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Working Paper

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FERDI Working Paper, No. P315

Provided in Cooperation with:
Fondation pour les études et recherches sur le développement international (FERDI), Clermont-Ferrand

Suggested Citation: de Melo, Jim (2023) : Environmentally-friendly trade policies to shape Mauritius' future, FERDI Working Paper, No. P315, Fondation pour les études et recherches sur le développement international (FERDI), Clermont-Ferrand

This Version is available at:
https://hdl.handle.net/10419/269594

FONDATION POUR LES ÉTUDES ET RECHERCHES SUR LE DÉVELOPPEMENT INTERNATIONAL

Working Paper 315 February 2023 Development Policies

Environmentally-friendly trade policies to shape Mauritius' future*

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Abstract

Mauritius and other Small Island Development States (SIDS) depend heavily on international trade. This presents challenges to environmental management. SIDS are vulnerable to all forms of environmental degradation, of which part are related to international trade, the focus of this chapter. While climate change causes of environmental degradation are beyond the control of the government, others like deforestation, loss of biodiversity or degradation of their maritime and terrestrial environments including depletion of fish stocks in their Extended Economic Zones (EEZs) are, at least, partly, under their control.

*Thanks to my co-authors Henri Casella and Jean-Marc Solleder for ideas and permissions to use materials in joint work and to Carlos Oya, Boopen Seetanah, and Verena Tandrayen-Ragoobur for helpful conversations. Thanks for support to the French National Research Agency under program ANR-10-LABS-14-01.

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The chapter evaluates Mauritius' performance through comparisons with 8 other selected SIDS: Barbados, Cape Verde, Comoros, Dominican Republic, Haiti, Jamaica, Seychelles, Trinidad & Tobago, countries with sufficiently 'similar' characteristics (size, latitude, importance of tourism), to justify a comparison of performance.

The chapter is organized around three sets of comparisons: (i) trajectories of per capita GDP growth vs social improvements as captured by a human development index purged of the GDP growth component over the period 1970-2015; (ii) overall environmental performance based on a comparison of indicators of the health of their ecosystems carried out with an Environmental Performance indicator (EPISI) designed to better reflect the environmental priorities of SIDS; (iii) benchmarking of growth in CO2 emissions contrasting the roles of scale, composition, and technical components, over 1995-2015. Indicators of the health of the environment suggest that Mauritius has failed to protect both its land and its maritime environment. As of 2015, Mauritius had not yet started decarbonizing, but has pursued environmentally-friendly trade policies.

Taken together, these comparisons show an average performance for Mauritius: rather below average for the protection of the environment, but above average for trade policies that are environmentally friendly since there are no tariffs on goods for the management of the environment or on goods that are environmentally-friendly in their life-cycle.

1. Introduction

In a span of fifty years, Mauritius is at the door of the high-income status according to the World Bank criterion, even reaching it briefly in 2019. Key to this success was the combination of effective policies and adaptation to changing external events cemented by close collaboration between Government, the private sector, unions, and civil society. In the case of Mauritius, economic appraisals have often touted a "Mauritian miracle" reflected in its high growth rates as reflected by the standard United Nations System of National Accounts that ignores depreciation of natural capital.

It is widely accepted that the health of the environment and its ecosystems is particularly fragile in Small Island Developing States (SIDS) because of population pressures, biodiversity loss, and climate-change related pressures to which they are more vulnerable. SIDS depend strongly on international trade. If not accompanied by policies that protect their environment, international trade can then result in the depletion of their natural resources (See Fischer (2012) for circumstances and examples). Tellingly, Pierre Poivre, the precursor of environmental economics was the first to warn about the environmental impact of the ongoing deforestation he was observing in Mauritius in the 18$^{th.}$ Century. [1]

Mauritius is an interesting case study of the channels of interaction between growth, trade and preservation of the environment. Usually, countries take better care of their environment as they become richer, both because citizens put greater weight on environmental quality and because governments have more resources at their disposal. How does this widely-held conjecture hold in small island economies with fragile environments that are highly dependent on trade and, often also on tourism? This chapter argues, with some supportive descriptive evidence based on a comparison of trajectories of economic and environmental indicators across 'comparable' SIDS, that Mauritius performance on the environmental front has not matched its performance on some of the standard economic indicators like GDP growth.

To give context to this case study, consider that Mauritius has fallen short on two important targets set on the global stage by Multinational Environmental Agreements (MEA). First, the country has missed the pledges it made during the Aichi Convention on Biological Diversity by a long shot.[2] On the Millenium Development Goals (MDGs) targets for CO2 emissions, the per capita emissions for 2015 was already off-track in 2010, continuing to grow every year, reaching 5.3Tco2e per capita in 2018 – 38% above the 2030 target.

This strong growth in GHG emissions has spurred Mauritius' Prime minister to announce at the COP27 an ambitious plan for 2030, pledging a reduction of greenhouse gas emissions of 40% as well as a green energy push (60% of energy from renewables) while phasing out coal-based electricity. The pledge also included other commitments like protecting the island's environment by moving towards a circular economy.[3]

[1] Describing Poivre's instructions in his Règlement Economique of 1769 to prevent deforestation, Brouard (1963), cited in Techera (2019), wrote « …hasten to control it [deforestation] with a good policy … examine the existing regulations on this subject, study the exact condition of the forests, exploit and utilise them in the most economical way possible, and only allow people to cut them if they ensure their conservation. This will be the object of a provisional regulation after which … a general forest policy and law will be set for all the forests of the two islands… » text in brackets added.

[2] Mauritius pledged to protect 17% of terrestrial and inland water as well as 10% of coastal habitat (Target 11) by 2025. As of now, only 4.725 % terrestrial area and 0.003% of marine and coastal area are protected (Voluntary national review report of Mauritius on SDG, 2019, Ministry of Foreign Affairs).

[3] High level statement at the COP26 in Glasgow. https://unfccc.int/documents

What then are the dimensions of Mauritius' protection of her environment? In this chapter, I evaluate Mauritius's environmental protection by comparing indicators of environmental performance across nine 'comparable' SIDS including Mauritius. In section 3, the comparisons are on environmental indicators of direct concern to Mauritius (deforestation, fisheries and ecosystems) that are aggregated in a specifically constructed overall indicator of environmental performance. That indicator abstracts from pledges relating to climate change mitigation which is covered separately in section 4 that reports on growth in CO2 emissions.

As a prelude, section 2 presents the 8 other SIDS and contrasts growth trajectories since 1970 (close to the year of independence) for two often-used yardsticks: Gross National Income (GNI) per capita and the Human Development Index Purged (HDIP) of the GDP component. This allows to check if material growth and improvements on the social front, as captured by the purged Human Development Index, go hand in hand. It turns out to be broadly the case across the selected SIDS, but there is great diversity across the countries.

The following sections concentrate on environmental performance, again in a comparative setting. Section 3 carries out comparisons of performance using a modified Environmental Performance Index for SIDS (EPISI) Introduced in Casella and Melo (2021). the EPISI focuses on indicators of health of land and maritime resources and on ecosystem resources (biodiversity), both crucial environmental indicators for Mauritius. Section 4 turns to a comparison of CO2 emissions trajectories across the SIDS over the period 1995-2015. Section 5 concludes with accomplishments and challenges facing the adoption of environmentally-supportive trade policies.

2. Prelude: A sustained growth trajectory

The UN definition (there are others) of SIDS has 38 countries. The UN-SIDS group is a political alliance that focuses on global environment issues. The alliance has proven an efficient negotiating group since the first Rio "Earth Summit" in 1992[1]. Notably, this alliance has successfully campaigned to include in the Paris Agreement (Art. 8) the acknowledgement that climate change threatens SIDS of specific "loss and damage". Yet, the group is disparate (high income like Singapore, low-income like Haiti, very small islands like Tuvalu and some like Guinea Bissau are not islands). SIDS are vulnerable to external economic shocks over which they have little control. This is the case for changes in their terms-of-trade whose effects are amplified because of their high trade share in GDP and export baskets concentrated in few commodities.

This disparity in membership characteristics and performance makes it difficult to select a comparator group for Mauritius. Here I pick 8 comparators. [4] All are low-latitude countries with populations and population densities roughly comparable to Mauritius. Tourism is also an important criterion as it is an additional reason for preserving the environment. High-income and/or sparsely populated islands (e.g. New Zealand and Papua New Guinea with a population density of 22 pkm^2) are excluded.

[4] Selection could have been based on propensity score matching methods, or the construction of a synthetic comparator. For this exercise, selection on an informal basis should be adequate to select a sufficiently (but not exceedingly) large group. Haïti and Dominican Republic stand out for their large population but offer an interesting comparison as they started from quite similar initial conditions and the same topography. All African countries in the UN grouping with data since 1970 are included since they are members of the Africa Continental Free Trade Area.

Table 1 compares the evolution of two performance indicators, the Human Development Index Purged (HDIP) of the per capita income component (cols 4-6) and GNI per capita (cols. 7-9) over the period 1970-2015. By including education and health, the HDIP serves as a proxy indicator of the effectiveness of social policies other than environmental performance. HDIP takes values in the [0,1] interval.

Mauritius and Seychelles had quasi-identical outcomes on HDIP. Cape Verde, Comoros and, especially Haiti, started with low scores on both indicators. Cape Verde started on the same footing with GNI, but with a better score on HDI. Barbados started with a high HDIP score that improved, but experienced negligible GDP per capita growth.

Figure A3 shows the yearly trajectories for both indicators over 1970-2015. A relatively flat (steep) trajectory shows greater improvement on the material (social) dimension. The irregular trajectories for some countries illustrate the importance of shocks, external and or internal. The irregular trajectories also remind us of the limits of any comparative assessment. Yet, together, table 1 and figure A3 show that Mauritius has fared relatively well within this group. Both indicators showed steady improvements over the period. Note though, that Barbados had insignificant GDP growth, but an impressive improvement on the HDIP while Dominican Republic and Seychelles achieved comparable improvements on the HDIP while starting from a lower per capita GDP than Mauritius.

Table 1: Growth and Social indicators: Mauritius and comparator SIDS
((HDIP) and economic GNIPpc)

COUNTRY	CODE	POP.	POP. DEN.	HDIP(1970)1	HDIP(2015)	ΔHDIP	GNIPC(1970)	GNIPC(2015)	GNIPC (%)
	1	2	3	4	5	6	7	8	9
MAURITIUS	MUS	1,300	637	0.22	0.43	0.21	4,662	18,322	293
BARBADOS	BRB	281	637	0.39	0.62	0.23	10,197	11,849	16
CAPE VERDE	CPV	593	147	0.15	0.40	0.25	1,385	6,266	352
COMOROS[A]	COM	837	449	0.15	0.27	0.12	961	1,696	76
DOM.REP.	DOM	11,200	231	0.21	0.42	0.21	2,488	13,762	453
HAÏTI	HTI	11,585	417	0.08	0.22	0.14	1,567	1,742	11
JAMAICA	JAM	2,800	257	0.31	0.43	0.12	6,135	7,024	14
SEYCEHELLES[A]	SYC	107	237	0.23	0.43	0.20	3,537	25,690	626
TRI&TOB	TTO	1,500	298	0.32	0.42	0.10	13,141	30,702	134

Notes:

Notes: Period 1970-2015 except a/ Starting date: 1980. Figure A3 displays the trajectories for HDIP and GNIpc
Col 1. Country code
Col. 2: Population (1'000)
Col 3: Population density (2020). Population per sqkm.
Col. 4, col. 5: (HDIP) Human Development Index purged of per capita GDP: geometric weight of health and education. Range [0-1]
Col.6: Change in HDI over relevant period. A positive value indicates an improvement
Col. 7, col. 8: Gross national income per capita in 2011 PPP
Col.9: GNI pc. growth rate over period
Source: Authors' from OWD and WDI.

Melo (2021) and other chapters in this volume expand on GDP performance. Suffice it here to note the role of favourable initial conditions [5], including performing institutions inherited from the British further developed in the early years of independence (Darga (1996)), and visionaries at the helm (cf. Poncini memoirs (2018)). All were crucial in shaping Mauritius' trajectory that resulted in a relatively inclusive growth built on cooperation between the government and the private sector.[6] For example, Melo identifies five pillars: Sugar, Textiles, Export Processing Zone (now offshore), Tourism, Outsourcing[7]. Of the five pillars, sugar and textiles have faded away. The other three can be preserved and/or expanded. He also mentions three new pillars, each requiring strong government commitment with cooperation:

- Education to face the 4th. Industrial revolution (and to preserve the three pillars)
- Developing a service centre for Africa (contingent on improved education outcomes)
- Protecting the environment (both the land and marine environments)

The first two are covered in other chapters in this volume. In the remainder of this chapter, I focus on protection of the environment with a focus on environmentally friendly trade policies.[8]

3. An environmental Dashboard to track SIDS vulnerabilities climate change and preparedness to environmental challenges[9]

Annex A1 identifies three channels of interaction linking a development strategy with its environmental outcome: the pattern of production (is it environmentally friendly?), by-product externalities (localRegional/global) and direct trade-related externalities (transport emissions, resource depletion, invasive species) (see figure A1). Three characteristics of SIDS make for strong trade-environment linkages. First, SIDS trade more intensely than other countries because of their small size. Second, for the 8 SIDS selected here, their exports are concentrated in commodities/products that are intensive in natural capital, subject to depreciation. In this more fragile environment, trade has a crucial role in the sustainability of their development trajectories. Under strong governance, trade and the environment will be in a virtuous circle. More trade will raise incomes that, in turn, will lead to a demand for greater protection of the environment. Under weak governance, property rights will be absent or poorly

[5] A widely publicized report by James Meade in 1960 had a pessimistic outlook about the future of Mauritius. However, in 1968, Seychelles and Mauritius had a life expectancy of 64 and 63 years at birth, 10 to 20 years above life expectancy in the rest of Africa at the time. Along the way, the small size of the country helped avoid competition from other countries when attractive fiscal conditions were offered to global business companies.

[6] Though increasing, income inequality is still lower than in many other developing countries. The top 10% capture 46% of gross national income vs. 17% for the bottom 50% placing Mauritius in a group of 16 (out of 48) African countries with the least disparity in income shares between the top and the bottom half. (Chancel et al. 2019). Over 2001-2015, the Gini coefficient increased by 16% to 0.42 (World Bank (2017)).

[7] Silve (2018) elaborates on the contributions of each pillar to what he calls the harmonious growth of Botswana and Mauritius because the usual conflicts over the sharing of rents (sugar and textiles for Mauritius and diamonds for Botwana) were handled well. Social policies started in the late 1950's with free primary education and school meals and free primary health care were also an important ingredient in this harmonious growth. As growth created wealth, the social safety net expanded with a big push starting in 1972.

[8] Bunwaree (2001) already signaled that education was 'the marginal' contributor to the Mauritian miracle. (Bunwaree (2001)). Grigoli (2014) finds that Mauritius lags behind many peers in efficiency of education expenditure, ranked 48th out of 89 developing countries.

[9] The dashboard, adapted from Casella and Melo, adds the PVCCII and modifies the EPI index subcomponents and omits the climate change index. They discuss individual indexes and display boxplots of a selection of indexes over a sample of 130-180 countries to identify where SIDS are outliers.

applied. Then trade is likely to lead to an over-exploitation and subsequent depletion of natural resources and a degradation of ecosystems.

3.1 An environmental Dashboard for Mauritius and selected SIDS:

Table 2 addresses three aspects of the environmental challenges facing Mauritius and the other comparator SIDS using three categories of indicators: (i) physical vulnerability to climate change; (ii) current health of the environment, and; (iii) state of preparedness to meet environmental challenges. Each indicator is multi-dimensional with sub-indices entering geometrically so that in most instances, indicator values vary little across countries. Because these indexes are ordinal rather than cardinal, rankings are provided along with index values. The reader should focus on these rankings rather than on the particular index values. Table 2 displays the rankings for the following three sets of indices:

- Part I: A Vulnerability to Climate Change Index in cols. 1-2.
- Part II: Health of the ecosystem with an indicator of the risk of extinction of species (RLI in cols 3-4) and of health of ecosystem (HLT in cols. 6-7).
- Part III: An index of preparedness to environmental challenges, the Ecosystem vitality (ECO) index in cols 7-8 combining three indices of (Biodiversity, Ecosystem Services, Fisheries in cols 9-13).

Classification in three parts is to help distinguish between exogenous (part I) and, at least partly, endogenous factors (parts II and III). The vulnerability to climate change in cols 1 and 2 (e.g. temperature change) is considered exogenous while the other indexes of the dashboard incorporate endogenous components (e.g. the quantity of pollutant in water). Furthermore, the endogenous part of the dashboard focuses either on the health of ecosystems (cols. 5-6) or the policy response to degradation of ecosystems (cols. 7-13). Part II and III components are combined into an Environmental Protection Index (EPI) for all countries and a modified index for SIDS, the EPISI. The elements, and associated weights are described in annex A2.

Table 2: SIDS Environmental dashboard

Category of indexes	Part I Vulnerability to Climate Change (PVCCI)		Part II Health of the ecosystems (HLT): Risk of extinction for species (RLI); risk to human life (HLT)				Part III Ecosystem vitality and its components							Part IV Overall environmental performance			
Sub-indexes	Physical Vulnerability to Climate Change Index (PVCCI)		Red List Index (RLI)		Health of the ecosystem (HLT)		Ecosystem Vitality (ECO)		Biodiversity and Habitat (BDH)		Ecosystem services (ECS)		Fisheries (FSH)	Environmental Performance Index (EPI)		EPI for Small Islands (EPISI)	
	score	rank	score	Rank	score	rank	score	Rank	score	rank	score	rank	score	score	rank	score	rank
Column	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(17)	(18)
Barbados	50,6	110	89,5	75	60,7	38	35,6	145	12,6	177	37,1	75	18,4	45,6	77	40,4	17
Cabo verde	52,6	84	90,5	66	30,4	119	34,5	154	14,3	176	93,7	14	20,7	32,8	144	30,7	27
Comoros	52,6	83	74,4	160	27,3	131	35,3	147	36,3	145	35,7	84	18,6	32,1	148	29,2	28
Dominican Republic	52,4	86	73,0	166	36,1	104	53,2	51	81,6	32	26,6	129	21,8	46,3	74	43,7	7
Haiti	57,0	62	71,7	171	21,8	147	30,5	168	34,5	147	26,2	130	16,7	27,0	170	24,0	33
Jamaica	65,0	7	66,3	187	45,5	83	50,0	65	58,2	101	35,2	87	4,7	48,2	66	42,5	11
Mauritius	63,8	16	40,3	193	60,0	41	35,3	147	19,3	170	49,5	43	15,0	45,1	82	42,4	12
Seychelles	55,3	73	66,7	185	50,8	59	63,1	24	78,9	36	84,3	19	18,1	58,2	38	54,4	2
Trinidad and Tobago	52,0	90	80,3	134	54,6	53	42,9	108	67,8	66	35,9	82	11,8	47,5	69	49,0	3

Sources: Author's Calculations:
Notes:

- A High score translates into a higher rank (i.e. better 'performance') except for PVCCI where a higher score indicates greater vulnerability (e.g. Seychelles is more vulnerable than Seychelles to climate-related shocks.
- (PVCCI) [RLI] rank (193) [253] countries. PVCCI global score is obtained from the root mean square of 5 sub-indices (flooding due to sea-level rise; increased aridity; rainfall; temperature; storms) not presented here. EPI, HLT, CCI, BDH rank 180 countries, ECS ranks 175 countries and FSH ranks 135 countries. EPISI ranks 33 SIDS.
- Col. 1-2 Feindouno, Guillaumont, Simonet (2020);
- Cols 3-4: RLI: IUCN Red List of Threatened Species
- Cols 5-6. HLT= Air, water quality, heavy metal particulates, water managements. Full names and weights in table A2
- Cols. 7 ECO: Ecosystem vitality
- Cols. 8-13. Components of ECO = BDH, ECS, FHS, APE, AGR, WWT. Full names and weights in table A2
- Cols. 14-15 EPI= $HLT^{0.6}ECO^{0.4}$. ECO(EPI)= $BDH^{.25}ECS^{.17}FSH^{.17}APE^{.05}$ $AGR^{.05}WRS^{.05}CCH^{.40}$
- Cols. 16-17 EPISI= $HLT^{0.5}ECO^{0.5}$. ECO(EPISI)= $BDH^{.42}ECS^{.17}FSH^{.17}APE^{.05}$ $AGR^{.05}WRS^{.05}$

EPISI is obtained from EPI by taking out the climate change component and rescaling the weights in the ECO component. See annex A2

PART I: Physical vulnerability to climate change

The PVCCI index (cols. 1-2) is built up from five sub-indices (sea level rise, increased aridity, rainfall, temperature shifts and frequency of storms). The PVCCI score ranges from 0 (not vulnerable) to 100 (very vulnerable). The index covers two types of risk related to climate change: (i) long-term risks of progressive slow-onset shocks (e.g. flooding due to sea level rise, growing aridity), and (ii) an increase in the intensity of recurrent shocks (heavy rainfalls, tropical storms, extreme heat events). Except for Barbados, the group is in the top half of countries less vulnerable to climate change with Jamaica and Mauritius, the two least vulnerable countries in the group.

PART II: Health of Ecosystems

Two indices measure the overall health of ecosystems. A high score is indicative of good health, and hence a low rank in the probability of extinction of species. The Red List Index (RLI) in cols. 3-4 classifies all fauna and flora species that are considered endangered from least to most at risk of extinction. Mauritius and Seychelles with a relatively high number of endemic species, have a high risk of extinction, if only because they still have a relatively large number of species. The low score for Haiti is due to extinction dating back a long time.

The health of the ecosystem (HLT index) in cols. 5-6 is strongly correlated with GDP p.c. (see table 3) However, the low correlation between biodiversity and per capita income shows that, as they move up the per capita income ladder, countries tend to have lower protection of their ecosystems. The correlation between the RLI index and p.c. GDP is low suggesting that preserving ecosystems has low priority as per capita income rises.

PART III: Preparedness to environmental challenges

The Biodiversity and Habitat Index (BDH) in cols 9-10 captures preparedness at confronting and limiting biodiversity loss. The index reflects the level of completion of national targets agreed at the 2010 Aichi's Convention on Biodiversity Convention as well as the protection of the habitat of the species. BDH index is a proxy for the long-term dynamics of ecosystems conservation.

The Ecosystem services index (ECS) in cols. 11-12 measures the loss of services provided by ecosystems to human societies. It takes a 10-year average of natural area lost to anthropogenic activities. ECS is almost exclusively (90%) estimated by tree cover loss. Mauritius is in the bottom half in the comparator group while the Dominican Republic and Seychelles have the highest index values.

The Fisheries Index (FSH) in col. 13 serves as a proxy for the overall sustainability of fishing activities. FSH includes three components: status of fish stocks, trophic index, use of trawling. Jamaica and Trinidad and Tobago have low scores. Mauritius also has a relatively low score in the group.

The Ecosystem Vitality (ECO) (cols. 7-8) is a geometric weighted average of the BDH, ECS, and FSH indices. ECO summarizes the preparedness to environmental challenges. The ECO index ranking is over 180 countries. Seychelles ranked 24th. is among the best prepared while Mauritius is ranked 147th., among the lowest in the SIDS group.

3.2 Overall environmental performance: Mauritius and other SIDS vs non-SIDS

Figure 1 summarizes overall environmental performance by comparing performance of the group of SIDS against all countries (figure 1a) using the EPI and across the sample of comparator SIDS (figure 1b) using the EPISI. [10]Values for Mauritius and for each country in the comparator group SIDS are highlighted in both figures. Both figures show that environmental performance as captured by the indexes in the dashboard are positively correlated with per capita income across all 182 countries (figure 1a) and also across the smaller sample of SIDS (figure 1b). Within each indicator category, the correlation across countries is low. This holds for the entire sample, but also for the smaller SIDS sample of 33 countries. This low correlation, reflecting heterogeneity across dimensions within SIDS, helps explain why it is difficult to establish common interests within the group.

On the EPI indicator (figure 1a), Jamaica, Dominican Republic, and Seychelles are above average performers. Haiti, Cabo Verde, Trinidad & Tobago, and Barbados are below average. Mauritius has an average performance for its per capita income. For the smaller SIDS sample with the EPISI indicator (figure 1b), the polynomial fit is more linear, probably a reflection that efforts at reducing GHG emissions (reflected in decarbonization---see figure 2) only kicks in at higher per capita income. Seychelles is still 'best in class', but now Mauritius is below average within the comparator group (along with Cabo Verde and Barbados).

In conclusion, the substantial heterogeneity in performance across countries at similar per capita incomes is an indirect indicator of the "performance" of policies targeted at protecting the environment.

[10] The EPISI omits performance on GHG emissions which is covered in section 4.

Figure 1a: Overall environmental performance: All countries SIDS

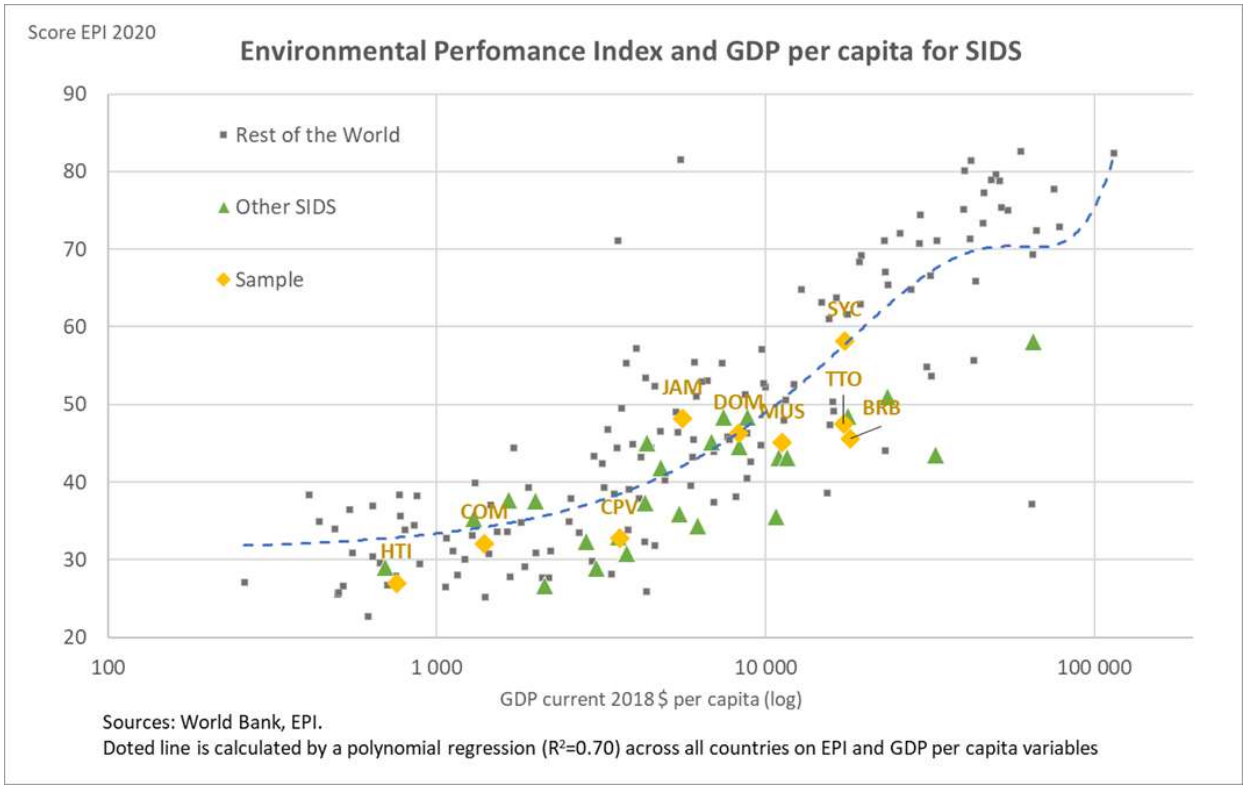
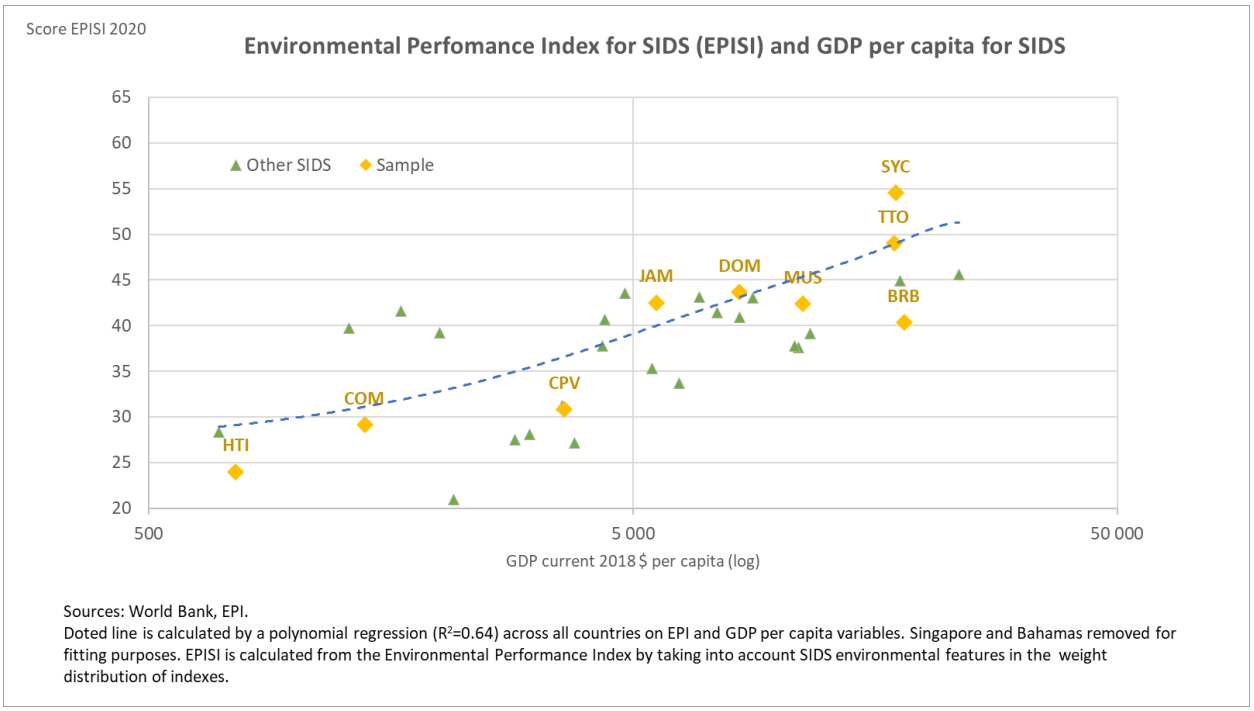


Figure 1b: Overall environmental performance: SIDS



Notes: A higher score indicates a better overall environmental performance. Figure 1a fit over all countries. For figure 1b fit over 33 SIDS
Source: Authors' calculations from EPI (figure 1a) and EPISI Index (figure 1b).

4. Greenhouse Gas Emissions

The CO2 equivalent (CO2e) of Green House Gases (GHGs) is the most popular indicator of anthropogenic activity on global warming. The CO2e measure includes CO2, and NOx, a local pollutant important to health and well-being. Here I compare Mauritius' performance on CO2e over the period 1995-2015 with those of its SIDS comparators. [11] Three issues are explored:

- Is Mauritius (and compactor SIDS), decarbonizing, i.e. are CO2e growth rates less than GDP growth rates?
- What are the respective roles of scale, composition and technique effects in CO2e growth rates over 1995-2015?
- Are export baskets more carbon-intensive than production?

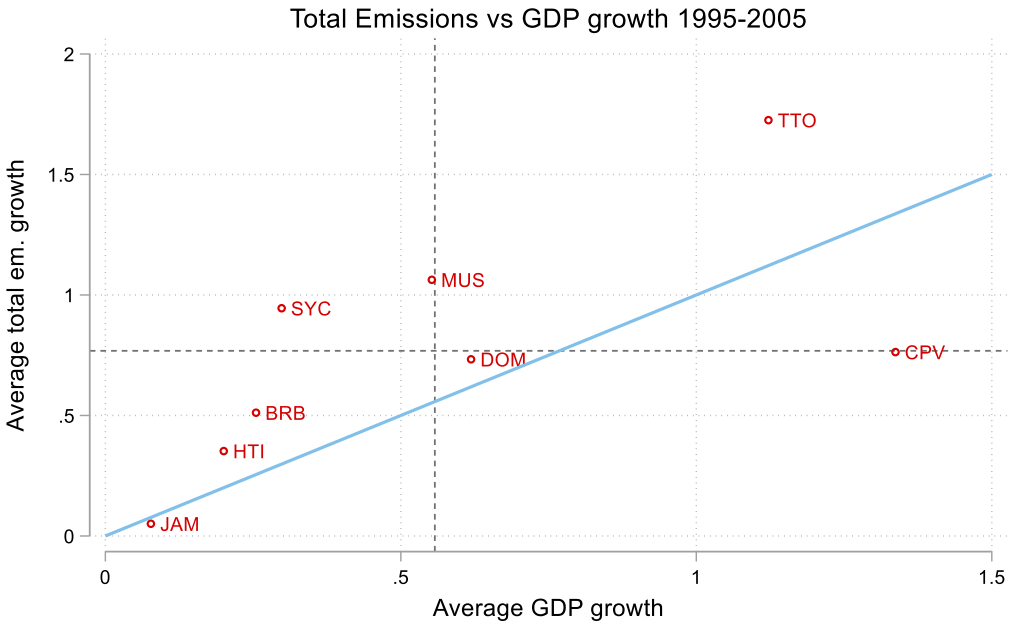
4.1 Little progress at decarbonizing

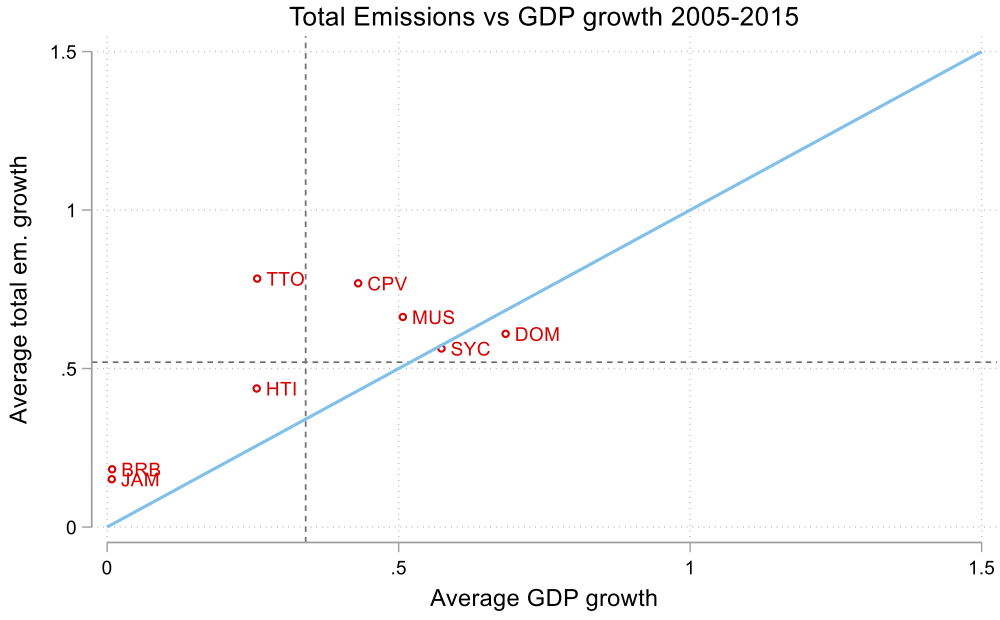
Figure 2 highlights three patterns for the selected SIDS over the period 1995–2005. First, on average, the comparator group was carbonizing over each period (the intersection of the average growth lines is above the 45° line). Second, is a contrast between countries within each period and within periods for some countries. For example, both Trinidad and Tobago (TTO) and Cape Verde (CPV) had high GDP growth during 1995-2015, but TTO was carbonizing while CPV was decarbonizing. TTO was carbonizing over both periods, while CPV switched to a carbon hungry growth path during 2005-2015. Third, with CO2 emission growth outpacing GDP growth, Mauritius (MUS) carbonized throughout. However, more recent data shows that Mauritius started decarbonizing since 2015.[12]

[11] Copeland et al. (2022) report that pairwise correlations across eight pollutants in the WIODare positive and statistically significant for 13 out of 28 pairwise combinations. This justifies focusing on a CO2e of CO2 and NOx. The estimates are from Melo and Solleder (2022) built on data in Cabernard and Pfister (2021) who construct an environmentally-extended "Resolved Multi-Regional input- output " (RMRIO) granular data base covering 163 sectors for 183 countries over 1995-2015.

[12] According to Our World in Data, over the period 2015-19, GDP grew by 15% while (consumption) [production] basesd GHG emissions grew by (8%) [4%].

Figure 2: Decadal growth rates: CO2e emissions vs. GDP: Mauritius and comparator SIDS (carbonizing are above 45° line)





Notes: Values represent growth over the decade. Vertical and horizontal dashed lines indicate simple average growth rates for GDP and CO2 emissions, respectively, over the sample. Intersection of the two lines [below] (above) the 45° line indicates that average emissions for the group are growing [slower (i.e., decoupling)] or (faster (i.e., carbonizing)) than average GDP. On average, SIDS are carbonizing over both periods. ISO country codes in Table 1.
Source: Author's calculations from RMRIO data reported in Cabernard and Pfister (2021).

4.2 Sources of CO2e growth

Identity (1) decomposes CO2e emissions per unit of output (CO/Y) into the product of the CO2e emission intensity of energy consumption (CO/CE) times the energy intensity of gross output (CE/Y):

$$\frac{CO}{Y} \equiv \frac{CO}{CE}\frac{CE}{Y} \qquad (1)$$

where: CO stands for emissions (in kilograms of CO2 equivalents), Y is gross output in €, and CE is primary energy consumption in kWh. A high emission intensity per unit of output (CO/Y) can be the outcome of a high emission per kWh of energy consumed (CO/CE), or of a high energy consumption per unit of output (CE/Y), or both. The former is likely to imply that "dirty" energy sources are used primarily in the economy. The latter suggests that either the country is specializing in energy intensive activities or that it lacks abatement technology—or incentives—necessary to reduce emissions.

Table 3 shows that Mauritius is the only country in the group where emission intensities (CO/Y) have not fallen over the period. Yet, even though Mauritius is one of the two countries with Cap Verde, that has increased its energy intensity over the twenty period, Mauritius has the lowest emission intensity of output. This probably reflects Mauritius' specialisation in financial services and tourism, two sectors with low emission intensities.

Table 3*:* Decomposition of total CO2e emissions: Mauritius and SIDS Comparators

	1995			2015			1995	2015
Country	Em/out (CO/Y)	Em/En (CO/CE)	En/out (CE/Y)	Em/out (CO/Y)	Em/En (CO/CE)	En/out (CE/Y)	Direct/Total Emissions[a]	Direct/Total Emissions[a]
BRB	0.14	0.09	1.64	0.13	0.19	0.69	26.0%	32.0%
CPV	0.07	0.02	3.77	0.05	0.06	0.73	8.0%	10.2%
DOM	0.42	0.07	5.60	0.19	0.18	1.06	62.8%	53.6%
HTI	0.89	0.39	2.28	0.46	0.69	0.67	82.5%	73.4%
JAM	0.85	0.29	2.92	0.38	0.29	1.30	67.0%	56.7%
MUS	0.05	0.02	3.11	0.07	0.10	0.78	7.5%	15.0%
SYC	0.02	0.01	3.02	0.33	0.04	0.62	3.9%	9.9%
TTO	1.2	0.04	28.19	1.20	0.22	5.51	77.2%	82.9%

Note: Decompositions of Equation 1. CO/Y=(CO/CE)*(CE/Y). Results rounded to 2 decimals

[a]/ Indirect emissions are those embodied in goods from other countries.

Source: Authors' calculations from RMRIO data reported in Cabernard and Pfister (2021).

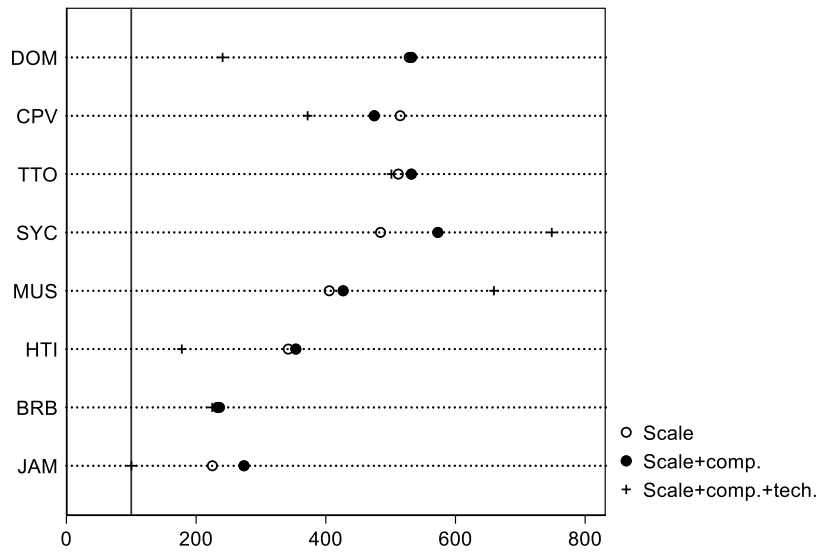
Table 3 also shows a sharp fall in the energy consumption per unit of output (CE/Y). The emission per kWh of energy consumed (CO/CE) increased in all countries, except Jamaica and Seychelles.

Differentiating (1) gives further insight into the sources of CO2e growth over the period 1995-2015 into three components: growth (scale effect), $(\widehat{Y})$; change in energy intensity (composition effect where emissions intensities at the sector level are kept at their 1995 values), $(\widehat{E_Y})$; and technique effect (change in the carbon intensity of output), $(\widehat{C_E})$, i.e.,

$$\widehat{CO} = \hat{Y} + \widehat{E_Y} + \widehat{C_E} \qquad (2)$$

Figure 3 applies the decomposition to each country in the SIDS group. Countries are listed by decreasing GDP growth (hollow circle) over the period. If technique and composition effects across countries and sectors remained unchanged, this would represent emissions growth over the period. This is the case for Jamaica where emissions and GDP grew at the same pace once the lower emission rate per unit of output is taken into account. Adding all three (scale+composition+technique) effects, Jamaica's growth in emissions over the period equalled GDP growth (see also figure 2). The filled blue circles show how emissions would have changed if composition and scale changed but techniques were unchanged.

Figure 3: Decomposition of emissions growth across Mauritius and comparators 1995–2015 (Scale, composition, and technique effects)



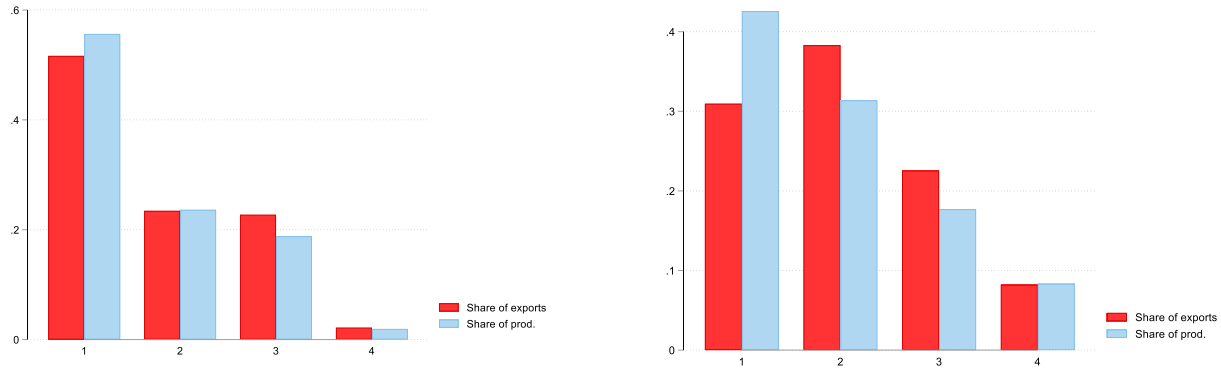
Notes: Horizontal line represents 100 times emissions in 1995. Dashed vertical line at "change in emissions" =100 corresponds to no change in emissions between 1995 and 2015.Countries ordered by descending scale values. No composition effects for Dominican Republic (DOM)and Barbados (BRB). Scale represents 100 times value-added in 2015 divided by GDP in 1995. Scale + composition modifies the scale value to keep technique (emission rate) constant for each country*sector as it was in 1995. Scale +composition + technique represent 100 times emissions in 2015 divided by emissions in 1995.
Source: Authors's calculations from Melo and Solleder (2022, figure 5) inspired from Copeland et al. (2022, figure 6).

4.3 Emission intensity of export baskets

Figure 4 shows the distribution of production and exports by quartile (about 40 sectors per quartile) for 2015 for Mauritius and for the average across the 8 comparators. The sectors are ranked by increasing CO2e intensities. If the distribution of the emission-intensities of production by quartiles was the same across countries, each quartile of production would have 25% of products. Clearly, SIDS production is concentrated in the least carbon-intensive activities. For all the SIDS comparators this carbon-frugal production pattern reflects the importance of Services in general, particularly tourism.

Figure 4:
CO2e emission intensities of exports and production:Mauritius and comparator SIDS
(By quartile of total emission intensities)

Mauritius *SIDS comparators*



Note: Quartiles are ordering sectors by their world production weighted average of direct emission intensity. 4 is the most pollution intensive quartile. Year of reference: 2015. For comparator group, average over the 8 countries.
Source: Authors' own estimates adapted from Melo and Solleder (2022).

Relative to the world average over 183 countries, around half of the production of the SIDS comparators is concentrated in the least CO2 intensive products. For Mauritius, less than 5% of its production takes place in the top quartile of CO2-intensive products. A similar, but less pronounced pattern holds for the comparator SIDS. Unambiguously, this group contributes little to global warming, not only on an absolute basis because of their size, but also because of their carbon-frugal production patterns.

5. Supportive Trade policies: Achievements, missed opportunities and challenges ahead

I conclude with trade policies. Removing barriers to trade on Environmental Goods (EGs) and Environmental Services (ESs) would help speed up their transition towards a green development path. This would also be a double win for the trade-dependent SIDS. By opening their markets of EGs to trade, SIDS would be in a better position to meet the challenges of sustainable development. First, tariff-free access to 'end-of-pipe' goods and services (e.g. services for the detection and control of losses in transmission lines or wastewater management services, recycling, etc.) lower the costs of cleaning up the environment, and lessen the impact of human activities. Second, the costs of transiting towards renewable energies would be reduced if the necessary technologies-- virtually all imported for African SIDS—were not to face tariff barriers. Third a shift towards consumption patterns based on 'green goods'--often called 'environmentally Preferable Products (EPPs)'—will also reduce the country's footprint on the environment.

Mauritius has done well on removing barriers to trade in EGs and ESs, but has missed the opportunity to join a club of small countries keen on accelerating their transition towards a green development path.

5.1 Achievements: Mauritius encourages trade in green goods and services

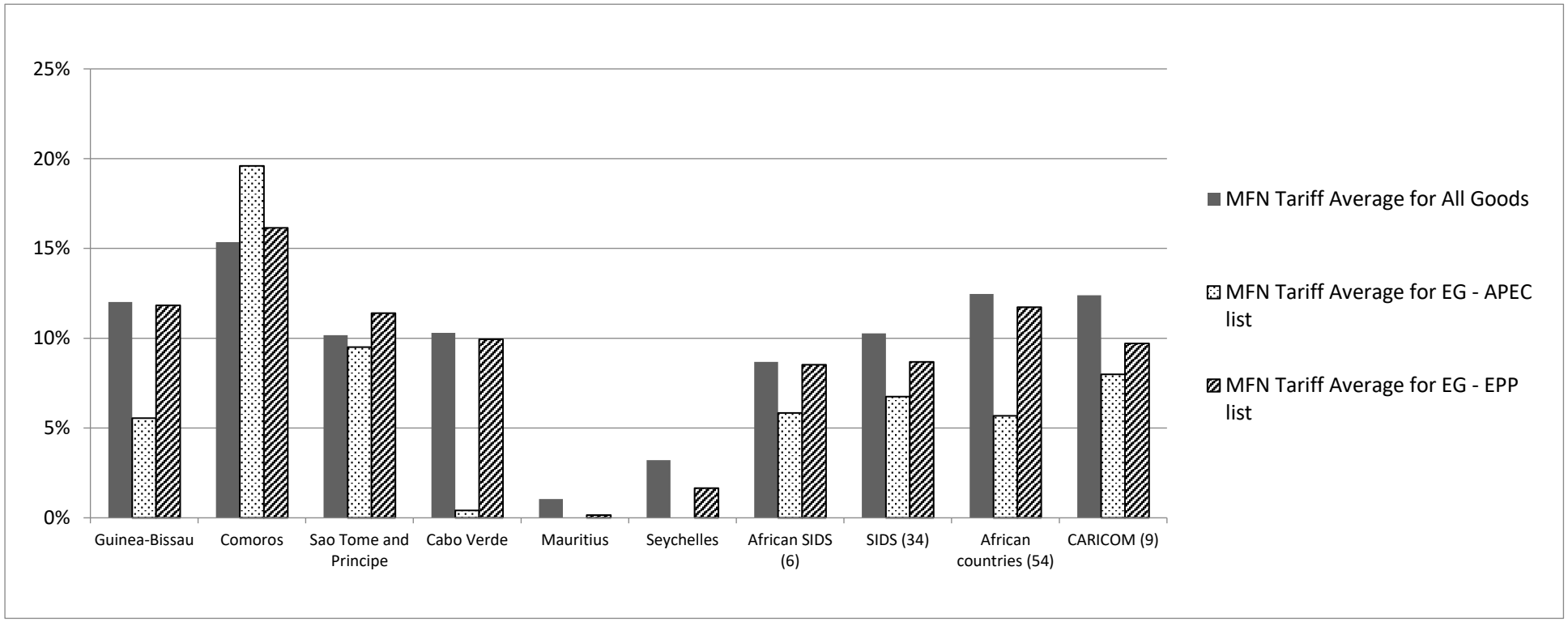
Regional Trade Agreements (RTAs) have the potential to address environmental issues of greatest interest to the SIDS, but, in practice, this is rarely the case. Notably the African Continental Free Trade Area (AfCFTA) to which Mauritius is a signatory does not even mention the environment in its preamble, nor does it exclude EGs from exemption to tariff elimination (the current average tariff on EGs across Africa is 5.7%). Also, SIDS interests are diluted in the Africa's Regional Economic Communities (RECs) where membership included countries with very different interests: coastal countries, landlocked countries, resource-rich and resource-poor countries. This situation stands in contrast to the RTAs among like-minded partners. As examples, environmental provisions are the centrepiece of Caribbean Community (CARICOM) and in the Pacific Island Countries Trade Agreement (PICTA). [13]

Since concerns with the environment have little weight in large memberships trade agreements like the African RECs and the AFCFTA, this leaves two options for Mauritius (and comparator SIDS). First they can advance their environmental agenda unilaterally by eliminating policy-imposed trade barriers on EGs. Second, they can join negotiations with countries that prize environmental provisions, like the CARICOM and PICTA groups that have more environmental provisions than the African RECs.

Figure 5 shows that Mauritius is ahead of other SIDS. It has the lowest average tariff on all goods, and also on the two lists of EGs, those for environmental management (the APEC list) and those that have a smaller environmental footprint (the E-EPP list).

[13] See the list of environmental provisions across RTAs across Africa, the Caribbean and the Pacific in Melo and Solleder (2022, tables 3.1 and 3.2).

Figure 5: Average applied Tariffs on Imports by lists: All goods and Environmental Goods (APEC and EPP list)



Notes: Simple average of applied tariffs 2018. Number of H6 level products in parenthesis: EG- APEC(54). EG-EPP(103). The APEC list includes goods for environmental management. The EPP list goods whose production/consumption/disposal has a smaller environmental footprint.
Source: Casella and Melo (2021, figure 6).

5.2 Missed Opportunity: Joining the ACCTS negotiations

A group of six like-minded countries (Costa Rica, Fiji, Iceland, New Zealand, Norway, Switzerland) launched in September 2019 negotiations for an Agreement on Climate Change, Trade and Sustainability (ACCTS). The following excerpt from the Joint Leaders statement at the ACCTS launch September 26, 2019 shows the perceived urgency for the signatories to engage in designing environmentally-friendly trade policies:

> "Trade can't sit outside of our work to tackle climate change. In fact international trade rules are uniquely placed to be part of the solution by removing trade barriers for green products and services and stopping pollution being subsidized. If trade rules can require subsidies to be removed from things like agriculture, then it is only consistent that they also require subsidies to come off polluting fossil fuels".
> Hon. Jacinta Ardern, Prime Minister of New Zealand about launch of ACCTS.

Other WTO members were invited to join. Joining the ACCTS would have sent a signal that Mauritius is taking the protection of the environment 'seriously'. According to the joint statement, the ACCTS agreement intends to:

- Remove tariffs on Environmental Goods (EGs) and make new commitments on Environmental Services (ESs);
- Establish concrete commitments to eliminate fossil fuel subsidies;
- Develop voluntary guidelines for eco-labelling programs and mechanisms.

All measures relating to the elimination of tariffs and to commitments on opening up markets on environmental services will be negotiated at the WTO with all reductions in barriers to trade on EGs and ESs to be extended to all WTO members on a Most-Favored-Nation (MFN) basis making commitments less susceptible to backtracking. Most importantly, this agenda is far more ambitious than previous attempts since the agenda extends beyond removing tariffs on EGs, which are already very low in the case of Mauritius. The ACTTS is to tackle fuel subsidies, to include barriers on ESs, and to develop guidelines on eco-labelling.

Melo (2020a) notes that had Mauritius joined the ACCTS group, no effort would have been required for reducing tariffs on EGs, but that tackling fuel subsidies would be politically more difficult since Mauritius has the next to lowest petrol and diesel prices in the ACTTS group. Parry (2012) estimates that applying corrective taxes on energy prices to correct damages from energy prices that do not reflect environmental damages would increase the Mauritian government revenue by 0.8% of GDP while reducing energy-related CO2 emissions by 9.7%. Joining the ACTTS would have sent a signal of commitment towards environmentally friendly policies.

6. Conclusions

Comparisons with other 'similar' small islands suggest that Mauritius has had a mixed environmental performance. Trajectories of per capita GDP growth vs social improvements as captured by a human development index purged of the GDP growth component over the period 1970-2015 show that Mauritius had a satisfactory performance. Indicators of the health of the environment suggest that Mauritius has failed to protect both its land and its maritime environment. Overall environmental performance captured by an Environmental Performance indicator designed to better reflect the environmental priorities of SIDS, the (EPISI), shows that Mauritius under-performed for its per capita income. Benchmarking the growth in CO2 emissions shows that Mauritius did not start to decarbonize over 1995-2015.

Taken together, these comparisons suggest an average performance for Mauritius: rather below average for an overall indicator of the protection of the environment, especially regarding the control of GHG emissions since decarbonization has only started recently. However, trade policies are environmentally friendly since there are no tariffs on goods for the management of the environment nor on goods that are environmentally-friendly in their life-cycle.

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Annexes

Environmentally-friendly trade policies to shape Mauritius' future

Annex A1 discusses the trade-environment nexus. Annex A2 describes the modifications brought to the EPI to construct the EPISI used in the text. Annex A3 lists additional tables and figures.

A1: Reconciling trade and environment objectives in SIDS

All human activities have a footprint on the environment. As illustrated by the CO2e trajectories in figure 3, in a growing economy, the footprint of economic activity on the environment is ambiguous as the scale effect leads to greater environmental damage while the efficiency effect usually reduces pressure on the environment thanks to environmentally friendly policies. This reduction of pressures on the environment is reinforced if growth is accompanied by better 'performing' property rights when institutional quality improves. In the SIDS comparator group here, this was not the case for Haiti. This annex discusses the trade-environment linkages which are particularly strong in the SIDS covered in this paper.

Figure A1 isolates three channels of interaction between a development strategy and its environmental implications and where trade enters into these channels:

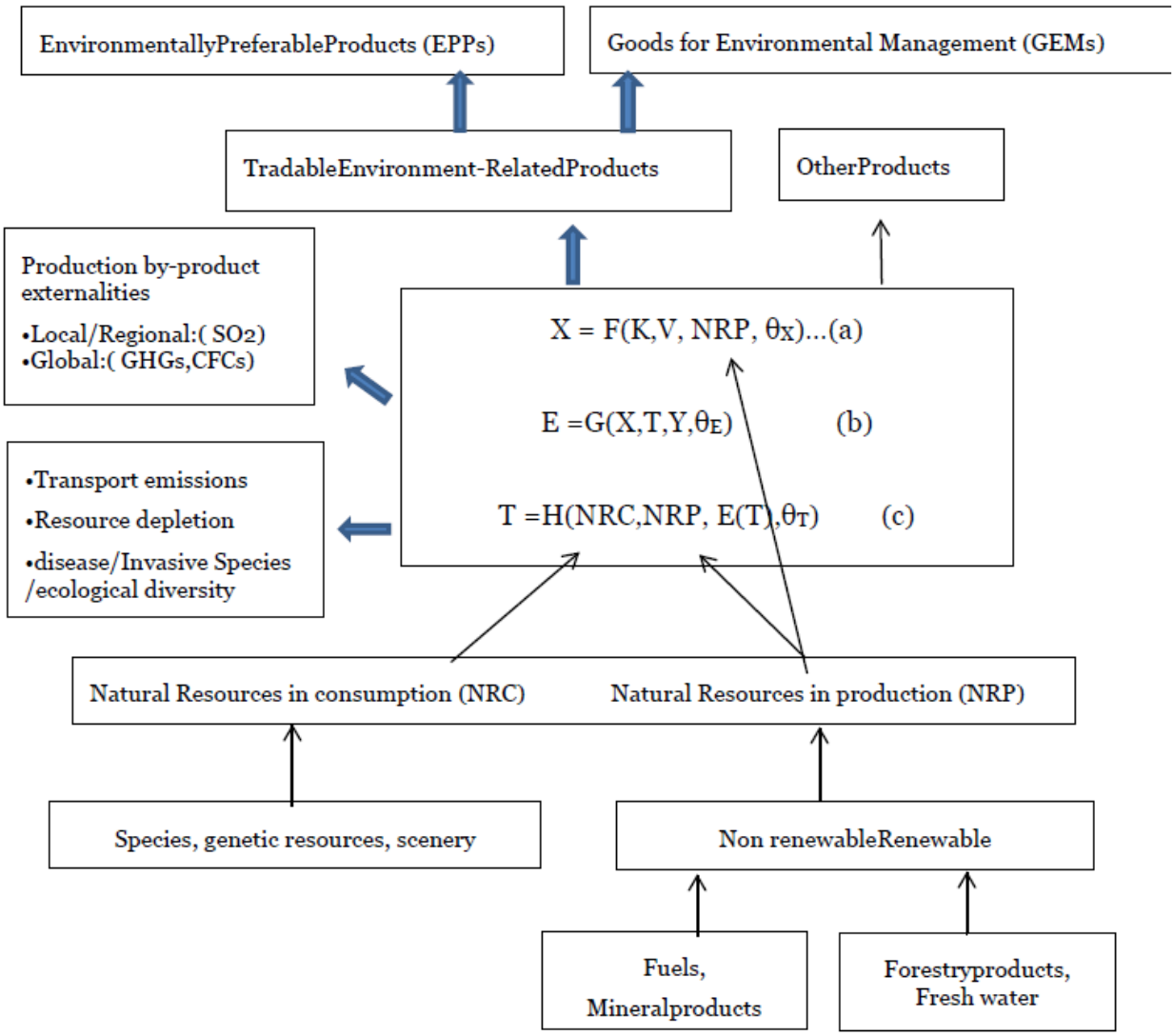
(i) pattern of production (a);
(ii) by-product externalities resulting from most human activities (b);
(iii) direct effects of trade on the environment (c).

The first channel is in the pattern of production: does the development strategy manage adequately the environment, and does it produce goods and services that are environmentally- friendly[ii]? The top of figure A1 distinguishes two types of environmentally-friendly products: EPPs and GEMs. Several lists of goods in each category are available. Two such lists (number of products in parenthesis) are given in Casella and Melo (2021, annex A1-3: APEC(54), EPP (103)).

The second channel works through the by-product externalities that inevitably accompany human activities, externalities that are becoming increasingly global. However, for SIDS, because of their relative isolation, cross-border externalities are less important. However, as discussed by Nurse et al. (2014, section 5.2), climatic processes observed in SIDS increasingly originate from other countries or regions. To give one example, they report that dust level emissions were a factor of nine lower during the 1950s when rainfall was at or above normal compared with the 1980s when the Sahel was hit by intense drought (Nurse et al. p. 1633).

The third channel covers the direct effects of trade on the environment. From their survey of estimates, Copeland Shapiro and Taylor (2011) conclude that different approaches yield an estimate of around 5% additional emissions from international trade, an order of magnitude smaller than the welfare gains of trade relative to autarky.

Figure A1: Natural Resources, the Environment and Trade: Channels of interaction



(a) X= Output; K= physical and human capital; V=Intermediate inputs, NRP= Natural resources in production; θ_X=Output-related policies (e.g. taxes or subsidies on fossil fuels)

(b) E= output-related emissions; Y=per capita income; θ_E= caps/taxes on emissions

(c) T= environment-related Trade; NRC=natural resources in consumption; E(T)=Emission related to transport; θ_T=border taxes

GHG= Green-house gases; CFC=chlorofluorocarbons;SO= Sulfuric oxides;

Source: Melo (2012, figure 1).

For SIDS, and other low-income countries where natural capital accounts for close to half their wealth, valuation and monitoring of their natural capital is essential. Natural resources can be categorized as non-renewable (fuels, mineral products), or renewable (forestry products, fresh water). [14] Goods are produced with natural resources in production (NRP). These are the raw materials that enter production (relation (a)). Natural resources also enter directly as natural resources in consumption (NRC such as fish, biodiversity and genetic resources). Both NRC and NRP may be characterized by poorly-defined property-rights which may be exacerbated because they are traded (relation (c)). In both cases, the appropriate policy consists of correcting the externality at source (e.g. establishing property rights or applying production/consumption taxes) and if the entire production is traded (e.g. ivory) a trade tax or trade ban is also the first-best policy.

For trade in natural resources, appropriate policies are difficult to design because environmental effects are generally local while policies boil down to laws and regulations at the national level that take should take into account the specificities of the biome and ecosystem. Their impact is difficult to trace in trade flows. Difficulties are also compounded when there is open-access (often the case for NRC, i.e. endangered species) or when there are strong vested interests reflected in lobbying activities (often the case for NRP, i.e. fossil fuels including consumption where the alternative is a shift towards renewable energy which can be incentivized by trade policy).

In the case of natural resources, the effects of trade depend on the property rights regime. When these can be secured, trade will be welfare-increasing. When property- rights are ill-defined, or when there is open-access, international trade is likely to lead to over-exploitation or disappearance of the resource as is the case for fishing. Then, if they can be implemented, restrictions on trade or a ban on trade in endangered species can be the appropriate policy in an environment where resources are open-access.

In the Low-income SIDS limited institutional capabilities complicates implementation of the two approaches used to protect their terrestrial and maritime environments. Andrew (2018) reviews state of play on the two approaches to promote sustainable outcomes for the terrestrial environment: (i) regulatory approach (ii); voluntary sustainable standards involving the private sector. [15]

To be effective, the policy requires cooperation from trading partners, as for instance, in the ban of trade in ivory. By contrast, an environmental policy to regulate local pollution does not require cooperation to the extent that "virtual trade in pollution" is limited.

[14] Close to half of the wealth of low-income countries comes from their natural assets compared with only 3 percent for industrialized countries (Lange et al. 2018 cited in WTO-UNEP 2018, 16)

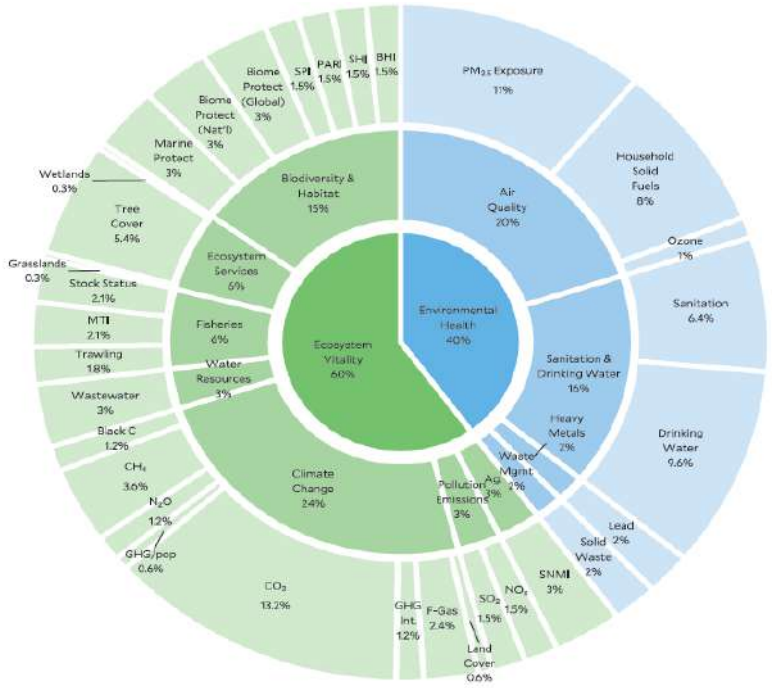
[15] Andrew (2017) also reviews results from scoping and screening methodologies applied to agriculture and services sectors such as tourism. He notes that until recently, the lack of environmental data at the local level obliged evaluations to concentrate on regulatory aspects and trade policy instrument applied on sensitive products.

A2: The Environmental Performance Index for the SIDS (EPSI)

This annex presents the "modified" Environmental Performance Index for the SIDS (EPISI)). The EPSI focuses more closely with the environmental priorities and environmental policies of the SIDS than the EPI. As example take fisheries and CO2 emissions. Fisheries is an important concern for SIDS individually and as a group while the consequences of their own CO2 emissions are negligible in terms of their impact on their environmental degradation. Any effort at mitigation on the part of the SIDS will have little effect on sea level rise or on rising temperatures in their habitat. Therefore the EPISI used here (see Casella and Melo (2021) for elaboration) excludes GHG Emissions growth from the EPI assigning the GHG weights to fisheries and biodiversity. At the same time, for comparisons over the whole sample of countries, we restrain from modifying it further by, say, replacing the CCH index by the RLI.

Figure A2 shows the 32 sub indicators in the EPI. The EPI has two policy objectives, environmental health (HLT) and ecosystem vitality index (ECO).

Figure A2: The two policy objectives: ecosystem vitality (ECO) and Environmental Health (HLT)



The 2020 EPI Framework. The framework organizes 32 indicators into 11 issue categories and two policy objectives, with weights shown at each level as a percentage of the total score.

Notes: Each objective has 11 issue categories (weights in each category). Weights in each slice add to total in next higher-level slice. HLT(40)=20+16+2+2. EPI score = $ECO^{0.6}HLT^{0.4}$.
Source: EPI 2020 Report p.11.

The EPISI brings two modifications to the EPI (weights in table A1)

- GHG emissions are excluded from the EPISI so the climate change policy objective with 24% weight disappears from the ECO index. The other weights in the ECO policy objectives and in the sub-indicators are scaled up proportionally to add up again to 100%.
- EPISI gives equal weight to the two components, HLT and ECO. Giving equal weight to the HLT and ECO components results in a proportional scaling up of all weights in the ECO components.

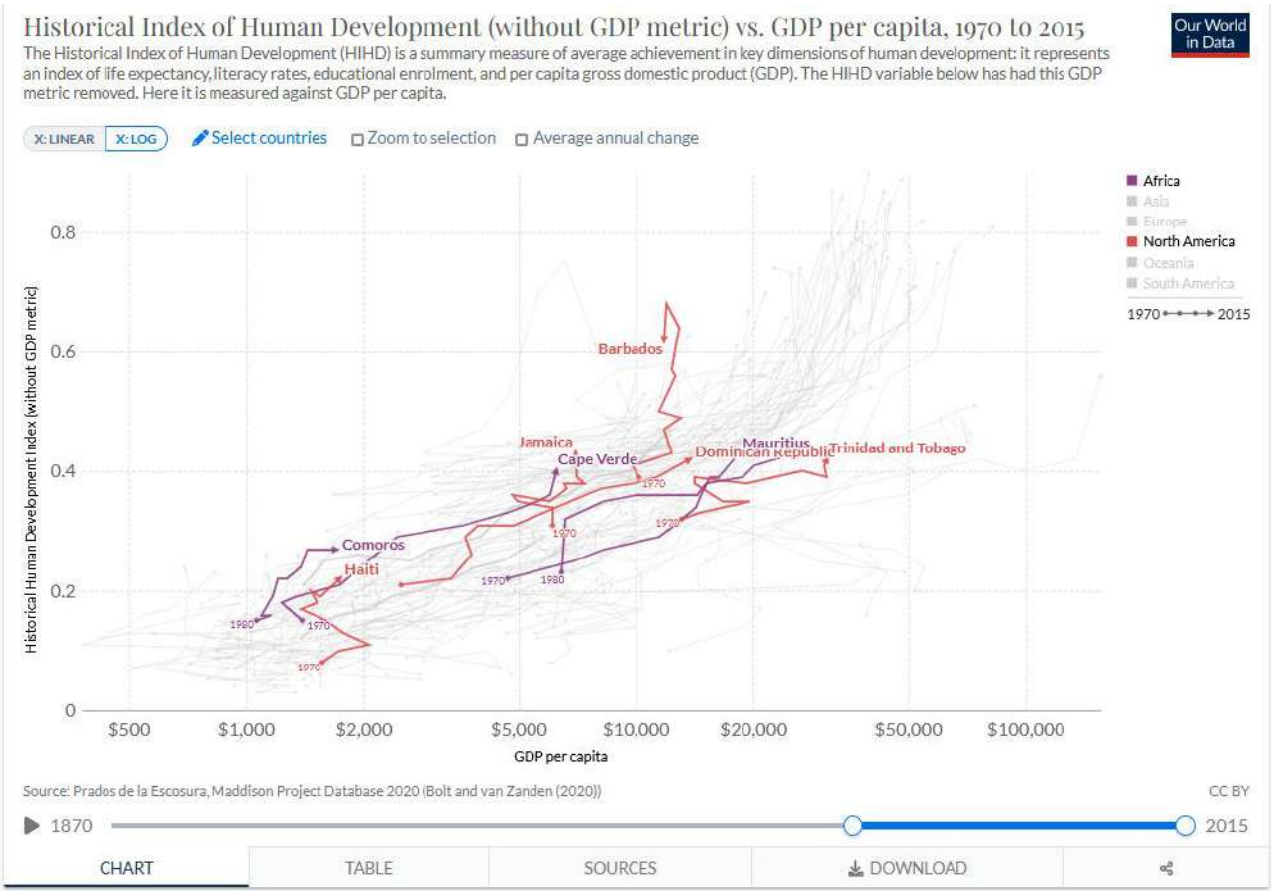
Table A1: Construction of the Environment Performance Index for Small Islands (EPISI)

	EPISI				EPI-EPISI comparison	
					Indicator weights in the final EPI/EPISI score	
Policy objective	TLA[a]	P-Weight[b]	TLA	S-Weight	EPI	EPISI[d]
Environmental Health HLT (50%)	AIR	50%	PMD	55%	11.0%	13.8%
			HAD	40%	8.0%	10.0%
			OZD	5%	1.0%	1.3%
	H2O	40%	USD	40%	6.4%	8.0%
			UWD	60%	9.6%	12.0%
	HMT	5%	PBD	100%	2.0%	2.5%
	WMG	5%	MSW	100%	2.0%	2.5%
Ecosystem Vitality ECO (50%)	BDH	42% (25%)	TBN	20%	3.0%	4.2%
			TBG	20%	3.0%	4.2%
			MPA	20%	3.0%	4.2%
			PAR	10%	1.5%	2.1%
			SHI	10%	1.5%	2.1%
			SPI	10%	1.5%	2.1%
			BHV	10%	1.5%	2.1%
	ECS	17% (10%)	TCL	90%	5.4%	7.7%
			GRL	5%	0.3%	0.4%
			WTL	5%	0.3%	0.4%
	FSH	17% (10%)	FSS	35%	2.1%	3.0%
			RMS	35%	2.1%	3.0%
			FGT	30%	1.8%	2.6%
	CCH	0% (40%)	CDA	0%	13.2%	0.0%
			CHA	0%	3.6%	0.0%
			FGA	0%	2.4%	0.0%
			NDA	0%	1.2%	0.0%
			BCA	0%	1.2%	0.0%
			LCB	0.0%	0.6%	0.0%
			GIB	0%	1.2%	0.0%
			GHP	0.0%	0.6%	0.0%
	APE	8% (5%)	SDA	50%	1.5%	2.0%
			NXA	50%	1.5%	2.0%
	AGR	8% (5%)	SNM	100%	3.0%	4.0%
	WRS	8% (5%)	WWT	100%	3.0%	4.0%

Notes:
TLA = Three letter Abbreviation of the specified indicator.
[a] See table A1 for the full description of the corresponding indicator and for the three letters abbreviation.
[b] Corresponding weight in EPI in parenthesis.
[c] Weights correspond to those in final score index. For example, in EPI PMD: 11%=55%*50%*40%.
In EPISI PMD:13.8%=55%*50%*50%.
[d] Values rounded to first decimal.
Source: Casella and Melo (2021), table A2.2.

A3: Additional tables and figures

Figure A3: Small Islands Trajectories; Human Development Index (HDI) and GNI



Notes: In brackets , population in 1'000 followed by population density per sq km. The purged HDI index is a geometric weight of its 2 components, health and education. Data starts in 1980 for Comoros and Seychelles
Barbados [281;637]; Cape Verde [593;147]; Comoros [837;439]; Dominican Republic [11,200;231]; Haïti [11,585;417]; Jamaica [2800;257]; Mauritius [1,300;637]; Seychelles[107;237];Trinidad & Tobago [1500,298].
Source : OWD for the figure. World Bank for population and population density
https://ourworldindata.org/grapher/hihd-without-gdp-vs-gdp-per-capita?time=1970..2005&country=CPV~COM~DOM~HTI~JAM~MUS~SYC~TTO~BRB.

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Pascal

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