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Lappeenranta University of Technology

Intermodal Freight Transportation Performance in Emergency Situations

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Structure of the presentation

- Seaborne transportation and Gulf of Finland
- Literature review and case study interviews
- Simulation as a problem solving tool
- Simulation cases
- Conclusions

Seaborne transportation and Gulf of Finland

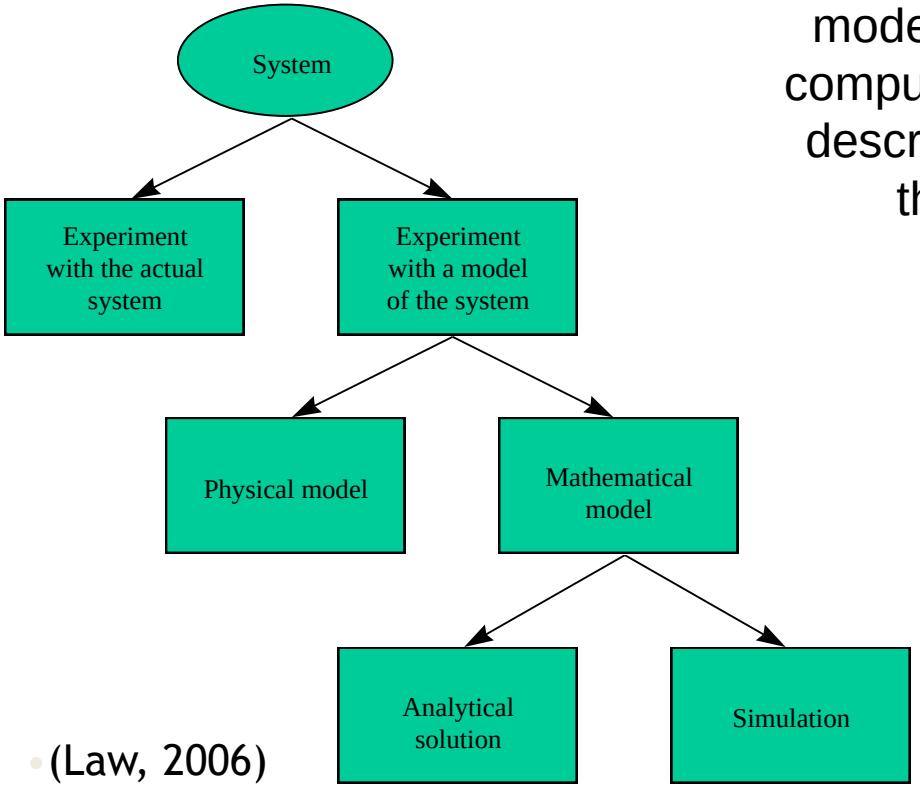
- Gulf of Finland contains many ”large” seaports: Tallinn, Helsinki, Sköldvik, St.Petersburg, Primorsk etc., some heavily focused
- Expected growth in oil transports
- Seaports part of multimodal transportation networks
- Over 75 percent (in tons) of Finnish foreign trade flows through sea ports

STOCA-project studies cargo flows in the GoF in emergency situations.

Literature review and case study interviews

- Especially prior to 9/11 research concentrated on efficiency and capacity issues to support forecasted growth
- Special risk in international ports caused by foreign containers and recreational vessels, interruptions typically caused by labor or weather conditions
- According to interviews the risk profile of ports and railway yards depend on infrastructure and cargo handled
- Sources of risk include energy supply, information systems, weather conditions and labor. A special risk in the region is connected to liquid bulk transportation.

Simulation as a problem solving tool



- (Law, 2006)

… process of designing a mathematical or logical model of a real system, and then conducting computer-based experiments with the model to describe, explain, and predict the behavior of the real system. (Naylor et al., 1966)

In this study we use system dynamics modeling.

Recent applications of simulation in sea transportation context

- strategic and tactical decision making for ship owners in the dry bulk sector (Engelen et al., 2006)
- future capacity needs of the Rotterdam port area (Ottjes et al., 2006)
- effect of information exchange in the Rotterdam port area on the waiting profiles (Douma et al., 2009)
- operations of ditch wharfs and container yards in future mega-container terminals (Tu and Chang , 2006)
- strategies for dispatching AGVs at automated sea port container terminals in single and dual-carrier mode (Grunow et al., 2006)

- material flows in whole port cargo system (Munitic et al., 2003)
- investing dynamics in large port systems (Sanders et al., 2007)
- demand development in different sea ports (Lättilä, 2009)

Simulation case 1: Seaport closure due to oil spillage at sea

- Kotka seaport cannot be used due to an oil spillage
- Helsinki seaport is used to take care of Kotka's container demand
- What is the impact of hinterland capacity on the performance of Helsinki seaport?

Simulation case 1: seaport closure

- The maximum capacity of Helsinki depends on two parameters:
  - Cargo handling capacity of the actual berths
  - Capacity of the container terminal
- Hinterland capacity impacts the speed at which the additional demand can be shifted to road or rail transportation
- As soon as the free storage space runs out, the amount of hinterland capacity determines how quickly the goods flow through the seaport


Lappeenranta
Hamina
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Inkoo
Hanko
Muuga
Kunda
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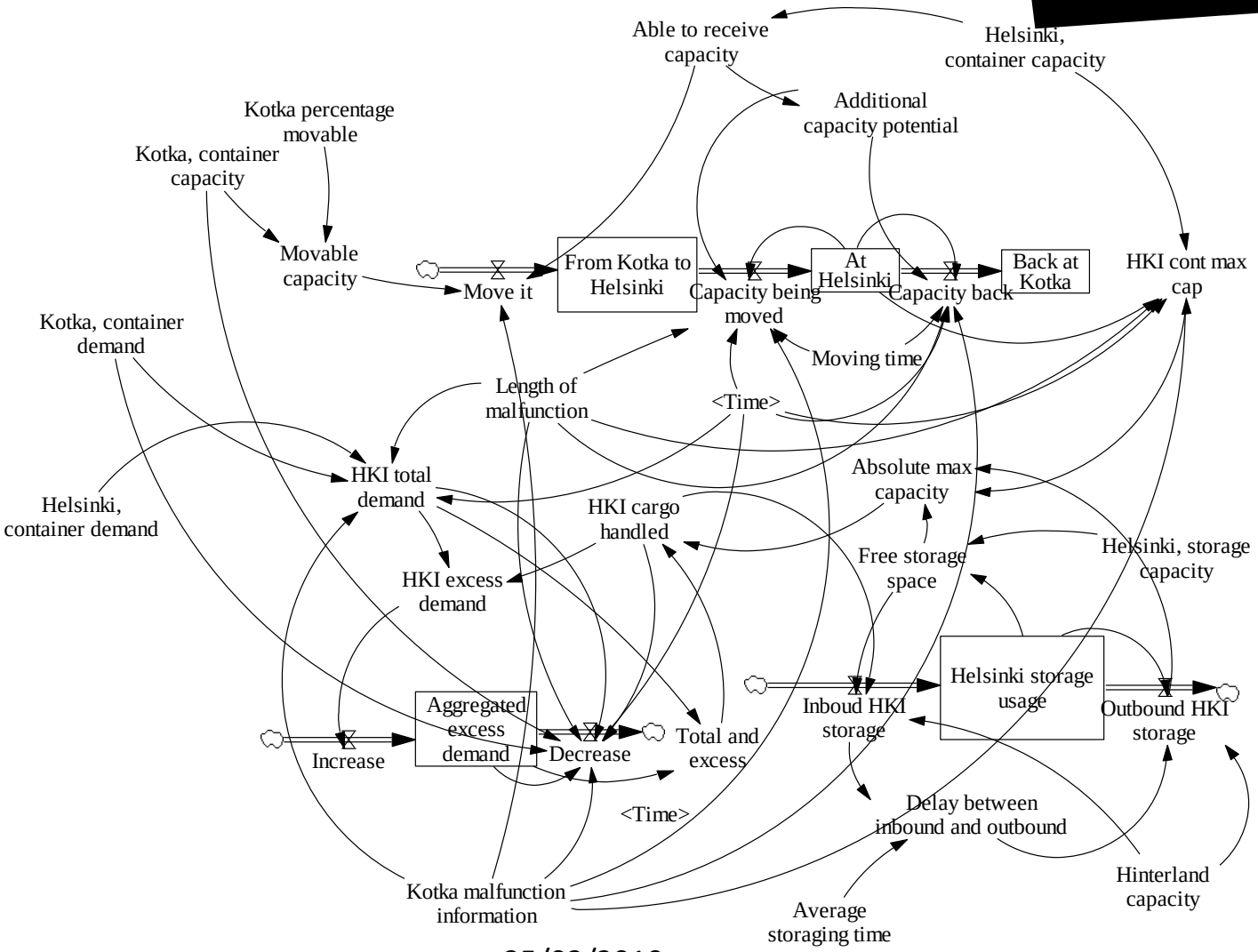
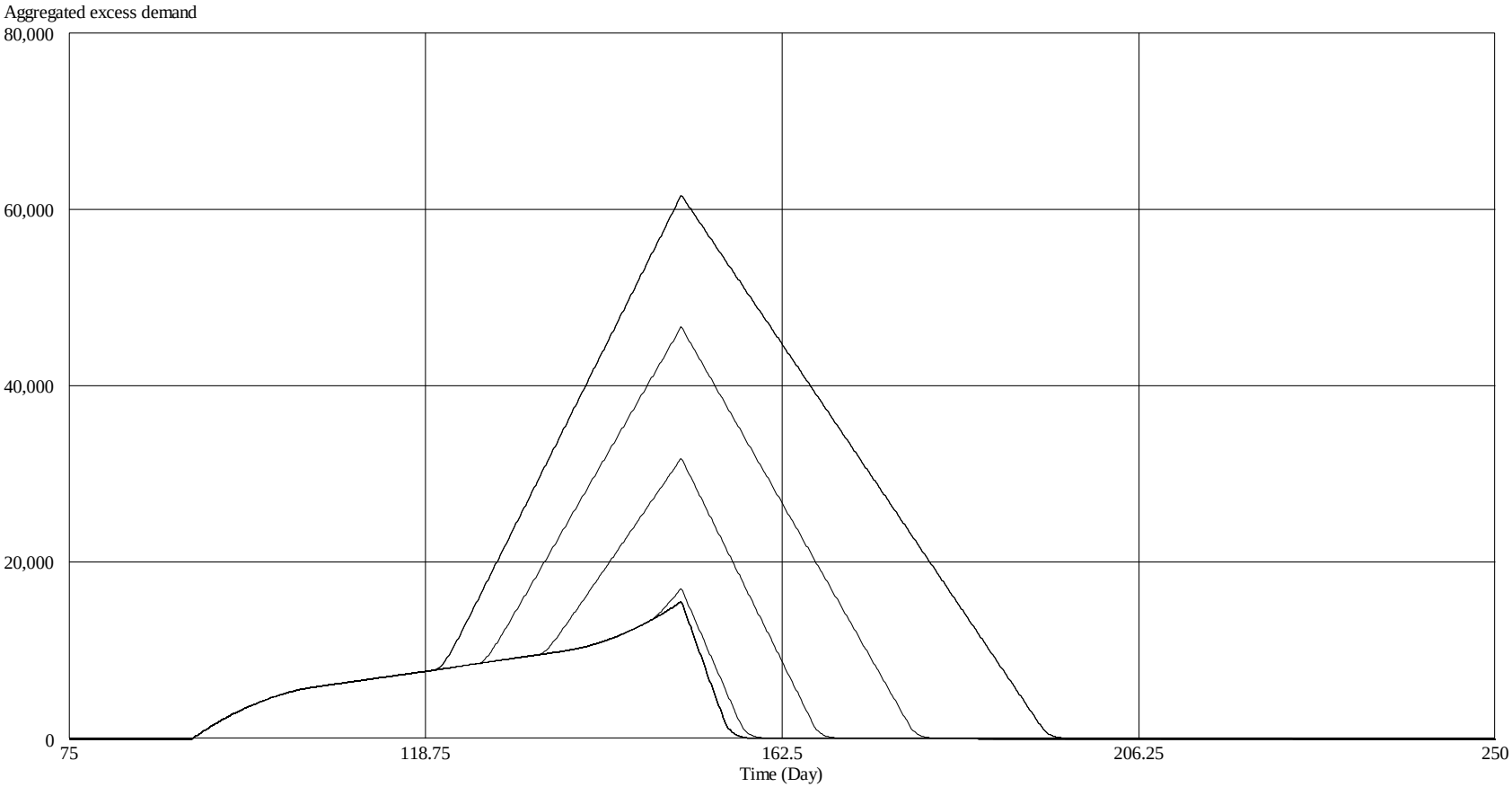
Tallinna
Sillamäe

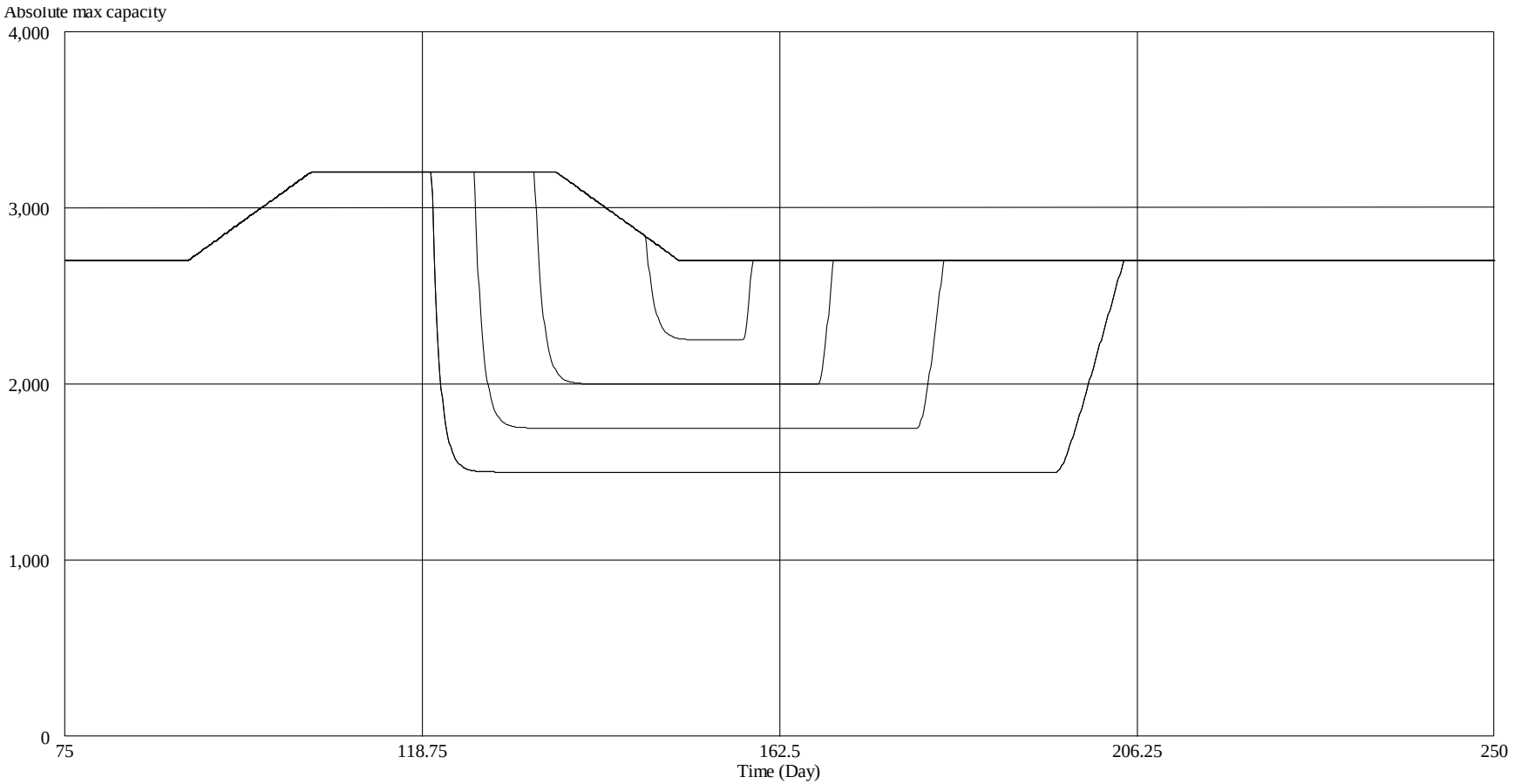
Simulation model 1



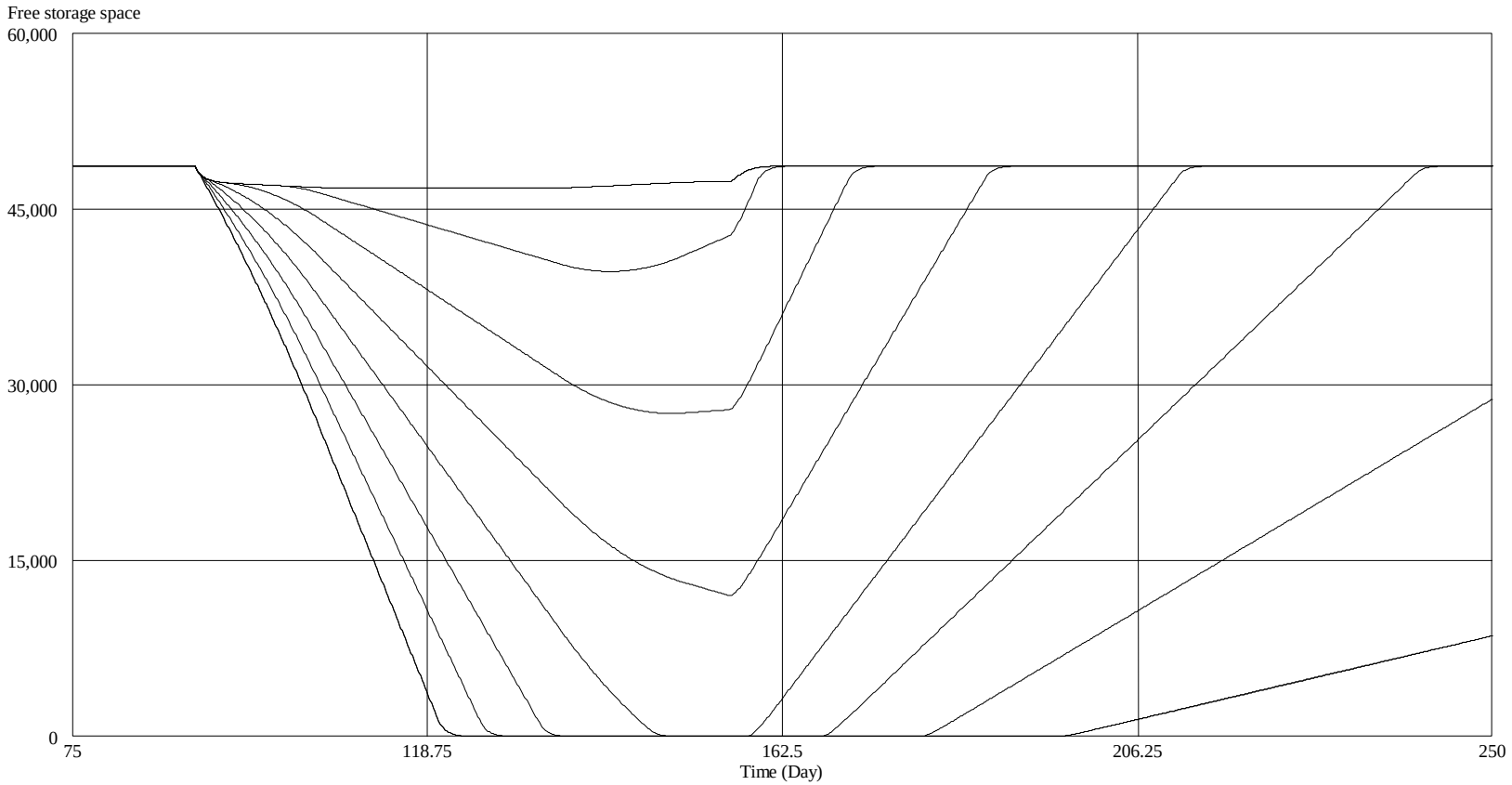
Results: Aggregated excess demand



Results: Available capacity



Results:
Amount of free storage space



Simulation case 2: Railway closure due to leaky tank wagon

- We analyze the situation where railway traffic between Kouvola and Lappeenranta is halted due to a spillage from a tank wagon
- A similar accident has happened in Estonia
- How do different parts of the railway chain react to disruptions of various lengths?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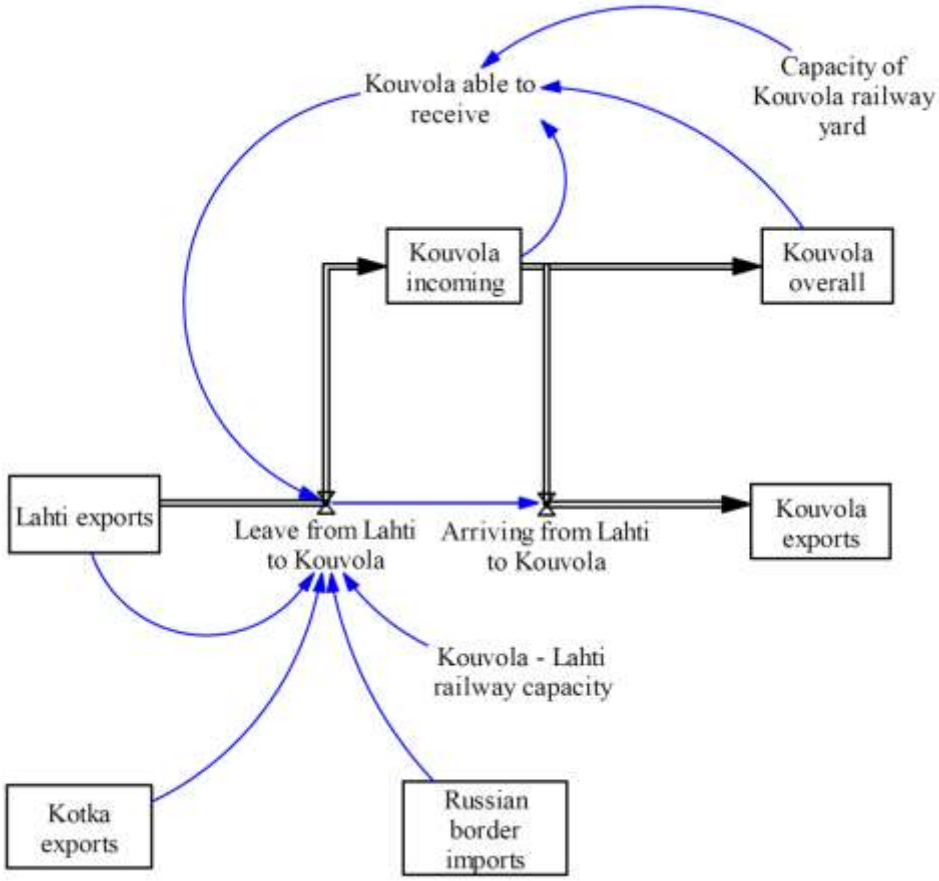
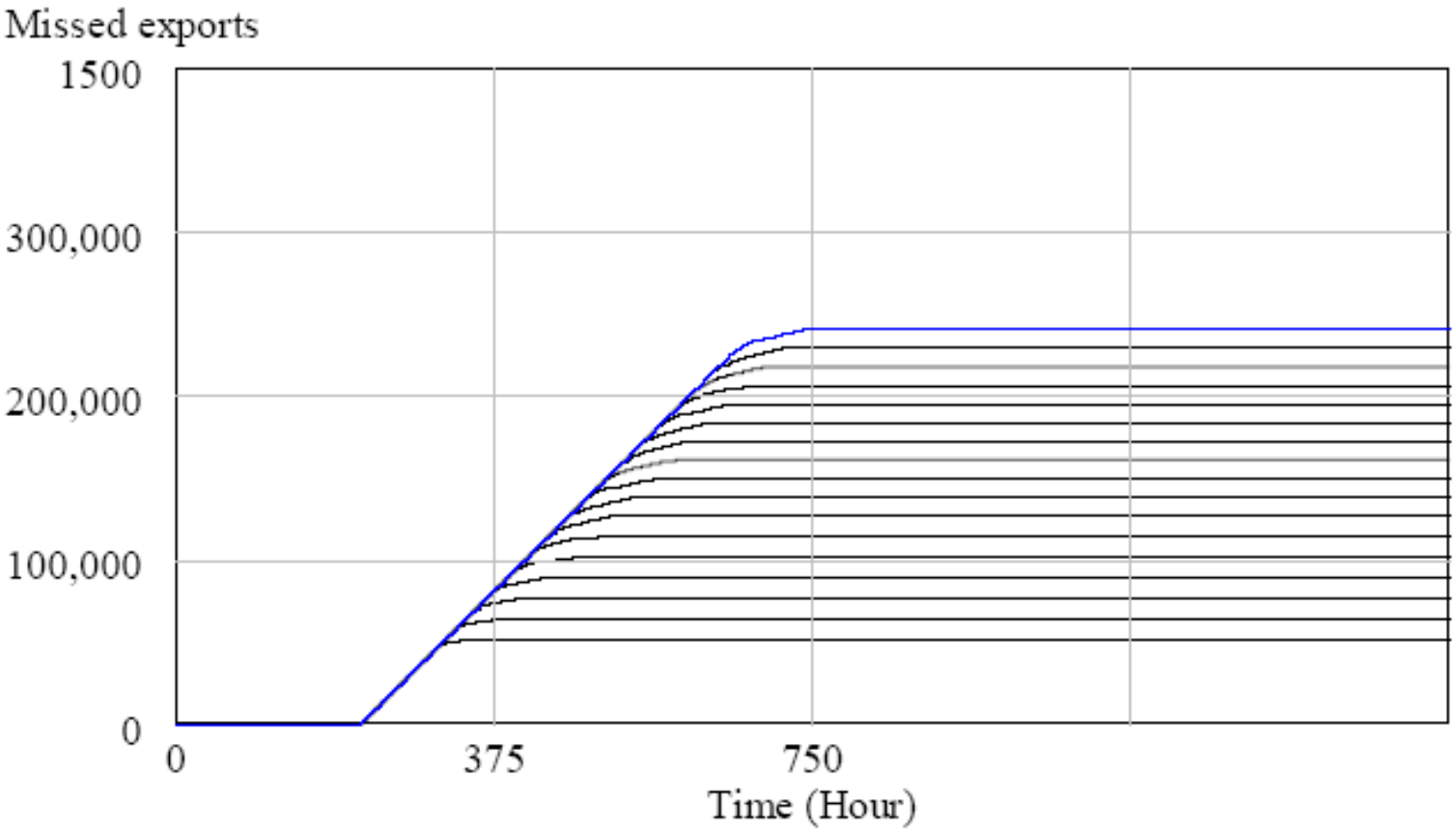
Simulation model 2



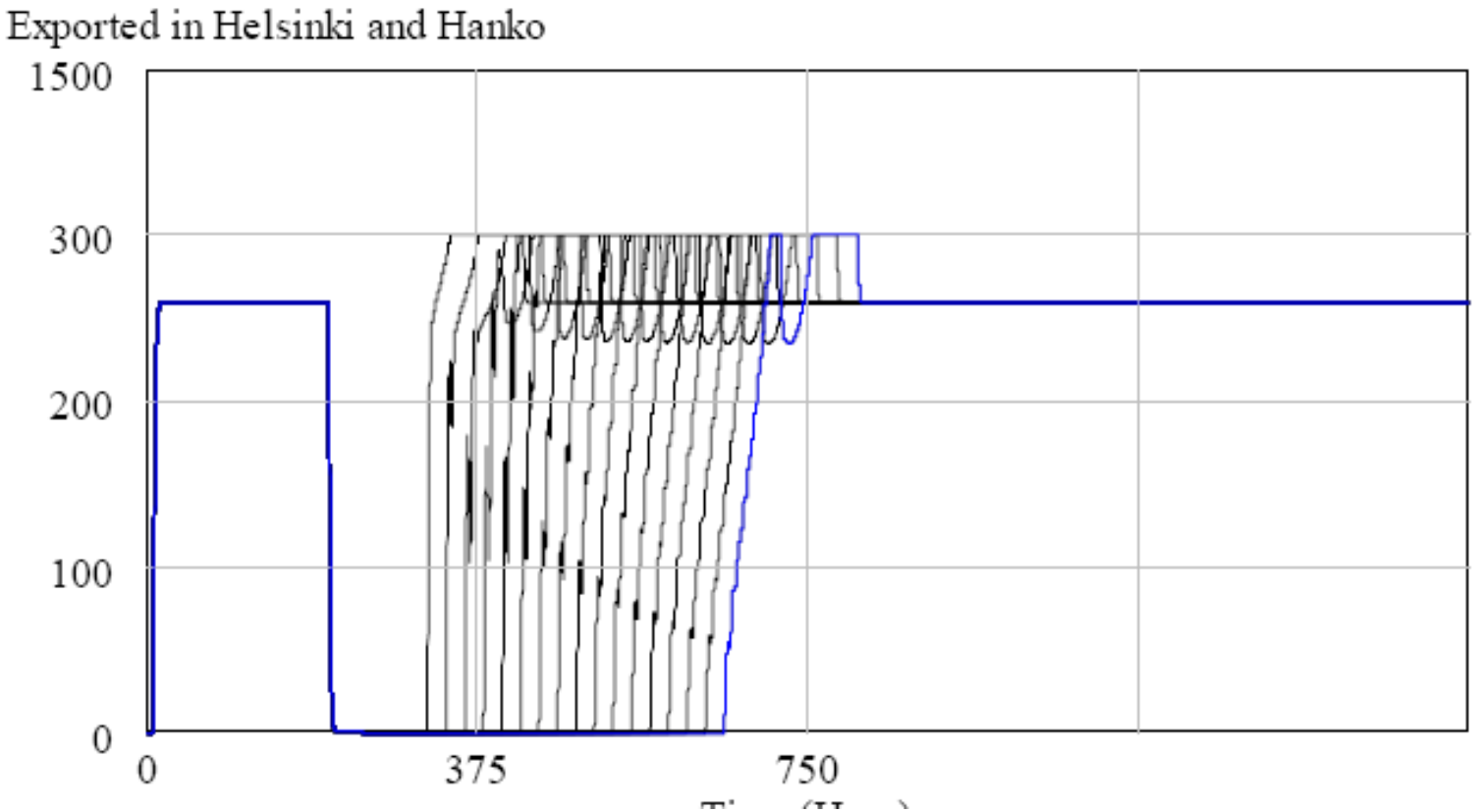
Simulation model 2: Parameters

Node or link	Capacity
Russian border	12000 tons
Kouvola	12000 tons
Kotka and Hamina	6000 tons
Lahti (Helsinki and Hanko)	12000 tons
Kouvola – Lahti	800 tons
Kouvola – Kotka / Hamina	600 tons
Kouvola – Russian border	900 tons

Results: Missed exports



Results: Exports in Helsinki and Hanko



Conclusions

- Hinterland capacity clearly impacts the performance of the system during a crisis
- If the amount of free storage space is small, hinterland capacity becomes even more important
- It takes a long time for the system to stabilize to normal situation if the amount of hinterland capacity is small
- Simulation model can be expanded to other seaports and cargo types as well
- Dissruption in the hinterland capacity creates a bullwhip effect

Thank You!

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http://www.stoca-simulation.fi

http://www.merikotka.fi/uk/STOCA.php