High Noon on the High Seas: *A Proximity–Complexity Model of Maritime Piracy Threats*

by James E. McGinley and Jonathan P. Berliner

Strategic Insights is a quarterly electronic journal produced by the Center for Contemporary Conflict at the Naval Postgraduate School in Monterey, California. The views expressed here are those of the author(s) and do not necessarily represent the views of NPS, the Department of Defense, or the U.S. Government.

Introduction

An apparent contradiction between rhetorical claims of piracy threats to international shipping and actual attack trends has established the need for a more structured approach to strategic risk assessment. This article provides new insight into risk assessment methodologies by integrating a structured, multi-dimensional approach to attack profiling within a more comprehensive Proximity–Complexity model. This model was empirically examined by conducting a comparative risk assessment in two regions widely cited as high risk, the Straits of Malacca in Asia and the coastal waters of Nigeria. Results indicate that the consideration of geographic proximity of attacks as a risk factor may need to be more carefully examined. Further, the authors suggest that counter-piracy strategies could benefit from a multi-stage risk assessment methodology that integrates both structured and geographic approaches within a more comprehensive analytic framework.

Sea-based trade may account for as much as 77 percent of worldwide trade measured in terms of volume, overwhelming overland (16 percent), international pipeline (6.7 percent), and international air freight trade (0.3 percent) as the dominant transportation mechanism.[1] Worldwide dependency has, in turn, led to increased concerns over the safety of international sea lanes. Reflecting the concerns of a post-9/11 world, the U.S. National Strategy for Maritime Security warns of the danger of a convergence of international armed piracy and terrorism.[2]

However, despite continued concerns over maritime and shipping threats, attack frequency has lessened in some high risk regions. The International Maritime Bureau reports that the numbers of attacks have increased in Nigeria and Somalia but that attacks have declined in Indonesia, the Straits of Malacca, and Bangladesh.[3] An apparent contradiction between rhetorical claims of threats and actual attack trends establishes the need for a more structured approach to the risk analysis of threats to international shipping. The aim of this study is to provide new insight into risk methodologies by integrating a structured threat assessment approach with geographic information analysis and visualization techniques. Sound threat and risk assessment methodologies are an essential prerequisite to the development of any effective counter-piracy strategy.

The threat assessment framework developed for this study was explored by conducting a comparative analysis in two regions widely cited as high risk, the Straits of Malacca in Asia and the coastal waters of Nigeria in western Africa. As much as one-third of the world's trade and one-half of its oil may transit through the Straits of Malacca.[4] In Nigeria disruptions of oil production can threaten a strained world oil market that is critically dependent on its contribution.[5] Additionally, variations in attack profiles within two differing regions may provide a realistic validation of this study's exploratory framework.

It is hypothesized that strategic maritime risk increases when attacks against international shipping occur in close proximity to strategically important locations, as attacks increase in complexity and lethality, and when attacks target shipping carrying inherently dangerous cargo (see Figure 1).

Figure 1. Conceptual framework for maritime risk.

Proximity refers to the distance between the attack and a strategic location within the region and was computed as line of sight distances. For the Straits of Malacca the strategic locus was defined as its narrowest point, the easternmost chokepoint (latitude/longitude, 02 16 17.19N/101 47 41.41E). For the coastal area of Nigeria the strategic locus was defined as the Shell Bonny Export Terminal (latitude/longitude, 04 12 40.00N/007 16 00.00E), a critical oil export facility. Distances were scaled from a value of 5 to 0 in increments of 50 nautical miles (nm) from each strategic locus. Attacks in the range of 0-50 nm were assigned a value of 5; 51-100 nm a value of 4; 101-150 nm a value of 3; 151-200 nm a value of 2; 201-250 nm a value of 1; and, attacks further than 250 nm a value of 0.

A complexity index was calculated by assigning values to variables for the number of perpetrators and the type of weapons used in an attack. Perpetrator values were: 0—number of person involved unknown; 1—1 to 4 persons; 2—5 to 10 persons; 3—more than 10 persons. Weapons values were: 0—weapon not known; 1—other; 2—armed with knives; 3—armed with guns. A complexity index was aggregated by summing the values for both number of perpetrators and for weapons use.

Lethality was calculated by assessing the type of violence enacted against both ship and ship crews. Lethality values were: 0—unknown; 1—ship hijacked; 2—ship missing; 3—threat of violence against crew; 4—actual violence against crew.

Target selection refers to the type of vessel selected for attack. Of the twenty-two types of vessels tracked by the International Maritime Bureau, five categories were selected as most dangerous based on inherent lethality. Target selection values were: 0—other; 1—cargo ship; 2—tanker; 3—chemical tanker; 4—LPG/LNG (liquid petroleum gas/liquid natural gas) tanker.

A composite risk index was compiled by summing all variable values. If all variables reflected their highest value, the score for the risk index would have a value of 19.

Method

This study utilized the International Chamber of Commerce's International Maritime Bureau's (IMB) annual Piracy and Armed Robbery against Ships report as a data source. The combined number of attacks reported for 2006 and 2007 were $N = 17$ and $N = 56$ for the Straits of Malacca and Nigeria respectively. Using the descriptive narrative provided for attacks in the IMB's annual reports covering reporting for 2006[6] and 2007[7], the authors were able to review each attack individually and to assess selected risk variables. Correlations between risk variables were computed using SPSS.[8] A RCGIS was utilized to compute geographic locations of strategically important locations, individually assess the geographic proximity of each attack, identify overall geographic patterns of attacks and to visualize results.[9]

Results

Correlational analysis was conducted to explore the relationship between all research variables for the Straits of Malacca and for Nigeria. For reported attacks in the Straits of Malacca, no statistically significant correlations were found between attack proximity (e.g., closeness to the easternmost chokepoint) and any other variable. A statistically significant positive correlation was found between complexity and lethality and between complexity and this study's risk index. In addition, a statistically significant positive correlation was found between attack lethality and the composite risk index (see Table 1).

Table 1. Correlation Matrix for the Straits of Malacca

	1	2	3	4	5
1. Proximity	1				
2. Complexity	-.12	1			
3. Lethality	.13	.50*	1		
4. Target selection	-.33	-.29	-.44	1	
5. Risk index	.46	.75**	.74**	-.33	1
Mean	1.82	2.18	.94	.82	5.76
SD	1.79	2.00	1.40	.73	3.07

* $p < .05$, ** $p < .01$, two-tailed

Table 2. Correlation Matrix for Nigeria

	1	2	3	4	5
1. Proximity	1				
2. Complexity	.27*	1			
3. Lethality	.21	.31*	1		
4. Target selection	-.38**	-.25	-.04	1	
5. Risk index	.67**	.69**	.72**	-.07	1
Mean	1.68	2.82	2.41	1.55	8.46
SD	2.11	1.78	1.79	1.04	3.84

* $p < .05$, ** $p < .01$, two-tailed

For reported attacks in Nigeria, statistically significant positive correlations were found between attack proximity (e.g., closeness to the Shell Bonny Export Terminal), complexity, and this study's risk index. A statistically significant negative correlation was found between attack proximity and target selection. A statistically significant positive correlation was found between complexity and lethality and the risk index. A statistically significant positive correlation was found between lethality and the risk index (see Table 2).

Geospatial analysis was conducted to explore the proximity of attacks as a dimension of strategic risk. Reported attacks were plotted according to location of occurrence and rated according to selected risk criteria. Geospatial analysis for the Straits of Malacca revealed that attacks occurred primarily in the vicinity of its eastern and western chokepoints (see Appendix). Results for Nigeria indicated that attacks occurred primarily in the vicinity of two locations with most attacks clustering near the Shell Bonny Export Terminal and the Lagos port facility (see Appendix).

Discussion

The purpose of this exploratory study was to provide new insight into threat assessment methodologies by developing and empirically examining a structured, multi-dimensional approach to profiling attacks on maritime shipping. The overall goal was to assess the ability of a Proximity–Complexity model and integrated geographic information to provide new perspectives on strategic maritime risk assessment.

As a comparative study, this study confirmed the existence of differing regional dimensions to maritime risk. The average composite risk index for Nigeria (8.46) was substantially greater than that for the Straits of Malacca (5.76). These results indicate that, overall, shipping is at greater risk in the coastal Nigeria region.

Specifically, results indicate that reported attacks in Nigeria are both more complex and more lethal than reported attacks in the Straits of Malacca. Average scores for attack complexity were 2.18 and 2.82 for the Straits of Malacca and Nigeria respectively. Average scores for attack lethality were .94 and 2.41 for the Straits of Malacca and Nigeria respectively. The greatest risk index for any single attack was for an attack in Nigeria in which well-equipped gunmen in multiple speedboats attacked a fuel-carrying barge, killing 3 soldiers providing security and kidnapping 25 Nigerian workers.[10] In no case was loss of life reported in an attack in the Straits of Malacca. It is likely that shipping in the Straits of Malacca enjoys the benefits from recently enacted anti-piracy measures.[11]

In general, this study's hypothesized Proximity–Complexity model fared well. Correlational analysis was able to find statistically significant relationships between the proposed composite risk index and three of the four supporting dimensions (proximity, complexity, and lethality). Only for the dimension of target selection was no statistically significant correlation found. These results provide tentative support for this study's Proximity–Complexity model.

This study's correlational analysis of risk factors may also provide new, useful insights to counter-piracy strategists. The risk factors for the Straits of Malacca when rank ordered according to the strength of their relationship to risk are: complexity (r = .75**), lethality (r = .74**), proximity (r = .46), and target selection (r = -.33). The results for Nigeria are similar, although stronger. The risk factors for Nigeria when rank ordered according to the strength of their relationship to risk are: lethality (r = .72**), complexity (r = .69**), proximity (r = .67**), and target selection (r = -.07).

These results may assist strategists and policy makers by providing an initial schema for the development and prioritization of piracy countermeasures. The results indicate that complexity and lethality play a dominant role in composite risk. The results also indicate that target selection plays a weaker role in composite risk than might have been assessed intuitively. Accordingly, these results may encourage the development of countermeasures that are designed to address target complexity and lethality and emphasize the overall threat environment versus a focusing solely on ships with dangerous cargo. For example, measures might be enacted to derive pirates of the sanctuary necessary to launch complex, massed attacks. Alternatively, measures might be taken to reduce the availability of weapons in the region. Finally, measures might be enacted that address piracy as a generalized threat to shipping.

A key finding of this research was the importance of properly sequencing analytic approaches. Since this study's conceptual framework for maritime risk began with an *a priori* decision regarding strategic geography (the easternmost chokepoint in the Straits of Malacca and the Shell Bonny Terminal in Nigeria) it was capable of assessing risk relative to a selected strategic locus but it was unable to uncover new risk areas. This problem was resolved through the integrated use of geographic information analysis techniques. Use of an *a priori* decision based on the general rhetorical discussion on chokepoint vulnerabilities concealed the presence of multi-loci threats within general geographic areas until it was revealed by geospatial analysis. This methodological finding generally supports the use of geospatial analysis before factor-based analysis.

Currently actual and attempted armed attacks at sea are mapped and visually displayed by the IMB's Piracy Reporting Centre.[12] However, by integrating additional attack dimensions (proximity, complexity, etc.) in conjunction with geographic information, this study was able to interpret and visualize reported attacks in more informative ways. Like the IMB's effort, this study was able to display historical geographic patterns of attacks. However, new insights were gained by re-examining attack patterns according to complexity and geographic location simultaneously. In this way, areas of greatest risk, such as those possessing a geographic cluster of complex or lethal attacks, were able to be discovered and visualized (see Appendix).

Based on the *a priori* selection of the Straits of Malacca's easternmost chokepoint as a single strategic epicenter, no statistically significant correlations were found between attack proximity and any other risk variable. However, the integrated use of geographic information did confirm separate clusters of threats to shipping in both the easternmost and westernmost sections of the Straits of Malacca. With regards to Nigeria, the integrated use of geographic information was able to confirm, as expected, threats to shipping in the vicinity of the Shell Bonny oil export terminal. It was also able to identify a second geographic cluster of complex attacks in the vicinity of the port of Lagos, Nigeria (see Appendix).

Some analysts have previously challenged the strategic vulnerability of sea-based trade, including oil flows. Blair and Lieberthal posit that maritime trade is buttressed by at least four resiliency factors including: the inherent size and strength of global tanker fleets, the inability of limited regional conflict and terrorist action to impact trade economics, the position of the U.S. as the only world power capable of disrupting trade and the inevitable formation of global coalitions to protect sea trade should a serious threat otherwise arise.[13] Highlighting the threat to shipping passing through the critical Straits of Hormuz as an example, Blair and Lieberthal also note that even at its height, the so-called Tanker War of the Iran-Iraq War in the 1980s affected only approximately 2 percent of oil tanker traffic through the Persian Gulf.[14]

While a catastrophic stoppage of oil production and distribution may represent a worse case global scenario, in a global oil market that is today faced with slim excess production margins and increasing demand from China and other countries it may be the secondary market effects that are the most immediately destabilizing aftershock of attacks. Sea-based trade may remain critically vulnerable, and at risk, where the shore interfaces with the sea, such as oil loading terminals and associated infrastructure.[15] Recent attacks in Nigeria appear to confirm this assessment. In April 2008 the Movement for the Emancipation of the Niger Delta (MEND) claimed credit for an attack on the oil pipeline that extends seaward to the Shell Bonny Island terminal and links it to mainland oil infrastructure.[16] While this attack only marginally impacted total world production, its immediate result was magnified due to tight, highly sensitive market conditions and contributed to a then record high oil price of over $117 per barrel.[17]

The April 2008 MEND attack, and similar attacks since, provides a general confirmation of this study's selection of the Shell Bonny Island terminal as a strategic geographic locus. However, since a cluster of complex attacks was also discovered in the vicinity of the major port of Lagos, Nigeria, the current study also provides evidence in support of the overall proposition that maritime risk may be potentially prominent at any point where strategic sea trade and land interdependencies exist. Alternatively, the general lack of complex, lethal attacks in the Straits of Malacca may indicate a lower overall threat environment.

Overall, this study highlighted the multi-dimensionality of threats to maritime trade. On one hand, the Nigerian case underscored the criticality of sea to shore infrastructure and its potential vulnerability. On the other hand, the Straits of Malacca case generally supported the commonly held proposition that maritime chokepoints represent key vulnerabilities. However, instead of finding a single, determinant area of vulnerability, in each case multiple areas of risk were found to exist simultaneously. This finding may challenge counter-piracy strategists and policy makers to adopt prevention, intervention, and containment strategies that are regionally focused, multi-faceted, and operationally integrated. The multi-dimensionality of threats to maritime trade may also highlight the important role that integrated analytic methodologies may play in identifying co-existent threats and assisting in their prioritization for strategists and policy makers.

Future research may extend this study's risk framework by incorporating the political dimension of piracy attacks as an element of composite risk. There has been a concern that terror groups such as Al Qaeda may use piracy as practice for a sea-based version of the 9/11 attacks in which a ship may be commandeered and run aground in a critical port[18] or scuttled in a strategic narrow.[19] There has been speculation that some attacks involving the temporary seizure of ships may have already, in fact, been trial runs in piloting captured ships.[20] Further, attacks in Nigeria have an overt political dimension. In an attempt to exert pressure against the Nigerian government Nigerian rebels proclaimed an "oil war" that targets industry infrastructure.[21] Unfortunately, the International Maritime Bureau database used as the foundation for this study does not include the identification of all attack perpetrators. However, a future study that combined the IMB database with information gathered from open sources (e.g., media, print, etc.) could capture both the physical and political dimensions of attacks and usefully extend this study's exploratory framework.

Conclusion

Despite limitations of under-reporting of maritime attacks,[22] this exploratory study was able to develop and empirically examine an integrated maritime risk assessment methodology that could potentially serve counter-piracy strategists. Based on this study's findings, the authors suggest that maritime risk assessment methodologies would benefit from a multi-stage approach involving the collection and display of the geographic dimension of attacks and the subsequent re-assessment of geographic patterns in terms of additional risk dimensions, such as attack complexity and lethality, in order to identify critical risk loci to which counter-piracy strategies could be applied. Due to research constraints, the current study was unable to examine other potentially important risk dimensions such as political intent. However, given worldwide concerns over terrorism, a more complete risk framework might additionally assess the criminal, political, or ideological motivations behind maritime attacks.

About the Authors

James E. McGinley, Ph.D. serves as an Assistant Professor at Northcentral University where he teaches Homeland Security courses in its School of Business and Technology Management. He also works at the U.S. Army, 1st Information Operations Command where he serves as the Senior Central Command Planner in the S3/Plans Division.

Jonathan P. Berliner works at the U.S. Army, 1st Information Operations Command where he serves as the Senior Pacific Command Planner in the S3/Plans Division. He is a Graduate of the United States Military Academy with a B.S. in Geospatial Information Science. He is actively serving as Captain in the U.S. Army Reserve.

Appendix

Figure 1: Density model representing overall complexity of Nigerian pirate attacks.

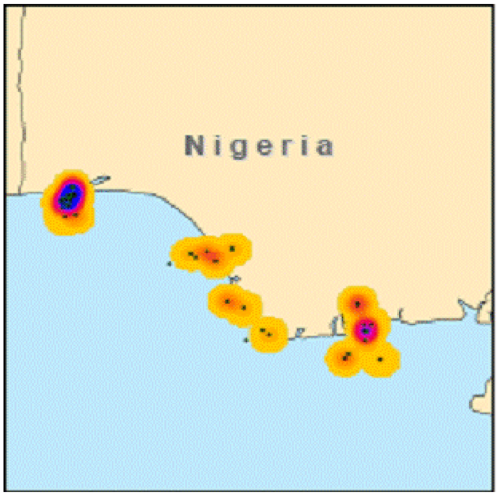


Figure 2: Density model representing risk associated with Nigerian pirate attacks.

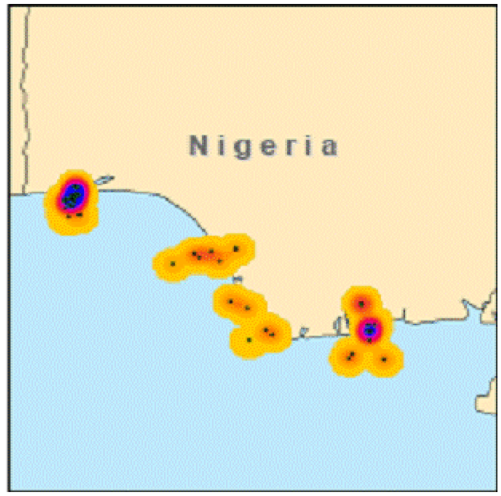


Figure 3: Density model representing complexity of attacks in the Straits of Malacca.

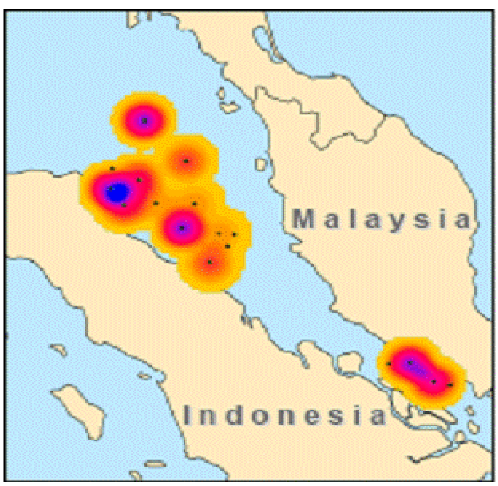
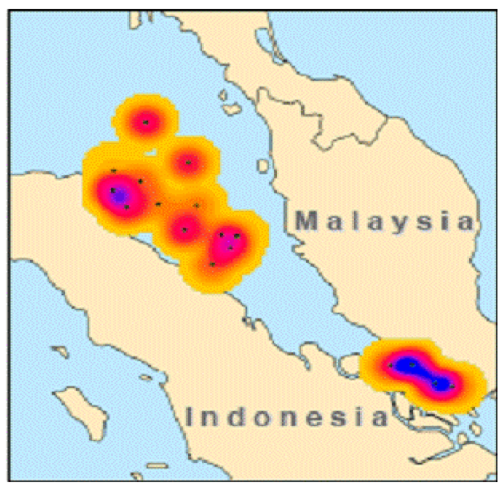


Figure 4. Density model representing overall risk associated with attacks in the Straits of Malacca.



For more insights into contemporary international security issues, see our *Strategic Insights* home page. To have new issues of *Strategic Insights* delivered to your Inbox, please email ccc@nps.edu with subject line "Subscribe." There is no charge, and your address will be used for no other purpose.

References

1. "Seaborne trade accounts for 77% of total world trade," *Lloyd's*, December 5, 2007.

2. The White House, *The National Strategy for Maritime Security*, September, 2005.

3. International Maritime Bureau, *Annual Report: Piracy and Armed Robbery Against Ships* (Kuala Lumpur: International Chamber of Commerce, 2008).

4. Victor Huang, “Building Maritime Security in Southeast Asia,” *Naval War College Review* 61, No. 1 (2008): 87-105.

5. Sam Fletcher,“Inventories vs. Possible Disruptions,” *Oil & Gas Journal* 104, No. 13 (April, 2006): 76.

6. International Maritime Bureau, *Annual Report: Piracy and Armed Robbery Against Ships* (Kuala Lumpur: International Chamber of Commerce, 2007).

7. International Maritime Bureau, *Annual Report: Piracy and Armed Robbery Against Ships* (Kuala Lumpur: International Chamber of Commerce, 2008).

8. *Statistical Package for the Social Sciences (SPSS) 11.0 for Windows Student Version* (New Jersey: Prentice-Hall, 2001).

9. ESRI, *ARCGIS ArcView, Version 9.2* (New York: ESRI, 2006).

10. International Maritime Bureau, *Annual Report: Piracy and Armed Robbery Against Ships* (Kuala Lumpur: International Chamber of Commerce, 2007).

11. Victor Huang, Op. Cit.

12. International Maritime Bureau, *IMB Live Piracy Map 2008*, ICC Commercial Crime Services.

13. Dennis Blair and Kenneth Lieberthal, “Smooth Sailing: The World's Shipping Lanes are Safe,” *Foreign Affairs* 86, No. 3 (2007): 83-90.

14. Ibid.

15. Glenn Davis, Charles Dragonette and Randy Young, “Dangers at Sea,” *Foreign Affairs* 86, No. 5 (2007): 162.

16. Kelvin Ebiri, “Militants Attack Shell Pipelines in Rivers,” *The Guardian*, April 19, 2008.

17. Julie Ziegler and Alexander Kwiatkowski, “Shell Nigeria's Bonny Crude Output Cut After Attack,” *Bloomberg*, April 21, 2008.

18. John S. Burnett, “The Next 9/11 Could Happen at Sea,” *New York Times*, February 22, 2005.

19. B. Raman, “Comprehensive Maritime Counterterrorism,” *South Asia Analysis Group*, No. 1403 (April 6, 2005).

20. Dana Dillon and Lucia Selvaggi, “Stopping an Al Qaeda attack in the Malacca Straits,” January 28, 2004.

21. Christian Purefoy, “Nigeria rebels declare ‘oil war’,” *CNN*, September 14, 2008.

22. International Maritime Bureau, *Annual Report: Piracy and Armed Robbery Against Ships* (Kuala Lumpur: International Chamber of Commerce, 2008).