Measuring the maritime potential of nations. The CenPRIS ocean index, phase one (ASEAN)

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1 December 2010

WORKING PAPER SERIES

CenPRIS WP 137/10

MEASURING THE MARITIME POTENTIAL OF NATIONS. THE CenPRIS OCEAN INDEX©, PHASE ONE (ASEAN)

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DECEMBER 2010

CenPRIS Working Paper No. 137/10
DEC 2010

ABSTRACT

MEASURING THE MARITIME POTENTIAL OF NATIONS. THE CenPRIS OCEAN INDEX©, PHASE ONE (ASEAN)

This paper describes the methods used to construct an index to measure the maritime potential of nations. This prototype uses a limited number of variables to measure (a) the locational advantage of having a long coastline in comparison to the landmass (Maritime Potential Index MPI) , (b) the maritime economy (MEI) and (c) the degree a nation or region has utilized its maritime potential (OI). A timeseries of data from 2000 to 2005 for ASEAN states are used to develop the prototype. It is planned to develop the index further by adding variables and extending the regional coverage to all states of Malaysia.

KEYWORDS: Ocean Research, National Development, Maritime Industries, Economic Geography, Development Policy, ASEAN

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ISSN : 2180-0146

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1. OCEANS, SHORE-LINES AND THE MARITIME SOCIETY AND ECONOMY

It is by now taken for granted by politicians and economists that in a global world economy countries as much as companies have to strive to improve their competitive position versus each other Numerous ranking systems have been designed to show the relative position of countries either regionally or globally. The underlying values and indicators are diverse but combined into indices they show whether a country holds a top position on dimensions like economic growth, good governance, human development, corruption, technology readiness or knowledge assets[1]. These indicators are usually devised to monitor socio-economic trends, but are also used as planning instruments that provoke administrative action or monitor results of policy measures. The "CenPRIS Ocean Index (OI)" described in the following paragraphs is a combination of a "Maritime Potential Index (MPI)", a "Maritime Economy Index (MEI)" and a "Maritime Achievement Index (MAI)". It is designed to be a planning instrument that will measure how much a nation has utilized its geographical location next to seas and oceans to develop a maritime economy.

All nations and regions are endowed with resources that range from minerals, oil and arable land to cultural diversity and knowledge assets. These assets are unevenly distributed between countries that have made full or less than optimal use of these resources. Fortunately there is a trade-off: Nations without natural resources can compensate for this by using human resources, talents and knowledge to maintain and enhance economic and socio-political performance. Nevertheless the search for new resources is still on, and once resources are defined they are either optimally utilized, over- or underexploited, though recent studies have emphasized sustainable development rather than just optimization of resource exploitation.

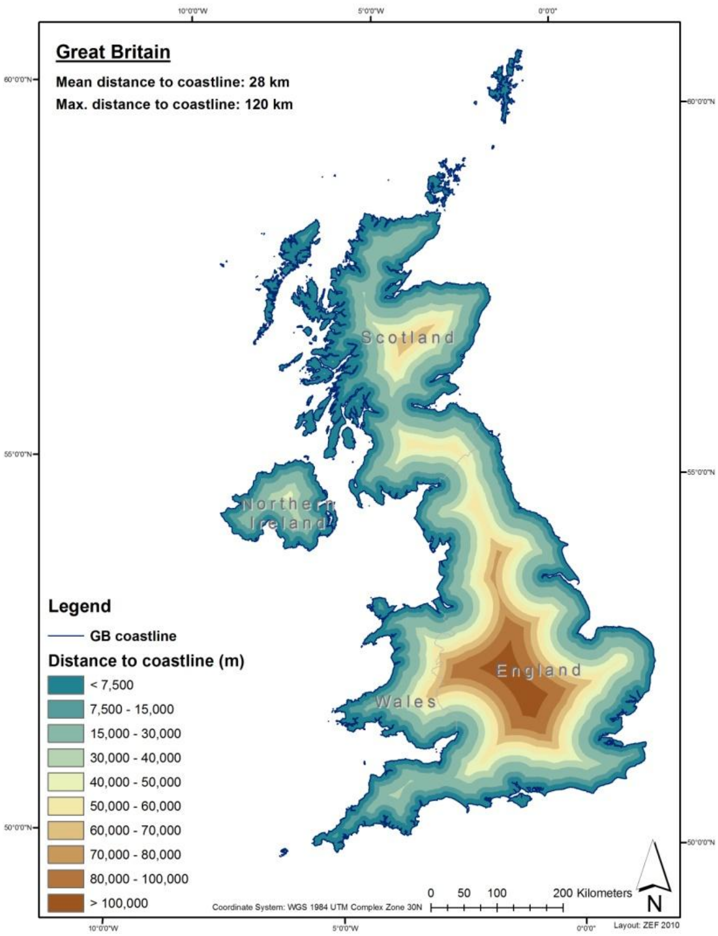
A less often discussed natural endowment consists of coasts and access to the world oceans. Nations with a long coastline will be in a better position to make use of maritime resources than countries with a short coast line, let alone land-locked countries. A long coast line offers the opportunity to engage in fishing, ship building, sea transport and other maritime industries. Its harbours facilitate international shipping, labour migration and the transfer of goods and knowledge. Location along an ocean and

[1] For example, UNDP: Human Development Index (HDI), Worldbank: Knowledge Economy Index (KEI), World Economic Forum: Technology Index, and many others.

access to blue water, maritime ecology and marine bio-diversity are as much a natural resource as gold, copper or oil, but unlike other natural resources it is fairly stable, not easily depleted and therefore naturally sustainable.

A look back in history shows that several great civilizations have been built on the advantages of a long coastline. The Roman Empire on Italy's far-stretched peninsula as well as Great Britain with its island position are civilizations that have made extensive use of their long coastlines and access to seas and oceans. The same holds true for Sumatran-based Srivijaya, and classical Melaka on the Malay Peninsula.

Figure 1 The Coastline of Great Britain

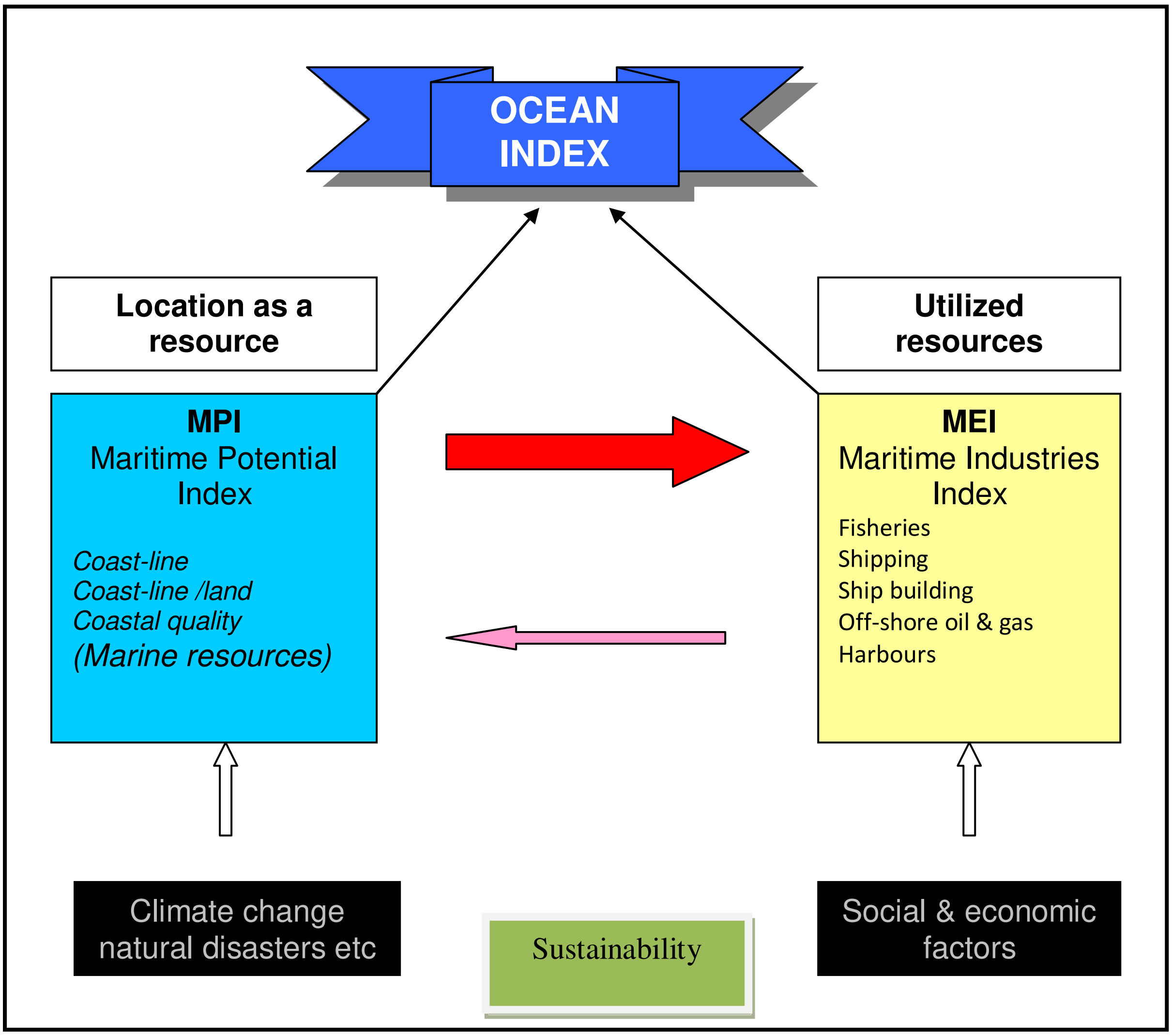


We propose to construct three indicators to measure the maritime potential and utilization of nations and regions. One index, named "Maritime Potential Index (MPI)" measures the geographical dimension of the above described natural resource "proximity to seas and oceans". It shows the natural potential of a nation, state or region to make use of this resource. A landlocked state has no natural potential to use maritime resources, whereas the potential of an island state or a state with a long coast line should be very high. The "Maritime Economy Index (MEI)" combines various typically maritime industries like fisheries, shipping, ship building, harbours and other economic fields. Whether or not the potential is utilized is measured by the "Maritime Achievement Index (MAI)" or "Ocean Index (OI)". Below we shall describe in greater detail, how the indices have been constructed.

The model, underlying the indicators, is shown in the following figure 1. It is based on the assumption that location, i.e. access to oceans and length of coastlines are factors impacting on the maritime industry of a nation. Other factors, depicted as “black boxes”, are neglected. There is a smaller feed back in so far as the maritime industry may change coast lines, divert access to oceans, reduce the quality of marine resources and lower bio-diversity.

Next to problems of measurement and index construction there are also other substantive issues that need further qualification, like the impact of population density, migration, the composition of the work force, poverty and income distribution or ethnic diversity.

Figure 1: Ocean Index model



2. METHODOLOGY

In constructing the indicators we have largely followed OECD standards (Nardo, Saisana et al. 2005). We have also adopted standard computing practices used for the Human Development Index (UNDP 2009:208-212) and the Knowledge Assessment Methodology (KAM) of the World Bank (World Bank Institute 2008). Furthermore, the Cluster Analysis Handbook (Sölvell, Lindquist et al. 2003) has been a useful source for the construction of indicators. The GIS mapping methods are described in our earlier paper (Evers, Genschick et al. 2009).

2.1 RESCALING OF VARIABLES AND INDICATORS

The rescaling or standardization of the variables that are used for the construction of the OI (and the sub-indices MEI and MPI, respectively) is based on the well established equation

$$I_{qc}^{t} = \frac{x_{qc}^{t} - \min_{c}(x_{q}^{t})}{\max_{c}(x_{q}^{t}) - \min_{c}(x_{q}^{t})}$$

where $\min_{c}(x_{q}^{t})$ is the minimum and $\max_{c}(x_{q}^{t})$ is the maximum value of x_{qc}^{t} across all countries *c* at time *t*. This rescaling function is also used in the construction of important development indices as the Human Development Index (HDI) (UNDP 2010). The normalized indicator values for I_{qc}^{t} basically vary between a minimum value of 0 (the “laggard) and a maximum value of 1 (the “leader”).

Generally, in order to guarantee the comparability of different indicators in time series analysis, “global” time-independent values for the maximum and the minimum of each indicator variable should be used for the construction of the OI. Accordingly, the rescaling equation should be transferred to the form

$$I_{qc}^{t} = \frac{x_{qc}^{t} - \min_{c}(x_{q}^{t0})}{\max_{c}(x_{q}^{t0}) - \min_{c}(x_{q}^{t0})}$$

where $\max_c(x_q^{t0})$ and $\min_c(x_q^{t0})$ are then based on the maximum and the minimum value that so far were measured for a certain variable; for instance the highest TEU throughput measured in a region, in our case ASEAN . If the maximum or the minimum values are time-dependently taken from an accordant distribution, it will bias the basis of comparison: e.g. even if a constant "leader" has a further growth in one sub-indicator variable within a time-series *t*1 and *t*2, the values of the indicators would not change if the maximum is taken from the variable distributions of *t*1 and *t*2 each. Only a time-independent maximum would reflect the further growth of the "leader" in the indicator value. Furthermore, in order to ensure future comparability, the ASEAN and Malaysian maximum values were multiplied with a sufficient factor of 1.5; while the minimum was set at 0.

Since this paper wants to introduce the OI and its sub-parts MPI and MEI as a "prototype" for measuring the utilization of maritime potentials in the non-landlocked ASEAN countries, and the states of Malaysia, the standardization of the variables was being conducted on the basis of the minimum and maximum values of the indicator variables for the years 2000 to 2005, the maximum being inflated by 50%. The minimum was set at 0.

2.2 PRELIMINARY INDICATORS – PROTOTYPES FOR MPI, MEI AND OI

For the "Maritime Potential Index" (MPI), the standardized variables "Mean Distance to coastline in kilometres" (MDC)[2] and "Percent of coastline of total country outline" (PCTCO) were chosen. The last mentioned variable potentially ranges between the poles of a landlocked country (=0) and a pure island country (=100). The variable "Mean Distance …" generally relativizes the maritime potential for those countries, which may have a higher percentage of coastlines in their total outlines but on the other hand also have relatively big landmasses; those countries are assumed to have a relatively lower maritime potential, which should be reflected in the MPI. Based on a principal component analysis check, each of the variables was weighted with the factor 0.5 in the construction of the MPI.

[2] The values for this variable were substracted from the value 100 so that both variables "Mean Distance to coastline (in kilometres)" and "Percent of coastline of total country outline" have the same poles (100=high maritime potential; 0=low maritime potential).

Other (potential) variables such as “ratio coastal area/ total area” were dropped for the construction of the MPI since there is no common definition of coastal area and the values of this variable fluctuate severely depending on the value for the number of kilometres chosen for defining a borderline of the coastal area.

Due to general data availability reasons, the standardized variables “Container throughput “(TEU)[3] and “Fisheries” (landed catch in metric tonnes, MT)[4] were chosen for the construction of the prototype MEI. The important “off-shore oil production” (barrel per Day, BpD)[5] will be introduced at a later day. The first mentioned variable is an estimator for the importance of maritime facilities for foreign trade; the other two are estimators for the degree of maritime value added per country. Both variables were weighted with the factor 0.5 for the prototype indicator. These weightings were chosen due to the respective loading values in an accordant principal component analysis. The final construction of the OI was then generated by the related values of the MPI and MEI; being put in equation form:

$$OI = 1 - \frac{MPI - MEI}{2}$$

where $MPI = \frac{MDC}{2} + \frac{PCTCO}{2}$ and $MEI = \frac{TEU}{2} + \frac{MT}{2}$.

The Ocean Index thus measures, how far a country has made use of its maritime potential; the higher the index the more a country has made use of its maritime potential. For those not familiar with indicator research, the following example may help to clarify the meaning of the Ocean Index. Say a group of boys take part in a sporting event of shot putter. The tall, lean guy has, of course, a larger potential to push the shot farther than the small fat boy. We take this into account, and measure how far the tall and the small have actually made use of their potential and reached their respective target. It may well be that the small fat boy does better than the tall, lean one, if the potential is taken into account. Another example would be the measurement of expected and achieved KPI (key performance indicators). The OI would then measure, how far the expected maritime KPI have been achieved.

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[3] Source: ASEAN Ports Association
[4] Source: Earth Trends Database
[5] United States Energy Information Administration

3. METHODS OF GIS MAPPING

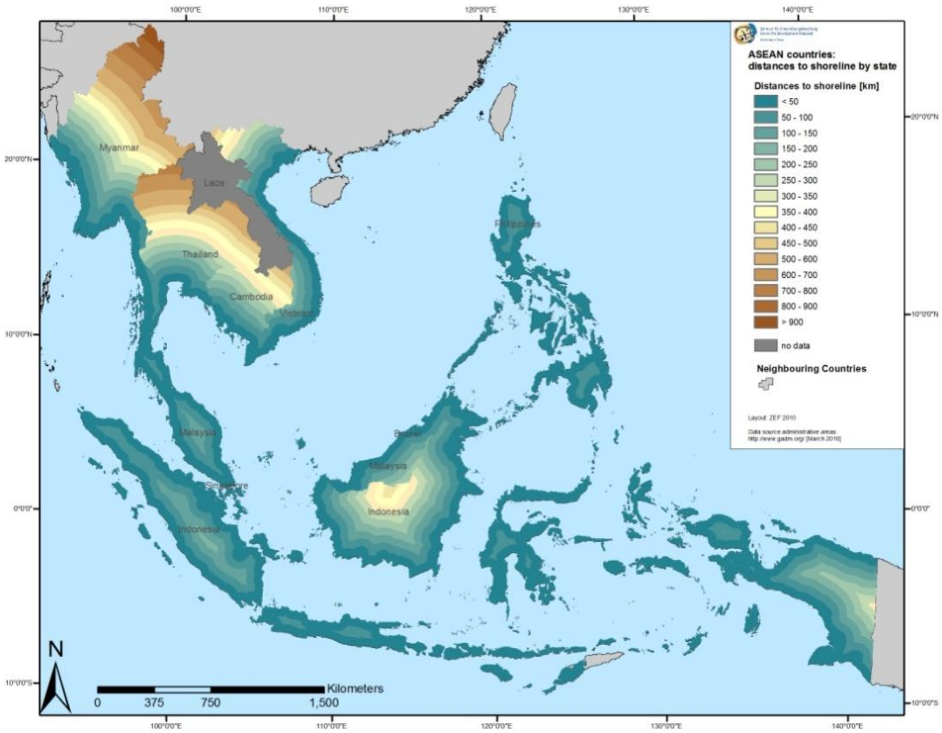
For spatial analysis and mapping ESRI ArcGIS 9.2 is applied. The spatial data sources are listed in table 1 at the end of this section.

3.1 COASTLINE EXTRACTION AND DISTANCE TO COASTLINE CALCULATION

In the following, it is described how to obtain the average distance to the state's coastline for each ASEAN state separately. The administrative boundaries used in this analysis are actually administrative areas consisting of the spatial information ("spatial feature", polygon shape file) and some attributes like the country name. First, a new rectangular feature is created encompassing the area of interest, for example all ASEAN countries or the whole world. This feature is clipped using the administrative area shape file to obtain a negative pattern of the countries. Then the «Feature to Line» tool in ArcGIS is applied resulting in a line feature including all land-ocean boundaries. Doing this the feature's attributes, e.g. the country name, need to be preserved. The line is then split at its vertices to divide it in a number of small sections. Subsequently, these lines are spatially joined based on the country name. The outcome is a multi-part feature which then has to be dissolved to a single-part feature, again based on the country name. Now the coastline for each country is created.

To calculate the distance to coastline for each country, the distance function of the Spatial Analyst in ArcGIS is applied to each coastline feature. As the distance is calculated to both sides of the line by default, the resulting raster file needs to be clipped by the administrative areas to obtain the distances to the coastline within each country and not within the ocean area (Fig 2).

Figure 2: Coastline Distance, ASEAN Countries

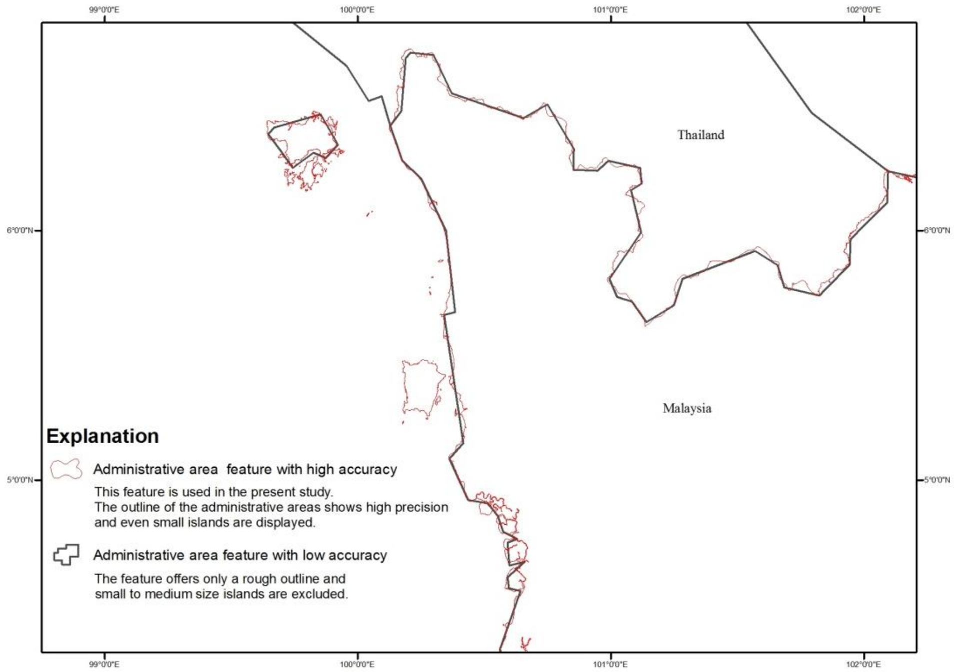


Based on the output data, the mean, maximum or minimum distance to the countries' coastlines can be calculated as well as the length of the coastline.

3.2 ACCURACY ISSUES OF COASTLINE LENGTH MEASUREMENTS

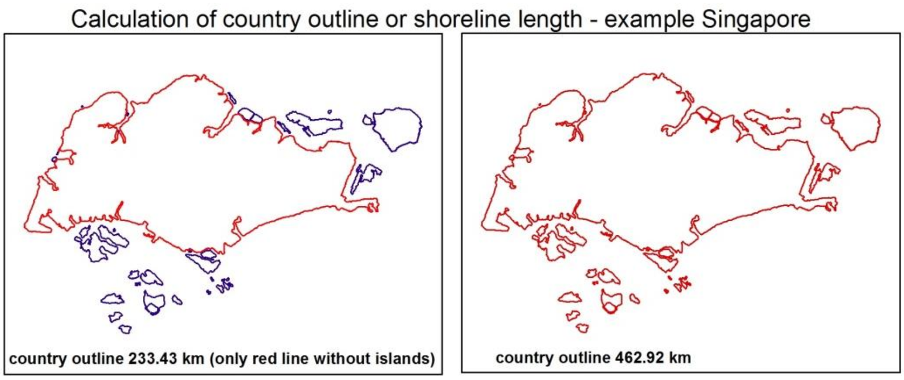
The results of the coastline calculations depend highly on the accuracy of the applied features. The precision of different administrative area shape files differ greatly as shown in figure 3.

Figure 3 Coastline Perlis, Kedah and Penang (Malaysia)



If the precise outline feature is applied, the question arises if small islands are included in the coastline calculation or not. Including small islands can lead to coastline length figures that are up to twice as big as the calculation results without small islands depending on the characteristics of the state. To exemplify the variety of results, different calculation approaches for Singapore are shown in figure 4. Singapore is a simply example as it does not share a land border with any other country so that the outline of the state equates its coastline.

Figure 4: Coastline Singapore



To avoid confusion at this stage of study and to make sure that the different spatial figures (area, land boundary, and coastline) used as variables in the index calculation are consistent, only data accessible in the internet (table 1) are used.

Table 1: Spatial Data List

Data	Description/Unit	Source
Administrative areas (GIS shape files)	Spatial features providing attributes for each area (spatial information, country name etc.)	Global Administrative Areas, http://www.gadm.org [last accessed May 2010]
Land area by country	Square kilometres	CIA The World Factbook (updated bi-weekly) https://www.cia.gov/library/publications/the-world-factbook/ [last accessed May 2010]
Total land boundary	Kilometres	
Coastline	Kilometres	

Other spatial data used in this study (e.g. coastal area, total outline etc.) is calculated based on the data listed above. The results of the index calculation (described in section 2) are visualized in ArcGIS by joining the result tables with the spatial features.

4. PRELIMINARY RESULTS: MEASURING THE MARITIME POTENTIAL OF ASEAN

Countries with a long coastline in relation to their landmass have a competitive advantage over countries with a shorter coastline. The Maritime Potential Index (MPI) is a composite measure of the geographical maritime potential and therefore a selected aspect of the competitive advantage of a nation. The question is, then, whether nations have made use of this potential and turned it into a competitive advantage in relation to other countries in their reference group. We have chosen the ASEAN countries as a reference group. Our preliminary data for 2005 show that ASEAN countries have, indeed, made different use of their maritime potentials. Brunei, Cambodia, Myanmar, Thailand and Vietnam rank below the average Ocean Index, Indonesia, Malaysia, the Philippines and Singapore rank above the average (Table 2, Figure 5 and 6).

Table 2 Ocean Indices, ASEAN 2000 and 2005

Country	MPI	MEI 2000	MEI 2005	OI 2000	OI 2005
Brunei	60,98	0,27	0,46	-0,20	0,00
Cambodia	22,68	0,92	1,75	40,79	41,66
Indonesia	86,54	83,36	88,59	60,33	65,84
Malaysia	72,39	38,65	65,74	28,17	56,67
Myanmar	12,36	14,46	19,22	65,88	70,90
Philippines	96,96	33,21	40,23	-3,40	3,98
Singapore	100,00	66,75	90,52	28,69	53,70
Thailand	22,75	55,87	57,27	98,53	100,00
Vietnam	54,98	25,83	36,60	33,00	44,33

Comparing the ASEAN countries, Singapore due to its big container harbour ranks highest, Brunei, Cambodia, Myanmar and the Philippines below the average of the Maritime Economy Index (MEI) (see figure 3). If we take, however, the maritime potential into account, a quite different picture emerges (figure 4). Singapore and Malaysia, the achievement index (Ocean Index OI) says, have achieved less than would have been expected according to the Maritime Potential Index (MPI). Both countries rank on the Ocean Index (OI) only minimally above the ASEAN average.

Figure 3 Maritime Economy Index ASEAN 2005

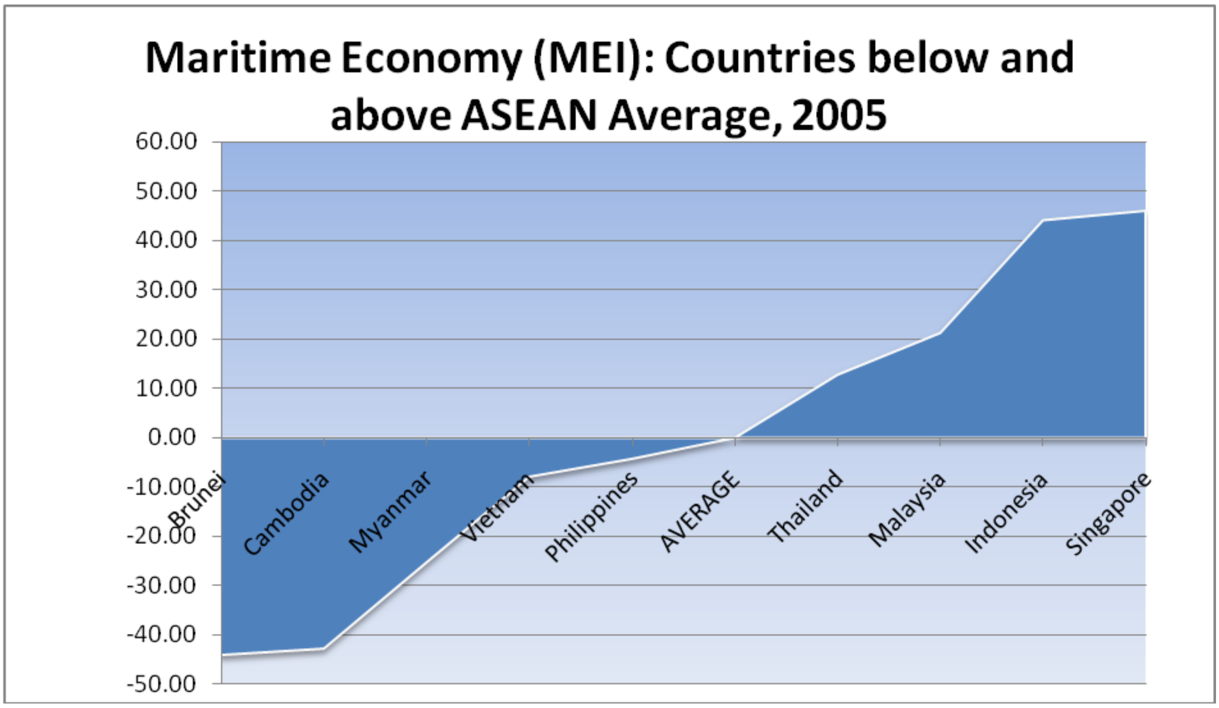
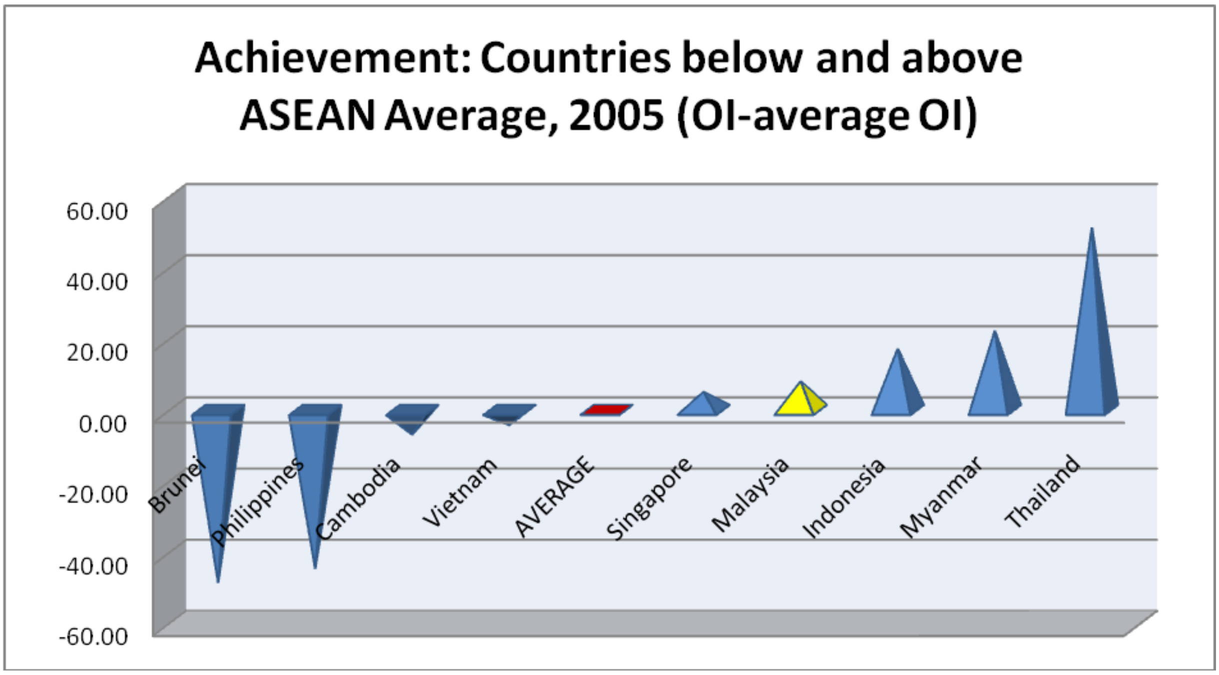
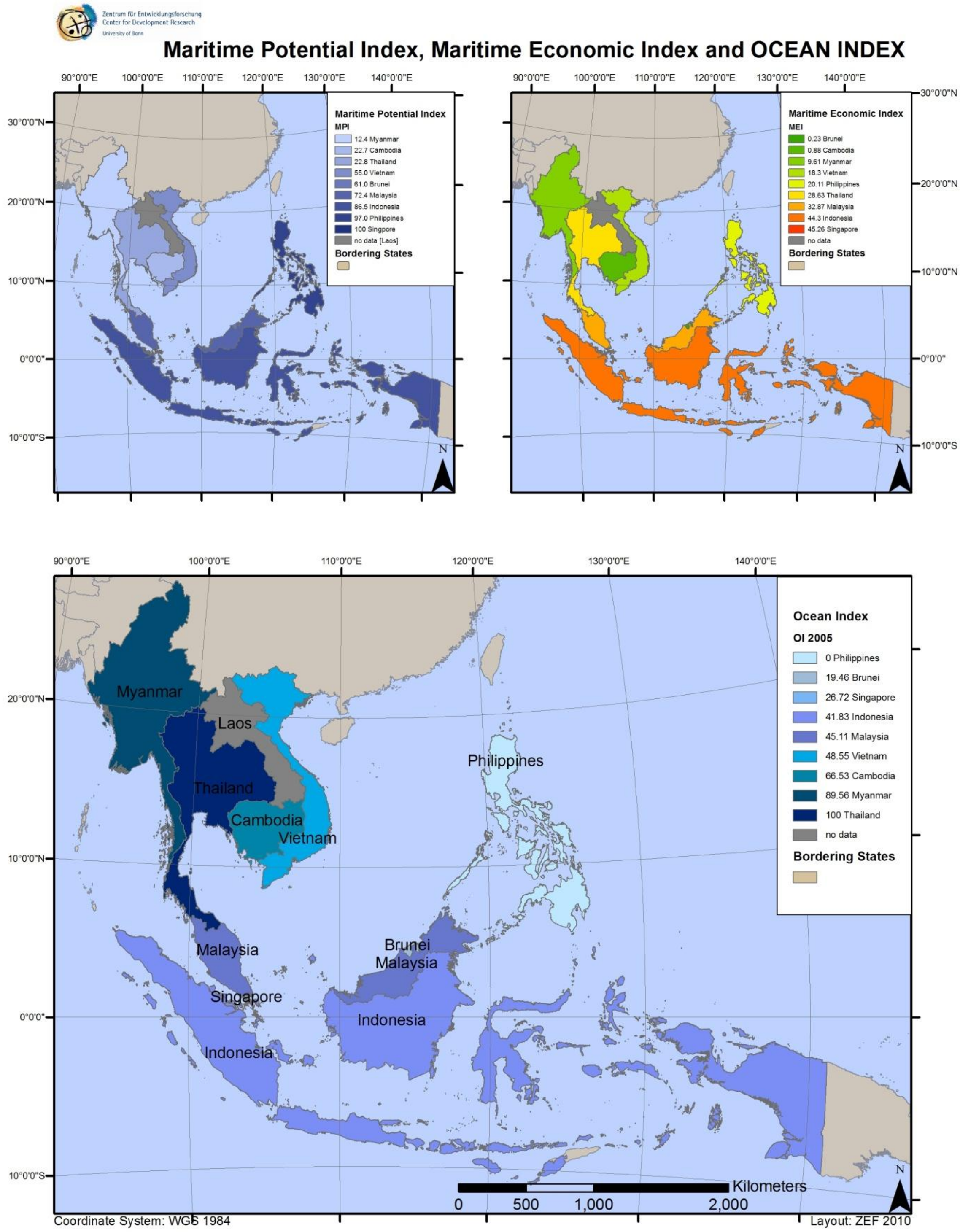


Figure 4 Countries below and above ASEAN Average, OI 2005



As for all other indices, comparing time series tends to reveal the most relevant results. Comparing the development of the Ocean Index from 2000 to 2005, it is evident that the utilization of the maritime potential has increased by about 11%. Malaysia's OI has risen by 57%, the highest next to Singapore. Likewise, higher values are also calculated for Indonesia and Vietnam. But changes of the Ocean Index of Brunei, Myanmar, and Cambodia seem to be negligible (figure 7).

Figure 7: MPI, MEI and OI, ASEAN 2005



5. CONCLUSION

This research note should be read as a first step towards the development of a more comprehensive and robust ocean index (OI). Towards this end additional variables will have to be introduced to enhance the accuracy of the Maritime Potential Index (MPI) and the Maritime Economic Index (MEI). Furthermore different weightings of the variable and different formulas to calculate the OI will have to be developed, before the OI can be used as a development planning instrument. Last not least a data base with longer time series for the MEI will have to be collected and updated, both for ASEAN and for the Malaysian states. It is hoped that the Index will be a useful tool to monitor the progress of the maritime industries, to locate possible gaps and to generate hypotheses and plans for further research into the maritime potential of nations, states and regions.

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