PARADISE ISLANDS?

ISLAND STATES AND THE PROVISION OF ENVIRONMENTAL GOODS

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ABSTRACT

Island states have been shown to trump continental states on collective action-related outcomes, such as democracy and institutional quality. The argument tested in this article contends that the same logic might apply to environmental goods. However, our empirical analysis shows counter-intuitive results. Firstly, among the 107 cross-national environmental indicators we analyze, being an island only has a positive impact on 20 measurements. Secondly, the causal factors suggested to make islands outperform continental states in other aspects have weak explanatory power when analyzing the variance of the states' environmental performances. We conclude by discussing how these findings can be further explored.

Keywords
Environmental goods; collective action; environment; island states.

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Introduction

Island states have recently shown outstanding performances in a number of governance and collective action-related outcomes. They have succeeded in establishing strong civil societies and seem to perform comparatively well on indices of political rights and civil liberties, while exhibiting, on average, higher levels of democracy than continental states. In his seminal work *Democracy and Development*, Hadenius (1992) found that in 1988 all but two of the thirteen most democratic developing countries were island states (Belize and Costa Rica being the only exceptions). Nowadays, data from Freedom House (2011) shows that among thirty countries that have the highest possible score on the Freedom House democracy index, ten are islands. Furthermore, 30 out of 39 islands states are classified as free and have the Freedom House democracy score ranging from 7 to 10 (Teorell, Samanni, Holmberg, & Rothstein, 2011), though there are also deviating examples. Several island states are found on the very opposite end of the democracy scale (e.g., Bahrain and Cuba). Yet, according to all the subsequent references to Hadenius (1992), his work, together with the newest data, has spurred a growing and broadened interest in the performance of island states. As a result we not only find (large- and small-N) studies of how well island states perform in regard to democracy (Srebrnik, 2004; Anckar, 2002), but also a number of articles investigating island states' capacity to provide a variety of social goods, such as economic development and rule of law (e.g., Briguglio, 1995; Anckar, 2006; Congdon-Fors, 2013).

In this paper, we study island states from a less explored angle, namely by investigating their capacity to maintain *environmental goods*. This orientation is motivated by two reasons. Firstly, as accounted for in this paper's theory section, it has previously been suggested that successful collective action in natural resource management is facilitated by many of the factors characterizing island states (Ostrom, 1990; Agrawal & Goyal, 2001; Grafton & Knowles, 2004; Naidu, 2009). Secondly, recent empirical findings indicate that there might be something in the features of island states that make them less harmful to the environment. For instance, Povitkina (2012) reports that compared to continental states, island states tend to be less likely to overharvest their marine fisheries.

More specifically, the aim of the study is twofold: First, we make a systematic comparison of how well island states and continental states perform in regard to different environmental indicators, measured on the national level. The data set on environmental indicators consists of 107 different measurements collected from what are commonly considered reliable sources, available across nations. As such, this article utilizes, to our knowledge, the most comprehensive set of data on environmental indicators available for researchers. Second, we narrow down our focus by selecting those 20 environmental indicators where island status, on average, tends to have a positive effect and we continue by investigating what factors seem to be driving these results. In this latter part, our criteria for selecting potential independent variables are founded in previous (sociopolitical) research demonstrating that colonial heritage, religious dominance, isolation, cultural homogeneity, population size, and occurrence of conflicts are factors that possibly explain why islands perform better in regard to level of democracy, economic development, and rule of law (Anckar, 2006; Congdon-Fors, 2013; Srebrnik, 2004). Rather than studying the impact from the areas in which islands outperform continental states—such as democracy, economic development, and the quality of government institutions—our focus here is hence to explore the impact from the underlying features of islands states on their environmental performance.[1]

In Table 1, we account for our specific research questions and the strategy outlining how they will be answered (the latter is further elaborated in the methodology section). The remainder of the paper is organized as follows. In the next section, we review previous research on island state performance and discuss what characteristics that previously have been argued to explain why island states outperform continental states. The subsequent section accounts for the methods used to fulfill our aim and present the data being used. The result section is then organized according to the two-fold aim. The article concludes with a critical examination of how these results can be brought further by suggesting a number of research questions for future research.

[1] The full list of island states analyzed in this paper is available in Appendix A.

TABLE 1. RESEARCH QUESTIONS AND EMPIRICAL STRATEGY

	Question	Empirical strategy
1.	*Do island states perform better than continental states in regard to providing environmental goods?*	We analyze a global sample (40 island states and 161 continental states) of states' performance in 107 different environmental indicators.
	If yes, in which respects?	We discuss patterns and potential congruence among the environmental indicators where island states, on average, perform better than continental states.
2.	*Can the factors identified as explanations for island states' relative success as regards political and economic development also explain islands' success in certain environmental indicators?*	Focusing on the 20 measurements where island status has a positive effect we analyze which factors from previous research (e.g., states' level of homogeneity and size) can most successfully explain the link between "islandness" and environmental performance.

Island States and Environmental Performance

While islands are usually defined as "sub-continental land areas, surrounded by water" (Glassner, 1990, p. 47), there is no agreed upon definition of what constitutes an island state. Anckar (1996, p. 702) identifies island states as "states that are islands, part of an island or consist of islands and part of islands." Congdon-Fors (2013, p. 11) provides a stricter definition of an island nation as "a country with no land borders." She claims that this understanding of an island country gives an advantage of making it "even more reasonable to assume that country size in area is exogenous." (2013, p. 11) Hereafter we will refer to the latter definition of an island state thus being a country with no land borders, since it assumes that a country's government is responsible for taking care of the whole territory surrounded by water and is fully accountable for the environmental outcomes of the island.[2]

A common conception in the literature is that island states suffer from their smallness and isolation. For example, Easterly and Kraay (2000) have argued that public goods provision has increasing

[2] Following the approach of Congdon-Fors (2013) we treat Cuba as an island state—though a small part of its border is constituted of the Guantanamo Bay—but do not treat Australia as a country but a continent. Moreover, we treat Taiwan as an island state, though it is formally a part of China.

returns to scale and, hence, that small states suffer from higher per capita costs of public goods (see also Easterly & Rebelo, 1993; Alesina & Spoalare, 1997; Kuznets, 1960; Harden, 1985). Other studies suggest that the private economy also has a lot of increasing returns to scale, and thus small states face disadvantages in terms of, for example, diversifying their production. They may also be at a disadvantage due to their limited labor force and the difficulties in recruiting high-quality candidates from their limited pool of workers (Congdon-Fors, 2007, 2013; Romer, 1986; Barro & Salai-Martin, 1995; Briguglio, 1995; Armstrong & Read, 1998). In addition, many islands are thought to suffer from their location because they are typically more remote, have higher transportation costs, smaller internal markets, and experience a higher degree of vulnerability to both economic shocks and natural disasters (Congdon-Fors, 2013; Srinivasan, 1986).

However, recent empirical studies largely turn these expectations on their head. Because, small states—and, as it seems, island states in particular (Anckar, 2006)—are shown to trump continental states on a number of institutional indicators and collective action-related outcomes. On average, they have both higher income and productivity levels. They perform well on indices of civil and political rights; they have provided bases for vibrant civil societies, compared to continental states (Srebrnik, 2004; Anckar & Anckar, 1995); and they tend to have stronger institutions in terms of democracy parliamentarism, plurality elections, direct democracy, and rule of law (Ott, 2000; Easterly & Kraay, 2000; Congdon-Fors, 2007, 2013; Anckar, 2006). How can this be understood?

The literature, finding a positive effect from smallness, and "islandness" in particular, suggests a number of causal mechanisms producing such beneficial outcomes. *First*, a common argument is that islands tend to be more ethnically and linguistically homogenous (Clague, Gleason, & Knack, 2001). Homogeneity is in turn said to facilitate collective action and coordination by giving citizens "a high degree of sympathetic identification with each other" and resulting in "a greater effort to feel others out" (Anckar & Anckar, 1995, p. 222; Hache, 1998). The sense of community and cohesiveness found in small island nations is, consequently, held to reduce the risk of conflict and, on the contrary, stimulates the development of exchange, high quality institutions, and economic productivity. The shared interests, intimacy, and distinct identity of island populations have also been interpreted in terms of social capital. According to this logic, islands are more prone than non-islands to foster a sense of national identity that is stronger than group identity. The “geographical precision” of island states hence gives island populations a distinct sense of place, which in turn may lead to a sense of unitarism and a better ability to accumulate national-level social capital as opposed to group-level social capital (Baldicchino, 2005, p. 35). Yet, whether or not it really is homogeneity per se that explains the effect from the “island dummy”—the dichotomous measure whether a state is an island or not— is up for discussion. There are in fact striking examples contradicting such claims. For example, the demographic profile of Mauritius would, according to the homogeneity argument, be expected to comprise a recipe for disaster. But although Mauritius is one of the most ethnically heterogeneous states in the world, this small island state still performs extraordinarily well in terms of economic and social development (Srebrnik, 2004). This clearly motivates both empirical investigations and a closer look at other potential causal factors.

The *second* mechanism said to work in favor of positive developments in island states is their distinct colonial history. Island states are, in this discussion, held to have experienced a comparatively deep penetration of colonialism and British and Christian influences in particular. As claimed by Clague et al. (2001), due to the fact that pre-imperial societies were less prevalent on most of the islands, this deep penetration was in turn not perceived as a foreign import challenging pre-existing values or established modes of political organization. Hence, the transplantation of institutions from the colonizer to the colony was much more effective and non-upsetting in island states. On islands democratic values have, thus, penetrated the citizenry to a larger extent than in continental colonies. The fact that the citizens of islands in many cases are descendants of slaves has also been argued to further stimulate such anti-authoritarian tendencies (Hadenius, 1992). Finally, the deep penetration of colonialism is said to have been facilitated by geographically determined borders, which made the borders less contested (Srebrnik, 2004).

Third, the fact that the island borders are given by nature is also a commonly maintained mechanism explaining island states’ outstanding performance in terms of political and social organization. More specifically, the natural barrier formed by the water surrounding islands has been said to reduce governments' investments in security. The geographic features of islands imply both that the incentives for a ruler to expand its territory and the de facto risk of getting invaded or embroiled in warfare are significantly reduced (Congdon-Fors, 2007, 2013). Islands are hence argued to be sheltered from conflict and the resulting lack of incentives to build up a strong military facilitates the decentralization of power conducive to the development of high-quality institutions, accountability, and responsiveness (Clague, Gleason, & Knack, 2001). In addition, because of the small jurisdictions, the cost of internal conflicts is thought to be higher on islands than in continental states, which in turn promotes the development of a basic consensus of values (King, 1993). Island inhabitants simply "must get along with each other" and for that reason develop "sophisticated modes of accommodation" (Lowenthal, 1987, pp. 38-39), or strategies for "managed intimacy" (Bray, 1991, p. 21; see also Srebrnik, 2004).

The *fourth* mechanism is size. Islands tend to be relatively small and the small size of the polity is said to bring a number of advantages. For example, smallness implies that there are more opportunities for interactions between the ruler and the ruled and such accessibility to the political system is generally perceived as encouraging citizen participation. Smallness per definition implies that there are fewer layers of political organization, and this is, in turn, expected to facilitate transparency and open channels of communication, which have positive effects on accountability and responsiveness on the part of governments (Anckar, 1999). The leaders may also more easily acquire information about the preferences and needs of their citizens, leading to greater government efficiency and potentially a higher quality of government (Congdon-Fors, 2007). Anckar (1999) also argues that while small units may be as categorically heterogeneous as larger polities, they tend to be more uniform in terms of attitudes and values. This line of reasoning fleshes out Etro´s (2006) claim that the inhabitants of small countries tend to more easily agree on a higher provision of public goods. In sum, smallness is, according to this logic, expected to foster "highly personalized and transparent societies" (Bray, 1991, pp. 38-39). However, a small geographical area and a small population size not only affect the relationship between the ruler and the ruled, but they also facilitate interaction within the populace. That is, since small-scale social structures tend to be personalistic and informal, interactions on all levels have a comparatively cooperative character.

The *fifth* and final mechanism focuses on aspects interchangeably referred to as remoteness, peripherality, or isolation. Ott (2000) argues that the overall pattern of interactions among island elites is more cooperative, and this behavior tends to be mimicked by the citizenry as a whole. Remoteness, peripherality, and isolation are hence expected to play a unifying role as inhabitants of remote locations face special problems, shared by all members of the community, which are thought to result in a shared frame of reference (cf. Anckar, 1999; Congdon-Fors, 2007). Remoteness and isolation thus facilitate preference homogeneity and cooperation since the links between self-interest and the interests of the nation are more obvious (Anckar & Anckar, 1995). More specifically, the geographic precision of island states facilitates unitarism and forms a shared national identity, which can explain island states' comparative success in terms of political and social development (Baldacchino, 2005).

Given the reviewed literature we identify five features that have been brought forward to explain why island states might perform better than continental states in collective action-related outcomes. In sum, when answering our second research question regarding which are the major factors explaining small islands' relative success in environmental performance, the following five factors will be included in the analysis:

- Homogeneity
- Colonial heritage
- Geographical characteristics
- Size
- Isolation

Island-related Environmental Collective Action: Theoretical Expectations

What bearing do these scholarly findings and arguments have on nations' environmental performance? Partly contrary to popular belief and previous theoretical expectations, the reviewed literature essentially shows that island states have several comparative advantages that may promote cooperation and, ultimately, the achievement of social, political, and economic development. Due to similarities in inducements for collective action between different social goods, it is thus reasonable to assume that (and worthwhile to investigate if) the same kind of logic being accounted for, applies also to environmental goods. Perhaps the rest of the world can learn immensely from how island states perform collective action?

In particular, theories about social, political, and economic development emphasize a number of collective action-related factors and social dilemmas that are equally at the core of theories about environmental goods. For example, it is a well-known fact that sustainable management of natural resources depends fundamentally on the extent to which resource users expect other resource users to act sustainably. Intuitively, it would of course be in each citizen's interest not to overuse natural resources. But as numerous deteriorating resource systems clearly indicate, environmental goods have certain characteristics that make all resource users expect that others are overharvesting the resource, thus engaging in overuse themselves (see Duit, 2011). This situation is similar to the familiar analogy of the tragedy of the commons, also conceptualized as a collective action dilemma, a social trap, or as the prisoner's dilemma (Axelrod, 1984; Bromley, 1992; Rothstein, 2005). In all these conceptualizations, horizontal expectations that other resource users will embark on a non-cooperative path and free ride on conservation efforts make every individual reluctant to participate in conserving the collective good or employing a cooperative strategy themselves. Hence, theory suggests that social capital—the standard measure of people's tendency to cooperate—should be beneficial for nations' environmental performance (Grafton & Knowles, 2004; Duit, Hall, Mikusinski, & Angelstam, 2009). Several of the causal mechanisms analyzed in the literature on the islands' performance have in fact been previously attributed as factors facilitating successful cooperation among individuals in natural resource management. For instance, the argument about *size* (both of the country and of the population) has been brought up when discussing the impact of group size on collective action outcomes in cooperation over common-pool resources. Accordingly, smaller groups will, on average, be more prone to cooperate as this feature facilitates coordination (see Poteete & Ostrom, 2004; Agrawal & Goyal, 2001). Similarly, *heterogeneity* has been shown to be a complex yet important factor for determining the outcomes in cooperation over natural resources (see Erdlenbruch, Tidball, & van Soest 2008; Naidu, 2009). As stated by Grafton and Knowles: "The greater the social divergence the lower is the opportunity for collective action that may help address environmental concerns" (2004, p. 340).

However, the natural resource management literature within social science does not only emphasize the importance of *horizontal* expectations. Recent research holds that in order to fully understand the drivers of unsustainable natural resource exploitation, state capacity—as well as the *vertical* relationship between the government and the resource users—needs to be addressed (Sjöstedt, 2014). That is, institutional scholars have started to pay attention to not only the workings of local-level institutional arrangements and horizontal expectations, but also to how those interact with, and are affected by, the surrounding local and national institutions in which they are embedded or nested (Ostrom, 1990; Firmin-Sellers, 1995; Agrawal & Gibson, 1999). As such, the issue of limited provisions of environmental goods can be considered an interesting exploration of further aspects of the performance of island states relative to continental states. The causal mechanisms reviewed above would certainly suggest an affirmative answer to such a query.

At the same time, however, there are probably reasons to be cautious about the causality and how the various mechanisms actually affect cooperative environmental behavior in the case of island states. From our point of view, one could equally twist the coin and argue that because of a number of other factors, we should rather expect *negative* outcomes when it comes to islands and environmental performance. For example, island states—and especially the small island developing states (SIDS)—are often considered to be more vulnerable to economic, political, or environmental shocks (Briguglio, 1995; Pelling & Uitto, 2001). In terms of the economy, island states are expected to suffer from greater output volatility and greater volatility in terms of trade, which might spur more intense resource exploitation. It has also been pointed out that the lack of diversity in the productive base of island states' economies can be assumed to have negative effects on their resilience to disasters (Pelling & Uitto, 2001). Moreover, from a political point of view, the flipside of the benefits from the personalistic and informal character of political interaction described above is that small polities might also be more vulnerable to nepotism, cronyism, patronage, and political clientelism (Baldacchino, 1997; Ott, 2000; Srebrnik, 2004), which can be expected to have clear-cut negative effects on environmental management. Finally, since islands tend to be located in geographic areas where hurricanes and typhoons are common, they can also be expected to be more vulnerable to environmental shocks in the form of natural disasters.

Bearing these critical reservations in mind, we now continue our exploratory endeavors of empirically investigating whether or not islands outperform continental states when it comes to the environment and if so, what may be the driving forces behind this. In the next section we account for the data and methods that we have used and how our dependent and independent variables are made operational. Thereafter we present our results. In the concluding remarks, we summarize our major findings, critically examine the research approach being chosen and suggest questions for future research.

Method and Data Description

Our empirical strategy consists of two parts. First, we evaluate in which environmental measurements island states fare better than other states. Using bivariate regression analysis on a large number of environmental indicators across countries, we find a number of environmental measurements in which island states on average seem to do better than continental states. Secondly, we then investigate why this is so. We analyze the measurements where islands perform better in order to investigate what factors seem to drive this relationship. We test the possible hypotheses derived from the literature and draw inferences regarding which factors seem to explain the relative success of island states in these environmental measurements.

Dependent Variables

It is inherently difficult to operationalize nations' performance in the provision of "environmental goods" into empirical measures with high content validity. As is known and widely discussed among scholars addressing this concept, it is difficult to capture the environmental performance of states in quantitative measurements (see Bell & Morse, 1999; Parris & Kates, 2003). As stated by Duit and colleagues: "A problem confronting most studies aiming to compare environmental management performance among countries is that of finding valid estimates of environmental quality" (2009, p. 43). However, there are numerous attempts to quantify states' environmental performance. The scholarly community and policy makers have increasingly made environmental indicators available in recent decades, measuring various aspects of national-level environmental performance (for overviews see Smeets & Weterings, 1999; Hammond, Rodenburg, Bryant, & Woodward, 1995). These measurements vary from aggregate indices such as the yearly Environmental Protection Index, where a country receives a score based on outcomes in numerous environmental aspects, to specific data on particular measures such as levels of a certain pollutant. A strategy to analyze nations' environmental performance is hence to study its position in such indices (see Grafton and Knowles, 2004). Yet, when scholars assess countries' environmental performance they often only focus on single environmental indicators (e.g., Cole, 2007; Koyuncu & Yilmaz, 2009). It has been identified that this is a serious threat to the inferences drawn about the various factors affecting the environmental performance of states (see Barrett, Gibson, Hoffman, & McDubbins, 2006).

In order to meet the challenging task of operationalizing the truly multi-faceted notion of environmental goods we adopt a rather ambitious approach. To capture this concept in its widest possible sense, we use a unique data set where we have compiled all environmental indicators available for large cross-country comparisons deemed to stem from reliable sources and measuring a relevant aspect of environmental performance. More specifically, this data set consists of 107 variables available across countries. We collected the measurements according to three criteria: 1) if they measure aspects of states' environmental performance, 2) if they are deemed as credible, and 3) if they are available across a large sample of countries for a recent year. Specifically, our criteria included only those measurements which had data for at least 10 islands states in order to get a comparable sample. With these principles in mind we collected the final number of measurements from various sources. We utilized existing sources of information where a large number of measurements are available to the public, for example the United Nations' GEO online database and the Quality of Government data set. Yet, we have found that no existing overview of environmental measurements capture the full availability of indicators for states' environmental performance. The data set we compiled is thus the, to our knowledge, most comprehensive overview of environmental indicators across a global sample of countries.

The result is a data set of 107 measurements where the unit of analysis is countries. For an overview of this data refer to Appendix B. When choosing environmental indicators, our aim was to capture the full variance of the measurements addressing the fact that environmental goods is a diverse concept where internal components will differ according to how they are affected by various factors (Barrett et al., 2006). In order to clearly see which environmental factors drive the result, we used the composite parts of environmental indices, choosing indicators as specific as possible. For example, the Environmental Vulnerability Index is an aggregate score but consists of a number of subcomponents. We therefore only study the composite parts of this index and not the built-up measurement in itself. Following the same logic, we avoided compiling different measurements into a larger index.

When collecting the data, we found indicators from different sources essentially quantifying the same concept. For example, several sources estimate national carbon dioxide emissions. In these instances we have selected the measurement covering the largest number of states. For a full list of environmental indicators being used as dependent variables in the empirical analysis in the first part of our analysis, see Appendix B.

Independent Variables

In the second stage of our analysis we focus on the indices in which island states on average seem to do better than continental states and set out to test the explanatory power of the causal mechanisms discussed in previous literature on the performance of small states. These factors are derived from the theoretical literature discussed above and are operationalized according to the following logic: *Population size* is a measure of number of people (thousands) per each nation. The figures refer to the year 2005 and are taken from the United Nations Population Division.[3] *Isolation* is the distance (kilometers) from the nearest continent. If a country is within a continent it is assigned the value zero. The figures are taken from the Environmental Vulnerability Index 2004.[4] *Homogeneity* is measured with the ethnic fractionalization variable. This measurement reflects the probability that two randomly selected people from a given country will not belong to the same linguistic or religious group. The high-

[3] The data is available at http://sedac.ciesin.columbia.edu/data/collection/cesic.
[4] The data is available at http://sedac.ciesin.columbia.edu/data/collection/cesic.

er the number in this measurement, the more fractionalized society is. The indicator is developed by Alesina, and colleagues (2003).[5] *Total area* is a variable expressed in squared kilometers and refers to a nation's total area. The data are obtained from the CIA World Factbook.[6] *Conflicts* are measured with a variable expressed in the average number of conflict years per decade within the country over the past 50 years. The data are taken from the International Disaster Database.[7] *Colonial heritage* is a dummy variable, assigning the value 1 if the country has ever been a British colony. This data is taken from Teorell and Hadenius (2005)[8]. *Island* is a dummy variable measuring if the country is an island (assigned 1).

Methodology

In the first part of the analysis the aim is to assess if island states perform better than continental states in our 107 environmental measurements. To fulfill this purpose we run separate bivariate OLS regressions for all the environmental indicators and use the island dummy as an independent variable to determine statistically whether island status is associated with better performance in the chosen measurements.[9] As we will discuss below, this renders a sample of 20 environmental indicators where we find positive effects from our island dummy variable.

In the second part of the analysis we focus on these 20 environmental indicators in which island status has a positive effect. The aim of the analysis is to determine which of the six independent variables discussed above—that is, population size, ethnic fractionalization, colonial heritage, conflicts, size, and isolation—can explain the islands' better performance in these 20 different measurements. In order to test what drives such results, we create interaction terms between an island dummy variable and each of the six explanatory factors. The reason for doing so is to create an estimate for the coefficients of each variable that is contingent on whether a country is an island or not. For instance, the

[5] The data is available at http://www.anderson.ucla.edu/faculty_pages/romain.wacziarg/downloads/fractionalization.xls.
[6] Data from Sudan is taken from before the partition. *See* https://www.cia.gov/library/publications/the-world-factbook/.
[7] The data is available at http://sedac.ciesin.columbia.edu/data/collection/cesic.
[8] Available through Quality of Government data set (Teorell, Samanni, Holmberg, & Rothstein, 2011)
[9] Regarding our numerous dependent variables, we took effort to investigate their individual dispersion. Six of our dependent variables (acidification exceedance from anthropogenic sulfur deposition, fish catch, generation of hazardous waste, and water footprint of production for blue water, green water, and return flows) were logarithmically transformed for a better model fit. When heteroskedasticity of errors was detected through Breusch-Pagan/Cook-Weisberg heteroskedasticity test, robust standard errors were added to correct for it.

interaction effect between the size of a country and the island dummy variable allows us to investigate if the positive effects on an environmental indicator from being an island stem from its size. We then use OLS regression analysis to examine the explanatory power of these interactions for each of the 20 dependent variables where islands perform better.[10]

Results

The environmental performance of islands states

In the first step of our analysis we investigate in which of the 107 environmental indicators that island states on average seem to do better in than continental states. Using OLS regression analysis we find that there is a large variance between the performances of island states across the different environmental indicators. On some indices the dummy variable measure of island status has a significant and positive impact. However, for the majority of the indices analyzed we find no significant effect from island status. Moreover, we even find a significantly negative effect from being an island on a number of the environmental indicators. The environmental indices in which islands on average perform better than continental states are listed in Table 2 in Table 5. The environmental indices where island status have a negative effect are reported in Table 3, while Table 4 reports the indices where we find no significant effect from the dummy measure of being an island state.

TABLE 2. THE ENVIRONMENTAL INDICES WHERE ISLAND STATUS HAVE A SIGNIFICANT POSITIVE EFFECT

#	Name of the variable
	Water and Sanitation
1	Percent of people with access to improved water supply
2	Percent of people with access to adequate sanitation
3	Change in water quantity
4	Water consumption (proximity to target)
5	Nitrogen loading (proximity to target)
	Air and emissions
6	Urban particulates (proximity to target)
7	Acidification exceedance from anthropogenic sulfur deposition
8	Carbon dioxide per GDP (proximity to target)
	Protected areas
9	Percentage of country's territory in threatened ecoregions
	Forest and vegetation

[10] Here we checked for a normal distribution of residuals and made sure, where needed, to transform the highly skewed independent variables—area and population size. The analysis of both raw data and the data corrected for normal distribution was performed and the model with normal distribution of residuals and better explanatory power was chosen.

10	Forest cover change
11	Timber harvest rate (proximity to target)
Fisheries and the marine environment	
12	Coastal shelf fishing pressure
13	Overfishing (proximity to target)
14	Fish catch in marine and inland waters
15	Clean waters
Ecological footprint	
16	Water footprint of consumption - Internal
17	Water footprint of production - Green water
18	Water footprint of production - Blue water
19	Water footprint of production - Return flows
Waste	
20	Generation of hazardous waste

TABLE 3. THE ENVIRONMENTAL INDICES WHERE ISLAND STATUS HAVE A SIGNIFICANT NEGATIVE EFFECT

Air	
21	Sulfur dioxide emissions per capita
22	Carbon dioxide per capita
23	Anthropogenic sulfur dioxide emissions per populated land area
24	Anthropogenic volatile organic compound emissions per populated land area
25	Use of ozone depleting substances per land area
Biodiversity	
26	Endangered species
27	Threatened native bird species as a percentage of total native species
28	Threatened native species as a percentage of total native mammal species
29	Threatened native reptiles as a percentage of total native reptile species
30	Threatened amphibian species as a percentage of known amphibian species in each country
Protected areas	
31	Marine protection
32	Ecoregion protection
33	Critical habitat protection
Forest	
34	Percentage of total forest area that is certified for sustainable management
Fisheries and the marine environment	
35	Sense of place - Lasting special places
36	Tons of fish catch per ton of fish catching capacity
37	Food provision - Mariculture
38	Natural products
Energy	
39	Renewable energy (proximity to target)
Agriculture, pesticides, fertilizers	
40	Fertilizer consumption per hectare of arable land
41	Pesticide consumption per hectare of arable land
42	Intensive farming
Land use	
43	Fragmented habitats
44	Percentage of land that is built upon
Water footprint	
45	Water footprint of consumption - External
Environmental regulation	
46	Number of environmental agreements
47	Participation in international environmental agreements
48	Number of memberships in environmental intergovernmental organizations
49	Participation in the Responsible Care Program of the Chemical Manufacturer's Association
Anthropogenic pressure	
50	Percentage of total land area (including inland waters) having very low anthropogenic impact
51	Percentage of total land area (including inland waters) having very high anthropogenic impact

TABLE 4. THE ENVIRONMENTAL INDICES WHERE ISLAND STATUS DID NOT HAVE ANY SIGNIFICANT EFFECT

	Water and sanitation
52	Freshwater availability per capita
53	Percentage of country under severe water stress
54	Water withdrawal score
	Air
55	Sulfur dioxide emissions per GDP
56	Carbon dioxide emissions per electricity generation
57	Import of polluting goods and raw materials as percentage of total imports of goods and services
58	Use of ozone depleting substances per capita
59	Regional ozone (proximity to target)
60	Anthropogenic NOx emissions per populated land area
	Biodiversity
61	Threatened flowering plants species as a percentage of all wild species
62	Threatened gymnosperms as a percentage of total native species of gymnosperms
63	Threatened native species of pteridophytes as a percentage of total native species
64	National biodiversity index
65	Extinctions
	Protected areas
66	Terrestrial protected areas
67	Wilderness protection (proximity to target)
	Forest and vegetation
68	Growing stock change
69	Forest loss
70	Natural vegetation cover remaining
71	Loss of natural vegetation cover
	Fisheries and the marine environment
72	Fishing stocks overexploited
73	Fish catching capacity per fish producing area score
74	Fishing effort
75	Percentage of fish species overexploited and depleted
76	Fisheries protection score
77	Ecosystem imbalance
78	Food provision - Wild caught fisheries
79	Sense of place - Iconic species
80	Biodiversity - Habitats
81	Biodiversity - Species
82	Carbon storage
83	Coastal protection
	Energy
84	Energy efficiency (proximity to target)
85	Energy materials score
	Agriculture, pesticides, fertilizers
86	Salinized area due to irrigation as percentage of total arable land
	Land use
87	Percentage of cultivated and modified land area with light soil degradation
88	Percentage of cultivated and modified land area with moderate soil degradation
89	Percentage of cultivated and modified land area with extreme soil degradation
90	Degradation
91	Percentage of modified land
92	Percentage of land cultivated
93	Percentage of cultivated and modified land area with strong soil degradation
94	Desertification sub-index
	Ecofootprint
95	Water footprint of consumption - total
96	Water footprint of production - stress on blue water resources (%)
97	Ecological footprint per capita
	Anthropogenic pressure
98	Spills
99	Mining
	Environmental regulation
100	World Economic Forum Survey on environmental governance
101	Local Agenda 21 initiatives per million people
102	IUCN member organizations per million population
103	Number of ISO 14001 certified companies per billion dollars GDP (PPP)
104	Pesticide regulation
105	Percentage of variables missing from the CGSDI "Rio to Joburg Dashboard".
	Other
106	World Economic Forum Survey on private sector environmental innovation
107	Contribution to international and bilateral funding of environmental projects and development aid

More specifically, analyzing the results reported in Tables 2 to 4, we find that being an island has a significantly positive impact in only 20 of our 107 environmental measurements. Island states seem to perform worse than continental states on average in 31 measurements in the analysis. However, in a majority of the indicators, 56 out of the total 107, island status does not have a statistically significant impact. Hence, this is the first important finding of this paper: the positive effect from being an island on the performance in the environmental measurements is far from a general one. In fact, in most of the measurements we find no such effect.

Judging from the first analysis, are there trends that lead us to infer that islands tend to perform better in a *certain type* of environmental outcomes? Overall, the results are diverse and the patterns are far from clear-cut. However, we find some trends in the bivariate results that might be worth exploring further. Judging from Table 2, it seems that there is a positive effect from being an island on several indices related to water quality. Inversely, islands seem to do worse in other groups of environmental measurements, for example, indicators related to protected areas and biodiversity. Also, on measurements gauging environmental regulations, island status seems to actually have a negative effect.

It should be noted that a focus on the exact number of measurements could be misleading here. In our analysis some environmental features are only measured by few indicators, such as greenhouse gas emissions, measured by the national levels of carbon dioxide emissions; other aspects of environmental performance are estimated by several indicators in our analysis. For instance, the detailed availability of data on biodiversity renders a more nuanced analysis of such indicators as threatened mammal species, bird species, amphibian species, etc. Hence, the large number of measurements for a certain concept might skew the general results if only analyzed in numerical terms. As mentioned before, we were careful not to include indicators that measure identical concepts. However, this concern begs us to be cautious when making an inference of the general pattern found in this analysis. But as a general pattern, the dummy measure of being an island state still has a significantly negative effect or no effect at all on far more indices than it has a significantly positive effect.

The Impact from our Independent Variables on the Indices Where Islands Perform Better

In the second part of our empirical analysis we analyze the 20 environmental indicators in which island status has a significantly positive effect (see Table 2). The aim is to assess to what extent the five factors (homogeneity, colonial heritage, geographical characteristics, size, and isolation), suggested in the literature as beneficial characteristics of islands (measured in the six indicators discussed above), can explain their good performance in these environmental indices. Hence, we are not interested in the impact from these characteristics on the indices in general, but specifically if they matter for the performance of island states. As mentioned, we therefore model interaction terms between the island dummy variable and each of the six independent indicators to see what features seem to drive the results from the positive effect of being an island on the 20 environmental indices where islands perform better.

TABLE 5. THE EFFECT OF ISLAND-SPECIFIC FACTORS ON SELECTED ENVIRONMENTAL OUTCOMES, OLS REGRESSION ANALYSIS

	Access to water	**Access to sanitation**	**Water quality**	**Water consumption**	**Nitrogen loading**	**Urban particulates**	**Acidification**	**CO2 per GDP**	**Threatened ecoregions**	**Forest cover change**	**Timber harvest rate**
Interpretation of the DV, direct: an increase is interpreted as "good" for the environment, inverse: an increase is interpreted as "bad" for the environment.	*direct*	*direct*	*direct*	*direct*	*direct*	*direct*	*inverse*	*direct*	*inverse*	*direct*	*direct*
Interaction, islands-Isolation	0.040	0.029	-0.023	-0.605	-0.001	-0.013	0.001	-1.665	-0.012	0.035	0.023
	(0.022)	(0.026)	(0.019)	(4.025)	(0.007)	(0.007)	(0.001)	(2.195)	(0.027)	(0.028)	(0.033)
Interaction, islands-Area	0.787	3.390	3.680	244.400	6.308**	0.000	0.216	552.300	9.963*	2.399	-2.200
	(4.056)	(5.735)	(3.409)	(710.000)	(2.333)	(0.000)	(0.127)	(313.100)	(4.851)	(5.410)	(2.072)
Interaction, islands-Ethnic fract.	0.408	-10.110	-37.820	-4.833	3.243	6.554	0.726	-5.618*	-18.220	24.300	-9.014
	(25.450)	(26.420)	(24.030)	(4.090)	(8.187)	(16.090)	(0.935)	(2.371)	(30.740)	(32.630)	(9.596)
Interaction, islands-Population	1.571	-0.340	-2.394	-90.330	-2.907	0.000	-0.270	-30.490	-6.726	-3.450	2.460
	(5.246)	(5.926)	(3.082)	(850.400)	(2.834)	(0.000)	(0.229)	(397.500)	(6.404)	(6.736)	(2.338)
Interaction, islands-Conflicts	0.004	0.110	-0.103	-8.015	0.219	-0.322	0.010	-107.300	3.011	0.472	0.252
	(1.783)	(1.133)	(0.875)	(246.000)	(0.567)	(0.953)	(0.063)	(103.700)	(2.218)	(2.293)	(0.672)
Interaction, islands-British	4.797	31.820*	6.368	1.823	-3.657	0.426	0.496	-156.100	-10.290	6.203	2.065
	(12.220)	(14.130)	(13.540)	(2.317)	(4.492)	(8.133)	(0.350)	(1.125)	(14.860)	(16.170)	(6.753)
Island dummy	-27.090	-38.710	-8.811	-121.100	-42.580**	9.884	-1.536	-2.383	-50.040	-8.053	13.050
	(32.820)	(42.450)	(28.520)	(6.916)	(16.050)	(7.653)	(1.032)	(3.006)	(36.290)	(41.150)	(14.810)
Isolation	-0.045*	-0.040	0.033	1.440	0.002	0.019**	-0.001	1.785	0.003	-0.032	-0.022
	(0.021)	(0.025)	(0.018)	(3.813)	(0.007)	(0.007)	(0.001)	(2.178)	(0.026)	(0.027)	(0.033)
Area	-5.768**	-4.242	2.543	-442.900	-6.487**	0.000	-0.298**	-233.700	-15.850***	-4.065	1.789
	(1.970)	(2.495)	(1.357)	(254.000)	(2.331)	(0.000)	(0.104)	(230.200)	(2.175)	(2.507)	(1.977)
Ethnic fractionalization	-47.910***	-49.970***	17.460*	1.657	-3.005	-4.492	-1.824**	116.000	5.064	-33.800**	8.227
	(10.020)	(11.770)	(6.987)	(1.278)	(8.102)	(9.487)	(0.632)	(1.042)	(12.350)	(12.950)	(9.295)
Population	4.040	2.514	-7.150***	-205.700	2.933	0.000	0.574***	53.900	17.16***	1.717	-2.575
	(2.355)	(2.646)	(1.615)	(299.800)	(2.827)	(0.000)	(0.135)	(271.100)	(2.886)	(3.024)	(2.290)
Probability of conflict	-1.903***	-1.905**	0.176	7.626	-0.250	-1.307*	-0.098**	11.900	-0.692	-0.269	-0.894
	(0.584)	(0.604	(0.409)	(73.880)	(0.563)	(0.577)	(0.037)	(64.360)	(0.727)	(0.752)	(0.517)
British colony	-2.318	-8.621	-3.643	-1.160	2.642	-8.970	-0.734**	197.600	-17.67*	-8.049	-6.540
	(5.617)	(6.119)	(3.917)	(721.700)	(4.445)	(5.853)	(0.282)	(529.600)	(6.988)	(7.299)	(5.869)
Constant	117.100***	104.9***	62.25***	13.328***	143.400***	71.760***	-0.743	7.904***	91.570***	120.100***	93.050***
	(17.720)	(24.140)	(13.380)	(2.356)	(16.020)	(4.564)	(0.879)	(1.978)	(18.260)	(21.650)	(13.800)
Observations	175	173	173	159	159	165	184	169	183	178	157
R-squared	0.349	0.336	0.351	0.136	0.137	0.178	0.308	0.077	0.377	0.158	0.100
Number of islands	30	29	28	15	15	23	35	30	34	32	16
Robust standard errors	no	yes	yes	no	yes	yes	yes	yes	no	no	yes
Population and area logged	yes	yes	yes	yes	yes	no	yes	yes	yes	yes	yes

*Notes: Standard errors in parentheses, ***=p<0.001, **=p<0.01, *=p<0.05. Population and area are logged where they improve fit of the model. Robust standard errors are included in the models where heteroskedastisity is detected.*

TABLE 5. CONT.

	Fishing pressure	Overfishing	Fish catch	Clean waters	Water footprint of consumption internal	Water footprint of production - Green water	Water footprint of production - Blue water	Water footprint of production - Return flows	Generation of hazardous waste
Interpretation of the DV, direct: an increase is interpreted as "good" for the environment, inverse: an increase is interpreted as "bad" for the environment.	*Direct*	*Direct*	*Inverse*	*Direct*	*Inverse*	*Inverse*	*Inverse*	*Inverse*	*Inverse*
Interaction, islands-Isolation	-0.027**	-0.025	-0.001	0.018	0.205	0.000	0.001	0.001	-0.003
	(0.009)	(0.017)	(0.001)	(0.010)	(0.552)	(0.002)	(0.003)	(0.002)	(0.007)
Interaction, islands-Area	0.000	0.000	0.288	-2.930*	0.000	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.221)	(1.207)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)
Interaction, islands-Ethnic fract.	-3.492	2.847	-0.970	19.240**	235.000	2.499	3.578	4.893	10.730*
	(25.070)	(22.970)	(0.867)	(7.063)	(641.500)	(1.903)	(2.921)	(2.628)	(4.191)
Interaction, islands-Population	0.000	0.000	-0.251	3.187*	-0.001	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.244)	(1.410)	(0.005)	(0.000)	(0.000)	(0.000)	(0.000)
Interaction, islands-Conflicts	0.001	-1.048	-0.010	0.312	44.160	0.145	-0.058	-0.025	0.297
	(1.075)	(1.406)	(0.041)	(0.380)	(31.700)	(0.094)	(0.144)	(0.130)	(0.310)
Interaction, islands-British	-3.742	8.218	0.148	-4.392	-171.300	-0.110	0.009	0.449	-4.044
	(11.020)	(10.430)	(0.726)	(3.681)	(321.900)	(0.955)	(1.466)	(1.319)	(3.110)
Island dummy	35.170*	16.740	-0.462	0.399	-329.200	-2.523**	-3.759**	-4.339***	-2.830
	(16.600)	(11.560)	(1.960)	(10.920)	(297.800)	(0.884)	(1.357)	(1.220)	(3.559)
Isolation	0.036***	0.031	0.000	-0.017	-0.066	0.000	-0.002	-0.002	-0.001
	(0.008)	(0.017)	(0.000)	(0.010)	(0.523)	(0.002)	(0.002)	(0.002)	(0.007)
Area	0.000	0.000	0.128	3.574***	0.000*	0.000***	0.000*	0.000**	0.000
	(0.000)	(0.000)	(0.072)	(1.014)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Ethnic fractionalization	9.403	23.210**	-0.146	-18.240***	499.900**	0.207	-1.749*	-2.261***	-3.380*
	(6.372)	(8.734)	(0.351)	(5.515)	(161.600)	(0.478)	(0.734)	(0.660)	(1.492)
Population	-0.000***	-0.000*	0.062	-4.585***	0.000	0.000***	0.000**	0.000**	0.000
	(0.000)	(0.000)	(0.097)	(1.016)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Conflict	-0.076	-0.418	-0.007	-0.278	-0.799	0.068*	0.111**	0.076*	-0.232*
	(0.321)	(0.496)	(0.020)	(0.301)	(8.917)	(0.027)	(0.041)	(0.037)	(0.089)
British colony	-2.828	-6.114	0.141	4.771	-29.110	-0.310	0.112	-0.209	-0.843
	(3.830)	(5.515)	(0.246)	(3.019)	(97.870)	(0.290)	(0.446)	(0.401)	(0.919)
Constant	-0.0269**	-0.025	-0.001	0.018	0.205	0.000	0.001	0.001	-0.003
	(0.009)	(0.017)	(0.001)	(0.010)	(0.552)	(0.002)	(0.003)	(0.002)	(0.007)
Observations	144	140	151	143	136	136	136	136	89
R-squared	0.464	0.325	0.180	0.320	0.187	0.456	0.382	0.429	0.434
Number of islands	35	34	29	35	14	14	14	14	14
Robust standard errors	yes	no	yes	yes	no	no	no	no	no
Population and area logged	no	no	yes	yes	no	no	no	no	no

*Notes: Standard errors in parentheses, ***=p<0.001, **=p<0.01, *=p<0.05. Population and area are logged where they improve model fit. Robust standard errors are included in the models where heteroskedastisity is detected.*

The results from the multivariate regression analysis, reported in Table 5, elucidate that the six variables we use as independent variables have little explanatory power for why island states perform better in these indices. When focusing on the interaction terms with the island dummy it is evident that there are very few instances where we find significant effects. In fact, we find that in only nine of our dependent variables the variance can to some extent be explained by the interaction terms. Specifically, islands situated closer to the continent seem to exert less damaging pressure on fish stocks on average. Smaller islands tend to have a lower percentage of their area situated in threatened ecoregions and have cleaner coastal waters. However, at the same time they tend to have higher nitrogen loading both in the water and atmosphere. However, on the contrary, islands with larger populations tend to have cleaner coastal waters on average. Ethnic heterogeneity of populations on islands tends to result in lower carbon dioxide emissions per capita and less generation of hazardous waste, while fractionalized island states on average tend to have worse coastal water quality. Finally, island states with a heritage of British colonialism tend to be associated with better access to sanitation. In other words, the six independent factors we study seldom seem to be robust predictors of the variance in the states' performance in these environmental indices and these factors are not especially good at predicting islands' environmental performance in particular.

Summing Up The Results

It should be stated that there are numerous predictors for how states perform in environmental measurements. We have, in the analysis performed in this paper, focused explicitly on the underlying five factors said to make island states perform better in numerous institutional aspects (e.g., democracy and economic development). As such, we have not controlled statistically for potential intermediary variables that might explain states' general performance in the environmental measurements. As stated, this is due to the fact that our aim has not been to explain fully how states perform in these indices, but explicitly to test: (1) if island status has an impact on environmental performance; and (2) if the variables identified as driving the islands' positive performance in other aspects are also important when analyzing their provision of environmental goods.

It is likely that an analysis of over a hundred dependent variables comes with a cost of nuances and specificity. This article has approached the topic of island states' environmental performance in the broadest sense possible and, hence, might have lost some fine-tuned findings of certain measurements if we would have, for instance, only studied one single environmental indicator. As the questions for research in this paper are fairly unexplored we urge other scholars to continue this discussion and perhaps complement this approach with a more in-depth examination. There is a need for a careful analysis of specific policy areas; for instance, why are island states possibly outperforming continental states in water-related indices? Also historical analysis can be performed in small-N studies investigating why certain island states might differ in their environmental performance in comparison to continental states. Future research could also take into account potentially omitted variables from the analysis performed in this paper. For instance, the relationship between island states and their environmental performance and economic development deserves more attention in future research.

Concluding Remarks

There is a large body of literature discussing why islands seem to have better governance and economic development than continental states, tracing this to certain features of islands' composition and history. Building on this literature and claiming that countries with better institutional performance provide social goods more efficiently, we introduce a seldom investigated question: do islands also perform better in terms of environmental goods, and if so, why? Using a unique data set of 107 environmental indicators available across countries, we perform the first empirical test of this kind. It seems that the results are ambiguous. Islands seem to perform better in some measurements and worse or with no difference from mainland states in others. Our findings do, however, suggest some interesting trends. For instance, there is a positive effect from being an island on indicators related to water quality, but a negative one on indicators related to environmental regulations and also numerous measures of protected areas and biodiversity. Hence, it seems that island states are not better in environmental performance than continental states in general.

We also analyze the environmental measurements where the island status of a state has a positive effect and we draw inferences on which factors seem to be driving the results. Here we find no unified pattern. For some indices, the factors are related to internal composition of islands, such as their homogeneity. On other measurements, the observed effects seem to stem from geographical factors of territory size, isolation, or their colonial history. For example, smaller islands tend to have cleaner coastal waters; ethnic homogeneity seems to explain country's performance in carbon dioxide emissions and the generation of waste, while former British colonies seem to have better access to sanitation.

The main contribution of our paper is the detailed comparative analysis of the provisioning of environmental goods provision by islands and continental states. Addressing the problem of measuring environmental performance, we have adopted a broad approach, where we analyze over a hundred variables related to environmental outcomes. Future research would benefit of addressing not only the underlying features of islands states—that is, the factors we focus on in this paper—but the effect from the numerous possible intermediate factors (such as democracy, economic development, and the quality of government institutions) that might determine states' environmental performance. We urge scholars to continue this endeavor by the use of different methods and approaches. Further research is also required in order to disentangle the issue of why islands perform better than continental states in respect to some indicators, while show worse outcomes in others.

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APPENDIX A. The list of independent island states used in the analysis:

1. Antigua and Barbuda
2. Bahamas
3. Bahrain
4. Barbados
5. Solomon Islands
6. Cape Verde
7. Sri Lanka
8. Comoros
9. Cuba
10. Cyprus
11. Dominica
12. Fiji
13. Kiribati
14. Grenada
15. Haiti
16. Iceland
17. Jamaica
18. Japan
19. Madagascar
20. Maldives
21. Malta
22. Mauritius
23. Nauru
24. Vanuatu
25. New Zealand
26. Micronesia
27. Marshall Islands
28. Palau
29. The Philippines
30. Saint Kitts and Nevis
31. Saint Lucia
32. Saint Vincent and the Grenadines
33. Sao Tome and Principe
34. Seychelles
35. Singapore
36. Tonga
37. Trinidad and Tobago
38. Tuvalu
39. Samoa

Island-colony, included in the analysis:

40. Taiwan (China)

APPENDIX B. The list of environmental indicators used as dependent variables

#	Name of the variable	Source of data	Original source	Reference year	N	N of island states	Interpretation	Explanation
	Water and Sanitation							
1	Access to drinking water (proximity to target)	EPI 2012	WHO/UNICEF	1990-2005, 2008	196	35	direct	percentage of a country's population that has access to an improved source of drinking water
2	Access to sanitation (proximity to target)	EPI 2012	WHO/UNICEF	1990-2005, 2008	192	33	direct	percentage of people with access to adequate sanitation facilities in relation to the total population
3	Change in water quantity (proximity to target)	EPI 2012	P. Döll, K. Fiedler, and J. Zhang. Global-scale analysis of river flow alterations due to water withdrawals and reservoirs, Hydrol. Earth Syst. Sci., 13	2005	202	32	direct	reduction of mean annual river flow from "natural" state resulting from water withdrawals and reservoirs
4	Water consumption (proximity to target)	EPI2006	University of New Hampshire, Water Systems Analysis Group	mean annual 1950-1995	171	16	direct	percentage, human water demand
5	Freshwater availability per capita	ESI 2005	Center for Environmental System Research, Kassel University	1961-1995 (long-term average)	150	10	direct	meters cubed/person; the sum of internal renewable water per capita (average annual surface runoff and groundwater recharge generated from endogenous precipitation, taking into account evaporation from lakes and wetlands) and per capita water inflow from other countries
6	Percentage of country under severe water stress	ESI 2005	Center for Environmental Systems Research, University of Kassel	1961-1995 (long-term average)	150	10	inverse	percentage of national territory in which water consumption exceeds 40 percent of available water
7	Water withdrawal score	Wellbeing index	FAO	2001	165	20	direct	annual withdrawals of ground and surface water for domestic, agricultural, and industrial uses, in cubic kilometers per year
8	Nitrogen loading (proximity to target)	EPI2006	University of New Hampshire, Water Systems Analysis Group	mean annual 1950-1995	172	16	direct	milligrams/liter; accounts for: atmospheric nitrogen deposition, nitrogen fixation, nitrogenous fertilizer loads, livestock nitrogen loading; and human nitrogen loading
	Air and emissions							
9	Sulfur dioxide emissions per capita (proximity to target)	EPI 2012	Smith et al. (2011). Anthropogenic sulfur dioxide emissions: 1850–2005, Atmos. Chem. Phys., WDI, CIA World Factbook	1850-2005	138	13	direct	Kilograms of sulfur dioxide /person
10	Sulfur dioxide emissions per GDP (proximity to target)	EPI 2012	Smith et al. (2011). Anthropogenic sulfur dioxide emissions: 1850–2005, Atmos. Chem. Phys., WDI, CIESIN	1850-2005	138	13	direct	grams of sulfur dioxide per US dollar PPP (in 2005 constant US dollars)
11	Carbon dioxide per capita (proximity to target)	EPI 2012	International Energy Agency	1960-2009	137	13	direct	kilograms of carbon dioxide per person
12	Carbon dioxide per GDP (proximity to target)	EPI2006	Carbon Dioxide Information Analysis	2000	181	34	direct	tons of carbon dioxide/ US dollar GDP PPP, in 2000 US dollar
13	CO2 emissions per electricity generation (proximity to target)	EPI 2012	International Energy Agency	1960-2009	137	13	direct	grams of CO2 per kWh
14	Urban Particulates (proximity to target)	EPI2006	Global Model of Ambient Particulates (GMAPS), World Bank	1999, 2000	180	27	direct	µg/m 3; only cities larger than 100,000 population and national capitals were considered, with a population weighted PM10 concentration to account for exposure
15	Anthropogenic NOx emissions per populated land area	ESI 2005	UNFCCC, Greenhouse gas (GHG) emissions database, etc.	1990-2003	158	19	inverse	metric tons NOx emissions per populated land area
16	Anthropogenic sulfur dioxide emissions per populated land area	ESI 2005	UNFCCC, Greenhouse gas (GHG) emissions database, etc.	1990-2003	153	17	inverse	metric tons sulfur dioxide per populated land area
17	Anthropogenic volatile organic compound emissions per populated land area	ESI 2005	UNFCCC, Greenhouse gas (GHG) emissions database, etc.	1990-2003	159	20	inverse	metric tons of non-methane volatile organic compounds per populated land area
18	Acidification exceedance from anthropogenic	ESI 2005	Stockholm Environment Institute at York	1990	236	40	inverse	percentage of total land area at risk of acidification exceedance

#	Name of the variable	Source of data	Original source	Reference year	N	N of island states	Interpretation	Explanation
	sulfur deposition							
19	Import of polluting goods and raw materials as a percentage of total imports of goods and services	ESI 2005	COMTRADE	2002	114	14	inverse	import of polluting goods and raw materials as a percentage of total imports of goods and services
20	Use of ozone depleting substances per land area	Wellbeing index	Ozone Secretariat, United Nations Environment Programme. 1999. Production and consumption of ozone depleting substances 1986-1998. Ozone Secretariat, UNEP, Nairobi	1995	154	27	inverse	the use of ozone depleting substances per hectare of total (land and inland waters) area in grams of ozone depleting potential (g odp/ha)
21	Use of ozone depleting substances per capita	Wellbeing index	Ozone Secretariat, UNEP. 1999. Production and consumption of ozone depleting substances 1986-1998	1995	154	27	inverse	use of ozone depleting substances per person in grams of ozone depleting potential (g odp/capita)
22	Regional ozone (proximity to target)	EPI2006	MOZART-data, dev. at NCAR processed at Princeton University	1990-2004	218	39	direct	parts per billion, ozone concentration; 10 highest concentrations from 1990-2004 years
	Biodiversity							
23	Threatened native bird species as a percentage of total native species	Wellbeing index	IUCN Species Survival Commission	1995	168	32	inverse	percentage
24	Threatened native species as a percentage of total native mammal species	Wellbeing index	IUCN Species Survival Commission	1995	176	31	inverse	percentage
25	Threatened native reptiles as a percentage of total native reptile species	Wellbeing index	IUCN Species Survival Commission	1995	139	31	inverse	percentage
26	Threatened amphibian species as a percentage of known amphibian species in each country	ESI 2005	IUCN-The World Conservation Union Red List of Threatened Species	2004	191	27	inverse	percentage
27	Threatened flowering plants species as a percentage of all wild species	Wellbeing index	IUCN Species Survival Commission	1995	142	30	inverse	percentage
28	Threatened gymnosperms as a percentage of total native species of gymnosperms	Wellbeing index	IUCN Species Survival Commission	1995	81	18	inverse	percentage
29	Threatened native species of pteridophytes as a percentage of total native species	Wellbeing index	IUCN Species Survival Commission	1995	69	15	inverse	percentage
30	Endangered species	EVI2004	Needed Source?	2000	230	39	inverse	number of endangered and vulnerable species per 1000 square kilometers; focuses on those species that have become endangered or threatened in a country with implied impacts on biodiversity and ecosystem integrity
31	Extinctions	EVI2004	IUCN Red Book 2000	1900-2000	229	39		number of species known to have become extinct since 1900 per 1000 square kilometers
32	National Biodiversity Index	ESI 2008	Convention on Biological Diversity, Global Biodiversity Outlook	2001	160	14	direct	score 0-1; assesses a country's species richness by measuring species abundance (includes some adjustment allowing for country size); countries with land area less than 5000 square kilometers are excluded as are overseas territories and dependencies
	Protected areas							
33	Marine protection (proximity to target)	EPI 2012	IUCN and UNEP-WCMC	1990-2010	185	40	direct	percentage of exclusive economic zone area protected
34	Terrestrial protected areas	WB	UNEP-WCMC, WRI	2010	202	34	direct	percentage of total terrestrial area
35	Ecoregion protection	NRMI	CIESIN	2011	233	40	direct	percentage of biome area protected within country's land area; capped at 10% for each biome, consistent with international target, and weighted by share of biome's area in the country land area.

#	Name of the variable	Source of data	Original source	Reference year	N	N of island states	Interpretation	Explanation
36	Percentage of country's territory in threatened ecoregions	ESI 2005	Jonathan M. Hoekstra, Timothy M. Boucher, Taylor H. Ricketts, and Carter Roberts. (2005). Confronting a biome crisis: Global disparities of habitat loss and protection. *Ecology Letters*, 8, pp. 23-29	2004	230	39	inverse	threatend ecoregions are ecoregions with high ratios of habitat conversion to habit protection that are classified as vulnerable, endangered, or critical
37	Critical habitat protection (proximity to target)	EPI 2012	UNEP-World Conservation Monitoring Centre	2011	88	22	direct	percentage of the total Alliance for Zero Extinction site area that is within protected areas
38	Wilderness protection (proximity to target)	EPI2006	World Database on Protected Areas	2000	204	31	direct	percentage of wild areas that are protected; for each biome in a country, the following were calculated: the mean and standard deviation of Human Influence Index values, the sum of the footprint of human habitation (settlements, land use), infrastructural development (transportation and electric grid), and the population density
	Forest and vegetation							
39	Growing stock change (proximity to target)	EPI 2012	FAO	1990, 2000, 2005 and 2010	155	19	direct	the standing tree volume of the forest resources, ratio of period 1 to period 0
40	Forest loss (proximity to target)	EPI 2012	FAO	1990, 2000, 2005 and 2010	189	31	direct	the percentage loss of forest area owing to deforestation from either human or natural causes
41	Forest cover change (proximity to target)	EPI 2012	FAO	1990, 2000, 2005 and 2010	215	37	direct	percentage change in the forest cover from period 0 to period 1
42	Percentage of total forest area that is certified for sustainable management	ESI 2005	The Forest Stewardship Council, WRI	2000, 2004	230	40	direct	percentage of total forest area that is certified for sustainable management by The Forest Stewardship Council or Pan-European Forest Certification Council
43	Natural vegetation cover remaining	EVI2004	WRI, FAO	2000-2001	155	19	direct	percentage of original (and regrowth) vegetation cover remaining
44	Loss of natural vegetation cover	EVI2004	WRI, FAO	2000-2001	155	12	direct	net percentage change in natural vegetation cover over the last five years
45	Timber harvest rate (proximity to target)	EPI2006	FAO	2000 and 2004	168	19	direct	timber harvest rate (percentage)
	Fisheries and the marine environment							
46	Fishing stocks overexploited (proximity to target)	EPI 2012	Sea Around Us Project	1950-2006	181	40	direct	fraction of exclusive economic zone with overexploited and collapsed stocks
47	Coastal shelf fishing pressure (proximity to target)	EPI 2012	Sea Around Us Project	1950-2006	185	40	direct	the catch from trawling and dredging gears divided by the exclusive economic zone area, tons per square kilometer
48	Overfishing (proximity to target)	EPI2006	Environmental Vulnerability Index	1993-1998	172	38	direct	average ratio of productivity to catch for five years 1993-1998
49	Fish catching capacity per fish producing area score	Wellbeing index	FAO, etc.	1995	154	32	direct	the score (0-100) for weight of fish catching capacity per unit of fish producing area
50	Fishing effort	EVI 2004	WRI	1994-1996	97	11	inverse	average annual number of fishers per kilometer of coastline over the last 5 years, captures the risk of damage to fisheries' stocks through overcapacity of human effort
51	Percentage of fish species overexploited and depleted	Wellbeing index	FAO Marine Resources Service	1995	80	14	inverse	overexploited species + depleted species + depleted but recovering species as a percentage of assessed species
52	Fisheries protection score	Wellbeing index	FAO Marine Resources Service	1995	80	14	direct	score (0-100) for overexploited species + depleted species + depleted but recovering as a percentage of assessed species, but the tops were set at five times those for the wild species indicators, since depleted and overexploited species are not necessarily threatened
53	Fish catch in marine and inland waters	Wellbeing index	FAO	1995	157	32	inverse	metric tons of catch
54	Tons of fish catch per ton of fish catching capacity	Wellbeing index	FAO	1995	157	32	direct	the score (0-100) for weight of catch per unit of fish catching capacity
55	Ecosystem imbalance	EVI2004	University of British Columbia, Fisheries	NA	180	39	inverse	+ or - change in trophic level calculated by weighting each

#	Name of the variable	Source of data	Original source	Reference year	N	N of island states	Interpretation	Explanation
			Centre, Lower Mall Research Station					trophic level present in the national catch by the tons reported.; captures the risk of ecosystem stress and loss of diversity/ balance; the greater the downward trend, the more likely that the marine biomass and trophic structures have been damaged
56	Food provision - Wild caught fisheries	OHI 2012	Ocean Health Index	2012	157	39	direct	index, 0-100; reflects the amount of seafood captured in a sustainable way; the more seafood harvested or cultured sustainably, the higher the goal score
57	Food provision - Mariculture	OHI 2012	Ocean Health Index	2012	157	39	direct	index, 0-100; reflects the amount of seafood raised in a sustainable way; the more seafood harvested or cultured sustainably, the higher the goal score
58	Natural products	OHI 2012	Ocean Health Index	2012	157	39	direct	index, 0-100; measures how sustainably people harvest non-food products from the sea
59	Carbon storage	OHI 2012	Ocean Health Index	2012	157	39	direct	index, 0-100; compares the current extent and condition of carbon dioxide storing coastal habitats (mangrove forests, seagrass meadows, and salt marshes) relative to their condition in the early 1980s.
60	Coastal protection	OHI 2012	Ocean Health Index	2012	157	39	direct	index, 0- 100; measures the condition and extent of habitats that protect the coasts against storm waves and flooding; compares the current extent and condition of five key habitats that protect coastlines (mangrove forests, seagrass meadows, salt marshes, tropical coral reefs, and sea ice) from flooding and erosion relative to their condition in the early 1980s.
61	Sense of place - Iconic species	OHI 2012	Ocean Health Index	2012	157	39	direct	index, 0-100; measures the condition of iconic species to indicate some of ocean's intangible benefits
62	Sense of place - Lasting special places	OHI 2012	Ocean Health Index	2012	157	39	direct	index, 0-100; measures the percent of protected coastline to indicate some of ocean's intangible benefits
63	Clean waters	OHI 2012	Ocean Health Index	2012	157	39	direct	index, 0-100; measures contamination of waters by trash, nutrients, pathogens, and chemicals
64	Biodiversity - Habitats	OHI 2012	Ocean Health Index	2012	157	39	direct	index, 0-100; reflects conservation status of marine species
65	Biodiversity - Species	OHI 2012	Ocean Health Index	2012	157	39	direct	index, 0-100; reflects the condition of key habitats that support high numbers of species
	Energy							
66	Energy efficiency (proximity to target)	EPI2006	Energy Information Administration	1994-2003	182	31	direct	percentage of hydroelectric, biomass, geothermal, solar, and wind power production of total energy consumption
67	Renewable energy (proximity to target)	EPI2006	Energy Information Administration	1994-2003	210	36	direct	hydropower and renewable energy production as a percentage of total energy consumption; some countries exceed 100 percent because they are net exporters of renewable energy
68	Energy materials score	Wellbeing index	FAO	2001	180	32	direct	the lower score of two indicators: energy consumption per hectare of total area and energy consumption per person; it is limited to an energy index because of a lack of data on consumption of materials and waste generation.
	Waste							
69	Generation of hazardous waste	ESI 2005	UNEP	1992-2001	91	15	inverse	metric tons of hazardous waste to be managed in the country
	Agriculture, pesticides, fertilizers							
70	Salinized area due to irrigation as a percentage of total arable land	ESI 2005	FAO	Arable land: 2000, Salinized area: MRYA 1990-1999	73	10	inverse	percentage of total salinized arable land from irrigation
71	Fertilizer consumption per hectare of arable land	ESI 2005	World Bank World Development Indicators	MRYA 2001-2003	176	27	inverse	100 grams fertilizer consumption per hectare of arable land
72	Pesticide consumption per hectare of arable land	ESI 2005	FAO	MRYA 1990-2003	127	17	inverse	kilograms of pesticide consumption per hectare of arable land
73	Intensive farming	EVI 2004	FAO	1995-2000	176	32		mean tons of intensively farmed animals produced per year per

#	Name of the variable	Source of data	Original source	Reference year	N	N of island states	Interpretation	Explanation
								square kilometer of land
	Land use							
74	Percentage of modified land	Wellbeing index	WCMC, etc.	mid-1990s	180	32	inverse	percentage
75	Percentage of land cultivated	Wellbeing index	FAO, UNECE & FAO	2001	180	32	inverse	percentage
76	Percentage of land that is built upon	Wellbeing index	WCMC, etc.	mid-1990s	180	32	inverse	percentage
77	Percentage of cultivated and modified land area with light soil degradation	Wellbeing index	UNEP/ISRIC, etc.	1990	167	19	inverse	a percentage of land with somewhat reduced agricultural suitability, where the light degree explains the level of soil degradation affecting an area given the weighted total percentage by the factors given; restoration to full productivity possible by modifying management; original biotic functions still largely intact
78	Percentage of cultivated and modified land area with moderate soil degradation	Wellbeing index	UNEP/ISRIC, etc.	1990	167	19	inverse	percentage of land with greatly reduced agricultural suitability; major improvements required to restore productivity; original biotic functions are partly destroyed
79	Percentage of cultivated and modified land Area with strong soil degradation	Wellbeing index	UNEP/ISRIC, etc.	1990	167	19	inverse	percentage of land that is non-reclaimable at farm level; major engineering works required for restoration; original biotic functions destroyed
80	Percentage of cultivated and modified land area with Extreme soil degradation	Wellbeing index	UNEP/ISRIC, etc.	1990	167	19	inverse	percentage of land that is unreclaimable and beyond restoration; original biotic functions fully destroyed
81	Degradation	EVI2004	FAO	2000	165	12	inverse	percentage of a country's land area considered severely and very severely degraded; reflects the status of loss of ecosystems in a country (land can no longer revert to its natural ecosystem without active and costly rehabilitation by humans to reverse permanent damage, if at all)
82	Desertification sub-index	EVI2004	EVI	2004	234	39		unweighted average of the scores for environmental risk occurrence (dry periods, hot winds, etc.)
83	Fragmented habitats	EVI2004	World Bank World Development Indicators 2001	1990-1999	169	23	inverse	total length of all roads in a country (km)/land area (sq km); cumulative area of all fragments of natural cover greater than 1000 hectares in the country as a percent of total land area; a proxy measure for pressure on ecosystems resulting from fragmentation into discontinuous pieces that also relates to habitat disturbance and degradation; fragmentation is likely to affect biodiversity
	Ecofootprint							
84	Water footprint of consumption - total	WWF 2008	Living planet report, WWF 2008	1997-2001	138	14	inverse	gigameters cubed/year; total amount of water that is used to produce the goods and services consumed by the inhabitants of the nation
85	Water footprint of consumption - internal	WWF 2008	Living planet report, WWF 2008	1997-2001	138	14	inverse	water footprint from domestic supply
86	Water footprint of consumption - external	WWF 2008	Living planet report, WWF 2008	1997-2001	138	14	inverse	water footprint from imported water
87	Water footprint of production - Green water	WWF 2008	Living planet report, WWF 2008	1997-2001	138	14	inverse	volume of rainwater stored in the soil that evaporates from crop fields

#	Name of the variable	Source of data	Original source	Reference year	N	N of island states	Interpretation	Explanation
88	Water footprint of production - Blue water	WWF 2008	Living planet report, WWF 2008	1997-2001	138	14	inverse	volume of freshwater withdrawn from water bodies that is used and not returned
89	Water footprint of production - Return flows	WWF 2008	Living planet report, WWF 2008	1997-2001	138	14	inverse	volume of water polluted as a result of the production process
90	Stress on blue water resources from production	WWF 2008	Living planet report, WWF 2008	1997-2001	138	14	inverse	Ratio of total production water footprint minus the green component to total renewable water resources available in a country.
91	Ecological footprint per capita	ESI 2005	Redefining Progress Ecological Footprint of Nations 2004	MRYA 1999-2000	145	10	inverse	hectares of biologically productive land required per capita
	Anthropogenic pressure							
92	Percentage of total land area (including inland waters) having very low anthropogenic impact	ESI 2005	The Human Influence Index, CIESIN	2004	222	39	direct	measures anthropogenic impact on land and inland waters based on human land uses, human access from roads, railways or major rivers, electrical infrastructure, and population density
93	Percentage of total land area (including inland waters) having very high anthropogenic impact	ESI 2005	The Human Influence Index, CIESIN	2004	222	39	inverse	Some repeat of above?
94	Spills	EVI2004	ITOPF 2002, CRED 2000	1996-2000	150	36	inverse	number of spills greater than 1000 liters between 1996-2000; captures the risk to marine, estuarine, riverine, lake, ground water, and terrestrial ecosystems from spills of hydrocarbons and other toxic fluids.
95	Mining	EVI2004	USGS - US Geological Survey	1996-2000	233	39	inverse	average total mining production from 1996-2000 in tons/square kilometers/year; captures the risk to terrestrial, aquatic ecosystems, and ground waters from the effects of ecosystem disturbance, accidents, oil spills and toxic leachates, and processing from mining of all kinds.
	Environmental regulation							
96	Number of environmental agreements total	ENTRI	ENTRI	2008	202	39	direct	Number of environmental agreements signed
97	Participation in international environmental agreements	ESI 2005	9 major environmental treaties considered	2004	230	40	direct	Score between 0 and 1 with 0 corresponding to no participation and 1 equal to full participation; combines ratifications of treaties and conventions with the level of active participation in, contribution to, and compliance with the treaties' obligations; comprises nine major environmental treaties including Kyoto protocol, CITES, UNCCD
98	Number of memberships in environmental intergovernmental organizations	ESI 2005	Yearbook of International Organizations	2003-2004	230	40	direct	number of memberships in environmental intergovernmental organizations
99	Pesticide regulation (proximity to target)	EPI 2012			232	40	direct	legislative status of countries on the Stockholm Convention on POPs usage, and also the degree to which the country has followed through on the objectives of the conventions by limiting or outlawing the use of certain toxic chemicals
100	World Economic Forum Survey on environmental governance	ESI 2005	World Economic Forum (WEF) Survey, The Global Competitiveness Report	2003-2004	102	12	direct	survey questions addressing several aspects of environmental governance
101	Local Agenda 21 initiatives per million people	ESI 2005	International Council for Local Environmental Initiatives, WDI	2001	112	13	direct	number of Local Agenda 21 initiatives per million people
102	Percentage of variables missing from the CGSDI "Rio to Joburg Dashboard"	ESI 2005	Consultative Group on Sustainable Development Indicators	2002	159	17	inverse	percentage; the greater the number of missing variables, the poorer the data availability in that country; environmental monitoring and data systems are vital for tracking progress towards environmental sustainability

#	Name of the variable	Source of data	Original source	Reference year	N	N of island states	Interpretation	Explanation
103	IUCN member organizations per million population	ESI 2005	IUCN-The World Conservation Union	IUCN memberships: 2004, Population: 2003	207	37	direct	number of member organizations per million people;
104	Participation in the Responsible Care Program of the Chemical Manufacturer's Association	ESI 2005	International Council of Chemical Associations	2002	230	40	direct	score 1-4; participation in the Responsible Care Program of the Chemical Manufacturer's Association; responsible handling of chemicals is important for environmental sustainability
105	Number of ISO 14001 certified companies per billion dollars GDP (PPP)	ESI 2005	For ISO14001/EMAS registered companies: Reinhard Peglau, c/o Federal Environmental Agency, Germany, For GDP (PPP) data: World Bank World Development Indicators 2004	ISO14001: 2003, GDP: MRYA 1998-2002	222	38	direct	number of ISO 14001 certified companies per billion dollars GDP (PPP)
	Other							
106	World Economic Forum Survey on private sector environmental innovation	ESI 2005	World Economic Forum	2003, 2004	102	12	direct	survey questions on private sector environmental innovation, which contributes to developing solutions to environmental problems
107	Contribution to international and bilateral funding of environmental projects and development aid	ESI 2005	Global Environmental Facility (GEF) contributions and receipts and Organisation for Economic Co-operation and Development (OECD) bilateral environmental aid; For ancillary economic data (GNI, PPP, USD current income): World Bank, World Development Indicators 2004; For population data: CIA World Factbook	2004	178	35	direct	score, 0-100