

# RISK REGIONAL ZONATION OF ENVIRONMENTAL POLLUTION ON THE PORT OF HAI PHONG, VIETNAM AND THE SURROUNDING AREA

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## INTRODUCTION

The Port of Haiphong has been recognized as the largest seaport in the North of Vietnam by cargo volume, which offers advanced facilities, complete and safe infrastructure suitable for multi-modal transportation and international trade. The Port of Hai Phong consists of different main branches, including Chua Ve Terminal, Tan Vu Terminal, Hoang Dieu Port, Dinh Vu Port, Tan Vu Port. Cargo throughput at the Port of Hai Phong in 2015 was 23,748,843 (MT) and 14,407,703 TEUs. The Vietnamese government is planning to upgrade the Port of Hai Phong. The Lach Huyen Port is being built as a general port and container port (Figure 1). This will be the main wharf area of the Hai Phong Port, being capable to receive ships of 50,000 to 80,000 DWT by 2020. Dinh Vu area is being dredged and renovated to be able to receive ships of 20,000 to 30,000 DWT. Another port will be built in Yen Hung as a specialized wharf that can accommodate 30,000 to 40,000 DWT vessels. In addition, there is the Nam Do Son wharf used for national security. These explanation and the growth of international trade in the Port of Hai Phong has resulted in corresponding rapid growth in the amount of goods being shipped by sea as well as the impacts on the marine environment. For many years, the port operations and maritime activities in Hai Phong have caused significant damage to water quality and subsequently to marine life and ecosystems, as well as human health [1].

This study presents an approach to carry out the regional risk zonation of marine pollution on the Port of Hai Phong and the surrounding area. The comprehensive risk index values were calculated and a quantitative risk zoning map can be obtained on the basis of risk index system. The quantitative risk zoning map helps risk analysts and scientists to explore the spatial nature of the risk of marine environmental pollution, exposure and effects, and provides a basis to implement control measures as a part of the environmental risk prevention and management for the largest seaport in the North of Vietnam.

## 2. MATERIALS AND METHODS

To assess the environmental pollution risk, the research region should first be divided into smaller units. The rectangular grid method was applied as the zonation unit in this study. The smallest grid size was 0.55 km<sup>2</sup> and the largest grid size was 22.17 km<sup>2</sup>. The total number of calculated grids was 40. The total calculated domain (along the coastline) was about 310 km<sup>2</sup>.

According to the Vietnamese regulation [2], the environmental pollution risk on each grid ( $I_g$ ) comprises three criteria, namely the risk of pollution ( $I_p$ ), the extent of pollution impact ( $I_i$ ), and the vulnerability of risk receptors ( $I_v$ ). The environmental pollution risk index is defined by Formula (1). All of the above indices have different component indices which are quantified by scoring from 1 to 4. In this study, the risk of pollution ( $I_p$ ) was accessed and ranked according to maritime risk factors,

maritime risk management and status of marine water quality. The extent of pollution impact ( $I_i$ ) was determined based on the results of a hydrodynamic model developed for these areas. The vulnerability of risk receptors ( $I_v$ ) was scored depending on actual natural and socio-economic characteristics in each zonation unit and by the judgment of a panel of experts. The comprehensive risk index ( $I_g$ ) was divided into 4 categories: very high risk area where  $I_g \geq 2.5$ ; higher risk area where  $2 \leq I_g < 2.5$ , medium risk area where  $1.5 \leq I_g < 2.0$ , and low risk area where  $I_g < 1.5$ .

$$I_g = (2I_p + I_i + 3I_v) / 6 \quad (1)$$

The results of the comprehensive risk indices were mapped by using GIS tool and then a zonation map of environmental pollution was obtained.

### 3. RESULTS AND DISCUSSION

The result showed that the Port of Hai Phong and the surrounding area comprised four zones according to very high, high, medium and low risk degrees of marine pollution (Figure 1). The areas of red color are very high risk zones which made up 6% of the study area. These areas were located at the Cam River channel (from Hoang Dieu Port to Tan Vu Port) and in the Ha Nam channel. The channels of Bach Dang and Lach Huyen had a high risk of marine pollution (in orange color in the Figure 1) and accounted for 30% of the study area. The areas of yellow color in the Figure 1 are medium risk zones which make up 28% of the study area. These are the estuary areas located outside the marine access channel leading into the ports of Hai Phong. About 36% of the study area belonged to low risk zones (in green color in the Figure 1). This area included the offshore of Hai Phong city.

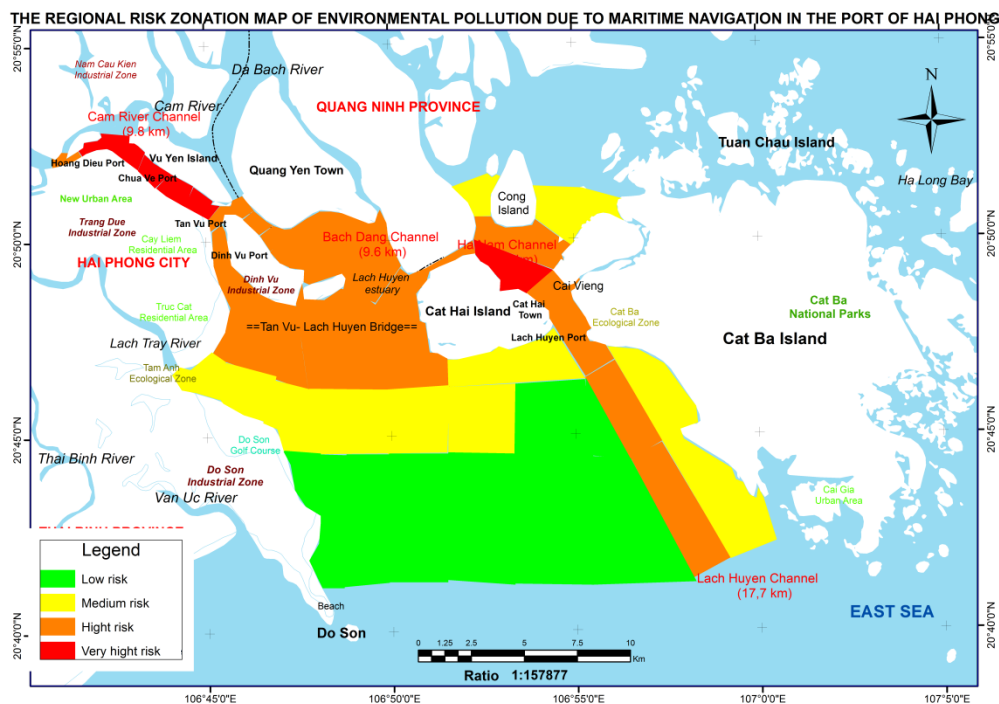


Figure 1: The regional risk zonation map of environmental pollution due to maritime navigation in the Port of Hai Phong

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