019. 'What Investors Want to Know: ESG Relevance Scores for Sovereigns.'
https://www.fitchratings.com/research/sovereigns/what-investors-want-to-know-esg-relevance-scores-for-sovereigns-08-04-2019.

Fitch Ratings. 2024. 'Sovereign Rating Criteria.'
https://www.fitchratings.com/research/sovereigns/sovereign-rating-criteria-24-10-2024.

G20 Independent Expert Group (IEG). 2023. 'Strengthening Multilateral Development Banks: The Triple Agenda.' Indian Council
for Research on International Economic Relations (ICRIER).
https://icrier.org/g20-ieg/pdf/The_Triple_Agenda_G20-IEG_Report_Volume1_2023.pdf.

Galí, Jordi. 2015. 'Monetary Policy, Inflation, and the Business Cycle: An Introduction to the New Keynesian Framework.'
Princeton University Press.

Gardes-Landolfini, Charlotte, William Oman, Jamie Fraser, Mariza Montes de Oca Leon and Bella Yao. (2024). 'Embedded
in Nature: Nature-Related Economic and Financial Risks and Policy Considerations.' IMF Staff Climate Note 2024/002.
https://doi.org/10.5089/9798400288548.066

Ghana Cocoa Board. 2024. 'Dynamic Agro-forestry: A Transformative Approach to Ghana's Conventional Cocoa Cultivation Practices.'
https://cocobod.gh/news/dynamic-agroforestry-a-transformative-approach-to-ghanas-conventional-cocoa-cultivation-practices

ICMA. 2021. 'Green Bond Principles: Voluntary Process Guidelines for Issuing Green Bonds.'
https://www.icmagroup.org/assets/documents/Sustainable-finance/2022-updates/Green-Bond-Principles-June-2022-060623.pdf

ICMA. 2024. 'Sustainability-Linked Bond Principles Voluntary Process Guidelines.'
https://www.icmagroup.org/assets/documents/Sustainable-finance/2024-updates/Sustainability-Linked-Bond-Principles-June-2024.pdf

International Monetary Fund. 2017. 'Press Release: IMF Executive Board Reviews the Joint IMF-World Bank Debt Sustainability Framework for Low Income Countries.'
https://www.imf.org/en/News/Articles/2017/10/02/pr17380-imf-executive-board-reviews-the-joint-imf-world-bank-debt-sustainability-framework-for-lics/

International Monetary Fund. 2024. 'Ghana: Third Review Under the Arrangement Under the Extended Credit Facility, Request for Modification of Performance Criteria, and Financing Assurances Review-Press Release; Staff Report; and Statement by the Executive Director for Ghana.' IMF Country Report 2024/334. https://doi.org/10.5089/9798400294907.002

IPBES. 2024. 'Assessment Report on the Interlinkages Among Biodiversity, Water, Food and Health: Summary for Policymakers.'
IPBES secretariat. https://doi.org/10.5281/zenodo.13850290

Kraemer, Moritz, and Ulrich Volz. 2022. 'Integrating Nature Into Debt Sustainability Analysis.'
SOAS Centre for Sustainable Finance and Finance for Biodiversity Initiative.
https://www.naturefinance.net/resources-tools/integrating-nature-into-debt-sustainability-analysis/

Moody's. 2025. 'Rating Symbols and Definitions'. https://ratings.moodys.com/api/rmc-documents/53954.

NatureFinance. 2023. 'Assessing Nature-Related Issues in Sovereign Debt Investment: Additional Considerations Building on TNFD Guidance'.
https://www.naturefinance.net/wp-content/uploads/2023/10/AssessingNatureRelatedIssuesInSovereignDebtInvestment.pdf

Network of Central Banks and Financial Supervisors for Greening the Financial System. 2024. 'Nature-Related Financial Risks: A Conceptual Framework to Guide Action by Central Banks and Supervisors.' NGFS Secretariat.
https://www.ngfs.net/system/files/import/ngfs/medias/documents/ngfs_conceptual-framework-on-nature-related-risks.pdf

PWC. 2023. 'PwC boosts global nature and biodiversity capabilities with new Centre for Nature Positive Business, as new research finds 55% of the world's GDP - equivalent to $58 trillion - is exposed to material nature risk without immediate action.'
https://www.pwc.com/gx/en/news-room/press-releases/2023/pwcboosts-global-nature-and-biodiversity-capabilities.html.

Ranger, Nicola, Jimena Alvarez, Anna Freeman, et al. 2023. 'The Green Scorpion: The Macro-criticality of Nature for Finance – Foundations for Scenario-Based Analysis of Complex and Cascading Physical Nature-Related Risks.' NGFS Occasional Paper.
https://www.ngfs.net/system/files/import/ngfs/medias/documents/ngfs_occasional_paper_green-scorpion_macrocriticality_nature_for_finance.pdf

S&P Global. 2021. 'General Criteria: Environmental, Social, And Governance Principles In Credit Ratings.'
https://disclosure.spglobal.com/ratings/en/regulatory/article/-/view/sourceId/12085396

UNDP. 2019. Knowing What You Spend: A guidance note for governments to track climate change finance in their budgets.
UNDP Guidance Note.
https://www.undp.org/publications/knowing-what-you-spend-guidance-note-governments-track-climate-change-finance-their-budgets

UNDP. 2024. SDG Budget Tagging: A proposal to measure SDG Financing. UNDP Policy brief.
https://www.undp.org/publications/dfs-sdg-budget-tagging-proposal-measure-sdg-financing

University of East Anglia. 2023. 'Climate Change and Sovereign Credit Ratings.'
https://www.uea.ac.uk/climate/evaluating-sovereign-risk

Wang, Dieter, Bryan O'Reilly Gurhy, Marek Hanusch and Philipp Kollenda. 2023. 'Could Sustainability-Linked Bonds Incentivize Lower Deforestation in Brazil's Legal Amazon?'. Policy Research Working Paper: WPS10558. World Bank Group.
http://documents.worldbank.org/curated/en/099354409042343013/IDU024051b5607a6f04cc809b4a0d926e299c521.

World Bank. 2020. 'Ghana: Country Environmental Analysis.'
https://documents.worldbank.org/en/publication/documents-reports/documentdetail/419871588578973802/ghana-country-environmental-analysis

World Bank. 2024. 'International Debt Report 2024'. http://hdl.handle.net/10986/42444

Nature as a Shock Absorber

A Financial Materiality Assessment of Forestry-linked Sovereign Indicators in Ghana

SUSTAINABLE SOVEREIGN DEBT HUB