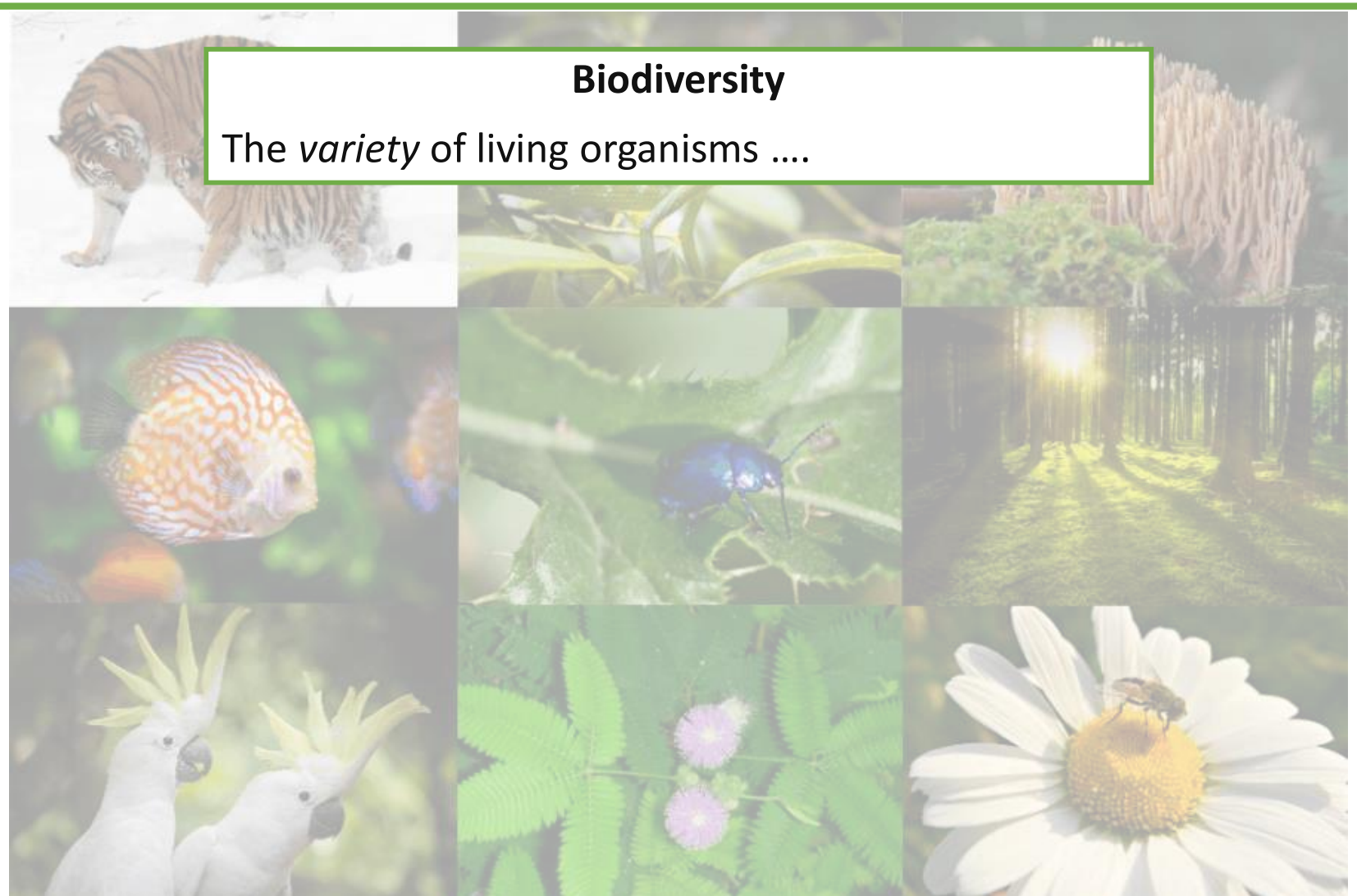
Do investors care about biodiversity?

Alexandre Garel (Audencia Business School)
Arthur Petit-Romec (Toulouse Business School)
Zacharias Sautner (University of Zurich, CEPR, ECGI, SFI)
Alexander Wagner (University of Zurich, CEPR, ECGI, Harvard, SFI)

Climate & Biodiversity Conference
Banque de France, Toulouse School of Economics, Toulouse University Capitole
May 22-23, Paris

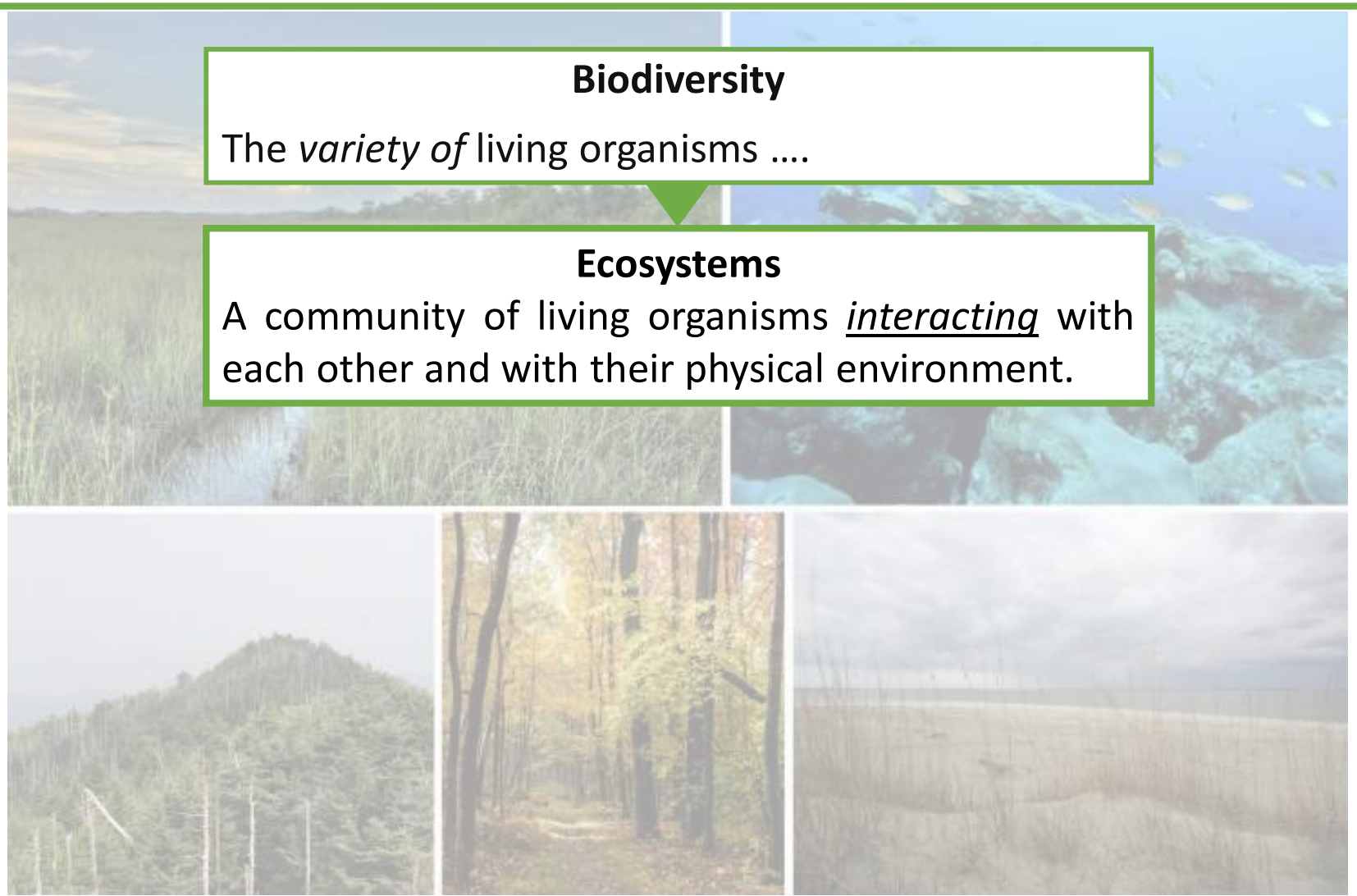
Biodiversity and ecosystem services



Biodiversity

The *variety* of living organisms ….

Biodiversity and ecosystem services



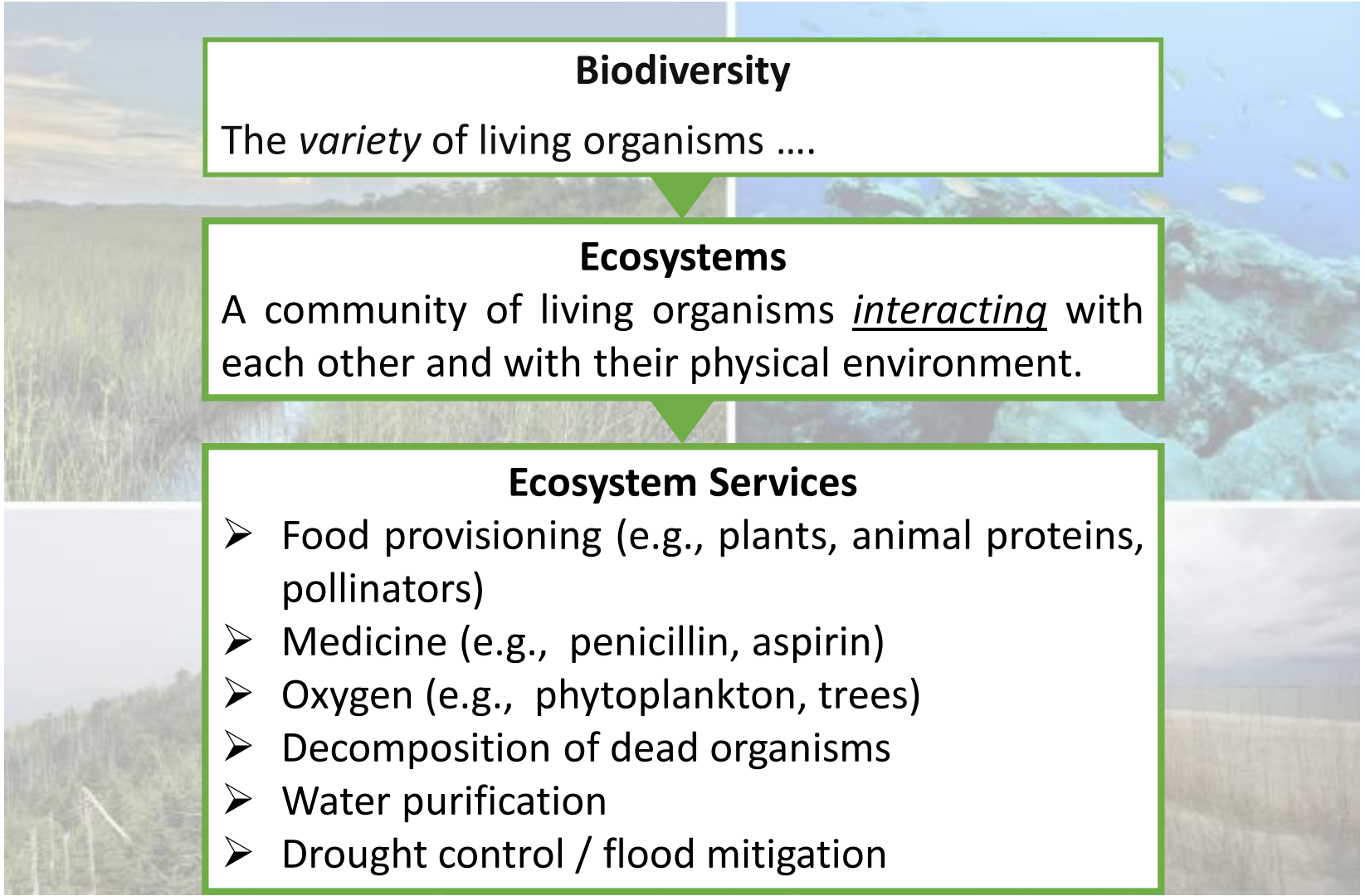
Biodiversity

The *variety of* living organisms ….

Ecosystems

A community of living organisms *<u>interacting</u>* with each other and with their physical environment.

Biodiversity and ecosystem services



Biodiversity

The *variety* of living organisms ….

Ecosystems

A community of living organisms *interacting* with each other and with their physical environment.

Ecosystem Services

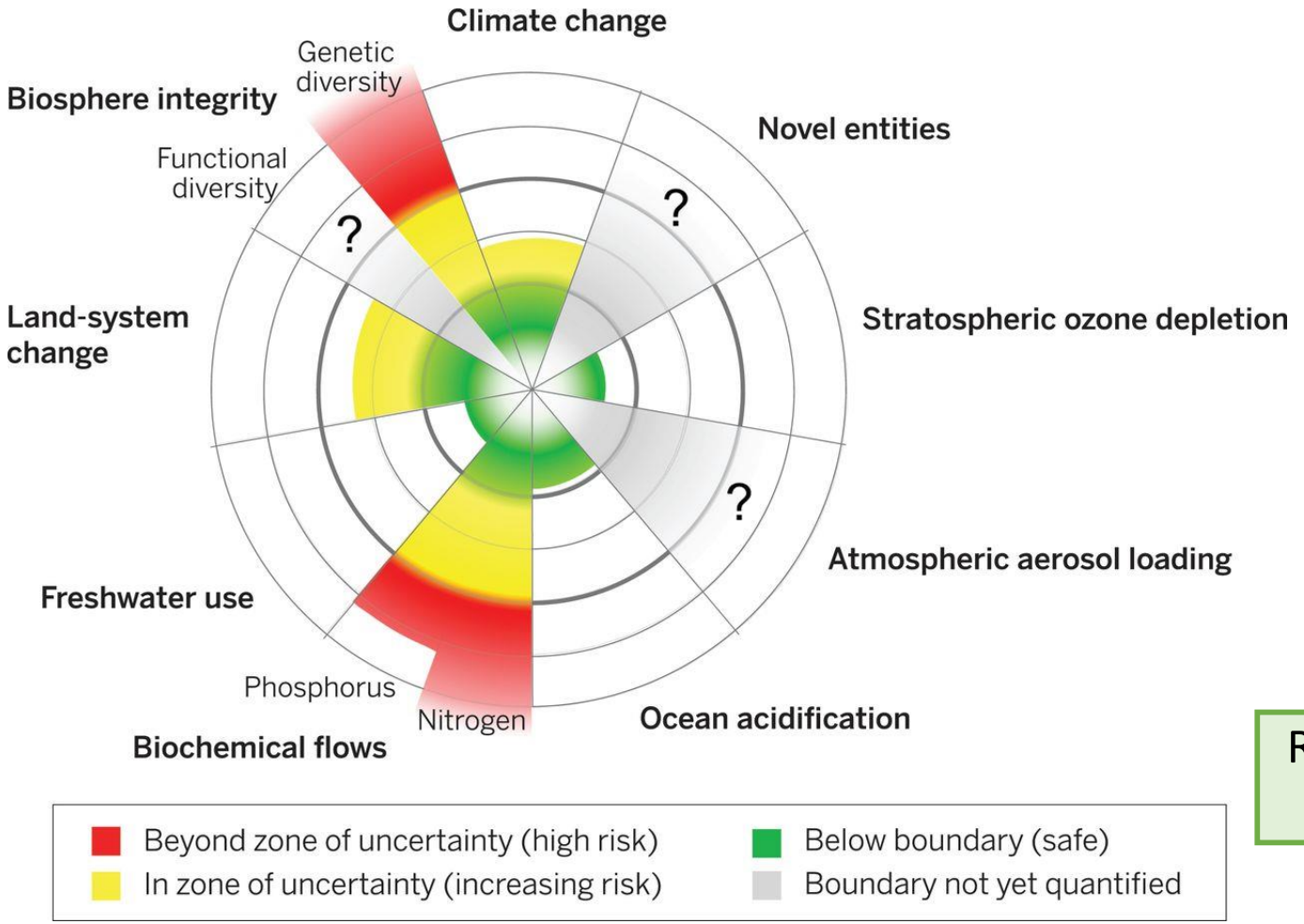
- Food provisioning (e.g., plants, animal proteins, pollinators)
- Medicine (e.g., penicillin, aspirin)
- Oxygen (e.g., phytoplankton, trees)
- Decomposition of dead organisms
- Water purification
- Drought control / flood mitigation

“Natural capital”

- The World Economic Forum (2020) estimates that half of the world’s gross domestic product stems from industries that depend on nature and ecosystem services (e.g., construction, agriculture, and tourism).

- In 2023, the Network for Greening the Financial System released a framework to help central banks and supervisors identify and assess sources of nature-related transition and physical risks

“Planetary boundary”



Rockström et al. 2009
Steffen et al. 2015

Policy momentum

Kunming Declaration (Oct. 2021):
>100 countries committed to developing, adopting, and implementing an effective global framework to put biodiversity on a path to recovery by 2030 at the latest.

Montreal Agreement (Dec. 2022) to protect 30% of the planet's lands, coastal areas, and inland waters by the end of the decade.

Policy momentum

2020 UN BIODIVERSITY CONFERENCE
COP 15 - CP/MOP10 - NP/MOP4
Ecological Civilization-Building a Shared Future for All Life on Earth
KUNMING · CHINA

Kunming Declaration (Oct. 2021):
>100 countries committed to developing, adopting, and implementing an effective global framework to put biodiversity on a path to recovery by 2030 at the latest.

Montreal Agreement (Dec. 2022) to protect 30% of the planet's lands, coastal areas, and inland waters by the end of the decade.

TNFD

Launch of the Task Force on Nature-Related Disclosures (June 2021), final recommendations (September 2023):
Seeks to develop and deliver a risk management and disclosure framework for organizations to report and act on evolving nature-related risks.

Early adopters, for example Norges Bank Investment Management

Emergence of a biodiversity transition risk ?

Post COP15

Increased investor awareness about the loss of biodiversity.

Biodiversity boom:

- Press coverage
- Earnings calls
- Funds
- Investors coalitions (NA100, FBF)
- NGFS
- Biodiv. credit market

Increased investor uncertainty about future biodiversity regulations or litigation.

Transition Risk

Prediction: Leads investors to require a risk premium for holding stocks of companies with a large biodiversity footprint (*Pastor and Veronesi, 2012*).

Would be consistent with investors demanding a compensation for exposure to carbon (Bolton and Kacperczyk 2021, 2023) or pollution (Hsu, Li, and Tsou 2023) risks.

Important for investors, for policy-makers, for modeling attempts.

Emerging literature on biodiversity and finance

- Still little research on biodiversity in finance (Karolyi and Tobin-de la Puente (2023), Starks (2023))
- Other recent work on asset prices: Giglio et al. (2023), Hoepner et al. (2023), Coqueret et al. (2024), Xin et al. (2023), …
- Project finance: Flammer et al. (2023)

Corporate Biodiversity Footprint

CBF: Corporate Biodiversity Footprint

- Corporate Biodiversity Footprint (CBF). ***Extent to which ecosystems affected by a firm's activities have been degraded from their pristine natural state***.
- CBF expressed in **MSA.km2**: *Loss in Mean Original Species Abundance over an area.*
- *A CBF value of -100 MSA.km2 means that 10% of the original biodiversity is lost over an area of 1,000 km2, or that a proportionally lower amount of biodiversity, 5%, is lost over the larger area of 2,000km2.*

Iceberg Data Lab
Enabling Sustainable Goals

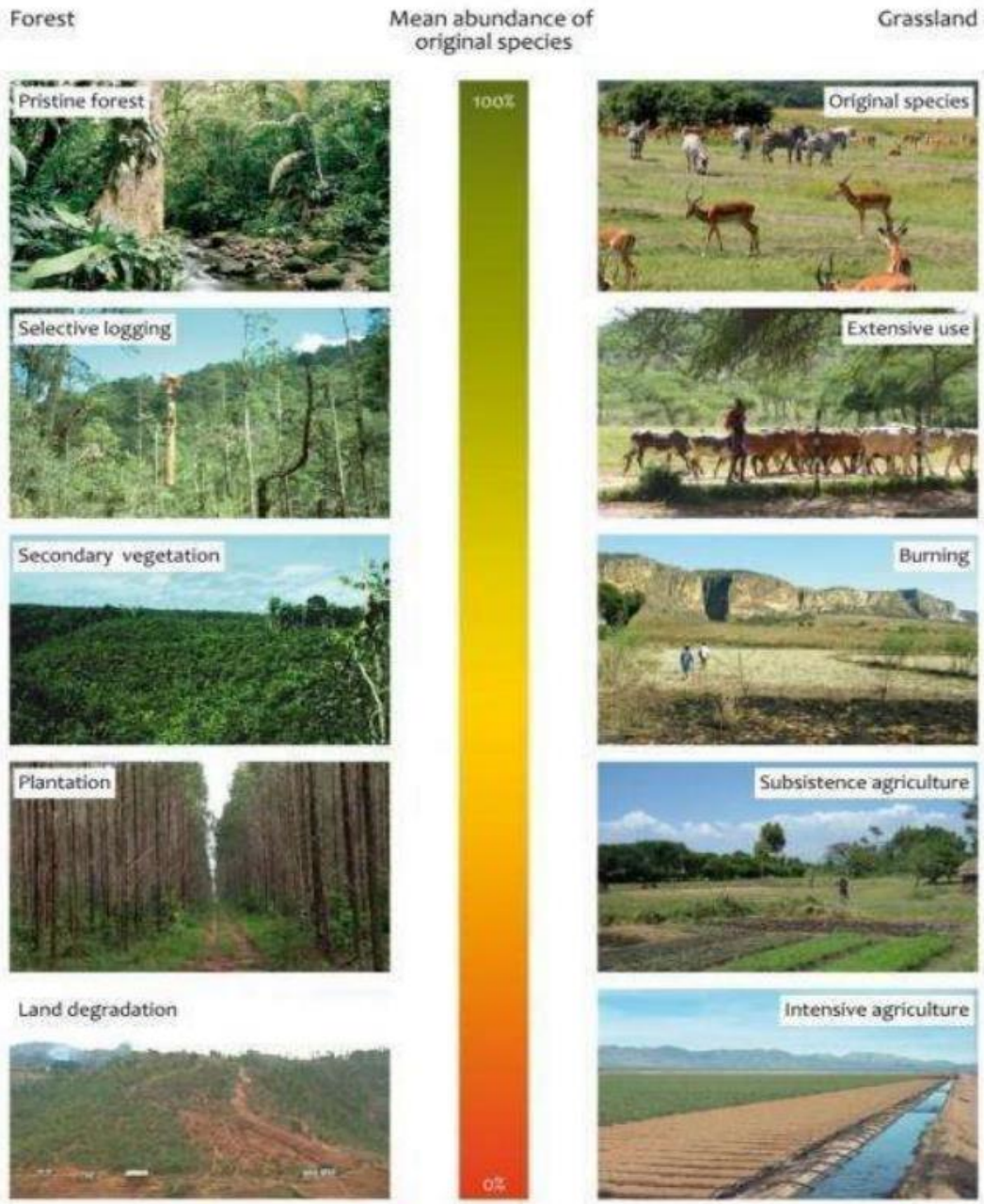


Figure 2: Photographic illustration of MSA variation for forest and grassland ecosystems (GLOBIO, 2019).

Features/bugs of MSA

- MSA does not allow the loss of an individual species, or class of species, to be tracked, and it treats all species as equally valuable.
- It does not account for an increase in a species, which is problematic, as an increase in abundance can have a stabilizing effect on an ecosystem.
- The reference points in the GLOBIO model, which constitutes a key element in the MSA calculation, are dated (going back to the 1990s), and limited information is available about the assumptions used to create the model.
- The ultimate quantity of interest is not a fall in MSA per se, but a reduction in ecosystem services.
- Etc. etc.
- Overall: MSA as a harmonized measure, widely accepted and used. But lots of opportunities for improved measurement

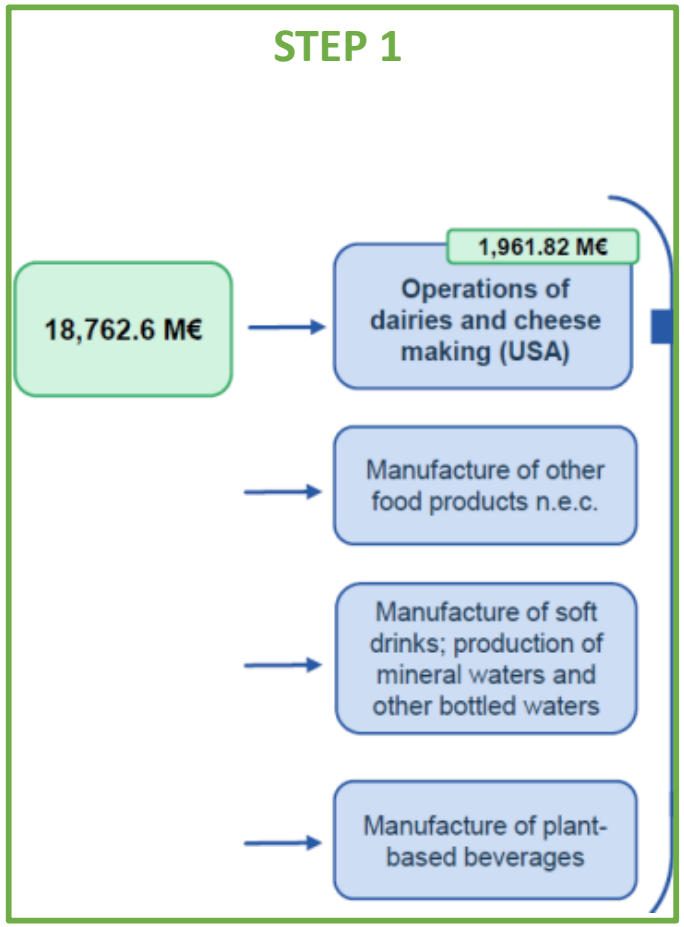
Three steps

- From business activities to commodities
- From commodities to pressures
- From pressures to impact

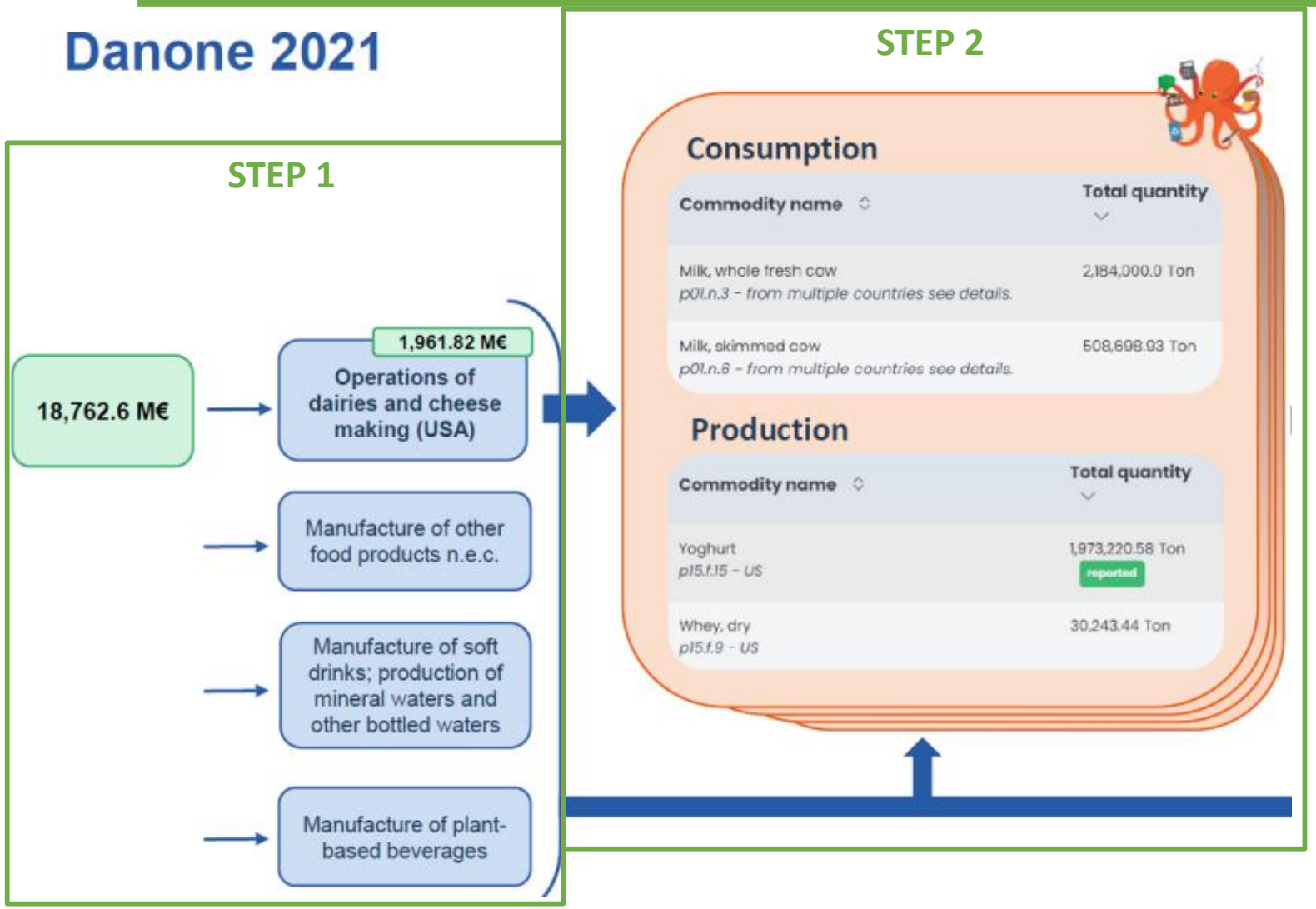
- Done yearly. From 2018. Large sample of international companies.
- 4 pressures [*land use*, *air pollution*, *water pollution*, *GHG*], some (partially) neglected (e.g., soil degradation, marine biodiversity)
- Scope 1, 2, and 3

CBF: Corporate Biodiversity Footprint

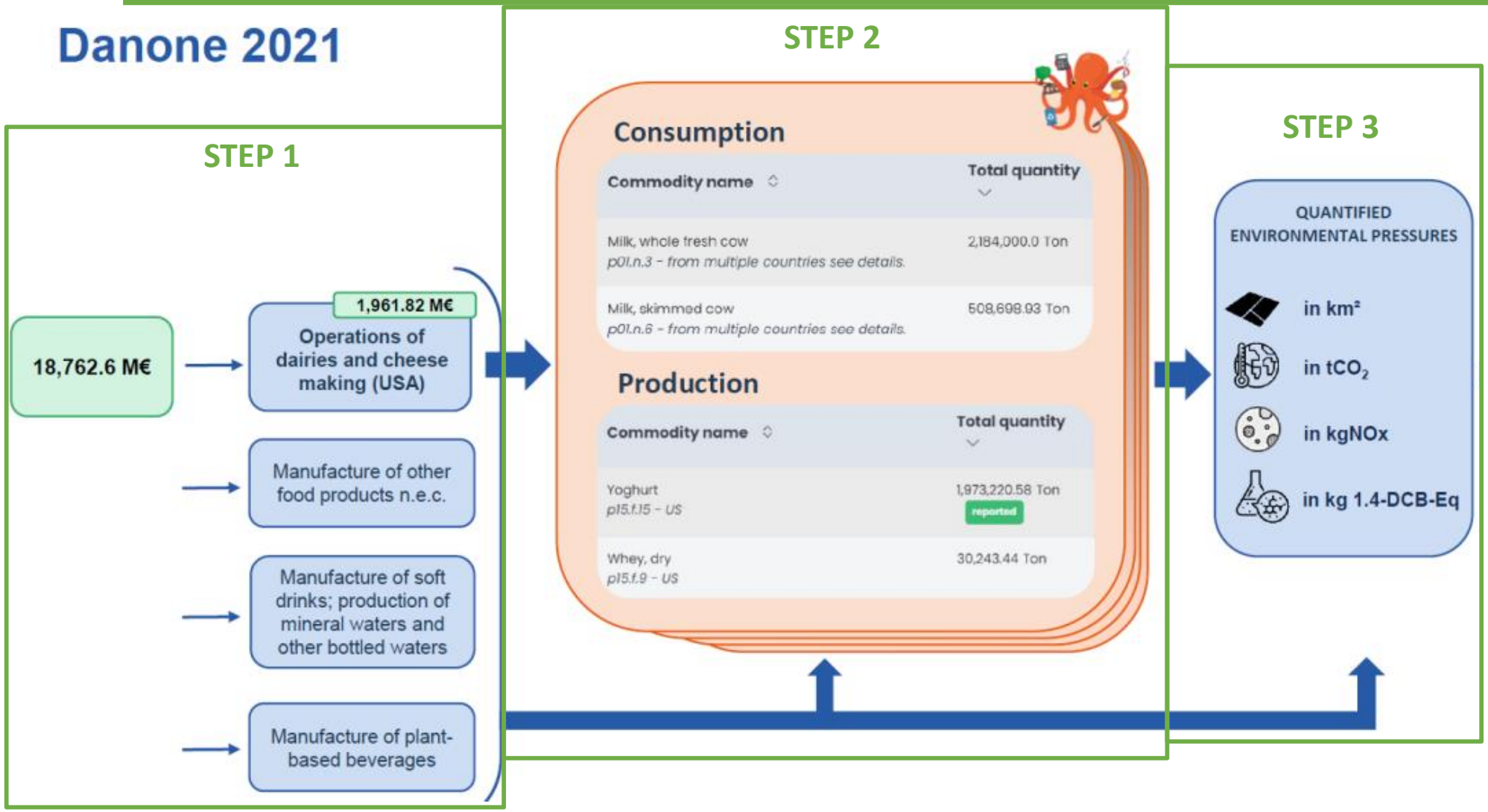
Danone 2021



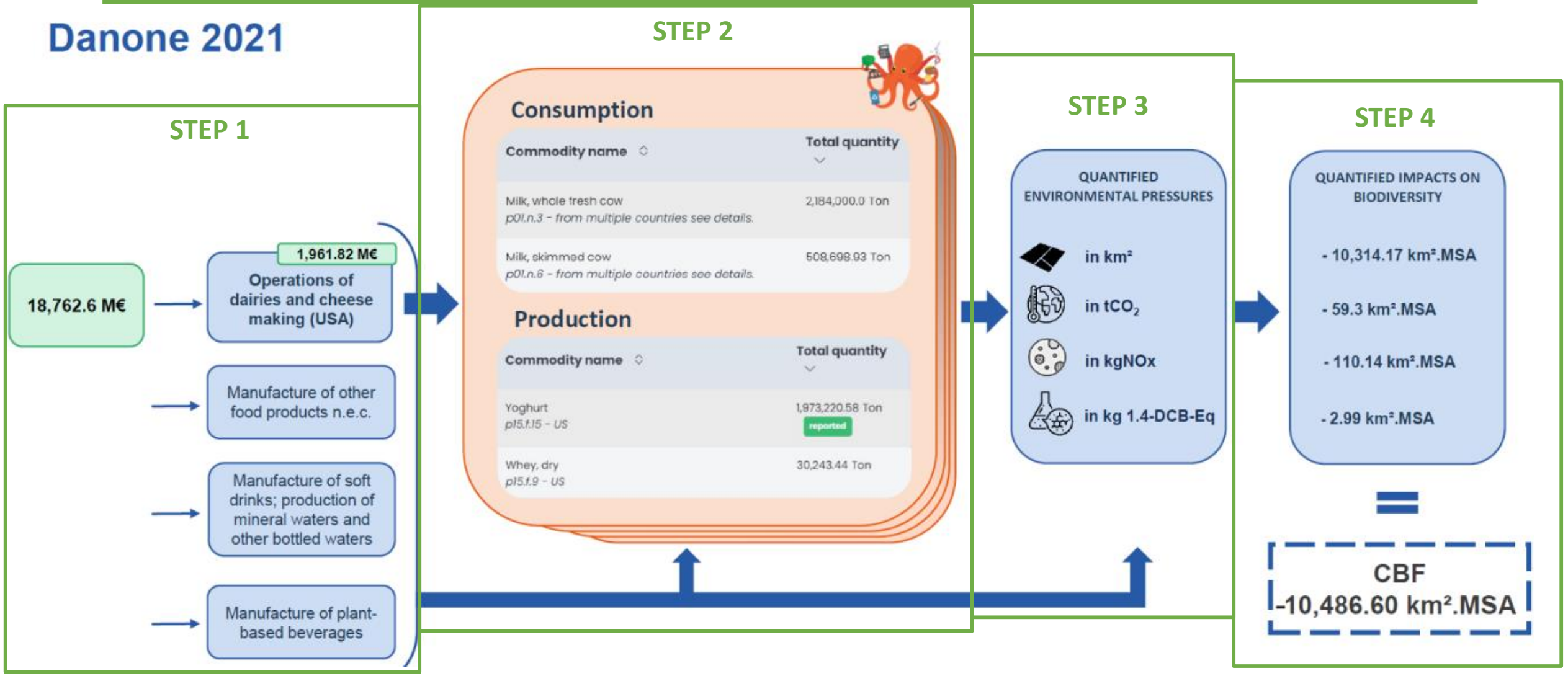
CBF: Corporate Biodiversity Footprint



CBF: Corporate Biodiversity Footprint



CBF: Corporate Biodiversity Footprint



Corporate Biodiversity Footprint: Some observations

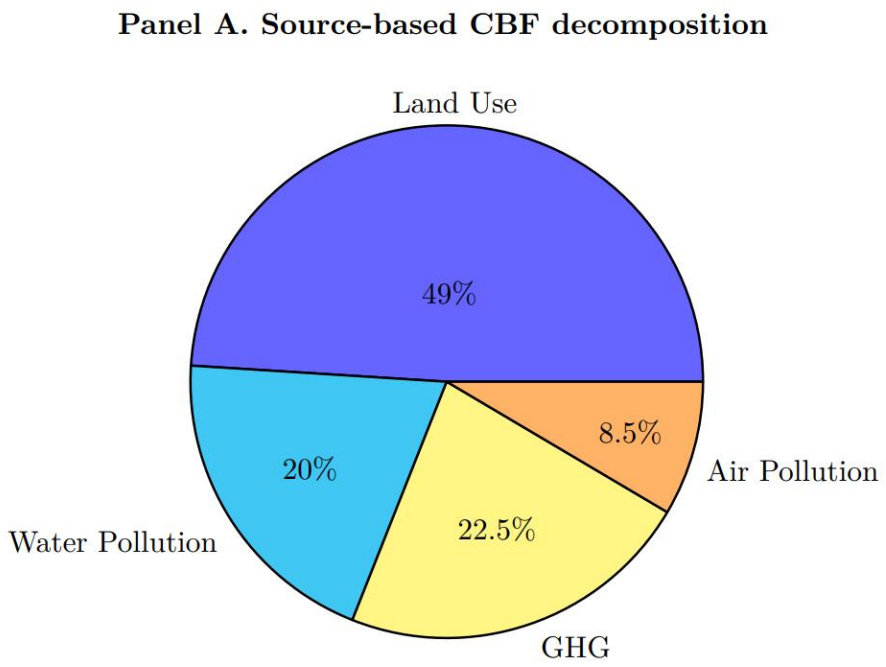
- Mean (Median) footprint: 122.7 (194.4) km2, large variation

Variables	#Obs.	Mean	S.D.	Min	0.25	Mdn	0.75	Max
Ln(CBF VALUE)	85,122	4.81	3.08	-9.25	3.20	5.28	7.00	13.78

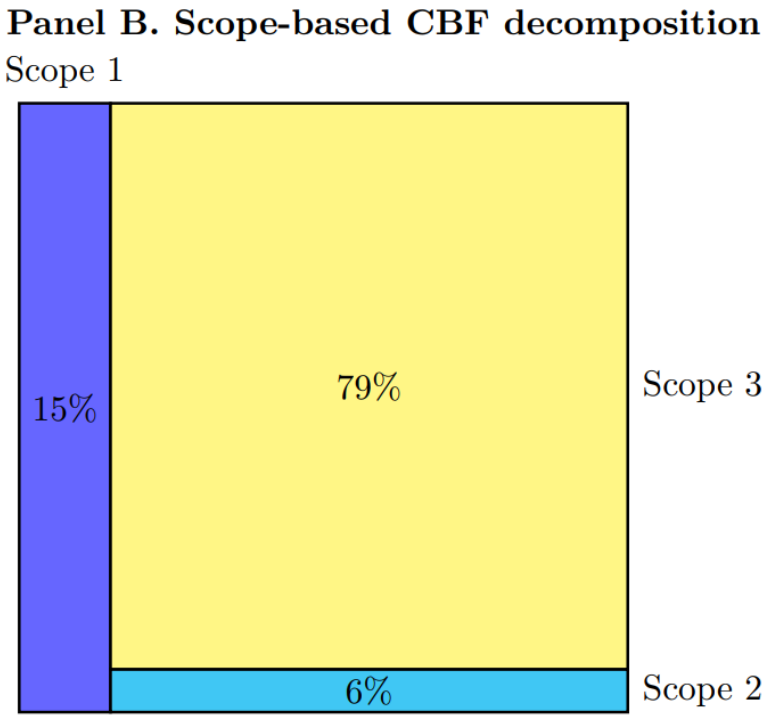
- Industries with largest CBF: Retail & Wholesale, Paper & Forest, Food, Asset Management
- Land use > GHG > Water Pollution > Air Pollution (but big variation across industries)
- Scope 3 very important (but big variation Waste industry vs. Asset Management)
- Firm-specific variation important

Some observations

Distribution by Source



Distribution by Scope



Scope 3 is dominant : large international firms either assemble and distribute products or provide services, implying that they usually do not have direct impacts on their environments (examples include retailers, banks, or tech firms): Upstream (e.g., providers of farming land or extracting raw materials) or downstream (e.g., usage of products and services by clients, financing activities by banks) activities. Firms with large scope 1 footprints tend to operate in the paper and forest business or in metals and mining, that is, with business models that have a much larger direct effect on the local biodiversity.

CBF Validation

Top Industries

Retail & Wholesale
Paper & Forest
Food

TNFD Taskforce on Nature-related Financial Disclosures

Recognized

Biodiversity funds & inst. investors

HSBC World Biodiversity Screened Equity ETF
Ossiam Food for Biodiversity ETF
AXA IM ACT Biodiversity Equity ETF …
BNP Paribas, Robeco, Mirova …

Other biodiversity metrics

Biodiversity disclosure score (31%)

REFINITIV

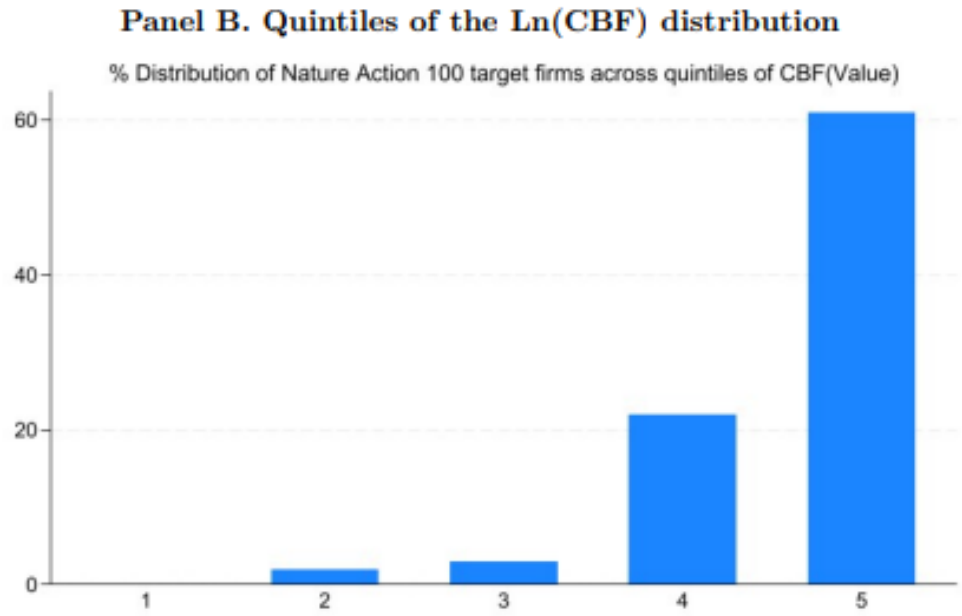
MSCI Biodiversity and land use exposure score (37%)

MSCI

Nature Action 100

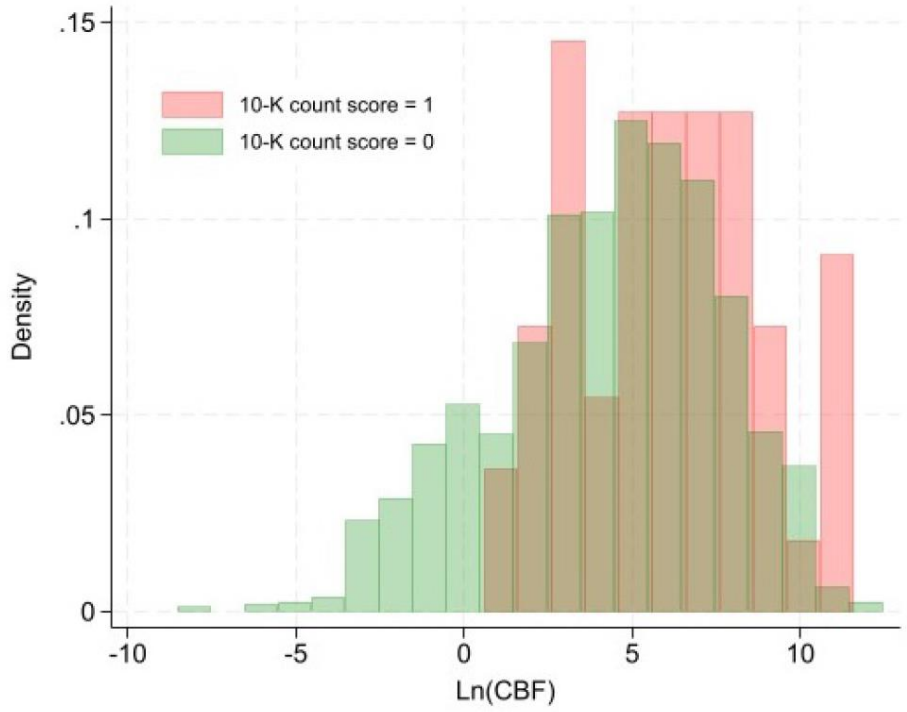
Institutional investor initiative ($27 trillion in assets)

100 firms across eight sectors to engage with in order to tackle biodiversity and nature loss.

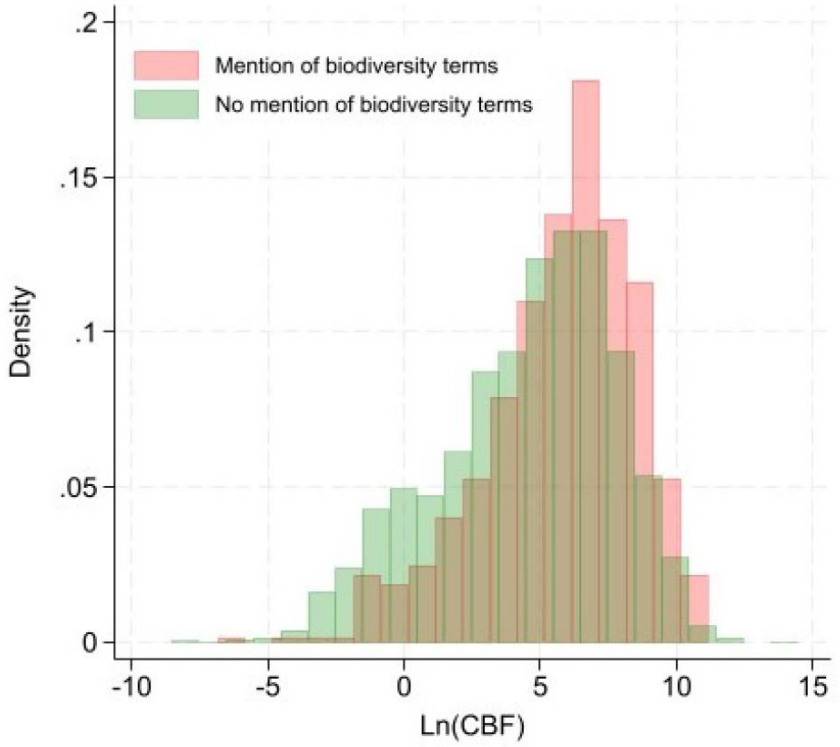


What can we learn from text-based measures at the moment?

Giglio et al. (2023), 10-K-based



Garel et al. Earnings call-based



Biodiversity and stock returns

Table 4. Corporate biodiversity footprint and stock returns

This table reports regressions relating monthly stock returns to Ln(CBF). The sample period in Columns 1–2 includes monthly returns over the full sample period from January 2019 to December 2022. The sample period in Columns 3–4 includes monthly returns from January 2019 to September 2021 (the COP15 in Kunming started in October 2021) and in Columns 5–6 monthly returns from October 2021 to December 2022. Ln(CBF) is measured as of the end of the previous year. The accounting-based right-hand variables are measured as of the last fiscal year. Market capitalization, volatility, and momentum are measured as of the end of the previous month. CBF is the corporate biodiversity footprint and reflects the biodiversity loss caused by the firm's annual activities. Standard errors are clustered at the year-month and firm level. Intercepts are not reported. *, **, and *** represent significance levels of 0.10, 0.05, and 0.01, respectively. Appendix A provides variable definitions.

	Monthly return (%)					
	Whole period		Pre-Kunming period		Post-Kunming period	
	(1)	(2)	(3)	(4)	(5)	(6)
Ln(CBF)	0.003	-0.000	-0.036	-0.036	0.061**	0.057**
	(0.019)	(0.018)	(0.022)	(0.022)	(0.026)	(0.026)
Ln(Total assets)	0.211	0.158	0.143	0.112	0.336	0.290
	(0.171)	(0.164)	(0.192)	(0.187)	(0.329)	(0.313)
Ln(Market cap)	-0.468***	-0.393***	-0.426**	-0.382**	-0.372	-0.305
	(0.153)	(0.143)	(0.187)	(0.178)	(0.252)	(0.238)
Book-to-market	-0.086	-0.043	-0.072	-0.047	-0.057	-0.043
	(0.159)	(0.158)	(0.196)	(0.189)	(0.285)	(0.289)
Leverage	0.353	0.372	0.630	0.701	-0.524	-0.496
	(0.351)	(0.347)	(0.438)	(0.435)	(0.562)	(0.576)
Capex/Total assets	1.933	2.265	6.695***	6.459***	-6.763*	-5.955
	(2.200)	(2.089)	(2.100)	(2.070)	(3.518)	(3.411)
PPE/Total assets	0.327	0.353	-0.319	-0.270	1.624*	1.569*
	(0.401)	(0.414)	(0.425)	(0.427)	(0.760)	(0.747)
ROA	2.216	2.014	0.979	0.969	5.534	5.109
	(1.864)	(1.724)	(1.712)	(1.584)	(3.493)	(3.457)
Asset growth	-0.408	-0.300	0.221	0.167	-1.491**	-1.343**
	(0.336)	(0.316)	(0.334)	(0.320)	(0.566)	(0.552)
Sales growth	-0.038	-0.218	0.047	0.398	0.101	-0.403
	(0.480)	(0.374)	(0.676)	(0.509)	(0.476)	(0.340)
Volatility	5.433	5.012	14.644**	13.513*	-2.692	-2.214
	(5.096)	(5.077)	(7.126)	(7.115)	(6.226)	(6.473)
Momentum	4.407	3.134	-1.459	-0.438	-3.682	-1.515
	(5.382)	(4.770)	(6.418)	(5.913)	(8.548)	(7.804)
Wald test (p-value): Column 3 vs. 5			0.019			
Wald test (p-value): Column 4 vs. 6					0.036	
Year-month fixed effects	Yes	No	Yes	No	Yes	No
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	No	Yes	No	Yes	No
Industry×year-month fixed effects	No	Yes	No	Yes	No	Yes
#Obs.	89,132	89,132	58,218	58,218	30,914	30,914
R^2	0.251	0.320	0.245	0.309	0.255	0.324

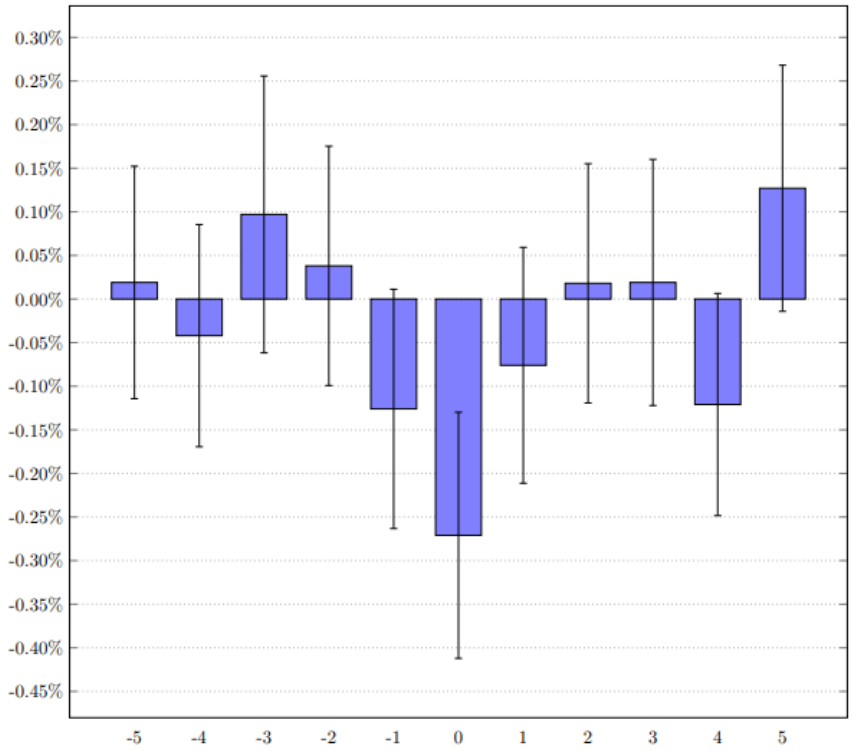
Realized monthly returns

- No significant association over 2019-2022.
- Positive association with monthly realized returns in the post-Kunming period (October 2021 to December 2022).
- A one-standard-deviation increase in Ln(CBF) is associated with an additional monthly return of 18.5 basis points, or a 2.2% annualized increase.
- Consistent with the emergence of a biodiversity footprint premium (a compensation for the transition risk) post Kunming Declaration.

Event study - Kunming Declaration

Figure 5: Kunming Declaration: Return differences between large- and small-CBF firms

This figure reports daily mean stock return differences around the Kunming Declaration between large- and small-CBF firms. It covers the event window [-5,+5]. The day of the Kunming Declaration (event date) is t=0. Returns are adjusted for the mean daily return of the country and the mean daily return of the industry. Large-CBF (small-CBF) firms have a CBF value that is above (below) the median as of end 2020. We also report 95% confidence interval. CBF is the corporate biodiversity footprint and reflects the biodiversity loss caused by the firm's annual activities.



- Market reaction to the announcement of the Kunming Declaration (13th of October 2023; t =0).
- We expect investors to revise downward their valuation of large-CBF stocks post Kunming declaration.
- First, compare abnormal returns of large-CBF firms vs the ones of small-CBF firms.
- Significant negative market reaction at *t=0*.
- No marked parallel trend or reversal.

Event study - Kunming Declaration

Table 6. Stock price reactions to Kunming Declaration

This table reports regressions documenting the stock price reactions to the Kunming Declaration, with the focal date of the event being October 13, 2021. We report results for firms with large versus small CBF values. The event window consists of the [-3,2]-day window around the focal date. The market reaction is computed as the within-firm difference in daily returns between the three trading days before versus after the event. Large CBF equals one for firms with a CBF value above the median (as of the beginning of the year), and zero otherwise. CBF is the corporate biodiversity footprint and reflects the biodiversity loss caused by the firm's annual activities. Post equals one in the three days after the event (days t=0 to t=+2), with day t=0 being the event date. Abnormal returns are returns in excess of their domestic stock market index returns (using MSCI domestic indices). Standard errors are clustered at the country level. Intercepts are not reported. *, **, and *** represent significance levels of 0.10, 0.05, and 0.01, respectively. Appendix A provides variable definitions.

	Daily return (%)				Abnormal daily return (%)			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Large CBF × Post	-0.381***	-0.372***	-0.189**		-0.295***	-0.380***	-0.209**	
	(0.064)	(0.057)	(0.084)		(0.073)	(0.055)	(0.078)	
Large CBF × t = -2				0.040				-0.043
				(0.213)				(0.204)
Large CBF × t = -1				-0.504*				-0.361
				(0.278)				(0.277)
Large CBF × t = 0				-0.671***				-0.590**
				(0.218)				(0.226)
Large CBF × t = +1				-0.642***				-0.461**
				(0.193)				(0.196)
Large CBF × t = +2				-0.301*				-0.241
				(0.164)				(0.166)
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Day fixed effects	Yes	No	No	Yes	Yes	No	No	Yes
Country×day fixed effects	No	Yes	No	No	No	Yes	No	No
Industry×day fixed effects	No	No	Yes	No	No	No	Yes	No
#Obs.	12,301	12,301	12,301	12,301	12,301	12,301	12,301	12,301
R^2	0.240	0.332	0.298	0.243	0.192	0.256	0.245	0.194

- DiD [-3,2] with firm and day FE.
- In the three days following the declaration, relative to the three days before, large-CBF firms experienced a cumulative stock price decline of 1.14%, relative to small-CBF firms.
- Consistent with investors starting to discount more heavily the cash flows of high-biodiversity-footprint companies because of a transition risk.
- Similar market reaction around the launch of the TNFD .

Robustness checks

Intensity instead of raw CBF	Controlling for carbon risk	Controlling for Climate Risk Exposure	MSCI Biodiv. Score
✓	✓	✓	✓
Restricting to ACWI universe	Alternative clustering of SE	Country of stock exchange	Dropping countries
✓	✓	✓	✓

IA Table A.5. Cross-section of returns: Controlling for climate transition risk

This table reports regressions relating monthly stock returns to Ln(CBF) after controlling for measures of climate transition risk. Ln(CO_2 Emissions) is the natural logarithm of Scope 1, 2, and 3 carbon emissions from Trucost. CCExposure^{Reg} is the regulatory climate change exposure measure from Sautner et al. (2023). The corporate biodiversity footprint (CBF) reflects the biodiversity loss caused by the firm's annual activities. The regressions use the same control variables as Table 4 (not reported). Standard errors are clustered at the year-month and firm level. Intercepts are not reported. *, **, and *** represent significance levels of 0.10, 0.05, and 0.01, respectively. Appendix A provides variable definitions.

	Monthly return (%)					
	Whole period	Post-Kunming	Whole period	Post-Kunming	Whole period	Post-Kunming
	(1)	(2)	(3)	(4)	(5)	(6)
Ln(CBF)	0.003	0.060*	0.030	0.063*		
	(0.019)	(0.028)	(0.022)	(0.030)		
Ln(CO_2 Emissions)	–0.007	–0.047				
	(0.067)	(0.124)				
CCExposure^{Reg}			0.404*	0.304		
			(0.230)	(0.231)		
Ln(CBF without GHG)					0.005	0.037*
					(0.017)	(0.020)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Year-month fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
#Obs.	88,113	30,663	45,266	15,660	89,132	30,914
R^2	0.252	0.256	0.316	0.329	0.251	0.255

Controlling for climate transition risk

- Our main findings hold when adding the carbon emissions control variable, when adding text-based climate change exposure, or when taking out the biodiversity impact of GHG emissions from CBF

Interpretation and Implications

Interpretations of the positive relation of CBF with stock returns (after Kunming)

1. Unlikely that expected cash flows are revised upward (Atilgan et al. 2023)

→ We don't find a relation with future earnings surprises.

→ Also, stock price reaction to TNFD/Kunming inconsistent with this idea.

2. Unlikely to be driven by unexpected shifts in investor preferences after the Kunming Declaration (e.g., Pastor et al. 2020, 2021).

3. Discount rates / Risk premium

(a) Post Kunming, a one-standard-deviation higher in Ln(CBF) is associated with an annualized implied cost of capital increase of around 0.7%.

(b) And biodiversity footprint association with stock returns **is stronger in countries with low levels of biodiversity protection =** where the regulatory *uncertainty* should be the highest.

Implications for research, companies, and policy

- Biodiversity and climate = two major crises, with potential tensions. Important to consider nature-related risks specifically.

- Biodiversity transition risk premium seems to have emerged

- Beyond corporate finance and asset pricing, this is potentially relevant
  - for (macro)economic models
  - for policy-makers, regulators, and central banks
  - for managers, as motivation to know their company's footprint (to do this, know about biodiversity concepts, plan ahead for disclosure requirements), and to understand investor needs

Thank you for your attention!

“DALL·E 2023-05-26 22.32.58 - Biodiversity threatened by money, on oil canvas”

Do investors care about biodiversity?

Biodiversity loss

Between 1970 - 2018, 69% loss of monitored wildlife (*Living Planet Index*)

"Sixth mass extinction"

Less stable and resilient ecosystems.
Less effective ecosystems services.

Human Activities

- Reshaped natural habitats (farmland, obtain natural resources). Fragmentation due to infrastructures.
- Sea and land use (primarily for large-scale food production). Deforestation.
- Overexploitation (overfishing, overhunting and overharvesting) for food, medicines, timber.
- Climate change. Growing impact.
- Pollution... Fertilizers, pesticides, plastic.
- Water use (dams, irrigation).
- Invasive alien species. Trade & Travel.
- Increasing human pop.; per capita consumption.