STABLE SEAS
MARITIME SECURITY INDEX:
CODEBOOK
VERSION 2.0

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I. THE STABLE SEAS MARITIME SECURITY INDEX

The Stable Seas Maritime Security Index is a first-of-its-kind effort to measure and map nine issues that are central to achieving sustainable maritime security and good maritime governance. The project highlights regional and country-specific strengths and challenges while demonstrating how issues like maritime trafficking, piracy and armed robbery, maritime mixed migration, and coastal welfare relate to each other. Stable Seas combines interesting case studies and qualitative vignettes with novel quantitative measures that bring new data to bear on maritime security challenges. This codebook describes these measures.

The 2019 edition of the index expands upon the first version, which was released in early 2018. Whereas the 2018 version covered 30 countries in Africa, the 2019 edition provides data for 70 countries and territories that encompass all of Africa, the Middle East, and much of the Indo-Pacific. Readers should note that there have been a few methodological and measurement changes to accommodate this broader geographic scope. These are described in detail in the sections that follow.

This technical documentation describes how each of nine maritime security issues is measured. These issues, which include both threats and buffers against those threats, are:

- International Cooperation
- Rule of Law
- Maritime Enforcement
- Coastal Welfare
- Blue Economy
- Fisheries
- Piracy and Armed Robbery at Sea
- Illicit Trades
- Maritime Mixed Migration

Each country is scored on each issue on a scale of 0 to 100, with 0 reflecting worse conditions and 100 reflecting better conditions. For ease of representation, each score is rounded to the nearest whole number.

These calculations represent the best available information about complex and under-reported activities occurring in expansive and remote maritime regions. Scores are derived from original research and information from external stakeholders and secondary sources. Quantitative data, surveys of subject-matter experts, and qualitative information are used to compile these scores. Some issue-area scores necessarily reflect operationalizations of concepts or best-faith estimates rather than precise numbers.

Vocabulary Note

The Stable Seas Maritime Security Index uses dozens of data points to measure each country’s threats and capacities across nine maritime security issue areas. All of the issue scores comprise multiple data sources, and some rely on nested hierarchies of components and subcomponents. The following terms are used to explain these data hierarchies throughout the codebook.

ISSUE-AREA SCORES: Each country receives nine issue-area scores corresponding to the nine sections of this codebook: International Cooperation, Rule of Law, Maritime Enforcement, Coastal Welfare, Blue Economy, Fisheries, Piracy and Armed Robbery at Sea, Illicit Trades, and Maritime Mixed Migration. These top-level scores are comprised of multiple inputs.

INDICATORS: Indicators are distinct data inputs or variables. These are the disaggregated parts for each score, component, and subcomponent used in the Stable Seas Maritime Security Index. Examples of indicators include coastline length, infant mortality rate, and composite scores adopted from other sources, such as Transparency International’s Corruption Perceptions Index.

COMPONENTS: A component occurs on the second level and is itself comprised of multiple indicators. For example, the Rule of Law Score includes a Judicial Integrity Component, which is itself formed from three indicators related to a country’s judicial norms and
SUBCOMPONENTS: Like components, subcomponents are formed from multiple distinct indicators to capture a unified concept. Subcomponents differ from components in that they are nested within components. For example, our Maritime Enforcement Score includes a Difficulty Component (second level). The Difficulty Component is further divided into two subcomponents: Geography (indicators for coast length and EEZ size) and Maritime Relations (indicators for the number of maritime neighbors and recognition of maritime boundaries in formal treaties).

Methodological Changes in Version 2.0

There are a few notable changes in methodology between Version 1.0 and Version 2.0, with key differences summarized here. Changes were made for a few different reasons. Expanding the Maritime Security Index beyond Africa required us to seek new data sources with superior global coverage. Some of the inputs used in Version 1.0 were altered, causing us to reevaluate these inputs. Finally, we were able to attract enough interest to execute a survey of African and Asian maritime security experts for the first time. We believe these changes greatly improve the quality of the scores, even if they problematize longitudinal comparison of scores over time.

- In International Cooperation, we added each state’s participation in one additional legal framework: the Food and Agriculture Organization of the United Nations Agreement to Promote Compliance with International Conservation and Management Measures by Fishing Vessels on the High Seas, which is more commonly known as the FAO Compliance Agreement. Because the regional maritime security strategies that are so important in most of Africa have no similar counterparts in some of the new regions we cover, we eliminated the Regional Security Strategies Component from the score.

- In Maritime Enforcement Capacity, we eliminated the Maritime Situational Awareness Component, but implemented a wide-reaching international survey to gauge perceptions of each country’s naval capabilities.

- In Coastal Welfare, we changed the data source for our conflict event data from the Uppsala Conflict Data Program to ACLED, but otherwise retained the same methodology as in the previous release of the Index.

- In Fisheries, we added a component for Marine Protected Areas and also changed the formula for calculating the Domestic Fisheries Legislation Component, and added new Regional Fisheries Management Organizations that are active in the broader region covered by the expanded Maritime Security Index.

- In Illicit Trades, we dropped scores for miscellaneous contraband and changed our data collection process to a survey of regional experts.

- In Maritime Mixed Migration, we adopted an improved Vulnerability Score from the Global Slavery Index and developed new data for Domestic Legal Protections.

II. INTERNATIONAL COOPERATION

Maritime instability causes economic, security, and social issues with spillover effects that ripple across the globe. Acknowledging this interdependency, a variety of international actors, from individual states to global institutions, have facilitated multilateral programs which aim to build a more secure African maritime domain. The International Cooperation Score measures participation in and commitment to multilateral efforts that facilitate maritime security and governance.

We measure the International Cooperation Score with two equally weighted components: International Agreements and Violations and Disputes.

International Agreements Component

The first component reflects the signing and ratification
of eight relevant global maritime legal agreements. In some states, the signing and the ratification of a treaty are separate legal processes. Agreements are typically signed at international conventions or negotiations. These signatures express a country’s willingness to participate, but they are not usually legally binding. Most countries require a separate ratification process in which the country’s legislature debates and votes to formally approve participation.

Signings are positive steps that reinforce the norms described in international treaties, but international agreements have a much stronger effect when ratification makes participating countries legally bound to the treaties.

The exception to this process applies to treaties that are accepted as customary international law. Customary law, though it may or may not be formally enshrined in a treaty, is legally binding on all states. It derives from the general practice of states. The United Nations Convention on the Law of the Sea (UNCLOS) is an example of customary international law. All states are bound by it, regardless of whether they have signed or ratified it. In the case of UNCLOS, ratification is a sign of commitment to the international process rather than being indicative of the application of the law.

The International Agreements Component accounts for both signings and ratifications of global treaties. For each of the treaties described below, countries receive a score of 0 if they have neither signed nor ratified an agreement, 0.33 if they have signed but not ratified, or 1 if they both signed and ratified by July 2019. The total score is divided by the maximum possible score (7) to arrive at a value that ranges between 0 and 1.

The eight agreements are:

- **THE UNITED NATIONS CONVENTION ON THE LAW OF THE SEA (UNCLOS)**
  UNCLOS is the most comprehensive international convention on state sovereignty over the use of maritime space. The agreement, established during the Conference on the Law of the Sea, which concluded in 1982, enshrined established principles as global standards that are central for global maritime governance, including definitions of territorial waters and exclusive economic zones. It entered into force in 1994.¹

- **UNCLOS PART XI**
  Part XI, which addresses Western concerns over the International Seabed Area, establishes international laws around the production of subsurface seabed minerals in international waters. This section of the agreement takes an important step toward reducing interstate conflict over offshore resources, so we consider it separately from the more general UNCLOS agreement.²

- **THE UNITED NATIONS FISH STOCKS AGREEMENT**
  The fisheries provisions in UNCLOS were not deemed fully comprehensive. In response, states convened at the 1993 Conference on Straddling Fish Stocks and Highly Migratory Fish Stocks. The outcome of the meeting, the UN Fish Stocks

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A 1988 meeting in Vienna established an international legal framework for combating international drug trafficking and money laundering.\(^7\)

**FAO COMPLIANCE AGREEMENT**

The Food and Agriculture Organization of the United Nations Agreement to Promote Compliance with International Conservation and Management Measures by Fishing Vessels on the High Seas (FAO Compliance Agreement) defines the roles of flag states and the responsibilities states have to ensure that their vessels comply with international law. This makes it a critical document for promoting the sustainability of global fisheries and the conservation of marine protected areas. The FAO Compliance Agreement was first negotiated in 1993.

**Violations and Disputes Component**

The second component of the International Cooperation Score is the presence of ongoing maritime boundary violations or disputes according to UNCLOS. We define violations as territorial water claims that extend beyond the twelve-nautical-mile boundary defined by UNCLOS. We define disputes as competing claims over the exclusive economic zones (EEZs) defined by UNCLOS.

We identify excessive territorial claims by reviewing claims recorded in the latest CIA World Factbook.\(^8\) In terms of disputes, many states have competing claims over their exclusive EEZs that have yet to be formally resolved under UNCLOS.

Countries receive a score of 0 for violations if they claim additional territorial waters or 1 if they do not claim additional territorial waters. Countries receive a score of 0 if they have EEZ disputes with their neighbors...
or 1 if they do not have EEZ disputes. The Violations and Disputes Component is an average of these two indicators.

Calculating the International Cooperation Score

We average the International Agreements Component and the Violations and Disputes Component and multiply by 100 to arrive at the International Cooperation Score.

### III. RULE OF LAW

Good maritime governance requires having bureaucratic and legal structures that are capable of designing, implementing, and enforcing policy. Threats to the rule of law, including corruption, bribery, discrimination, and underdeveloped and ineffective political institutions, impede a state’s capacity to provide good maritime governance.

We measure the Rule of Law Score with five equally weighted components: Corruption, Government Efficacy, Government Efficiency, Judicial Integrity, and Inclusion.

#### Corruption Component

Corrupt officials fail to enforce policy and thus enable transnational crime and corruption in maritime governance. Maritime trade is especially affected because nearly all international trade transits the maritime space.

Many organizations have already created corruption measures, so we adapt Transparency International’s Corruption Perceptions Index\(^9\) to create the Corruption Component. This measure averages 13 other corruption variables on a scale from 0 to 100, with more corrupt countries earning lower scores.

Transparency International does not collect CPI scores for Palestine, but it did produce a detailed paper on conditions within Palestine. This paper said, according to World Bank sources, that corruption there is slightly better than the regional average and on par with places like Tunisia and Morocco. Both of these countries were coded “43” for this period, so that score is transferred to Palestine for the purpose of this Maritime Security Index.

#### Government Efficacy Component

An ineffective government cannot enforce policy, and this hinders a state’s ability to secure its maritime space and prevent illicit maritime activities. We measure efficacy by rescaling the Functioning of Government

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indicator from Freedom House. This indicator, published as part of the annual *Freedom in the World* report, reflects expert responses to questions like:

*Do non-state actors, including criminal gangs, the military, and foreign governments, interfere with or prevent elected representatives from adopting and implementing legislation and making meaningful policy decisions?*

*Are there independent and effective auditing and investigative bodies that function without impediment or political pressure or influence?*

Freedom House’s Functioning of Government indicator ranges from 0 to 12, with the most efficacious governments receiving higher scores. We divide the score by 12 to create a range of 0 to 1. The 2019 *Freedom in the World* report website provides these scores.

**Government Efficiency Component**

Governments with unnecessary administrative and bureaucratic hurdles provide more opportunities for bribery and corruption, especially as these systems relate to trade, customs, and international migration. Because international trade flows through seaports, port administrators are uniquely positioned to demand bribes, permit illicit economic activity, and undermine good governance.

Each year, the World Bank’s *Doing Business* report gauges government efficiency in several areas, one of which is Trading Across Borders. This indicator is computed from expert estimates of the amount of time and money required to move a standard shipping container into the country. The measure is especially relevant for efficiency in African maritime governance, as the region’s international trade transits almost exclusively through seaports.

The score is scaled between 0 and 100 and it is available for all 30 countries. To arrive at the Government Efficiency Component, we simply divide the Trading Across Borders indicator by 100 to set it to a 0 to 1 interval. We use the 2019 World Bank *Doing Business* report.

**Judicial Integrity Component**

Judicial integrity is important to the enforcement

<table>
<thead>
<tr>
<th>Component</th>
<th>Justification</th>
<th>Measurement Strategy</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CORRUPTION</strong></td>
<td>Corrupt officials fail to enforce policy and enable transnational crime.</td>
<td>The Corruptions Perceptions Index produced by Transparency International</td>
</tr>
<tr>
<td><strong>GOVERNMENT EFFICACY</strong></td>
<td>Ineffective governments cannot enforce policy, and this hinders a state's ability to secure its maritime space and prevent illicit maritime activities.</td>
<td>The Functioning of Government score produced by Freedom House</td>
</tr>
<tr>
<td><strong>GOVERNMENT EFFICIENCY</strong></td>
<td>Governments with unnecessary administrative and bureaucratic hurdles provide more opportunities for bribery and corruption.</td>
<td>The Ease of Trading Across Borders score from the World Bank Doing Business report</td>
</tr>
<tr>
<td><strong>JUDICIAL INTEGRITY</strong></td>
<td>Where judges are bribed and laws go unenforced, the rule of law is too weak for policies aimed at the maritime domain to be effective.</td>
<td>Judicial Accountability, Judicial Attacks, and Judicial Bribery measures from the Varieties of Democracy Project</td>
</tr>
<tr>
<td><strong>INCLUSION</strong></td>
<td>Non-discrimination ensures inclusive maritime governance.</td>
<td>Varieties of Democracy Project data on unequal treatment under the law according to social group, subnational region, religion, socioeconomic status, and gender</td>
</tr>
</tbody>
</table>

10 Available at [doingbusiness.org](http://doingbusiness.org)
of existing laws and to ensuring that the de jure regulations are de facto conditions. Where judges are bribed and laws go unenforced, the rule of law is too weak for policies aimed at the maritime domain to be effective.

We create the Judicial Integrity Component using three indicators—Judicial Attacks, Judicial Accountability, and Judicial Bribery—from the Varieties of Democracy Project (V-Dem), a leading dataset on the strength of governance around the world. The three questions used to create these indicators are described at length in the Varieties of Democracy Codebook, version 8. Answers reflect what occurred in 2017.11

The Judicial Attacks indicator captures how often the government attacks the judiciary in public. The Judicial Attacks question asks experts, “How often did the government attack the judiciary’s integrity in public?” Respondents can answer on a scale ranging from “Attacks were carried out on a daily or weekly basis” (0) to “There were no attacks on the judiciary’s integrity” (4).

The Judicial Accountability indicator captures how often corrupt or inept judges are held accountable and removed from office. For Judicial Accountability, experts answer, “When judges are found responsible for serious misconduct, how often are they removed from their posts or otherwise disciplined?” Responses range from “Never” (0) to “Always” (4).

The Judicial Bribery indicator captures how often individuals and businesses pay bribes in return for favorable or speedy decisions. The Judicial Bribery indicator asks, “How often do individuals or businesses make undocumented extra payments or bribes in order to speed up or delay the process or to obtain a favorable judicial decision?” Responses range from “Always” (0) to “Never” (4).

We weight Judicial Accountability and Judicial Bribery more heavily than verbal attacks from the government, so we divide Judicial Attacks by 2 and sum responses to the three questions to arrive at a component that ranges from 0 to 10. In doing so, Judicial Accountability and Judicial Bribery each account for 40 percent of the component, while Judicial Bribery determines the final 20 percent of the Judicial Integrity Component. We then divide by 10 to achieve a measure of Judicial Integrity with a range of 0 to 1.

Inclusion Component

We gauge political inclusion with five indicators from the Varieties of Democracy Project (V-Dem). These cover unequal treatment under the law according to social group identification, subnational region, religion, socioeconomic status, and gender.

These are measures of equal treatment under the law, not of the absolute provision of liberal and transparent governance. Non-democratic states can score well if the law is equally applied across all five of these social divisions.

The phrasing of the survey questions varies slightly for each indicator. For the questions about gender, socioeconomic status, and social group, respondents are asked: “Is political power distributed according to...?” Responses range from “A favored group has a monopoly of political power” (0) to “Power is distributed equally” (4).

The religion question asks: “Does the government attempt to repress religious organizations?” Answers range from “Severely” (0) to “No” (4).

The region question asks: “Does government respect for civil liberties vary across different areas of the country?” Here, respondents are constrained to “Yes” (0), “Somewhat” (1), or “No” (2).

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11 For more information, see the codebook at [https://www.v-dem.net](https://www.v-dem.net).
12 The Judicial Attacks measure is variable name v2jupoatck_ord in V-Dem.
13 The Judicial Accountability measure is variable name v2juaccnt_ord in V-Dem.
14 The Judicial Bribery measure is variable name v2jucorrdc_ord in V-Dem.
15 Unequal treatment under the law according to social group identification is variable name v2pepwrsoc_ord in V-Dem.
16 Unequal treatment under the law according to subnational region is variable name v2clrgunev_ord in V-Dem.
17 Unequal treatment under the law according to religion is variable name v2crlrgrep_ord in V-Dem.
18 Unequal treatment under the law according to socioeconomic status is variable name v2pepwrses_ord in V-Dem.
19 Unequal treatment under the law according to gender is variable name v2pepwrgen_ord in V-Dem.
All of the scores are rescaled to be between 0 and 1 by dividing the raw score by the maximum possible response. The Inclusion Component is the average of these five rescaled indicators of inclusion.

Calculating the Rule of Law Score

We create the Rule of Law Score by taking the average of the five components: Corruption, Government Efficiency, Government Efficacy, Judicial Integrity, and Inclusion. We multiply by 100 to achieve a score that ranges from 0 to 100.

Rule of Law Variables in the Data File

<table>
<thead>
<tr>
<th>RL_FINAL</th>
<th>Rule Of Law Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>RL_CORRUPTION_RAW</td>
<td>Raw CPI Indicator From Transparency International</td>
</tr>
<tr>
<td>RL_CORRUPTION_FINAL</td>
<td>Converted Corruption Perceptions Index Indicator</td>
</tr>
<tr>
<td>RL_EFFICACY_RAW</td>
<td>Raw Functioning of Govt Indicator From Freedom House</td>
</tr>
<tr>
<td>RL_EFFICACY_FINAL</td>
<td>Efficacy Component</td>
</tr>
<tr>
<td>RL_EFFICIENCY_RAW</td>
<td>World Bank Ease of Trading Across Borders</td>
</tr>
<tr>
<td>RL_EFFICIENCY_FINAL</td>
<td>Efficiency Component</td>
</tr>
<tr>
<td>RL_JUD_ATTACK</td>
<td>Judicial Attacks From Varieties of Democracy</td>
</tr>
<tr>
<td>RL_JUD_ACCT</td>
<td>Judicial Accountability From Varieties of Democracy</td>
</tr>
<tr>
<td>RL_JUD_CORRUPT</td>
<td>Judicial Corruption From Varieties of Democracy</td>
</tr>
<tr>
<td>RL_JUD_FINAL</td>
<td>Judicial Integrity Component</td>
</tr>
<tr>
<td>RL_INC_RELIGION</td>
<td>Varieties Of Democracy Inclusion of Religion</td>
</tr>
<tr>
<td>RL_INC_REGION</td>
<td>Varieties of Democracy Inclusion of Subnational Region</td>
</tr>
<tr>
<td>RL_INC_SES</td>
<td>Varieties of Democracy Inclusion of Socioeconomic Status</td>
</tr>
<tr>
<td>RL_INC_GROUP</td>
<td>Varieties of Democracy Inclusion of Social Group</td>
</tr>
<tr>
<td>RL_INC_GENDER</td>
<td>Varieties Of Democracy Inclusion of Gender</td>
</tr>
<tr>
<td>RL_INC_FINAL</td>
<td>Inclusion Component</td>
</tr>
</tbody>
</table>

IV. MARITIME ENFORCEMENT

Good maritime governance is not possible without navies and coast guards that are adequate for monitoring territorial waters and exclusive economic zones. Where states are up to this task, smugglers and traffickers cannot operate freely and fisheries laws are enforceable. However, inadequate capacity to govern the maritime space can hamper a country’s efforts to regulate maritime activity and effectively render any maritime legislation irrelevant. Poor capacity in this area provides tempting opportunities for those who seek to profit from the absence of real enforcement of maritime law.

For this reason, we measure and define Maritime Enforcement as each country’s capacity to effectively patrol its territorial waters and EEZ for the purposes of investigating illicit activity and enforcing maritime law. The score is not concerned with legal regimes or naval warfighting efforts, though both of these related concepts are greatly affected by Maritime Enforcement. Rather, this score focuses on the difficulty of managing a state’s specific maritime space, its capacity to perform constabulary duties in that space, and the development and regional integration of its maritime domain awareness systems.

We measure the Maritime Enforcement Score with three components: EEZ Difficulty, Coastal Patrol Assets, and Naval Capacity Assessment.

Difficulty Component

The Difficulty Component measures the difficulty of governing one’s maritime space, and is determined by the unique geographical attributes of a country’s particular maritime space. The component is derived from two the following equally weighted inputs: Geography of the EEZ and Maritime Boundaries.

Geography of the EEZ

We measure the Geography of the EEZ subcomponent as an average of two indicators: EEZ size and coastline
length. Though these two concepts are correlated, they can diverge based on the shape of a coastline and the arrangement of neighboring EEZs. Cameroon, for example, has a very low EEZ-to-coastline ratio because its offshore claims quickly meet those of island neighbors like Equatorial Guinea. Conversely, Cabo Verde’s relative isolation in the mid-Atlantic means it has an EEZ that extends many nautical miles in all directions. Analyzing EEZ size captures the problems faced by states with expansive maritime territories, such as Seychelles. Including coastline length accounts for how more complex coastal areas and archipelagos like the Niger River Delta can ease smuggling and evasion of law enforcement authorities.

Data on EEZ size is drawn from maritimeregions.org, an online gazetteer produced by the Flanders Maritime Institute. This resource contains comprehensive geospatial and legal information about maritime spaces around the world. Rather than using the raw value, we make three transformations to the data before including it in the Geography of the EEZ Score. First, we log-transform the size of each EEZ. This allows the effect of small increases in size to be much greater in countries with small EEZs while minimizing the additional effect of size in countries that already have very large EEZs. For example, an additional 1,000 square kilometers is a much greater challenge for a state that only had 1,000 square kilometers to patrol than it is for a large country that already had an expansive EEZ.

Second, we rescale the data to the interval between 0 and 1 by establishing a maximum benchmark. Setting that benchmark at the global maximum (France’s EEZ) would effectively eliminate meaningful variation among other countries because France is an extreme outlier with a global EEZ that is nearly eight times larger than the largest African EEZ. Instead, we set a maximum possible value of 2.5 million square kilometers (approximately the size of the Indian EEZ), which approximates the global 90th percentile. This allows for more meaningful variation among countries with EEZs that are closer to the global mean. Any countries with larger EEZs are given the maximum value.

<table>
<thead>
<tr>
<th>Component</th>
<th>Justification</th>
<th>Measurement Strategy</th>
</tr>
</thead>
<tbody>
<tr>
<td>EEZ DIFFICULTY</td>
<td>GEOGRAPHY OF THE EEZ</td>
<td>Some maritime spaces require more resources than others, specifically very large EEZs and those with longer coastlines.</td>
</tr>
<tr>
<td></td>
<td>MARITIME BOUNDARIES</td>
<td>As the number of maritime boundaries increases, a state will have more difficulty governing the borders of its maritime space, especially when those borders have not been mutually agreed upon and formally recognized.</td>
</tr>
<tr>
<td>COASTAL PATROL ASSETS</td>
<td></td>
<td>All else being equal, countries with larger navies and coast guards will have greater capacity to patrol their maritime spaces.</td>
</tr>
<tr>
<td>NAVAL CAPACITY ASSESSMENT</td>
<td></td>
<td>More capable navies can intercept threats before they reach coasts and monitor for illicit maritime activity.</td>
</tr>
</tbody>
</table>

Table 3 Components of the Maritime Enforcement Score
Finally, we rescale EEZ size to a 0 to 1 scale by calculating the ratio of a country’s EEZ to the maximum EEZ size. More formally, where $Z_c$ is the size of the EEZ in country C in tens of thousands of kilometers:

$$\text{Scaled EEZ Size} = \frac{\ln(Z_c+1)}{\ln(250+1)}$$

Data on coastline length is drawn from the CIA World Factbook. We create our measure of coastline length following the same three steps as in the EEZ Size measure. Coastline lengths are log-transformed, benchmarked to a maximum of 7,000 kilometers (the approximate coast length of India, or the global 90th percentile), and converted into a ratio using the following equation, where $C_c$ is the coastline length of country C in hundreds of kilometers:

$$\text{Scaled Coastline Length} = \frac{\ln(C_c+1)}{\ln(70+1)}$$

**Maritime Boundaries**

Two indicators form the Maritime Boundaries subcomponent: the number of EEZ neighbors and the proportion of those neighbors with which a state has not come to a formal mutual agreement about the placement of maritime boundaries. We argue that the difficulty of patrolling a maritime space increases with the number of direct maritime neighbors and that this patrolling is even more difficult when borders are not explicit and mutually agreed upon.

We draw both indicators from the Flanders Maritime Institute. The number of neighbors is rescaled to a 0 to 1 scale by dividing the number of neighbors by five. Countries with five or more EEZ neighbors receive the maximum value of 1. We then calculate the proportion of neighbors with which a country does not have a formal agreement recognizing the EEZ boundary. The Maritime Boundaries subcomponent is the average of these two indicators.

Finally, to calculate the Difficulty Component, we average the Maritime Boundaries subcomponent and the Geography of the EEZ subcomponent. In effect, this measure is a simple average of rescaled EEZ size, coastline length, number of EEZ neighbors, and the proportion of neighbors without a formal agreement. We subtract this average from 1 to achieve a measure that ranges from 0 (most difficult EEZ to patrol) to 1 (least difficult EEZ to patrol).

**Coastal Patrol Assets Component**

We measure the number of coastal patrol vessels available to federal forces, which may include a navy, coast guard, port police, and/or other maritime enforcement division. We derive these vessel counts from *The Military Balance 2018*, an annual global report from the International Institute for Strategic Studies (IISS). This report did not include information for São Tomé and Príncipe or Comoros, so we supplemented these data with in-house research and inquiries to regional stakeholders. We adopt the coastal patrol vessel definition from the Military Balance report:

*Patrol and Coast Combatants are: “surface vessels designed for coastal or inshore operations. These include corvettes..., ... offshore patrol ships..., patrol craft..., and patrol boats.”*

A simple vessel count does not take into account vessel age, working condition, or funding, but we address these factors in the Naval Capability Component below.

We create the Coastal Patrol Assets Component that ranges from 0 to 1 by first identifying a reasonably high benchmark of 100 coastal patrol vessels. Any country that has 100 or more coastal patrol vessels receives a score of 1.

Second, we account for the diminishing returns of each additional vessel by log-transforming each country’s vessel count. Third, we measure the ratio of a country’s vessel count to the benchmark where C is a country’s coastal patrol vessel count:

$$\text{Coastal Patrol Assets} = \frac{\ln(C+1)}{\ln(100+1)}$$

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20 In every instance in which we use logged values, we add “1” to the value being logged. Doing so is necessary to avoid undefined values that approach negative infinity. When “1” is added to the logged value, the minimum is set to 0.

21 Measures of naval warfighting capacity often measure total tonnage rather than the number of vessels based on the argument that larger ships have more fighting power. Because we are interested in a force’s ability to patrol physical space rather than ability to compete with opposing fleets, we use the number of vessels. This better approximates the amount of physical space a force can monitor at a given time.
Naval Capability Assessment

Counts of vessels miss some important aspects of naval capability. Equipment can be outdated and navies can be underfunded or inadequately trained. To address this reality and complement our Coastal Patrol Vessels Component, we designed a survey of naval capabilities and solicited responses from a diverse group of maritime security experts. Respondents classified naval capability according to the following rubric.

Naval Capacity Assessment

This assessment gauges a country’s capacity to enforce its laws and exercise governance of its waters based on the number, type, and capability of its naval assets (including coast guard and other agency assets) and a subjective evaluation of the ways in which those assets are employed in support of maritime enforcement and governance. Assessment of a country at a certain rank implies that country has the capacity to also meet the requirements of the subordinate rankings.

Tier 6: Regional Naval Power
These are countries with naval, coast guard, and other agency assets capable of executing the full range of naval operations, from maritime enforcement to naval warfighting and limited offensive power projection, from the coastline to beyond the nation’s EEZ.

Tier 5: Full Offshore Constabulary Capacity
These are countries that have assets of sufficient capability and in sufficient numbers to conduct regular and routine patrols, and to respond to incidents, out to the limits of the EEZ. This implies a force consisting of large offshore patrol vessels (ranging from 50m to small frigate size) capable of sustained at-sea operations of a week or more, supported by an organic naval aviation or land-based maritime patrol aircraft capability.

Tier 4: Limited Offshore Constabulary Capacity
These are countries that have assets capable of patrolling and responding to incidents beyond the limits of territorial waters but which, whether for lack of numbers, range, or sustainment resources, do not do so regularly or routinely or cannot cover the entire EEZ. This implies a force consisting of a small number of capable offshore patrol vessels (OPVs) or a larger number of smaller OPVs, and possibly a limited maritime patrol aircraft capability.

Tier 3: Inshore Constabulary Capacity
These countries have primarily inshore (i.e., extending to the limit of their territorial waters) capabilities, making them capable of constabulary duties within, and perhaps slightly beyond, the 12nm limit. This implies a force comprising smaller OPVs (vessels up to 30m in length) that actually patrol the country’s territorial waters routinely.

Tier 2: Coastal Constabulary Capacity
These are countries with naval assets sufficient in number and capability to allow maritime enforcement along the coast, in estuaries, and along approaches to ports. Such countries may or may not have limited inshore patrol capability but do not routinely or regularly patrol their territorial waters.

Tier 1: Token Capacity
These are navies that have some minimal capability, but this often consists of little more than a formal organizational structure and a few coastal craft. These states, the world’s smallest and weakest, perform the most limited constabulary functions.

Tier 0: No Naval Capacity
These countries have no naval, coast guard, or other maritime law enforcement agency to speak of.

The score is the mean of the responses each country received, which was then standardized to a scale of 0 to 1 by dividing by 6.
Calculating the Maritime Enforcement Score

We calculate the Maritime Enforcement Score as a function of Difficulty, Coastal Patrol Assets, and Naval Capability. We weight the Coastal Patrol Assets Component by the Difficulty Component before taking the average. Thus, the formula is:

Maritime Enforcement Score = \{(1 - Difficulty + Coastal Patrol Assets) / 2 + Naval Capability / 2\}

Last, we multiply the result by 100 to achieve a score ranging from 0 (weakest) to 100 (strongest).

Maritime Enforcement Variables in the Data File

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ME_FINAL</td>
<td>Maritime Enforcement Score</td>
</tr>
<tr>
<td>ME_COAST_RAW</td>
<td>Coastline Length, CIA World Factbook</td>
</tr>
<tr>
<td>ME_COAST_FINAL</td>
<td>Rescaled Coastline Length</td>
</tr>
<tr>
<td>ME_EEZ_RAW</td>
<td>EEZ Size</td>
</tr>
<tr>
<td>ME_EEZ_FINAL</td>
<td>Rescaled EEZ Size</td>
</tr>
<tr>
<td>ME_GEOG_FINAL</td>
<td>Geography (Coast/EEZ)</td>
</tr>
<tr>
<td>ME_AGREE</td>
<td>Number Of Maritime Neighbors With Formal Recognition Of Maritime Borders</td>
</tr>
<tr>
<td>ME_UNESTABLISHED</td>
<td>Number Of Maritime Neighbors With No Formal Recognition Of Boundaries, But No Active Dispute</td>
</tr>
<tr>
<td>ME_DISPUTE</td>
<td>Number Of Maritime Neighbors With Which Country Has An Active Maritime Boundary Dispute</td>
</tr>
<tr>
<td>ME_NEIGHBORS</td>
<td>Total Number Of Maritime Neighbors</td>
</tr>
<tr>
<td>ME_NEIGHBORS_SCALED</td>
<td>Neighbors Rescaled</td>
</tr>
<tr>
<td>ME_NOTREATY</td>
<td>Sum Of ME_UNESTABLISHED And ME_DISPUTE, As Percentage Of Neighbors</td>
</tr>
<tr>
<td>ME_BOUNDARIES_FINAL</td>
<td>Maritime Neighbors Score</td>
</tr>
<tr>
<td>ME_DIFFICULTY_FINAL</td>
<td>Difficulty Component</td>
</tr>
</tbody>
</table>

V. COASTAL WELFARE

The security of a maritime region is closely linked to the well-being of the people living in adjacent coastal areas. The economically insecure are more likely to turn toward piracy, smuggling, and trafficking. Transnational criminal networks are especially likely to establish themselves along coastlines that are weakly governed and affected by armed conflict and other forms of violence. As seen in Nigeria, Somalia, the Philippines, and elsewhere, violent non-state actors operating onshore often turn to the maritime space to profit from poor governance or to smuggle arms and illicit goods.

We conceptualize coastal welfare as a function of a population’s physical and economic security, both on the coast and in a country more generally. We calculate the Coastal Welfare Score with four equally weighted components: Coastal Physical Security, Coastal Economic Security, Countrywide Physical Security, and Countrywide Economic Security.

Countrywide Physical Security Component

We use two indicators to measure the Countrywide Physical Security Component: countrywide armed-conflict events and homicide rates.

The first indicator is derived from the Armed Conflict Location & Event Data Project (ACLED). The dataset includes geocoded information about specific instances of political violence, such as battles between armed actors, uses of violence against civilians, and protests across a large portion of Africa, Asia and the Middle East. The project codebook defines political violence and describes qualifying events as:
“Political violence is defined as the use of force by a group with a political purpose or motivation. ACLED records political violence through its constituent events, the intent of which is to produce a comprehensive overview of all forms of political disorder, expressed through violence and demonstrations, within and across states. A politically violent event is a single altercation where often force is used by one or more groups toward a political end, although some non-violent instances – including protests and strategic developments – are included in the dataset to capture the potential pre-cursors or critical juncture of a violent conflict.”

ACLED data is updated continually. Data for conflict events was downloaded from the ACLED website in March 2019. We counted all events resulting in at least one fatality during the 2018 calendar year. Of the 70 territorial entities included in the Stable Seas Index, 58 are included in the ACLED data. For the remaining twelve entities, the Stable Seas team conducted searches of open source information for a variety of key words which would signal the presence of fatal political violence events.

We made three adjustments to the counts of armed-conflict events to arrive at a score that ranges from 0 (extremely high frequency of conflict) to 1 (no conflict). First, we log-transformed event counts to account for the decreasing importance of an additional event as the number of total events increases. Second, we established a maximum benchmark of 250 events to reduce the influence of extreme outliers like Iraq, Afghanistan, and Somalia. Finally, we took the ratio with the following formula, where \( C \) is the count of armed-conflict events:

\[
\text{Transformed Armed-Conflict Event Count} = \max(0,1-\ln(C+1) / \ln(250+1))
\]

Any country that had an event count above the 90th percentile of countries worldwide (above 250 events) received the lowest possible score of 0, while states suffering zero instances of armed conflict received a score of 1.

The second indicator in the Countrywide Physical Security Component is the homicide rate taken from the United Nations Office on Drugs and Crime (UNODC). Homicide data were taken for the most recent available year for each country.

As in the armed-conflict event measure above, we set a maximum benchmark around the global 90th
percentile (20 homicides per 100,000). Any country with a homicide rate above this threshold receives the lowest score of 0. Next, to achieve a curve that depreciates with the homicide rate, we convert the rate to a logged ratio. The denominator is the log-converted maximum threshold (20 per 100,000), while the numerator is the country’s homicide rate subtracted from this maximum threshold. Leaving the unit in the homicides per 100,000 produces a curve that declines far too gradually. Countries with homicide rates around double the global mean (approximately 15 per 100,000) earn roughly 0.59 on a 0 to 1 scale. To produce a sharper curve, we convert the unit to homicides per 10,000 by dividing by 10. Under this transformation, scores drop more sharply as the homicide rate climbs. After this conversion, a country with the same homicide rate would earn around 0.37. After converting to homicides per 10,000 and adding “1” to both the numerator and denominator to avoid undefined logged values, we get a denominator of ln(20/10 + 1) = ln(3) and a numerator of ln(20/10 + 1 - H/10) = ln(3-H/10). Homicide rates, which are measured as a count of homicides per 100,000 citizens, were transformed to a 0 to 1 scale using the following formula, where \( H \) is the homicide rate:

\[
\text{Transformed Homicide Rate} = \max(0, \ln(3-H/10)/\ln(3))
\]

Finally, we created the Countrywide Physical Security Component for each country as an average of the transformed countrywide armed-conflict event count and homicide rate.

**Coastal Physical Security Component**

To isolate armed conflict occurring near the coastline, we identified events of armed conflict occurring within 50 kilometers of a country’s coast using the same ACLED data. This reduced the number of events to 5096 across 45 of the 70 territorial entities included in the study area.

This distinction between coastal armed conflict and countrywide armed conflict used in the Countrywide Physical Security Component above helped us capture the geographic differences in armed conflict in each affected country. Some countries, like Somalia and Thailand, experienced most of their armed-conflict events near the coast. Others, like the Democratic Republic of the Congo and Syria, suffered conflict in interior regions but significantly less in coastal areas.

We transformed the coastal armed-conflict event count for each country to a 0 to 1 scale using the following formula, where \( C \) is the count of coastal armed-conflict events:

\[
\text{Coastal Physical Security Score} = \max(0, 1-\ln(C+1)/\ln(101))
\]

As in the measure of countrywide armed conflict, we set a maximum benchmark to eliminate the influence of extreme outliers. We set the benchmark to 100 events to approximate the global 90th percentile of coastal armed-conflict events. As in all of our logged transformations, we add “1” to each value before logging to avoid undefined results.

**Coastal Economic Security Component**

We use two indicators to measure coastal economic security. The first is the Artisanal Fishing Opportunities goal from the Ocean Health Index (OHI). The second is the Coastal Livelihoods and Economies goal from the OHI weighted by the Human Development Index (HDI) produced by the United Nations Development Program (UNDP).

The Artisanal Fishing Opportunities goal from the OHI measures “whether people who need to fish on a small, local scale have the opportunity to do so.”\(^{22}\) In other words, it captures whether the demand for fishing opportunities is met on the coast in a lawful and sustainable manner. Anecdotes from Somalia, Nigeria, and elsewhere demonstrate the importance of sustainable artisanal fishing as a deterrent against illicit economic activity. The score is measured on a scale from 0 (worst) to 100 (best). We divide the scores for each country by 100 to get a measure within the 0 to 1 interval.

---

The Coastal Livelihoods and Economies goal from the OHI assesses jobs and revenue produced from marine-related industries relative to national trends in employment and GDP. The goal thus captures the relative economic well-being of coastal areas in comparison to the rest of the country. The industries considered in the measure are: 1) commercial fishing, 2) mariculture, 3) tourism and recreation, 4) shipping and transportation, 5) whale-watching, 6) ports and harbors, 7) ship- and boatbuilding, and 8) renewable energy production (wind and wave). Like the Artisanal Fishing Opportunities goal, it is also scaled 0 to 100 and can be reset to the 0 to 1 interval through a simple division by 100.

Because Coastal Livelihoods and Economies is a measure of coastal well-being relative to conditions elsewhere in a country, it is not particularly useful for cross-national comparisons unless it is transformed. A very poor country like Somalia can receive an outstanding Coastal Livelihoods and Economies measure so long as the people on the coast are no more impoverished than those living in the country’s interior.

Accordingly, we transform the Coastal Livelihoods and Economies goal with the Human Development Index to ensure that the final indicator takes into account differences between states rather than just within them.

The Human Development Index is perhaps the world’s most influential score of social well-being. The HDI seeks to capture well-being by looking at three key measures of economic and human development: life expectancy, education provision, and gross national income.

We transformed the Coastal Livelihoods and Economies goal from the OHI with the following formula:

$$\text{Transformed CLE} = \frac{\text{CLE}}{100 * \text{HDI}}$$

Finally, we calculated the Coastal Economic Security Component for each country as an average of the Artisanal Fishing Opportunities goal and the transformed Coastal Livelihoods and Economies goal.

Countrywide Economic Security Component

We measure countrywide economic security using two indicators: The Human Development Index (HDI) from the UNDP and infant mortality data from the World Bank.

The first indicator, the HDI score, is described above in the Coastal Economic Security Component section.

The second indicator is the infant mortality rate (IMR), which is commonly viewed as one of the best single indicators of social welfare. To improve infant mortality rates, countries must invest in health care, transportation infrastructure, nutrition, and women’s education across all socioeconomic classes and social groups. We use the most recent data from the World Bank, which defines infant mortality as the number of infants per 1,000 live births who perish before reaching their second birthday.

As with other measures in the index, we establish a maximum benchmark near the global 90th percentile to reduce the influence of extreme outliers. Any country where infant mortality exceeds 75 per 1,000 receive a score of 0. The score can reach 1 only when infant mortality is in effect eliminated throughout a country. As with the homicide conversion described above, we first convert the IMR into deaths per 100 to achieve a sharper curve with greater penalties for higher infant mortality rates. We also add “1” to the numerator and denominator to avoid undefined values. This results in the following conversion:

$$\text{Transformed Infant Mortality Rate} = \max(0, \ln(8.6 - \text{IMR}/10) / \ln(8.6))$$

Finally, we calculate the Countrywide Economic Security Component as an average of the HDI and the transformed infant mortality rate.

Calculating the Coastal Welfare Score

The final Coastal Welfare Score equally weights the four components described: Countrywide Physical Security, Coastal Physical Security, Coastal Economic}

<table>
<thead>
<tr>
<th>Coastal Livelihoods and Economies</th>
<th>Countrywide Economic Security Component</th>
<th>Calculating the Coastal Welfare Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Coastal Livelihoods and Economies goal from the OHI assesses jobs and revenue produced from marine-related industries relative to national trends in employment and GDP. The goal thus captures the relative economic well-being of coastal areas in comparison to the rest of the country. The industries considered in the measure are: 1) commercial fishing, 2) mariculture, 3) tourism and recreation, 4) shipping and transportation, 5) whale-watching, 6) ports and harbors, 7) ship- and boatbuilding, and 8) renewable energy production (wind and wave). Like the Artisanal Fishing Opportunities goal, it is also scaled 0 to 100 and can be reset to the 0 to 1 interval through a simple division by 100.</td>
<td>We measure countrywide economic security using two indicators: The Human Development Index (HDI) from the UNDP and infant mortality data from the World Bank. The first indicator, the HDI score, is described above in the Coastal Economic Security Component section. The second indicator is the infant mortality rate (IMR), which is commonly viewed as one of the best single indicators of social welfare. To improve infant mortality rates, countries must invest in health care, transportation infrastructure, nutrition, and women’s education across all socioeconomic classes and social groups. We use the most recent data from the World Bank, which defines infant mortality as the number of infants per 1,000 live births who perish before reaching their second birthday. As with other measures in the index, we establish a maximum benchmark near the global 90th percentile to reduce the influence of extreme outliers. Any country where infant mortality exceeds 75 per 1,000 receive a score of 0. The score can reach 1 only when infant mortality is in effect eliminated throughout a country. As with the homicide conversion described above, we first convert the IMR into deaths per 100 to achieve a sharper curve with greater penalties for higher infant mortality rates. We also add “1” to the numerator and denominator to avoid undefined values. This results in the following conversion: $$\text{Transformed Infant Mortality Rate} = \max(0, \ln(8.6 - \text{IMR}/10) / \ln(8.6))$$ Finally, we calculate the Countrywide Economic Security Component as an average of the HDI and the transformed infant mortality rate.</td>
<td>The final Coastal Welfare Score equally weights the four components described: Countrywide Physical Security, Coastal Physical Security, Coastal Economic...</td>
</tr>
</tbody>
</table>
Security, and Countrywide Economic Security. We convert to a 0 to 100 scale as in all of the other issue areas by multiplying this value by 100.

**Coastal Welfare Variables in the Data File**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CW_FINAL</td>
<td>Coastal Welfare Score</td>
</tr>
<tr>
<td>CW_PHYS_COAST_RAW</td>
<td>Raw Count of Conflict Events Within 50 Km Of Coast</td>
</tr>
<tr>
<td>CW_PHYS_COAST_FINAL</td>
<td>Coastal Physical Security Component</td>
</tr>
<tr>
<td>CW_PHYS_NAT_INCID_RAW</td>
<td>Raw Count of Conflict Events In Country In 2016</td>
</tr>
<tr>
<td>CW_PHYS_NAT_INCID_FINAL</td>
<td>Log-Transformed Country-wide Conflict Events</td>
</tr>
<tr>
<td>CW_PHYS_NAT_HOM_RAW</td>
<td>Homicides Per 100,000 Per UNODC</td>
</tr>
<tr>
<td>CW_PHYS_NAT_HOM_FINAL</td>
<td>Log-Transformed Homicide Rate</td>
</tr>
<tr>
<td>CW_PHYS_NAT_FINAL</td>
<td>Countrywide Physical Security Component</td>
</tr>
<tr>
<td>CW_ECON_NAT_HDI</td>
<td>Human Development Index From UNDP</td>
</tr>
<tr>
<td>CW_ECON_NAT_IMR_RAW</td>
<td>Raw Infant Mortality Rate</td>
</tr>
<tr>
<td>CW_ECON_NAT_IMR_FINAL</td>
<td>Log-Transformed IMR</td>
</tr>
<tr>
<td>CW_ECON_NAT_FINAL</td>
<td>Countrywide Economic Security Component</td>
</tr>
<tr>
<td>CW_ECON_COAST_LIVELIHOODS</td>
<td>Coastal Livelihoods Goal</td>
</tr>
<tr>
<td>CW_ECON_COAST_ARTFISH</td>
<td>Artisanal Fishing Goal</td>
</tr>
<tr>
<td>CW_ECON_COAST_FINAL</td>
<td>Coastal Economic Security Component</td>
</tr>
</tbody>
</table>

**VI. BLUE ECONOMY**

We measure the Blue Economy Score with six equally weighted components: Fisheries, Marine and Coastal Tourism, Maritime Transportation and Shipping, Offshore Oil and Gas, Adjusted Net Savings, and Climate Change.

**Fisheries Component**

Fisheries are an important part of many economies. In some countries, fisheries products are the top-grossing export. In others, income from artisanal and small-scale fisheries is important for livelihoods. We combine the values of wild-caught marine fish and mariculture for this score.

The value of wild-caught marine fish taken in by a given country was obtained from The Sea Around Us \(^\text{23}\) the most recent year available. The total landed value of fish catch (in real 2010 USD), regardless of location of that catch, was summed from the category “Fishing Entity.” That is, we did not limit the value of the catch to a country’s own EEZ.

The value of mariculture to a given country was obtained from the UN Food and Agriculture Organization’s Global Statistical collection’s Global Aquaculture Production database.\(^\text{24}\) The definition of mariculture includes fish-farming occurring in the ocean or coastal zones and farming of marine species.\(^\text{25}\) The query was also limited to marine waters, and marine and brackish water environments.

The values of domestic wild fish catch and mariculture were summed and divided by the national population estimated by the World Bank.\(^\text{26}\) We adjusted values by benchmarking to the global 90th percentile. All countries in the 90th percentile or higher received a score of 1, and those below 90th percentile received


\(^{25}\) Specifically, for a given country, the following species groups were included in the query: brown seaweeds; green seaweeds; seaweeds not elsewhere included; red seaweeds; crabs and sea-spiders; lobsters and spiny rock lobsters; miscellaneous marine crustaceans; shrimps and prawns; salmons, trouts, and smelts; marine fishes; sea-squirts and other tunicates; sea-urchins and other echinoderms; abalones, winkles, and conchs; clams, cockles, and arkshells; miscellaneous marine molluscs; mussels; oysters; scallops and pectens; squids and cuttlefishes; and octopuses.

Table 5 Components of the Blue Economy Score

<table>
<thead>
<tr>
<th>Component</th>
<th>Justification</th>
<th>Measurement Strategy</th>
</tr>
</thead>
<tbody>
<tr>
<td>FISHERIES</td>
<td>Wild fisheries and increasingly aquaculture (fish farming) contribute to local economies and national (export) economies.</td>
<td>Value, per capita, of combined wild fish and aquaculture production from the UN Food and Agriculture Organization and The Sea Around Us</td>
</tr>
<tr>
<td>MARINE AND COASTAL TOURISM</td>
<td>The tourism sector generates jobs and supports coastal economies, especially in Small Island Developing States.</td>
<td>Ocean Health Index goal for Tourism and Recreation</td>
</tr>
<tr>
<td>MARITIME TRANSPORTATION AND SHIPPING</td>
<td>Ports support extensive national and regional trade networks and provide local jobs and services.</td>
<td>Indicators of port size, quantity of port-based trade, port infrastructure</td>
</tr>
<tr>
<td>OFFSHORE OIL AND GAS</td>
<td>The offshore energy sector contributes to national trade economies, produces income through resource licensing, and supports employment.</td>
<td>Original indicators of oil and gas reserves and potential for future accessibility</td>
</tr>
<tr>
<td>ADJUSTED NET SAVINGS (ANS)</td>
<td>Sustainable growth is key to a thriving Blue Economy. ANS measures standard economic growth conditioned by a country’s investment in education and the environment.</td>
<td>World Bank Adjusted Net Savings index</td>
</tr>
<tr>
<td>CLIMATE VULNERABILITY</td>
<td>Climate change may threaten Blue Economy gains. Climate Vulnerability measures the risks a country faces from climate change.</td>
<td>Notre Dame’s Global Adaptation Initiative (ND-GAIN) Country Index</td>
</tr>
</tbody>
</table>

a score divided by 0.9. After adjusting for the global range, Stable Seas countries ranged from $397.20 per person (Seychelles) to $0.50 per person (the Democratic Republic of the Congo) with a regional average of $67.93.

Marine and Coastal Tourism Component

Sustainable coastal tourism supports jobs and livelihoods in coastal communities. We use the Tourism and Recreation goal\(^\text{27}\) in the Ocean Health Index. The Ocean Health Index assesses countries on biological, physical, economic, and social factors to measure how sustainably humans are using the ocean. The Tourism and Recreation goal measures the proportion of the total labor force engaged in the coastal tourism and travel sector, factoring in unemployment and sustainability, and countries where such employment was 9.5 percent or greater of the total labor force received a perfect score (100). The Ocean Health Index collects data for all countries of the world and issues annual updates. We used the 2016 score for all countries without transformation or alteration other than dividing by 100 to convert to a range of 0 to 1.

Maritime Transportation and Shipping Component

Maritime ports and the shipping and commerce they support are pillars of the Blue Economy. Large, well-functioning ports support larger volumes of shipping and greater export and import markets and link national economies to the global economy. We calculated this component by combining two indicators: port quantity and port quality.

Port Quantity

Port quantity was calculated from the Liner Shipping Connectivity Index,\(^\text{28}\) a national-level metric developed

\(^{27}\) See [http://www.oceanhealthindex.org/methodology/goals/tourism-and-recreation](http://www.oceanhealthindex.org/methodology/goals/tourism-and-recreation)

by the UN Conference on Trade and Development that ranges from 0–100. This indicator includes the number of ships using a country’s ports, the container capacity of those ships, the maximum vessel size, the number of services, and the number of companies that operate in ports. We converted it to range from 0–1 by dividing by 100.

**Port Services and Quality**

We developed an indicator of port services and quality that accounts for harbor size plus availability of the following services: first port of entry, tug assist, air and rail communications, medical facilities, water and fuel supplies, and dry-dock repair. Data from the International Maritime Organization’s Global Integrated Shipping Information System\(^{29}\) was collected for each country. Our indicator was calculated by assigning points values as follows.

- Harbor size: values of small = 1, medium = 2, large = 3, and very large = 4 were divided by 4.
- First port of entry: yes = 1, no = 0
- Tug assist available: yes = 1, no = 0
- Communications available: air = 0.5, rail = 0.5
- Medical facility: yes = 1, no = 0
- Supplies available: provisions, water, fuel, and diesel each received 0.25
- Drydock available: values of none = 0, small = 1, medium = 2, and large = 3 were divided by 3.

For each port in a country, points were tallied and the total divided by 7 so the range was 0 to 1. Of all the ports within a country, the port with the highest score was used for the national score.

The overall Maritime Transportation and Shipping Component was calculated by equally weighting the port quantity and quality indicators.

**Offshore Oil and Gas Component**

Offshore oil and natural gas development contributes substantially to many economies but the distribution is highly skewed. However, the oil and gas scene is changing rapidly as new discoveries and new extraction technologies are creating opportunities for emerging oil and gas players.

We created the Oil and Gas Component from six indicators, four of which are drawn directly from the U.S. Energy Information Agency (EIA), a resource providing annual data on hydrocarbon production, consumption, and discovery. The four indicators downloaded are the most recent data available for national-level oil production, proved oil reserves, natural gas production, and proved natural gas reserves. The two remaining indicators are original weights for offshore oil and offshore gas industries. We combine these indicators into four subcomponents for Oil Production, Oil Reserves, Gas Production, and Gas Reserves.

**Offshore Oil and Offshore Gas Indicators**

Our first step was to ascertain the percentage of each country’s oil industry and gas industry focused on offshore resources. We consider offshore resources to include those off the coasts in oceans and adjacent seas. We do not include activity in major inland lakes and seas. Using EIA’s country profiles and industry reports specific to each country and oil field, we estimated offshore resources as a percentage of a country’s total oil and gas industry, placing them in a range from 0 to 1. Each country received one score for oil and another for gas.

**Total Petroleum and Other Liquids Production (Thousands of Barrels Per Day)**\(^{30}\)

The EIA measures oil production in thousands of barrels per day and this measure is highly skewed toward the world’s largest producers. In 2016, only 46 countries produced at least 100,000 barrels a day and only 20 produced at least 1 million. The data are skewed by the three countries producing in excess of 10 million barrels per day: Saudi Arabia, the United States, and Russia.

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\(^{29}\) See [https://gisis.imo.org/Public/Default.aspx](https://gisis.imo.org/Public/Default.aspx)

\(^{30}\) See [https://www.eia.gov/beta/international/rankings/#?iso=VEN&cy=2016&tl_id=5-A](https://www.eia.gov/beta/international/rankings/#?iso=VEN&cy=2016&tl_id=5-A).
To rescale these estimates between a minimum of 0 and a maximum of 1, we first convert to billions of barrels per year by multiplying by 365.25 and dividing by 1,000,000. Next, we use a logged ratio transformation, as is used in other parts of this report. The global 90th percentile for oil production is approximately 0.34 billion barrels per year, but experts estimate roughly 30 percent is produced offshore. We use these figures to identify a high benchmark of 0.1 billion barrels, or 100 million barrels per year. Any country producing more receives the maximum value of 1. Where $P$ is production in billions of barrels per year and $W$ is the offshore oil weight, Oil Production is:

\[
\text{Oil Production Subcomponent} = \min\left(1, \frac{\ln(PW+1)}{\ln(0.1+1)}\right)
\]

**Crude Oil Proved Reserves (Billion Barrels)**

The EIA estimate of proved reserves captures untapped oil that is feasible to extract with current extraction technology. Production captures profitability in the present, but reserves indicate future potential and the likelihood of future investment.

Proved reserves are measured in billions of barrels and, like production figures, are highly skewed. In 2016 only 29 countries had at least 3 billion barrels. Of these, 12 had at least 30 billion barrels and Venezuela had 300 billion barrels—nearly a fifth of the world’s proved reserves.

Just as we did above, we rescaled these estimates by setting a high benchmark at one-third the global 90th percentile, or 15 trillion cubic feet. Then, where $R$ represents a country’s gas reserves and $W$ is the offshore gas weight:

\[
\text{Gas Reserves Subcomponent} = \min\left(1, \frac{\ln(RW+1)}{\ln(15+1)}\right)
\]

**Gross Natural Gas Production (Billion Cubic Feet)**

Natural gas is measured in cubic feet, rather than in barrels, but we use the same process described above to rescale gas production to the 0 to 1 interval. First, we convert production and reserves to the same unit, trillions of cubic feet, by dividing Natural Gas Production by 1,000. We calculate the global 90th percentile at around 1.5 trillion cubic feet per year and then reduce this by two-thirds to 500 billion because the EIA estimates only one-third of proved natural gas lies offshore. Where $G$ is gas product in trillions of cubic feet and $W$ is the offshore gas weight:

\[
\text{Gas Production Subcomponent} = \min\left(1, \frac{\ln(GW+1)}{\ln(5+1)}\right)
\]

**Proved Reserves of Natural Gas (Trillion Cubic Feet)**

Finally, the same process is applied to natural gas reserves. We set a high benchmark at one-third the global 90th percentile, or 15 trillion cubic feet. Then, where $R$ represents a country’s gas reserves and $W$ is the offshore gas weight:

\[
\text{Gas Reserves Subcomponent} = \min\left(1, \frac{\ln(RW+1)}{\ln(15+1)}\right)
\]

**Calculating the Oil and Gas Component**

Oil and gas often, though not always, occur in the same geographic space. This is common in West Africa, whereas East Africa has abundant natural gas and very little oil. One consequence of this is that taking an average score across both resources would greatly penalize countries that have extensive industries around one resource but not the other. This problem is exacerbated by the log-transformations; a country like Mozambique can have one of the largest gas reserves in the world and no oil yet receive a lower score than a country like Ghana, which has moderate reserves of both resources but nowhere near the economic potential of Mozambique.

---


We correct for this by creating an Oil and Gas Component that accounts for both industries while weighting a country’s better of the two industries more heavily. The component is calculated from two terms; the first is the average of the four subcomponents (oil production and reserves, gas production and reserves) and the second is the average of production and reserves in the stronger industry. Mathematically, this is calculated as:

\[
\text{Oil and Gas} = \frac{(OR+OP+GR+GP)}{8} + \frac{\text{MAX}(OR+OP,GR+GP)}{4}
\]

The first term shows the four subcomponents divided by 8. This produces a value ranging from 0 to 0.5. The second term identifies whether oil or gas is the higher-scoring resource in a given country, sums the resources and production scores for that resource, and then divides that sum by 4. This also results in a score that will range from 0 for a country with neither oil nor gas to 0.5 for a country that exceeds the maximum benchmarks in both production and reserves of its stronger resource. When these are summed to create the Oil and Gas Component, we have, in effect, a measure that is weighted 75 percent toward a country’s more important resource and 25 percent toward its less important of the two resources.

### Adjusted Net Savings Component

Adjusted Net Savings (ANS) is a measure of true savings in a country after taking into account depletion of natural resources and damages as well as investments in human capital. Many economists have adopted ANS as a metric that overcomes some shortfalls in using Gross Domestic Product to measure economic growth and development. ANS is derived from the standard national accounting measure of gross saving by making four adjustments: consumption of fixed capital is deducted to obtain net national saving; current public expenditure on education is added to account for investment in human capital; estimates of the depletion of a variety of natural resources are deducted to reflect the decline in asset values associated with extraction and depletion; and deductions are made for damages from carbon dioxide and particulate emissions.

We use ANS measures from the World Bank’s World Development Indicators Little Green Book. The regional average was used for countries without ANS values. We first standardized scores to range from 0–1 according to the maximum and minimum regional values. This results in the country with the highest regional score earning a perfect 1.0.

Our final ANS Component for country \( n \) was

\[
\text{ANS}_n = \frac{(X_n + \text{abs}(X_{\text{min}}))}{(X_{\text{max}} + X_{\text{min}})} \times 0.89
\]

where the minimum and maximum ANS values were calculated from the list of Stable Seas Maritime Security Index countries.

### Climate Vulnerability Component

Several components of the Blue Economy, such as fisheries and tourism, may be affected by global climate change. To account for this risk, we included an indicator of vulnerability to climate change. We used the University of Notre Dame’s Global Adaptation Index (known as ND-GAIN), which is calculated at a national scale and updated annually. The index measures a country’s vulnerability to climate change based on: 1) exposure to climate-related or climate-exacerbated hazards, 2) sensitivity to the hazard’s impacts, and 3) capacity to adapt or manage to the impacts. We use the ND-GAIN score from 2016. ND-GAIN ranges from 0–1 so we did not adjust the numbers.

### Calculating the Blue Economy Score

The final Blue Economy Score equally weights the six components described above: Fisheries, Marine and Coastal Tourism, Maritime Transportation and Shipping, Offshore Oil and Gas, Adjusted Net Savings, and Climate Vulnerability. The six components were averaged and multiplied by 100 to achieve a final score between 0 and 100.
VII. FISHERIES

Maritime security includes the ocean having the capacity to provide food and livelihoods to coastal people. The health of marine fisheries is a critical component of food and livelihood provision. Threats to fisheries include pollution, over-exploitation, and poor governance capacity. When fisheries are abundant and well-managed, they can contribute to maritime security by improving national economies, local livelihoods, and nutrition. Nations that engage in formal governance mechanisms and have strong fisheries laws are better able to monitor and enforce policies that support healthy fisheries. Likewise, clean waters and healthy fish stocks support economic growth and reinforce governance norms. Nations that do not prioritize fisheries management and governance are not fully leveraging a critical natural resource and may lose profit and food to larger, faster foreign and distant-water fishing fleets.

We measure the Fisheries Score with six equally weighted components: Fishery Health, Foreign Fishing, Fisheries Legislation, Regional Fisheries Management Organizations (RFMOs), Ocean Pollution, and Marine Protected Areas.

**Fishery Health Component**

Fishery health refers to the status of fish stocks from the perspective of sustainable harvesting of fisheries resources. We used the value of the Wild Caught Fisheries sub-goal of the Food Provision goal in the Ocean Health Index. The Ocean Health Index\(^\text{36}\) measures countries on biological, physical, economic, and social factors to assess how sustainably humans are using the ocean. The Wild Caught Fisheries sub-goal measures how well a nation achieves optimal sustainable production of seafood compared to a biological baseline. The target is for a given nation to maintain a fish population at the level that produces Maximum Sustainable Yield (known as $B_{\text{MSY}}$). Countries are penalized for both underfishing and overfishing. Thus, this metric is not solely one of conservation—a nation that does not fish will not earn the highest score because they are leaving potential revenue in the water. We divided the Wild Caught Fisheries sub-goal by 100 to achieve a Fishery Health Component between 0 and 1.

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\(^{36}\) See Oceanhealthindex.org.
### Table 6 Components of the Fisheries Score

<table>
<thead>
<tr>
<th>Component</th>
<th>Justification</th>
<th>Measurement Strategy</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>FISHERY HEALTH</strong></td>
<td>Fish stocks produce the highest economic and livelihood gains when they are</td>
<td>Ocean Health Index sub-goal for Wild Caught Fisheries</td>
</tr>
<tr>
<td></td>
<td>sustainably utilized (e.g., not overfished).</td>
<td>---------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td><strong>FOREIGN FISHING</strong></td>
<td>The presence of foreign fishing vessels can be a destabilizing factor and</td>
<td>Percent of fishing conducted by foreign-flagged vessels from catch data from The Sea</td>
</tr>
<tr>
<td></td>
<td>reduce maritime security through direct interactions with domestic fleets or</td>
<td>Around Us</td>
</tr>
<tr>
<td></td>
<td>competition for finite fish stocks.</td>
<td>---------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td><strong>FISHERIES LEGISLATION</strong></td>
<td>Fisheries laws that have strong provisions for management, enforcement, and</td>
<td>Original scoring of domestic fisheries legislation archived with the UN Food and</td>
</tr>
<tr>
<td></td>
<td>defined access are more productive and sustainable.</td>
<td>Agriculture Organization</td>
</tr>
<tr>
<td><strong>RFMOs</strong></td>
<td>Members of regional fisheries management organizations have better reporting</td>
<td>Binary factor where 1 = yes and 0 = no if a country is a member of an RFMO whose</td>
</tr>
<tr>
<td></td>
<td>and enforcement mechanisms and have signaled willingness to work with</td>
<td>jurisdiction overlaps that specific EEZ</td>
</tr>
<tr>
<td></td>
<td>recognized international institutions on fisheries management.</td>
<td>---------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td><strong>OCEAN POLLUTION</strong></td>
<td>Waters with less pollution support healthier fisheries, which contributes to</td>
<td>Ocean Health Index Clean Waters goal</td>
</tr>
<tr>
<td></td>
<td>the food supply, the economy, and fisheries livelihoods.</td>
<td>---------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td><strong>MARINE PROTECTED AREAS</strong></td>
<td>Fish stocks are healthier where states demonstrate their commitment to</td>
<td>The percentage of each state’s EEZ designated as a Marine Protected Area</td>
</tr>
<tr>
<td></td>
<td>conservation and sustainability by protecting critical habitats and breeding</td>
<td>---------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td></td>
<td>grounds within their EEZs.</td>
<td>---------------------------------------------------------------------------------------</td>
</tr>
</tbody>
</table>

### Foreign Fishing Component

The presence of foreign fishing vessels in EEZ waters can be a cause of maritime insecurity and conflict. In African waters, domestic fishing fleets tend to be small-scale and artisanal, using small boats and gear. Foreign vessels, especially those from distant-water fleets that have traveled thousands of miles to fish, are larger, faster, and use larger sets of gear. This can cause direct conflict between domestic and foreign vessels. In some African countries, foreign vessels have been accused of destroying artisanal gear, crowding out smaller boats, destroying marine habitat, and depleting fisheries resources. Case studies in both East and West Africa demonstrate that illegal, unreported, and unregulated (IUU) fishing is often related to, and even caused by, the presence of foreign fishing vessels in a nation’s waters. This is not universally true, and some nations that have large foreign fleets have low levels of IUU fishing. Likewise, not all foreign vessels perpetuate conflict. Given the lack of a comprehensive and comparative estimate of the amount of IUU fishing in EEZs, we calculate the percent of total fish catch made by foreign vessels within an EEZ.

We use data collected and maintained by the Sea Around Us that assigns all reported or reconstructed fish catch in an EEZ to a given country based on the flag of the ship catching fish. Total catch was divided into domestic catch and foreign catch using the identifying category “Entity,” which identifies by flag the country responsible for fish catch and measures in metric tons. Foreign catch was divided by total catch to get a percentage. This was then subtracted from 1 to reverse the order of the scale so that lower component values aligned with higher percentages of foreign fishing.
and higher component values aligned with lower percentages of foreign fishing.

**Fisheries Legislation Component**

Strong domestic fisheries laws include clear directives for management, provisions for enforcement, and mandates for data collection that inform fisheries management plans. When governments have strong fisheries laws, conflict is minimized through having clear guidelines on access rights and approved fishing methods. We measure the strength of domestic fisheries laws by coding each country’s fisheries legislation, which is housed online by the UN Food and Agriculture Organization, for mandates on the following:

- an observer program
- data collection
- foreign vessel licensing
- gear restrictions
- catch limits based on Maximum Sustainable Yield

A country received one point for each related mandate in their domestic legislation, and the Fisheries Legislation Component was calculated by dividing each country’s point total by 5 (the maximum possible value). This created a component that ranged from 0 to 1.

**Regional Fisheries Management Organization Component**

Governments that engage and collaborate with international fisheries bodies are more likely to adopt norms around fisheries management and scientific data collection and to adopt best practices for monitoring, control, and surveillance. Regional fisheries management organizations are international bodies with voluntary membership by those countries whose fishing interests fall within the RFMO’s jurisdiction. Some RFMOs are defined solely by geographic extent, while others are defined by the scope of the fishes they manage (e.g., tuna and other highly migratory species). We used maps showing the boundaries of RFMOs to identify overlap between RFMO jurisdictions and EEZs. Scores were calculated by counting the number of RFMO memberships a country had from the pool of RFMOs that had overlapping jurisdictions (i.e., countries did not get penalized for not joining RFMOs outside their EEZs and we assume countries should be members of those RFMOs that touch or overlap their EEZs). The total of points earned was then divided by total possible points to scale the component between 0 and 1.

**Ocean Pollution Component**

Marine pollution can negatively impact fisheries by disrupting breeding or feeding areas, reducing reproduction, or introducing diseases. It is also a proxy for coastal development which disrupts marine habitat such as seagrass beds and coral reefs. We used the score from the Clean Waters goal in the Ocean Health Index. The Clean Waters goal measures pollution from chemicals, nutrients (agriculture), pathogens, and trash (including plastics) in EEZ waters. We divided the Clean Waters score by 100 to get a value between 0 and 1.

**Marine Protected Areas**

Many states have committed to protecting vital fisheries habitats by designating fragile ecosystems and breeding grounds as Marine Protected Areas (MPAs). In fact, states have committed through the Sustainable Development Goals (SDG 14) to protecting 10% of coastal and marine areas by 2020. Using data from the Atlas of Marine Protection, we calculate the share of a country’s EEZ that is set aside as an MPA. We create the score by multiplying this percentage by 10 to arrive at a score that ranges from 1 for states protecting 10% or more to 0 for states with no designated MPAs.

**Calculating the Fisheries Score**

The final Fisheries Score equally weights the six components described: Fishery Health, Foreign Fishing, Fisheries Legislation, RFMOs, Ocean Pollution, and Marine Protected Areas.

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39 www.mpatlas.org
The five components were averaged and multiplied by 100 to achieve a final score between 0 and 100. The strongest relationship between components is between foreign fishing and fishery health: nations with lower levels of foreign fishing in their EEZs had, on average, healthier fish stocks.

**Fisheries Variables in the Data File**

<table>
<thead>
<tr>
<th>Component</th>
<th>Justification</th>
<th>Measurement Strategy</th>
</tr>
</thead>
<tbody>
<tr>
<td>FI_FINAL</td>
<td>Fisheries Score</td>
<td>2018 data on incidents of piracy and armed robbery at sea from Stable Seas State of Piracy report</td>
</tr>
<tr>
<td>FI_FOREIGN</td>
<td>Foreign Fishing Component</td>
<td></td>
</tr>
<tr>
<td>FI_FOREIGN_PERCENT</td>
<td>Percentage of Total Catch by Foreign-Flagged Vessels</td>
<td></td>
</tr>
<tr>
<td>FI_LEGISLATION</td>
<td>Fisheries Legislation Component</td>
<td></td>
</tr>
<tr>
<td>FI_LEGIS_RAW</td>
<td>Total Points Given to Domestic Fisheries Legislation</td>
<td></td>
</tr>
<tr>
<td>FI_RFMO</td>
<td>RFMO Component</td>
<td></td>
</tr>
<tr>
<td>FI_POLLUTION</td>
<td>Ocean Pollution Component</td>
<td></td>
</tr>
<tr>
<td>FI_MPA</td>
<td>Marine Protected Areas Component</td>
<td></td>
</tr>
</tbody>
</table>

**VIII. PIRACY AND ARMED ROBBERY AT SEA**

The Piracy and Armed Robbery at Sea Score measures the instances of piracy occurring in proximity to a country’s EEZ. Following international legal definitions established in UNCLOS, we define piracy and armed robbery at sea as follows.

**Piracy:** “Any illegal acts of violence or detention, or any act of depredation, committed for private ends by the crew or the passengers of a private ship or a private aircraft, and directed: (i) on the high seas, against another ship or aircraft, or against persons on property on board such ship or aircraft; (ii) against a ship, aircraft, persons, or property in a place outside the jurisdiction of any State.”

**Armed Robbery:** “Unlawful act of violence or detention or any act of depredation, or threat thereof, other than an act of piracy, committed for private ends and directed against a ship or against persons or property on board such a ship, within a state’s internal waters, archipelagic waters, and territorial sea.”

Legally, these activities are mainly distinguished by where they occur. Events occurring within the territorial waters of a state, typically within 12 nautical miles of the baseline, are acts of armed robbery at sea. Incidents occurring farther from the coast, including those occurring within an EEZ, are acts of piracy. Our data cover events occurring on the high seas, within EEZs, and within territorial waters. They do not include port crimes or incidents in states’ internal waters with the exception of events that occur within the High Risk Area (Gulf of Guinea) defined by the International Transport Workers Federation.

We measure Piracy and Armed Robbery at Sea with one component: Proximity.

Using geographic information system (GIS) data, we calculated the minimum distance between every country’s EEZ and each incident of piracy or armed robbery at sea recorded in the Stable Seas State of Piracy report in 2018. Distances were measured as the minimum length from the latitude and longitude of the incident to the closest border of the EEZ. Distances for events occurring within an EEZ were measured as 0.

**Table 7 Components of the Piracy and Armed Robbery Score**

<table>
<thead>
<tr>
<th>Component</th>
<th>Justification</th>
<th>Measurement Strategy</th>
</tr>
</thead>
<tbody>
<tr>
<td>PROXIMITY</td>
<td>Many attacks occur against international vessels operating just beyond a state’s EEZ. To capture these incidents as well as those occurring in a country’s EEZ, we measure the country’s proximity to incidents of piracy and armed robbery rather than a simple count of events within an EEZ.</td>
<td>2018 data on incidents of piracy and armed robbery at sea from Stable Seas State of Maritime Piracy report</td>
</tr>
</tbody>
</table>
Then, we identified each country’s set of closest incidents and rank-ordered them according to distance. We measured distances in hundreds of kilometers and set a maximum distance of 1,000 kilometers, meaning anything occurring farther away than that cannot count against a state’s score. To scale these distances to the 0 to 1 interval and to account for the diminishing importance of increased distance (10 vs. 50 kilometers is more relevant than 210 vs. 250 kilometers, for example), we log-transformed each distance with the following equation:

\[
\text{Transformed Event Distance} = \frac{\ln(\text{distance}/100+1)}{\ln(1000/100+1)}
\]

Finally, we calculated the Proximity Component for each country based on the transformed distances for events of piracy and armed robbery at sea by keeping the transformed distances for the nearest 25 events and then weighting them in reverse order.\(^{40}\) In other words, we multiplied the transformed distance of the closest event by 25, the second-closest by 24, and so on until we multiplied the 25th-closest event by 1. We then summed these weighted distances for each country and divided by 325 (the sum of all whole numbers between 1 and 25) to arrive at the final Proximity Component.

We multiplied by 100 so that scores would range from 0 to 100, with 0 reserved for states with at least 25 events within their EEZ and 100 for states without a single event within 1,000 kilometers of their EEZ boundary.

**Piracy and Armed Robbery Variables in the Data File**

<table>
<thead>
<tr>
<th><strong>PAR_FINAL</strong></th>
<th>Piracy and Armed Robbery at Sea Score</th>
</tr>
</thead>
</table>

**IX. ILLICIT TRADES**

Forces of globalization, such as advancements in communication and transportation technologies, have facilitated the integration of formerly isolated domestic markets. However, these same forces have also fueled the rise of transnational organized crime, including in the maritime domain. As transnational criminal networks become entrenched, some expand and diversify their activities. It is not uncommon to find linkages between various trafficking activities. Some criminal networks directly fund non-state actors engaged in rebellion and terror.

Illicit trades are a problem nearly everywhere, but the goods being trafficked vary by region. To capture the breadth of the maritime illicit trades, we created scorecards evaluating each country’s participation in the illicit maritime movement of the following products: coca and its derivatives, opiates, cannabis, synthetic narcotics, small arms and light weapons, and wildlife products. The nature of the shadow economy means precise estimates of the scale of these trades are impossible to obtain. However, we can evaluate the relative severity of each trade and the diversity of illicit goods moving through each country’s waters.

We build the Illicit Trade Score with two components: Breadth of Maritime Illicit Trades and Depth of Most Severe Maritime Illicit Trades.

**Assessment**

For each of the seven illicit trades, survey respondents assessed the severity of the problem and the extent to which each trade is a maritime issue (rather than land-based or air-based). The following is a brief summary of the goods covered.

**Arms**

This score focuses on illegal transfers of weapons and ammunition across country borders. It does not cover legal arms sales between governments, but instead aims to capture illegal flows that primarily involve non-state actors. Most of these arms are categorized as small arms and light weapons. The buyers are often—though not always—violent non-state actors operating

---

\(^{40}\) The threshold of 25 events is admittedly arbitrary, but because there is a diminishing effect for each additional event, increasing this threshold does not dramatically change the score.
in the region.

**Drugs**

The drug-trafficking analysis is divided into the same four categories that organize major publications like the United Nations Office on Drugs and Crime’s World Drug Report: cannabis, coca, opiates, and synthetic narcotics. Africa is not only a transcontinental transport hub, it has recently transitioned to also being a major consumer of these drugs, and increasingly a producer of methamphetamines.

**Wildlife**

The final issue area analyzed, wildlife trafficking, covers poaching of protected species and illicit transfers of animals (e.g., exotic pets) as well as animal products (e.g., ivory and pelts) acquired through illegal means.

Each of the areas is evaluated with two rubrics.

*Question 1: The Presence of an Illicit Trade in a Country*

0: We could find no credible evidence that this occurs here.

1: We could find limited reporting on this, possibly indicating this is a minor problem.

2: There is some evidence that this is a significant problem, but it is far from universally accepted as a major problem.

3: There is widespread acceptance that this is a significant and uncontained problem.

4: This country is nearly universally recognized as a global hotspot for this activity and the severity of the problem is substantially worse than it is in most other countries.

*Question 2: The Extent to Which This Trade is a Maritime Problem*

0: We could find no credible evidence that this occurs in the maritime space. Goods are moved almost exclusively by land or air.

1: Goods are mostly moved by land or air, with minor sea-based transit.

2: There is significant movement of goods by land, air, and sea.

3: Most known illicit traffic moves by sea, with limited reporting of land or air routes.

4: This country is recognized as a major shipping hub for this illicit product and nearly all known transit of this good is by sea.

As this is a score of maritime illicit trade, we scale the first question using the second. In this way, a state that has a significant land-based trafficking problem will not be penalized to the same extent as a country with a significant sea-based trafficking problem. Land-based
problems are relevant because routes often shift and land or air traffic can make a maritime space more vulnerable to the emergence or expansion of sea-based traffic. Our primary objective is to focus on the most severe sea-based trades in the present, though land or air trafficking means there is a higher risk for a rapid shift to maritime trafficking than there is in countries without these routes. We accomplish this with the following formula, where \( P \) is the response to Question 1 and \( M \) is the response to Question 2:

\[
\text{Trade Score} = \frac{(P + M \times P)}{20}
\]

If a country is coded as a global leader in a trade (\( P = 4 \)) and that trade is nearly exclusively sea-based (\( M = 4 \)), the numerator will equal 20 and the country will receive the maximum score of 1. This score is sharply reduced if the problem is mostly (\( M = 1 \), score = 8) or exclusively (\( M = 0 \), score = 4) land- or air-based.

**Breadth of Trade Component**

We evaluate the breadth and severity of maritime illicit trades by summing a country’s score for each of the six goods and then dividing that sum by six. Countries with many severe and sea-based trades will receive much higher scores than those that have fewer trades or more land or air activity.

**Depth of Trade Component**

A drawback of the breadth score is that it overlooks countries that may not be involved in many trades but which are a global hotspot for a specific good like cocaine or opiates. Accordingly, we create an additional indicator for a country’s most severe illicit maritime trade by recording the worst score. This is calculated simply as the maximum of the six scores for each illicit trade.

**Calculating the Illicit Trades Score**

Finally, we create the final score from these components. Greater numbers of trades indicate deeper and more entrenched transnational criminal networks with deeper connections to more corners of

<table>
<thead>
<tr>
<th>Illicit Trade Variables in the Data File</th>
</tr>
</thead>
<tbody>
<tr>
<td>IT_FINAL</td>
</tr>
<tr>
<td>IT_WORST</td>
</tr>
<tr>
<td>IT_SUM</td>
</tr>
<tr>
<td>IT MAR</td>
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<tr>
<td>IT_ARMS_T</td>
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<tr>
<td>IT_SYN</td>
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<tr>
<td>IT_WILD_T</td>
</tr>
<tr>
<td>IT_WILD_M</td>
</tr>
<tr>
<td>IT_WILD</td>
</tr>
</tbody>
</table>
the global illicit economy, so the Breadth Component is weighted at \( \frac{2}{3} \) and the Depth Component is weighted at \( \frac{1}{3} \). To align this score with the others, which are coded so that high values represent better maritime security situations, we multiply this value by 100 and then subtract it from 100. Consequently, countries with high scores have the least-significant maritime illicit trades and countries with low scores are major shipping hubs for several illicit goods.

\[
\text{Illicit Trades Score} = 100 - 100 \times (\text{Breadth} \times \frac{2}{3} + \text{Depth} \times \frac{1}{3})
\]

X. MARITIME MIXED MIGRATION

Mixed migration is a complex and rapidly evolving issue, and this complicates efforts to measure it even where some data on migration, trafficking, and human smuggling are available. Our effort to measure mixed migration focuses less on raw numbers of people involved in some aspect of mixed migration and more on the variety of activities known to occur in each country, the role of the sea in these activities, each country’s international and domestic legal efforts, and a population’s baseline vulnerability to exploitation based on relevant socioeconomic factors. We adopt a definition of mixed migration from the International Organization for Migration, which uses the following:

“
The principal characteristics of mixed migration flows include the irregular nature of and the multiplicity of factors driving such movements, and the differentiated needs and profiles of the persons involved. Mixed flows have been defined as ‘complex population movements including refugees, asylum seekers, economic migrants and other migrants.’ Unaccompanied minors, environmental migrants, smuggled persons, victims of trafficking and stranded migrants, among others, may also form part of a mixed flow.”

We measure the Mixed Maritime Migration Score with four equally weighted components: Maritime Trafficking, Maritime Transit, Legal Protections, and Socioeconomic Vulnerability.

Maritime Trafficking Component

The first component captures the severity of human trafficking in each country, as well as the extent to which problems occur in a country’s maritime space. We accomplish this by scoring the severity and breadth of forced labor and sex trafficking and the role of the country as an international “transit hub” for smuggled and trafficked persons and then weighting these scores according to whether they occur exclusively, predominantly, or rarely at sea.

The following describes these three indicators in greater detail.

Types of Trafficking

Rather than rely on inconsistent estimates of the number of victims, we account for the diversity in the types of trafficking occurring in a given country. More specifically, we use the Trafficking in Persons Report (TiP) from the United States Department of State to create eight scores corresponding to the two types of trafficking (sex and forced labor) across four populations: men, women, boys, and girls. If these country reports elaborate on a specific form of trafficking against a specific population (e.g., sex trafficking of girls, boys trafficked for forced labor, etc.), then we code this as a significant activity. Three coders worked independently to code these data according to the following rubric:

0: This activity/population was not mentioned in the TiP report.

1: This activity/population was mentioned but was either briefly mentioned or was qualified as a relatively minor or poorly understood problem.

2: This activity/population was mentioned and the activity was emphasized as a significant problem.

After initial coding, the coders resolved the few differences by meeting and reviewing sources. The coders found that very small differences in sentence structure could result in a disagreement between a 0 and 1, so we only code activities that are discussed enough to warrant a score of 2 in the above rubric. This score is the share of the eight scores for which a country received a score of 2. For example, a country with a profile that discusses, to the degree of a 2 score, forced labor affecting men and boys, forced domestic servitude for women and girls, and sex trafficking of children (boys and girls) would receive a score of 6/8, or 0.75.

Possible scores range from 0 (no discussion of any kind of trafficking) to 8 (significant numbers of men, women, girls, and boys are victims of both sex trafficking and forced labor). We divide this score by 8 to set all scores within the 0 to 1 interval. We set missing values to the regional mean.

Transit Countries

Migrants and other vulnerable populations are most likely to be subjected to a form of trafficking in the countries recognized as crucial transit hubs in the Trafficking in Persons report. Countries are classified as “transit countries” when international migrants commonly pass through in their journeys to be smuggled to other countries. For example, Libya is an important transit country for migrants making their way from West Africa to Europe via the Mediterranean routes. This variable is coded 0 (not named as a transit hub) or 1.

Maritime Activities

The Trafficking in Persons report does not systematically report on maritime activities, so we broadened our search to find resources that could describe where these trafficking activities occur. We then created an original four-value scale:

0: We could find no evidence that this country’s trafficking activities are occurring at sea or in maritime industries.

1: We could find some mention of maritime activities, such as forced labor in the fishing industry or sex trafficking in port facilities, but this issue is poorly understood and the available evidence is weak.
2: This is a well-documented activity occurring at sea or in service of maritime industries in this country.

3: All available evidence suggests forced labor, sex trafficking, and the transit of trafficked persons are occurring nearly exclusively at sea or in maritime industries.

We divide this outcome by 3 to obtain a score that ranges from 0 to 1.

**Calculating the Maritime Trafficking Component**

Finally, we calculate the Maritime Trafficking Component using the same methodology described for the Illicit Trades section with the following formula where A is the Types score, B is the Transit score, and C is the Maritime score:

\[ \text{Maritime Trafficking} = \frac{(A+B) \times (1+C)}{4} \]

First, we sum the types and transit scores so that countries with extensive forced labor, sex trafficking, and international transit of persons receive a maximum of 2, while countries with no known problems receive the minimum of 0. This is captured by the term \((A+B)\) in the above formula.

Second, just as land-based problems are relevant to illicit trades in goods due to the potential for shifting routes and smuggling networks, these problems are relevant here even if maritime activities are minimal at present. We capture this with the second term, \((1+C)\). If there is no known maritime activity, a country’s Types/Transit score is unchanged by this term. However, if there is good evidence of existing maritime activity, the score increases with the strength of the evidence for maritime transit and trafficking. Note that the maximum score of 4 would only apply to an international mixed-migration transit-hub country \((B = 1)\) with severe forced labor and sex trafficking affecting men, boys, girls, and women \((A = 1)\) that occurs nearly exclusively in the maritime domain \((C = 1)\).

As a final step, we divide this product by 4 so that the score will range from 0 (no known problems, no maritime problems) to 1 (severe trafficking of every kind concentrated in the maritime space).

Because these scores focus on maritime activity, they will not always align with other reports that focus on onshore smuggling, trafficking, internally displaced persons, and refugees. The Democratic Republic of the Congo, for example, has well-known challenges in these areas; however, there is very little maritime smuggling and trafficking due to the coastal area of the country being small, remote, and very far from the humanitarian challenges occurring in the distant eastern part of the country.

**Maritime Transit Component**

Whereas the Maritime Trafficking Score aims to capture the extent of trafficking at sea, the Maritime Transit Component focuses on the movement of people in the maritime space, rather than their exploitation. Many persons who are not being trafficked transit by sea as they pay smugglers to take them to their destinations. We approximate the extent of this kind of maritime transit by considering a country’s refugee rate and the prevalence of maritime routes relative to routes by land or air.

**UNHCR Refugee Rate**

We use data from the United Nations High Commissioner for Refugees (UNHCR) to calculate a logged per capita refugee rate. The score is higher when a greater share of a country’s population has sought refugee status in another country in the last year. The rate is calculated as the logged refugee rate (refugees per million) divided by the log of 100,000. This gives us a score ranging from 0 (no refugees) to 1 (10 percent of the population). This is a reasonable benchmark because it approximates the region’s observed maximum.\(^{42}\)

\[
\text{Refugee Rate} = \frac{\ln(\text{Refugees}/(\text{Population in Millions})+1)}{\ln(100000+1)}
\]

Maritime Transit Weight

Accurately and consistently calculating the number of people crossing a specific maritime route is impossible due to the inherently evasive nature of smuggling and other forms of mixed migration. However, we can create a proxy measure by using a country’s refugee rate (described above) and an assessment of whether most migration from a country occurs by land (as in the Democratic Republic of the Congo) or by sea (as in Comoros). We code each country on a four-point scale ranging from 0 (exclusively land-based transit) to 3 (exclusively maritime transit) with the following rubric:

0: We could find no evidence that persons transiting this space move by sea; land and air routes are much more likely.

1: We could find some mention of maritime routes, but most move from or through this country by land or air.

2: Maritime routes are well-documented and mixed migration occurs by sea in addition to significant land and air routes.

3: This country is a major regional or global hub for maritime mixed migration and sea-based routes are more commonly used than land or air routes.

We divide this score by 3 to achieve a 0 to 1 interval before calculating the final Maritime Transit Component. Using the same methodology we use to create the Maritime Trafficking Component, we derive the Maritime Transit Component from the following formula:

Maritime Transit Component = (Refugee Rate)*(1+Maritime Weight) / 2

The result is a metric that ranges from 1, which is earned only by countries with very high numbers of refugees and predominantly sea-based routes, to 0, which is earned only by countries with minimal refugee populations and minimal transit through the maritime domain.

Legal Protections Components

The legal protections portion of the score is comprised of an international agreements indicator and a domestic legislation indicator. These indicators are averaged to create a single component for this section.

International Agreements

As in the International Cooperation section, we identify relevant agreements, code whether states have signed or ratified them, and then transform them so that states earn 0 if they have not signed, 0.33 if they have signed but not ratified, and 1 if they have both signed and ratified. This score examines seven agreements. Scores are summed and divided by 7 to arrive at a value from 0 to 1.

The seven agreements are:

- The International Labour Organization Forced Labour Convention of 1930
- The International Labour Organization Abolition of Forced Labour Convention of 1957
- The International Labour Organization Worst Forms of Child Labour Convention of 1999
- The International Labour Organization Domestic Workers Convention of 2011
- The International Labour Organization Work in Fishing Convention of 2007

Domestic Legislation

The domestic portion of the score is adapted from the “3P Anti-trafficking Policy Index” by Seo-Young Cho. This index uses the Trafficking in Persons report to annually score a state’s legal efforts in the areas of prosecuting traffickers, protecting potential victims,

43 Data are available for download at http://www.economics-human-trafficking.org/anti-trafficking-3p.html. As with all resources linked to the Trafficking in Persons report, Sao Tome and Principe is missing. We imputed using regional averages.
and preventing trafficking networks. The most recent version of these data are coded on a scale of 0 to 15 (5 possible points per “p”). We apply the methodology to the most recent TIP report and then divide these scores by 15 to rescale the score from 0 to 1, with 1 indicating the country has the ideal package of domestic legislation to support victims of human trafficking.

Finally, we calculate the Legal Protections Component as the average of Domestic Legislation and International Agreements.

**Socioeconomic Vulnerability Component**

Finally, populations are more vulnerable to trafficking where political systems are ineffective, human capital is low, and socioeconomic conditions are poor. We operationalize a population’s vulnerability with the Vulnerability to Slavery score calculated by the Walk Free Foundation as part of its Global Slavery Index.

**Global Slavery Index Vulnerability Indicators**

The Walk Free Foundation assesses a population’s vulnerability to slavery with an index that includes 24 political, economic, and demographic statistics.\(^4\)

This indicator ranges from 0 to 100. We input missing values using the regional average.

**Calculating the Maritime Mixed Migration Score**

We calculate the Maritime Mixed Migration Score as the average of the Maritime Activity, Maritime Transit, Legal Protections, and Socioeconomic Vulnerability Components. Because the other components of the Maritime Mixed Migration Score are coded so that higher scores represent more severe problems, we reverse the direction of the Legal Protections score before combining it with the others. In the final score, countries with low scores have the weakest legal protections, the most vulnerable populations, and the greatest existing challenges related to maritime migration, smuggling, and trafficking at sea. High scores represent less vulnerability and less maritime activity, as well as stronger domestic and international legal efforts.

**Maritime Mixed Migration Variables in the Data File**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>MMM_FINAL</td>
<td>Maritime Mixed Migration Score</td>
</tr>
<tr>
<td>MMM_FORMS</td>
<td>Maritime Trafficking Score</td>
</tr>
<tr>
<td>MMM_MAR_ACT</td>
<td>Maritime Trafficking Activity Weight</td>
</tr>
<tr>
<td>MMM_TIP_TRANSIT</td>
<td>Transit Country Indicator</td>
</tr>
<tr>
<td>MMM_ACTIVITY</td>
<td>Maritime Activity Component</td>
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<tr>
<td>MMM_REFUGEE</td>
<td>Logged Per Capita Refugee Rate</td>
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<tr>
<td>MMM_MAR_TRANS</td>
<td>Maritime Transit Weight</td>
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<tr>
<td>MMM_TRANS_TOT</td>
<td>Maritime Transit Component</td>
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<tr>
<td>MMM_WFF</td>
<td>Walk Free Foundation Vulnerability Score</td>
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<tr>
<td>MMM_VULN</td>
<td>Vulnerability Component</td>
</tr>
<tr>
<td>MMM_DOMESTIC</td>
<td>Rescaled Domestic Efforts Indicator</td>
</tr>
<tr>
<td>MMM_INTLAW</td>
<td>Rescaled International Legal Indicator</td>
</tr>
<tr>
<td>MMM_LEGAL</td>
<td>Final Legal Efforts Component</td>
</tr>
</tbody>
</table>
One Earth Future (OEF) is a self-funded, private operating foundation seeking to create a more peaceful world through collaborative, data-driven initiatives. OEF focuses on enhancing maritime cooperation, creating sustainable jobs in fragile economies, and research which actively contributes to thought leadership on global issues. As an operating foundation, OEF provides strategic, financial, and administrative support allowing its programs to focus deeply on complex problems and to create constructive alternatives to violent conflict.

Stable Seas, a program of One Earth Future, engages the international security community with novel research on illicit maritime activities such as piracy and armed robbery, trafficking and smuggling in persons, IUU (illegal/unregulated/unreported) fishing, and illicit trades in weapons, drugs, and other contraband. These activities perpetuate organized political violence and reinforce each other to threaten economic development and the welfare of coastal populations.