Seasteading Location Study:

Ship-Based and Large-Scale City Scenarios

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Our Mission: To further the establishment and growth of permanent, autonomous ocean communities, enabling innovation with new political and social systems.

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Seasteading Report

Location Study

Abstract

To determine the most promising locations for seastead communities, The Seasteading Institute has evaluated the entire ocean, based on a comprehensive set of criteria related to environmental, economic, legal and political considerations.

Weighting factors were assigned to each criterion in proportion to their perceived importance in the context of two different seastead scenarios. One scenario represents a small community of a few hundred residents that would be typical of an early seastead. The other scenario represents a much larger community, with tens of thousands of residents, embodying the Institute's long-term vision of enabling a full-fledged city on the ocean.

Data sets for each criterion are presented for each of the two scenarios in the form of color-coded heat maps depicting the desirability of possible locations. Readers are encouraged to consider how they might assign weights differently to each criterion to match their own seasteading scenarios.

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1. Introduction

The Seasteading Institute promotes the establishment of permanent, autonomous communities in the open ocean in order to develop new political and social systems. Since all of the world's land has already been claimed as the territory of existing governments, the only place to start new countries is on the open sea.

Throughout the ages, humans have found countless ways to live, work, and play on (and under) the sea. However, these activities have been almost universally transitory in nature. The establishment of *permanent* communities in the open ocean is literally "uncharted territory." One of the challenges is to determine *where* such communities should ideally be located. Given the sheer surface area of the earth's oceans, making an informed judgment about where to locate a seastead community is a daunting task.

In many ways, the process is similar to deciding where to locate a residential community or a commercial facility on land, where relevant considerations may include proximity to natural resources, customers, workers, communication, and transportation, as well as factors like the level of taxation and regulatory burden. The importance of each of these factors depends on the nature of the enterprise, and decisions will always involve trade-offs among various criteria. One of the main challenges in selecting a location for a seastead arises from the fact that there is virtually no empirical data to suggest which sites in the open ocean might be most suitable for permanent activities.

Therefore, the first task in this study was to develop a global database of all the factors that are considered relevant to the selection of the best location for a seastead. As described in Section 2 of this report, these factors include characteristics of the physical environment, business and economic considerations, as well as political and legal concerns. Each factor's data set is organized as an individual "layer" in the database.

The second task in this study was to "score" the layers, by transforming different quantitative and qualitative measures associated with each data set into scalar measures on a numerical scale from 1 to 100. This process is described in Section 3 of this report.

The final task in this study was to develop combinations of weighting factors for each of the two general seasteading scenarios, identified as follows:

- The Shipstead Scenario – A small community (between 100 to 1,000 people) devoted to a single enterprise or business model; representing an early seastead community
- The Metropolistead Scenario – A large community (50,000 people or more) engaged in a wide range of enterprises; representing the long-term vision of seasteading, a complete city-at-sea

Magnitudes of weighting factors were based on the relative importance of the various criteria in the context of each scenario. Results are discussed in Sections 4 and 5 of this report.

One of the primary results of this study was the development of the methodology and related databases, which can aid informed decision-making based on a wide range of relevant criteria. Global data sets for each layer have been carefully developed, and the scoring functions for each layer can be customized to suit new scenarios as they arise. Weighting functions for any scenario can be redefined to evaluate the sensitivity of results to changes in any of the scoring functions or other factors defining a scenario.

The reader is warned not to attach too much significance to the specific locations determined to be more or less desirable for either of these generalized scenarios, since more specific scenarios will require different weights for the various criteria. For example, an algae farm would likely attach a high weighting factor to sea-surface temperature, but a low weighting factor to proximity to high-speed data links. Conversely, for a seastead engaged in software development or other types of business-support activities, proximity to high-speed data connections would be vital, whereas the sea-surface temperature would be of little consequence.

The main value of the present study comes from the establishment of a methodology that can facilitate the balancing of multiple factors that may be important in different scenarios, and from the provision of a sound basis for planning and decision-making.

However, this study does still offer valuable insights into identifying potentially favorable sites. Our results indicate that the most promising locations for shipstead scenarios are generally within the EEZ of highly developed nations in North America, Western Europe, East Asia (China, Japan and South Korea), and the eastern coast of Australia. By contrast, the most favorable sites for the Metropolistead scenario are found along the western coasts of Central and South America, off the Brazilian coast, and in certain areas of the South Pacific.

To facilitate the interpretation of the data sets and output from this study, all data layers and results are presented in the form of global heat maps, which are color-coded based on the desirability of different locations for seasteading purposes. Regions shaded in red are deemed to be least desirable for a particular set of assumptions, while those shaded in green are judged to be most desirable.

2. Methodology

The overall strategy used for this study required us to create a model that calculates overall desirability of various locations by weighting different decision-making criteria according to their perceived significance in the context of seasteading. Data sets for each criterion were stored in discrete layers and mapped onto a global grid with a resolution of 0.05 degrees x 0.05 degrees.

Data sets encompass multiple layers within three core domains:

- Physical environment
  - Wind speed – average, 90th, and 99th percentile
  - Significant wave height – average, 90th, and 99th percentile
  - Current speed – average, 90th, and 99th percentile
  - Bathymetry
  - Air temperature – average, 90th, and 99th percentile
- Economic and business environment
  - Proximity to urban areas (assuming high-speed ferry to and from shore)
  - Land-based data-link access
  - Proximity to sub-sea data cables
  - Per capita GDP of nearby countries
  - Regulatory burden of nearby countries
  - Proximity to shipping lanes
- Legal and political environment
  - Legal status (i.e., freedom from claim by other nations)
  - Dangerous regions (i.e., pirate-infested waters)

Layer Scoring Using Transformation Functions

Each of the three domains is composed of multiple criteria, each of which corresponds to a single attribute used to evaluate a seastead location (wave height, current speed, per capita GDP of nearby nations, etc.). For each criterion, a transformation function was developed by experts in the relevant field to map the raw layer values into numerical scores on a 1 to 100 scale, in accordance with the following assessments:

- 100: Highly compatible
- 50: Moderately compatible
- 10: Almost entirely incompatible
- 1: Totally incompatible

For example, wind speeds were transformed in the following manner:

Score	Value
100	0 to 5 meters per second (m/s)
80	5 to 8 m/s
60	8 to 11 m/s
40	11 to 14 m/s
20	> 14 m/s

In this process, layers were converted to raster grids, as illustrated in Appendix A.

Scored layers were then assigned weights based on the importance of each criterion to specific scenarios. Every grid cell of the world map thus received a score calculated from a weighted average of all criteria. The result is referred to as a scenario heat map.

Domain Weighting

Different seastead business models have different functions and weights attached to the various criteria within each domain (for example, proximity to urban areas would probably be of much greater importance to a seastead engaged in medical tourism than it would be to one practicing aquaculture).

In this study, criteria weighting was implemented in a two-step process; an overall relative weighting was assigned to each of the three domains, and then a lower-level weighting was assigned to the individual criteria within each domain. The domain weighting functions for the shipstead and Metropolistead scenarios are compared in the table below:

Comparison of Domain Weighting Factors

	SHIPSTEAD	METROPOLISTEAD
Physical Environment	20%	40%
Economic and Business	40%	20%
Legal and Political	40%	40%

These weights reflect the assumption that legal and political considerations will always be important factors for seasteads (hence the consistent 40% rating). The reversal of the weights for physical environment and economic/business criteria stems from the fact that early (smaller) seasteads will rely heavily on surrounding areas for economic activity, while Metropolisteads will generate their own economic vitality. Individual criterion weights for each of these scenarios are provided in the following sections of this report.

Potential Sources of Error

Discrepancies in the results obtained could come from some of the following sources:

- Some gaps in the raw data sets were eliminated using a re-projection method that extrapolated from nearest available values
- Some data layers had a very coarse resolution; the process of re-sampling to smaller cell sizes may have introduced some errors
- Some loss of resolution resulted in relatively small errors when converting shape files to raster format
- Wave and wind maps are based on 40-year global hindcast data, but the data set may not include severe storms such as hurricanes or typhoons, nor does the data set adequately resolve coastal wind and wave conditions
- The borders of the Malacca strait were drawn in an approximate way, so results around Singapore should be interpreted cautiously
- While every attempt has been made to use accurate information, validation of the individual data sets was beyond the scope of this investigation

3. Transformation Functions

To construct heat maps for each of the three domains considered in this study, or for any particular seastead scenario, it is necessary to combine multiple layers of data comprised of vastly different metrics. To do this we need a common basis to compare the relative merits of a linear measure like water depth, for example, with a measure of velocity like wind speed. Even more problematic is the question of how to compare economic criteria, such as distance from urban population centers, with political considerations like the degree of regulatory burden.

It might be ideal to relate all criteria to a common denominator, such as monetary value. However, the scope of the present study did not allow for an analysis of each criterion in terms of its net monetary impact; there are far too many variables to be considered, and many of the cost factors would depend on the specific technologies employed in any particular scenario.

Instead, this study relies on the informed judgments of a team of expert individuals, who made reasonable estimates as to how to each criterion could be transformed into a common numerical scale based on the degree to which each factor impacts the presently perceived objectives of seasteading.

The transformation functions developed for each criterion are discussed in the remainder of this section. Heat maps depicting the raw data for each criterion are presented as Appendices A, B and C in this report. Heat maps of the aggregation layers for each domain are presented in the remainder of this section.

3.1. Environmental

Environmental variables considered in this study included the following:

- Wind speed
- Significant wave height
- Current speed
- Bathymetry
- Air temperature

Heat maps for each of the individual criteria are depicted in Appendix A. Transformation functions for each are presented in the remainder of this section.

- **Wind Speed**

Wind speed affects the ability of a seastead to remain in a given location. For a dynamically positioned seastead, operating in areas with high average wind speeds will result in increased fuel consumption due to the stronger environmental forces that must be overcome. Maximum expected wind speeds may also influence the initial cost of the seastead, because the mooring and/or dynamic positioning systems must be tailored to the maximum environmental forces expected to occur.

Transformation Function: Wind Speed

Score	Value (m/s)
100	0 - 5
80	5 - 8
60	8 - 11
40	11 - 14
20	> 14

Each location was scored based on average wind speed in meters per second (m/s), specifically the 90th percentile of all data points in the time history.
Source: ECMWF 40 year reanalysis 10m U Wind Component
Website: http://data-portal.ecmwf.int/data/d/license/era40/

- **Significant Wave Height**

Wave height is the distance between the trough and the crest of a wave. The significant wave height is defined as the average height of the highest one-third of waves in a given sea condition. Since significant wave height represents an average of the largest waves, many individual waves will be even higher. As a general rule, the largest individual waves occurring in a given sea state are expected to be nearly two times higher than the significant wave height. This criterion is of great importance, since ocean waves pose one of the greatest challenges for seasteads in terms of comfort and survivability during bad weather conditions.

There are several strategies for mitigating the effects of large waves. For shipsteads, one tactic is to change location in advance of predicted storm activity, although this approach may not always be successful, since storms can sometimes develop quickly and move along erratic paths. Increasing the size of the shipstead is another option, but this comes at a higher cost. Using a more robust hull form, such as a semi-submersible is another possibility, but this approach also carries a corresponding economic penalty.

For the Metropolistead scenario, it is envisioned that an entire floating community might be surrounded by a massive floating breakwater, creating an oasis of calm in the tumultuous open ocean. In this instance, the transformation function would be more dependent on the size and effectiveness of the floating breakwater, with higher waves necessitating larger, more robust breakwaters.

Even though the same wave transformation function was used for both scenarios, different weighting functions can be assigned based on differences between a ship form and a semi-submersible hull form (for a small seastead), for example, or between a seastead with a floating breakwater versus a seastead without one (in the Metropolistead scenario).

Transformation Function: Significant Wave Height

Score	Value (m)
100	0 - 1
80	1 - 2
60	2 - 3
40	3 - 4
20	4 - 5
1	> 5

The heat map shows the 90th percentile of the monthly averages of significant wave height for the past 40 years.
Source: ECMWF 40-year reanalysis Significant Wave Height
Website: http://data-portal.ecmwf.int/data/d/license/era40/

- **Current Speed**

Ocean currents produce forces on the submerged portion of a seastead. To keep a seastead in its intended location, the mooring and/or dynamic positioning system must be capable of resisting the forces associated with the maximum current speeds that may occur in a given location. Moreover, for a dynamically positioned seastead, high average current speeds will result in greater fuel consumption to maintain position.

Transformation Function: Current Speed

Score	Value (m/s)
100	< 0.5
80	0.5 - 0.75
60	0.75 - 1
40	1 - 1.5
20	> 1.5

Locations were scored based the 90th percentile of the current magnitude throughout the 18-year data set.
Source: NOAA Ocean Surface Current Analyses (OSCAR)
Website: http://dapper.pmel.noaa.gov/dapper/oscar/

- **Bathymetry**

Bathymetry relates to the depth of the seabed. It is of particular importance when considering the cost of a mooring system. The greater the water depth, the longer and more expensive the mooring lines will be. The same applies to the mooring of a floating breakwater.

Transformation Function: Bathymetry

Score	Depth (meters)
100	0 - 300
80	300 - 600
60	600 – 1,000
40	1,000 – 1,500
20	1,500 or deeper

Source: NOAA ETOPO1 Global Relief Bedrock Model
Website: http://www.ngdc.noaa.gov/mgg/global/global.html

- **Air Temperature**

Concern about air temperature arises mainly in the context of passenger comfort, and the higher costs associated with increased power required to provide air conditioning or heating. As indicated in the transformation function below, the "sweet spot" is 24 to 27 degrees Celsius; temperatures higher or lower than this range are assigned less desirable score values.

Transformation Function: Air Temperature

Score	Degrees (C)	Degrees (F)
100	24 - 27	75.2 - 80.6
80	27 - 30	80.6 - 86
60	30 - 33	86 - 91.4
40	33 - 37	91.4 - 98.6
40	15 - 18	59 - 64.3
20	> 37	> 98.6
20	< 15	< 59

Locations were scored based the 90th percentile of the data points in the data history.
Source: ECMWF 40 years reanalysis
Website: http://data-portal.ecmwf.int/data/d/license/era40/

- **Environmental Aggregation Layer**

As noted at the beginning of this section, heat maps showing the transformations of each environmental variable are provided in Appendix A.

The next step is to assign a relative weighting to each environmental criterion. This weighting factor will be dependent on how important each factor is to any particular scenario. Later sections of this report illustrate aggregation layers for the two scenarios considered in this location study.

Of course, it is expected that the priorities of specific alternative scenarios will necessitate different sets of weighting factors, which will produce different aggregation layers tailored to the specific needs of the scenarios.

3.2. Economic

Economic and business variables considered in this study included the following:

- Per capita GDP of nearby countries
- Regulatory burden of nearby countries
- Proximity to urban areas (assuming high-speed ferry to and from shore)
- Land-based data-link access
- Proximity to sub-sea data cables

Heat maps for each of the individual criteria are depicted in Appendix B. Transformation functions for each are presented in the remainder of this section.

- **Proximity to Consumers with Disposable Income (GDP)**

Gross Domestic Product (GDP) is defined as the market value of all final goods and services produced in a country within a given period. GDP per capita usually indicates a country's standard of living and purchasing power. Therefore, proximity to consumers with high disposable income will play a key role for the economic success of a seastead community, as these individuals will be more likely to use or invest in the goods and services provided by seasteads.

Based on a rank-ordered list of GDP per capita for each country, a transformation function was developed that assigned a score based on GDP ranking of the host nation (i.e., the nation in whose waters the seastead is located).

Transformation Function for GDP:

Score	Value*
100	1 - 17
75	18 - 35
50	36 - 70
10	Other countries

* Value is not based on GDP per capita *per se*, but on the *ranking* of GDP per capita for all countries. For instance "1 – 17" corresponds to the 17 countries with the highest GDP per capita in the world; these countries would be scored 100, meaning "most favorable" to seasteading.

Source: CIA Fact book Per Capita PPP GDP
Website: http://geocommons.com/overlays/13631

- **Degree of Regulatory Burden Imposed on Consumers**

From a commercial point of view, regulatory burden may be defined as "the cost involved in complying with regulatory requirements, collecting taxes and responding to information demands." The degree of regulatory burden imposed on the consumers of high GDP per capita nations may also affect the economic development of seasteads. Seasteads would offer an attractive alternative for businesses located in countries with moderate to heavy regulatory burdens, as they would provide an alternative environment for business development. In countries that are already relatively free of undue regulatory burden, there would be less incentive for entrepreneurs to relocate their businesses to a seastead. At the other extreme, although businesses in highly repressed countries would have a strong desire to relocate to a seastead, and consumers might wish to patronize those enterprises, a highly repressive regime such as North Korea would probably make it impossible for businesses or consumers to establish any relationships with a seastead community.

Accordingly, the highest scores go to locations near countries with a moderate to heavy regulatory burden, as these regions would have the strongest incentive to locate enterprises on a seastead. In heavily repressed regions, there may be an even greater incentive, but having a limited or non-existent ability to act on those incentives, repressed regions are given the lowest score, as shown in the table below.

Transformation Function for Regulatory Burden:

Score	Regulatory Burden
100	Moderate to Heavy
80	Moderately Free
65	Mostly Free
40	Free
10	Repressed

(Scores based on the economic rating of the country that has maritime claims on the given ocean location)
Source: The Seasteading Institute Heritage Index Layer, Thematic Mapping World Borders 0.3
Website: http://www.heritage.org/index/

- **Proximity to Major Urban Economic Center**

Proximity to a major urban economic center would allow seasteads to attract more attention and establish more connections with potential investors and entrepreneurs. In terms of trade, it would facilitate the exchange of goods and services and reduce the cost of products necessary to sustain the seastead (meat, produce, etc.). A promising location would be situated within 1.5 hours on a high-speed ferry from a major urban area. It is assumed that if transit takes more than three hours by ferry, various economic and transportation related penalties would be incurred, including higher cost of essential supplies, and reluctance of customers and/or business partners to forge relationships with the seastead.

Transformation Function for Proximity to Urban Economic Center:

Score	Value (Hours)
100	< 1
75	1 - 2
55	2 - 3
40	3 - 4
32	4 - 8
20	8 - 16
5	> 16

(Scores based on the travel time on a high-speed ferry from the nearest major urban area, defined as having a population greater than 500,000 people)

Source: Nordpil World Database of Large Urban Areas 1950 - 2050
Website: http://nordpil.com/go/resources/world-database-of-large-cities/

- **Proximity to Land-Based Internet**

Internet access is likely to be crucial to any seastead. While it is technically feasible to use satellite data links from almost anywhere on the earth, cost considerations favor locations within range of existing wireless links. It is anticipated that shipsteads will have an antenna mounted on a tall mast, effectively increasing the line-of-sight distance to land-based data links.

Transformation Function: Proximity to land-based Internet

Score	Value (km)
100	0 - 15
90	15 - 60
50	60 - 160
30	160 - 150
1	> 500

(Location scores are based on distance from nearest shoreline.)

- **Proximity to Active Data Line**

Data lines refer to cables or wireless channels used for high-speed communications.

Seasteads could potentially take advantage of existing data lines by tapping into them at repeater points along the ocean floor. Tapping into these repeater points in deep water is difficult, because it requires running underwater cable from the repeater to the seastead. Alternatively, in some coastal locations, it would be possible to run cable directly from a shore-based repeater to the seastead. In either case, the scoring function is related to the distance from an active data line to the seastead. As this distance increases, the cost of running subsea cable increases, until it becomes more cost-effective (but still expensive) to utilize a satellite link.

Transformation Function: Active Data Line

Score	Value (km)
100	0 - 15
90	15 - 45
65	45 - 60
50	60 - 150
30	150 - 500
10	> 500

(Score locations based on their distances from existing undersea data lines)
Source: Compilation from numerous publicly available sources
Website: http://www.cablemap.info/

3.3. Legal and Political

Economic and business variables considered in this study included the following:

- Dangerous regions (i.e., pirate-infested waters)
- Ownership score (i.e., freedom of claim by other nations)

Heat maps for each of the individual criteria are depicted in Appendix C. Transformation functions for each are presented in the remainder of this section.

- **Dangerous Regions**

This criterion relates to certain unstable zones of the world, most notably the upper part of the African continent and the Philippines, where pirate attacks happen frequently. Concern for the safety of future seasteads is paramount; locations where pirate attacks are known to occur, however infrequently, are not acceptable.

Transformation Function: Dangerous Regions

Score	Piracy/Proximity to Dangerous Region
100	No pirate activity
1	Within EEZ of dangerous region

Source: Dangerous Regions based on US State Dept. Travel Advisories,
Borders determined from Thematic Mapping World Borders 0.3
Websites: http://travel.state.gov/travel/cis_pa_tw/tw/tw_1764.html;
http://thematicmapping.org/downloads/world_borders.php

- **Legal Status**

Legal status relates to the proximity of neighboring nations and the claim that such nations can make on any particular site. Broad categories of legal status include the following:

- Territorial waters
- Contiguous zone
- Exclusive Economic Zone (EEZ)
- High seas

Legal status is of crucial importance to the establishment and development of seasteads, as it will determine the degree of legal and political autonomy that can be achieved.

Within the territorial waters of a host nation, seasteads would be bound by the same laws and regulations as shore-based enterprises. Unless a coastal state could be persuaded to provide special contracts or concessions to the seastead, thereby allowing it to locate a platform with low or no regulation within their waters, there would be no particular benefit to locating a seastead within a nation's territorial waters, or what is commonly thought of as the three-mile limit from the coastline.

Contiguous zones exist in the area beyond a nation's territorial waters, extending some 12 to 24 miles offshore. Within the contiguous zone, coastal states may exercise the control necessary to prevent and punish infringement of their customs, fiscal, immigration, and sanitary laws and regulations to the same extent as applies in their territorial waters. In all other respects, contiguous zones offer freedom similar to that of the high seas with regard to navigation, over-flight and related activities.

Each coastal nation also has an Exclusive Economic Zone (EEZ), generally extending up to 200 miles from the shoreline. Within the EEZ, the coastal state has sovereign rights for the purposes of exploring, exploiting, conserving and managing natural resources, and for the economic exploitation and exploration of the zone (e.g., the production of energy from the water, currents and winds). Within the EEZ, coastal states also have jurisdiction with regard to establishing and using artificial islands, installations and structures with economic purposes, as well as those for marine scientific research and the protection and preservation of the marine environment. Other states may, however, exercise traditional high seas freedoms of navigation, over-flight and related activities within the EEZ.

While locations within a host nation's EEZ are substantially less restricted than territorial waters or contiguous zones, it is only international waters (high seas) that are virtually unencumbered by regulations of any host nation, being bound by only the broadest of international agreements.

Notwithstanding the foregoing definitions, determining a scoring function based on legal status is complicated by the fact that some areas are claimed by multiple coastal states, so it is not always clear which country would be recognized as the host nation. Therefore, one component of the legal-zone-score is based on the location's "ownership score," as delineated in the following table. Locations where ownership is undisputed are given the highest score, while the scores for other areas are discounted in proportion to the degree of dispute over ownership rights.

Because shipsteads can be relocated with relative ease, uncertainty over ownership rights are penalized only slightly; if an ownership dispute were to become problematic for a shipstead, it could move to a different location quite easily. By contrast, a Metropolistead community would be a significantly harder to relocate, so uncertainties in ownership are assigned a much lower score for that scenario.

The second component of the legal-zone-score is based on the degree of control that the host nation can exert over a given area: this "claim score" essentially corresponds to the different legal statuses discussed above, but with additional categories defined for special circumstances. These categories and the scoring functions associated with each are shown in the claim-score table on the following page.

As was the case with ownership-score, the transformation functions for claim-score are also different for the two scenarios considered in this study. Claim-scores for the shipstead scenario are more favorable for factors associated with locations closer to a host nation (contiguous zone, development zone, economic zone, fishing zone and the like) as well as for shallower waters (shoals and banks). Lower scores assigned to these factors for the Metropolistead would thus favor sites on the high seas for that scenario.

The aggregate legal-zone-score is taken as being simply the lesser of the two values for ownership-score and claim-score.

Ownership-Score is based on the value of the Ownership field:

Score-S	Score-M	Value
100	100	Exclusive Undisputed Ownership
100	100	Joint Ownership
60	30	Disputed Ownership
85	60	Unresolved
85	50	Hypothetical Ownership
100	100	None – Refers to High Seas

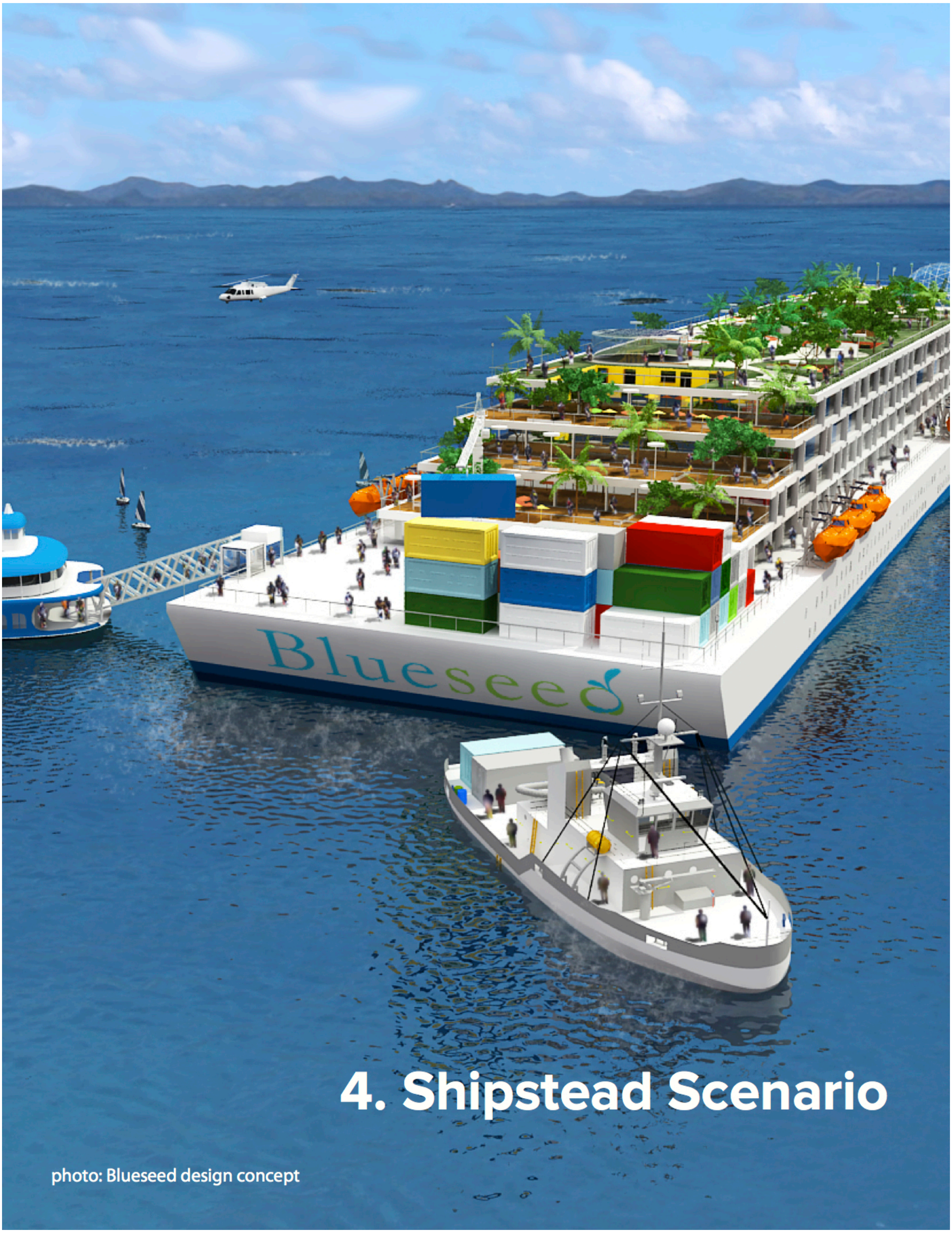
Note: Score-S denotes the Shipstead scenario
Score-M denotes the Metropolistead scenario

Claim-Score is based on the value of the Claim field:

Score-S	Score-M	Value
70	1	Bank
30	15	Contiguous Zone
80	40	Development Zone
80	40	Economic Zone
80	40	Fishing Zone
100	100	High Seas
7	1	Internal Waters
15	7	Intertidal
1	1	Island
80	40	Joint Development Zone
1	1	Land
2	1	Military Zone
70	1	Shoal
85	45	Special Zone
85	45	Special Zone – Fishing
85	45	Special Zone – Sovereignty
12	6	Territorial Seas

Note: Score-S denotes the Shipstead scenario
Score-M denotes the Metropolistead scenario

Source: The Global Marine Boundaries Database
Website: http://www.gd-ais.com/index.cfm?acronym=gmbd



4. Shipstead Scenario

photo: Blueseed design concept

4. Shipstead Scenario

The term "shipstead" refers to a seastead concept that is patterned after a conventional cruise ship or barge. The motivation for the concept stems from the idea that a path of least resistance to implementing initial seasteads might be to convert cruise ships of modest size that have been retired from active service in the commercial cruise industry. Although the largest cruise ships can presently accommodate more than 6,000 guests, a shipstead only needs to be large enough to house about 100 to 1,000 residents.

Justification for establishing the lower bound of 100 residents is based on the results of a parametric engineering study that was recently conducted by The Seasteading Institute. The study found that "unit costs" can approach or exceed $700 to $800 per square foot of residential/commercial space for small seasteads with fewer than 100 residents. Although it is easy to conceive of small floating units that are substantially less expensive, such units would likely be suitable only for use in relatively sheltered waters, rather than long-term deployment in the open waters of an EEZ or on the high seas. Thus, from a business and legal standpoint, very small floating dwellings might not achieve the main objectives of seasteading.

Shipsteads that are robust enough to withstand the perils of long-term exposure to the open sea will likely be large enough to accommodate a population somewhere between 100 to 1,000 residents, under the assumptions of the aforementioned study. Within this size range, unit costs in the range of $400 to $500 per square foot were found to be achievable, which are comparable to residential and commercial space near major metropolitan centers, and reasonable enough to be economically viable for a substantial segment of the population.

For much larger shipsteads, suitable for populations of several thousand residents, economies of scale could reduce unit costs to about $300 per square foot; however, the capital costs of such large-scale projects could easily exceed $500M. A financial commitment of that magnitude is considered unrealistic for early seasteads. Nevertheless, in the long term, communities of much larger scale are envisioned, as discussed in Section 5 of this report.

4.1. Goal (Scenario Description)

This scenario investigates ideal locations for the near-term vision of seasteading: Shipsteads, or ship-shaped hulls converted to accommodate a variety of businesses, stationed outside the territorial waters of an agreeable host nation, most likely within the contiguous zone or EEZ.

As a baseline, a cruise ship of 140-160 meters length and with a capacity of 800 passengers would serve as a likely candidate. Preliminary research on “retired” cruise ships presently on the market suggests that an initial budget for acquisition and conversion of such a vessel might be around $40M. With the more spacious accommodations envisioned for seastead quarters (as opposed to a typical stateroom on an older cruise ship), a shipstead of this size could accommodate about 300 residents along with a reasonable amount of commercial and common space.

If it is anticipated that technology-oriented businesses would be the most likely candidates for office spaces and residences, then there is little incentive to locate outside the EEZ; indeed, locating in the contiguous zone might be desirable in that it would bring customers and resources within relatively close proximity to the enterprise. Examples of industries that might be suitable for a shipstead located within a host nation’s contiguous zone are listed below:

- Medicine: research and practice, particularly with experimental procedures that have not received formal regulatory approval in certain jurisdictions
- Knowledge-based activities: Internet, software, consulting
- Near-shore outsourcing: financial services, arbitration services
- Residential: permanent, time-share
- Hospitality and recreation: corporate or personal retreats

For businesses engaged in resource extraction, including certain forms of energy conversion, locations outside the EEZ would be the least encumbered, unless a host nation conceded certain rights within the EEZ on the grounds that the seastead’s planned activity was beneficial to its interests.

Unlike permanently moored seasteads, shipsteads with a high degree of self-mobility could establish themselves in a much larger range of locations, and easily relocate to avoid storms, follow the seasons, etc. The most mobile seasteads would probably require the use of a dynamic positioning system (DPS). Rather than mooring the ship in a classical manner, with anchors fixed to the seabed, the DPS would keep the ship at a pre-determined location without any attachments to the seafloor, through the use of thrusters located near the bow and stern. Thrusters would automatically maintain the vessel’s position and heading as the various environmental forces (wind, waves and current) applied pressures on the hull. Thrusters could also provide propulsive forces to move the seastead to a different location when desired.

The potential mobility of a shipstead means that environmental conditions may be of lesser importance compared with legal, political and economic criteria. Shipsteads would most likely be located near enough to the coastline of a host nation that they could reasonably seek safe-harbor well in advance of severe storms.

4.2. Criteria

Based on the goals stated in the previous section, the domain weights below were chosen for the shipstead scenario:

Domain	Weight (%)
Environmental	20
Economic	40
Legal and Political	40
Total	100

These weightings reflect the collective judgment that legal/political and economic criteria would be the most important concerns for initial seasteads.

4.2.1 Environmental

Given that shipsteads are intended for long-term residence at sea, the comfort of those aboard is a high priority. Therefore, wave conditions receive the highest weighting among the environmental criteria. Despite the inherent mobility of a shipstead and the possibility that it could avoid severe storm conditions, a shipstead should be capable of remaining at its intended location in all normal weather conditions, meaning areas where the predominant waves are smaller will be more desirable.

Wind and currents are the other environmental conditions of concern. Assuming that the shipstead is dynamically positioned, it will be preferable to locate in areas where wind and current speeds are moderate, so as to minimize the fuel required to keep the shipstead on location.

Air temperature is given a minimal weighting in this scenario, on the assumption that interior spaces will be climate-controlled. Residents will acclimate to temperatures outdoors in much the same way they do on land.

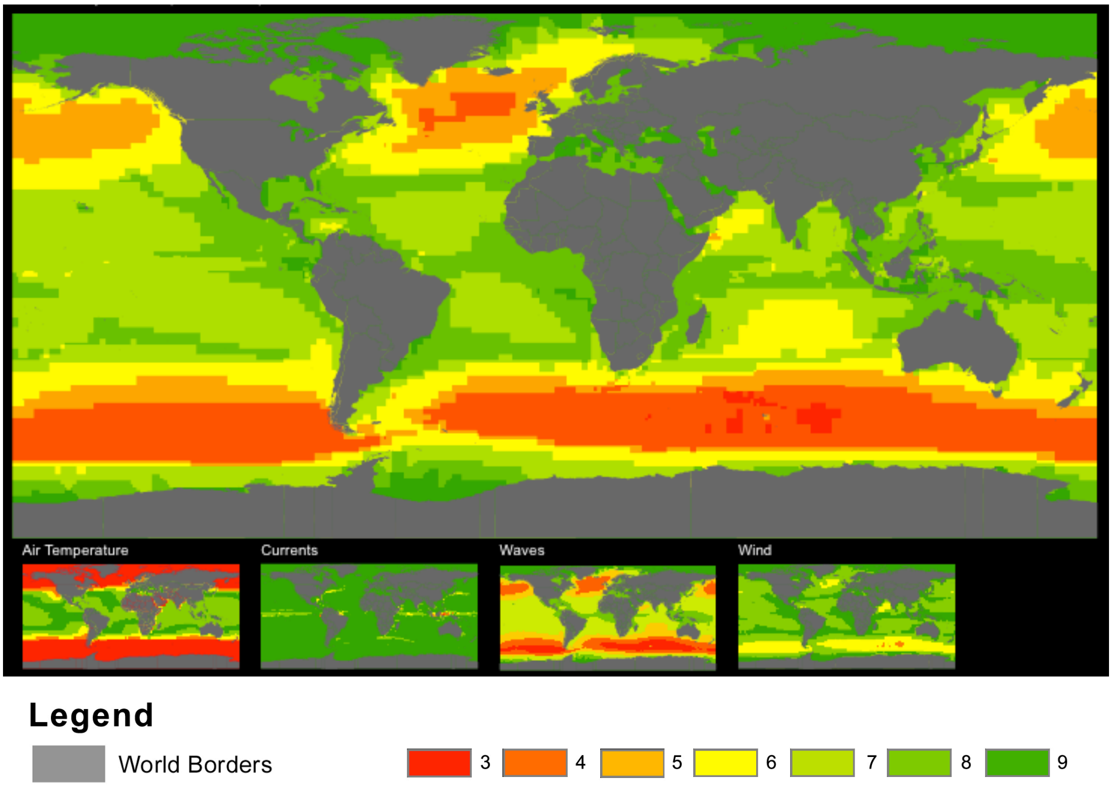
Bathymetry, or water depth, is given no weighting in the shipstead scenario, on the assumption that shipsteads will be dynamically positioned. In a moored vessel scenario, water depth might be given a weighting of 10%, while the weight given to waves might be reduced by the same amount.

The weighting factors for environmental criteria are summarized in the table below.

Criteria	Weight (%)
Air Temperature	10
Bathymetry	0
Current speed	20
Waves	50
Wind speed	20
Total	100

These weighting factors were applied to each individual criterion to produce an aggregated heat map combining all of the environmental factors, as shown in the image below.

Environmental Aggregation Layer:



Heat maps of each individual criterion are shown at the bottom of the figure above; larger images of these criteria are provided in Appendix A.

4.2.2 Economic

In the shipstead scenario, proximity to consumers with high disposable income is given the highest weighting, on the assumption that the shipstead will be providing services that will be marketed primarily to customers in the nearby host nation; being close to a customer base with high disposable income is clearly desirable.

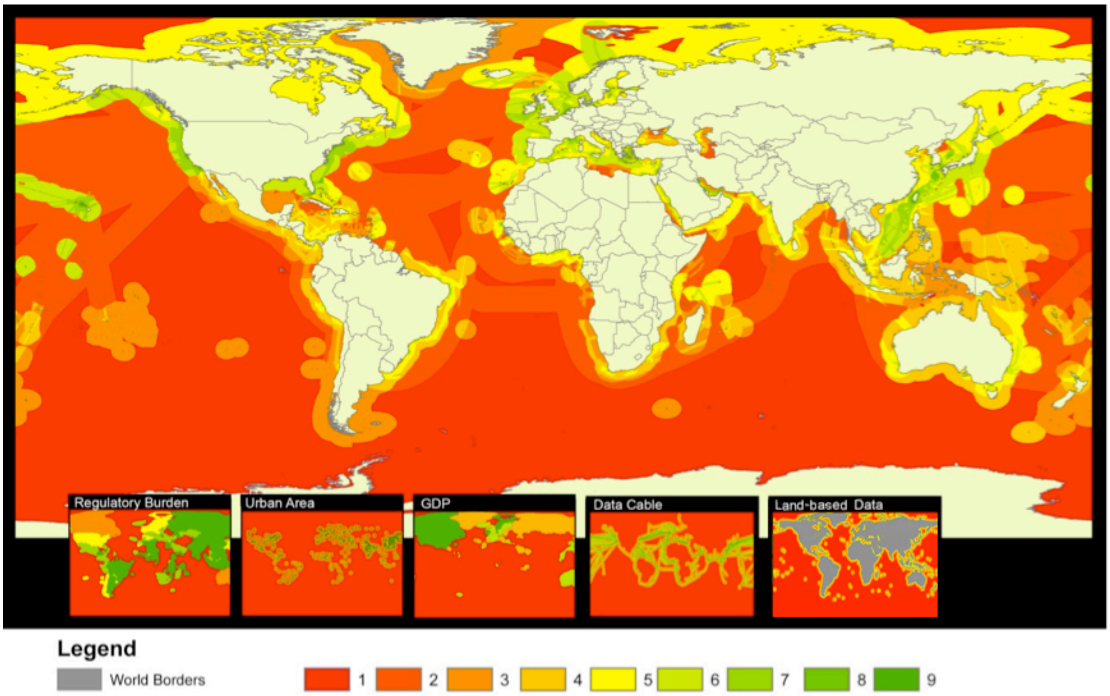
The degree of regulatory burden is also highly weighted. This is because freedom from restrictive laws and regulations will give seastead-based enterprises a competitive advantage compared to shore-based competitors by allowing the seastead to offer certain services that are not available from shore-based enterprises.

Proximity to a major urban economic center is the third highly-weighted factor, and while it may seem to significantly overlap with the first criterion (proximity to high GDP), there is no presumption of affluence implied in the major urban economic center, only that there is abundant economic activity, which consequently creates opportunities for entrepreneurs.

Weighting factors for all economic criteria are summarized in the table below, along with a heat map depicting the aggregated economic layer.

Criteria	Weight (%)
Proximity to consumers with disposable income (GDP)	35
Degree of regulatory burden imposed on consumers	25
Proximity to major urban economic center	25
Proximity to land-based internet	10
Proximity to active data line	5
Total	100

Economic Aggregation Layer:



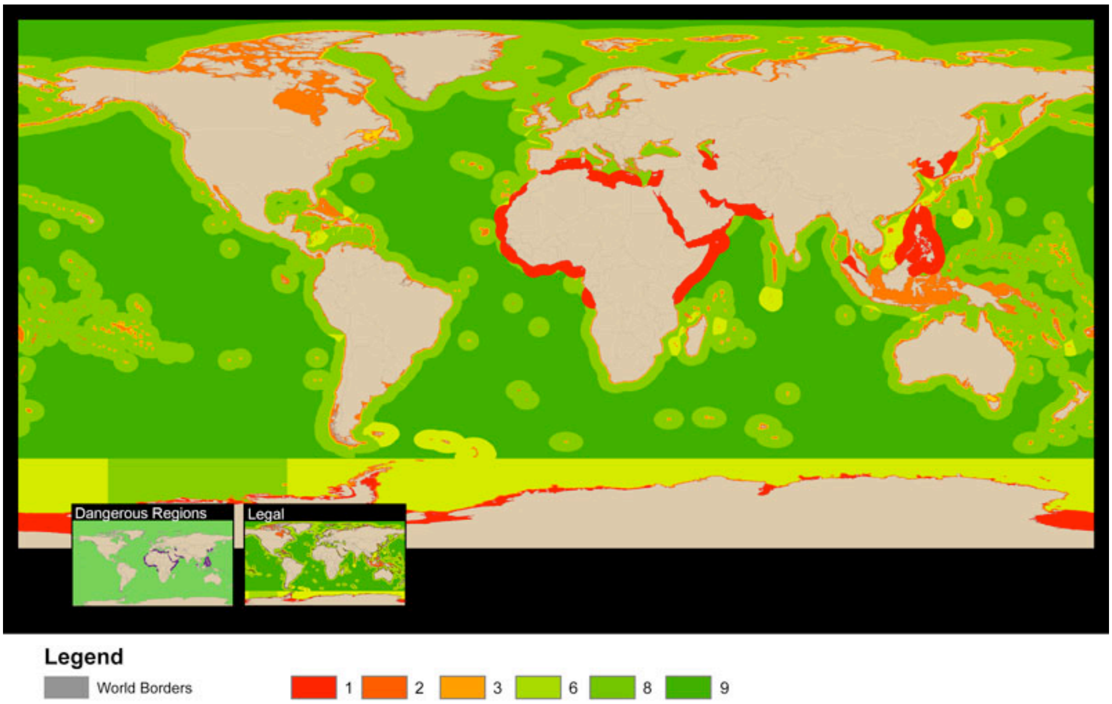
Heat maps of each individual criterion are shown at the bottom of the figure above; larger images of these criteria are provided in Appendix B.

4.2.3 Legal and Political

Based on the transformation functions defined previously in Section 3.3 for the shipstead scenario, the following weighting factors were applied to develop the legal and political aggregation layer shown below.

Criteria	Weight (%)
Dangerous Regions	50
Legal Status	50
Total	100

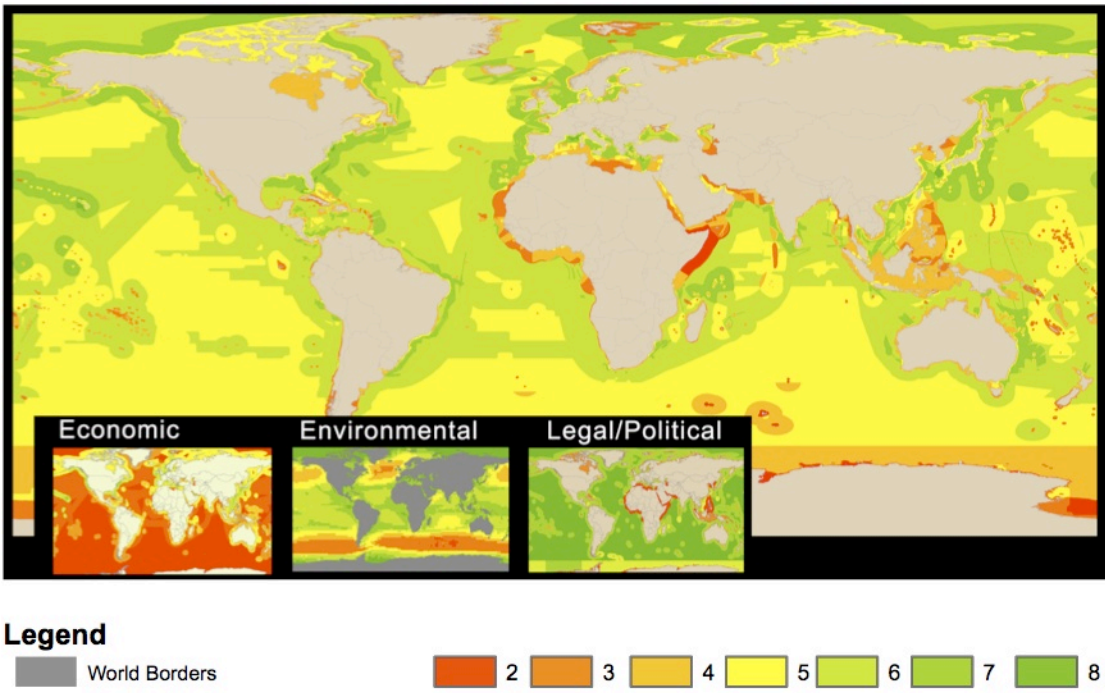
Legal and Political Aggregation Layer:



Heat maps of each individual criterion are shown at the bottom of the figure above; larger images of these criteria are provided in Appendix C.

4.3. Overall Results

The following heat map illustrates the overall results for the shipstead scenario, taking into account the environmental, economic and legal/political domains with all of their associated criteria. The most favorable regions (indicated by successively darker shades of green) mainly appear in the EEZs of the most developed countries in North America, Western Europe, East Asia (China, Japan, South Korea), and the Eastern Australian cost.



A few of the most promising areas for the establishment of shipsteads are listed below:

- Off the coasts of the United States
- Southwest of Japan
- Within the Baltic Sea
- Portugal/northeast of Spain
- Australia, Sydney region

It is also important to note the areas shaded in red and orange. These areas were deemed to be ill-suited to seasteading under the shipstead scenario, with deeper shades of red indicating the least hospitable locations, principally along portions of the African coast, and well-known trouble spots in parts of Asia and the Philippines.

5. Metropolistead Scenario

5.1 Goal (Scenario description)

This scenario examines a long-term seasteading vision: a Metropolistead, or floating mega-city sprawling over some 20 square miles of the ocean's surface, home to tens of thousands of people.

Seasteading's aspirations for new political and social systems may only succeed if such floating cities possess a great degree of autonomy and independence. This suggests that the ideal locations for a floating city are in international waters, where coastal state regulations do not apply. However, it is well known that the sea is a harsh mistress--there are very few areas in the open ocean that are not vulnerable to occasional bouts of genuinely severe weather.

One of the major challenges to achieving the vision of a Metropolistead is the question of how such a floating city can be protected from potentially catastrophic waves. One strategy under consideration is to encircle the city with a massive floating breakwater; however, even if such a device was developed and found to be capable of providing the necessary protection, it would likely be very expensive to build and maintain. Therefore, a high premium is placed on locations where the weather is hospitable, particularly as it affects wave height.

A related issue has to do with keeping the Metropolistead at its intended location. The environmental forces on such a massive floating body would make dynamic positioning an unlikely option; moreover, use of a floating breakwater simply shifts the problem to one of keeping the breakwater in position. Putting aside other options that have been proposed (drifting with gyres, or "lazy" station-keeping), it is most likely that Metropolisteads will be moored to the ocean floor. Accordingly, areas such as seamounts (open ocean sites with relatively modest depth) will be the most favorable locations for such large-scale seastead communities.

In terms of business development, many industries could gain substantial advantages from establishing themselves offshore. For the current scenario, all viable seastead industries are considered. These were separated in two main categories:

1. Ocean resource-based industries
    - Aquaculture
    - Energy
    - Seabed resource extraction

2. Non-ocean resource-based industries
    - Medicine: Research, practice
    - Knowledge Work: Internet, software, consulting
    - Near-shore outsourcing: financial services, arbitration services
    - Residential: Permanent, time-share
    - Hospitality/recreation: Corporate or personal retreat
    - Strategic location: Military, customs, refueling/re-supply
    - Tourism: Snorkeling, deep sea exploration

5.2 Criteria

Based on the goals stated above, the following domain weights were chosen for the Metropolistead scenario:

Domain	Weight (%)
Environmental	40
Economic	20
Legal and Political	40
Total	100

These percentages are based on the collective judgment that a large-scale community would create its own economy, reducing the weight of economic criteria. The environmental weighting was increased because a large community will require either a floating breakwater or some other expensive technology to provide protection from waves, given that the community will be located in the unsheltered waters of the open sea.

5.2.1 Environmental

As discussed in the preceding paragraphs, protection from extreme waves is of paramount concern. Even if effective floating breakwaters can be made affordable, it will be highly desirable to locate in an area where wave heights tend to be relatively moderate.

Wind speed is also an element of concern, not only because strong winds are often associated with large waves, but also because there are no natural features at sea that can offer any protection; the massive seastead will have to take the full brunt of any storm that occurs.

Water depth and current speed are given a minimal weighting, reflecting the fact that they bear on the difficulty of keeping the seastead on station, but do not directly affect safety or survivability.

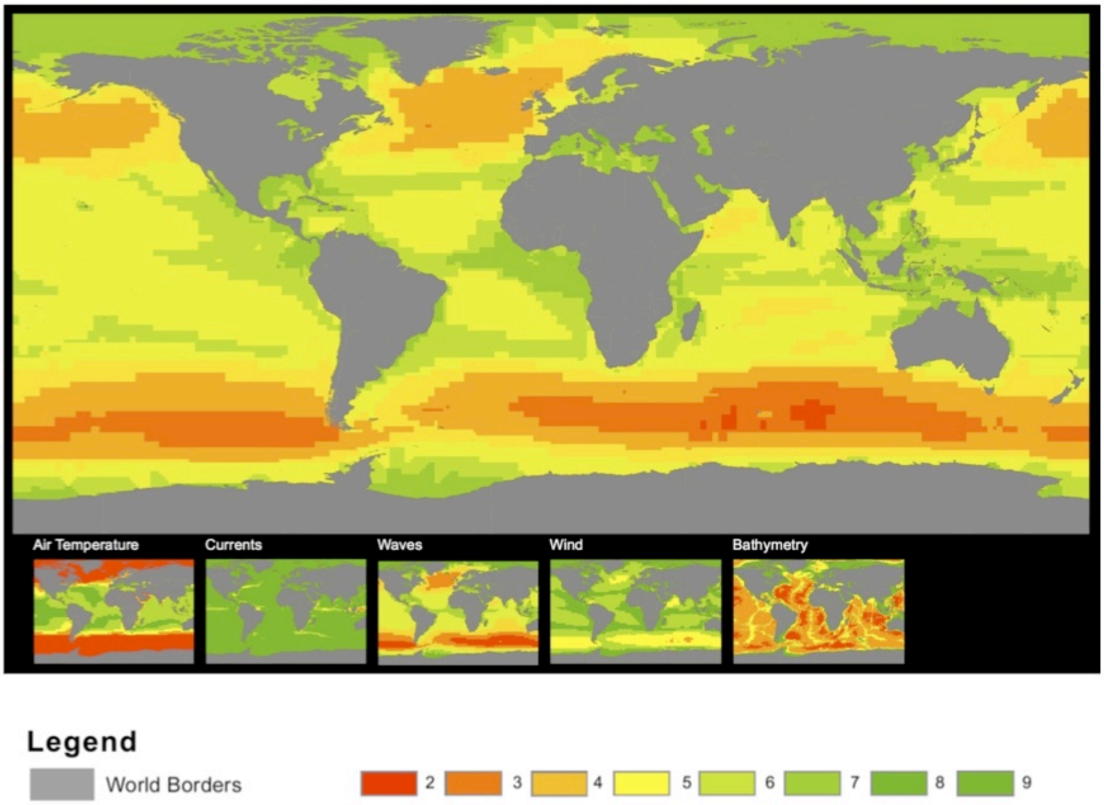
Air temperature is given a minimal weighting in this scenario, on the assumption that interior spaces will be climate-controlled. Residents will acclimate to temperatures outdoors in much the same way they do on land.

The weighting factors for environmental criteria are summarized in the table below.

Criteria	Weight (%)
Air Temperature	10
Bathymetry	10
Current speed	10
Waves	50
Wind speed	20
Total	100

These weighting factors were applied to each of the individual criteria to produce an aggregated heat map combining all of the environmental factors, as shown in the image below.

Environmental Aggregation Layer:



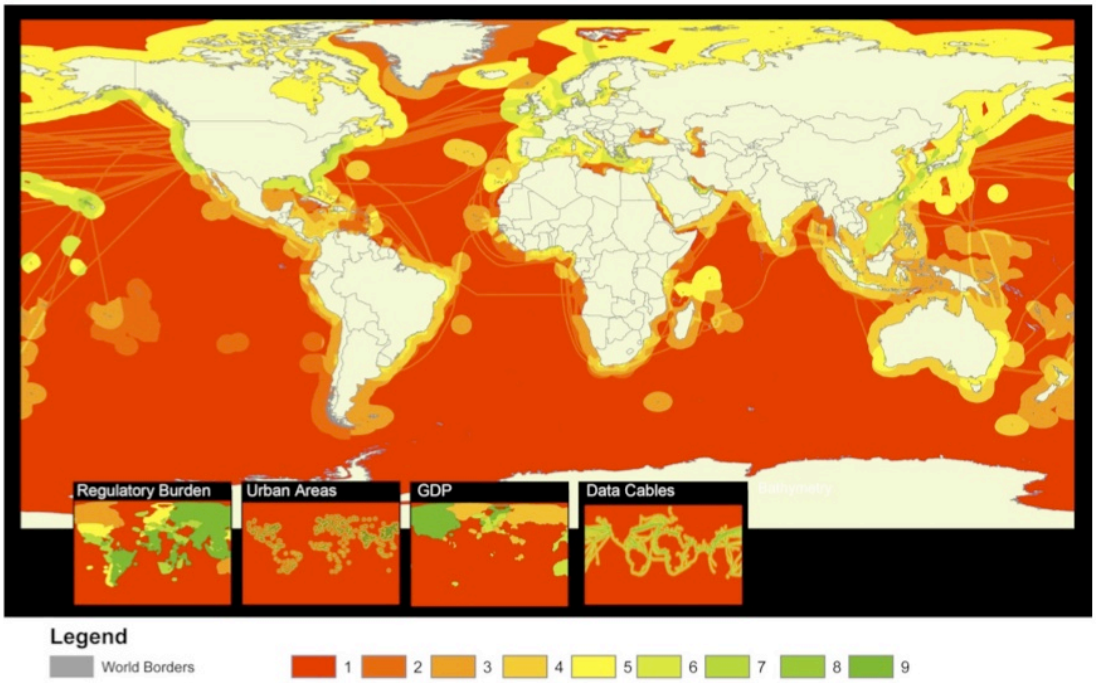
Heat maps of the individual criteria are shown at the bottom of the figure above; larger images of these criteria are provided in Appendix A.

5.2.2 Economic

Criteria evaluated for the economic aspect of the location study are detailed below. For this domain in particular, it should be kept in mind that future developments in technology are likely to alter the relative importance of individual criteria, such as proximity to land-based Internet and/or active data lines. For example, if the cost of satellite communication decreases significantly, or if other technologies facilitate the implementation of high-speed, low-cost data links, then the weighting associated with those criteria might conceivably be reduced to zero.

Criteria	Weight (%)
Proximity to consumers with disposable income (GDP)	35
Degree of regulatory burden imposed on those consumers	25
Proximity to major urban economic centers	35
Proximity to land-based internet	0
Proximity to active data line	5
Total	100

Economic Aggregation Layer:



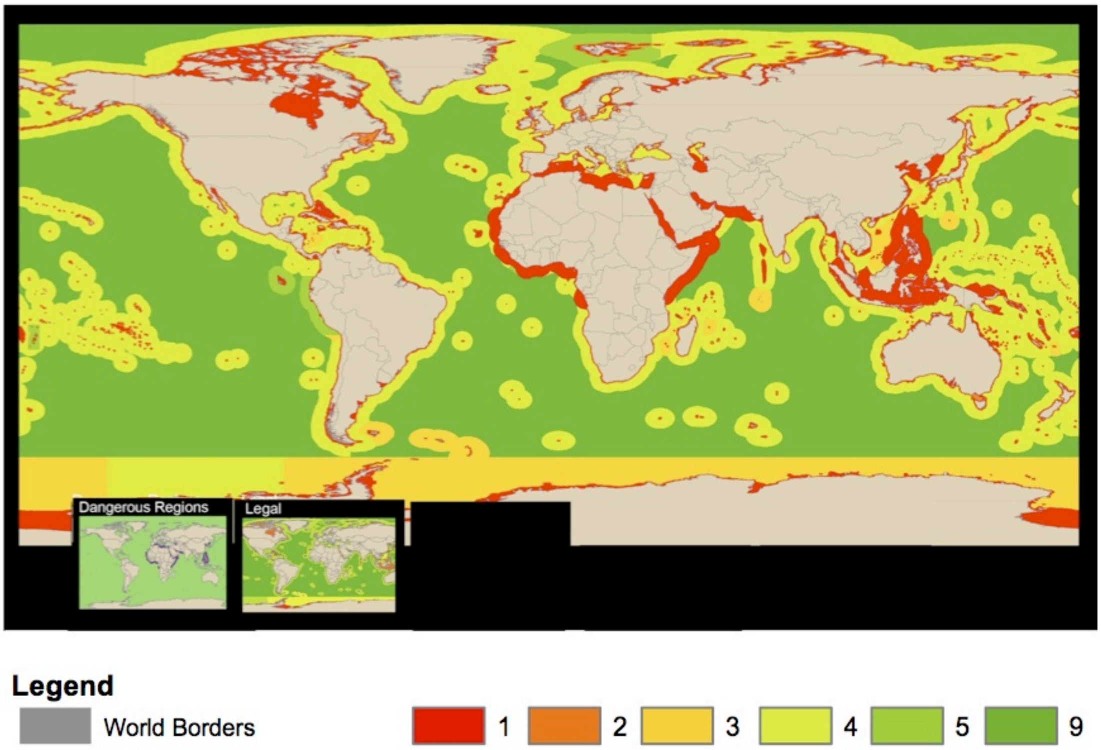
5.2.3 Legal and Political

Based on the transformation functions defined previously in Section 3.3 for the Metropolistead scenario, the following weighting factors were applied to develop the legal and political aggregation layer shown below.

Criteria	Weight (%)
Dangerous Regions	50
Legal Status	50
Total	100

Legal and Political Aggregation Layer:

For the legal domain, a different weighted average calculation method was used. The overall layer presented below comes from the superposition of the red regions from the “Dangerous Regions” layer on the top of the legal status layer.

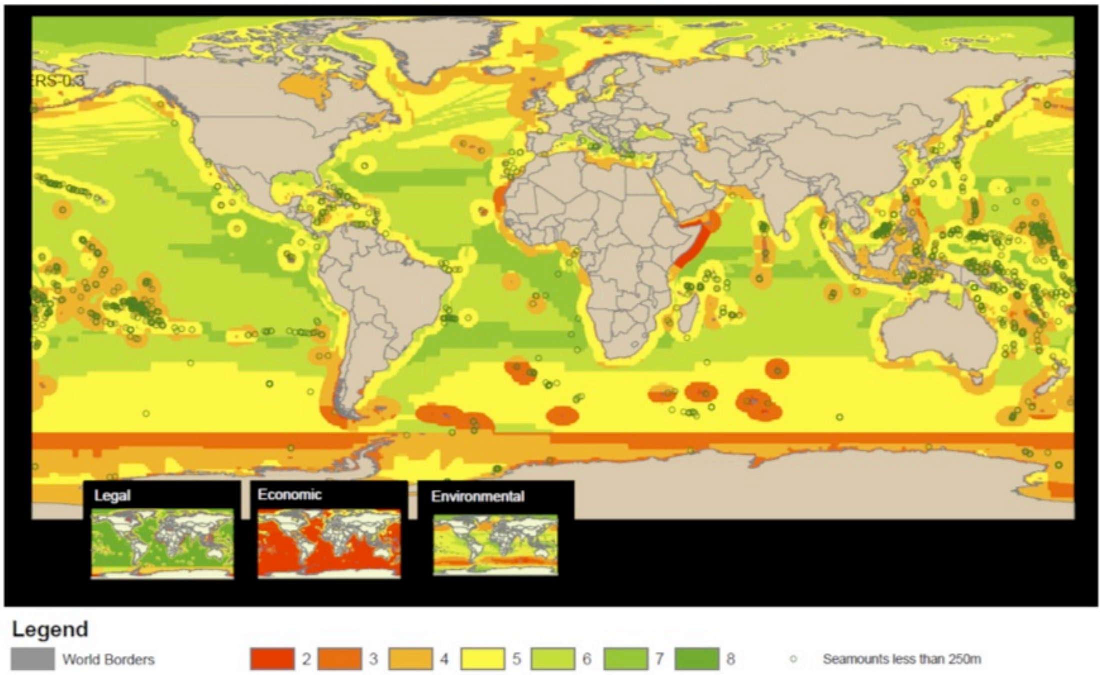


Heat maps of each individual criterion are shown at the bottom of the figure above; larger images of these criteria are provided in Appendix C.

5.3 Overall Results

The following heat map illustrates the overall results for a Metropolistead scenario, taking into account the environmental, economic and legal/political domains with all their associated criteria. The most favorable regions (indicated by successively darker shades of green) appear to be the following areas:

- About 1000km west of the Galapagos island, “Isla Isabella”.
- The entire region situated roughly 200km off the Brazilian coast, between Rio de Janeiro and the border with Uruguay.
- Approximately 300km east of the coast of southern Angola and Namibia.



Of particular interest are the locations atop seamounts (where the ocean is less than 250 meters deep) in areas where wave conditions are relatively benign. These locations are indicated by small green circles on the heat map above; the coincidence of these seamounts with areas that are otherwise shaded in green would be the most promising locations for a Metropolistead community.

6. Conclusions and Recommendations

There is no single perfect location on the globe for the establishment of seasteads, but this study has identified a few promising regions that offer fair compromises between all the selected environmental, economic, legal and political criteria.

Environmental: Coastal regions appear to be generally favorable, mostly because predominant weather conditions tend to be more benign closer to the shore. For the shipstead scenario, there are also wide swathes of open ocean in the tropical and semi-tropical latitudes with moderate wind and current conditions that make dynamic positioning less costly. By contrast, water depth considerations considerably narrow the field of promising open ocean locations for the Metropolistead scenario.

Economic: Heat maps of economic criteria suggest that the most promising areas are located along both coasts of the continental United States, as well as Hawaii, the United Kingdom, and the South China Sea. This trend is similar for both scenarios, and is mainly driven by considerations of proximity to urban population centers and areas of high GDP.

Legal and political: Criteria for this domain favor locations far from coastal areas and in international waters, to allow seasteads greater independence and autonomy. For the shipstead scenario, the areas to avoid are those considered dangerous because of piracy or other acts of violence on the high seas. In addition, for the Metropolistead scenario, areas between Southeast Asia and Australia, for example, are also to be avoided, due to uncertain or disputed territorial claims by nations in the region.

Overall, considering the relative importance of all three domains, the following locations appear to be most favorable for the shipstead scenario:

- Coastal regions off the United States
- Southwest of Japan
- Within the Baltic Sea
- Portugal/northeast of Spain
- Australia, Sydney region

By comparison, for the Metropolistead scenario, the following locations appear to be most favorable:

- About 1000km west of the Galapagos island, “Isla Isabella”
- The entire region situated roughly 200km off the Brazilian coast, between Rio de Janeiro and the border with Uruguay
- Approximately 300km east of the coast of southern Angola and Namibia

Locations atop seamounts, where the ocean is relatively shallow and where wave conditions are relatively benign, are particularly promising. These locations would be among the best candidates for a Metropolistead community.

In constructing the heat maps corresponding to each of the domains considered in this study, or for any particular seastead scenario, one of the major challenges was combining data from multiple layers of the data set while accounting for the fact that layers are comprised of inherently different kinds of information. Even more problematic was the question of how to compare economic criteria, such as distance from urban population centers, with political considerations like the degree of regulatory burden.

Ideally, it would have been possible to relate all criteria to a common denominator, such as monetary value. In this way, the economic implications of water depth could have been based on, for example, the incremental cost of a mooring system per unit of change in depth relative to some baseline cost. As another example, "distance from urban population centers" could have been scored based on an estimated value of the time that people would need to spend in transit, along with fuel cost, etc. This would have facilitated comparison with other related criteria, such as proximity to data lines, as well as the degree of regulatory burden (i.e., do the advantages of a less regulated business climate outweigh the increased costs of transportation and communication?).

It is necessary to come to grips with questions like these in order to develop a meaningful assessment of potential seastead locations. Seasteading entrepreneurs must be able make comparisons between not just apples and oranges, but among the contents of a whole shopping basket. The scope of the present location study was not intended to quantify each criterion in terms of its net monetary impact. There are far too many variables to allow for such an ambitious undertaking at this stage in development. Instead, this study relied on the informed judgments of a team of individuals to make reasonable estimates as to how to each criterion could be transformed into a common numerical scale, based on the degree to which each factor was relevant to the presently perceived challenges and objectives of seasteading.

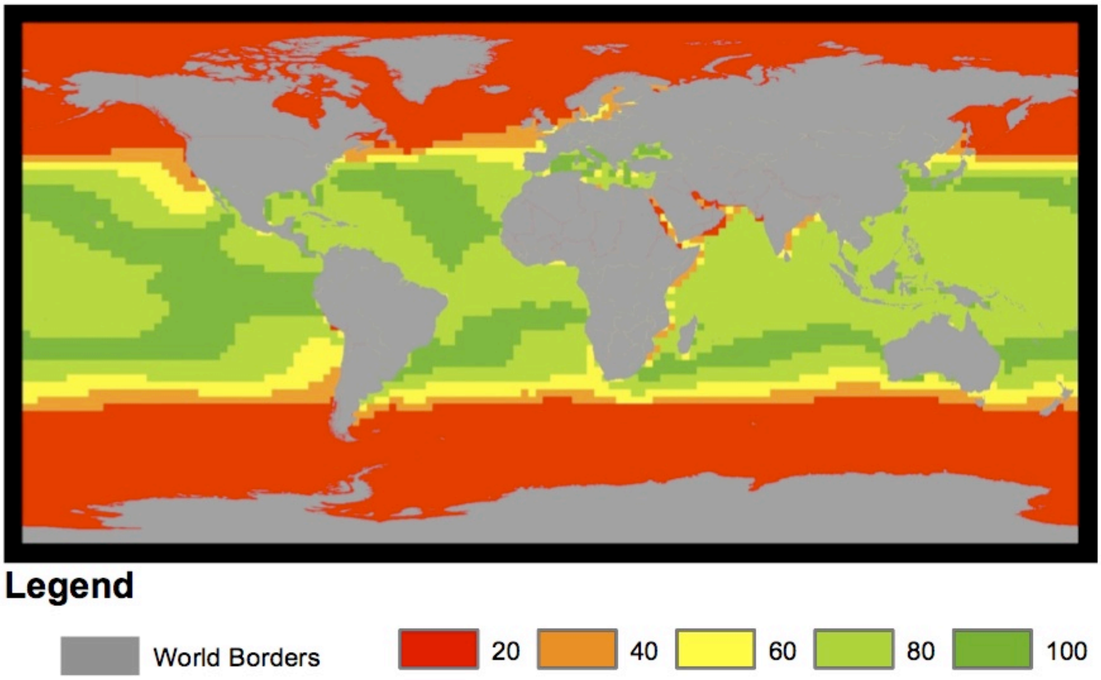
As a recommendation for future research, it would he highly beneficial to quantify the economic implications associated with each criterion; e.g., determining the incremental cost per unit of water depth for mooring a seastead, or the incremental cost per unit of distance from urban population centers. These are daunting economic questions, but they should be addressed in the future if we are to realize the full potential of the insights that can be gained from the database and methodology developed in this study.

Appendix

Heat maps of all criteria analyzed are presented below.

A. Environmental Criteria

Air Temperature



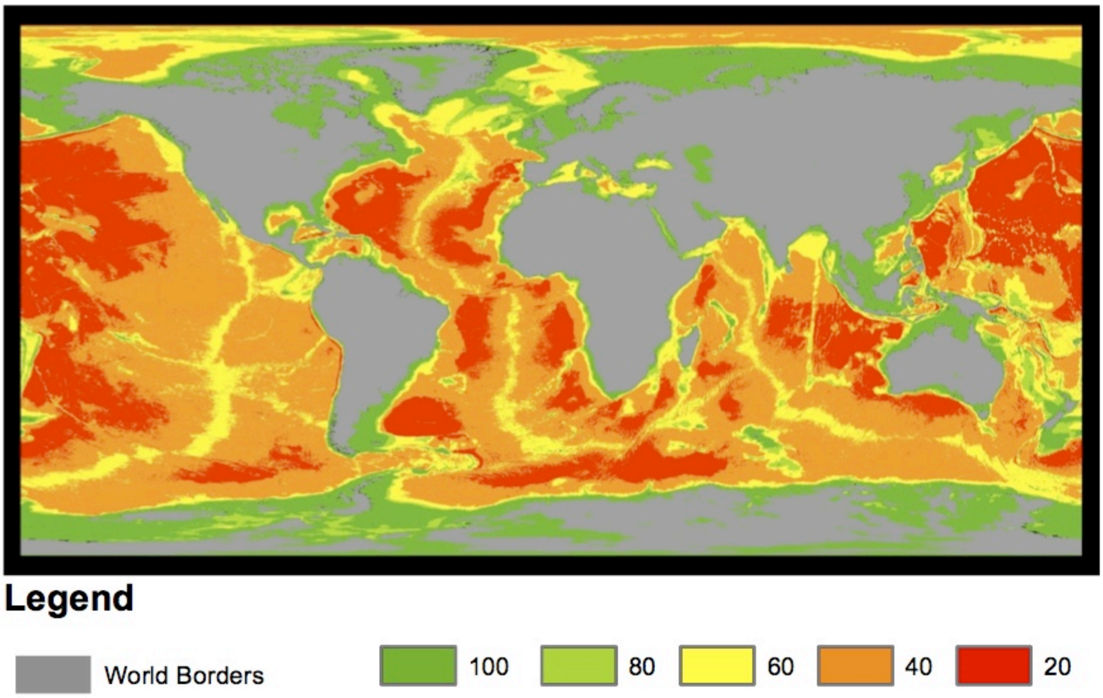
Transformation Function: Air Temperature

Score	Degrees (C)	Degrees (F)
100	24 – 27	75.2 – 80.6
80	27 – 30	80.6 – 86
60	30 – 33	86 – 91.4
40	33 – 37	91.4 – 98.6
40	15 – 18	59 – 64.3
20	> 37	> 98.6
20	< 15	< 59

Locations were scored based the 90th percentile of the data points in the data history.

Source: ECMWF 40 years reanalysis
Website: http://data-portal.ecmwf.int/data/d/license/era40/

Bathymetry

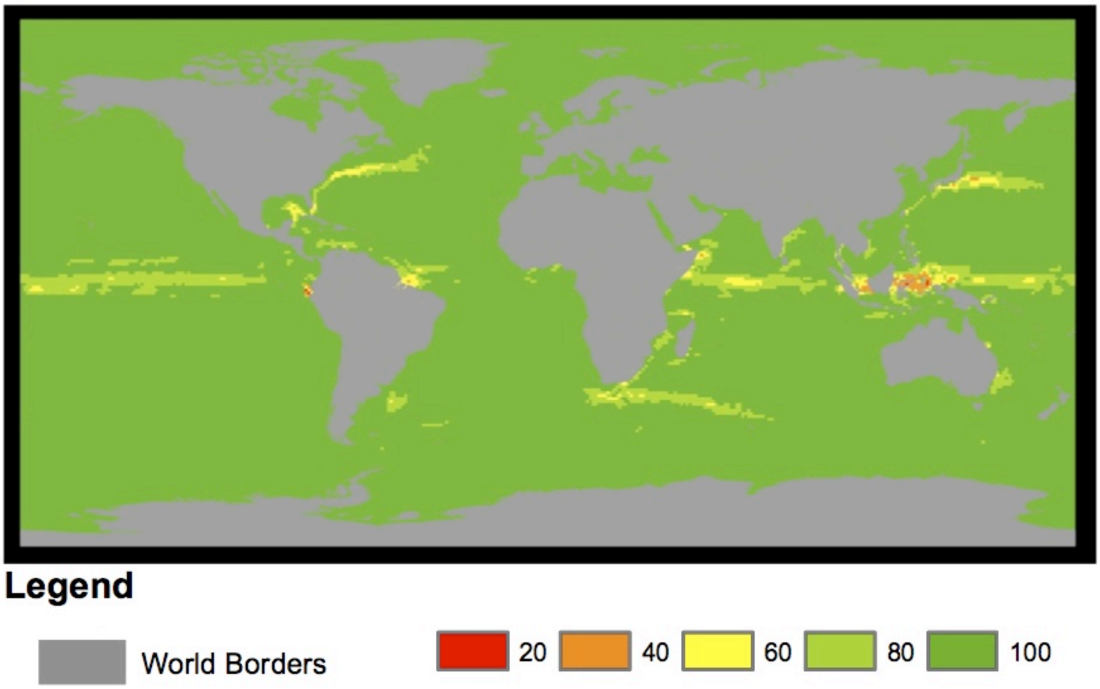


Transformation Function: Bathymetry

Score	Depth (meters)
100	0 - 300
80	300 - 600
60	600 – 1,000
40	1,000 – 1,500
20	1,500 or deeper

Source: NOAA ETOPO1 Global Relief Bedrock Model
Website: http://www.ngdc.noaa.gov/mgg/global/global.html

Current Speed

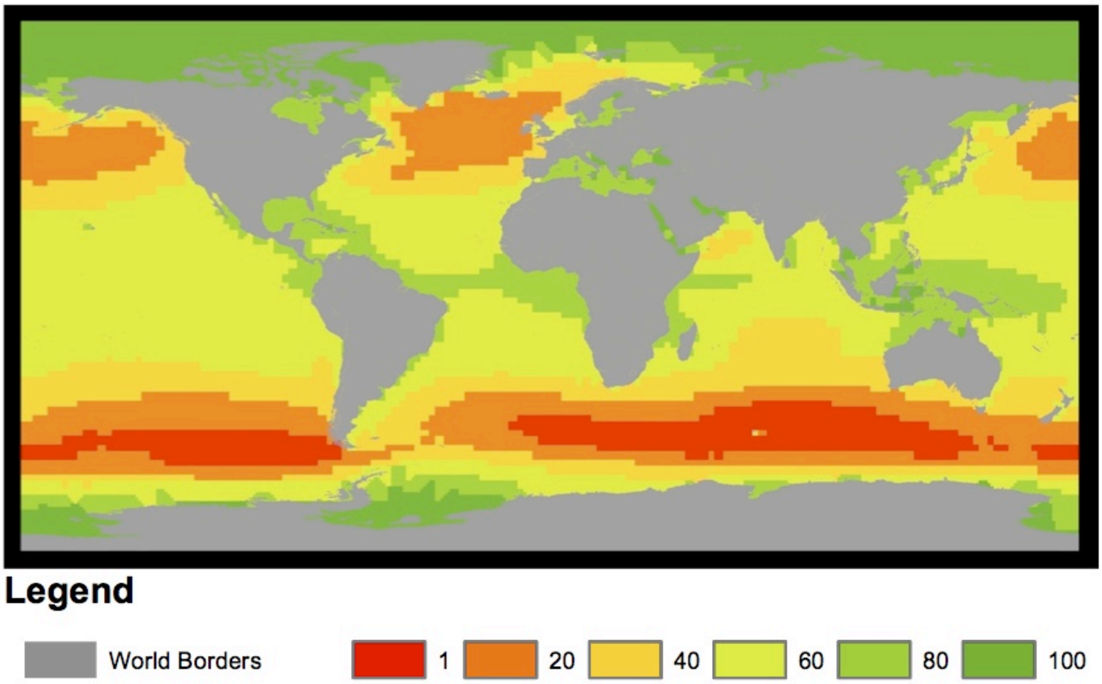


Transformation Function: Current Speed

Score	Value (m/s)
100	< 0.5
80	0.5 - 0.75
60	0.75 - 1
40	1 - 1.5
20	> 1.5

Source: NOAA Ocean Surface Current Analyses (OSCAR)
Website: http://dapper.pmel.noaa.gov/dapper/oscar/

Significant Wave Height



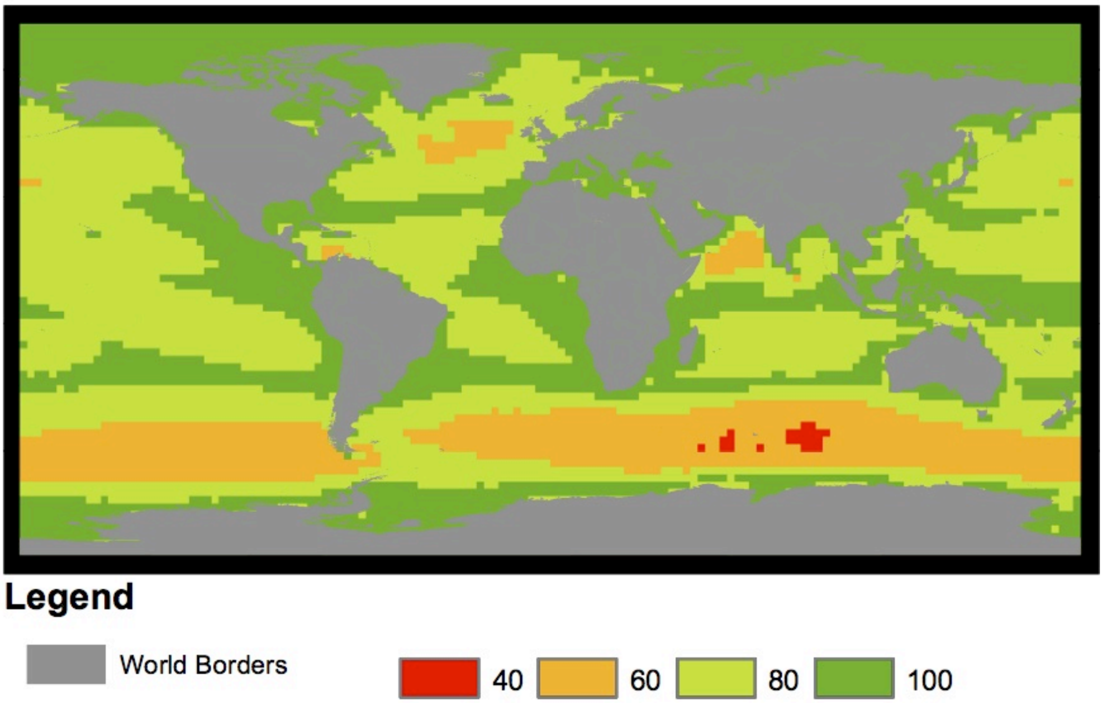
Transformation Function: Significant Wave Height

Score	Value (m)
100	0 - 1
80	1 - 2
60	2 - 3
40	3 - 4
20	4 - 5
1	> 5

The heat map shows the 90th percentile of the monthly averages of significant wave height for the past 40 years.

Source: ECMWF 40-year reanalysis Significant Wave Height
Website: http://data-portal.ecmwf.int/data/d/license/era40/

Wind Speed



Transformation Function: Wind Speed

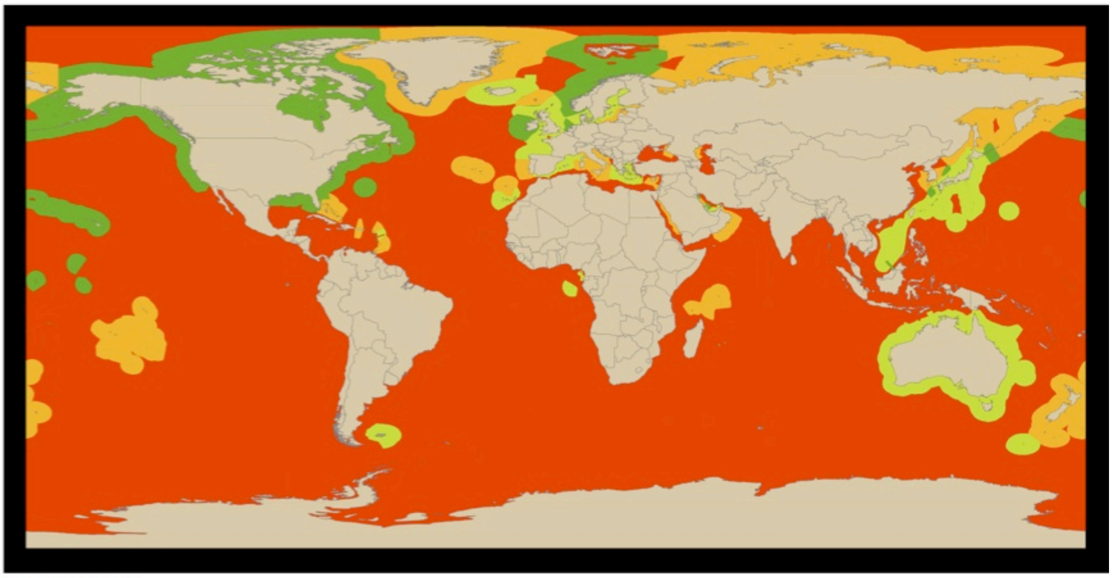
Score	Value (m/s)
100	0 - 5
80	5 - 8
60	8 - 11
40	11 – 14
20	> 14

Each location was scored based on average wind speed in meters per second (m/s), specifically the 90th percentile of all data points in the time history.

Source: ECMWF 40 year reanalysis 10m U Wind Component
Website: http://data-portal.ecmwf.int/data/d/license/era40/

• B. Economic Criteria

Proximity to consumers with disposable income (GDP)



Legend

World Borders | 10 | 50 | 75 | 100

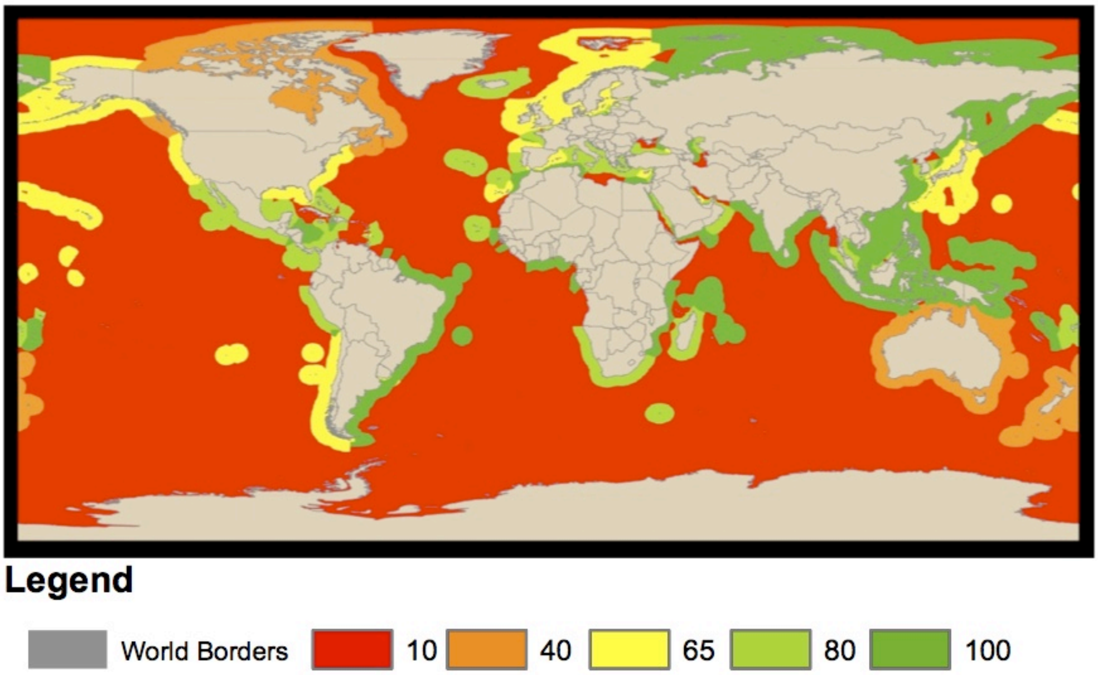
Transformation Function for GDP:

Score	Value*
100	1 - 17
75	18 - 35
50	36 - 70
10	Other countries

* Value is not based on GDP per capita *per se*, but on the *ranking* of GDP per capita for all countries. For instance "1 – 17" corresponds to the highest 17 GDP per capita countries in the world; these countries would be scored 100, meaning "most favorable" to seasteading.

Source: CIA Fact book Per Capita PPP GDP
Website: http://geocommons.com/overlays/13631

Degree of regulatory burden imposed on those consumers



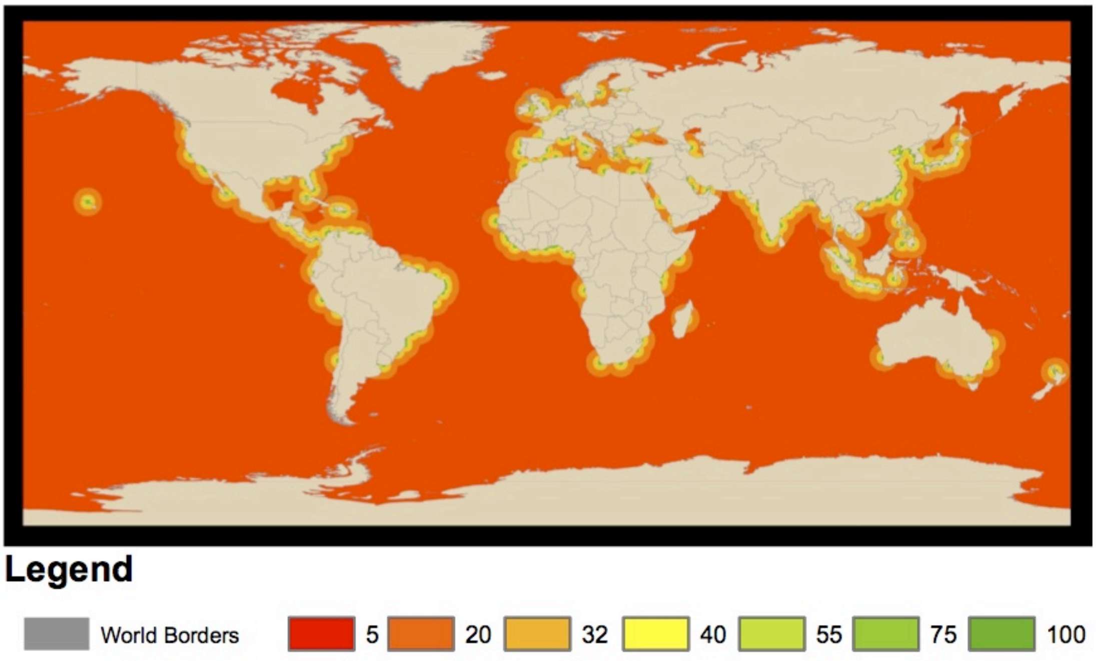
Transformation Function for Regulatory Burden:

Score	Regulatory Burden
100	Moderate to Heavy
80	Moderately Free
65	Mostly Free
40	Free
10	Repressed

(Scores based on the economic rating of the country that has maritime claims on the given ocean location)

Source: The Seasteading Institute Heritage Index Layer, Thematic Mapping World Borders 0.3
Website: http://www.heritage.org/index/

Proximity to major urban economic center



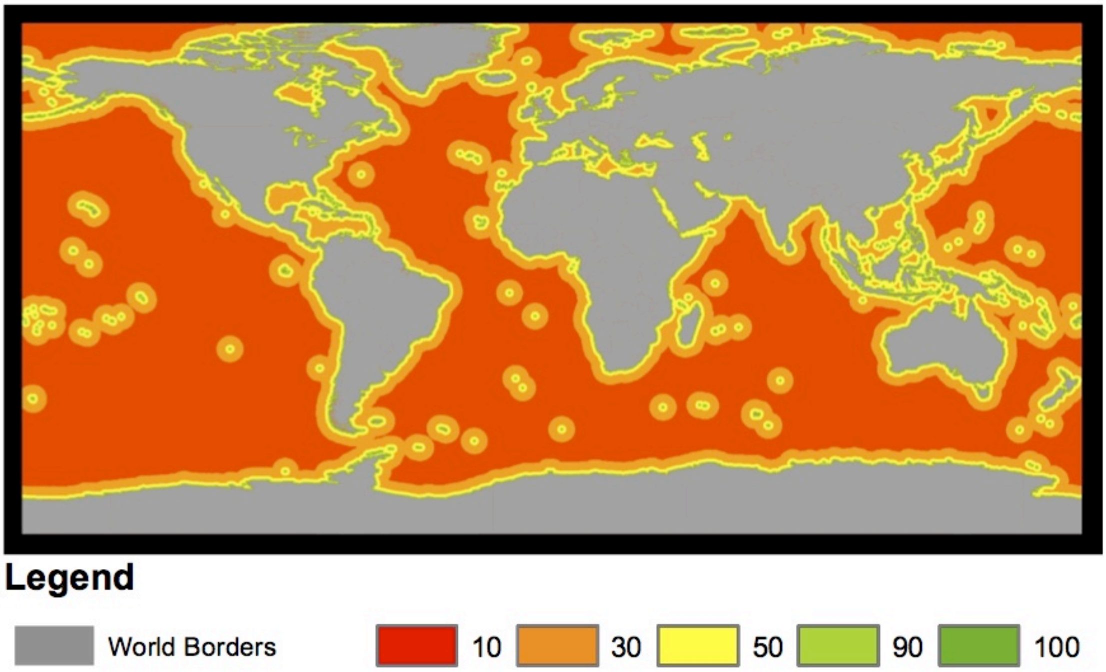
Transformation Function for Proximity to Urban Economic Center:

Score	Value (Hours)
100	< 1
75	1 - 2
55	2 - 3
40	3 - 4
32	4 - 8
20	8 - 16
5	> 16

(Scores based on the travel time on a high-speed ferry from the nearest major urban area, defined as having a population greater than 500,000 people)

Source: Nordpil World Database of Large Urban Areas 1950 - 2050
Website: http://nordpil.com/go/resources/world-database-of-large-cities/

Proximity to land-based data availability

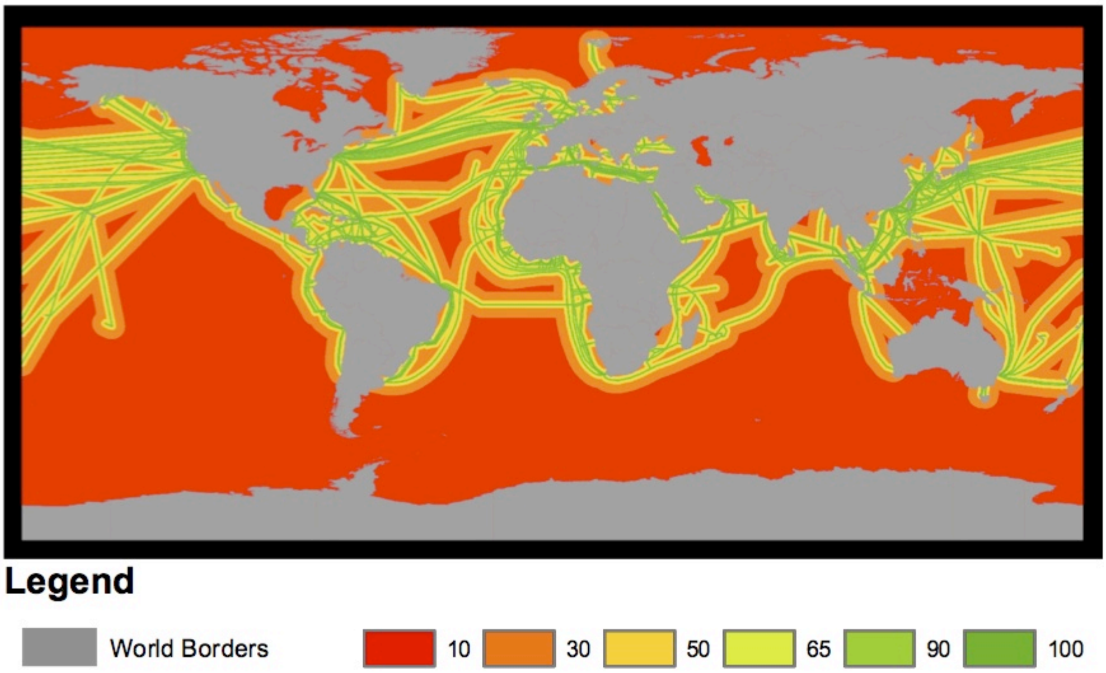


Transformation Function: Proximity to land-based Internet

Score	Value (km)
100	0 - 15
90	15 - 60
50	60 - 160
30	160 - 150
1	> 500

(Location scores are based on distance from nearest shoreline.)

Proximity to active data line



Transformation Function: Active Data Line

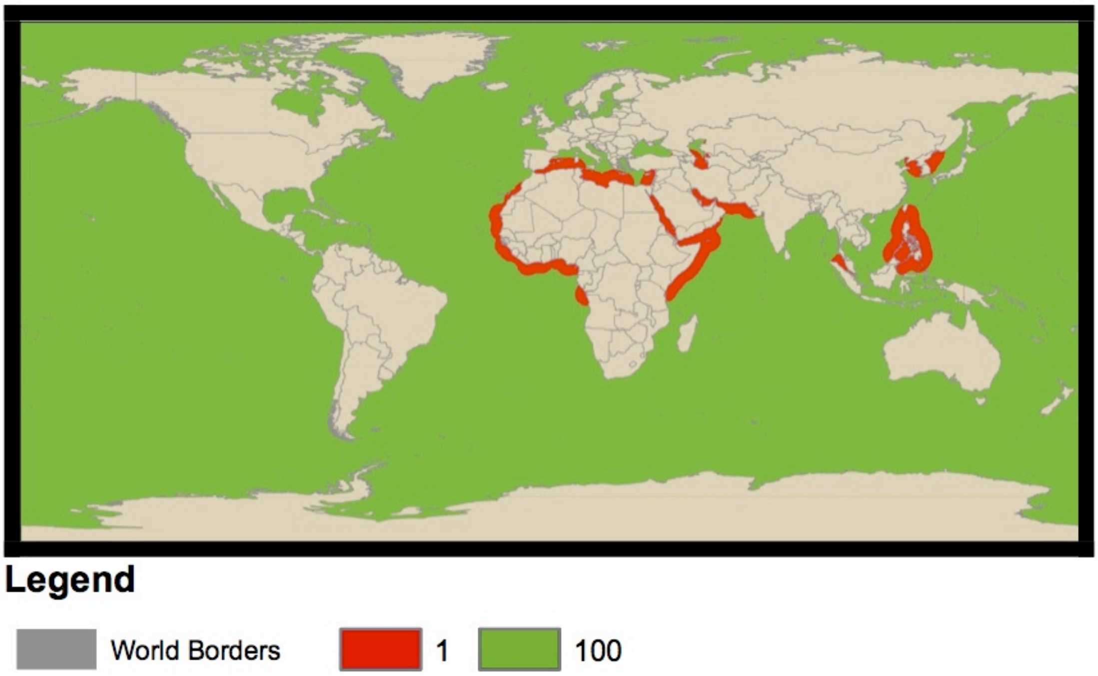
Score	Value (km)
100	0 - 15
90	15 - 45
65	45 - 60
50	60 - 150
30	150 - 500
10	> 500

(Score locations based on their distances from existing undersea data lines)

Source: Compilation from numerous publicly available sources
Website: http://www.cablemap.info/

C. Legal and Political Criteria

Dangerous Regions



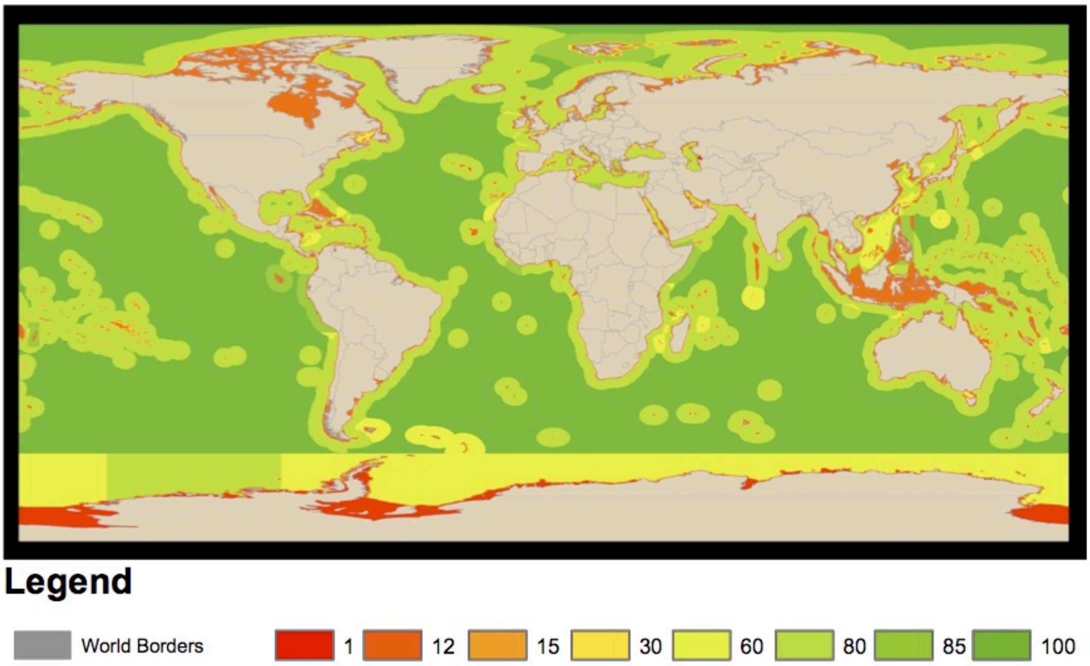
Transformation Function: Dangerous Regions

Score	Piracy/Proximity to Dangerous Region
100	No pirate activity
1	Within EEZ of dangerous region

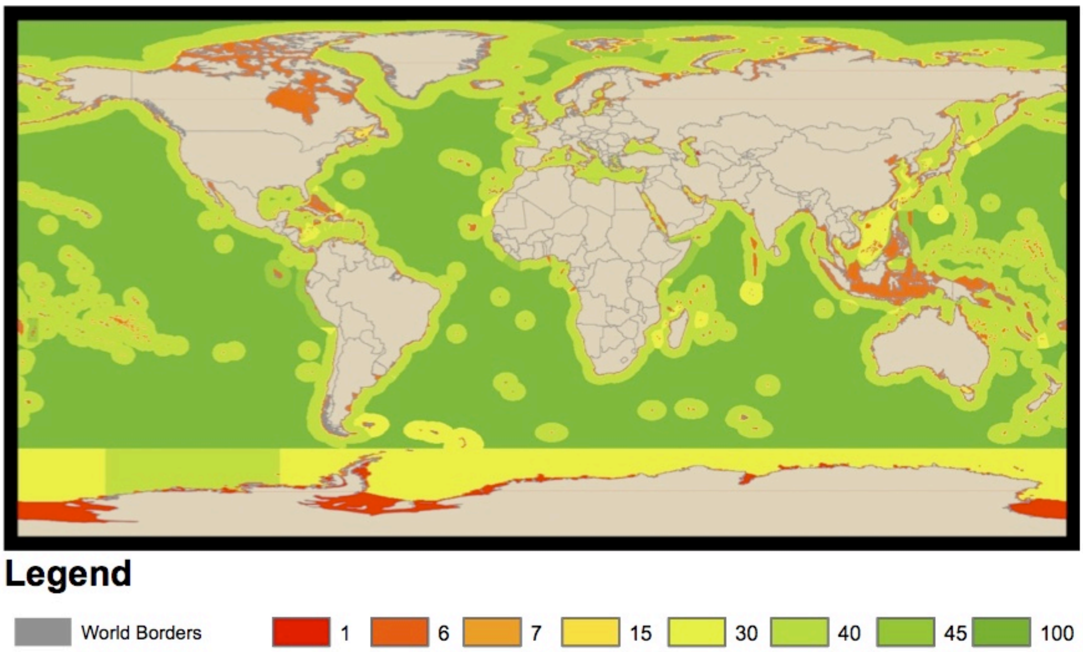
Source: Dangerous Regions based on US State Dept. Travel Advisories, Borders determined from Thematic Mapping World Borders 0.3
Websites: http://travel.state.gov/travel/cis_pa_tw/tw/tw_1764.html; http://thematicmapping.org/downloads/world_borders.php

Legal Status

- **Shipstead Scenario:**



- **Metropolistead Scenario:**



Ownership-Score is based on the value of the Ownership field:

Score-S	Score-M	Value
100	100	Exclusive Undisputed Ownership
100	100	Joint Ownership
100	100	Special Case Ownership – Svalbard Islands
60	30	Disputed Ownership
85	60	Unresolved
85	50	Hypothetical Ownership
100	100	None – Refers to High Seas

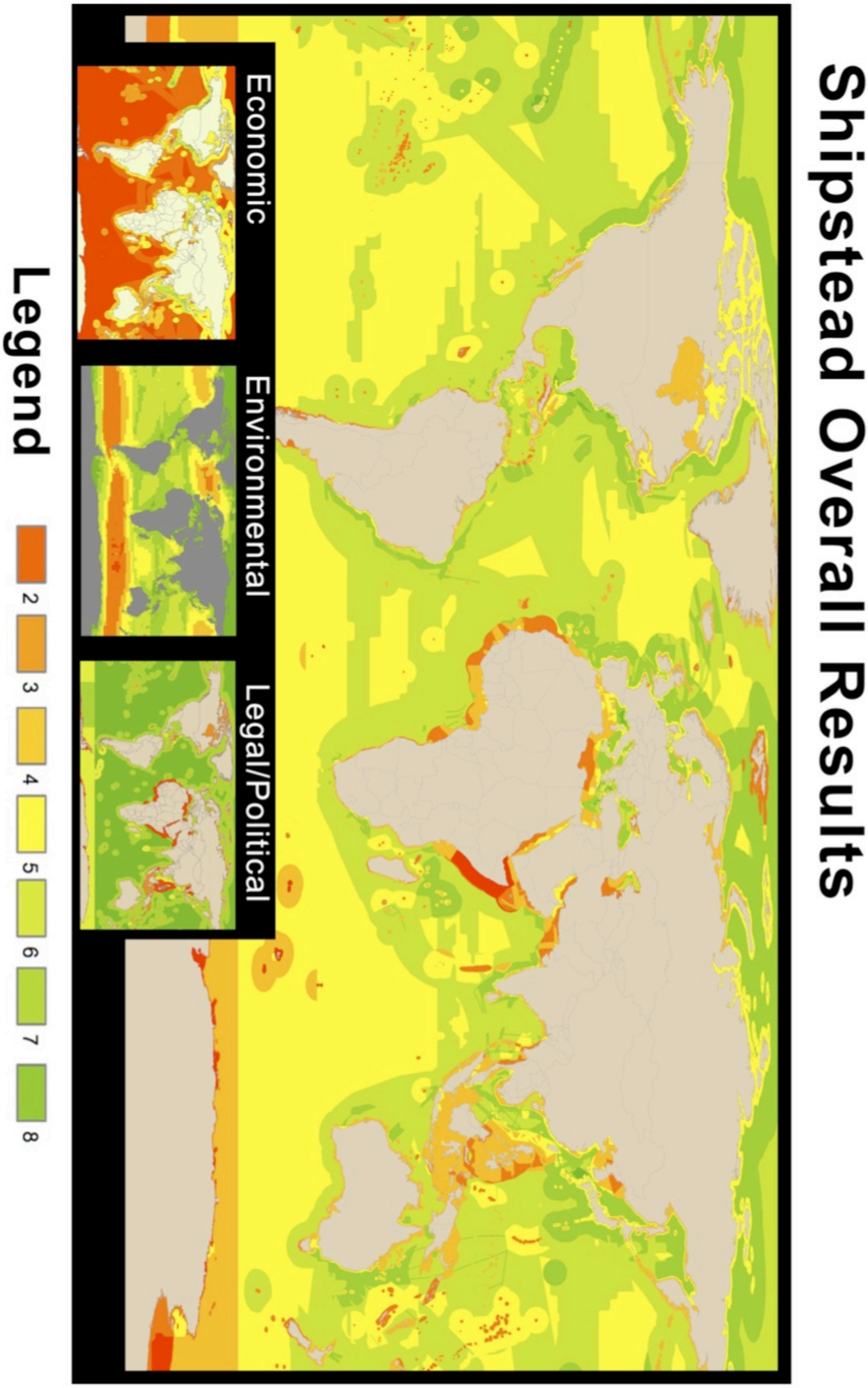
Note: Score-S denotes the Shipstead scenario
Score-M denotes the Metropolistead scenario

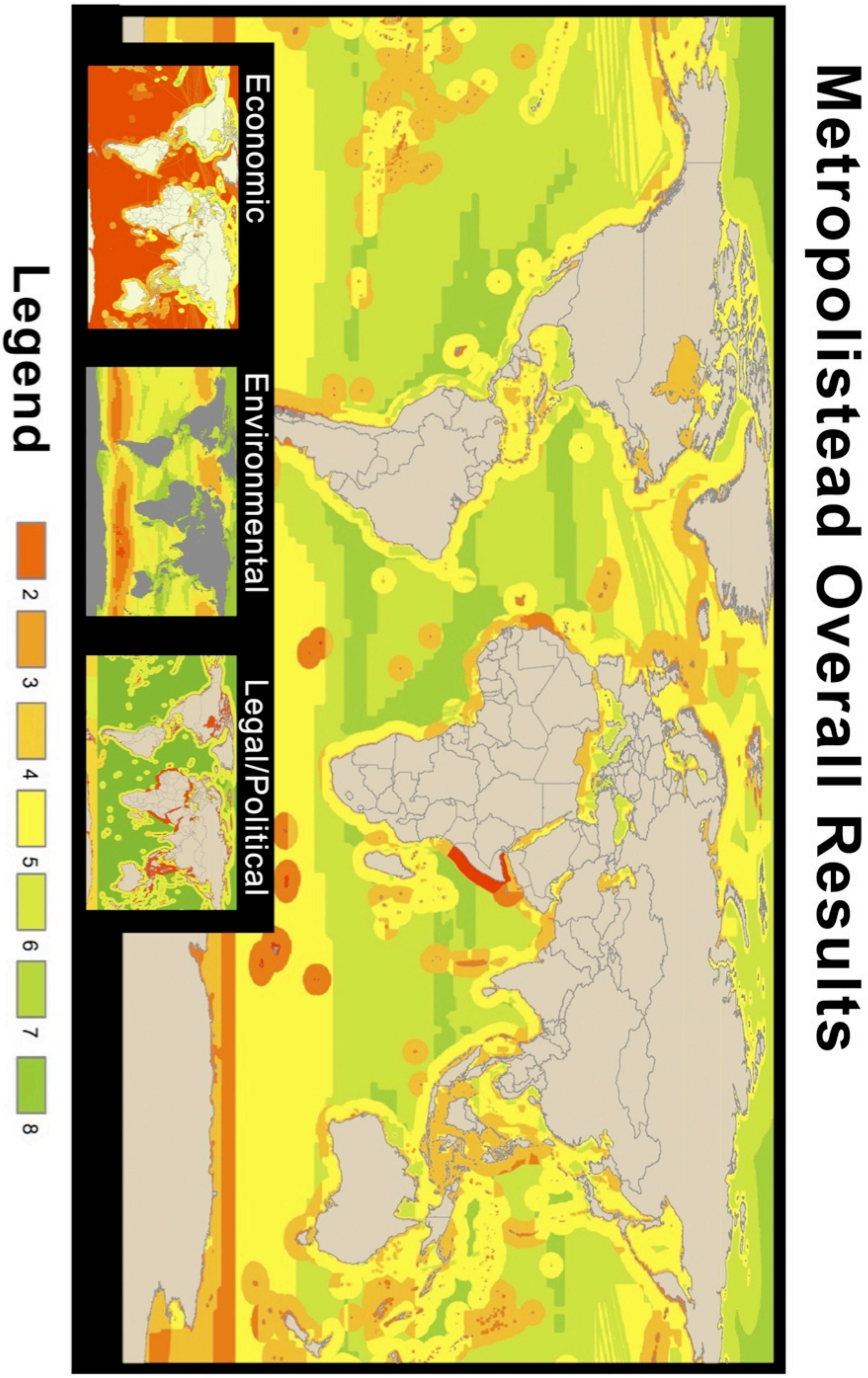
Claim-Score is based on the value of the Claim field:

Score-S	Score-M	Value
70	1	Bank
30	15	Contiguous Zone
80	40	Development Zone
80	40	Economic Zone
80	40	Fishing Zone
100	100	High Seas
7	1	Internal Waters
15	7	Intertidal
1	1	Island
80	40	Joint Development Zone
1	1	Land
2	1	Military Zone
70	1	Shoal
85	45	Special Zone
85	45	Special Zone – Fishing
85	45	Special Zone – Sovereignty
12	6	Territorial Seas

Note: Score-S denotes the Shipstead scenario
Score-M denotes the Metropolistead scenario

Source: The Global Marine Boundaries Database
Website: http://www.gd-ais.com/index.cfm?acronym=gmbd


Shipstead Overall Results
Economic
Environmental
Legal/Political
Legend
2
3
4
5
6
7
8


Metropolistead Overall Results
Economic
Environmental
Legal/Political
Legend
2
3
4
5
6
7
8