UDC 351.74:656.078.5
DOI 10.37772/2309-9275-2025-1(24)-6
JEL classification: G 21, H 56, L 94

ASSESSMENT OF THE CONSEQUENCES FOR CRITICAL SECTORS IN UKRAINE AS A RESULT OF THE 2014–2025 WAR

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Abstract. This study assesses the consequences of risks for critical infrastructure using the risk matrix method. Objectives include analyzing risk assessment approaches, examining the destruction of Ukraine's critical infrastructure, and developing evaluation methods for potential threats. The research employs threat analysis, probabilistic risk assessment, and scenario modeling. The study develops an approach to risk assessment for critical infrastructure, considering military threats and cybersecurity challenges. The review highlights the destruction of energy and infrastructure facilities in Ukraine, emphasizing the need for enhanced protection. Research on cyber threats, such as the 2015 cyberattack on Ukraine's power grid, demonstrates the necessity of modern security measures. The findings can aid in developing restoration strategies and reducing infrastructure vulnerability. The study also explores wartime disruptions to medical institutions, pharmacies, and clinics, classified as Insignificant, Moderate, Severe, or Catastrophic. Minor disruptions cause temporary shortages, while severe cases lead to healthcare system collapse, affecting emergency and routine care. The impact of wartime impacts on education, universities and research institutions has been assessed. Additionally, disruptions to water supply and sewage systems pose major public health risks, potentially leading to widespread disease outbreaks. These insights help policymakers and emergency planners mitigate wartime disruptions.

Keywords: critical infrastructure, risks, cyber threats, war, medical institutions, educational institutions, water supply.

Author's contribution
The authors made an equal contribution to the article. Together they selected literature, analyzed it and drew common conclusions.

Disclosure statement
The authors have not any competing financial, professional, or personal interests from other parties.

INTRODUCTION

In our article (Berezutskyi V., Tokhtamysh T., 2024) we considered the basic methods of identifying risks by comparing the probability and consequences of events. In the article it was shown that various methods based on the comparison of the probability and consequences of events are used to assess risks. The risk matrix method (Johnivan J.R., 2024) is the most widely used method. It includes a two-dimensional matrix:

- probability of an event (low, medium, high, very high);
- consequences of an event (minor, moderate, severe, catastrophic).

Taking into account the large volume of research, the previous article considered the method for determining the probability of events for critical objects. This article will consider the assessment of consequences for critical objects.

THEORETICAL REVIEW

The war has led to the systemic destruction of Ukraine's critical infrastructure, with long-term consequences for the economy, security, and environment. Recovery will require substantial financial resources, international assistance, and the implementation of new technologies, including enhanced cybersecurity and the construction of infrastructure resilient to attacks. Without effective recovery and modernization strategies, the consequences of this destruction could negatively impact Ukraine's stability for decades to come. Below is a concise overview of scientific articles examining the consequences of destruction and negative impacts on critical infrastructure in Ukraine during the 2014–2025 war.

Cyberattacks on Energy Infrastructures: Modern War Weapons.This scientific articles (Aljohani, 2022) study analyzes the cybersecurity threats to energy infrastructures, focusing on incidents like the 2015 cyberattack on Ukraine's power grid. It discusses the methodologies used in such attacks and emphasizes the need for robust cybersecurity measures to protect critical infrastructure.

Impact Assessment of Hypothesized Cyberattacks on Interconnected Bulk Power Systems. This paper (Ten et all, 2018) evaluates the potential impacts of coordinated cyberattacks on interconnected power systems, using Ukraine's 2015 power grid attack as a case study. It highlights the vulnerabilities in supervisory control and data acquisition (SCADA) systems and the cascading effects of such attacks on power stability.

An Open-Source Tool for Mapping War Destruction at Scale in Ukraine using Sentinel-1 Time Series. This research (Dietrich et all, 2024) introduces a scalable method for assessing war-induced building damage in Ukraine using Synthetic Aperture Radar (SAR) satellite imagery. The tool aids in rapid damage assessment, crucial for humanitarian efforts and infrastructure rebuilding.

Impact of State and State-Sponsored Actors on the Cyber Environment and the Future of Critical Infrastructure. This paper (Durojaye & Raji, 2022) explores the influence of state and state-sponsored actors on cybersecurity, with a focus on critical infrastructures like Ukraine's power grid. It discusses the challenges in detecting and attributing such cyberattacks and their implications for national security.

Environmental Impact of the Russian Invasion of Ukraine. This article (Environmental Impact of the Russian Invasion of Ukraine, 2025) examines the environmental consequences of the Russian invasion, detailing the damage to industrial sites, pollution, and the long-term ecological effects on Ukraine's natural reserves and critical infrastructure.

Impact of the Russian Invasion of Ukraine on Nuclear Power Plants. This article (Impact of the Russian Invasion of Ukraine on Nuclear Power Plants, 2025) discusses the effects of the invasion on Ukraine's nuclear facilities, highlighting incidents at the Chernobyl and Zaporizhzhia plants, and the broader implications for nuclear safety and energy security.

Zaporizhzhia Nuclear Power Plant Crisis. This article (Zaporizhzhia Nuclear Power Plant Crisis, 2025) provides a detailed account of the crisis at the Zaporizhzhia Nuclear Power Plant during the invasion, including the safety concerns, military activities, and the international response to the threats posed to this critical infrastructure.

Destruction of the Kakhovka Dam. This article (Destruction of the Kakhovka Dam, 2025) examines the destruction of the Kakhovka Dam, detailing the immediate and long-term impacts on infrastructure, the environment, and the socio-economic conditions in the affected regions of Ukraine.

Environmental Impact of War. This article (Environmental Impact of War, 2025) explores the broader environmental consequences of warfare, with references to the Ukrainian context, discussing

how modern military activities lead to environmental degradation and the destruction of critical infrastructure.

2015 Ukraine Power Grid Hack. This article (2015 Ukraine Power Grid Hack, 2025) details the 2015 cyberattack on Ukraine's power grid, the first publicly acknowledged successful cyberattack on a power grid, discussing the methods used and the implications for critical infrastructure security.

METHODOLOGY

The ongoing war in Ukraine since 2014 has caused severe destruction and negative consequences for the country's critical infrastructure. Key facilities such as energy systems, water supply, transportation networks, communications, and nuclear facilities have suffered direct attacks, cyberattacks, and significant physical damage.

1. Energy Infrastructure:

• Cyberattacks, particularly the 2015 power grid attack, have demonstrated the vulnerability of electricity networks to hacking;

• Direct shelling and bombings of power plants, including the Zaporizhzhia Nuclear Power Plant, have created risks of radiation contamination and energy instability.

2. Hydrotechnical Structures:

• The destruction of the Kakhovka Dam led to large-scale flooding, the devastation of ecosystems, and loss of water supply for many people and enterprises.

3. Environmental Consequences:

• Military actions have caused significant soil, water, and air pollution due to the destruction of industrial facilities, particularly in the Donbas region;

• Contamination with radioactive and toxic substances has occurred due to damage to chemical plants and waste storage sites.

4. Destruction of Transport and Communication Infrastructure:

• Bridges, railways, roads, and airports have suffered significant damage, complicating logistics and the evacuation of civilians;

• The destruction of telecommunications hubs and mobile communication towers has led to information isolation in certain regions.

These view provide a comprehensive overview of the various impacts on Ukraine's critical infrastructure during the conflict period. In this regard, there is a need for a more detailed study of the risks of critical objects that arise as a result of military conflicts and wars.

As in the previous study, the ChatGPT artificial intelligence program was used (ChatGPT, 2025). The impact assessment of events was performed for the same critical sectors during the war as in the previous study (Berezutskyi & Tokhtamysh, 2024):

1.Financial Institutions (Banks);
2. Food Supply Chains (Stores, Warehouses);
3. Energy Systems (Electric Power, Transmission);
4. Information Systems (Data Centers, Internet);
5. Space Research and Satellite Communication Centers;
6. Educational Institutions (Schools, Research Centers);
7. Logistics (Transport Networks, Fuel Stations);
8. Communication Systems (Mobile Networks, Radio, TV);
9. Water Supply and Sewerage Systems;
10. Healthcare Systems (Hospitals, Pharmacies).

1. Assessment of the consequences for financial institutions, banks and other critical objects of the financial infrastructure during the war. Consequences Defined (Insignificant, Moderate, Severe, Catastrophic).

Table 1. Assessment of the consequences of negative impacts on critical infrastructure in points

Consequences	Point
Insignificant	0–25 (12)
Moderate	26–50 (38)
Severe	51–75 (63)
Catastrophic	76–100 (88)

Source: formed by the authors

In further research we will use the same classification, which is given in Table 1.

When assessing the consequences of disruptions to financial institutions and banks during wartime, we categorize them based on the Consequences Framework: Insignificant, Moderate, Severe, and Catastrophic (Report on the European Central Bank – annual report 2023, 2023, Cybersecurity studies from the World Economic. Reports, 2025, Post-war Reconstruction: Case Studies, 2022):

a) Insignificant Consequences. Description: *Minor* disruptions that do not affect core operations significantly. Financial Context: An insignificant consequence would involve temporary delays in services like localized ATM outages or minor glitches in online banking services. Example: During an early stage of conflict, an isolated attack on a small branch that is quickly restored without impact on the broader financial system;

b) *Moderate* Consequences. Description: Noticeable disruptions, but the system can recover with some effort and resources. Financial Context: Disruptions to specific financial services, like regional delays in transactions, may cause temporary inconvenience but do not undermine confidence in the system. Example: A cyberattack that disables regional online banking services or credit card processing systems for a short period, affecting consumers and businesses until fixed;

c) *Severe* Consequences. Description: Substantial impact, with a significant effect on the economy and financial operations. Financial Context: Severe consequences could include the prolonged unavailability of critical banking services or the loss of large amounts of data, which could erode public trust in financial institutions. Example: During the Russia-Ukraine conflict, widespread cyberattacks on Ukraine's financial system led to service disruptions and reduced banking functionality. If the financial market experiences such attacks for an extended period, this could lead to national economic instability and panic among citizens;

d) *Catastrophic* Consequences. Description: Systemic collapse or prolonged disruption that causes long-term damage and is difficult to recover from. Financial Context: A catastrophic consequence could include the destruction of critical financial infrastructure or long-term paralysis of the national banking system, leading to severe economic consequences like hyperinflation, currency collapse, or an inability to conduct any financial transactions domestically and internationally. Example: In war-torn countries like Syria and Yemen, banking infrastructure has collapsed, with citizens unable to access basic financial services. This disrupts the entire economy, increases poverty, and leads to the breakdown of financial markets.

Factors That Influence the *Severity* of Consequences

• Cyberattacks: Financial institutions are highly vulnerable to cyberattacks during war, which can cause severe or catastrophic damage. For example, coordinated attacks could disable critical infrastructure, leading to long-term inoperability.

• Physical Destruction: Bombings and physical attacks on financial hubs can lead to the destruction of infrastructure, causing systemic failures.

• Market Confidence: Wars often erode confidence in financial markets, leading to currency devaluation, runs on banks, and collapse in stock markets, exacerbating economic damage.

• International Sanctions and Isolation: During wartime, international financial institutions may impose sanctions, causing isolation and collapse of local banks, leading to severe to catastrophic financial consequences.

In conclusion, the consequences for financial institutions during wartime can range from *moderate* to *catastrophic* depending on the intensity of attacks and the resilience of the systems in place. A comprehensive risk management plan, focusing on cyber-defense and physical protection, is critical to mitigating these risks.

2. An assessment of the impact on grocery stores, food warehouses and all commercial infrastructure during wartime. Consequences Defined (Insignificant, Moderate, Severe, Catastrophic). Assessing the consequences of disruptions to grocery stores, food warehouses, and commercial infrastructure during wartime follows a framework categorized as Insignificant, Moderate, Severe, and Catastrophic (Conflict and hunger, 2023, Global Report on Food Crises (GRFC) 2024, 2024, Reports and Documents, Protecting Civilians against Digital Threats during Armed Conflict, 2024, The Syrian conflict, 2018, Case study on Humanitarian crisis in Syria, 2023).

Each level of impact reflects different degrees of disruption to food availability, supply chains, and the broader economy:

a) Insignificant Consequences. Description: *Minor* and temporary disruptions with minimal impact on overall operations or food supply. Impact on Food Infrastructure: Short-term delays in deliveries or temporary shortages of specific products that do not severely affect food availability. Example: Localized issues like transportation delays due to a temporary road closure or an isolated incident affecting one warehouse. The general public may experience short-term inconveniences, but food availability remains stable overall;

b) *Moderate* Consequences. Description: Noticeable disruptions that cause operational challenges but can be managed with some effort. Impact on Food Infrastructure: Interruptions to the food supply chain in a particular region or city due to attacks on transportation routes or warehouses. This could lead to temporary shortages of essential goods or price increases but would not lead to widespread food insecurity. Example: During the early phases of a conflict, damage to a key distribution center causes supply shortages in certain regions. Grocery stores may experience stock limitations for several days, leading to price fluctuations and inconvenience for the population, but the system stabilizes once alternative routes are established;

c) *Severe* Consequences. Description: *Major* disruptions that significantly impact the availability of food and commercial infrastructure, affecting the economy and population well-being. Impact on Food Infrastructure: Severe damage to multiple warehouses, food processing plants, or transportation networks can disrupt supply chains on a larger scale. This can lead to sustained shortages of essential food items, price spikes, and food rationing. Example: Bombing of food warehouses or destruction of transportation routes (e.g., railways or highways) used for food logistics. This could lead to long-term scarcity in certain areas and place immense pressure on food security, especially in cities that rely heavily on external supplies;

d) *Catastrophic* Consequences. Description: Complete or near-complete breakdown of the food supply system, causing widespread famine, economic collapse, and severe social unrest. Impact on Food Infrastructure: The destruction of key food supply hubs, collapse of supply chains, and long-term inability to replenish stocks would lead to large-scale food shortages. The commercial infrastructure would be crippled, and basic goods would become unavailable, severely affecting civilian populations. Example: A prolonged and targeted campaign against food infrastructure, including destruction of warehouses, farms, transportation hubs, and food markets, resulting in widespread famine. Cities and towns may become cut off from food supplies entirely, leading to catastrophic hunger, economic destabilization, and humanitarian crises. This level of disruption can also trigger social unrest and mass displacement as people seek food and safety elsewhere.

Factors Worsening Consequences:

• targeting of Supply Routes: Destruction of critical roads, railways, and ports that transport food can amplify the severity of the consequences;

• cyberattacks: Disruption of logistics management systems through cyberattacks could paralyze food distribution efforts, compounding physical damage;

• dependency on Imports: Countries that rely heavily on food imports face higher risks of catastrophic consequences if ports or border crossings are compromised.

Historical Examples:

• Syria: The civil war has seen food warehouses and supply chains targeted, leading to severe food shortages in besieged areas and catastrophic humanitarian crises.

• Yemen: Ongoing conflict has caused widespread destruction of food distribution infrastructure, with millions facing famine due to blockades and destruction of supply routes.

In conclusion, disruptions to grocery stores, food warehouses, and other commercial infrastructures during wartime range from *moderate* to *catastrophic*, depending on the intensity and duration of the conflict and the resilience of the infrastructure. Prolonged disruptions can lead to severe food insecurity, economic decline, and humanitarian disasters.

3. Assessing the consequences of disruptions to power supply systems and sources of electricity during wartime uses the same Consequences Framework: Insignificant, Moderate, Severe, and Catastrophic (Ukraine's Energy Security and the Coming Winter An energy action plan for Ukraine and its partner, 2024, Schweikert A., Nield L., Otto E., Deinert M., 2019, Ukraine's energy system under attack, 2024). Each level reflects the impact on the electrical grid, energy distribution, and society's reliance on power;

a) Insignificant Consequences. Description: Minor, localized disruptions that do not significantly affect the overall power supply system. Impact on Power Infrastructure: Short-term outages in small areas, such as a localized attack on a substation or damage to transmission lines that are quickly repaired. Example: A temporary power outage in a small city or neighborhood due to a minor disruption, causing inconvenience but quickly restored without long-term effects. Essential services like hospitals and communication centers would continue operating with backup generators:

b) Moderate Consequences. Description: Noticeable disruptions that affect larger areas or regions but can be managed through alternative means. Impact on Power Infrastructure: Disruptions in power generation or transmission across a significant region, leading to rolling blackouts, reduced power availability, or energy rationing. Example: Attacks on key power generation plants or transmission lines affecting a city or region for several days. There may be power rationing and reliance on alternative energy sources (e.g., backup generators or renewable energy). Economic activities would slow down, and essential services would operate on emergency power supplies:

c) Severe Consequences. Description: Major and prolonged disruptions that substantially impair energy supply and national economic activity. Impact on Power Infrastructure: Severe damage to multiple power plants, major transmission lines, or grid control systems. Large regions of the country could face long-term blackouts, drastically affecting both civilian life and military operations. Example: A missile strike that disables a major power plant and knocks out significant portions of the grid for weeks. Industrial production would halt, essential services like hospitals would be stretched thin on emergency power, and public morale would be affected. Long-term power outages also weaken the ability of a country to defend itself, as military bases and communication systems rely on consistent power:

d) Catastrophic Consequences. Description: Systemic collapse of the power supply system, leading to national power failure, economic collapse, and severe humanitarian crises. Impact on Power Infrastructure: Total destruction of critical power infrastructure, including power plants, transmission lines, and control systems. The country faces a prolonged inability to generate or distribute electricity on a national scale, affecting every aspect of life, including communication, healthcare, food supply

chains, and military operations. Example: During the Ukraine war, large-scale attacks on power grids have led to widespread outages across the country. In some cases, power cuts lasted for extended periods, affecting millions of civilians. A complete and sustained attack on Ukraine's power grid could have led to catastrophic failure, plunging entire regions into darkness, severely disrupting military command structures, food production, healthcare, and water supply.

Factors Contributing to Consequences:

• Targeting of Key Infrastructure: Direct attacks on power plants, substations, and transmission lines during conflicts are common, leading to widespread outages;

• Cyberattacks: Power grids are increasingly vulnerable to cyberattacks, which can paralyze national systems without physically destroying infrastructure;

• Geographic Concentration of Energy Assets: Countries reliant on a few large power plants are more vulnerable to catastrophic consequences if these plants are targeted during war;

• Backup and Renewable Energy: The availability of renewable energy sources (e.g., solar, wind) and backup systems (e.g., generators) can mitigate some of the impacts, but widespread damage can overwhelm these measures.

Historical Examples:

• Ukraine Conflict: Ukraine's power grid has been a constant target during the ongoing war, with missile strikes and cyberattacks causing widespread blackouts. The loss of power affects heating, medical services, food storage, and overall civilian survival;

• Syria: In the Syrian civil war, power plants and transmission infrastructure were frequently targeted, leading to severe blackouts that exacerbated humanitarian crises.

In conclusion, the impact on power supply systems and electricity sources during wartime can range from *moderate* to *catastrophic*, depending on the extent of the damage, the duration of the conflict, and the nation's ability to recover or protect its critical infrastructure.

4. Assessment of the consequences of the impact on the operation of information systems and databases during the war. Assessing the consequences of disruptions to information systems and databases during wartime, using the Consequences Framework-Insignificant, Moderate, Severe, and Catastrophic – reveals how essential information infrastructure impacts both civilian and military operations (NATO and European Union release final assessment report on resilience of critical infrastructure, 2023, Events, 2024, Cyber War and Ukraine, 2022, Ukraine War, 2025). The integrity of data systems is critical to communication, decision-making, logistics, and national security:

a) Insignificant Consequences. Description: Minor and temporary disruptions with limited impact on the overall functionality of information systems. Impact on Information Infrastructure: Localized or short-term interruptions that affect non-critical databases or services. Systems can be restored quickly with minimal data loss or downtime. Example: A temporary loss of access to local government databases or minor disruptions to non-essential services such as municipal websites. While inconvenient, these disruptions would not hinder national security, public safety, or military operations;

b) Moderate Consequences. Description: Disruptions that impact critical systems but can be mitigated through alternate systems or timely recovery. Impact on Information Infrastructure: Loss of access to important databases or information systems that could delay decision-making or military operations, but backups and redundancies prevent long-term data loss or irreparable damage. Example: A cyberattack on a government database that temporarily hinders communication between government agencies or delays supply chain logistics for military or humanitarian aid. Though operations are slowed, data recovery processes and contingency plans ensure that the system is restored within a few days;

c) Severe Consequences. Description: Significant and sustained disruptions affecting key databases and information systems, with major impacts on national security, military command, or public services. Impact on Information Infrastructure: Loss or corruption of sensitive information, extended downtime of critical systems, and inability to coordinate military operations or public services. There would be

major impacts on both civil and military decision-making. Example: A prolonged cyberattack or physical destruction of data centers responsible for military communication or government command structures. This could paralyze real-time decision-making, disrupt logistics and supply chains, and impact emergency response systems. Data theft or corruption could compromise national security and expose vulnerabilities;

d) Catastrophic Consequences. Description: Total or near-total collapse of key information systems and databases, leading to widespread failure of national infrastructure and security. Impact on Information Infrastructure: Destruction or permanent loss of critical national databases, including those related to military operations, energy grids, healthcare, and communication systems. The consequences include the inability to coordinate national defense, manage civilian crises, or provide essential public services. Example: A full-scale cyber or physical attack that completely wipes out a nation's data centers and backups, destroying all communication networks, banking systems, transportation coordination, and public service management systems. This would result in widespread chaos, economic collapse, and potentially the loss of national sovereignty as the country would be unable to defend itself or maintain basic infrastructure.

Factors Contributing to Consequences:

• Targeting of Key Systems: Cyberattacks and physical destruction of data centers, especially those housing military, government, or financial data, significantly increase the likelihood of severe or catastrophic consequences;

• Cybersecurity Deficiencies: Lack of adequate protection, such as encryption and redundancy in critical infrastructure, can accelerate the severity of consequences;

• Reliance on Digital Systems: Countries that are highly digitized and rely on interconnected information systems are more vulnerable to severe disruptions.

Historical Examples:

• Ukraine Cyberattacks (2017): The "NotPetya" cyberattack crippled many Ukrainian systems, affecting banks, energy companies, and government services, leading to millions in damages and highlighting the vulnerability of critical infrastructure to digital threats;

• Estonia (2007): Estonia experienced one of the earliest widespread cyberattacks targeting government and banking systems, severely impacting national operations and underscoring the need for robust cybersecurity in modern conflicts.

In conclusion, the consequences of attacks on information systems and databases during wartime can range from *moderate* to *catastrophic*, depending on the nature and extent of the disruption. The loss of critical data or the inability to maintain operational systems could result in national security vulnerabilities, economic collapse, and widespread disruption of essential services.

5. Determination of the consequences of the impact on the work of space research centers and satellite communication stations during the war. Assessing the consequences of disruptions to space research centers and satellite communication stations during wartime, using the Consequences Framework (Insignificant, Moderate, Severe, Catastrophic), involves understanding the critical role these infrastructures play in communications, military operations, and national security (NATO's approach to space, 2024, Protecting our critical satellite infrastructure, 2023, ITU Journal explores fast-approaching future of satellite communications, 2024, Report of the International Telecommunication Union, 2021, Case studies on the impact of satellite disruption during the Russia-Ukraine War, 2022, Hacking the Cosmos, 2024).

a) Insignificant Consequences. Description: Minor and localized impacts that cause temporary disruptions without severely affecting operations. Impact on Space Infrastructure: Minor damage to non-critical satellite systems or space research centers. Temporary loss of communication with satellites or interruptions in space research activities. Example: A brief interruption in non-essential satellite communication systems used for academic or exploratory purposes. Research activities might be delayed, but overall, these disruptions would not affect military operations or national infrastructure;

b) Moderate Consequences. Description: Disruptions that affect the availability of satellite communications or research data but can be mitigated through backup systems. Impact on Space Infrastructure: Loss of some satellite communications or degradation in the quality of data provided by space research centers. Military and civilian communication systems could experience delays, but redundancies or other satellite networks would mitigate long-term impacts. Example: A temporary attack on a satellite ground station that delays space-based research or communication between military units. While some delays in satellite imagery or communications could occur, alternative satellite links could keep key operations running, though not at full efficiency;

c) Severe Consequences. Description: Significant disruptions that impair communication and space-based operations, including the military and critical civilian services. Impact on Space Infrastructure: Loss of critical satellite communications or permanent damage to space research centers that are central to national defense, weather forecasting, and global positioning systems (GPS). The ability to gather intelligence and coordinate military operations could be compromised. Example: A missile attack on a satellite ground control station that controls GPS or military communications satellites, causing widespread delays in military coordination and disrupting civilian services that depend on GPS (e.g., transportation, emergency services). This could lead to the degradation of military performance and a slower response to civilian crises;

d) Catastrophic Consequences. Description: Complete failure of satellite communication networks or space research capabilities, leading to national and military paralysis. Impact on Space Infrastructure: Destruction of multiple satellites or satellite communication stations, leading to the permanent loss of communication channels, intelligence-gathering capabilities, and critical services like GPS. The country would lose its ability to operate efficiently in both military and civilian sectors. Example: A coordinated attack that destroys key satellite communication centers or space research facilities, resulting in the total loss of satellite-based military communication, reconnaissance, and weather data. This could cripple a nation's defense capabilities and lead to catastrophic consequences for military strategy, national security, and civil coordination.

Factors Contributing to Consequences:

• Reliance on Space-based Systems: Countries with a high reliance on satellite communications for military, economic, and civilian operations are more vulnerable to severe or catastrophic consequences;

• Redundancy in Satellite Networks: Nations with multiple layers of satellite networks and backup systems can mitigate the risk of total failure, reducing the likelihood of severe consequences;

• Vulnerability to Cyberattacks: Space systems are vulnerable to cyberattacks, which can disrupt or take control of satellites, leading to significant or catastrophic outcomes depending on the target.

Historical Examples:

• Ukraine Conflict: Russia has targeted Ukrainian satellite communications during the war, disrupting military communications and affecting command and control capabilities. Despite these attacks, Ukraine's ability to access alternative satellite systems, including Starlink, has helped mitigate catastrophic consequences;

• Gulf War (1991): U.S. forces relied heavily on satellite communications and GPS to conduct operations. A similar attack on those systems would have severely impacted coordination and effectiveness, demonstrating the strategic importance of space-based infrastructure.

In conclusion, disruptions to space research centers and satellite communication stations during wartime can range from *moderate* to *catastrophic*, with the worst-case scenario resulting in a total breakdown of military and civilian communications, intelligence, and navigation systems.

6. Determination of the consequences of the impact on the work of educational institutions, universities and research institutes during the war. Assessing the consequences of the impact on educational institutions, universities, and research institutes during wartime, using the Consequences Framework (Insignificant, Moderate, Severe, Catastrophic), helps understand how disruptions in the

educational sector affect society, knowledge production, and long-term national development (Journalists in the midst of full-scale war: report on Ukraine, 2024, Emergency international assistance to Ukraine, 2022, Ukraine, 2024, Identify and reduce risks related to attacks on education, 2023, Education under attack, 2024).

a) Insignificant Consequences. Description: Minor disruptions that do not significantly alter the institution's ability to provide education and conduct research. Impact on Educational Institutions: Some temporary closures or minor damage to infrastructure, but classes and research activities continue through alternative methods, such as online education or temporary relocation. Example: Brief interruptions in university operations due to localized threats or temporary evacuations. Educational institutions shift to remote learning with minimal disruption to students' academic progress;

b) Moderate Consequences. Description: More substantial disruptions that affect a portion of educational services or research activities, leading to temporary setbacks. Impact on Educational Institutions: Extended closures of schools or research centers in affected areas, with limited capacity for online or alternative instruction. Research projects may be delayed or lose funding due to instability. Example: Universities in conflict zones may have to pause in-person classes, forcing students to rely on sporadic online learning. Research activities, especially those requiring physical laboratories or international collaboration, are delayed. However, efforts to restore education continue through relocation or digital platforms, though with lower effectiveness;

c) Severe Consequences. Description: Major disruptions that significantly hinder educational operations and research, affecting a broad portion of the country's educational system. Impact on Educational Institutions: Prolonged closures of multiple universities and research centers, with the destruction of infrastructure and equipment. The education system may face long-term setbacks, impacting the quality of education and the ability to conduct critical research. Example: During the war, the destruction of several university campuses and research facilities leads to a dramatic reduction in available educational services. This affects hundreds of thousands of students and researchers, leaving an entire generation with gaps in their education and limited access to research opportunities. The disruption of research affects national innovation and technological development;

d) Catastrophic Consequences. Description: Total or near-total collapse of educational and research infrastructure, leading to a significant decline in the country's knowledge production and human capital development. Impact on Educational Institutions: Widespread destruction of educational infrastructure, including universities, research centers, and schools, leading to the permanent closure of key institutions. A generation of students and researchers may be left without access to formal education or the ability to conduct research. Example: Entire regions lose access to education for extended periods due to bombings or military occupation. Research institutions, including those focused on critical fields like medicine, engineering, or agriculture, are destroyed, affecting long-term national development and technological progress. The intellectual capital of the country suffers, potentially leading to a "brain drain" as academics and students leave the country in search of stability.

Factors Contributing to Consequences:

• Access to Online Education: The ability of institutions to rapidly shift to remote learning can mitigate the consequences of physical damage to campuses;

• Global Research Collaboration: International support and partnerships with foreign universities may help sustain research projects disrupted by the war;

• Destruction of Intellectual Capital: The loss of faculty, researchers, and students due to death, displacement, or emigration leads to long-term consequences in the rebuilding of educational systems.

Historical Examples:

• Ukraine (2022): Many universities in conflict zones faced severe disruptions during the Russian invasion. Some institutions moved to remote learning, while others had to halt operations entirely due to the destruction of facilities or the displacement of students and faculty;

• World War II: In many parts of Europe, universities and research centers were bombed, leading to a temporary collapse of higher education in affected areas. Some scientists and academics fled, leading to the loss of intellectual capital for decades.

In conclusion, the consequences of the impact on educational institutions, universities, and research institutes during wartime can range from *moderate* to *catastrophic* depending on the extent of the damage and the country's ability to adapt. Long-term consequences include disruptions to human capital development, technological innovation, and national progress.

7. Determination of the consequences of the impact on the operation of logistics transport systems, maintenance stations, and refueling during wartime. Assessing the consequences of the impact on logistics transport systems, maintenance stations, and refueling infrastructure during wartime is crucial for understanding how disruptions can affect military operations, civilian mobility, and supply chains. The consequences can be categorized as Insignificant, Moderate, Severe, or Catastrophic depending on the extent of the damage and the reliance on these systems (Caramuta C., Grosso A., Longo G., 2023, Ti R., Kinsey Ch., 2023, Understanding World War II Logistics Operations, 2024, Algire K. D., 1951, Global driver shortages, 2022):

a) Insignificant Consequences. Description: Minor disruptions that cause temporary delays in transportation or maintenance but do not significantly impact overall logistics operations. Impact on Logistics Systems: Short-term disruptions in transport routes or maintenance facilities, with backup systems or alternative routes quickly mitigating the effects. Refueling infrastructure remains largely intact, allowing continued operations with minimal delay. Example: A small maintenance station being temporarily shut down due to a local attack, causing minor delays in vehicle repairs, but the impact on broader logistics operations is minimal as other facilities take over;

b) Moderate Consequences. Description: More significant disruptions that delay the movement of goods, troops, and essential supplies but can still be managed with contingency plans. Impact on Logistics Systems: Prolonged closures of key transport routes, fuel shortages at some refueling stations, or limited access to maintenance facilities. Some delays in transporting military supplies or humanitarian aid, but alternate transport routes or facilities may be available. Example: A major road or railway is damaged due to military actions, causing delays in the transport of fuel or food supplies. Maintenance stations may face challenges in repairing vehicles due to damaged infrastructure, but operations continue at a slower pace through alternative methods;

c) Severe Consequences. Description: Widespread disruptions in logistics and transport operations that severely affect the ability to move troops, military supplies, and civilian goods. The supply chain becomes strained, impacting military and civilian operations alike. Impact on Logistics Systems: The destruction of key transportation hubs such as bridges, railways, or highways. Multiple refueling stations and maintenance facilities may be damaged or destroyed, leading to significant delays in the movement of goods and troops. Supply chains experience bottlenecks, leading to shortages of fuel, food, and critical equipment. Example: An airstrike targeting a major highway or railway hub, effectively cutting off a key supply route. Refueling stations in the region may be destroyed, causing fuel shortages that halt military convoys and civilian transport. Maintenance stations face a backlog of vehicles in need of repair, further slowing logistics operations;

d) Catastrophic Consequences. Description: Total collapse of logistics, transport, and refueling systems, leading to an inability to sustain military or civilian operations. Supply chains break down entirely, leading to widespread shortages of essential goods and services. Impact on Logistics Systems: The destruction of multiple critical infrastructure points such as roads, bridges, railways, refueling stations, and maintenance facilities. Transportation of goods, fuel, and military supplies becomes impossible, leading to severe consequences for both military strategy and civilian life. The inability to repair vehicles or refuel them exacerbates the crisis, halting operations entirely. Example: A strategic campaign targeting all major transport and logistics hubs within a region, cutting off the ability to transport military supplies and humanitarian aid. Maintenance facilities and fuel depots are

systematically destroyed, leading to a complete breakdown in the logistics network. Military operations grind to a halt, and civilian populations suffer from shortages of food, water, and medical supplies.

Factors Contributing to Consequences:

• Reliance on Specific Routes: Areas that rely heavily on specific transport routes or refueling stations are more vulnerable to severe or catastrophic consequences if these are destroyed;

• Logistical Redundancy: Countries or regions with redundant logistics networks, alternative transportation routes, or mobile refueling and maintenance capabilities are better able to mitigate the impact of disruptions;

• Geographic Vulnerability: The geographic spread and terrain of a country affect how easily logistics systems can be disrupted or rerouted.

Historical Examples:

• Russia-Ukraine War (2022): Logistics infrastructure, including fuel depots and railway lines, has been heavily targeted, leading to severe delays in military supply chains and shortages of critical goods. The destruction of key transport routes has caused significant logistical bottlenecks for both military and humanitarian efforts;

• World War II: The strategic bombing of transport infrastructure, including railways, bridges, and fuel depots, was a key tactic used to weaken the enemy's ability to move troops and supplies. In some cases, the destruction of logistics systems led to catastrophic consequences for military operations and civilian populations.

In conclusion, the consequences of disruptions to logistics transport systems, maintenance stations, and refueling infrastructure during wartime can range from *moderate* to *catastrophic*, with the worst-case scenarios leading to the total breakdown of supply chains and severe shortages of essential goods and services for both military and civilian needs.

8. Determination of the consequences of the impact on the operation of communication systems (mobile communications, telephony, radio, television) during the war. Consequences Defined (Insignificant, Moderate, Severe, Catastrophic) (Pytlak A., Lad Sh., 2024, ITU issues warning on interference with radio navigation satellite service, 2022, Duguin S., Pavlova P., 2023). The consequences of disruptions to communication systems (mobile communications, telephony, radio, television) during wartime can have varying levels of severity, ranging from Insignificant to Catastrophic, depending on the scale of the impact and the availability of alternatives:

a) Insignificant Consequences. Description: Minor interruptions in communication systems that are quickly resolved, with limited impact on both military and civilian operations. Impact on Communication Systems: Short-term outages of mobile or radio services in specific areas, but redundant systems or backup methods ensure that communication is restored quickly. Example: A temporary disruption in mobile communication services in a city due to a localized attack on a cell tower. Communication is quickly restored through other towers or emergency backup systems;

b) Moderate Consequences. Description: Disruptions that affect communication in certain regions or for certain users, but overall communication infrastructure remains functional. Impact on Communication Systems: Loss of communication in specific regions due to damaged infrastructure (cell towers, radio stations, etc.), with delays in the dissemination of information. Military or civilian coordination is hampered, but alternative methods such as satellite phones or emergency broadcasting systems mitigate the impact. Example: A radio station being destroyed by a bombing, leading to a temporary blackout in local news and information. Military and emergency services face delays in coordinating efforts but are able to adapt using alternate communication channels;

c) Severe Consequences. Description: Widespread communication outages that significantly impair the ability of military forces to coordinate, or disrupt civilian communication on a broad scale. Impact on Communication Systems: Major disruption to mobile networks, radio, and television services across a large region, resulting in an inability to quickly disseminate critical information to both military and civilian populations. Delays in command-and-control functions, emergency responses, and public

announcements occur. Example: Large-scale attacks on communication infrastructure, such as bombing of multiple cell towers and broadcast stations, leading to widespread outages. This creates confusion among the public, limits access to news and emergency alerts, and significantly impairs military coordination;

d) Catastrophic Consequences. Description: Total or near-total collapse of communication systems, leading to an inability to coordinate military operations and a breakdown in civilian communication. Impact on Communication Systems: Destruction of critical national infrastructure such as telecommunications hubs, satellite communication systems, and broadcasting facilities. The country is effectively cut off from both internal and external communication, which can lead to a breakdown in military command structures, emergency responses, and the spread of vital information to the population. Example: A coordinated series of cyberattacks and physical bombings that target the backbone of national telecommunications networks. Mobile communications, television, radio, and the internet are rendered inoperative, leading to widespread panic, inability to coordinate military defense efforts, and leaving citizens without access to emergency services or critical information.

Factors Contributing to Consequences:

• Availability of Backup Systems: Countries with robust emergency communication protocols, such as satellite phones or alternative broadcasting systems, can better mitigate severe or catastrophic disruptions;

• Redundancy in Infrastructure: If communication networks have sufficient redundancy (e.g., overlapping cell towers or multiple broadcasting stations), the impact of individual attacks is minimized;

• Resilience of Cyber Infrastructure: Cyberattacks during war can target communication networks, causing disruptions without physically destroying infrastructure. The resilience of digital systems becomes critical in such scenarios.

Historical Examples:

• Ukraine Conflict (2022): During the war in Ukraine, communication systems were repeatedly targeted by physical attacks and cyber warfare, leading to widespread disruptions in mobile and internet services. However, the use of satellite internet (e.g., Starlink) helped to maintain some communication capabilities in affected areas;

• World War II: Radio stations and communication lines were key targets during the war. In many instances, bombing raids destroyed broadcasting stations, cutting off entire populations from information.

In conclusion, the consequences of disrupting communication systems during wartime can range from *insignificant* to *catastrophic* depending on the extent of the damage and the nation's ability to deploy alternative systems. The breakdown of these systems can lead to severe communication gaps, impacting both military operations and civilian life.

9. Determination of the consequences for the work of medical institutions, pharmacies and clinics during the war. Consequences Defined (Insignificant, Moderate, Severe, Catastrophic) (Ri et all, 2019, Expert Report: Russia's Attacks on Health Care in Syria, 2024, What we see in times of war and conflict, 2021, Year in Review 2023, 2023). The consequences of disruptions to medical institutions, pharmacies, and clinics during wartime can be devastating, affecting the healthcare system's ability to treat the wounded, provide regular medical care, and ensure public health. These consequences can be classified as Insignificant, Moderate, Severe, or Catastrophic, depending on the extent of damage and the system's capacity to cope with disruptions:

a) Insignificant Consequences. Description: Minor disruptions with a limited impact on the ability of medical institutions to function. Healthcare services are slightly delayed but continue to operate, and alternative facilities or backup systems manage the situation effectively. Impact on Healthcare: Small clinics or pharmacies may experience temporary shortages of supplies or personnel, but larger

hospitals remain functional, and critical care is not interrupted. The effects are localized and quickly resolved. Example: A local pharmacy is temporarily closed due to a supply chain disruption, but patients can still access medication from nearby facilities, and essential services continue without major setbacks;

b) Moderate Consequences. Description: Significant disruptions that lead to delays or partial shutdowns of medical services, but the healthcare system can still manage critical cases and emergencies. Impact on Healthcare: Some hospitals or clinics may be damaged, reducing their capacity to treat patients. Supply chain disruptions may cause shortages of medications or medical equipment. Non-urgent care may be postponed, but emergency services continue to operate. Example: A regional hospital loses power after an airstrike, relying on backup generators to maintain critical care services. Non-essential surgeries are delayed, and there are shortages of certain medications, but life-threatening cases are still handled;

c) Severe Consequences. Description: Widespread disruptions across multiple medical facilities, causing significant delays or breakdowns in healthcare services. The healthcare system struggles to provide necessary care, and patients face substantial risks. Impact on Healthcare: Major hospitals may be destroyed or severely damaged, leading to the collapse of critical care services in certain regions. Shortages of medical personnel, equipment, and drugs become common, and the system is overwhelmed by the volume of casualties. Both emergency and routine care are heavily affected. Example: A series of attacks targets several hospitals and clinics in a major city, resulting in the shutdown of emergency services. Clinics are overwhelmed, and there is a severe lack of medical supplies, causing delays in treatment for the injured and a rise in preventable deaths;

d) Catastrophic Consequences. Description: The total collapse of the healthcare system in affected areas, with an inability to provide basic medical services. This leads to large-scale loss of life and worsening public health crises. Impact on Healthcare: The destruction of hospitals, clinics, and pharmacies across wide areas means no access to emergency care, surgeries, or routine medical treatment. Critical shortages of medical supplies, staff, and infrastructure result in the system's inability to cope with the volume of injuries, disease outbreaks, and routine health needs. The death toll rises dramatically, and diseases spread unchecked. Example: A prolonged military campaign results in the destruction of all major hospitals in a region, leaving thousands without access to medical care. The lack of functional clinics, combined with outbreaks of infectious diseases, creates a public health disaster, with widespread loss of life.

Factors Contributing to Consequences:

• Geographical Impact: Areas with a higher concentration of healthcare facilities may face less severe consequences due to redundancy, while rural or isolated regions may experience catastrophic outcomes from even minor disruptions;

• Logistical and Supply Chain Disruptions: During war, the destruction of transport routes and supply chains can prevent the delivery of medical supplies, exacerbating shortages;

• International Humanitarian Aid: In some cases, international organizations may provide emergency medical assistance, which can mitigate severe or catastrophic consequences, but this is not always guaranteed or sufficient.

Historical Examples:

• Syria Civil War: Targeted attacks on hospitals in conflict zones led to the near-total collapse of healthcare services in some regions, with many hospitals and clinics bombed or forced to close. The humanitarian toll was severe, as civilians lacked access to critical care and medical supplies;

• Yemen Conflict: Similar attacks on healthcare facilities in Yemen have left millions without access to basic medical care, contributing to one of the worst humanitarian crises in the world, with widespread disease and malnutrition.

In summary, the consequences of disruptions to medical institutions, pharmacies, and clinics during wartime can range from *insignificant* to *catastrophic*, depending on the scale of the attack and the

system's resilience. In the worst-case scenario, the collapse of the healthcare system leads to widespread loss of life, disease outbreaks, and a severe public health crisis.

10. The consequences of disruptions to water supply systems and sewage infrastructure during wartime can have severe and widespread effects on both public health and safety. These consequences can be classified into Insignificant, Moderate, Severe, and Catastrophic, depending on the scale of the damage and the capacity of the system to recover (WHO Global water, sanitation and hygiene Annual report 2022, 2022, World health statistics 2024, 2024, Timothy Grieve (UNICEF), 2019, Water and conflict, 2024):

a) Insignificant Consequences. Description: Minor disruptions in the water supply or sewage systems, which are quickly resolved without major public health risks or interruptions to daily life. Impact on Water and Sewage Systems: Localized issues such as small-scale contamination or minor interruptions to water supply in a limited area. The system has sufficient backup mechanisms or alternative sources to address the issue without causing long-term problems. Example: Temporary water outages in a neighborhood due to damage to a single water pipeline. Backup systems, such as water trucking or alternative wells, are used until repairs are completed;

b) Moderate Consequences. Description: More significant disruptions affecting water access for a larger portion of the population, with potential for temporary public health risks due to limited access to clean water or functional sewage systems. Impact on Water and Sewage Systems: Partial disruption of the water supply network, leading to water rationing or limited access in certain regions. Sewage systems may become overwhelmed, leading to localized outbreaks of waterborne diseases, though most critical services remain functional. Example: A regional pumping station is damaged, leading to water shortages across a city. Temporary water supplies are provided by emergency services, but rationing is implemented, and some areas face contamination issues as sewage systems struggle;

c) Severe Consequences. Description: Widespread damage to water and sewage systems, causing large-scale health risks, including waterborne diseases, and significant disruption of daily life. The healthcare system becomes overwhelmed with disease outbreaks linked to contaminated water. Impact on Water and Sewage Systems: Major pipelines or treatment plants are destroyed, leading to a collapse of the water supply in several regions. Sewage overflows into urban areas, spreading diseases like cholera and dysentery. Emergency responses are delayed, and long-term reconstruction efforts are required. Example: Bombing of a water treatment facility leads to a severe contamination of water supplies. Hospitals report large numbers of patients with waterborne illnesses, and the government is forced to rely on international humanitarian aid for water and sanitation;

d) Catastrophic Consequences. Description: Total or near-total collapse of water supply and sewage systems, with devastating impacts on public health and the survival of affected populations. Long-term humanitarian crises emerge due to the unavailability of clean water and adequate sanitation. Impact on Water and Sewage Systems: Entire regions are left without access to clean water or functioning sewage systems for extended periods. Epidemics of waterborne diseases spread rapidly, and there is widespread death and displacement due to the lack of safe drinking water. Recovery requires massive international aid and long-term rebuilding efforts. Example: A complete destruction of a country's main water supply infrastructure during war leads to a national water crisis. Millions are left without clean drinking water, leading to a significant increase in mortality due to diseases such as cholera. The situation becomes a major international humanitarian disaster, requiring coordinated relief efforts from multiple countries and organizations.

Factors Contributing to Consequences:

• Pre-existing Infrastructure Resilience: Systems that are already under strain or outdated may suffer greater consequences from wartime disruptions. More modern or well-maintained systems may be better able to withstand and recover from attacks;

• Availability of Alternative Water Sources: Regions with multiple water sources, such as rivers, lakes, or wells, may be less affected than those dependent on a single centralized system;

• International Aid: In some cases, international aid can mitigate the worst effects of water supply disruptions by providing bottled water, water purification tablets, or mobile treatment plants;

• Public Health Preparedness: The presence of public health interventions, such as vaccinations and rapid response teams, can reduce the spread of waterborne diseases, lessening the severity of the impact.

Historical Examples:

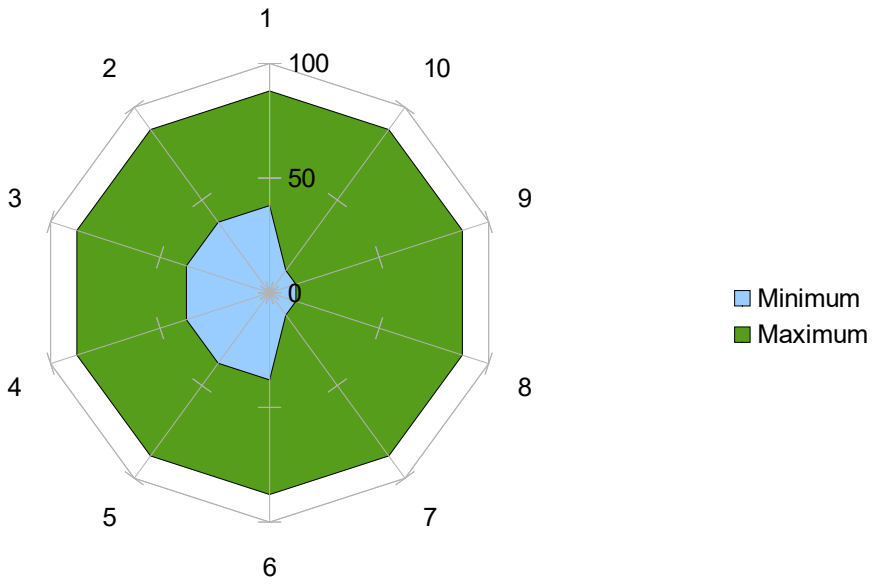
• Syria Conflict: During the Syrian Civil War, repeated attacks on water treatment plants led to severe water shortages in cities like Aleppo, where public health crises emerged due to contaminated water supplies and a lack of functional sewage systems;

• Yemen Crisis: The destruction of water infrastructure in Yemen has resulted in one of the largest cholera outbreaks in modern history, with millions affected by contaminated water and lack of sanitation facilities.

In conclusion, the consequences of disrupting water supply and sewage systems during wartime can range from *insignificant* to *catastrophic*, depending on the scale of the disruption and the population's access to alternative water sources. The breakdown of these systems can lead to widespread public health crises, including deadly outbreaks of waterborne diseases.

CONCLUSIONS

The results of the study showed that the negative impact of Russian military actions in Ukraine in the period from 2014 to 2025 ranges from minor to catastrophic (8-10 points) and from moderate to catastrophic, depending on the circumstances, as well as depending on the degree of damage caused and the country's ability to adapt.



Pic. 1. Generalized results of studies of the consequences of the impact of military actions in Ukraine for 2014-2025

Source: formed by the authors

Pic. 1 shows a diagram of the distribution of the consequences of military actions on critically important objects of the Ukrainian economy. In Pic. 1, the minimum and maximum are indicated based on the data indicated in Table 1 for the corresponding ranges of indicators in consequence points for each object under study.

REFERENCES

Berezutskiy V., Tokhtamysh T. (2024) Risks of critical infrastructures during war. *Law and innovative society, 2*(23). 55-70 DOI 10.37772/2309-9275-2024-2(23).

Johnivan J.R.(2024).Risk Assessment Matrix: What It Is and How to Use It. 16 February 2024 https://project-management.com/risk-assessment-matrix/.

Aljohani T. M. (2022). Cyberattacks on Energy Infrastructures: Modern War Weapons. http://dx.doi.org/10.48550/arXiv.2208.14225

Ten C. W., Yamashita K., Yang Z., Vasilakos A. V., Ginter A. (2018). Impact Assessment of Hypothesized Cyberattacks on Interconnected Bulk Power Systems. IEEE Transactions on Smart Grid, No 9(5). 4405-4425. https://doi.org/10.48550/arXiv.1801.01048.

Dietrich O., Peters T., Sainte Fare Garnot V., Sticher V., Ton-That Whelan T., Schindler K., Wegner J. D. (2024). An Open-Source Tool for Mapping War Destruction at Scale in Ukraine using Sentinel-1 Time Series. http://dx.doi.org/10.48550/arXiv.2406.02506.

Durojaye H., Raji O. (2022). Impact of State and State-Sponsored Actors on the Cyber Environment and the Future of Critical Infrastructure. http://dx.doi.org/10.13140/RG.2.2.36453.06883.

Environmental Impact of the Russian Invasion of Ukraine. (2025). Wikipedia, The Free Encyclopedia. https://en.wikipedia.org/wiki/Environmental_impact_of_the_Russian_invasion_of_Ukraine.

Impact of the Russian Invasion of Ukraine on Nuclear Power Plants. (2025).Wikipedia, The Free Encyclopedia. https://en.wikipedia.org/wiki/Impact_of_the_Russian_invasion_of_Ukraine_on_nuclear_power_plants.

Zaporizhzhia Nuclear Power Plant Crisis. (2025). Wikipedia, The Free Encyclopedia. https://en.wikipedia.org/wiki/Zaporizhzhia_Nuclear_Power_Plant_crisis.

Destruction of the Kakhovka Dam. (2025). Wikipedia, The Free Encyclopedia. https://en.wikipedia.org/wiki/Destruction_of_the_Kakhovka_Dam.

Environmental Impact of War. (2025). Wikipedia, The Free Encyclopedia. https://en.wikipedia.org/wiki/Environmental_impact_of_war.

2015 Ukraine Power Grid Hack. (2025). Wikipedia, The Free Encyclopedia. https://en.wikipedia.org/wiki/2015_Ukraine_power_grid_hack.

ChatGPT. https://chatgpt.com/c/670d6c53-368c-8012-9e4a-f26a60a330e1.

Report on the European Central Bank – annual report 2023 (2023) https://www.europarl.europa.eu/doceo/document/A-9-2023-0412_EN.html/

Cybersecurity studies from the World Economic. Reports (2025). 13 January 2025 https://www.weforum.org/publications/global-cybersecurity-outlook-2025/.

Post-war Reconstruction: Case Studies. Experience of damage assessment and reconstruction organization (2022). 1 June 2022 https://kpmg.com/ua/en/home/insights/2022/12/post-war-reconstruction-of-economy-case-studies.html.

Conflict and hunger (2021). https://www.wfp.org/conflict-and-hunger.

Global Report on Food Crises (GRFC) 2024 (2024). https://www.wfp.org/publications/global-report-food-crises-grfc.

Reports and Documents, Protecting Civilians against Digital Threats during Armed Conflict: Final report of the ICRC's Global Advisory Board (2024). https://international-review.icrc.org/articles/reports-and-documents-protecting-civilians-against-digital-threats-during-armed-conflict-925.

The Syrian conflict: a case study of the challenges and acute need for medical humanitarian operations for women and children internally displaced persons (2018) 11 May 2018 https://bmcmedicine.biomedcentral.com/articles/10.1186/s12916-018-1041-7.

Case study on Humanitarian crisis in Syria (2023) 15 January 2023 https://moderndiplomacy.eu/2023/01/15/case-study-on-humanitarian-crisis-in-syria/

Ukraine's Energy Security and the Coming Winter An energy action plan for Ukraine and its partner (2024). https://iea.blob.core.windows.net/assets/cec49dc2-7d04-442f-92aa-54c18e6f51d6/UkrainesEnergySecurityandtheComingWinter.pdf.

Schweikert A., Nield L., Otto E., Deinert M. (2019) Resilience and Critical Power System Infrastructure. Lessons Learned from Natural Disasters and Future Research Needs https://documents1.worldbank.org/curated/

en/245911560800329681/pdf/Resilience-and-Critical-Power-System-Infrastructure-Lessons-Learned-from-Natural-Disasters-and-Future-Research-Needs.pdf

Ukraine's energy system under attack (2024). https://www.iea.org/reports/ukraines-energy-security-and-the-coming-winter/ukraines-energy-system-under-attack

NATO and European Union release final assessment report on resilience of critical infrastructure (2023). 23 June 2023 https://www.nato.int/cps/en/natohq/news_216631.htm?selectedLocale=en

Events (2024). https://www.csis.org/programs/strategic-technologies-program/events.

Cyber War and Ukraine (2022). 16 June 2022 https://www.csis.org/analysis/cyber-war-and-ukraine.

Ukraine War (2025). 29 January 2025 https://www.csis.org/topics/ukraine-war.

NATO's approach to space .(2024) 21 March 2024 https://www.nato.int/cps/en/natohq/topics_175419.htm.

Protecting our critical satellite infrastructure: the importance of space-based infrastructure to humanity and its status within NATO (2023). 24 October 2023 https://www.nato.int/docu/review/articles/2023/10/24/protecting-our-critical-satellite-infrastructure-the-importance-of-space-based-infrastructure-to-humanity-and-its-status-within-nato/index.html.

ITU Journal explores fast-approaching future of satellite communications (2024). 24 June 2024 https://www.itu.int/hub/2024/06/itu-journal-explores-fast-approaching-future-of-satellite-communications/.

Report of the International Telecommunication Union (ITU) on the use of the geostationary-satellite orbit (GSO) and other orbits (2021). https://www.unoosa.org/res/oosadoc/data/documents/2021/aac_105c_12021crp/aac_105c_12021crp_13_0_html/AC105_C1_2021_CRP13E.pdf.

Satellites in the Russia-Ukraine War (2024) https://media.defense.gov/2024/Aug/21/2003529805/-1/-1/0/20240822_Gurantz_Satellites_Online_b%201.PDF.

Hacking the Cosmos: Cyber operations against the space sector. A case study from the war in Ukraine (2024). 04 October 2024 https://css.ethz.ch/en/center/CSS-news/2024/10/hacking-the-cosmos-cyber-operations-against-the-space-sector-a-case-study-from-the-war-in-ukraine.html.

Journalists in the midst of full-scale war: report on Ukraine (2024). https://unesdoc.unesco.org/ark:/48223/pf0000389770?posInSet=2&queryId=N-EXPLORE-238d4718-3bff-4c42-96d3-45e2c1cb9ae8.

Emergency international assistance to Ukraine (2022) https://unesdoc.unesco.org/ark:/48223/pf0000386897?posInSet=4&queryId=N-EXPLORE-a891481c-78ee-42a9-bb05-d1b2d1ea059b.

Ukraine (2024). https://protectingeducation.org/wp-content/uploads/eua_2024_ukraine.pdf.

Identify and reduce risks related to attacks on education (2023). March 2023 https://protectingeducation.org/wp-content/uploads/Identify-and-Reduce-Risks-related-to-Attacks-on-Education.pdf.

Education under attack (2024). 27 December 2024 https://www.unicef.org/education-under-attack.

Caramuta C., Grosso A., Longo G. (2023) Logistics chain responsiveness to war impacts: A case study in North Adriatic Region. *Case Studies on Transport Policy, 14*. https://doi.org/10.1016/j.cstp.2023.101086.

Ti R., Kinsey Ch. (2023) Lessons from the Russo-Ukrainian conflict: the primacy of logistics over strategy. *Defence Studies. Vol. 23*, 381-398 https://doi.org/10.1080/14702436.2023.2238613.

Understanding World War II Logistics Operations: A Critical Analysis (2024). 27 April 2024 https://militarysaga.com/world-war-ii-logistics-operations/.

Kent D. Algire. Major logistics lessons of world war II (1951). *Naval War College Information Service for Officers, 3*(6), 25-43. https://www.jstor.org/stable/44794459?seq=1.

Global driver shortages: 2022 year in review (2022). 22 December 2022 https://www.iru.org/news-resources/newsroom/global-driver-shortages-2022-year-review

Pytlak A., Lad Sh. (2024) The International Telecommunications Union (ITU) and Cyber Accountability. 24 September 2024 https://www.stimson.org/2024/the-international-telecommunications-union-itu-and-cyber-accountability/

ITU issues warning on interference with radio navigation satellite service (2022). 23 August 2022 https://www.itu.int/hub/2022/08/warning-harmful-interference-rnss/

Duguin S., Pavlova P. (2023) The role of cyber in the Russian war against Ukraine: Its impact and the consequences for the future of armed conflict. https://www.europarl.europa.eu/RegData/etudes/BRIE/2023/702594/EXPO_BRI(2023)702594_EN.pdf

Ri S., Blair A. H., Kim Ch. J., Haar R. J. Attacks on healthcare facilities as an indicator of violence against civilians in Syria: An exploratory analysis of open-source data (2019). https://pubmed.ncbi.nlm.nih.gov/31181095/

Expert Report: Russia's Attacks on Health Care in Syria (2024). 24 May 2024 https://phr.org/our-work/resources/russias-attacks-on-health-care-in-syria/
What we see in times of war and conflict (2021). https://www.msf.org/war-and-conflict-depth
Year in Review 2023 (2024). 15 July 2024 https://www.msf.org/year-review-2023
WHO Global water, sanitation and hygiene Annual report 2022 (2022). https://iris.who.int/bitstream/handle/10665/372401/9789240076297-eng.pdf?sequence=1
World health statistics 2024. Monitoring health for the SDGs, Sustainable Development Goals. (2024). https://iris.who.int/bitstream/handle/10665/376869/9789240094703-eng.pdf?sequence=1
Timothy Grieve (UNICEF). Water Under Fire. Emergencies, development and peace in fragile and conflict-affected contexts (2019). https://www.unicef.org/media/58121/file/Water-under-fire-volume-1-2019.pdf
Water and Conflict: Addressing water insecurity issues in fragile and conflict-affected countries (2024). https://www.genevawaterhub.org/sites/default/files/atoms/files/unga78_side_event_on_water_and_conflict_summary_report.pdf

ОЦІНКА НАСЛІДКІВ ДЛЯ КРИТИЧНИХ СЕКТОРІВ В УКРАЇНІ В РЕЗУЛЬТАТІ ВІЙНИ 2014–2025 РОКІВ

Анотація. Дослідження оцінює наслідки ризиків для критичної інфраструктури, використовуючи метод матриці ризиків. Мета включає аналіз підходів до оцінки ризиків, вивчення руйнування критичної інфраструктури України та розробку методів оцінки потенційних загроз. Використано аналіз загроз, ймовірнісну оцінку ризиків та моделювання сценаріїв. У роботі розроблено підхід до оцінки ризиків для критичної інфраструктури з урахуванням військових загроз та кібербезпеки. Огляд висвітлює руйнування енергетичних та інфраструктурних об'єктів України, підкреслюючи необхідність посилення захисту. Дослідження кіберзагроз, зокрема кібератаки на енергомережу України у 2015 році, доводить необхідність сучасних заходів безпеки. Супутниковий аналіз виявився ефективним для оцінки збитків та планування відновлення. Також розглянуто екологічні наслідки війни, включаючи забруднення та руйнування природних територій. Отримані результати можуть допомогти у розробці стратегій відновлення та зменшенні вразливості інфраструктури. Дослідження також аналізує порушення роботи медичних установ, аптек та клінік під час війни, класифікуючи наслідки як незначні, помірні, серйозні або катастрофічні. Незначні збої викликають тимчасові перебої, тоді як серйозні випадки призводять до колапсу системи охорони здоров'я, впливаючи на екстрену та планову допомогу. Історичні приклади, такі як конфлікти в Сирії та Ємені, демонструють руйнівний вплив цілеспрямованих атак. Крім того, порушення водопостачання та каналізаційних систем створює значні ризики для здоров'я населення, потенційно спричиняючи спалахи захворювань. Оцінено вплив наслідків воєнного часу на освіту, університети та дослідницькі установи. Отримані висновки допоможуть політикам та екстреним службам пом'якшити наслідки воєнних дій.

Ключові слова: критична інфраструктура, ризики, кіберзагрози, війна, медичні установи, заклади освіти, водопостачання.

ASSESSMENT OF THE CONSEQUENCES FOR CRITICAL SECTORS IN UKRAINE AS A RESULT OF THE 2014–2025 WAR

Abstract. This study assesses the consequences of risks for critical infrastructure using the risk matrix method. Objectives include analyzing risk assessment approaches, examining the destruction of Ukraine's critical infrastructure, and developing evaluation methods for potential threats. The research employs threat analysis, probabilistic risk assessment, and scenario modeling. The study develops an approach to risk assessment for critical infrastructure, considering military threats and cybersecurity challenges. The review highlights the destruction of energy and infrastructure facilities in Ukraine, emphasizing the need for enhanced protection. Research on cyber threats, such as the 2015 cyberattack on Ukraine's power grid, demonstrates the necessity of modern security measures. Satellite analysis proves effective for assessing damage and planning recovery. The study also examines war-induced environmental damage, including pollution and destruction of natural areas. The findings can aid in developing restoration strategies and reducing infrastructure vulnerability. The study also explores wartime disruptions to medical institutions, pharmacies, and clinics, classified as Insignificant, Moderate, Severe, or Catastrophic. Minor disruptions cause temporary shortages, while severe cases lead to

healthcare system collapse, affecting emergency and routine care. Historical examples, such as conflicts in Syria and Yemen, highlight the devastating impact of targeted attacks. The impact of wartime impacts on education, universities and research institutions has been assessed. Additionally, disruptions to water supply and sewage systems pose major public health risks, potentially leading to widespread disease outbreaks. These insights help policymakers and emergency planners mitigate wartime disruptions.

Keywords: critical infrastructure, risks, cyber threats, war, medical institutions, educational institutions, water supply.

Cite this article: Berezutskyi, V. & Tokhtamysh, T. (2025). Assessment of the consequences for critical sectors in ukraine as a result of the 2014–2025 war. *Law and innovative Society, 1*(24), 63-82. doi: https://doi.org/10.37772/2309-9275-2025-1(24)-1.