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How natural disasters harm the security of global supply chains: The case of the forest fires in the United States

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ABSTRACT
In recent years, global supply chain challenges have proliferated due to globalization,geopolitical risks, natural disasters and the pandemic. Among them, natural disasters such as droughts, floods and heat waves pose a threat to the security and stability of the global supply chain. Natural disasters not only cause traffic chaos to the affected enterprises but also have severely damaged the infrastructure of enterprises. In 2025, the uncontrolled wildfires in the United States have led to the closure of some major roads and highways in Los Angeles, the damage of Amazon's warehouses, and the loss of agriculture and tourism, increases in return rates and fluctuations in consumer demand due to supply chain disruptions. The fires warned companies in the global supply chain to respond to the shock by multi-distribution and procurement, increasing distribution modes and establishing logistics centers.

KEYWORDS
natural disasters; global supply chain; forest fire

1 Introduction

The large-scale, multi-agent, and multi-factor supply chain network has led to the complexity of the supply chain production and operation environment far beyond the capacity of the traditional production model. New management methods such as lean production and service outsourcing have emerged. The supply chain faces the test of its resilience since greater risks are likely to be around the corner. Since the beginning of the globalization process, the supply chain has been partially damaged in an endless stream due to the external imbalance of the supply chain, including uncontrollable natural disasters such as earthquakes, fires, etc.. Those risks are potentially a heavy blow to large and small enterprises, even the entire supply chain system.

California wildfires have a long history, with thousands of wildfires recorded each year since 1930. Their scale and destructive power are constantly expanding. In January 2025, wildfires raged in the Los Angeles area of California. The death toll rose to 24 on January 12. California wildfires not only burn down homes and infrastructure, shut down roads, and cause a large number of casualties, but also release large amounts of air pollutants that affect the health of surrounding residents.

The fire is yet another shock to the security of global supply chains and its impact is worth exploring. The fire caused damage to logistics and warehousing facilities. This would directly affect the storage and transportation of goods. Many Amazon FBA warehouses in the Los Angeles area have suspended receiving or refused to accept goods due to power outages and fires. Unfortunately, this can result in cross-border goods unable to enter and exit the warehouse as usual. Logistics costs have soared, order delivery has been delayed and delivery timeliness cannot be guaranteed. The disaster also triggered a sharp increase in demand for firefighting supplies and medical supplies.

Real natural disasters have gradually attracted the attention of business managers and scholars in related fields. How to quickly respond to the global threat to reduce the losses caused by local supply chain disruptions and restore to a stable state as soon as possible is a key issue in supply chain security and risk management. Although there are many academic studies on the challenges of geopolitical conflicts and trade barriers to supply chains, the existing studies often fail to consider the challenges of uncontrollable natural factors to supply chains. In addition, in order to discuss global supply chain security more realistically, it is necessary to study supply chain management issues in conjunction with human risk factors.

2 Literature Review

The keywords in this article are "natural disasters" and "supply chain security". Combined with relevant domestic and foreign literature, it explains the current research status of domestic and foreign scholars on the above keywords:

The focus of global supply chain uncertainty is the uncertainty of supply and demand. The external environment is changing and various public events that are difficult to predict may occur in the competitive cooperation relationship between the upstream and downstream of the supply chain. Those may pop up as new policies, regulations, financial crises, a certain enterprise's capital chain break, changing market supply and demand, etc. Among them, the sudden

change in market demand is the main reason for the error in market demand forecasting. The bullwhip effect is a typical phenomenon of demand fluctuations in the supply chain throughout the whole period. As the step-by-step deviation of demand-related information gradually amplifies, the uncertainty factors that induce supply-side distributor inventory increase. All these ultimately trigger the "bullwhip effect".

In recent years, challenges facing global supply chains have surged. Negative factors such as globalization and geopolitical risks, natural disasters and climate change contribute to disruptions. Among them, the threat of natural disasters such as heavy rain, drought, floods and heat waves to the safety and stability of corporate supply chains around the world cannot be ignored. The relentless natural disasters around the world test the resilience of the supply chain. The handling of almost all major public emergencies is accompanied by a large amount of emergency materials and market demand.

Scholars from home and abroad have gradually expanded the targets of natural disasters' impact on society from economic growth [12] and government fiscal revenue [4] to locally affected supply chains and affected enterprises [13].

On one hand, natural disasters seriously damage the infrastructure of enterprises. This will result in water and power outages, factory collapses, and inventory materials. On the other hand, natural disasters may damage transportation facilities and cause logistics obstruction. Thus, the transportation of products, raw materials, and further the timely completion of the orders by enterprises will gain disorder. In response to this heavy blow, Shan Tiwei [5] recommends that the governments form an emergency supply chain network based on the current situation of emergency rescue and the structure of emergency supply chain in my country. The network should include "upstream material suppliers, midstream emergency command centers, and downstream disaster relief points". Factories are suggested to establish close cooperative relationships with raw material suppliers. Fang Lei [6] and others conducted in-depth research and found that the emergency supply chain involves a wide range. This makes it difficult for their research object to determine the priority among several definitions. The uncertainty of natural disasters directly leads to uncertainty in demand in disaster areas, and the uncertainty of demand also leads to a fault in the determination of main information.

A series of scholars' impacts and measures on natural disasters on country's supply chain security are of reference significance for this article to explore supply chain security nationwide. Wei Long [7] and other studies have found that natural disaster shocks have the characteristics of "propagation along the supply chain vertically". It will not only increase the funds and time costs of customers' global procurement, but also destroy the capital chain of the affected companies based on commercial credit. In the short term, a significant decline in sales revenue will be part of the consequences. However, diversified supply chains allow enterprises to have higher cost elasticity and more sources of funds, which are less affected by adverse impacts. This shows that the supply chain diversification strategy is an effective choice to improve the resilience of enterprises.

Therefore, this topic takes a relatively macro perspective and explores the latest occurrence of California forest fires in the United States. It has important theoretical value and practical significance to the global supply chain challenges. Through searching the literature, it was found that in this grand context, many researchers will choose a smaller entry point. However, there is currently less literature on natural disasters, especially forest fires that affect supply chain safety. Unfortunately, a rare winter forest fire occurred in California this year. So this article takes this as an example to discuss the new possible impacts of natural disasters on supply chain safety and response measures.

3 The overall loss from the 2025 American wild fire and its effects

On January 7, wildfires broke out in southern California, spreading continuously as of February 9. The fire has killed 21 people, with 27 out of touch and over 12,000 houses damaged or uninhabitable. Thick black smoke turned days into nights. In recent years, due to climate change, winter rainfall has been delayed and drought has continued to hit the strong monsoon Santa Ana winds. This winter, when wild fire is usually unexpected to occur, welcomed bad news.

3.1 Brief analysis on wild fire data ranging from the year2020 to 2024

Analysis of global forest fire data(*Figure.1*) for 2020-2024 leads to the following conclusions:

(1) More events were recorded in 2020 and 2021

(2) By studying the origin and accompanying disasters of fires, it can be found that fires are often caused by drought, high temperature and strong wind. They are usually accompanied by heat waves hitting the affected areas.

(3) A study of the duration and severity of fires shows that the longer a fire lasts, the more severe it is. For example, in 2021, Bolivia is experiencing a nine-month period of fire damage. However, the reality is more complicated. Fires in Turkey are significantly shorter in duration but are further spread due to dry air and local winds In addition, the fact that Turkey has too few firefighting aircraft, and the lack of water load became one of the reasons for such serious losses. To sum up, the causes and effects of fires vary in different regions, and fire prevention strategies need to be developed accordingly

according to specific circumstances.

(4) Two line charts (*Figure.2 and Figure.3*) were made through *Figure.1*, in which the five-pointed star symbol is used to represent the data of this year's forest fires in the United States. It's obvious that the severity of this fires is higher than the average of previous years. It ' s somehow necessary to figure out its effects on global supply chain.

Country	Location	Origin	Associate	Start Year	Start Mon	Start Day	End Year	End Montl	End Day	Total Deaths	Total Affe
United States of /	Otero and			2024	6	17	2024	7	15	2	1502
Bolivia (Plurinatic	Santa Cru	Drought		2020	1		2020	10		5	126000
North Macedonia	Strumica,		Heat wave	2021	7	30	2021	9		1	80000
Canada	Alberta, B	Dry condit	Heat wave	2023	5	6	2023	7		2	30000
Argentina	Cholila (C			2021	3	8	2021	3	12	15	1207
Russian Federatic	Krasnoïars	Violent w		2022	5	6	2022	5	10	16	2202
China	Liangshan			2020	3	30	2020	3	31	19	1200
Chile	Viña del M			2022	12	22	2022	12	29	2	8406
Greece	Elekistra,		Heat wave	2021	7	29	2021	8	12	2	7500
Greece	Athenes; I		Heat wave	2023	7	17	2023	7	26	3	19011
Cyprus	Arakapas (		Heat wave	2021	7	3	2021	7	5	4	150
Pakistan	Sherani di			2022	5	15	2022	5	24	4	4004
Ukraine	Novoaidai			2020	7	6	2020	7	6	5	300
Algeria	Bejaia, Jij			2022	8	14	2022	8	21	44	6768
United States of /	Plumas Cc	Heat, drou		2021	7	13	2021	8	11	3	1261
Ukraine	Stanychnc			2020	9	30	2020	10	8	11	1668
Russian Federatic	Tyumen, K			2023	5	7	2023	5	8	21	15000
Türkiye	Antalya M		Heat wave	2021	7	28	2021	8	7	9	561088

Figure.1 Global forest fire data between 2020-2024

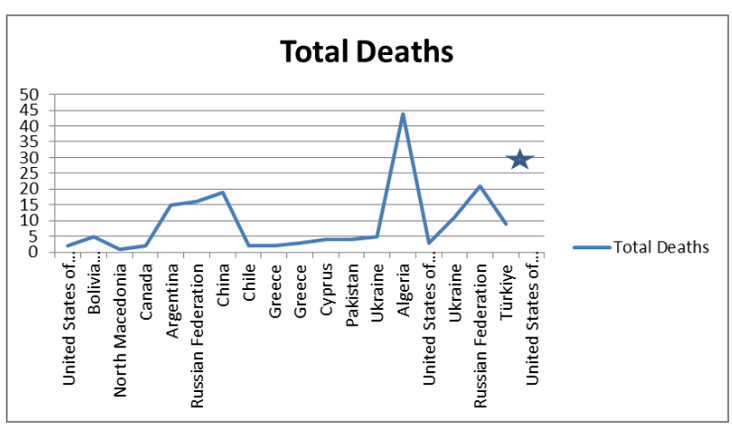

Figure.2 A line chart of the number of total deaths

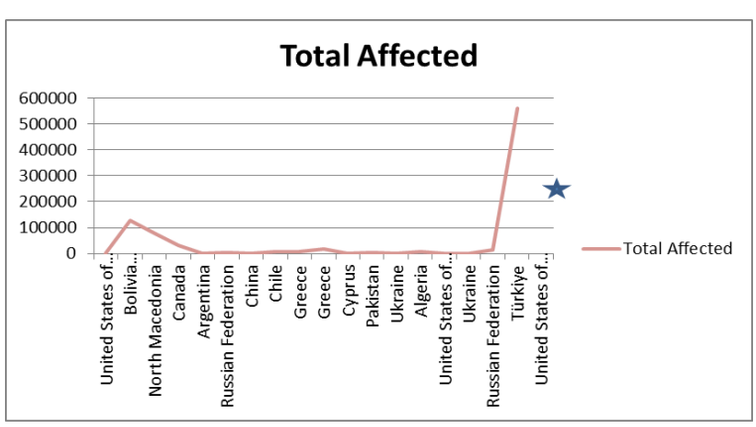

Figure.3 A line chart of the number of people affected by fires

3.2 The direct effects of the 2025 American wild fire on global supply chain

Amazon is one of the most affected company in these fires. They destroyed the normal operation of corporate infrastructure. Due to the unexpected rapidity of its spread, several Amazon warehouses were closed urgently, the LBG8-LAX9 warehouse had power outages and the delivery was suspended, and a large fire broke out near the LGB8. In addition, according to SmartSupplyChainInc, as of January 8, Amazon SWF2, RFD2, SMF3, FTW1, GEU3, IUSP and other warehouses have no approval. The rejection rate of warehouses such as MCO2, SNA4, XLX1 is as high as 90%. IAH3, XLX6, RMN3 and other warehouses will be approved for 3 weeks or even 1 month later. Fortunately, since California's fires are

mainly concentrated in parts of Southern California and most warehousing and logistics centers are located in the inland empire, many companies operate well. In addition, the fire may affect the normal operation of transportation facilities, causing the logistics link to be blocked. In Los Angeles County, there are closed highways and burned roads. Grounds collapses and cracks. These make local transports unable to function normally. In order to avoid casualties and property losses, the transportation department has implemented strict traffic control measures in some areas close to the fire site, prohibiting unrelated vehicles from entering.

Meanwhile, the thick smoke and ash produced by wildfires will reduce the visibility of the airport and affect the safety of the aircraft's takeoff and landing. All those above affect the transportation of raw materials and products, which further affects the company's timely completion of orders all over the world.

3.3 The following problems caused by 2025 American wild fire on global supply chain

The impact of forest fire logistics companies in California in the United States is extremely significant in 2025. This can be specifically manifested in the following aspects:

3.3.1 Transportation timeliness

As a logistics hub in the West, Los Angeles has delayed truck delivery by 1-2 weeks. The efficiency of carrying cabinets at the dock has been reduced. Air transport is affected by thick smoke so flights at Los Angeles International Airport are delayed. Thus, the timeliness of cross-border logistics relying on air transport has further deteriorated.

3.3.2 Increased operating costs

Sellers are forced to seek help from spare warehouses in other parts of the United States, China, or Canada. An increase in transportation distance is expected and leads to higher logistics costs. Inventory backlog is in warehouses or ports in China, and warehousing and insurance costs increase.

3.3.3 Difficulty in fulfilling orders

Logistics delays have caused buyers to cancel or change their orders. Return rates are likely to surge. Some sellers failing too many orders are facing the risk of platform ratings or even account freezing due to delivery timeouts.

3.3.4 Post-disaster demand fluctuations

During the post-disaster reconstruction phase, demand for emergency supplies (such as air purifiers, tents, anti-haze masks) surged. Sellers whose inventory is concentrated in damaged warehouses may miss the business opportunity and struggle with order loss. Unsatisfied customers turn to other markets for solutions.

3.3.5 Risk of supply chain breakage

Sellers relying on a single warehouse are facing supply chain breaks and need to reevaluate inventory distribution and supplier cooperation model.

4 Diversified layout of logistics : An effective way to deal with challenges

The California forest fire revealed the vulnerability of regional centralized warehousing. The lessons of the California forest fires show that companies need to incorporate regional risks into their strategic planning and combine policy dividends (such as North American economic integration) with technological innovation to achieve multi-dimensional synergies in warehousing and transportation information. It is necessary to enhance resilience in the long run. Multi-warehouse layout technology is an ideal choice to hedge risk. For some seriously affected enterprises such as Amazon, short-term domestic demand coordination of the national storage network to alleviate regional pressure.

This may promote further optimization of warehouse geographical distribution and disaster recovery system in the long run.

Resilient supply chains can be realized through geographical dispersion multimodal transport and technology empowerment. With the increasing complexity of climate change and globalization, diversified layout will become a key strategy for the logistics industry to cope with uncertainty.

4.1 Benefits of diversified layout of logistics

4.1.1 Risk diversification and supply chain resilience improvement

By setting up warehousing nodes in different geographical areas, we can avoid supply chain disruptions when something unpredictable happen, including California forest fires. There are frequent forest fires in California (In October 2024, Oakland fires caused hundreds of residents to evacuate and damage to buildings). If warehousing is concentrated here, the logistics system will face major risks. Dispersed layout can reduce regional dependence and enhance risk resistance.

4.1.2 Efficiency optimization of multimodal transport

By integrating road, railway and other modes of transportation, we are able to form an efficient multimodal transport network. For example, the Chicago Logistics Port realizes rapid cargo distribution through road-rail intermodal transportation.

4.1.3 Regional Economic Synergy and Accelerated Market Response

Deploy warehousing and distribution centers (e.g., US East, Mexico) close to consumer markets to shorten delivery times and meet immediate customer needs. At the same time, under the trend of economic integration in North America (Mexico and Canada deepen trade cooperation), cross-border warehousing can make full use of regional trade agreements to reduce tariff barriers.

4.2 Ways to achieve a diversified layout

4.2.1 Decentralization of warehousing

The 2025 wild fire warned business owners that they should consider separate working units to avoid a total breakdown. In this case, entrepreneurs can set up U.S. East & U.S. China Center for backup. This can be realized by adding warehousing in Chicago, Atlanta and other places to undertake the original inventory function in California.

The existing Chicago Logistics Port's large-scale operations area can be used as a template.

We can also take advantage of Mexico's labor cost advantage and Canada's stable policy environment to establish a cross-border warehousing network. It could be a regional distribution center in Montreal or Mexico City.

4.2.2 Multimodal Transport Infrastructure Integration

Multimodal transport infrastructure integration refers to the organic integration and collaborative construction of the infrastructure of multiple modes of transport. Through certain ways and means, we are able to achieve seamless connection, efficient conversion and resource sharing between different modes of transport. In this way, we can improve the efficiency and effectiveness of the entire transport system, reduce logistics costs and eventually meet the diversified transportation needs of goods and passengers.

To be specific, entrepreneurs copied with govnments can build a comprehensive transportation hub to realize the centralized layout and seamless connection of multiple transportation modes in the hub. For example, the construction of railway and highway hubs, so that railway stations are closely connected with highway passenger stations and freight stations, so as to facilitate passenger transfer and cargo transfer; Build an air-rail intermodal transport hub, realize the convenient connection between airports and railway stations, and develop air-rail intermodal transport business.

In addition, strengthening the construction of collection and distribution roads for ports, railway freight yards, logistics parks and other infrastructure can improve the efficiency of cargo collection and distribution. We can also consider building a fast channel connecting the hub and the surrounding areas to realize the rapid evacuation and convenient transportation of goods, and reduce the congestion and backlog of goods around the hub.

Referring to the land, sea and air multimodal transport project of Xi'an Port, it may be a useful idea to set up a transshipment center at the U.S.-Mexico border to connect the Mexican manufacturing industry with the North American consumer market.

At the same time, it's essential to promote container standardization and throw-and-hang transportation to improve the operational efficiency of cross-mode transportation.

5 Conclusion

In the new era, the supply chain is facing increasing complexity. supply chain security are threatened by aggressive

policies, fluctuant market demand and so on. Among them, real natural disasters have gradually received attention from business owners and scholars. How to effectively and timely respond to the challenges and minimize the losses from disrupted supply chain and restore it to a stable state would be an unsolved mystery. Capturing qualitative data from previous disasters is essential for modifying the present structure of local supply chain and improving disaster response strategies. This data is vital for future decision-making and enhancing strength of global supply chain.

This essay takes the 2025 American wildfire as an example. It's obvious that the normal operation of warehouses in the local transport system was interrupted due to the fire. This could lead to a series of issues such as unfulfilled orders and, furthermore, risk of supply chain breakage. To improve the resilience of supply chain, the essay suggests business owners and technicians to diversify layout of logistics. In this way, we can reduce the effect from a sudden breakout.

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