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Simulation modeling of the vessel traffic in Delaware River: Impact of deepening on port performance

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ABSTRACT

This paper deals with simulation modeling of the vessel traffic in Delaware River. The purpose is to study the impact of deepening on the navigational efficiency in the River. In this regard, vessel calls to terminals, lightering and barge operations, tidal and navigational rules in the River, terminal and anchorage properties as well as vessel profiles are considered in the model. The simulation model is specifically built to be able to perform scenario and policy analyses as well as a comprehensive risk analysis of the Delaware River and Bay area. This paper investigates effects of deepening on port performance measures. The statistics tracked in this respect are the overall port and terminal utilization, port times and terminal calls, anchorage visits and delays based on various vessel visits, categories and movements.

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1. Introduction

Delaware River has a history of more than 300 years as a commercial maritime route for handling import and export of raw and manufactured goods. Today it has more than 40 port facilities with their associated businesses located 60–100 miles up the River with about 3000 vessels visiting each year.

The region has proximity to the densest population base in the US and 27 million people living within 100 miles and 90 million within 500 miles give its ports a widespread natural consumer market. In this respect, approximately 65% of the region's cargo tonnage is in petroleum. Other major cargoes are steel, wood products, and perishable items such as fresh fruit, nuts, cocoa beans, and meat products. Major ports covered are Wilmington, Chester, Philadelphia, Camden, and Trenton, with major facilities at Delaware City, DE; Paulsboro, NJ; and Marcus Hook, PA [1–3].

The River is the port of call for large commercial ships and tug/barge units that can only navigate in the main ship channel. The River's 40-foot channel appears to be shallow when compared to other ports in the region, restricting its ability to compete for shipments via the new generation of mega-ships that require deeper drafts.

In view of the current expansion of the Panama Canal, deepening of the main ship channel of Delaware River to 45 ft has been proposed and debated over a number of years. The project consists of the navigation channel from deep water in Delaware Bay to Philadelphia Harbor, PA and to Beckett Street Terminal, Camden, NJ. The plan introduces modifying the existing Delaware River Federal Navigation Channel from 40 to 45 ft below Mean Low Water (MLW) and provision of a two-space anchorage to a depth of 45 ft at Marcus Hook. Accordingly, the benefits are expected to be the reduced costs of transportation realized through operational efficiencies (reduced lightering and light-loading), and the use of larger

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and more efficient vessels, both resulting from navigation improvements by means of cost reduction per ton for shipping commodities into or out of the Delaware River Port System [4,5].

In this respect, the motivation behind this study is to analyze the impact of deepening on navigational efficiency based on port performance measures. Navigational benefits may include shortened port time per vessel call, lesser anchorage delays and lesser tidal delays, among others. When a port is deepened, it becomes a new port and therefore, it is essential to develop a model of the current scenario to provide a practical and realistic tool for performance analysis. This helps to investigate the dynamics of vessel movements once the River is deepened, possible increases in vessel calls, possible changes in vessel particulars, and changes in navigational rules. The proposed model is also aimed to be used to examine feasibility and the effects of port expansion projects and to perform logistics and risk analysis in the Delaware River and Bay (DRB) area (Fig. 1). These may include construction of new terminals, installation of new infrastructure facilities or energy projects such as off-shore wind farms. Clearly, such a tool can be developed for other ports and waterways for the same objectives.

2. Literature review

Simulation modeling has been used in various fields where analytical models cannot be used due to complex nature of problems. Simulation studies in maritime transportation domain can be categorized under applications on port/terminal operations and logistics, modeling of vessel traffic on waterways for scenario and policy analyses and using simulation platforms as a tool to evaluate accident probabilities, risks and various economic and technical issues.

There are numerous studies in literature in which simulation techniques were used to study terminal logistics which is beyond the scope of this study. Some of these use simulation models for solving optimization problems. Among them, Lag-

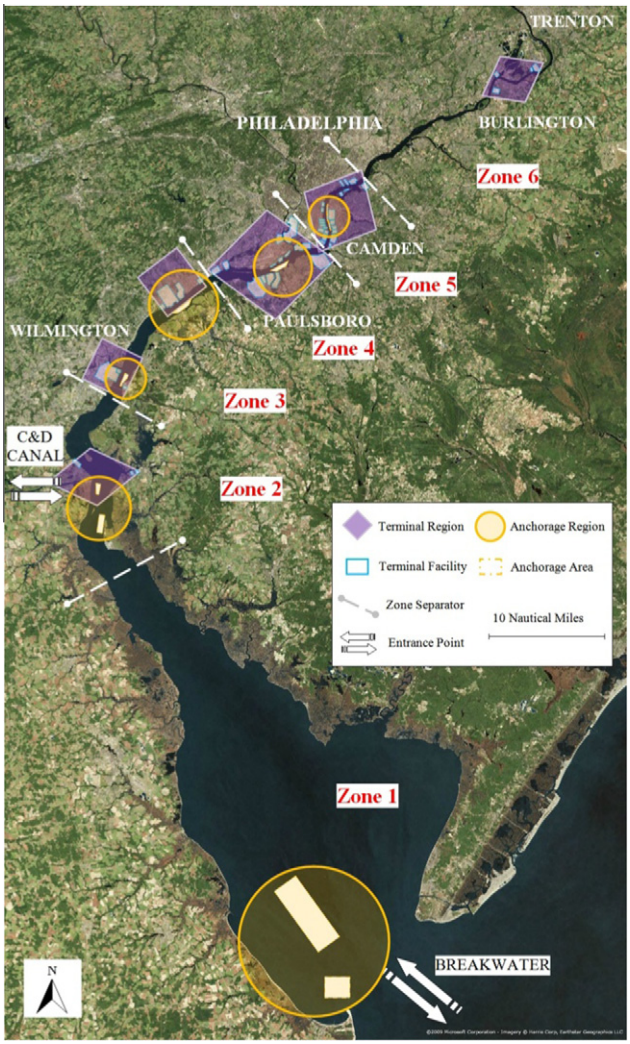

Fig. 1. Delaware River and Bay.