

WFP and Ukraine

A Network Analysis of the Ukraine Crisis and WFP Operations

SCH-MGMT 533: Humanitarian Logistics

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"Before the war, Ukraine's food exports fed approximately 400 million people annually."

— World Food Programme

Presentation Overview

Central Question: How did the war in Ukraine disrupt both humanitarian relief logistics inside the country AND global food supply chains beyond it — and what does WFP's response reveal about managing network risk, resilience, and coordination failure under conflict?

01

Untold Backstories

History, demographics & cascades you won't find in textbooks

02

Ukraine as a Disrupted Network

Pre-war role, critical infrastructure, key shocks

03

WFP Inside Ukraine

Operations, access, & operational surprises

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The Global Food Cascade

Black Sea Grain Initiative & second-order effects

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Resilience & Adaptation

Rerouting, multi-modal redesign, paradoxes

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Insights & Lessons

Network theory, game theory, policy implications

01

Untold Backstories

History, demographics & cascades you won't find in most news coverage



Backstory #1: From Famine Victim to World Feeder

25–30%

of Earth's
chernozem

Chernozem = "black earth"
the world's most fertile soil
type. Ukraine sits on the
world's single largest deposit.

**This is WHY
Ukraine matters.**

1932–33

The Holodomor

Stalin's collectivization
policy forcibly confiscates
Ukrainian grain to feed
Soviet industrialization.
An estimated 3.5–7
million Ukrainians die
from engineered famine.
The word 'Holodomor'
means 'death by hunger.'

1945–91

Breadbasket of the USSR

Soviet planners
deliberately intensify
Ukrainian grain
production. Ukraine
provides ~25% of the
entire Soviet Union's
agricultural output. The
fertile black-earth regions
become central to Soviet
food security.

1991–2010

Independence & Privatization

Post-Soviet Ukraine
privatizes agriculture,
attracts foreign
investment, and
modernizes its farming
sector. Output and export
capacity surge. Ukraine
becomes top-5 globally in
sunflower oil, wheat,
corn, and barley.

2022

History Repeats — In Reverse

Russia attacks the same
grain infrastructure Stalin
built. The devastating
irony: the country that
was starved TO FEED
others is now weaponized
to STARVE others by
removing its supply from
global markets.

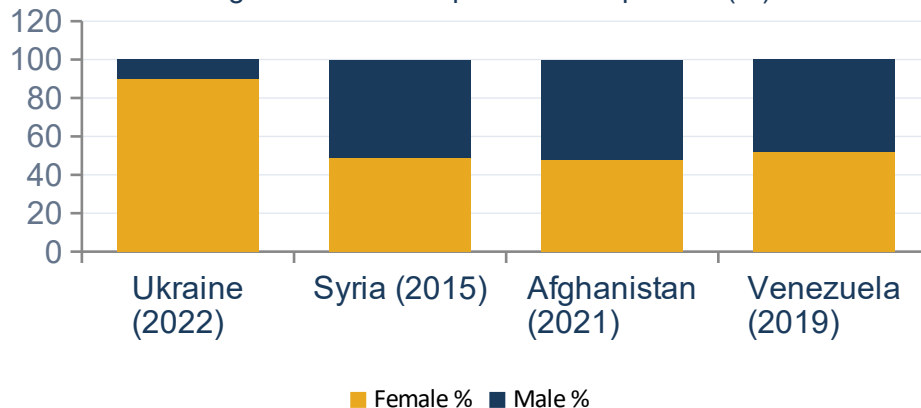
Backstory #2: A Refugee Crisis Unlike Any Other

~90%

of Ukrainian refugees
abroad are women,
children & elderly

Ukraine's Mobilization Law prohibits men aged 18–60 from leaving the country — a legal restriction with profound humanitarian logistics implications.

Refugee Gender Composition Comparison (%)



Supply Design

Standard WFP ration kits are designed for mixed-gender populations. All-female caseloads need reproductive health supplies, infant nutrition, and sanitary items in quantities that standard kits don't anticipate.

Education Logistics

High child-to-adult ratio means school infrastructure becomes a critical humanitarian logistics node — not just food. WFP's school feeding program had to scale in Poland, Germany, and Czech Republic simultaneously.

Labor Integration

Unusually high working-age female population enabled faster EU labor market integration — which in turn reduced WFP's direct assistance burden. A rare positive feedback loop.

Backstory #3: Lebanon — 72 Hours from Running Out of Bread

August 4, 2020



Shock #1: Beirut Port Explosion

4,000 tons of ammonium nitrate explodes in Beirut harbor. The blast destroys the city's main grain silos — which held 85% of Lebanon's national grain reserves (~15,000 tons). The silos' ruins became a haunting landmark; debate over their demolition continues today.

February 24, 2022



Shock #2: Ukraine War Begins

Lebanon imported 80%+ of its wheat from Ukraine and Russia. With those sources severed, Lebanon — which imports 85% of all its food and had near-zero grain reserves — faced existential supply disruption. The Lebanese pound had already lost 95% of its value, making alternative sourcing economically catastrophic.

Combined Effect: By summer 2022, Lebanon had **zero grain storage capacity, zero hard currency, and zero primary supply**. Reports emerged that the country was within 72 hours of running out of flour for bread. WFP emergency-sourced grain from Romania and France at crisis prices — a logistical and financial triage operation.

Key Concept — Vulnerability Stacking: Lebanon demonstrates how pre-existing vulnerabilities (destroyed storage, currency collapse) exponentially amplify a supply-chain shock. In network terms: a node that was already degraded collapsed entirely under a second-order disruption.

02

Ukraine as a Disrupted Network

Pre-war role, key infrastructure, and how conflict severed critical links



Pre-War Ukraine: The World's Breadbasket

#1

Sunflower Oil Exporter

~50% of global supply

#5

Wheat Exporter

~10% of global wheat

~400M

People Fed Annually

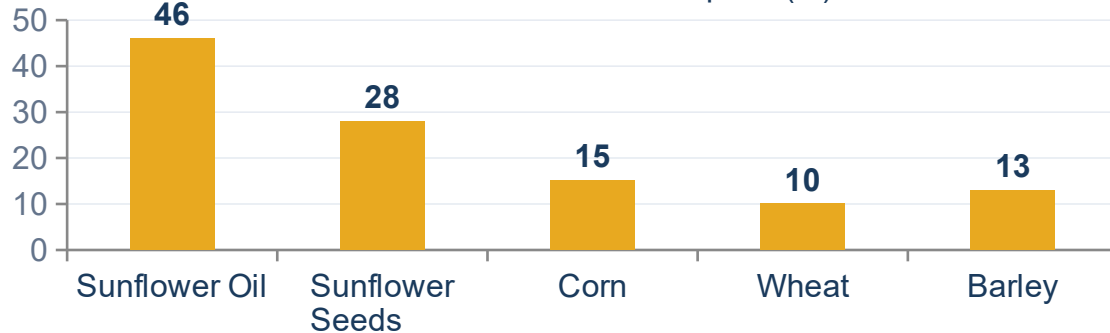
Before Feb 2022

#4

Corn Exporter

~15% of global corn

Ukraine's Share of Global Exports (%)

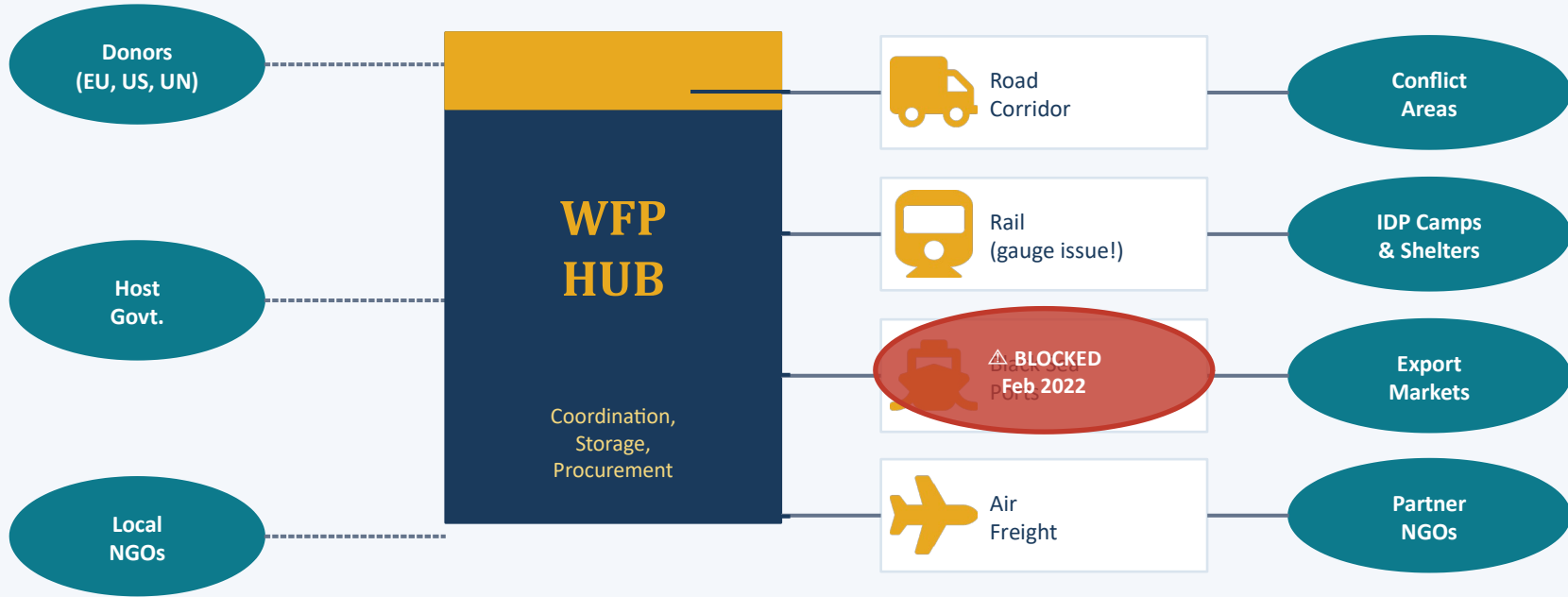


Key Insight

Ukraine is not merely a country at war — it is a **critical hub in a scale-free global food network**.

Its disruption is equivalent to removing a high-degree hub — the effects are non-linear and far-reaching.

Network Topology: Ukraine's Humanitarian & Food Logistics



The Black Sea ports were Ukraine's primary export gateway — their closure in 2022 is the single biggest infrastructure shock in this network.

Critical Infrastructure Under Attack: A Timeline

Key Infrastructure Disruption Events (2022–2023)



Fascinating Insight #1: The Rail Gauge Problem



Why couldn't Ukraine simply reroute everything by rail to Europe?

Ukraine / Former Soviet Rail

Gauge: 1,520 mm (Broad Gauge)

- Inherited from Soviet-era infrastructure
- Covers entire former USSR network
- Cannot directly connect to Western European tracks
- Trains must STOP at the Polish/Slovak/Hungarian border
- Cargo is physically transferred to EU-gauge wagons
- Creates hours of delay and throughput bottleneck per train

EU / Western European Rail

Gauge: 1,435 mm (Standard Gauge)

- Standard gauge used across most of Western Europe
- 85 mm narrower than Ukrainian/Soviet track
- Incompatible without gauge-change equipment or transfer
- Gauge-changing axles exist but slow and limited capacity
- Poland/Slovak border was overwhelmed in 2022–23
- This 85 mm difference became a strategic logistics crisis

Network Theory Insight: This is a classic **interface bottleneck** — a structural constraint at the boundary of two network systems that cannot be resolved by increasing capacity within either system alone. It requires **network redesign**, not just scaling.

Fascinating Insight #2: The Ghost Ships of Odesa

80+

cargo vessels
trapped in
Ukrainian ports

*Some crews were
stranded for 5–9 months*



What happened when Russia blockaded the Black Sea?

- 80+ commercial cargo ships were instantly trapped inside Odesa, Mykolaiv, and Chornomorsk ports
- Insurance companies declared all vessels in Ukrainian waters a 'war risk zone' — standard marine insurance became void
- Shipping companies faced a brutal choice: abandon cargo (worth hundreds of millions) or risk losing the ship
- Grain in ships' holds began to deteriorate — temperature, humidity, and time were ticking
- Crew members from the Philippines, India, and Turkey were stranded onboard, unable to leave
- BSGI ships required mine-detection inspections in Istanbul before departure — each taking 2–3 days

The Sunflower Oil Supermarket Shock

Within days of the invasion, supermarkets across the UK, Spain, Germany, and Italy rationed sunflower oil — limited to 2 bottles per customer. Ukraine produces ~46% of the world's sunflower oil. This was the first moment ordinary Europeans felt the Ukraine crisis in their kitchens. It became a vivid symbol of how global supply chains connect a conflict zone in Eastern Europe to a household in Manchester or Barcelona.

WFP Nobel Peace Prize Timing: WFP won the 2020 Nobel Peace Prize, accepted in 2021 — just months before the Ukraine crisis. The Nobel committee cited the "link between armed conflict and hunger." The Ukraine crisis then proved this thesis at a scale the committee likely never anticipated.

03

WFP Inside Ukraine



How the world's largest humanitarian logistics operator adapted to active conflict

WFP Ukraine: Scale, Scope & Operational Surprises

3M+

People Assisted

Monthly, at peak operations

18M+

IDPs Displaced

Internally displaced since Feb 2022

6M+

Refugees Abroad

Fled to neighboring countries



Active Conflict Logistics

WFP operates in frontline areas with real-time security risk. Convoy routes must be cleared before each mission. WFP logistics officers use military-grade intelligence to plan delivery windows.



Cold Chain Collapse

October 2022 power grid attacks destroyed 40% of energy capacity nationwide, crippling refrigerated storage. WFP redesigned all food packages to shelf-stable, non-refrigerated formats within weeks.



Last-Mile Delivery

Villages near front lines are accessible only via unmarked routes. Logistics planners compress decision cycles from days to hours using satellite imagery and ground intelligence.



Cash-Based Transfers: The Pivot

Where markets function, WFP shifted to e-vouchers — reaching ~1.5M people. CVA requires almost no physical logistics, eliminating last-mile risk. Grocery stores in Kyiv effectively became humanitarian distribution points.

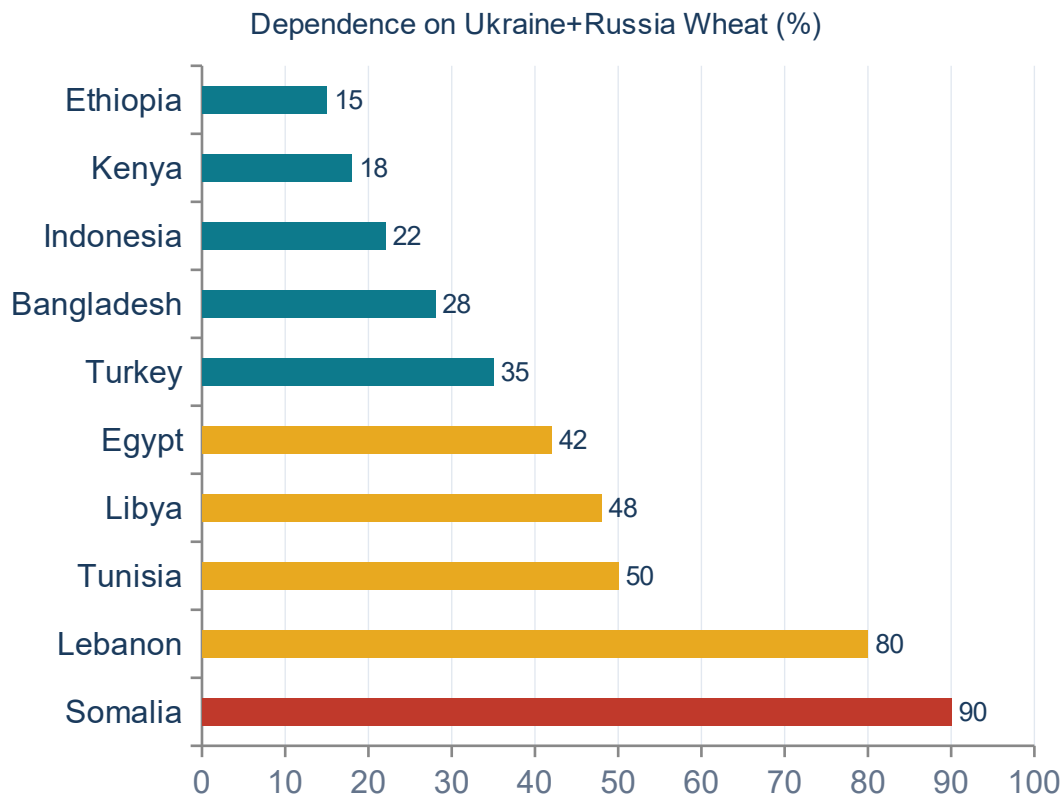
04

The Global Food Cascade

How one conflict zone triggered food insecurity across three continents



Global Ripple Effects: Who Was Hit Hardest?



Cascade Mechanism

① War blocks Black Sea ports (Feb 2022)

② 22M tons of grain trapped in silos

③ Global wheat futures spike +60%

④ Food-import-dependent nations face crisis

⑤ WFP's own food purchases become ~30% more expensive

⑥ WFP can feed fewer people with same budget

⑦ Donor attention & funding shift to Ukraine

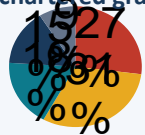
⑧ Funding gaps widen for Yemen, Horn of Africa

Net result: one conflict zone created a second-order global humanitarian emergency affecting 345M people facing acute food insecurity (WFP, 2023).

The Black Sea Grain Initiative: Logistics + Diplomacy



WFP-chartered grain destinations (BSGI period):



- WFP Programs (Ethiopia, Yemen, Afghanistan)
 ■ Middle East & N.Africa
 ■ Sub-Saharan Africa
- South & SE Asia
 ■ Other

Fascinating Insight #3: The Solidarity Lanes Paradox



How a humanitarian logistics corridor created a political crisis in the EU

1

May 2022: EU Creates Solidarity Lanes

EU creates land corridors through Poland, Romania, Hungary, Slovakia, Bulgaria for Ukrainian grain exports. Duty-free passage. A major logistical achievement.

2

2022–23: Grain Leaks into EU Markets

Some grain diverts into local EU agricultural markets. Ukraine's grain is heavily pre-war subsidized — dramatically cheaper than local EU grain.

3

Apr 2023: Polish Farmers Blockade Border

Polish, Hungarian, Slovak, and Romanian farmers blockade Solidarity Lane crossings. The humanitarian corridor becomes a trade dispute overnight.

4

Apr–Jun 2023: Unilateral Import Bans

Poland, Hungary, Slovakia, Bulgaria unilaterally ban Ukrainian agricultural imports — defying EU trade law. Brussels is furious but politically paralyzed.

5

Jun 2023: EU Negotiates Transit-Only Protocol

Complex compromise: grain can transit but not be sold locally. Real-time cargo tracking and sealing required. Logistics overhead rises 20–30% to enforce compliance.

Key Insight: Humanitarian logistics corridors create economic externalities in the countries they pass through. The Solidarity Lanes paradox shows that a supply-chain solution at the global level can become a political crisis at the local level — a coordination problem no logistics model alone can solve.


05

Resilience & Adaptation

How WFP and Ukraine redesigned their logistics network under fire



Resilience Strategies: How the Network Adapted



Multi-Modal Diversification

WFP deployed trucks, ships, aircraft, and rail simultaneously. No single mode carries >40% of load — redundancy by design. The WFP supply chain uses all transport modes globally.




Alternative Export Corridors

When Black Sea was blocked: Danube River route (Reni, Izmail ports), EU road corridors, and intermodal rail-to-truck at EU borders. Daily throughput via Danube reached 3M tons/month by late 2023.




Pre-Positioning: The Lviv Hub

WFP pre-positioned food stocks in Lviv (western Ukraine) before anticipated escalations. Lviv's proximity to the Polish border allowed 3-4 weeks of supply continuity even when eastern corridors were severed.



Cash & Voucher Transfers (CVA)

In areas with functioning markets, WFP shifted to digital cash — reaching ~1.5M people. Grocery stores in functional cities became de facto distribution points. Near-zero physical logistics risk.



Local Partner Network Scale-Up

WFP rapidly onboarded 80+ local NGO partners with ground-level access. Hub-and-spoke model: WFP handles bulk logistics, partners handle final delivery in contested areas.



Real-Time Supply Chain Intelligence

WFP deployed logistics cluster tools, live route risk assessments, and satellite-based warehouse monitoring. Decision cycles compressed from days to hours under active shelling.

06

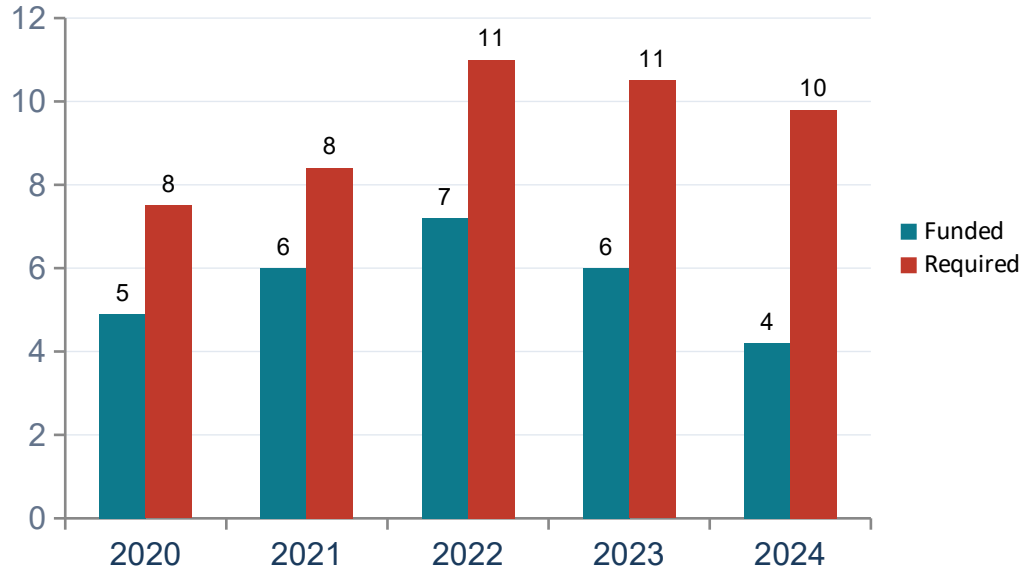
Insights & Lessons



Network theory, game theory, and what Ukraine teaches us about humanitarian logistics

Insight #4: The Funding & Coordination Failure

WFP Budget: Required vs Funded (USD Billion)



Game Theory Perspective

Donor Allocation as a Nash Equilibrium:

- Each donor maximizes domestic political utility from aid allocation
- Ukraine crisis attracts disproportionate donor attention (high media visibility)
- Each donor's optimal strategy shifts funding to Ukraine
- Result: Nash Eq. where total humanitarian coverage is sub-optimal
- No single donor has incentive to unilaterally rebalance → coordination failure
- WFP as 'network coordinator' trying to internalize these externalities

Critical Finding: As Ukraine crisis dominated headlines in 2022, WFP reported its largest-ever funding gap for other operations. Yemen, Somalia, and Afghanistan were effectively crowded out. A single high-visibility crisis restructured the global humanitarian funding equilibrium — a textbook **attention externality**.

Network Theory Insights from the Ukraine Case

I

Hub Criticality & Single Points of Failure

Odesa and its Black Sea ports were ultra-high-degree nodes. Their blockade mirrors what network theory predicts: targeted removal of a hub causes disproportionate disruption — far worse than equivalent capacity loss distributed across smaller nodes.

II

Network Efficiency (Nagurney–Qiang Measure)

The N-Q network efficiency measure quantifies logistics performance degradation after node/link removal. Ukraine's case suggests Odesa contributed ~35–45% of the food export network's efficiency — consistent with scale-free hub dynamics.

III

Redundancy vs. Efficiency Trade-off

Pre-war Ukrainian logistics were optimized for cost efficiency — lean, heavily centralized on Black Sea. Post-war redesign sacrificed efficiency for resilience: multi-modal, distributed, lower throughput but much greater fault-tolerance.

IV

Interface Bottlenecks (The 85mm Rule)

The EU rail gauge boundary is a structural constraint that cannot be resolved within either sub-network alone. Ukraine's logistics redesign required cross-system coordination at the boundary — a principle generalizable to any interoperability challenge in HL.

Conclusion

Central Thesis:

The Ukraine crisis demonstrates that humanitarian logistics under conflict must be studied as a network problem where local infrastructure damage, demographic disruption, access constraints, and global food corridor disruption interact to shape both emergency relief and worldwide food security.

- ✓ Ukraine's history as famine victim turned breadbasket makes it the defining case for 21st-century food supply chain fragility
- ✓ The Black Sea corridor was a critical hub — its loss produced non-linear, cascading global effects across 3 continents
- ✓ Demographic profile (all-female displacement) fundamentally reshaped what 'humanitarian assistance' had to look like
- ✓ The Solidarity Lanes paradox: humanitarian solutions at the global scale can become political crises at the local scale
- ✓ Game-theoretic donor dynamics (attention externality) created second-order humanitarian crises far from the conflict zone
- ✓ Network topology determines crisis response options — resilience must be designed in before the disaster, not improvised during it

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