Lecture 1: Background and Introduction

Professor Anna Nagurney

John F. Smith Memorial Professor Director – Virtual Center for Supernetworks Isenberg School of Management University of Massachusetts Amherst, Massachusetts 01003 and Guest Professor – Vienna University of Economics and Business, Austria

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I am very grateful for the opportunity to be a Guest Professor at the Vienna University of Economics and Business and to deliver this course to you.

I would like to extend my thanks to Professor Petra Staufer-Steinnocher and to Professor Tina Wakolbinger for the invitation to instruct this course at the Vienna University of Economics and Business.

Special acknowledgments also go to Professor Manfred Fischer, a long-time colleague through the Regional Science community.

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- The number of disasters is growing, as well as the number of people affected by them.
- Logistics plays a central role in all phases of disaster management and supporting humanitarian operations.
- The fundamental task of a logistics system is to deliver the appropriate supplies, in quality condition, in the right amounts, to the locations at the time that they are needed.

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• there may be great uncertainty due to the disruptions, among other complications.

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This short course covers the **challenges** and **solutions** associated with humanitarian logistics in emergency mitigation and preparedness, disaster response, and recovery.

The course overviews **similarities** and **differences** between **commercial** supply chains and **relief** chains, introduces performance metrics, and provides tools for the analysis and design of supply chains for humanitarian critical needs products, as well as for the coordination and teaming of humanitarian organizations.

It also covers such **major issues** as material convergence and earmarked financial funds for disasters.

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This short course is based on primary source reading materials, including journal articles, case studies, newspaper articles, and videos.

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The word *logistics* comes from the Greek *logistikos*, which means "skilled in calculating," and from medieval Latin, where *logisticus* means "of calculation."

The Random House dictionary defines *logistics* as the branch of military science and operations dealing with the procurement, supply, and maintenance of equipment, the movement of personnel, the provision of facilities, and with related matters.

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The US Department of Defense (2002) defined *logistics* as the science of planning and carrying out the movement and maintenance of forces ... those aspects of military operations that deal with the design and development, acquisition, storage, movement, distribution, maintenance, evacuation and disposition of material.

There is a military saying, which speaks volumes:

Armchair generals talk strategy. Real generals talk logistics.

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To business, *logistics* is defined as the planning framework for the management of material, information, financial, and service flows and includes the increasingly complex material, informational, communication and control systems in today's business environment.

Complex Logistical Network



In this course, we will use *supply chains* and *logistics* interchangeably.

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Supply chains consist of manufacturers and suppliers, distributors, retailers, and consumers at the demand markets. Supply chains may span thousands of miles, involve numerous decision-makers and be underpinned by transportation and telecommunication networks.

Examples of Commercial Supply Chains

- food and food products
- high tech products
- automotive
- energy (oil, electric power, etc.)
- clothing and toys

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Food Supply Chains





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High Tech Products





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Automotive Supply Chains



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Energy Supply Chains



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Clothing and Toys



Humanitarian and Healthcare Supply Chains

In this course, we will be focusing on humanitarian and healthcare supply chains.

Humanitarian Relief Chains



Healthcare Supply Chains



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Hence, any formalism that seeks to model supply chains and to provide quantifiable insights and measures must be a system-wide one and network-based.

Indeed, such crucial issues as the stability and resiliency of supply chains, as well as their adaptability and responsiveness to events in a global environment of increasing risk and uncertainty can only be rigorously examined from the view of supply chains as network systems.

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Multilevel Network Structure of the Supply Chain

Flows are Prices



A. Nagurney, K. Ke, J. Cruz, K. Hancock, and F. Southworth, 2002. Dynamics of supply chains: A multilevel

(logistical/informational/financial) network perspective, Environment and Planning B 29, 795-818.

Characteristics of Supply Chains Today

- large-scale nature and complexity of network topology;
- congestion, which leads to nonlinearities;
- alternative behavior of users of the networks, which may lead to paradoxical phenomena;
- possibly conflicting criteria associated with optimization;
- interactions among the underlying networks themselves, such as the Internet with electric power networks, financial networks, and transportation and logistical networks;
- recognition of their fragility and vulnerability;
- policies surrounding them may have major impacts not only economically, but also socially, politically, and security-wise.

The Fritz Institute working with senior logisticians came up with the following definition of *humanitarian logistics* since there was a clear need: *it is the process of planning, implementing and controlling the efficient, cost-effective flow of and storage of goods and materials as well as related information, from point of origin to point of consumption for the purpose of meeting the end beneficiary's requirements* (Thomas and Mizushima (2005)).

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For humanitarians, logistics consists of the processes and systems involved in mobilizing people, resources, skills and knowledge to help vulnerable people affected by disaster (Van Wassenhove (2006)).

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Moreover, donors, who pledge millions in aid and goods, see the impact of the aid.

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Humanitarian Sector Funding Flows



Source: A. Thomas and L. R. Kopczak, 2005. From logistics to supply chain management: The path forward in the humanitarian sector, Fritz Institute. DAC report on the sector.
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- 3). results in a declaration of a state of emergency;
- 4). results in calls for international assistance.

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- causes extensive damage or destruction of facilities that provide and sustain human needs; produces an overwhelming demand on state and local response resources and mechanisms;
- causes a severe long-term effect on general economic activity;
- and severely affects state, local, and private-sector capabilities to begin and sustain response activities.

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From these definitions, we see that although disasters may have different meanings, depending on the specific domain, they have one thing in common: they have a catastrophic effect on human lives and a region's or even a nation's resources.

	Natural	Man-made
Sudden-onset	Earthquake Hurricane Tornadoes	Terrorist Attack Coup d'Etat Chemical leak
Slow-onset	Famine Drought Poverty	Political Crisis Refugee Crisis

Classification of Disasters

L.N. Van Wassenhove, 2006. Blackett Memorial Lecture: Humanitarian aid logistics: supply chain management in high gear, *Journal of the Operational Research Society* **57**, 475-489.

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- The triple (earthquake/tsunami/nuclear) disaster in Japan on March 11, 2011 with a death toll over 18,000.

Superstorm Sandy

Superstorm Sandy struck the northeastern US and beyond on October 29, 2012. It killed at least 125 people in the United States, including 54 in Haiti. Sandy is being blamed for about \$62 billion in damage and other losses in the US, the vast majority in New York and New Jersey a number that could increase. It was the second-costliest storm in US history after 2005's Hurricane Katrina, which caused \$128 billion in damage in inflation-adjusted dollars. Sandy caused at least \$315 million in damage in the Caribbean.



What About Recent Disasters in Europe?

According to a United Nations Office for Disaster Risk Reduction (UNISDR) (2009) report, when it comes to disaster statistics in Europe: Floods, droughts, and storms are a major threat and Europe suffers significantly from disasters in both human and economic terms. Among them, European Union countries have chalked up major losses due to climate-related disasters in the last few decades and have faced major storms and severe winter conditions over several winters.

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In the past 20 years, 953 disasters killed nearly 88,671 people in Europe, affected more than 29 million others and caused a total of 269 US\$ billion economic losses. Compared to the rest of the world, economic loss per capita is high in Europe partly because it is very densely populated.

Italy and Germany have recorded major economic damages mainly due to floods and storms. In the last two decades, Spain had the highest number of victims among all European countries and Russia, the highest numbers of disasters (120 disasters).

What About Recent Disasters in Europe?

Floods and storms in Europe accounted for, respectively, 40% and 33% of the total economic damages during the period 1989-2008.

Floods and storms explain part of the economic losses as weather-related disasters have devastating effects on infrastructures which have, on the average, a higher value in Europe than in Asia or Africa.

The trend will probably continue to rise as floods and storms are expected to become more frequent and severe in the future in Europe.

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Storms, floods and heat waves are major threats to Europe, and it is important to invest in disaster risk reduction policies to adapt to climate change.

Hurricane Katrina in 2005



Hurricane Katrina has been called an "American tragedy," in which essential services failed completely.

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Video and Commentary of Devastation Wreaked by Hurricane Katrina and the Aftermath

URL is http://www.youtube.com/watch?v=pvoEiBnpCc8

Click on underlined text: Images of Devastation of Hurricane Katrina in August 2005



The Haitian and Chilean Earthquakes



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Graphic Video of the Aftermath of the Haiti Earthquake from *The New York Times*

URL is

http://video.nytimes.com/video/2011/01/09/world/americas/1248069541193/surviving-the-haiti-earthquake.html

Click on underlined text:

Graphic Video of the Aftermath of the Haiti Earthquake from The New York Times

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The Triple Disaster in Japan on March 11, 2011



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H1N1 (Swine) Flu

As of May 2, 2010, worldwide, more than **214** countries and overseas territories or communities have reported laboratory confirmed cases of pandemic influenza H1N1 2009, including over **18,001** deaths (www.who.int).

Parts of the globe experienced serious flu vaccine shortages, both seasonal and H1N1 (swine) ones, in late 2009.



The Impact of Disasters

Disasters have brought an unprecedented impact on human lives in the 21st century and the number of disasters is growing. From January to October 2005, an estimated 97,490 people were killed in disasters globally; 88,117 of them because of natural disasters.



Humanitarian Logistics and Healthcare

The number of disasters is increasing globally, as is the number of people affected by disasters. At the same time, with the advent of increasing globalization, viruses are spreading more quickly and creating new challenges for medical and health professionals, researchers, and government officials.

Between 2000 and 2004, the average annual number of disasters was **55%** higher than in the period 1994 through 1999, with **33%** more humans affected in the former period than in the latter (cf. Balcik and Beamon (2008) and Nagurney and Qiang (2009)).

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Natural Disasters (1975–2008)



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The Impact of Disasters

Although the average number of disasters has been increasing annually over the past decade the average percentage of needs met by different sectors in the period 2000 through 2005 identifies significant shortfalls.

According to Development Initiatives (2006), based on data in the Financial Tracking System of the Office for the Coordination of Humanitarian Affairs, from 2000-2005, **the average needs met by different sectors in the case of disasters were:**

- ▶ 79% by the food sector;
- ▶ 37% of the health needs;
- 35% of the water and sanitation needs;
- ▶ 28% of the shelter and non-food items, and
- ► 24% of the economic recovery and infrastructure needs.

Disaster response may be at the local/regional, national, or international levels (Van Wassenhove and Pedraza Martinez (2012)).

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Typically, the immediate response to disasters comes from *local* systems. These systems are comprised of governmental agencies NGOs (non-governmental agencies) with local representation, National Societies of Red Cross and Red Crescent with local branches, the army, fire and police departments, and other civil agencies.

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When the local response system is overwhelmed by the size of the disaster, the national system is activated.

If the national system does not have the capability/capacity to respond and the affected country approves it, the international system is activated.

The international disaster response system is organized in clusters (food, health, shelter) and is coordinated by the OCHA – the United Nations Office for the Coordination of Humanitarian Affairs.

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The response, as a whole, should be led by the national government of the hosting country, with respect for the national sovereignty (Van Wassenhove and Pedraza Martinez (2012)).

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The ultimate humanitarian supply chain has to be able to respond to multiple interventions on a global scale as quickly as possible, and within a short time-frame.

Therefore, such supply chains need to be multiple, global, dynamic and temporary.

L. N. Van Wassenhove, 2006. Blackett Memorial Lecture: Humanitarian aid logistics: supply chain management in high gear, *Journal of the Operational Research Society* **57**, 475-489.

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Due to the enormous impact of disasters, disaster management and humanitarian logistics have become topics that are drawing attention from researchers in various disciplines.

Practitioners and researchers are working more closely together to learn from one another and to push knowledge in this growing and very challenging field forward.

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Bellagio Conference on Humanitarian Logistics

Humanitarian Logistics: Networks for Africa



Conference Organizer: Anna Nagurney, John F. Smith Memorial Professor University of Massachusetts at Amherst

See: http://hlogistics.isenberg.umass.edu/

References

- ⇒ B. Balcik and B. Beamon, 2008. Facility location in humanitarian relief, *International Journal of Logistics: Research and Applications* 11, 101-121.
- ⇒ Department of Defense (2002), Dictionary of Military and Associated terms, University Press of the Pacific, USA.
- ⇒ Development Initiatives, 2006. Global humanitarian assistance 2006 report, Somerset, United Kingdom.
- ⇒ Emergency Events Database, 2008. Center for Research on the Epidemiology of Disasters, Catholic University of Louvain, Belgium.
- ⇒ Federal Emergency Management Agency, 1992. Federal response plan. FEMA Publication 229.

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References

- ⇒ A. Nagurney, 2006. Supply Chain Network Economics: Dynamics of Prices, Flows, and Profits, Edward Elgar Publishing, Cheltenham, England.
- ⇒ A. Nagurney, K. Ke, J. Cruz, K. Hancock, and F. Southworth, 2002. Dynamics of supply chains: A multilevel (logistical/informational/financial) network perspective, *Environment and Planning B* 29, 795-818.
- ⇒ A. Nagurney and Q. Qiang, 2009. Fragile Networks: Identifying Vulnerabilities and Synergies in an Uncertain World, John Wiley & Sons, Hoboken, New Jersey.
- ⇒ A. Thomas and L. R. Kopczak, 2005. From logistics to supply chain management: The path forward in the humanitarian sector, Fritz Institute.
- ⇒ A. Thomas and M. Mizushima, 2005. Logistics training: necessity or luxury? *Forced Migration Review* 22, 60-61.

- ⇒ L. N. Van Wassenhove, 2006. Blackett Memorial Lecture: Humanitarian aid logistics: supply chain management in high gear, Journal of the Operational Research Society 57, 475-489.
- ⇒ L. Van Wassenhove and A. J. Pedraza Martinez, 2012. Using OR to adapt supply chain management best practices to humanitarian logistics, *International Transactions in Operational Research* 19, 307-322.

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