A System Dynamics Study on Emergency Material Mobilization Capacity for County-Level Disaster Response

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Abstract. This study employs system dynamics methodology to construct a county-level disaster emergency material mobilization model encompassing five core dimensions: emergency reserves, temporary requisition, emergency production, external support, and civilian mobilization conversion. A causal loop diagram and stock-flow diagram are developed to characterize the dynamic interrelationships among system components. Using the demand for flood-control sandbags in Fugou County during the 2021 Henan extraordinary rainstorm as an empirical case, the model validity is verified through simulation. Key findings indicate that government mobilization intensity is significantly and positively correlated with material supply efficiency; the reserve capacity of enterprises, institutions, and residents constitutes the critical foundation of mobilization capability; and external aid is dually influenced by social attention and the severity of disasters in surrounding areas. Sensitivity analysis identifies mobilization adjustment time, enterprise inventory levels, and regional disaster conditions as the most influential parameters. The study recommends that county-level governments strengthen routine reserve systems, optimize mobilization mechanisms, enhance local production capacity, and improve regional coordination frameworks. This research provides a novel analytical framework for evaluating emergency material guarantee capacity at the county level.

Keywords: County-Level Disaster Management, System Dynamics, Emergency Material Guarantee, Mobilization Capacity, Simulation.

1 Introduction

1.1 Research Background

With the intensification of global climate change, natural disasters such as earthquakes, floods, and typhoons are occurring with increasing frequency, posing severe threats to human safety and socioeconomic development. According to the National Natural Disaster Situation Report published by China's Ministry of Emergency Management for April 2026, various natural disasters affected approximately 3.0535 million people nationwide within a single month, resulting in 10 deaths, the emergency relocation or

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urgent livelihood assistance of 22,500 individuals, the collapse of over 300 rooms across more than 120 households, damage to 20,500 rooms across 11,000 households, crop losses spanning 289,900 hectares, and direct economic losses totaling 4.188 billion yuan [1]. These figures underscore the urgency of robust emergency material guarantee systems.

As the foundational administrative unit of emergency management, counties bear critical responsibilities for disaster prevention, emergency response, and post-disaster reconstruction. During the critical 72-hour golden window following a disaster, county-level emergency material mobilization capacity directly determines rescue effectiveness and the protection of life and property. However, existing county-level emergency material guarantee systems face persistent challenges, including structural mismatches between stockpiles and actual demand, insufficient inter-departmental coordination, inadequate social participation, and constraints arising from limited fiscal resources and personnel shortages.

In 2024, China's Ministry of Emergency Management issued the *Guiding Opinion on Further Strengthening the Emergency Material Guarantee System and Capacity Building* [2], emphasizing the need to enhance material guarantee capabilities at the grassroots level. Against this policy backdrop, developing a scientific evaluation model for county-level emergency material mobilization capacity carries significant practical importance.

System dynamics, with its unique advantages in modeling complex feedback systems, provides a powerful methodological lens for examining the dynamic interrelationships among mobilization system components. This approach can effectively reveal how system behavior evolves over time and identify the key variables and intervention points that govern system performance.

1.2 Literature Review

Emergency material management has attracted extensive scholarly attention, generating rich research output across several interconnected themes.

In the domain of demand forecasting, Chen et al. proposed an improved ant colony optimization–BP neural network (IACO-BP) algorithm for flood emergency material demand prediction, improving material satisfaction rates from 80.9% to 95.9% [3]. Fei and Wang constructed a prediction model integrating case-based reasoning (CBR) with Dempster-Shafer theory to address feature incompleteness and temporal dynamics in disaster impact assessment [4]. Ma et al. applied a metabolic grey prediction model GM(1,1) to forecast material demand under public health emergencies, focusing on urgency and satisfaction dimensions [5]. In seismic contexts, Zhan and Cheng proposed a GWO-BP neural network model for transitional shelter phases [6], while Zhang et al. innovatively combined real-time online information with historical seismic data using a BERT-CNN model enhanced by TOPSIS for demand urgency assessment [7].

Regarding reserve decision-making, Yu et al. developed a humanitarian-oriented procurement model that incorporates disaster victim distress levels [8]. Gong et al. examined government-enterprise trilateral reserve decisions from the perspectives of joint production capacity and quantity flexibility contracts [9], while Wang et al. constructed

a pricing game model for joint reserves based on flexible contracts [10]. Wang G et al. studied option contract-based reserves considering low-carbon disposal costs [11], and Jiang et al. designed a three-level regional collaborative mechanism for emergency resource reservation and pre-dispatch [12].

In scheduling and distribution, Long et al. proposed a dispatch model balancing delivery urgency and fairness [13]; Wang et al. developed a two-stage optimization model incorporating transshipment nodes [14]; and Ma et al. introduced a multi-stage dynamic scheduling approach for flood-season road emergencies [15]. At the international level, Sun constructed a multi-period allocation model integrating efficiency, effectiveness, and equity [16]; Weng applied blockchain technology to multi-stage production emergency material distribution [17]; Wan et al. addressed multi-period dynamic multi-objective distribution under uncertain demand [18]; Zidan et al. modeled cross-regional dynamic scheduling for COVID-19 contexts [19]; and Wang et al. applied deep reinforcement learning to storm surge logistics [20].

In the specific area of mobilization capacity, Li examined production mobilization using system dynamics but limited the scope to the production subsystem [21]. Wang and Zhang evaluated mobilization potential for finished petroleum products at the national level [22], which differs substantially from county-level operational realities. Critically, neither study adequately addresses the multi-channel supply structure—encompassing upper-level allocation, civilian donations, and social organization assistance—that characterizes county-level disaster response. This gap motivates the present study.

1.3 Research Objectives and Significance

This study aims to employ system dynamics to construct a county-level emergency material mobilization model, systematically analyze the interaction mechanisms among key influencing factors, and provide a scientific basis for strengthening grassroots emergency management. Specifically, the model incorporates emergency production under government mobilization, temporary requisition, upper-level material allocation, and social support, capturing the multidimensional nature of county-level mobilization systems. Through simulation and sensitivity analysis, the study explores strategies for enhancing mobilization capacity, offering theoretical foundations and decision-making references for local governments seeking to optimize their emergency material guarantee systems [24].

2 System Model Construction

2.1 System Boundary

Emergency material mobilization capacity constitutes a multi-dimensional integrated system encompassing five core subsystems: the foundational guarantee capacity of urban emergency reserves, rapid industrial mobilization through temporary production, emergency requisition of social resources, effective acquisition of external aid, and a unique civilian mobilization conversion mechanism.

The civilian mobilization conversion mechanism is of particular significance in county-level disaster response. Through effective government guidance and social communication, this mechanism mobilizes residents' sense of social responsibility, encouraging them to voluntarily contribute personal emergency stockpiles to relief operations. This bottom-up resource mobilization mode complements administrative measures and is treated as a distinct subsystem in this model.

A representative case is provided by the 2021 Henan extraordinary rainstorm. During the "7·20" disaster, Fugou County—a downstream flood discharge zone—faced severe pressure with limited external assistance, as public attention was concentrated on major urban centers such as Zhengzhou and Xinxiang. Local villagers and flood-control personnel collaborated spontaneously, contributing woven bags and other household materials to compensate for sandbag shortages. The system boundary of the mobilization model is illustrated in Figure 1.

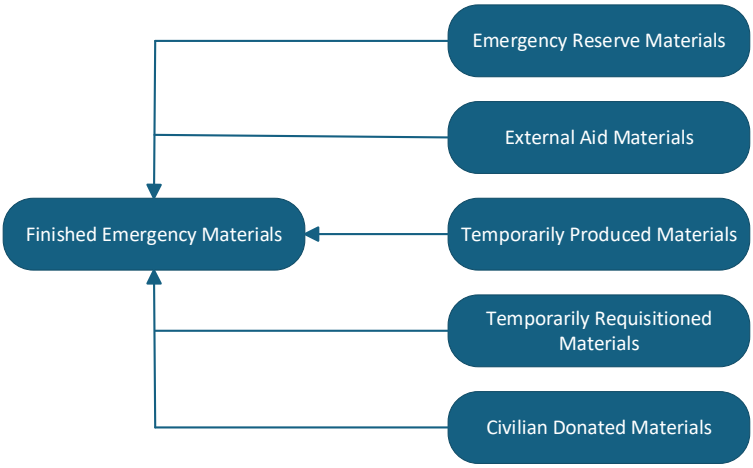


Fig. 1. System boundary diagram of the emergency material mobilization model.

2.2 Causal Loop Diagram

Based on the system boundary analysis, the model is structured around five key sub-modules. The emergency reserve sub-module incorporates government direct reserves, enterprise consignment reserves, and production capacity reserves, recognizing that storage costs remain fixed regardless of mobilization status and that raw material conversion capacity constitutes an essential component of reserve capability [24]. The temporary requisition sub-module captures the mobilization of enterprise and institutional stockpiles under government directive. The emergency production sub-module encompasses both converted production capacity and regular output capacity. The external support sub-module differentiates between upper-level government allocation—determined by disaster severity assessments—and social donations organized by civil society organizations. The civilian conversion sub-module captures the voluntary contribution of un-registered private stockpiles through government mobilization. The resulting causal loop diagram is presented in Figure 2.

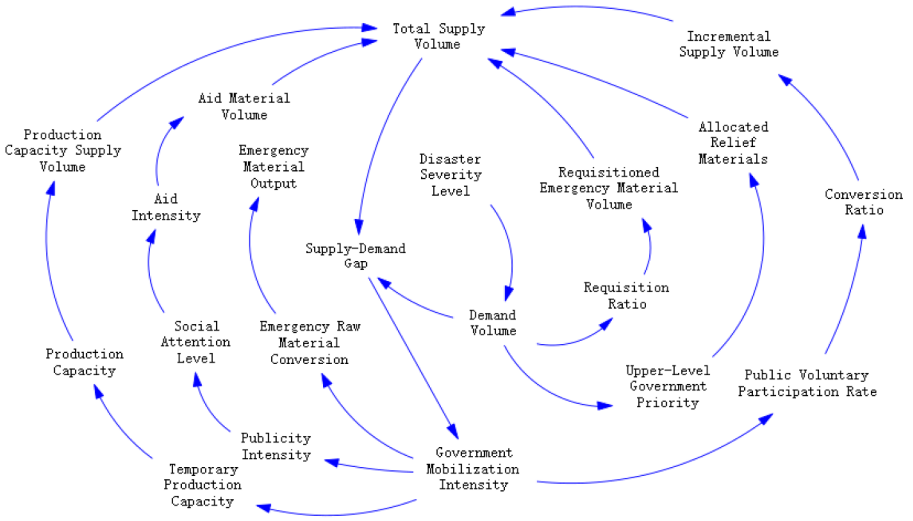


Fig. 2. Causal loop diagram of the emergency material mobilization system.

2.3 Stock-Flow Diagram

To move beyond qualitative causal relationships and enable quantitative dynamic analysis, a stock-flow diagram is constructed. Following the theoretical principles of system dynamics modeling, all variables are classified into three categories: stock variables, flow variables, and auxiliary variables. The complete stock-flow diagram is presented in Figure 3.

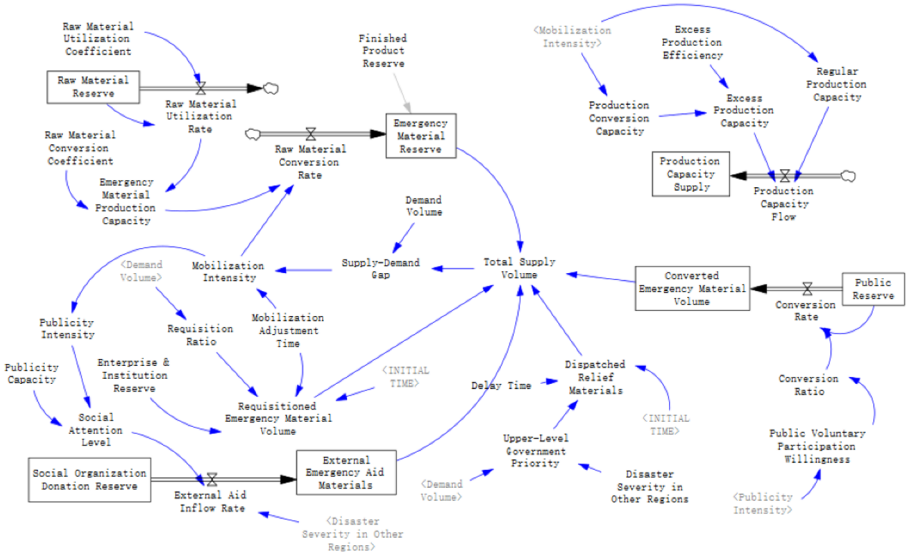


Fig. 3. Stock-flow diagram of the emergency material mobilization model.

2.4 Model Equations and Key Parameters

The overall supply level of county-level emergency materials is jointly determined by existing reserve inventory, requisitioned materials, emergency production output, external aid inflows, and civilian conversion volumes. The principal system dynamics equations are summarized in Table 1.

Table 1. Principal system dynamics equations of the mobilization model.

Variable	Type	Equation
Emergency Material Reserve	Stock	*INTEG(Raw Material Conversion Rate, Finished Product Reserve)*
Raw Material Reserve	Stock	*INTEG(−Raw Material Conversion Rate, Initial Value)*
External Aid Material	Stock	*INTEG(External Aid Inflow Rate, Initial Value)*
Social Donation Reserve	Stock	*INTEG(−External Aid Inflow Rate, Initial Value)*
Civilian Reserve	Stock	*INTEG(−Conversion Rate, Initial Value)*
Converted Emergency Material	Stock	*INTEG(Conversion Rate, Initial Value)*
Production Capacity Supply	Stock	$INTEG(Production\ Capacity, Initial\ Value)$
Raw Material Utilization Rate	Flow	*Raw Material Reserve × Utilization Coefficient*
Public Conversion Rate	Flow	*Civilian Reserve × Conversion Ratio*
Raw Material Conversion Rate	Flow	*MIN(Mobilization Intensity, Emergency Production Capacity)*
Production Capacity	Flow	$Excess\ Production\ Capacity + Regular\ Production\ Capacity$
Supply-Demand Gap	Auxiliary	*Demand−Total Supply*
Mobilization Intensity	Auxiliary	*IF THEN ELSE(Supply−Demand Gap≤0, 0, Supply−Demand Gap/Adjustment Time)*
Upper-Level Priority	Auxiliary	*Demand×(1−Severity of Disasters Elsewhere)*
Requisitioned Material	Auxiliary	$RAMP(Enterprise\ Reserve \times Requisition\ Ratio / Adjustment\ Time, tstart, tstart + Adjustment\ Time)$
Requisition Ratio	Auxiliary	*LOOKUP(Demand, [[(0,0)-(100,0.8)],(0,0),(20,0.1),(100,0.8))*

The finished product reserve refers to immediately deployable materials managed directly by government agencies or stored by contracted enterprises, enabling rapid response without further processing. Raw material reserves constitute a second layer,

requiring conversion under emergency conditions. In accordance with the bottleneck principle, actual production output at any time step is determined by:

$$Q_{actural} = min(C_{production}, Q_{raw\ material})$$

where $C_{production}$ denotes maximum processing capacity and $Q_{raw\ material}$ denotes the available convertible raw material volume. The quantity of materials available for requisition under emergency conditions is primarily determined by two factors: the existing reserve scale of various units and the corresponding requisition ratio. The requisition ratio increases progressively with demand level but is capped at 0.80, retaining a surplus to ensure the basic operational continuity of requisitioned units.

3 Empirical Analysis

3.1 Case Background

This study uses Fugou County's flood-control sandbag demand during the 2021 Henan extraordinary rainstorm as the empirical basis. Between July 17 and 23, 2021, Henan Province experienced historically unprecedented rainfall, with Zhengzhou recording 380 disaster-related deaths and direct economic losses of 40.9 billion yuan [23]. To alleviate severe urban waterlogging in Zhengzhou, upstream flood discharge was initiated on July 20, significantly increasing the flood control burden on downstream Fugou County. Compounding this pressure, flood waters from the Jialu River were partially redirected back into Fugou County due to downstream flood control requirements in Zhoukou City, substantially worsening local disaster conditions. Based on government work reports and related meeting records, total sandbag demand for Fugou County is estimated at 1 million units, primarily for levee reinforcement, flood control operations, and urban area protection.

3.2 Parameter Settings

Simulation initialization: start time = 0, end time = 10, time step = 0.5, time unit = days. Parameters are derived from analysis of official news reports and government portal data. Key parameter values are summarized in Table 2.

Table 2. Key parameter settings for the Fugou County simulation.

Variable	Value	Unit
Finished Product Reserve	16	10000 bags
Raw Material Reserve	200	10000 bags
External Aid Material (initial)	0	10000 bags
Social Organization Reserve	200	10000 bags
Regular Production Capacity	10	10000 bags
Demand	100	10000 bags
Enterprise and Institution Reserve	30	10000 bags

Requisition Ratio	0.8	
Raw Material Utilization Coefficient	0.2	
Raw Material Conversion Coefficient	0.5	
Severity of Disasters Elsewhere	0.86	
Mobilization Adjustment Time	4	day

3.3 Simulation Results and Analysis

Demand for flood-control sandbags is not static but escalates rapidly as disaster conditions intensify. Heavy rainfall struck Henan Province on July 17, 2021 (t = 0). Prior to the upstream flood discharge decision, Fugou County's disaster situation was relatively manageable, with material demand maintained at a low level of approximately 100,000 bags. On July 20 (t = 3 days), the implementation of upstream flood discharge in Zhengzhou triggered a sharp and abrupt demand surge, which subsequently stabilized at a new elevated plateau of 1,000,000 bags. This dynamic is captured by the step function:

$$D(t) = 10 + STEP(90,3)$$

Simulation results (Figure 4) show that during the initial phase (Day 1), existing reserves adequately covered demand. A pronounced supply-demand gap emerged between Days 2 and 3. External aid and civilian conversion channels, both dependent on information dissemination effects, exhibited a time-delayed response, beginning to take effect from Day 3 onward. The supply-demand gap narrowed rapidly from Day 3 and reached equilibrium at Day 8, at which point mobilization intensity fell to zero. Due to system inertia, final supply marginally exceeded demand.

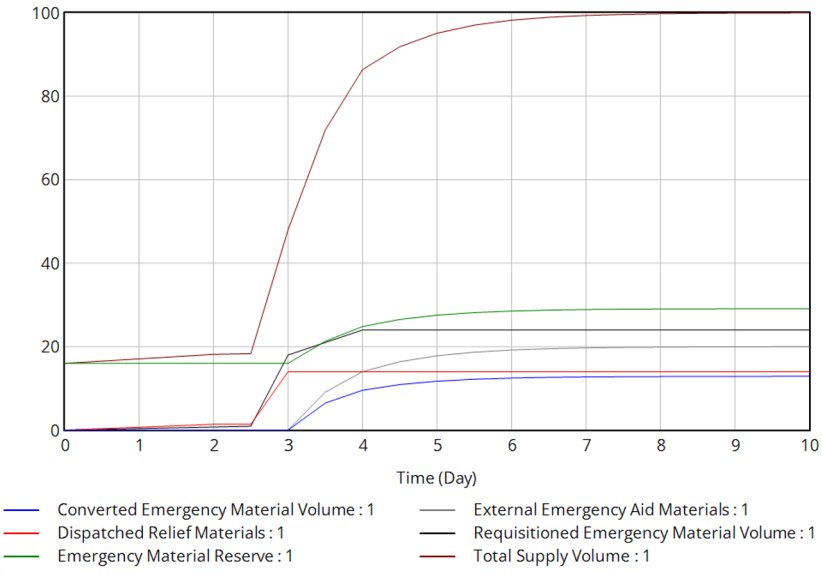


Fig. 4. Supply channel dynamics over the simulation period.

Figure 5 illustrates the correlation between mobilization intensity and supply volumes across channels. Prior to the demand surge, existing government sandbag reserves met actual needs, and mobilization intensity remained at zero. Following the sudden demand escalation, the government rapidly intensified mobilization, activating multi-channel supply including social requisition, raw material conversion, and external aid reception. As aggregate supply expanded and the supply-demand gap narrowed, mobilization intensity progressively declined, ceasing entirely when total supply met demand. A notable time lag exists between government mobilization actions and resulting supply responses (external aid and conversion), reflecting the propagation delay inherent in mobilization effects.

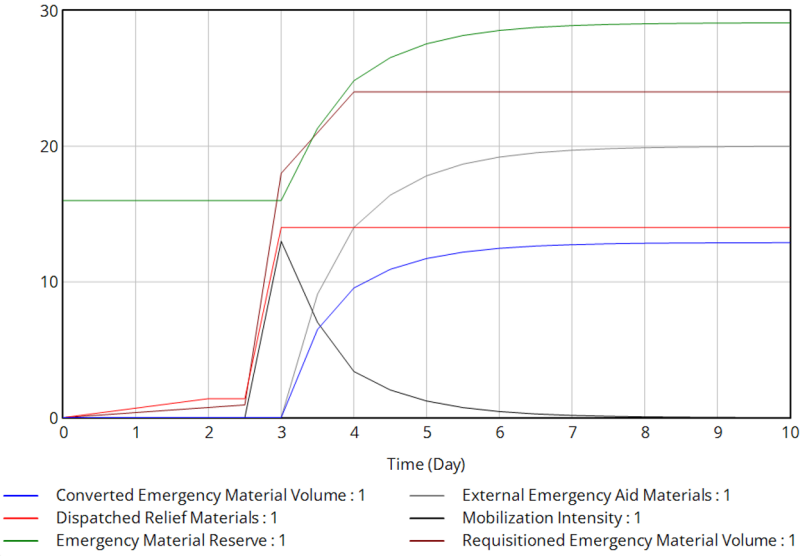


Fig. 5. Relationship between mobilization intensity and material supply volumes.

4 Sensitivity Analysis

4.1 Methodology

Parametric sensitivity analysis is conducted by systematically varying key exogenous variables to observe resultant changes in simulation outputs. This approach evaluates the adaptive capacity of the emergency resource allocation system under different conditions and identifies the parameters most critical to mobilization performance [24].

4.2 Results

Three parameters are examined: mobilization adjustment time, enterprise and institution inventory level, and severity of disasters elsewhere. Detailed results are presented in Figure 6.

When the mobilization adjustment time is reduced to 2 days, mobilization intensity increases, and total supply reaches the required 1 million units at approximately Day 4.5. When enterprise inventory is raised to 600,000 units, a threshold effect is observed: the expanded requisition base substantially shortens the time required to meet demand to approximately 5 days. As an exogenous variable, the severity of disasters elsewhere operates through dual pathways: it determines the scale of upper-level resource allocation and interacts with social attention to influence external aid intensity. When this parameter decreases from 0.86 to 0.70, upper-level allocation and external aid increase sharply, reaching the 1-million-unit threshold by Day 5. When the parameter is set to 0.40, concentrated external support enables the threshold to be reached by Day 3.5.

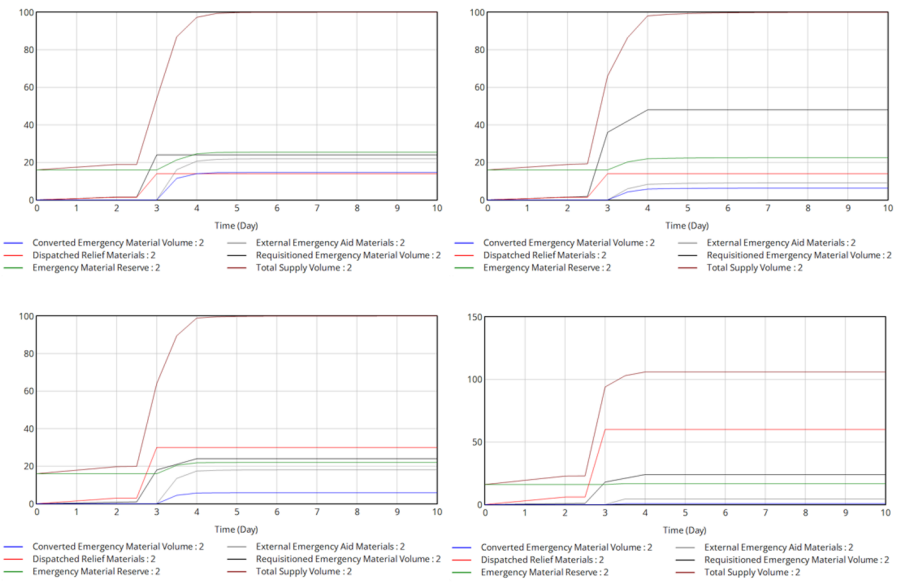


Fig. 6. mobilization adjustment time: 2 & enterprise inventory level: 60 & Sensitivity analysis: disasters elsewhere = 0.70 & Sensitivity analysis: disasters elsewhere = 0.40.

Sensitivity analysis reveals that severity of disasters elsewhere exerts the greatest influence on mobilization outcomes, as it simultaneously affects upper-level government allocation and social resource orientation. Mobilization adjustment time ranks second, influencing multiple supply channels through mobilization intensity. Importantly, excessively short adjustment times may generate oversupply, leading to material waste; hence, optimization of this parameter should be balanced against supply efficiency.

5 Scenario Simulation

Investigation reveals that Fugou County currently lacks dedicated flood-control sandbag manufacturing enterprises. Given the prevalence of regional flood disasters,

neighboring areas face parallel supply pressures, limiting external material acquisition. This underscores the necessity of enhancing local self-sufficiency in emergency material production.

To evaluate the feasibility of localized production, production capacity supply is introduced as a key intervention variable. Simulation results (Figure 7) demonstrate that with established local production capacity, the 1-million-unit demand can be satisfied within 4.5 days—a substantial improvement under conditions where surrounding areas are severely affected. To prevent waste, mobilization intensity serves as the core control variable within an automatic supply-demand balancing mechanism: when supply meets demand, the supply-demand gap approaches zero, mobilization intensity falls to zero, and production ceases. This dynamic regulation mechanism simultaneously ensures material adequacy and minimizes unnecessary production activity during disaster periods.

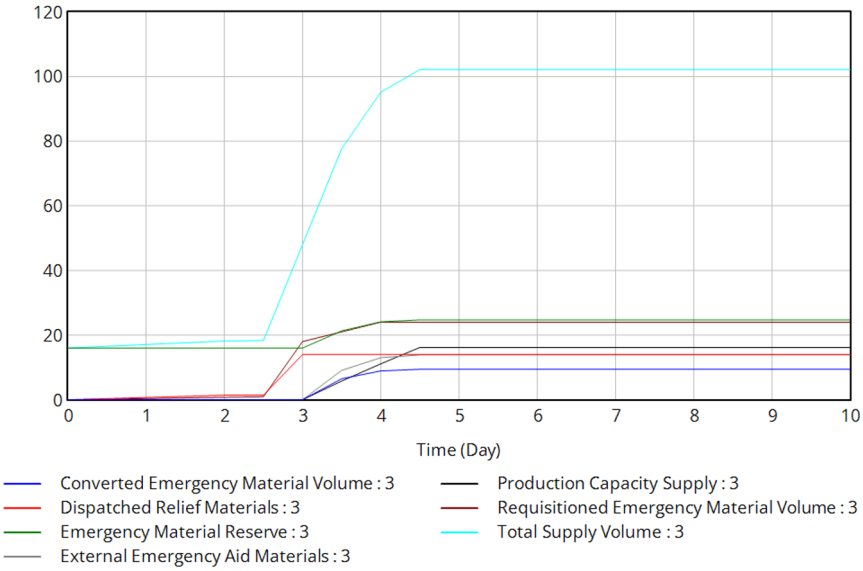


Fig. 7. Simulation results with local production capacity introduced.

6 Conclusions

This study constructs a multi-dimensional county-level disaster emergency material mobilization model incorporating emergency reserves, external support, temporary requisition, emergency production, and civilian conversion sub-systems, grounded in system dynamics theory. The model is validated through empirical simulation and sensitivity analysis using data from the 2021 Fugou County flood disaster.

Four principal conclusions are drawn. First, government mobilization intensity is significantly and positively correlated with emergency material supply efficiency; higher mobilization intensity not only augments overall capacity but accelerates supply

velocity, effectively shortening the gap-closure period. Second, the reserve capacity of enterprises, institutions, and residents constitutes the critical foundation of mobilization capability; the effectiveness of requisition and conversion measures is substantially conditioned by the scale of baseline reserves, emphasizing the necessity of constructing multi-level routine reserve systems. Third, external aid exhibits a complex influence mechanism shaped by social organization capacity, regional disaster severity, and social attention levels; county-level governments can enhance aid inflows by proactively disseminating disaster information to raise societal awareness. Fourth, under conditions of constrained external resource access, establishing local emergency material production capacity or concluding production agreements with neighboring enterprises substantially enhances self-sufficiency and resilience.

This study is subject to several limitations. The model does not fully incorporate all exogenous variable interactions; extreme disruption scenarios such as supply chain interruptions and organizational failures are not addressed; and some parameter values carry inherent subjectivity due to data constraints. Furthermore, several operational factors critical to real-world mobilization capacity are not explicitly modeled, including material quality specifications such as sandbag size and strength requirements, transport-related factors such as delivery distance, road conditions, and vehicle availability, and labor constraints such as the personnel required for sandbag filling and placement. These omissions suggest that the model's supply estimates may represent an upper bound on operationally achievable mobilization capacity. Future research should expand the model boundary, enhance disruption simulation capabilities, incorporate operational constraints, and improve the objectivity of parameter estimation through more systematic data collection.

The theoretical contribution of this study lies in providing a systematic analytical framework for evaluating county-level emergency material mobilization capacity, offering theoretical guidance and decision-making references for local governments seeking to optimize emergency material guarantee systems.

References

1. Ministry of Emergency Management of China. (2026). National Natural Disaster Situation in April 2026 [Report]. https://www.mem.gov.cn/xw/yjglbgzdt/202605/t20260509_602951.shtml
2. Ministry of Emergency Management of China: Guiding Opinion on Further Strengthening the Emergency Material Guarantee System and Capacity Building. https://www.mem.gov.cn/gk/zfxxgkpt/fdzdgknr/202410/t20241023_506225.shtml (2024). Accessed 23 Sept 2024
3. Chen, F., Chen, J., Liu, J.: Forecast of flood disaster emergency material demand based on IACO-BP algorithm. Neural Comput. Appl. (2022).
4. Fei, L., Wang, Y.: Demand prediction of emergency materials using case-based reasoning extended by the Dempster-Shafer theory. Socio-Econ. Plan. Sci. **84**, 101386 (2022). https://doi.org/10.1016/j.seps.2022.101386
5. Ma, Z., Zhang, J., Gao, S.: Research on emergency material demand based on urgency and satisfaction under public health emergencies. PLoS ONE **18**(3), e0282796 (2023). https://doi.org/10.1371/journal.pone.0282796

6. Zhan, W., Cheng, C.: Emergency material demand prediction in post-earthquake transitional resettlement phase based on GWO-BP. China Saf. Sci. J. **34**(10), 17–23(2024). https://doi.org/10.16265/j.cnki.issn1003-3033.2024.10.0131.
7. Zhang, S., Huang, M., Liu, S., Zhou, W., You, Q.: Emergency material demand forecasting based on network information and BP neural network: a case study of Jishixian 6.2 earthquake. J. Inst. Disaster Prev. **26**(3), 76–85 (2024)
8. Yu, N., Feng, G., Tian, J., Liu, Y.: Emergency material procurement model considering disaster victim distress under government delegation and coordination strategy. Syst. Eng.-Theory Pract. 45(8), 2623–2642 (2025)
9. Gong, L., Jiang, X., Ji, Q.: Joint reserve decision of physical stock and production capacity for government- enterprise three-level emergency materials. J. Hainan Univ. (Soc. Sci. Ed.) 44(2), 137–146 (2026). https://doi.org/10.15886/j.cnki.hnus.202312.0231
10. Wang, Z., Shan, H., Tao, M., Luo, M.: Pricing game model for joint government-enterprise emergency material reserve based on flexible contracts. J. Saf. Sci. Technol. China **20**(9), 20–28 (2024)
11. Wang, G., Wang, J., Pang, J., et al.: Emergency material reserve problem with option contract considering low carbon disposal cost. Evol. Intell. **17**(1), 361–369 (2024). https://doi.org/10.1007/s12065-022-00756-0
12. Jiang, J., Ma, J., Chen, X.: Multi-regional collaborative mechanisms in emergency resource reserve and pre-dispatch design. Int. J. Prod. Econ. **270**, 109161 (2024). https://doi.org/10.1016/j.ijpe.2024.109161
13. Long, K., Liu, J., Gao, Z., Chen, S., Zhang, Z.: Emergency vehicle scheduling model considering delivery urgency and fairness. J. China Foreign Highw. **44**(6), 251–258 (2024)
14. Wang, J., Zou, J., Wang, Y.: Two-stage optimization scheduling of emergency materials considering transshipment. Comput. Technol. Dev. (2024).
15. Ma, S., Zhang, J., Shen, B., Wen, Z., Gao, X., Zou, R.: Multi-stage dynamic scheduling method for emergency resources in flood-season road incidents. Highway **69**(11), 236–245 (2024)
16. Wang, S.L., Sun, B.Q.: Model of multi-period emergency material allocation for large-scale sudden natural disasters in humanitarian logistics: efficiency, effectiveness and equity. Int. J. Disaster Risk Reduct. **85**, 103530 (2023). https://doi.org/10.1016/j.ijdrr.2023.103530
17. Ma, W.: Multi stage distribution method of production emergency materials based on blockchain technology. In: Proceedings of the 4th International Conference on Big Data and Informatization Education (ICBDIE 2023), pp. XX–XX. Atlantis Press, Amsterdam (2023)
18. Wan, M., Ye, C., Peng, D.: Multi-period dynamic multi-objective emergency material distribution model under uncertain demand. Eng. Appl. Artif. Intell. **117**, 105530 (2023). https://doi.org/10.1016/j.engappai.2022.105530
19. Zidan, S.H.A.N., et al.: Research on the multi-objective optimization dispatching model and algorithm of emergency supplies under emergency events: a case of COVID-19. Oper. Res. Manag. Sci. **32**(1), 34 (2023)
20. Wang, Y., Chen, X., Wang, L.: Deep reinforcement learning-based rescue resource distribution scheduling of storm surge inundation emergency logistics. IEEE Trans. Ind. Inform. **19**(10), 10004–10013 (2023).
21. Li, Z.: Construction of production emergency mobilization capacity model based on system dynamics. Sci. Technol. Manag. Res. **36**(1), 190–195 (2016)
22. Wang, Z., Zhang, J.: Evaluation of emergency material mobilization potential based on system dynamics. Syst. Eng.-Theory Pract. **39**(11), 2880–2895 (2019)

23. Ministry of Emergency Management of China: Investigation Report on the "7·20" Extraordinary Rainstorm Disaster in Zhengzhou, Henan. https://www.mem.gov.cn/gk/sgcc/tbzdsgdcbg/202201/P020220121639049697767.pdf
24. Wang, X., Xu, Z.: Research on urban emergency material mobilization potential based on system dynamics. J. Catastrophol. **39**(3), 30–35 (2024)

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