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Refining ESG models: embedding natural capital valuation beyond box-ticking compliance towards confronting planetary boundaries[1]

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Refining ESG Models: Embedding Natural Capital Valuation Beyond Box-Ticking Compliance Towards Confronting Planetary Boundaries

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Abstract

This paper examines Environmental, Social, and Governance (ESG) frameworks in current environmental management practices, uncovering significant flaws, especially in their capacity to adequately evaluate the impact of sustainability initiatives on global challenges such as climate change and land degradation. It explores the intrinsic shortcomings of existing ESG models, including their reliance on simplified theoretical models and the absence of concrete, quantifiable metrics, which may lead to greenwashing. A crucial point of criticism is the lack of sufficient emphasis on the social and governance dimensions in relation to environmental issues, which are essential in supporting the environmental pillar of ESG. This paper proposes an improved methodology that incorporates a detailed valuation of natural capital to better measure impacts within the environmental pillar of ESG. Furthermore, it introduces an innovative approach to natural capital valuation using an actuarial balance framework focused on loss distribution analysis, enhancing the ability to quantify and manage long-term environmental risks effectively.

Keywords: ESG, sustainability, natural capital valuation, ecosytem.

JEL classification: Q50, O30, C80, G2, R52

1. Introduction

This paper critically examines the flaws within current Environmental, Social, and Governance (ESG) frameworks, particularly in their capacity to adequately assess sustainability initiatives' impact on pressing global issues such as climate change and land degradation. One of the primary shortcomings of these models is their reliance on simplified theoretical frameworks that lack concrete, quantifiable metrics, leading to the risk of greenwashing, where companies exaggerate their environmental contributions (Macpherson & Gasperini, 2021; Singhania & Saini, 2023). Additionally, these models often fail to emphasize the interconnected roles of the social and governance pillars in supporting environmental outcomes, further limiting their effectiveness.

A critical issue highlighted is the over-reliance on theoretical models without sufficient empirical foundations, resulting in an oversimplification of environmental impacts (Rook & Monk, 2019). The absence of tangible, measurable metrics makes it challenging to objectively evaluate sustainability efforts or compare entities meaningfully. This oversimplification is compounded by rigid assumptions in these models, which restrict their applicability across varying contexts and scenarios. Furthermore, the complexity of ESG frameworks mirrors the pitfalls found in expert-based credit scoring systems,

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where high operational costs, subjective biases, and lack of transparency undermine their reliability (Park & Oh, 2022).

ESG models are also criticized for overparameterization, which can dilute important factors and distort risk scores, creating a disconnect between high ESG ratings and actual sustainability outcomes. This disconnect often stems from insufficient weighting of the social and governance components, which are crucial for tangible environmental impact, particularly in areas like land degradation neutrality. The challenges of data collection under ESG initiatives, including cost, speed, and reliability (Cruz & Matos, 2023), further exacerbate the limitations of these frameworks, casting doubt on their overall effectiveness.

Obtaining high-quality ESG data is fraught with challenges, primarily due to the inconsistency in reporting practices and the absence of standardized frameworks. This leads to significant discrepancies in the data reported across companies, making comparisons difficult (Kotsantonis & Serafeim, 2019). The presence of data gaps and differing methodologies for filling these gaps further complicates analysis and often results in disagreements among data providers (Amel-Zadeh & Serafeim, 2018). Interestingly, more public disclosure can increase the variation in ESG ratings due to differing interpretations by stakeholders, highlighting the complexities involved in acquiring reliable and comparable data (Kotsantonis & Serafeim, 2019).

Additionally, ESG rating systems are undermined by varying methodologies, with some agencies using as many as 1000 data points or metrics while others rely on fewer than 100. This raises the issue of quality versus quantity, as an abundance of metrics can lead to overparameterization and obscure key indicators, thereby facilitating greenwashing. Models that fail to fully account for the complexities of real-world ecosystems increase model risk, especially when limited field studies are used. Furthermore, unified models with two-dimensional industry-specific approaches often rely on sector classifications that are not aligned with international standards, making cross-industry and regional comparisons difficult.

The lack of a common taxonomy across more than 600 ESG frameworks globally (Ernest & Young, 2021), further complicates standardization efforts, as even sophisticated frameworks like the European Union taxonomy are not fully applicable in developing countries. This underscores the need for global cooperation to align ESG standards with the Paris Agreement's goals. Moreover, larger companies tend to face less scrutiny in environmental evaluations, making it critical to introduce green ratios akin to financial metrics in the Basel framework to improve transparency in sustainability performance, particularly for the "E" (environmental) pillar.

ESG ratings are often based on voluntary corporate disclosures, with assessments focused on data availability rather than quality. This reliance on incomplete or inconsistent data leads to significant data gaps and risks greenwashing. Furthermore, companies can contest low scores through non-transparent bilateral processes with rating agencies, highlighting the need for an independent, transparent intermediary system to manage disputes and ensure accountability.

Finally, the customer-vendor dynamic between companies and rating agencies, where companies pay for their ratings, raises concerns about bias. To mitigate this, independent supervisory bodies should regularly audit ESG ratings to ensure their fairness and reliability.

Moreover, impact-based valuation models should be used to account for the complexities of ecological systems and the contributions of vulnerable social groups, as opposed to relying solely on market mechanisms. The Planetary Boundaries framework, which identifies critical environmental thresholds, offers a vital tool for evaluating corporate sustainability and emphasizes the need for reforms in ESG rating systems to better align with the Earth's ecological limits.

To address most of these gaps, this paper proposes incorporating natural capital valuation into the environmental pillar of ESG. Recognizing the degradation of ecosystem services, this approach would integrate tools like Co$tingNature (https://www.policysupport.org/costingnature) within satellite-based decision support systems. Furthermore, the paper suggests adopting a loss-based actuarial balance model to enhance the valuation of natural capital and better understand long-term environmental risks. As a case study on land degradation neutrality demonstrates, sustainable agricultural practices can not only reduce carbon footprints but also improve food quality and sovereignty.

We also suggest integrating environmental responsibility into governance and social practices for sustainability. The argument that the governance and social pillars of ESG do not directly address planetary boundaries is rooted in their current focus on corporate ethics, transparency, and social issues. While these areas are essential for responsible business practices, they often lack the direct engagement with ecological sustainability seen in the environmental pillar. To enhance their impact, both the governance and social pillars can be reframed to more closely align with environmental goals.

For the governance pillar, this could involve integrating environmental responsibility into corporate decision-making processes. This would mean embedding sustainability into governance frameworks, such as ensuring supply chain sustainability and proactively managing risks related to environmental disasters. Studies highlight the growing need for ESG governance to evolve beyond corporate efficiency, incorporating broader stakeholder interests and ecological concerns, thus fostering long-term sustainability (Monteiro et al, 2021).

The social pillar, meanwhile, could be expanded to emphasize environmental health and safety, community engagement in conservation efforts, and training for human capital on sustainable practices. This would create a more robust link between social policies and environmental sustainability, ensuring that labor practices, community relations, and employee development all support ecological goals (de Souza Barbosa et al, 2023).

Incorporating strategies like the circular economy and nature-based solutions into the environmental pillar would further align business practices with planetary boundaries. This would not only ensure a more holistic ESG framework but also drive innovation and accountability toward global environmental objectives. By doing so, the governance and social dimensions of ESG would contribute more directly to ecological sustainability, reinforcing the interconnectedness of business, society, and the environment.

2. Natural Capital Value Integrated ESG Model for Food Systems

The integration of sustainable farming methodologies, such as agroecology, permaculture, and regenerative agriculture, is pivotal in mitigating environmental degradation. These practices are complemented by judicious resource management strategies, including the implementation of rainwater harvesting, drip irrigation, and soil health enhancement techniques like composting, cover cropping, and minimized tillage. These practices, which align with Rockström et al. (2009)'s *planetary boundaries* framework, are essential for maintaining agricultural operations within safe environmental limits, ensuring long-term resilience and preventing irreversible ecological damage. By adhering to the thresholds for key environmental processes like climate regulation, land use, and nitrogen cycles, these farming methods contribute to the overall health of ecosystems while addressing critical challenges like climate change and biodiversity loss.

Furthermore, the preservation of biodiversity through species diversification and intercropping is crucial for maintaining ecological equilibrium. Costanza et al. (1997) provided a foundational framework for valuing ecosystem services, demonstrating the immense economic value of these practices in maintaining long-term environmental sustainability. In this context, integrating these services into agricultural practices is vital for both ecological integrity and economic resilience.

In the realm of climate action, the adoption of agroforestry and other carbon sequestration methods, alongside adaptation strategies to counteract the effects of climate change, plays a significant role. Additionally, waste reduction is achieved through upcycling, the responsible disposal of agricultural chemicals, and the recycling of farm by-products, thereby contributing to the overall sustainability of agricultural ecosystems. Daily & Matson (2008) emphasize the importance of incorporating ecosystem services into decision-making processes, reinforcing the need for comprehensive strategies that go beyond carbon footprint reduction to include biodiversity and nutrient management, such as nitrogen sequestration strategies. This ensures a more holistic approach to environmental stewardship, addressing not only greenhouse gas emissions but also nutrient pollution and land degradation.

In addressing the environmental component, it is insufficient to merely target a specific carbon footprint reduction. There is a pressing need to also integrate nitrogen sequestration strategies. This is because the challenges extend beyond CO_2 levels to encompass land degradation. The comprehensive approach should therefore encompass both carbon and nitrogen management practices to mitigate not only the atmospheric concentration of greenhouse gases but also to address soil health and prevent further degradation of terrestrial ecosystems. In addition to traditional carbon footprint considerations, the concept of a 'nitrogen footprint' should also become a focal point for green financing initiatives. Incorporating strategies for managing nitrogen into finance plans aimed at sustainability enables a broader approach to caring for the environment, addressing not just carbon emissions but also the pressing challenge of nutrient overload and its consequences for ecosystems.

The social pillar of the agricultural ESG framework is foundational to fostering ethical and sustainable agricultural methodologies. Central to this is the concept of worker well-being, which underscores the necessity for equitable employment conditions, prioritizing safe working environments, fair wages, and strict adherence to labor rights, including specific considerations for the unique challenges faced by indigenous people and migrant workers within the agricultural sector. Community Engagement expands the sector's social obligations, emphasizing the importance of forming positive connections with local communities, which includes supporting the economies and initiatives of indigenous populations and enhancing the integration and well-being of migrant workers and their families.

Addressing “Food Security” is crucial, with a focus on ensuring the production of abundant, accessible, and nutritious food, thus contributing to the resilience and sustainability of global food systems. The role of education and training is highlighted as essential for the empowerment and skill development of all workers, including indigenous and migrant communities, promoting sustainable agricultural practices and the use of innovative technologies. Health and safety are paramount, with a dedicated focus on safeguarding the health of all employees and consumers, particularly addressing the specific health risks and needs of indigenous people and migrant workers, through responsible management of agricultural inputs and the elimination of hazardous practices. Collectively, these components advocate for a socially responsible agricultural sector that champions the welfare of all workers, the engagement and upliftment of communities, and the promotion of health and safety, all within the framework of sustainable and inclusive agricultural practices.

In the agricultural ESG framework, while the Governance pillar is essential, it often carries a relatively lighter emphasis compared to the Environmental and Social pillars. The Governance aspect underscores the importance of adhering to legal and regulatory standards across both local and international landscapes, ensuring transparency in reporting agricultural methodologies and operations. It advocates for the maintenance of Ethical Business Practices, highlighting the necessity for anti-corruption efforts and the promotion of equitable competition.

The valuation of natural capital emphasizes the quantification and incorporation of ecosystem services into agricultural practices. This involves not only recognizing services such as carbon sequestration, biodiversity, and water purification as critical components of agricultural sustainability but also implementing practices that actively enhance these services. For instance, adopting regenerative agricultural methods that rebuild soil organic matter and restore degraded soil biodiversity can significantly increase the natural capital value, thereby contributing to long-term environmental sustainability. Engaging communities in decision-making processes related to ecosystem management fosters a sense of stewardship and shared value, reinforcing the social fabric and ensuring that the benefits of natural capital are equitably shared. Embedding the concept of food sovereignty into the social pillar is crucial to fostering sustainability and resilience, especially as those who cultivate nutrient-rich foods that enhance natural capital often lack access to these very resources. Governance practices should facilitate risk management strategies that account for natural capital degradation risks, ensuring that agricultural operations are resilient to environmental changes and capable of sustaining their natural capital base over the long term.

An effective ESG model in agriculture would require continuous monitoring, reporting, and updating practices to align with the latest sustainability standards and stakeholder expectations. In the subsequent section, we examine a case study where natural capital valuation is incorporated into a decision support system powered by Geographic Information Systems (GIS) and Remote Sensing (RS), detailing the data requirements necessary for operating the system.

3. Reframing Natural Capital Valuation: Recognizing Humans as Providers of Ecosystem Services

Natural capital valuation traditionally views nature as the sole provider of ecosystem services, predominantly benefiting humans in a unidirectional manner. This perspective tends to overlook the significant role that social dynamics play within the ESG framework. In reality, some individuals themselves act as providers of ecosystem services to others, functioning within the broader context of natural capital. This concept challenges the traditional one-way view of ecosystem services, advocating for a more integrated, cyclical understanding where humans are both recipients and providers of these services.

It acknowledges the vital contributions humans make to the sustainability and functionality of ecological systems, emphasizing the interdependence between human and natural systems. This approach highlights the crucial roles of social structures, cultural knowledge, and community governance in sustaining and enhancing ecosystem services.

Adopting this perspective broadens the discussion on ecosystem services, asserting that sustainability involves more than just preserving the physical environment; it also requires nurturing and supporting the human capabilities and social infrastructures that effectively manage these systems. This enriched viewpoint fosters a deeper appreciation of the symbiotic relationships within ecosystems, promoting a more holistic approach to environmental stewardship and sustainability.

Integrating the concept that humans can be considered providers of ecosystem services into the social and governance pillars of ESG frameworks introduces significant ethical considerations, especially concerning labor practices. This perspective sheds light on issues surrounding the exploitation of cheap labor, framing it not only as a social and ethical issue but also as a matter of environmental sustainability. This redefined understanding can be effectively operationalized within the ESG framework to address the ethical use of human capital more comprehensively.

In the social pillar, it is critical to ensure fair compensation and labor practices. Workers, particularly those whose roles directly impact or manage natural resources, should be fairly compensated, reflecting the true value they add to the ecosystem services they help sustain. For instance, agricultural workers engaged in sustainable farming practices should be paid wages that recognize their contributions to biodiversity and soil health—both crucial for long-term ecological sustainability. Additionally, commitments to worker rights and safety need to be strengthened, especially for jobs involving direct environmental interaction, such as those in forestry, agriculture, and mining. This includes providing necessary safety equipment and training and ensuring that workers have a say in the management practices that affect their work and the ecosystems they engage with. Furthermore, investing in community development programs that improve local living standards and education supports sustainable practices and enhances community well-being, enabling workers and communities to implement sustainable practices in their daily lives and work.

Within the governance pillar, ethical supply chain management is essential. This involves implementing and enforcing strict guidelines in the supply chain to prevent the exploitation of cheap labor, particularly in industries that directly impact natural resources. Regular audits and transparency from suppliers regarding their labor practices are necessary to ensure that all parts of the supply chain adhere to high ethical standards concerning labor. Developing sustainable procurement policies that prioritize products and services adhering to recognized labor and environmental standards is also crucial. This includes favoring suppliers who pay fair wages, use sustainable practices, and actively contribute to the preservation of ecosystem services. Additionally, active engagement with stakeholders—including labor unions, community groups, and NGOs—is vital for monitoring and discussing labor practices. This engagement helps ensure that the company's labor practices support its environmental goals and align with broader ESG objectives.

Overall, by considering humans as active providers of ecosystem services, ESG frameworks can promote a more holistic approach to sustainability, emphasizing the need for ethical labor practices that support both human welfare and environmental health.

Case Study: Integrating Natural Capital Valuation into Türkiye's LDN DSS

The land degradation neutrality decision support system[3] (LDN DSS) refers to a comprehensive tool or framework designed to assist in decision-making processes related to land management and conservation efforts in Türkiye. Its primary aim would be to achieve land degradation neutrality (LDN), a key sustainability target that aims to maintain or improve the health and productivity of land resources by balancing the loss of productive lands with the restoration of degraded areas.

The system integrates various data sources, including GIS & RS, and other environmental and socio-economic datasets, to assess current land conditions, identify degradation hotspots, predict future degradation trends, and evaluate the effectiveness of different land management practices. By doing so, it supports policymakers, land managers, and other stakeholders in making informed decisions that contribute to sustainable land use, restoration of degraded lands, and overall environmental conservation, aligning with Türkiye's commitments to global sustainability goals and conventions.

Co$tingNature is a web-based tool designed for environmental policy support, providing comprehensive analyses of ecosystem services, biodiversity, and the environmental impacts of development. It helps in assessing the value of nature in specific areas, enabling policymakers, conservationists, and researchers to make informed decisions regarding land use, conservation strategies, and sustainable development.

The tool utilizes advanced algorithms and incorporates a wide range of data, including GIS data, RS data, biodiversity distribution, and socio-economic information. Co$tingNature can model and map various ecosystem services like carbon storage and sequestration, water resources management, and biodiversity conservation. It also assesses the potential impacts of human activities and climate change on these services.

By providing insights into how different land-use decisions might affect ecosystem services and biodiversity, Co$tingNature supports the planning and implementation of conservation actions, sustainable land management, and development projects that minimize environmental impacts. It's particularly useful for identifying areas of high conservation value, understanding the trade-offs between development and conservation, and prioritizing areas for ecosystem service protection or restoration.

The integration process began with leveraging Co$tingNature to conduct a comprehensive valuation of ecosystem services across Türkiye's diverse biomes. This step involved detailed mapping and assessment, focusing on services critical to the country's ecological and economic well-being, such as water regulation, soil stabilization, and carbon sequestration.

Utilizing Co$tingNature's advanced algorithms, the project team analyzed biodiversity patterns within Türkiye, identifying key conservation areas and biodiversity hotspots. This analysis informed strategic conservation planning within the LDN DSS framework, ensuring the protection of vital habitats and species.

The integrated system employed Co$tingNature's scenario modeling capabilities to simulate various land management strategies and their potential impacts on ecosystem services and biodiversity. This allowed for the identification of land use practices that align with LDN goals while optimizing environmental and social benefits.

[3] https://projectgeffao.users.earthengine.app/view/ldn-turkey

Insights and visualizations generated through the integrated system were shared with a broad spectrum of stakeholders, including policymakers, landowners, and conservationists. This facilitated informed decision-making and policy development, with a strong emphasis on evidence-based conservation and land management strategies.

The integration significantly enhanced the LDN DSS's ability to quantify the economic value of natural capital, providing a more holistic view of land management implications. Conservation priorities were more accurately identified, enabling targeted action in areas of critical ecological significance. Land use policies and strategies developed through the integrated system were grounded in comprehensive environmental data, leading to more sustainable and effective land management practices. Increased stakeholder engagement and collaboration were observed, with the transparent sharing of data and findings fostering consensus and collective action towards LDN goals.

The integration of Co$tingNature into Türkiye's LDN DSS represents a pioneering approach to sustainable land management, where the intrinsic value of natural capital is meticulously accounted for. This case study exemplifies how leveraging advanced tools and frameworks can significantly bolster national efforts to achieve LDN, ensuring that land management practices contribute positively to both ecological integrity and societal well-being.

4. Regulatory Financial Institutions' Role in Advancing Sustainable Land Management through LDN DSS-Co$tingNature Collaboration

The collaboration between the LDN DSS-Co$tingNature case study and the banking system of Türkiye could catalyze a transformative approach to green financing, deeply rooted in principles related to performance criteria that underscore sustainability and conservation. This partnership could unfold as follows:

1. Green Financing Initiatives with Performance Criteria: By harnessing insights from the case study, the Banking system could refine green financing initiatives to include specific performance criteria that projects must meet to qualify for funding. These criteria would be based on the tangible impacts on ecosystem services and biodiversity conservation, thereby ensuring that investments not only align with LDN goals but also demonstrate measurable environmental benefits. Financial incentives, such as reduced interest rates, could be tied directly to these performance metrics, encouraging projects that have a significant positive impact on land sustainability.

2. Risk Management Through Environmental Criteria: The comprehensive understanding of environmental risks gleaned from the case study's integration of natural capital valuation offers a robust framework for the Banking system to enhance its risk management strategies. Incorporating environmental criteria into financial stability analyses would ensure that both the bank and associated financial institutions account for land degradation risks in their operations, promoting a more sustainable financial landscape.

3. Promoting Sustainable Land Management: Building on the economic insights from the case study, banks can take a leadership role in promoting the integration of sustainable land management and conservation into financial and economic strategies. This may include advocating for the adoption of regulations that prioritize green financing standards, and encouraging fiscal and monetary frameworks that support LDN and broader environmental sustainability goals. By fostering a financial

environment that aligns with ecological objectives, banks can help ensure that sustainability is central to economic decision-making.

4. Enhanced Sustainability Reporting: The financial authorities' drive to integrate natural capital and LDN considerations into sustainability reporting has the potential to transform transparency within the financial sector. By mandating that financial institutions report in accordance with green financing performance criteria, the bank would drive a shift towards more accountable and environmentally conscious financial practices, with institutions required to demonstrate their contribution to sustainable land management and conservation.

5. Capacity Building Aligned with Green Criteria: The banking system's role in facilitating educational initiatives would further entrench the principles of green financing within the sector. Through targeted workshops and seminars that emphasize the integration of natural capital valuation and adherence to performance criteria in financial decision-making, the bank could cultivate a financial ecosystem that is well-versed in sustainable practices and equipped to support Türkiye's LDN ambitions.

In this collaborative model, the Central Banks stand to play a pivotal role in steering the nation's financial practices towards a model that not only supports economic growth but also prioritizes the preservation and enhancement of Türkiye's natural landscapes, aligning financial mechanisms with the imperative of environmental stewardship and land sustainability.

5. Actuarial Balance Approach to Natural Capital Valuation:

The actuarial balance approach could significantly enhance the Co$tingNature tool by adding a financial dimension that quantifies long-term economic risks associated with the loss of natural capital. Incorporating the actuarial balance concept into the evaluation of natural capital degradation necessitates a forward-looking and comprehensive analysis of the economic implications tied to environmental loss, set against the backdrop of the invaluable services provided by intact ecosystems. Actuaries, leveraging their proficiency in financial risk management and liability forecasting, engage in an exhaustive quantification of the costs stemming from the depletion of natural resources and the reduction of ecosystem services. This analysis extends its scope beyond immediate remediation costs to include a wider array of economic impacts, such as potential revenue losses from ecosystems that can no longer deliver essential services, leading to reduced agricultural yields, heightened flood risks, and deteriorating air and water quality.

The actuarial balance framework for natural capital helps us understand the long-term costs of damaging the environment, just like how insurance companies plan for the costs of accidents or medical bills in the future. Natural capital refers to the Earth's resources—like forests, rivers, soil, and biodiversity—that provide essential services such as clean air, water, and fertile land.

This framework helps us predict how much it will cost if these resources (natural capital) are degraded or lost, and how we can plan ahead to restore or protect them. By doing this, we ensure that we have enough resources (both financial and natural) to fix problems and maintain the benefits that nature provides us in the long run.

The act of evaluating claims associated with environmental damage is central to this actuarial scrutiny, offering a detailed perspective on both historical and contemporary trends in ecosystem degradation and their financial consequences. These insights are crucial for the development of environmental insurance products, wherein premiums and coverages are precisely tailored to mirror the assessed risks and forecasted claims, thus facilitating risk-aware pricing and encouraging policyholders to adopt risk-reducing measures.

Moreover, the actuarial balance approach aims to achieve a financial equilibrium, ensuring that reserves, insurance schemes, and strategic investments are sufficiently robust to shoulder the projected expenses for comprehensive ecosystem restoration, compensation for environmental harm, and adaptation to evolving environmental conditions. This equilibrium is essential for synchronizing financial and economic strategies with the principles of sustainable environmental management, advocating for initiatives that both alleviate the negative effects of natural capital degradation and actively support the restoration and sustainable governance of ecosystems.

Expanding the actuarial balance approach to include the valuation of natural capital unveils a robust framework for weaving environmental considerations into the fabric of financial decision-making and economic policy development. This broader viewpoint calls for a systemic environmental risk management strategy, integrating sustainability and conservation tenets into economic models and strategies. It emphasizes the need for a concerted effort among policymakers, corporations, insurers, and financial entities to cultivate a resilient, sustainable, and equitable economic infrastructure that aligns human ambitions with the ecological limits of our planet. In this context, reserve logic plays a crucial role, necessitating the accumulation of adequate financial reserves to address potential future environmental liabilities, thereby ensuring long-term sustainability and resilience. Such forward-looking policy decisions, informed by actuarial analyses, are instrumental in steering economic activities towards sustainability, facilitating the transition to an economic system that respects and preserves the delicate balance of our natural environment.

The actuarial balance approach to natural capital valuation distinguishes itself from other methods through its rigorous focus on risk assessment, financial liability forecasting, and the establishment of financial reserves to manage future uncertainties related to environmental degradation. Drawing parallels to the Cost of Illness (COI) approach used in medical research or disability compensation schemes, the actuarial approach focuses on the expenses required to rehabilitate the beneficiaries of natural capital, diverging from the commonly seen replacement cost of the capital itself in other natural capital valuation techniques.

6. Recommendations

To effectively address the complexities of natural capital valuation within ESG frameworks, a broad and integrated approach is essential. Central to this is the adoption of globally recognized frameworks such as the United Nations-Natural Capital Protocol (NCP) and the System of Environmental-Economic Accounting (SEEA) and guidance of Organisation for Economic Co-operation and Development (OECD), World Bank and European Union. These frameworks provide a standardized methodology for natural capital valuation that can be applied consistently across industries and regions. By aligning with these standards, companies can enhance comparability and transparency in their ESG reporting, making natural capital valuation more reliable and globally applicable. This alignment is particularly crucial for harmonizing practices between developed and developing countries, where economic and environmental conditions vary widely, yet the need for a unified approach remains critical.

Another key component in simplifying natural capital valuation is the use of proxy indicators that can represent broader ecosystem services. Proxy indicators such as carbon sequestration rates, biodiversity indices, and water-use efficiency metrics offer measurable, concrete ways to assess environmental health without the complexity of valuing each ecosystem service directly. These indicators can be incorporated into the "Environmental" pillar of ESG frameworks, enabling businesses to report progress in a way that is scientifically grounded and easy to track. This broader benchmarking approach allows for scalability and adaptability across different sectors, ensuring that companies from diverse industries can meaningfully participate in sustainability initiatives.

Technology plays an essential role in operationalizing these broader benchmarks. Advanced tools such as GIS, RS, and data analytics are critical for tracking changes in ecosystem services over time. These technologies offer real-time monitoring capabilities, providing accurate, up-to-date information that enhances the precision of natural capital valuation. By leveraging such tools, companies and regulators can improve transparency and make the valuation process more accessible, fostering trust among stakeholders. Moreover, technology-driven transparency allows for more dynamic engagement with communities, investors, and policymakers, ensuring that the assessment of natural capital is both credible and participatory.

Beyond the conventional focus on carbon emissions, expanding natural capital valuation to include additional environmental metrics such as biodiversity, water management, and land degradation neutrality is essential for a holistic approach to sustainability. These broader metrics capture the interconnectedness of ecosystem services and provide a more comprehensive view of sustainability. Integrating them into ESG frameworks ensures that companies address a full spectrum of environmental impacts, not just carbon reduction, making their sustainability strategies more resilient and comprehensive. For example, biodiversity and water management are critical resources that are often undervalued in traditional ESG models but are essential for long-term ecosystem resilience and global sustainability.

A forward-looking solution to the complexities of natural capital valuation is the adoption of actuarial models, as suggested in the paper. These models offer a method to assess long-term risks and financial liabilities associated with natural capital depletion. Actuarial methods help businesses forecast the financial impacts of environmental degradation, ensuring that they account for future liabilities while planning strategically. This financial foresight is critical for embedding natural capital valuation into long-term business planning, linking environmental outcomes directly to economic risks and opportunities. The actuarial approach complements broader benchmarks by providing a structured, data-driven way to assess and manage long-term sustainability risks.

For broader adoption, regulatory frameworks and government incentives must support the integration of natural capital valuation into ESG models. Policymakers should design tax breaks, subsidies, or preferential access to green financing for companies that demonstrate measurable improvements in ecosystem services such as carbon sequestration, biodiversity enhancement, or improved water management. These incentives create a financial rationale for businesses to incorporate natural capital into their strategic planning, aligning sustainability goals with economic rewards. Furthermore, linking financial incentives to broader benchmarks ensures that businesses are incentivized to adopt practices that improve multiple dimensions of natural capital, not just single metrics like carbon reduction.

Financial institutions also play a pivotal role by developing sustainability-linked loans and green bonds that are tied to broader natural capital benchmarks. These financial products can incentivize businesses to improve their environmental performance by offering favorable terms based on the achievement of sustainability targets. By integrating natural capital valuation into green financing mechanisms, businesses can align their environmental and financial strategies, creating a stronger market-driven incentive for sustainability. This integration ensures that financial and environmental sustainability goals are mutually reinforcing, driving long-term resilience across industries.

As for the data issues, we recommend the establishment of a Special Purpose Vehicle (SPV) involving a public-private-research entity partnership to address the data challenges outlined in the ESG framework. This SPV will standardize ESG data collection and reporting, ensuring transparency and comparability across sectors. By leveraging advanced technologies such as GIS and RS, it will enhance data accuracy and facilitate investment in sustainability-focused projects. Independent governance will ensure unbiased data management and prevent potential conflicts of interest in ESG evaluations.

In summary, overcoming the complexities of natural capital valuation requires a comprehensive strategy that integrates standardized frameworks, broader environmental benchmarks, advanced technologies, actuarial risk assessments, and supportive regulatory policies. To enhance natural capital valuation at the micro level, integrating methodologies akin to the NCP and leveraging frameworks such as the SEEA would be essential. These efforts would allow for more standardized, detailed environmental accounting, enabling businesses to align their sustainability practices with macro-level economic and environmental metrics. By aligning these elements with transparent reporting and market-driven incentives, companies can embed natural capital valuation into their ESG strategies in a meaningful and scalable way. This approach not only enhances the credibility of ESG assessments but also ensures that businesses contribute to the global effort to preserve and restore vital ecosystem services, aligning economic growth with environmental sustainability.

7. Conclusion

This study underscores the critical deficiencies within traditional ESG frameworks and highlights the potential for actuarial balance approaches to provide a more accurate and holistic valuation of natural capital. By incorporating detailed risk assessments, future liability forecasting, and financial reserve strategies, actuarial methods address the multifaceted nature of environmental impacts more effectively than current ESG assessments. The paper advocates for the adoption of these methodologies across different sectors, with a particular focus on agriculture, to ensure that sustainability assessments are not only comprehensive but also grounded in practical, actionable strategies. Furthermore, it calls for a broader application of these refined frameworks to drive meaningful environmental policies and practices that are capable of achieving true sustainability goals. Emphasizing the importance of collaboration among policymakers, businesses, insurers, and financial institutions, the paper suggests that a united approach will be essential for the successful integration of these innovative methodologies into established systems, ultimately leading to a sustainable alignment of economic activities with ecological sustainability.

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Refining ESG Models: Embedding Natural Capital Valuation Beyond Box-Ticking Compliance Towards Confronting Planetary Boundaries

CBRT-IFC Workshop on "Addressing Climate Change Data Needs: The Global Debate and Central Banks' Contribution"

İzmir, 7 May, 2024

Prof. Kasırga Yıldırak (Hacettepe University)

Ömer Kayhan Seyhun (Senior Specialist CBRT)

*The views expressed in this presentation are those of the author and do not necessarily reflect those of the CBRT and Hacettepe University

OVERVIEW

- Motivation/Planetary Boundaries

- Weaknesses of Typical ESG Approaches

- Natural Capital Valuation

- Embedding Natural Capital Valuation into Sustainability Risk Models

- Case Study:

i) Decision Support Systems, Natural Capital, Sustainable Agriculture & Land Degradation Neutrality
ii) Co$tingNature- Policy Support System

- Steps to Follow For Closing Data Gaps for effective ESG

MOTIVATION

Planetary Boundaries

- Stability & Resilience of Earth System
- Heavily Effected by Anthropogenic processes

Alarming

1) Climate Change ↑

2) Biodiversity Integrity (Loss) ↑

3) Biogeochemical flows ↑

4) Freshwater Use ↑

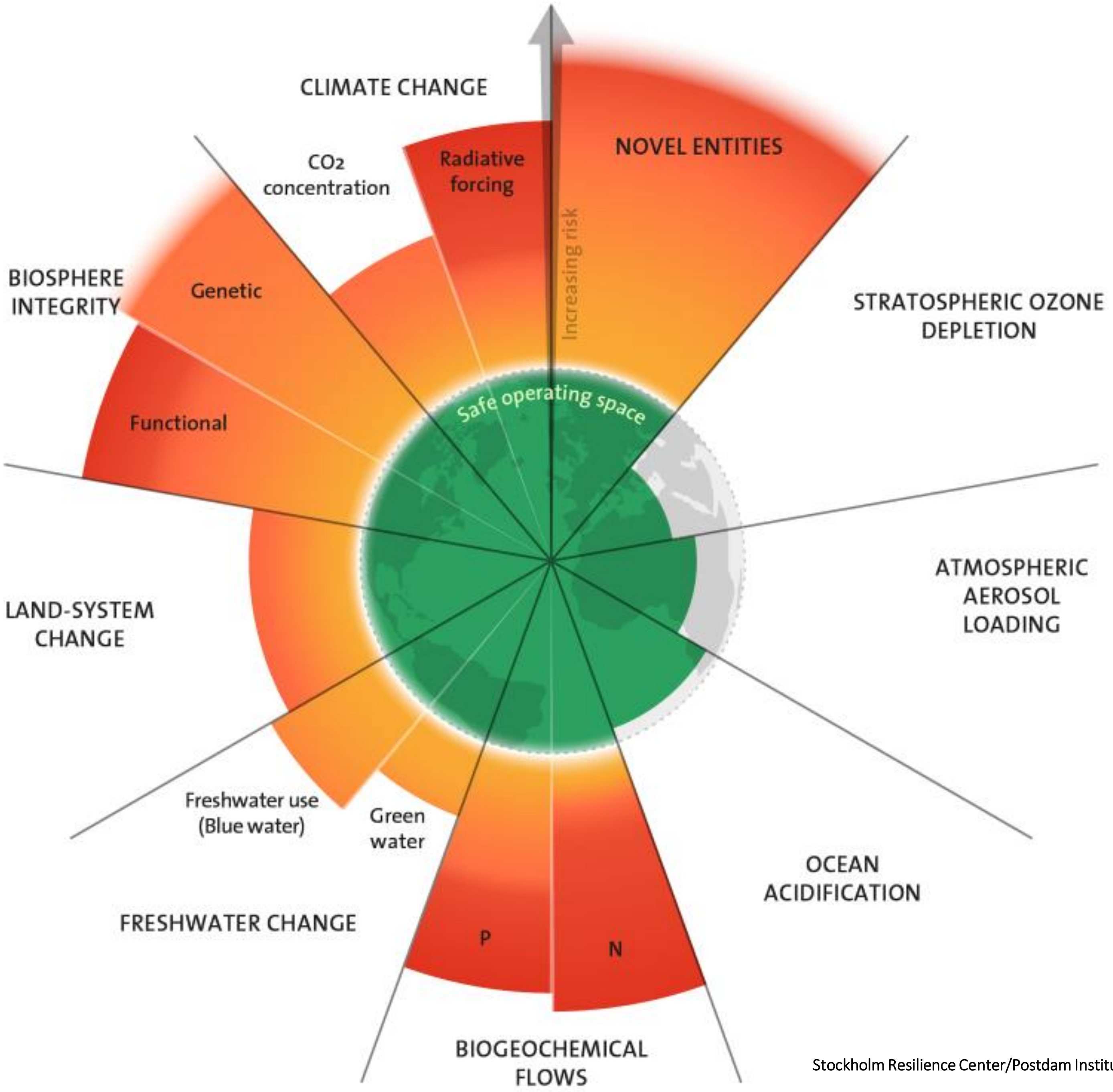
5) Land-System Change ↑

6) Novel Entitites (New Pollutants) ↑

7) Athmospheric Aerosol Loading (stable)

8) Ocean Acidification (closing to limit)

9) Stratospheric Ozone Depletion (stable)



Stockholm Resilience Center/Postdam Institute

MOTIVATION

Planetary Boundaries

Alarming

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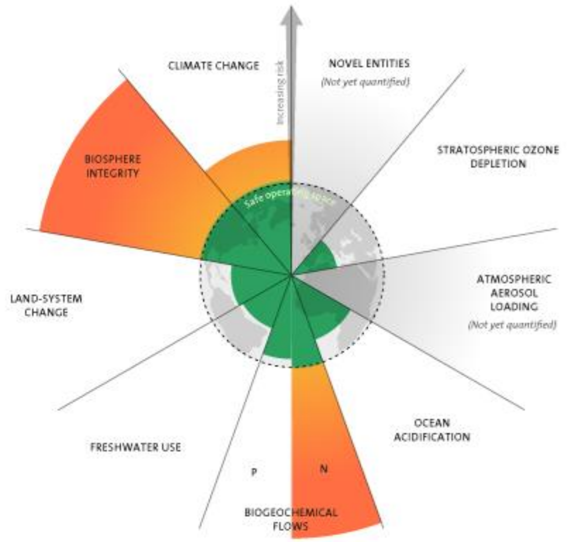
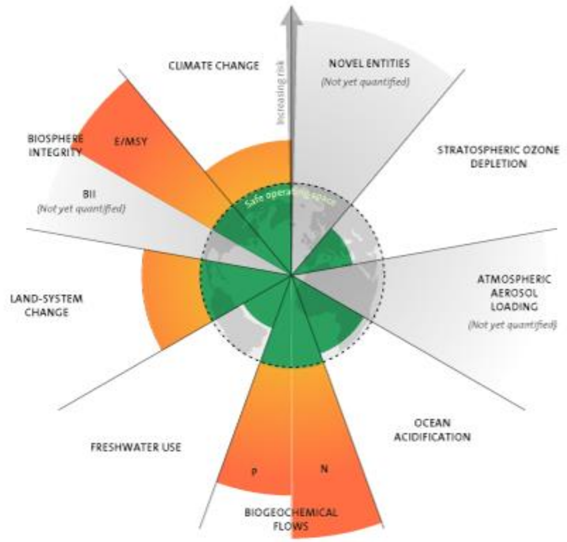
2009



7 boundaries assessed,

3 crossed

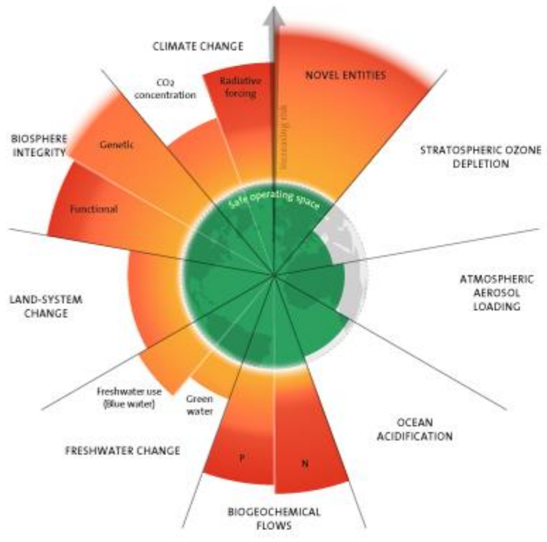
2015



7 boundaries assessed,

4 crossed

2023



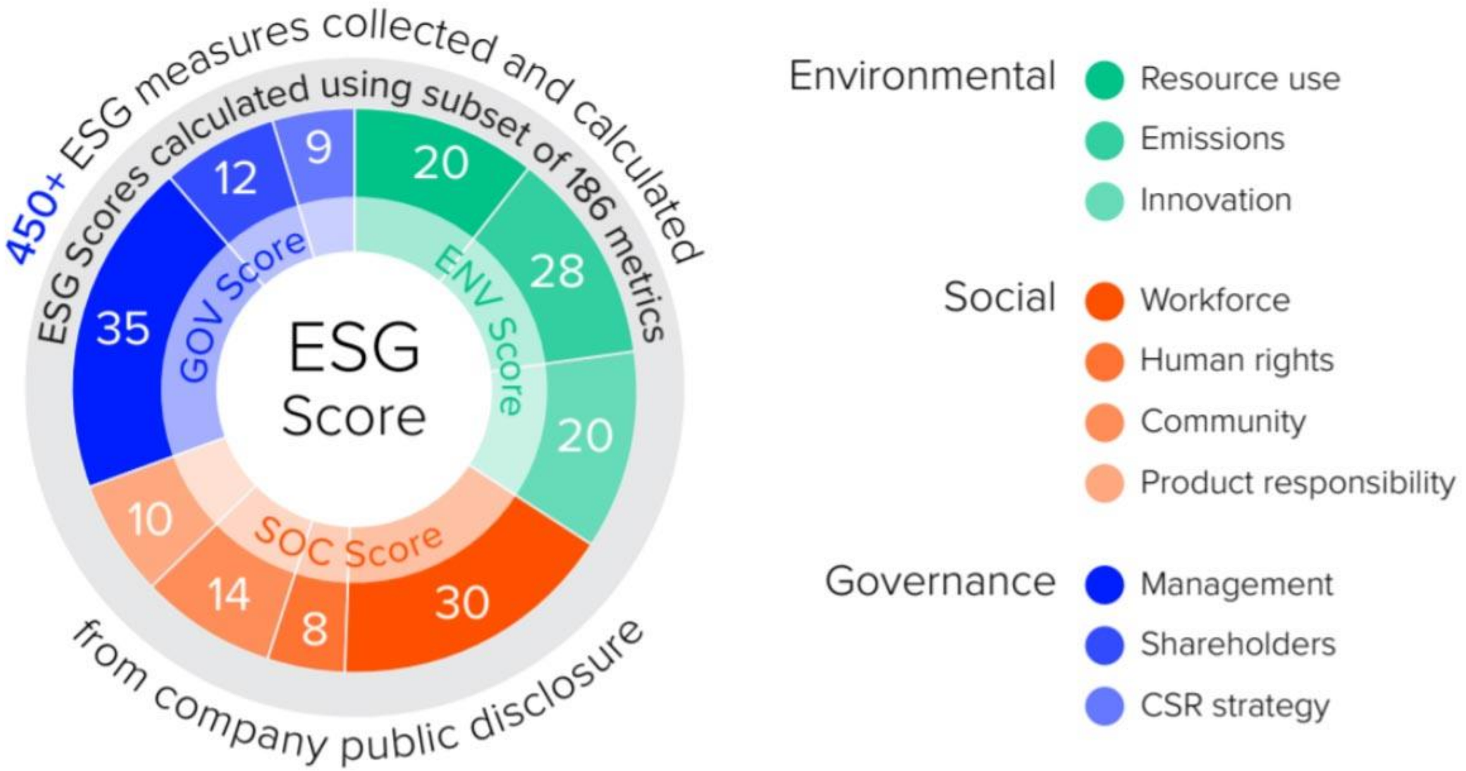
Stockholm Resilience Center/Postdam Institute

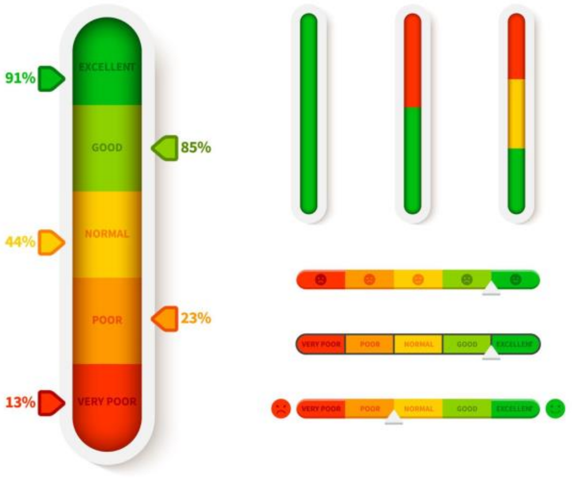
9 boundaries assessed,

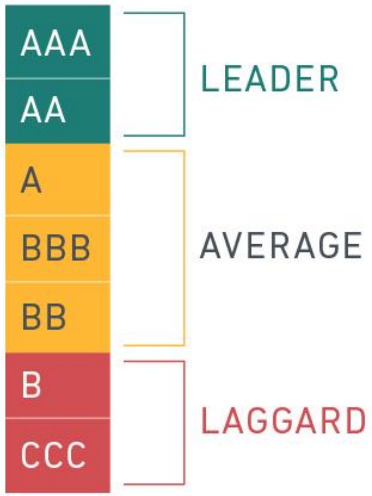
6 crossed

WEAKNESSES OF ESG

- Relying on Simplified Theoretical Models
- Absence of Quantifiable Metris
- Not unified reporting methodology
- Market value calculation not intrinsic value
- Overparameterization
- No Impact base evaluation
- ESG Sustainable System doesn't imply good impact
- Extremely high model risk
- Doesn't capture real world complexities







Natural Capital Accounting Approach

What is natural Capital Accounting (World Bank Definition)

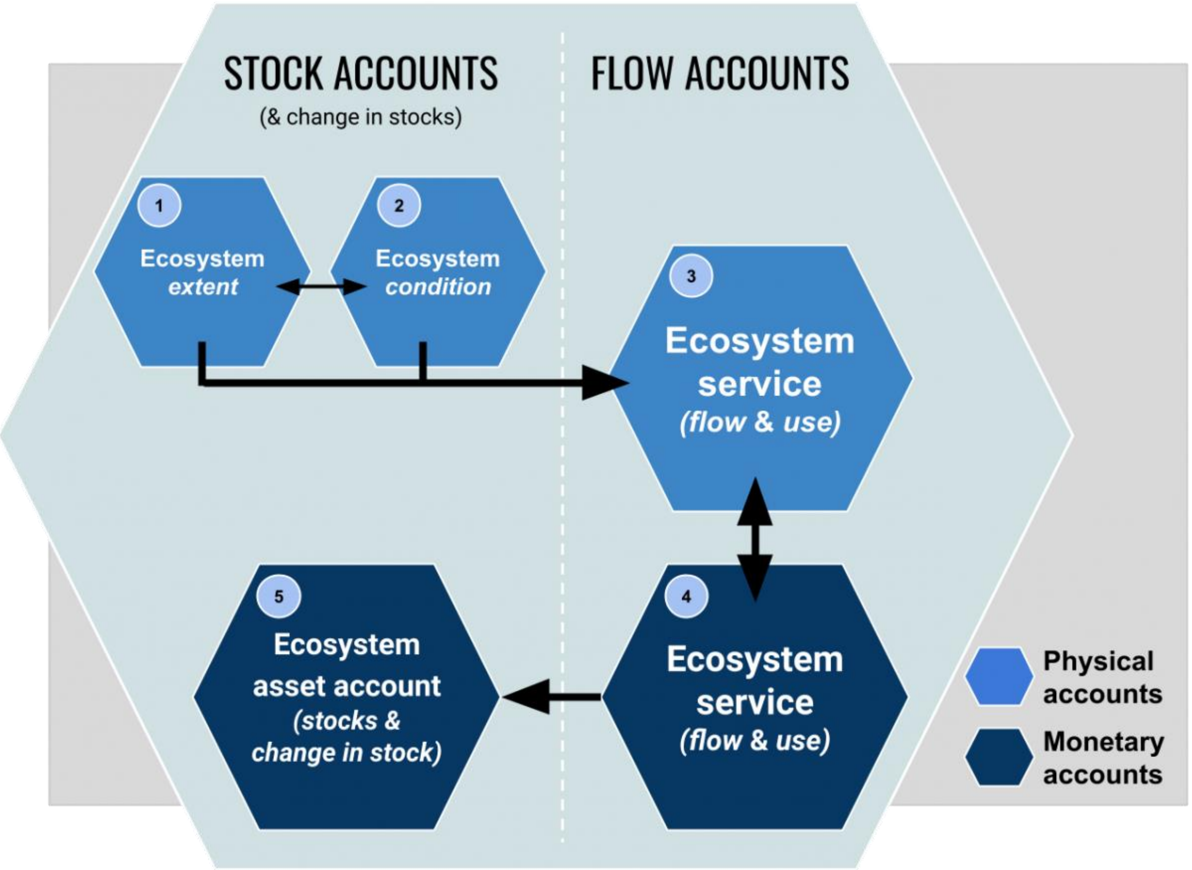
It is part of broader wealth accounting, integrates natural resources, economic valuation and analysis, providing a better understanding of development progress and its impacts on society and environment than standard measures such as Gross Domestic Product (GDP).

It provides whole picture of ecosystem.

SYSTEM OF ENVIRONMENTAL ECONOMIC ACCOUNTING(SEEA EA)

Natural Capital

- Forests **E**
- Agricultural Lands **E**
- Fisheries **E**
- Minerals **E**
- Human made/produced capital **S**
- Skills&Experince of Population **S&G**



Case Study: Integrating Capital Valuation into Türkiye's Land Degradation Neutrality Decision Supporting System (LDN DSS)

Data Set:

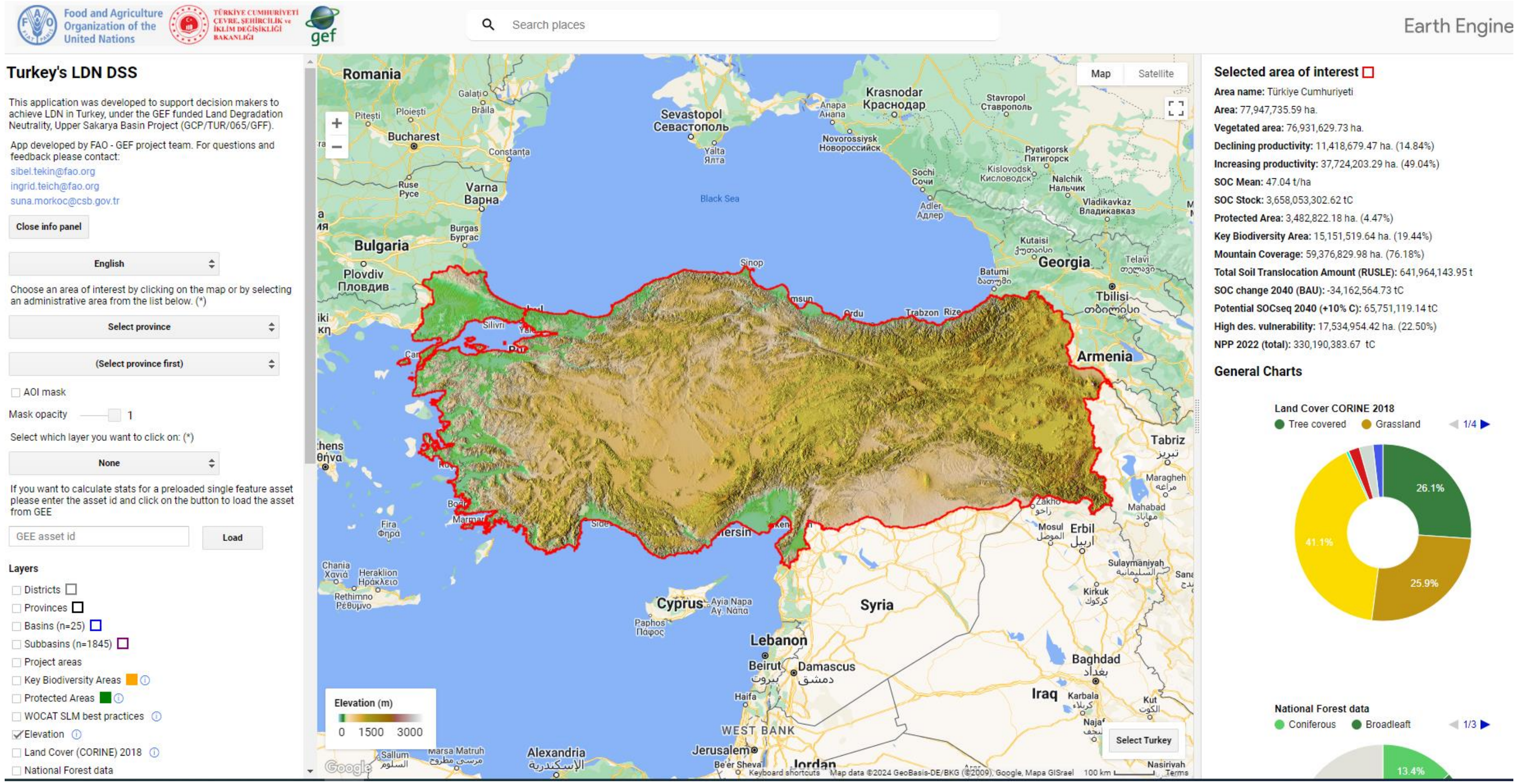
- Geographic Information System (GIS)
- Remote Sensing (RS)
- Environmental and Socio Economic Dataset

https://projectgeffao.users.earthengine.app/view/ldn-turkey

Aim:

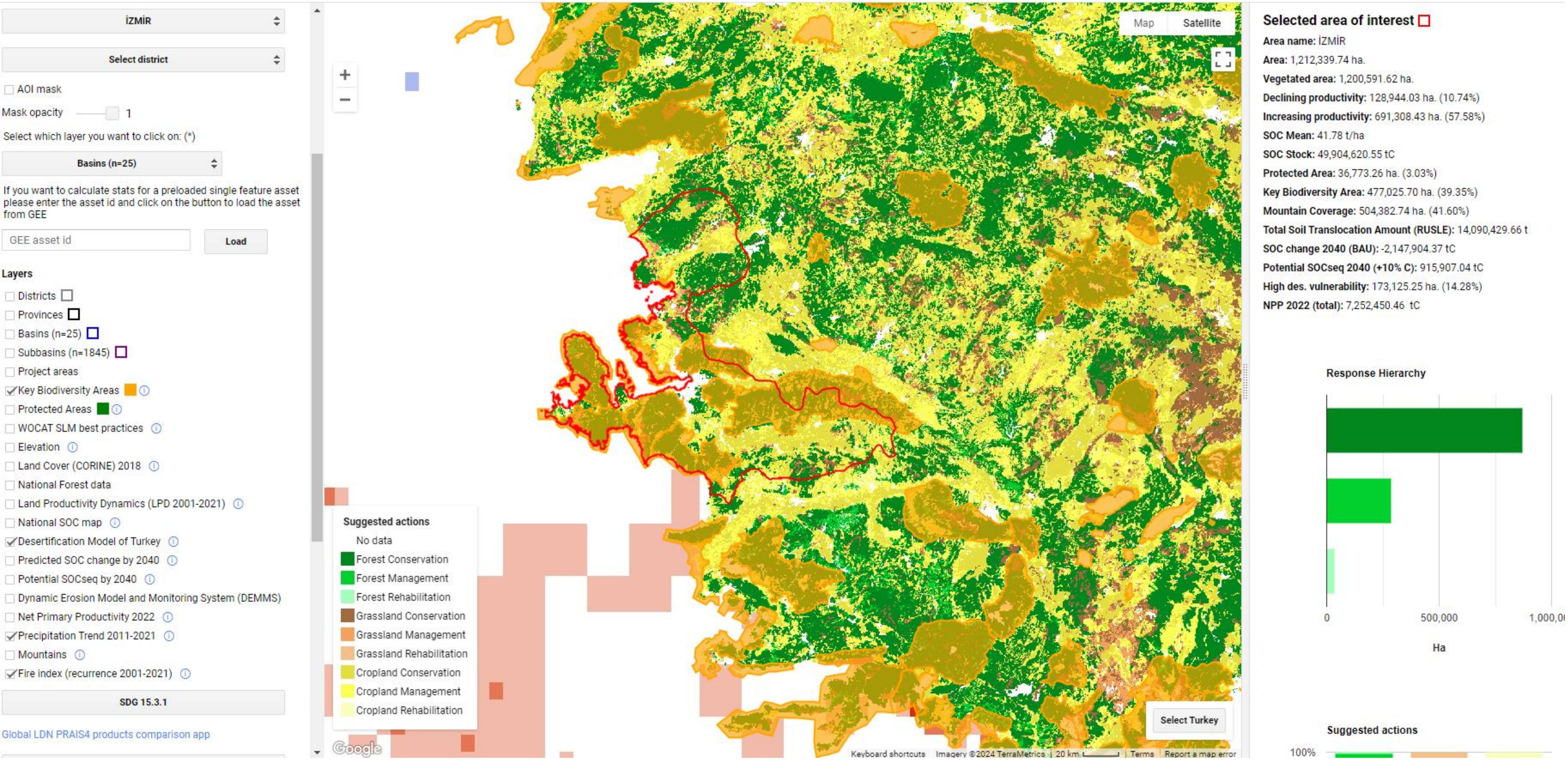
Supports policymakers, land managers, and other stakeholders in making informed decisions that contribute to sustainable land use, restoration of degraded lands, and overall environmental conservation, aligning with Turkey's commitments to global sustainability goals and conventions.

Pilot Study: Upper Sakarya Basin Project



- Available since 2021

(LDN DSS)-İZMİR REGION

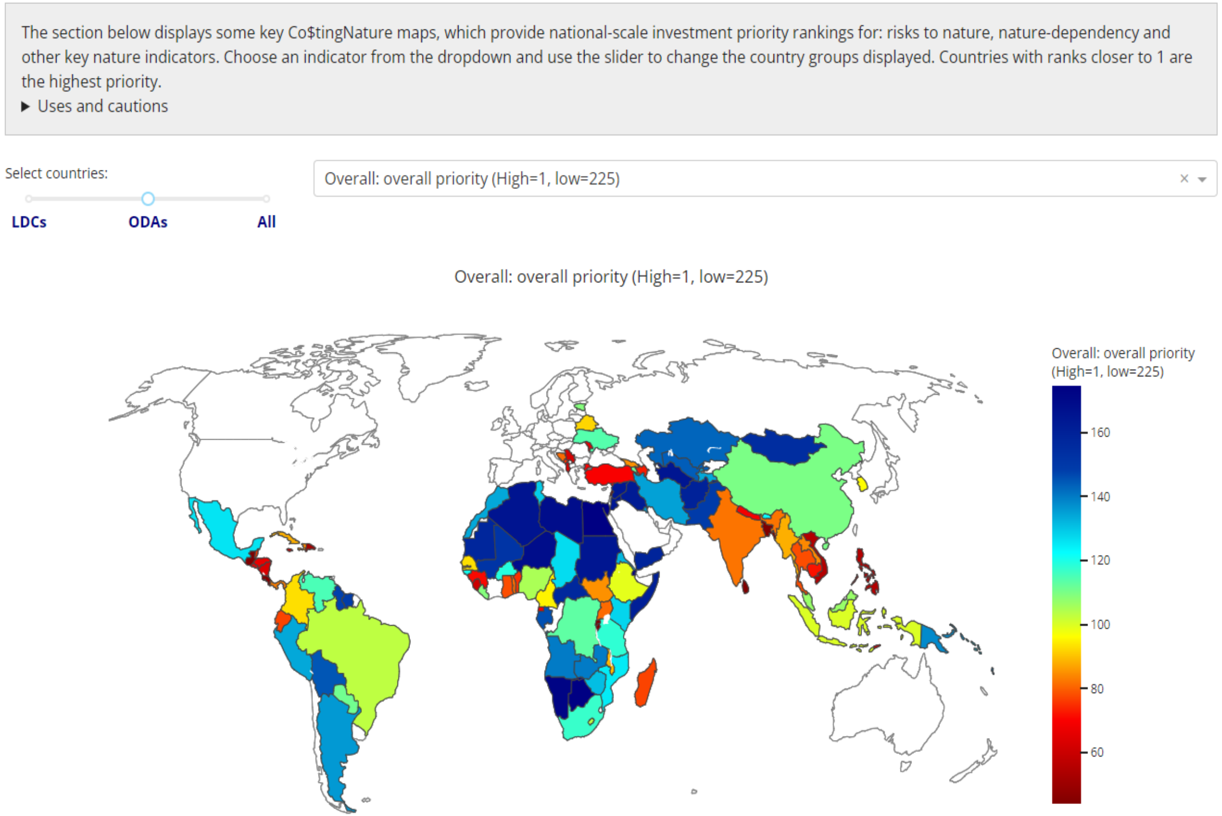


Tool to Assess Natural Capital Valuation

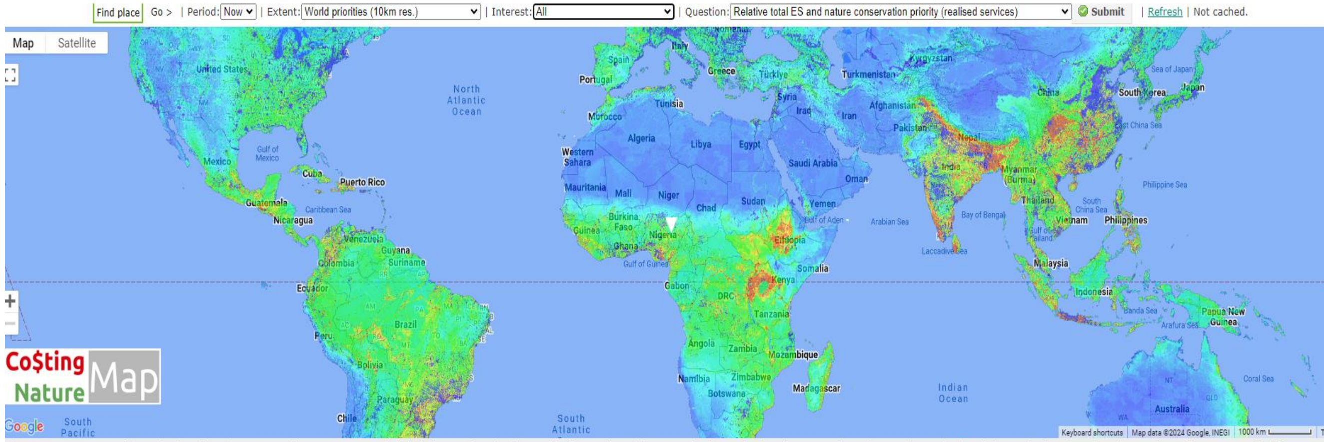
Co$tingNature

- Sophisticated web-based spatial policy support system (PSS) for natural capital accounting and analysing the ecosystem services provided by natural environments (i.e. nature's benefits)
- Identifying the beneficiaries of these services and assessing the impacts of human interventions.
- Adapting to ESG Models (Possible recommendation)

Module for Sustainable Development



Module for Nature-Related financial risk disclosure



Developers: King's College London (applications, data, models), AmbioTEK (software, data, models), UNEP WCMC (applications, data)-open source

https://www.policysupport.org/costingnature
http://www1.policysupport.org/cgi-bin/ecoengine/pssmap.cgi?project=CNMap&action=Map
https://analytics.policysupport.org/cn4sd
https://projectgeffao.users.earthengine.app/view/ldn-turkey

Co$tingNature (Methods-Assumptions and Limitations)

Co$ting Nature

Country specific applications

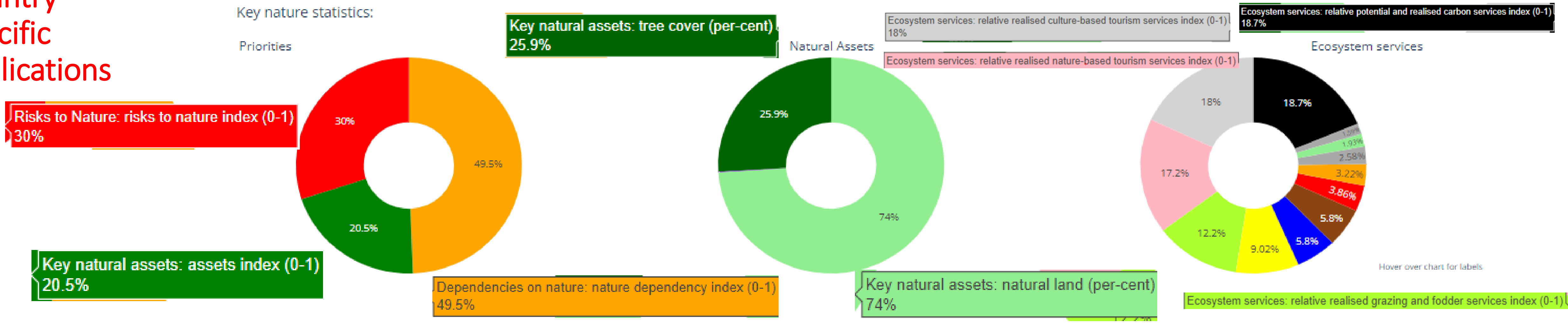
Turkey: nature data

Nature overview

The section below shows some key Co$tingNature nature indicators for Turkey. These include: the contribution of each component metric to the overall nature-investment priority (left pie chart), the natural asset priorities (middle pie chart) and the nature-dependency (ecosystem service) priorities (right pie chart). For this country, the current pressure that is greatest over the most territory is: **infrastructural intensity**, the future threat that is greatest over the most territory is: **deforestation**, and the ecosystem service (nature-dependency) that is greatest over the most territory is: **water**. Nature's contribution to meeting the UN Sustainable Development Goals (SDGs) for this country is (on scale of 0-1): **0.65**. Nature's contribution is greatest over the most territory to: **SDG1: No poverty**. The overall nature-investment priority value (1=highest, 255=lowest) for this country is: **70**.

▶ Explanation
▶ Uses and cautions

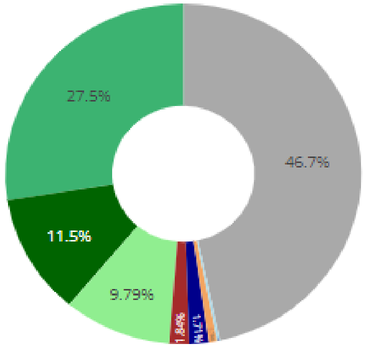
Key nature statistics:



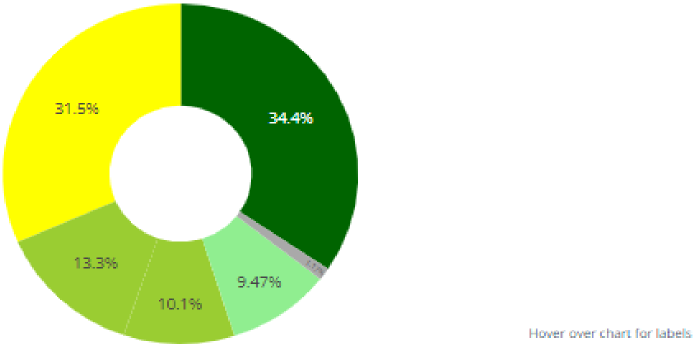
Land cover and use (2020):

https://analytics.policysupport.org/cn4sd/Turkey

Land cover



Land use



Co$tingNature (Economic Units)

- Economic valuation mode the economic value of each ecosystem service is calculated, based on information available in a country's national accounts
- Suited to investment and policy applications focused on valuation of ecosystem services
- Complete a matrix of economic values for each ecosystem service to each beneficiary class.
- Future sceneario analysis
- Maps 22 potential and 22 realised ecosystem service values

	Use value	Non-use value	Exclude for PAs	Max. attainable	
Water (intakes)	240000000	0	No	unlimited	?
Water (rural)	3	0	No	unlimited	?
Sediment (intakes)	1000000	0	No	unlimited	?
Carbon	2	0	Yes	1000000	?
Hazard mitigation	1	0	No	unlimited	?
Nature based tourism	108000000	0	No	unlimited	?
Environmental quality	10000	0	Yes	unlimited	?
Fuelwood (hardwood)	10	0	No	unlimited	?
Fuelwood (softwood)	6	0	No	unlimited	?
Commercial timber (hardwood)	98	0	Yes	unlimited	?
Commercial timber (softwood)	63	0	Yes	unlimited	?
Domestic timber (hardwood)	98	0	No	unlimited	?
Domestic timber (softwood)	63	0	No	unlimited	?
Commercial inland fisheries	1000	0	Yes	unlimited	?
Artesanal inland fisheries	1000	0	No	unlimited	?
Livestock (grazing)	110	0	No	unlimited	?
Cultural/heritage/spiritual	255000000	0	No	unlimited	?
Non-wood forest products	126	0	No	unlimited	?
Wildlife dis-services	1000	0	No	unlimited	?
Wildlife services	1000	0	No	unlimited	?
Species Richness	0	0	No	unlimited	?
Species Endemism	0	0	No	unlimited	?

Check and Submit

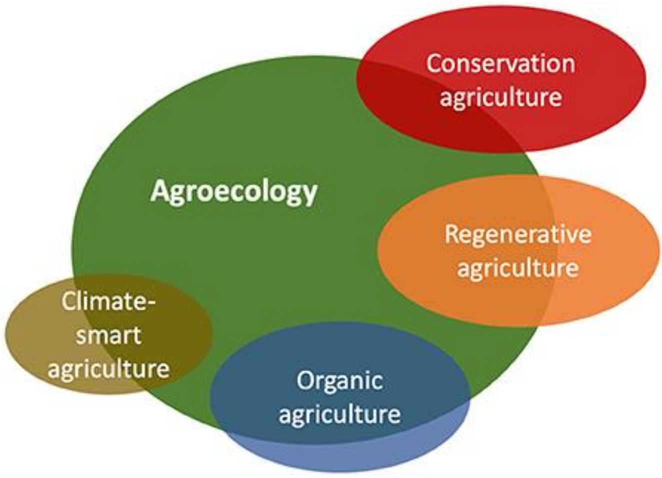
Natural Capital Valuation (Sustainable Agricultural Practices)

Natural Capital Value Integrated ESG Model for Food Systems

- The integration of sustainable farming methodologies
- Agroecology,
- Permaculture,
- Regenerative agriculture

"Environmental"

- Pivotal in mitigating environmental degradation. (Sequestor CO_2)

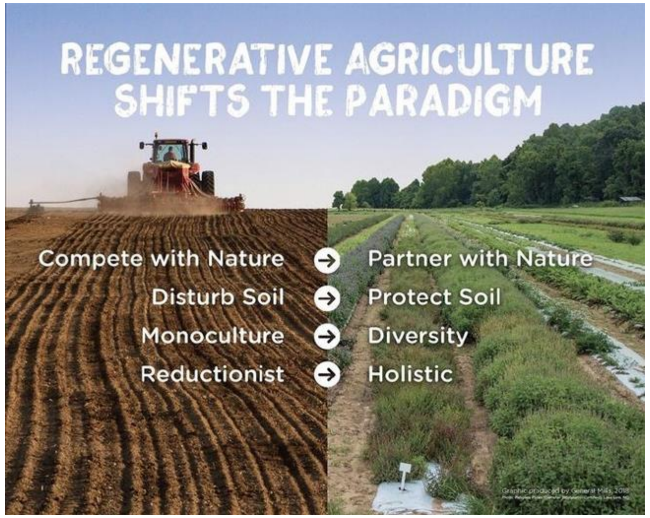


Sustainable Agricultural Methods

For local community , seasonal workers and Indigenous(not conventional agriculture practioners)

- Necessity for equitable employment conditions
- Prioritizing safe working environments
- Fair wages
- Strict adherence to labor rights.

" Social"

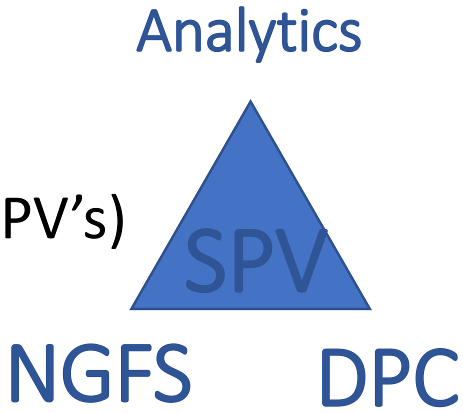


Natural Capital Valuation and ESG

- E
- Ensure that parameters in the E pillar directly or indirectly influence the Value of Ecosystem Services and adjust the weights accordingly.
- S
- Ecologists often consider humans as separate from ecological systems. While this holds some truth, it overlooks the role of local communities and seasonal workers who contribute to the ecosystem's natural capital as active participants.
- Their contributions should not be weighted the same as those of communities that have outsourced their responsibilities to the corporate sector or engaged in financial offsetting mechanisms.

Steps to Follow For Closing Data Gaps for effective Sustainability Risk Metric

- Behavior Change vs Delegation
- Respect and link your outcomes with Planetary Boundaries
- Collaboration for Data Sharing beyond market economy (Establishing SPV’s)
- Adapting Natural Capital Valuation to ESG Models



(LDN DSS, Co$tingNature Modules Practices to fill data gaps)

THANK YOU

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