RUTGERS Center on Public Security

BRIEF

Forecasting Global Maritime Piracy Utilizing the Risk Terrain Modeling (RTM) Approach

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Background

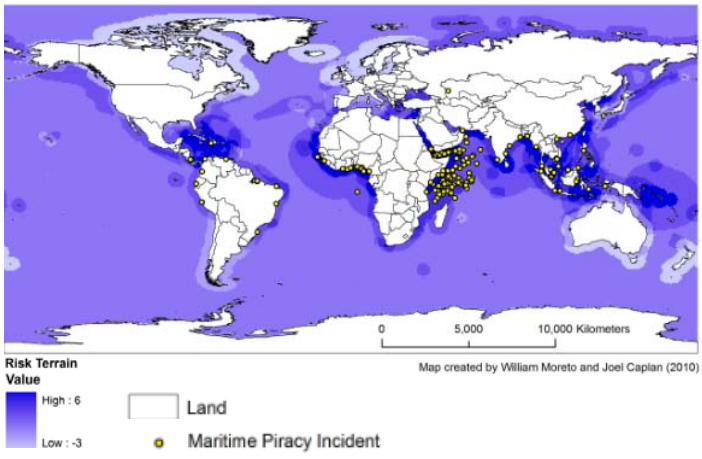
Recent maritime piracy[i] incidents on the coast of Somalia, the Gulf of Aden and the Horn of Africa (HoA) have not only received significant attention from the media and the international community, but have also garnered the attention of policy strategists and academic researchers as well. While maritime piracy is not a new phenomenon, modern changes in geographic "hot spots" and the increased frequency of incidents and the severity of attacks warrant that the current maritime piracy situation be addressed forthright and responded to in an effective and efficient manner.

While there have been anecdotal evidence outlining specific geo-spatial and temporal factors that contribute to maritime piracy, there has been no attempt to empirically test how such factors intersect at places to create a context for maritime piracy to occur. Indeed, the identification of the primary land-based factors that contribute to maritime piracy has been considered a vital topic in need of assessment[ii]. But current sea-based risk assessments rely solely on hotspot locations of past incidents to predict locations of future similar events. This univariate analysis assumes a static environment—that the locations of pirate attacks do not change over time. This is an unreasonable assumption given the dynamic nature of the social, natural, and built environments in our world today. The research briefed here tested Risk Terrain Modeling (RTM) as an innovative approach to forecasting locations of global maritime piracy and provides empirical support to our recommendation that RTM be used for tactical action and strategic decision-making in response to and for the prevention of maritime piracy worldwide.

Data and Methods

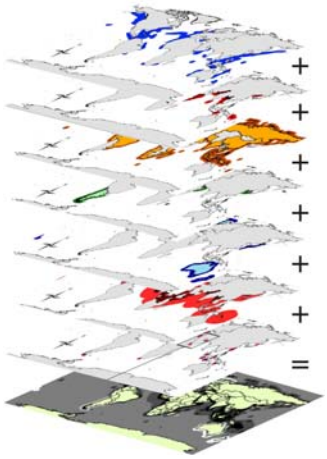
This study [iii] utilized a Risk Terrain Modeling (RTM) Approach [iv] and ArcGIS, a Geographic Information Systems (GIS) by ESRI, to create risk map layers based on specific factors that were believed to contribute to maritime piracy. The specific factors included were (i) maritime shipping routes, (ii) maritime chokepoints[v] and (iii) countries assessed in the Failed States Index[vi]. From these three factors, seven risk layers were created. Risk was categorized in a dichotomous manner (either a specific geographical location was at high risk or it was not); results from existing empirical research, industry literature and reports, and professional experiences supported the operationalization of each risk factor to a separate risk map layer that, when combined, would become a composite Risk Terrain map.

The risk posed by maritime shipping routes was operationalized as: locations with a high density of shipping routes would result in an increased number of shipping vessels; thus, leading to an increased number of potential targets and a higher level of risk[vii]. Maritime chokepoints were believed to create an environment conducive to piracy due to their (i) physical geography, which limits the speed and maneuverability of vessels leading to increased vulnerability and (ii) the logistical importance of such locations for shipping companies. Areas within 200 nautical miles from a maritime chokepoint were operationalized as high risk, all other areas were considered not high risk. Operationalizing countries assessed in the Failed States Index (2008) was conceptually and technically multifaceted. While prior literature has focused on the link between failed states and maritime piracy[viii], there has been neglect on the mitigating or aggravating influences of other types of states (i.e.



"weak," "moderate," and "sustainable"). This study acknowledged and corrected for this by attributing risk-levels to the Exclusive Economic Zones (EEZ) of states based on their score in the Failed States Index. Only littoral states were included due to the nature of the study. Lastly, recent data has shown that maritime piracy attacks near some failed states (i.e. Somalia) have occurred as far as 900 nautical miles from the coastline; thereby, signifying an additional level of risk at distances beyond just the EEZ[ix]. This was also accounted for as a separate risk map layer.

Individual risk map layers were created and a composite risk terrain map was produced whereby each individual cell on the map had a value ranging from -3 (least amount of risk) to +6 (highest amount of risk). Cells were 42x42 nautical miles and, essentially represented non-land places on Earth. Piracy incident data from 2009 was obtained from the International Maritime Bureau[xi] and coordinates for piracy incidents were mapped in ArcGIS and then superimposed on the 2008 Risk Terrain map, as the map on page 1 shows.



Results

The Risk Terrain produced with data from 2008 significantly predicted locations where maritime piracy incidents occurred in 2009. A logistic regression analysis showed that for every one unit increase in risk, the likelihood of a pirate attack occurring increased by 184% ($p < .001$). A Pearson Chi-squared test showed that the top 10% of high-risk cells in the 2008 Risk Terrain correctly predicted the locations of 61% of the maritime piracy incidents during 2009 (N=88093; value=502.29; $p < .01$). This is quite a feat considering that pirate attacks only occurred in approximately 1.3% of all the cells, globally. So, out of the vast ocean, our Risk Terrain Model was able to identify these places in advance with more than 60% accuracy.

TABLE 1: Logistic Regression for Risk Value on Pirate Attack or Attempt

Period 1 Risk Terrain* Forecasting Period 2 Incidents

	B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I. for Exp(B)	
							Lower	Upper
Risk Value	1.04	.047	500.00	1	<.001	2.84	2.59	3.11

* -2 Log likelihood = 2141.47; Nagelkerke R Square = .15; n=88093 cells

Discussion

Preliminary results from this study suggest that Risk Terrain Modeling can significantly identify the locations where global maritime piracy incidents will occur. This unprecedented and innovative approach supports the push towards a proactive stance on efficient resource allocation and strategic tactical deployment to combat piracy and mitigate its effects on global maritime trade. By focusing on qualities of space[x] that enable piracy to happen most easily *rather* than solely on the hotspot locations of past pirate attacks, policy-makers and all other stakeholders may be able to respond to the global threats of maritime piracy in a more effective manner. The flexibility of RTM to be applied to any extent—global, regional, or local—is also a noteworthy advantage, as it could be used to assess the risks of maritime piracy at a micro-level and then be used to evaluate the impact of interventions at those locations, such as the International Recommended Transit Corridor in the Gulf of Aden.

As previously mentioned, this preliminary study only incorporated a few of many possible risk factors into the final Risk Terrain. We acknowledge that high risk areas are not constantly at high risk throughout the year and that temporal factors must also be considered (i.e. seasonal variation) for a more accurate risk terrain to be created. We are currently developing ways of creating multi-dimensional risk terrains that incorporate temporal factors that not only identify regions of high risk but also *when* such locations are at their highest levels of risk. For now, we believe it safe to conclude that when refined further, Risk Terrain Modeling may enable stakeholders to be more effectively proactive and identify areas with the greatest probability of becoming hot spots for maritime piracy in the future. Not just because statistics show that incidents occurred there yesterday, but because the environmental conditions are ripe for incidents to occur there tomorrow.

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[i] There is no universal definition for maritime piracy; however, for the purposes of this study, the authors used the statistical definition utilized by the International Maritime Bureau (See ICC-IMB Piracy and Armed Robbery Against Ships: Annual Report, 2009).

[ii] Chalk (2009). *Maritime Piracy: Reasons, Dangers and Solutions*. Testimony for the RAND Corporation. Santa Monica, CA.

[iii] Findings from this study were presented at the *Symposium on Emergent Threats in the 21st Century: Searching for a Common Methodology* (March 18-19, 2010).

[iv] See Caplan and Kennedy (2009) for a brief description on Risk Terrain Modeling: http://www.rutgerscps.org/publications/RiskTerrains%20as%20Intelligence_Brief.pdf

[v] The authors would like to thank Dr. Jean-Paul Rodrigue of Hofstra University for generously creating maritime shipping route and maritime chokepoint shapefiles based on data from the National Center for Ecological Analysis and Synthesis: http://www.nceas.ucsb.edu/globalmarine/impacts

[vi] See the Fund for Peace website for a description of the methodology used in the categorization of states: http://www.fundforpeace.org/web/index.php?option=com_content&task=view&id=99&Itemid=140

[vii] Locations of risk were categorized with a value of +1 and all other locations given the baseline value of 0. Scores in this pilot study were not weighted and were relative to the geo-spatial factors addressed. However, for the littoral states in the Failed States Index, EEZ risk values were based on the category a state was given and was relative to one another (i.e. a failed state received a risk value of +2 and a sustained state received a risk value of -2).

[viii] Chalk, 2009; Murphy, M.N. (2009). *Small boats, weak states, dirty money: Piracy and Maritime Terrorism in the Modern World*. New York, NY: Columbia University Press; Hastings, J.V. (2009). Geographies of state failure and sophistication in maritime piracy hijackings. *Political Geography, 28*(4), pp.213-223.

[ix] Piracy incidents have occurred from as far as 900-1000 nautical miles (International Maritime Bureau, 2010).

[x] Brantingham, P.J., & Brantingham, P.L. (Eds.). (1991). *Environmental Criminology*. Prospect Heights, IL: Waveland Press, Inc.