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Preserving Science during Wartime

White Paper

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scienceatrisk.org



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Summary

This study is based on the experience of preserving science in Ukraine during the armed conflict with Russia that started in 2014 and escalated into a full-scale invasion in 2022. Preserving science during wartime is a comprehensive task, since the structure of challenges is often varied. In particular, it includes:

- Support of personal physical safety and psycho-emotional stability of scientists;
- Reintegration and engagement of scientists who have relocated abroad;
- Preservation of capable scientific teams and vectors, creation of new ones as a response to the challenges of the current times;
- Development of international scientific cooperation, scientific diplomacy, integration into the European and global scientific space;
- Preserving research infrastructure (in particular, historical and cultural infrastructure, museum heritage, archives, collections, etc.).

During this research, a series of in-depth semi-structured interviews and an online survey of Ukrainian scientists were conducted. Key recommendations include introducing flexible tools for supporting scientists and science teams, who are mostly in Ukraine and located in various parts of the territory, providing opportunities to continue research and adapt to the situation, creating tools and conditions for development of international partnerships and cooperation with businesses, civil society, local authorities, organizing measures to preserve archives, collections, cultural heritage. Data collection during wartime is also important. Volumes of destroyed and damaged research infrastructure, data on the movement of scientists inside and outside the country, the destruction of scientific groups and partnerships and the formation of new ones — these data will make it possible to make better, informed decisions and monitor their effectiveness, substantiate requests for assistance to international donors and lay the foundation for post-war reconstruction.

As the subject of preserving science is further studied, more attention should be paid to studying international experience of the science sector responding to armed conflicts, as well as natural and man-made disasters. Analyzing activities of networks of international actors focused on helping scientists in danger can provide more data about long-term consequences and best strategies for providing aid.

These recommendations can be useful for specialists who develop and implement the national policy in the science sector, for national and international agencies financing scientific research, for scholars who study the impact of armed conflicts on the science sector, and for everyone interested.

Introduction

Writing this book, the authors heard air raid alarms multiple times, and later, when power would go back on for a few hours, they would find out that yet another object of critical or civilian infrastructure has been damaged or destroyed. Such objects included universities, scientific institutions, museums, and archives. The biggest losses are the deaths of Ukrainians, including Ukrainian scientists and educators. Russia inflicts devastating blows not only on the military and energy infrastructure. Centers of culture, education, and science are being deliberately destroyed – this is how Russia is trying to destroy the future of Ukraine.

Russia's full-scale invasion of Ukraine, preceded by 8 years of war in the east of Ukraine and the annexation of Crimea, showed how difficult it is to preserve science during the war, and how the country and the world turned out not ready to tackle this challenge. There are no systemic responses to most challenges at the national level, and at the international level, they are adapted to a greater extent for scientists who are forced to leave their countries during crises and integrate from scratch in new places, often permanently. Considering that Ukraine is a large country, most scientists remain on its territory¹, and its purpose is to win and modernize, becoming a regional leader and an EU member. This approach is thus not viable.

Preserving science during wartime is a complex task that requires careful analysis, data collection, and learning from the experiences of those trying to take action. This study is a first step in that direction.

Outlining existing risks shows threats to the following:

- people and basic human needs – physical and psychological protection, living conditions, financial support;
- scientific teams;
- scientific topics and focus areas;
- scientific institutions and institutions of higher education, research infrastructure;
- libraries, archives, collections, etc.

1 Lutsenko A. et al The Results of The Survey on The Needs of Ukrainian Scientists (First Wave Report) Max Planck Institute for Innovation & Competition Research Paper № 23–03
https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4335098

It is also important to understand that the challenges of the war are exacerbated by the problems that existed in the scientific field before the crisis, the previous history (in the case of Ukraine, the war began in 2014 — and since then, there have been a number of unresolved problems), the institutional field and the capacity of specific organizations, etc.

Research methodology

This study was conducted by a working group of 8 people. Its composition was formed taking into account the principles of ensuring age, gender, professional (different scientific fields), organizational (higher education institutions (*HEIs*) and scientific institutions of the National Academy of Sciences (*NAS*) of Ukraine) and territorial diversity (cities of Ukraine).

This research entailed **a series of in-depth semi-structured interviews and online surveys of Ukrainian scientists in Ukraine and abroad.** During the research, the team created a sample of respondents for interviews and online surveys, particularly by using the method of convenience sampling and partially using probability sampling.

To assess the situation with preserving science during the war, the interviews and the survey were put together using 56 questions. The questions were grouped into the following thematic sections:

1. personal safety (physical and psycho-emotional);
2. ways of preserving the scientific team, establishing teamwork in war conditions and cooperation with partners (business, public organizations, grant programs);
3. preservation of scientific research, their purpose, duration, priority, and ways to present research findings in the scientific world, their promotion and preservation;
4. financing status (of institutions, projects; individual financial status);
5. preserving research infrastructure (preservation of historical and cultural (museum) heritage, archives, collections, etc.).

The team conducted **a series of in-depth semi-structured online interviews** with 15 scientists. There were 10 men and 5 women among the respondents. For the interview part, the team selected respondents from various areas of science, representing various research institutions and organizations, higher education institutions of various vectors and locations. The purpose of the interviews was to learn about the experience of preserving science during the war and obtain expert recommendations in this regard. Interviews were conducted online or by telephone with audio or video recording. The average duration of an interview was 30–60 minutes.

The interview texts were analyzed using the method of thematic analysis, which involves compiling a list of all the responses, identifying key ideas in the responses, identifying statements and citations reflecting key ideas, dividing the tags into four groups: a) peculiarities of a scientist's

work during the war; b) negative experience of the war impacting the development and preservation of science; c) new opportunities to preserve science during the war; d) preferred expectations and vectors of action to preserve and reboot science.

An **online survey of scientists** representing at least 26 scientific institutions and higher education institutions was conducted, **in which 46 Ukrainian scientists who are in Ukraine and abroad took part**, using the convenience sampling method and Google Forms. Among the respondents, half belong to the age group of 41–55 years, 31.3% — 26–40 years, 12.5% — over 67 years, 6.2% — 56–67 years. Survey dates: from November 27 to December 14, 2022.

Context. Legal conditions before and during the full-scale invasion

At the state level, scientific activity is regulated by the Constitution of Ukraine, as well as laws of Ukraine «On Scientific and Scientific-Technical Activities,»² «On Priority Branches of Science and Technology Development,» «On Scientific and Scientific Technical Expertise,» «On Scientific Parks,» «On Innovation Activity,» «On the Priority Directions of Innovation Activity in Ukraine,» and other regulatory acts.

Amendments to the framework law «On Scientific and Scientific-Technical Activities» that came into effect in 2016 provide for the operation of two new institutions. The National Research Fund has been launched and is currently operating. It provides grant funding for research based on competitive selection. In addition, the National Science and Technology Council, which is an advisory body at the level of the Cabinet of Ministers of Ukraine, is currently in operation.

The direction of European integration is of great importance for the development of Ukrainian science. According to Chapter 9 of Title V of the Association Agreement between the European Union and the European Atomic Energy Community and their Member States, of the one part, and Ukraine, of the other part, the Parties shall develop and strengthen their scientific and technological cooperation in order to contribute both to scientific development itself, and to reinforce their scientific potential for contributing to the resolution of national and global challenges. Ukraine's integration into the European Research Area (ERA) through the implementation of its priorities is laid down in the Law «On Scientific and Scientific-Technical Activities.» The roadmap for the integration of Ukraine into the ERA was approved by the Order of the Ministry of Education and Science at the beginning of 2021. Ukraine participates as an associate member in the EU framework programs for supporting science and innovation, in particular, in the current Horizon Europe program.

2 Law of Ukraine «On Scientific and Scientific-Technical Activities» with amendments for 2022 № 848-VIII of 26.11.2015, version of 06.09.2022 (№ 2564-IX). More: <https://zakon.rada.gov.ua/laws/show/848-19#Text>

The legal regime of martial law is stipulated by the Laws of Ukraine «On Legal Regime of Martial Law» and «On the Defense of Ukraine.» Notably, during martial law, human rights can be restricted under the current legislation of Ukraine. At the same time, human rights tied to the national security sector are to be protected regardless of special legal regimes.³ During martial law, introduced under the Law of Ukraine «On Legal Regime of Martial Law,» there are restrictions and peculiarities of organizing labor relations established by the Law of Ukraine «On the Organization of Labor Relations during Martial Law.»

Under martial law, the Ministry of Education and Science of Ukraine recommends the heads of education management bodies and/or heads of educational institutions to make a decision on the transfer of an employee to remote work, if the nature of work provides for possibility of performing it remotely, with the help of information and communication technologies (letters of February 28, 2022, № 1/3292–22, of March 7, 2022, № 1/3378–22, of March 15, 2022, № 1/3463–22).

According to the order of the Ministry of Education and Science «On Certain Issues of Organizing the Work of Professional Pre-University and University Education Institutions during Martial Law» of March 7, 2022, № 235, an institutional basis has been formed to take measures for protection of participants in the educational process, employees, and for protecting property of educational institutions; organizing evacuation activities if needed. Legal conditions were also established for evacuation and relocation of educational institutions from the occupied territories and territories with active hostilities. More than 50 orders of the Ministry of Education and Science have been issued regarding this.⁴

Order of the Presidium of the National Academy of Sciences of Ukraine «On the work of institutions, organizations, and enterprises of the National Academy of Sciences of Ukraine in the conditions of martial law in Ukraine» of February 24, 2022, № 143 instructs the Presidium of the NASU, institutions, organizations, and enterprises of the NASU to ensure the work of institutions, organizations, and enterprises in conditions of martial law. The Presidium of the NASU adopted Resolution № 79 of March 17, 2022,

3 Chasnyk, D.V. (2022). Ensuring human rights in the field of national security in the conditions of opposing the military aggression of the Russian Federation. *Scientific Notes of Lviv University of Business and Law*, 34, 61–67. Retrieved from <https://nzlubp.org.ua/index.php/journal/article/view/600>

4 <https://mon.gov.ua/storage/app/media/zagalna%20serednya/serpneva-konferencia/2022/Mizhn.serp.n.ped.nauk-prakt.konferentsiya/Inform-analityczbirn-Osvita.Ukrayiny.v.umovakh.voyennoho.stanu.22.08.2022.pdf>

«On the international activity of the NASU in the conditions of martial law,» particularly regarding appeals to international organizations on termination of any cooperation with Russian scientific organizations and condemning Russia's military aggression.

The Parliament is currently considering draft law 8024⁵ on implementation and maintenance of electronic registers for accounting and management of cultural heritage. This is a problem that has been exacerbated by the war: due to the lack of complete digital registers, Ukraine does not have an exhaustive list of items of cultural value, including ones stolen or destroyed by the occupiers, which complicates their return (as exemplified by the museum in Kherson).

Together with experts, the Government of Ukraine developed the Plan for Ukraine's Recovery, with the first version presented in Lugano in June 2022. The updated version of the section on education and science — «Recovery plan. Education and science. Draft as of 03.08.2022»⁶ — contains a number of proposals concerning the necessary reforms in the science sector, but the plan overall does not indicate the perception of science as a driving force behind Ukraine's post-war reconstruction.

During the first year of Russia's full-scale invasion into Ukraine, a number of publications on Ukraine's post-war recovery have come out, including ones discussing the issue of preserving and developing human potential, science, etc.^{7 8 9 10}

5 <https://itd.rada.gov.ua/billInfo/Bills/Card/40287>

6 <https://mon.gov.ua/storage/app/media/gromadske-obgovorennya/2022/08/19/H0.projekt.Planu.vidnovl.Osv.i.nauky-19.08.2022.pdf>

7 Becker, T. et al. (2022). «A Blueprint for the Reconstruction of Ukraine», Rapid Response Economics, №1, CEPR, London, https://cepr.org/system/files/publicationfiles/147614a_blueprint_for_the_reconstruction_of_ukraine.pdf

8 REBUILDING UKRAINE: PRINCIPLES AND POLICIES Edited by Yuriy Gorodnichenko, Ilona Sologoub, and Beatrice Weder di Mauro Centre for Economic Policy Research London EC1V 0DX UK P 467 ISBN: 978–1-912179–67-1 <https://cepr.org/publications/books-and-reports/rebuilding-ukraine-principles-and-policies>

9 Building back a better innovation ecosystem in Ukraine. OECD, 2022

<https://www.oecd.org/ukraine-hub/policy-responses/building-back-a-better-innovation-ecosystem-in-ukraine-85a624f6/>

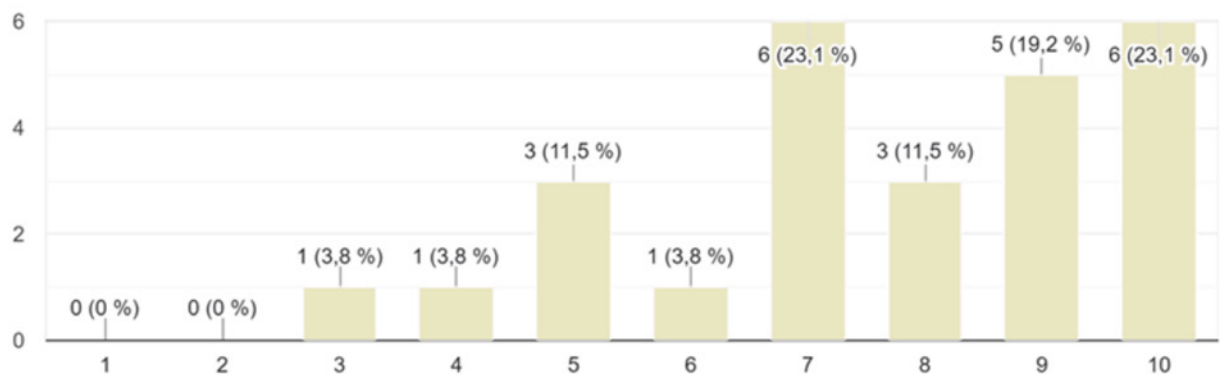
10 OECD (2022). Policy responses: Ukraine tackling the policy challenges. Відновлення України: побудова більш сталої, процвітаючої та стійкої економіки, 1 July 2022. https://uploads-ssl.webflow.com/625d81ec8313622a52e2f031/631985c8ab8fa2e9c1b1e3ba_UA%20Economic%20Recovery_UKR.pdf?fbclid=IwAR2WYwCyl71nNMg7gDnKGnNivAPU9l_Szv4c70B9yaJQxtDVyou2ypU4wvA

Challenges for science during the war. Analysis of surveys and interviews

1. The primary challenge of the war is scientists' personal physical and psycho-emotional security.

The majority of respondents stated that they are physically present in Ukraine and that they constantly feel psychological and physical discomfort due to missile attacks and forced isolation in bomb shelters and basements. A significant part of the respondents (81.3%) noted that they tend to stay inside for several days; 18.8% of respondents in Ukraine use alcohol and tobacco to relieve stress (this indicator among respondents outside Ukraine is lower — about 11%).

On a scale from 1 to 10, the majority of interview respondents indicated a significant impact of the war on their work.



Among the main challenges that respondents encountered during the war in their scientific activities are organizational, psycho-emotional, and motivational. Individuals who have changed their place of residence naturally have higher anxiety — the need to adapt to a new place, a situation of uncertainty, a change in the usual living conditions became additional stress factors.

At the same time, $\frac{3}{4}$ of the respondents, despite the above-mentioned situation, are determined to continue the fight against the aggressor and believe in the victory of Ukraine.

2. Challenges of preserving the scientific teams, establishing teamwork in war conditions and cooperation with partners (business, civil society organizations, grant programs, etc.);

More than 60% of respondents reported that during Russia's full-scale war against Ukraine, their scientific institutions and higher education institutions were forced to lay off employees due to the reduction in budget funding. Many interviewed scientists relocated to safer places in Ukraine or left the country. Therefore, the members of the same scientific team found themselves far from each other and their workplaces, which greatly complicates the research and in numerous instances makes it impossible. Respondents point out that there are objective threats to the scientific potential and the dynamic of scientific development in Ukraine if the war gets prolonged.

On the other hand, scientists continue to work and adapt to new conditions. Despite the reduction in funding, more than half of the surveyed scientists who left Ukraine remained full-time employees of their institutions, some of them were invited to work with foreign partners with the provision of financial and other necessary assistance from the receiving party. A third of the respondents joined projects supporting scientists abroad. More than half of the respondents noted that their institution's cooperation with other organizations had undergone significant changes and became more difficult since the beginning of the war, but the need for cooperation and communication had increased significantly.

Respondents positively evaluate digital tools of communication and joint remote work, which reduce the negative impact of the forced isolation of wartime on scientists and promote active interaction with partners.

During 2022, a number of support tools for Ukrainian scientists were created in the EU, or programs that already existed were expanded. This includes programs MSCA4Ukraine,¹¹ Alexander von Humboldt Foundation (Germany, Philip Schwartz

¹¹ <https://sareurope.eu/msca4ukraine/>

initiative),¹² PAUSE (France)¹³, and others. At the EU level, there are also programs Science4Refugees¹⁴ and MSCA – Researchers at Risk¹⁵. The European Commission launched the European Research Area for Ukraine (ERA4Ukraine) platform to provide information and support services for Ukrainian researchers.¹⁶ Individual proposals from individual institutions or research groups are shared on the Science for Ukraine platform.¹⁷

3. Risks related to the continuation of scientific research (retention of scientific topics, duration of their implementation), presentation and promotion of their results.

All respondents indicate that the research activity planned for 2022 in their educational or research institutions is ongoing. However, some respondents noted the deterioration or termination of funding of projects that were at the implementation stage until 2022. This puts the durability of research at risk, creates a situation when long-term research topics can be interrupted, experiments suspended, etc. Before the start of the full-scale war, the funding of science in Ukraine had a tendency to decrease for many years. In 2020, the science intensity of the GDP constituted 0.41% of the GDP from all sources (vs. 1.7% of the GDP in 1997)¹⁸. In 2022, as a result of several State Budget sequestrations, the funding of some science support tools was significantly reduced or completely terminated. For example, the National Research Fund of Ukraine did not have the opportunity to continue financing projects whose financing began before 2022, and to

12 <https://www.humboldt-foundation.de/en/apply/sponsorship-programmes/philipp-schwartz-initiative#h31307>

13 <https://anr.fr/en/call-for-proposals-details/call/pause-anr-ukraine-program-ukrainian-scientists-support/>

14 <https://euraxess.ec.europa.eu/jobs/science4refugees>

15 <https://marie-sklodowska-curie-actions.ec.europa.eu/about-msca/guidelines-for-inclusion-of-researchers-at-risk>

16 <https://euraxess.ec.europa.eu/ukraine>

17 <https://scienceforukraine.eu/>

18 <https://data.worldbank.org/indicator/GB.XPD.RSDV.GD.ZS?locations=UA>

finance projects under competitions where the winners were supposed to start implementing projects in 2022. On the other hand, the Ministry of Education and Science announced contests of scientific and technological inventions on state commission for 2023–2024, projects of fundamental scientific research, applied research, experimental inventions, research designs, and inventions of young scientists¹⁹. In general, the situation with funding of science during the war deteriorated significantly, which becomes critical when combined with systematic lack of funding from the previous years.

Among the productivity indicators of scientific, research and innovation activities available publicly is the number of applications filed for registration of inventions and utility models, in the nine months of 2021 and 2022, according to the SE «Ukrainian Institute of Intellectual Property.»²⁰ In 2022, there were 3,638 applications filed for inventions and utility models, compared to 5,524 for the same period in 2021 (i.e., 65%). This rather high indicator, despite a significant drop, may indicate, on the one hand, the motivation of researchers to work for the future, protecting their intellectual property. On the other hand, this may be due to the need to report to one's organization (attestation of research workers, reports of professors, etc.) and the state (state attestation of research institutions and higher education institutions).

In addition, according to the Ministry of Education and Science, the «List of Scientific Conferences on Higher Education and Science in 2022»²¹ indicates that there were 677 international conferences held in Ukraine in 2022, 369 national ones, and 233 online conferences. The materials of 54 conferences were indexed in the Scopus scientometric database. In the absence of information about the quality of the events, it is impossible to claim that this indicates active communication of new scientific results. However, the very fact that such events are held shows that scientific communication remains very active even during the full-scale invasion.

One example is the International Conference on Smart Technologies in Urban Engineering (STUE-2022),²² held by O.M. Beketov Kharkiv National University

19 <https://mon.gov.ua/ua/naukova-naukovo-tehnichna-ta-innovacijna-diyalnist-u-period-pravovogo-rezhimu-voyennogo-stanu>

20 See in detail <https://ukrpatent.org/uk/articles/9mt-2022>

21 <https://imzo.gov.ua/2022/01/14/lyst-imzo-vid-12-01-2022-22-1-10-28-pro-perelik-naukovykh-konferentsiy-z-problem-vyshchoi-osvity-i-nauky-u-2022-rotsi/>

22 <http://stue.kname.edu.ua/>

of Urban Economy in Kharkiv on June 9–11, 2022. Based on the materials of the conference, a book was published by Springer publishing house. During the period when the conference was prepared and held, Kharkiv was under intense shelling, sometimes on a daily basis. Among the keynote speakers were David Henson (creator of the humanoid robot Sophia) and Bertrand Piccard (one of the designers of the Solar Impulse airplane, which he flew around the globe). The participants represented 76 universities and research institutions (40 from Ukraine, 36 from other seventeen countries of the world).

Since February 24, 2022, the attention of the international community to Ukraine was reflected in the scientific cooperation of Ukrainian scientists with their foreign colleagues. The fact that 26.9% of respondents noted an increase in the access of their scientific teams to international projects is encouraging. At the same time, scientists who find opportunities to work abroad are not always able to preserve and develop their scientific subjects.

During 2022, only a small amount of foreign funding was available for scientists who remained to work in Ukraine. One example is a joint program from the US National Academy of Sciences and the Polish Academy of Sciences,²³ where priority is given to research groups working in Ukraine. There are also several programs of individual support and remote positions at the level of individual foreign universities and research institutions.²⁴

At the same time, during 2022, only 40% of respondents tried to get funding from support programs, of which 26.7% of applications were successful.

87% of respondents reported a significant impact on the budget of their research institutions and higher education institutions; 73.9% noted that attracting funding has become more difficult, and only one respondent reported that the institution managed to diversify funding sources.

In the situation resulting from the full-scale war, most research institutions in Ukraine actively sought new forms of funding. At the same time, almost all respondents noted that their higher education institutions and research institutions were also engaged in charity, despite the difficult conditions. This proves the high level of solidarity and a strong civic stance of Ukraine's scientific community in the situation of financial hardship and war.

23 <https://mon.gov.ua/ua/news/polska-ta-amerikanska-akademiyi-nauk-ogolosili-programu-dlya-pidtrimki-ukrayinciv>

24 <https://news.harvard.edu/gazette/story/newsplus/shuri-launches-non-residential-fellowships-to-support-ukrainian-scholars/>

Among the non-governmental initiatives, we can point out the contest Sikorsky Challenge 2022: Innovative Transformation of Ukraine.²⁵ More than two hundred projects from Ukraine and beyond took part in the competition. The projects received contacts of interested actors and prizes on the day when the results were summed up, as well as constant help of the competition team in finding partners for implementation throughout the next year.

4. Preserving research infrastructure, as well as historical and cultural (museum) heritage.

Ukrainian science currently operates under missile strikes, during destruction of research infrastructure objects, research facilities, higher education institutions, laboratories, museums, archives, the loss of historical and cultural heritage. At this stage, data collection and a detailed study of each case is critical.

The rules of warfare prescribe preserving cultural values. This prescription is enshrined in the Hague Convention of 1954, which, in particular, prohibits the deliberate destruction of religious and cultural institutions and historical monuments. Russia, among other countries, also signed this convention, but during the war, it violates these requirements every day, deliberately and systematically destroying Ukrainian culture. Therefore, Russia's actions may be considered a component of the crime of genocide against the Ukrainian identity and Ukrainian people.

Before the war, Ukraine had more than 500 museums, 65 historical and cultural reserves, and almost 170,000 monuments, including seven UNESCO World Heritage sites (one of them in the temporarily occupied territory). According to the information of the Ministry of Culture and Information Policy, as of January 5, 2023, 1,189 objects of cultural infrastructure were damaged or destroyed due to the war in Ukraine. A third, 446 objects, have been completely destroyed. Regarding museums: 22 have been destroyed, 41 damaged. These statistics mostly include architectural monuments, buildings of museums, schools, universities, and cultural centers in the Donetsk, Mykolaiv, Luhansk, Kharkiv, Sumy, Kherson, Chernihiv, Zaporizhia, and Kyiv oblasts. Russians also systematically loot museums in the occupied territories. «We are probably dealing with the biggest robbery of museum collections since World War II. But we are also dealing with the largest evacuation

²⁵ <https://www.sikorskychallenge.com/festival-sikorsky-challenge>

of collections since World War II,» said Oleksandr Tkachenko, Minister of Culture and Information Policy. The occupiers stole artifacts from 40 Ukrainian museums. The Ministry of Culture has verified 540 episodes of destruction of cultural infrastructure, including objects of cultural heritage, institutions and religious buildings. UNESCO has already confirmed missile damage to 199 historical sites in 12 regions of Ukraine. Among them are 84 churches and other religious objects, 37 buildings of historical significance, 37 buildings for cultural activities, 18 monuments, 13 museums, and 10 libraries. Therefore, much depends on the efforts of Ukraine today aimed at preservation and protection.

The Center for Strategic Communication²⁶ regularly publishes information about Russians' crimes against the Ukrainian culture.

Problems of preservation of museum collections are not only one of the most important tasks for museum workers, but also a challenge for authorities at various levels. Currently, there is no comprehensive state program for the preservation of national heritage, as well as methodological recommendations on the procedure in war conditions. There are general instructions for the preservation of museum objects, which are of a generalized nature and are not applicable in wartime. Therefore, for the most part, the preservation of museum collections depends entirely on the teams of institutions, their vision and resources.

Several museums of Ukraine acted in advance and managed to take part of the collection to the west of the country even before the beginning of the Russian invasion (for example, the museums of Odesa, partially Mariupol); such transportations were not advertised, or alternatively, they were formalized as guest exhibitions. Since the beginning of the full-scale war, the Heritage Rescue Headquarters has been active, members of which are also part of the specialized working group under the Ministry of Culture. The coordinators of the Headquarters are Vasyl Rozhko, the head of the Tustan NGO, and Ihor Poshyvailo, the director of the Museum of the Revolution of Dignity. The Headquarters works on the protection of museum collections, documentation of losses, coordination with other initiatives and humanitarian assistance. In addition, the Museum Crisis Center has been established. Its initiator was Olha Honchar, director of the Lviv museum Territory of Terror. «Action and inaction are of a critical significance at the local level. As an example, in Kherson, workers helped the occupiers to take out museum exhibits, while others hid historically valuable exhibits in their homes, the same applies to the State Archive of Kherson oblast...»²⁷

²⁶ <https://spravdi.gov.ua/>

²⁷ https://lb.ua/culture/2022/04/01/511860_vid_arhitekturi_virtualnih.html

The Ministry of Culture does not comment on the details of the work on the preservation of cultural heritage, which is quite understandable from the point of view of security. From general protocols, we know that every Ukrainian museum has a «red list» of its collection, which includes objects subject to priority evacuation in case of a threat.

Digitization of museum collections is an effective and quick mechanism in wartime conditions, which allows not only to demonstrate digitized exhibits to the public (*VR, AR, MR technologies*), but also prevents sudden loss of identifiable information about a unique heritage object under the threat of destruction.

From the first days of the war, the TOP PROJECT company, represented by Vlad Tiunov, the company manager, and Diana Hryniuk, a teacher at Taras Shevchenko Kyiv National University, started a volunteer mission to digitize the historical and cultural heritage of Ukraine with the aim of preserving it within the original volunteer project StandByUkraine.²⁸ They organized digitization and 3D scanning in museums of Kyiv and oblast (Museums of Taras Shevchenko Kyiv National University, Museum of Kyiv History, certain collections of St. Sophia Cathedral, the National Museum of Folk Architecture and Life of Ukraine etc.) and some specific collections. However, there is a need to engage additional financial resources in order to scale the digitization project to other objects and regions of Ukraine. As of March 2023, the number of damaged and destroyed objects of cultural heritage and cultural institutions of Ukraine recorded in the database of the Ministry of Culture and Information Policy is 553.²⁹

The problem of preserving research infrastructure is covered in more detail in the material.³⁰

28 <https://standbyukraine.com.ua/>

29 <https://culturecrimes.mkip.gov.ua/>

30 https://scienceatrisk.org/whitepaper/bazy-danykh-poshkodzheno-i-ta-zruinovanoi-doslidnytskoi-infrastruktury?fbclid=IwAR15PKIXCP1Hkh_jbaRPxEhUbT0jAYt9tmi2LNQFnaAmaPHvgkRyRsaZUJ8

Recommendations about preserving science during the war

Based on our research, we identified a number of challenges typical of science during the war. We assume that most of them are typical of crisis phenomena, so the relevant recommendations can be universal and can be a component of response and aid strategies in other countries.

It is expected that most of the recommendations should be implemented at the state level, with specification at the level of individual institutions, their divisions and science groups. Resources must be provided with financial support from donors and partners (especially international) and necessary legal conditions from the state. Decentralization of efforts and organizational autonomy in the conditions of war allows finding optimal solutions to problems for each specific situation. Instead, one of the key tasks of the government should be removing legal barriers for research and education institutions engaging and using international and private funds, deregulating all processes that are not critically important for security, and establishing a strategic framework for post-war development.

The following focus areas and actions can be singled out among the tools for effective preservation of the science sector and establishing prerequisites for its recovery.

1. Support of personal physical safety and psycho-emotional stability of scientists.

1. Simplify the organization and optimization of legal support for remote work and flexible working hours of scientists, in particular those who work from abroad.
2. With the involvement of international donors, create programs of individual financial support for scientists. In addition to paychecks, scholarships, and continued project funding, these could be individual scholarship programs based on past achievements that are independent of the ability to conduct research during the war.

3. Reduce the burden on scientists, scientific institutions and higher education institutions by simplifying reporting procedures, project paperwork, procurement, etc. Digitize interaction with authorities, increase efficiency and avoid duplication of efforts, repeated provision of information, etc.
4. Involve scientists in projects related to the challenges of war and post-war reconstruction through long- and short-term contracts for scientific and research work initiated, in particular, by defense and high-tech enterprises.

2. Reintegration and engagement of scientists who have relocated abroad.

1. Introduce or disseminate national and foreign tools for financing existing or new research groups, with the possibility of such groups being located in various places across Ukraine (territorially or across different institutions, higher education institutions) or partially located outside of Ukraine.
2. Carry out a targeted international policy regarding the initiation of return support programs in the countries of temporary stay of Ukrainian scientists.
3. Preserve research subjects of Ukrainian scientists (where possible) by host institutions abroad and create conditions for their official continuation with Ukrainian research or education institutions.
4. Provide conditions for joint work of science teams, particularly based on hubs for collective use of research equipment.
5. Create opportunities to suspend scientific research with a guarantee of their further restoration in the post-war period.

3. Preservation of capable scientific teams and vectors, creation of new ones as a response to the challenges of the current times.

1. Identify and prioritize funding of strategic areas of scientific research for defense capability and recovery of the economy as a necessary component of economic stability and sustainable development after the war.
2. Preserve and progressively increase the shares of basic funding of research areas in higher education.
3. Complete the legislative framework for full-fledged activities of the National Research Fund and the Fund of the President of Ukraine for the support of education, science, and sports.
4. Adapt already approved scientific research to the real conditions of technical tasks in order to continue the joint work of teams (depending on the scientific vector and the situation, it can be a transition from experimental to theoretical research, conducting experiments in partner organizations and further data processing, conducting computer simulations, etc.).
5. Completely finance the programs of capable organizations with a guarantee, particularly of the National Research Fund, to continue supporting the subjects and vectors that were competitive before the full-scale invasion, and announce research calls that are relevant in the current times.
6. Start a program of co-financing projects and partnerships between scientists, civil society organizations, business, local authorities related to the challenges of war and post-war reconstruction.
7. Decentralize research through the creation and development of regional scientific centers and stimulation of constructive competition between them.
8. In addition to the above financial instruments, create and maintain targeted ones, in particular, for young scientists.

4. Development of international scientific cooperation, scientific diplomacy, integration into the European and global scientific space.

1. Build partnership networks with relevant organizations and teams abroad for joint activities (research funding, information and logistical support, etc.) in formats that reflect the capabilities of teams and organizations during a crisis.
2. Encourage scientists and organizations to participate in professional associations and support their activities.
3. Create programs and conditions for professional development, study of foreign languages, peer exchange with foreign colleagues.
4. Simplify regulation of academic mobility and support relevant programs. Create an effective mechanism for short-term departure of scientists and professors of higher education institutions abroad to work in international projects.
5. Collect and systematically analyze data on the movement of scientists and their needs.
6. Systematically work with scientists in the diaspora, in particular through the involvement of its representatives in expert reviews, conduct events and image-building events, engage resources for the reconstruction of scientific institutions.

5. Preserving research infrastructure, as well as archives, collections, etc.

1. Collect data on destroyed research infrastructure, displaced material objects of scientific purpose.
2. Develop a unified methodology for assessing losses as a result of hostilities.
3. Analyze and update plans for evacuation and preservation of material values, in particular abroad.
4. Develop a targeted state program for procurement of fire-fighting, protective and ventilation equipment for the protection of exhibits.
5. Support and accompany the relocation of scientific institutions and higher education institutions.

6. Preserve the amount of financial support for scientific objects of national significance.
7. Create a nationwide electronic register of Ukrainian heritage, which will include data on museum collections.
8. Digitize and catalog museum and archival collections as much as possible.

Findings

Preserving science during wartime is a comprehensive task, since the structure of challenges is often varied. The most acute preservation challenges include ensuring the scientists' personal physical and psycho-emotional safety; preservation of scientific teams, establishment of teamwork and workflow with partners; preservation of scientific research and opportunities to present their results; ensuring funding of science; prevention of loss of research infrastructure and preservation of historical, cultural, museum heritage, archives, etc.

Preservation and development of human potential is a key guarantee of the state's stability, economic development and defense capability. Therefore, the actions of all domestic stakeholders and international donors and partners should focus on ensuring it.

Key recommendations include introducing tools for supporting scientists and science teams, who are mostly in Ukraine and located in various parts of the territory, providing opportunities to continue research and adapt to the situation, creating tools and conditions for development of international partnerships and cooperation with businesses, civil society, local authorities, organizing measures to preserve archives, collections, cultural heritage. Data collection during wartime is also important. Destroyed or damaged research infrastructure, data on the movement of scientists inside and outside the country, the destruction of scientific groups and partnerships and the formation of new ones — these and other data will make it possible to make better, informed decisions and monitor their effectiveness, substantiate requests for assistance to international donors and lay the foundation for post-war reconstruction.

As the subject of preserving science at risk is further studied, more attention should be paid to studying international experience of responding to armed conflicts, as well as natural and man-made disasters. Analyzing activities of networks of international actors and organizations focused on helping scientists at risk, some of which have been functioning since World War II, can provide more data about long-term consequences and best strategies for providing aid.

The materials of this study are the first step towards finding optimal tools and strategies for preserving science during war and crisis situations. Ukraine's experience and the global response show that despite crisis phenomena like wars, natural or man-made disasters being quite widespread, there is no established set of policies and turnkey tools for effective preservation of science in a country undergoing a crisis with a focus on further high-technology restoration.

Appendix: Results of the thematic analysis of interviews with scientists (key ideas in the responses)

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