UADAMAGE
MONITORING PLATFORM

MISSIONEAST

neo-eco
світ без відходів

70 rural settlements in Mykolaiv: Debris volumes, costs and potential

27 June 2023

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Executive Summary

The task of rebuilding Ukraine's infrastructure and economy during and after the war represents a huge challenge, but also a significant opportunity to modernize the country with a view to EU accession. At the same time, considering the scale of the destructions, it is crucial to identify cost-efficient means of rebuilding, while at the same time protection environment and climate.

Digital solutions have been applied in a wide range of sectors including banking and finance, agriculture and food production, and energy. In that regard, digital transformation is key to a well-functioning nation, impacting democratic participation, and public services and infrastructure for the future.

Ukraine's ICT (information and communications technology) industry has been extremely successful since 2014*, and as the digital revolution transcends and affects all economic sectors, it is evident that cutting-edge technology should be integrated to accelerate reconstruction efforts.

As a result, **Mission East**, whose work ranges from emergency relief in crisis situations to long-term development assistance, particularly in the Danish focus region of Mykolaiv, has partnered with Neo-Eco Ukraine and UADamage to provide an open-source damage assessment report of numerous settlements in the province.

Neo-Eco Ukraine has 17 years of expertise in industrial engineering solutions for waste recycling and advises companies on the creation of circular economy loops and know-how in the recovery of used materials, eco-design and the setting up of recovery channels. As a result, the company can propose pragmatic circular economy solutions for industries, territories, and their large infrastructure projects.

UA Damage's mission is to provide Ukrainian authorities and citizens with the latest, accurate data and visibility to advance reconstruction efforts, by processing satellite images with a neural network pipeline. By comparing land and buildings before the war with the current situation, and using a classification system, this data will become a key decision-making tool for local authorities, NGO's and other interested parties to take informed decisions about the rebuilding of Ukrainian communities and infrastructures.

Together, the three organizations have partnered to prepare a detailed damage assessment report of 70 settlements in Mykolaiv which aims to be an enabler for the efficient planning and execution of the region's reconstruction and to promote awareness on the potential for applying circular economy in the rebuilding efforts. The objective of this innovative data-driven approach, using the latest advances in AI technology, is to ensure better accountability, accuracy, and transparency in rebuilding a better, more sustainable Ukraine for generations to come.

*Digital Will Drive Ukraine's Modernization (csis.org)

01.

Background

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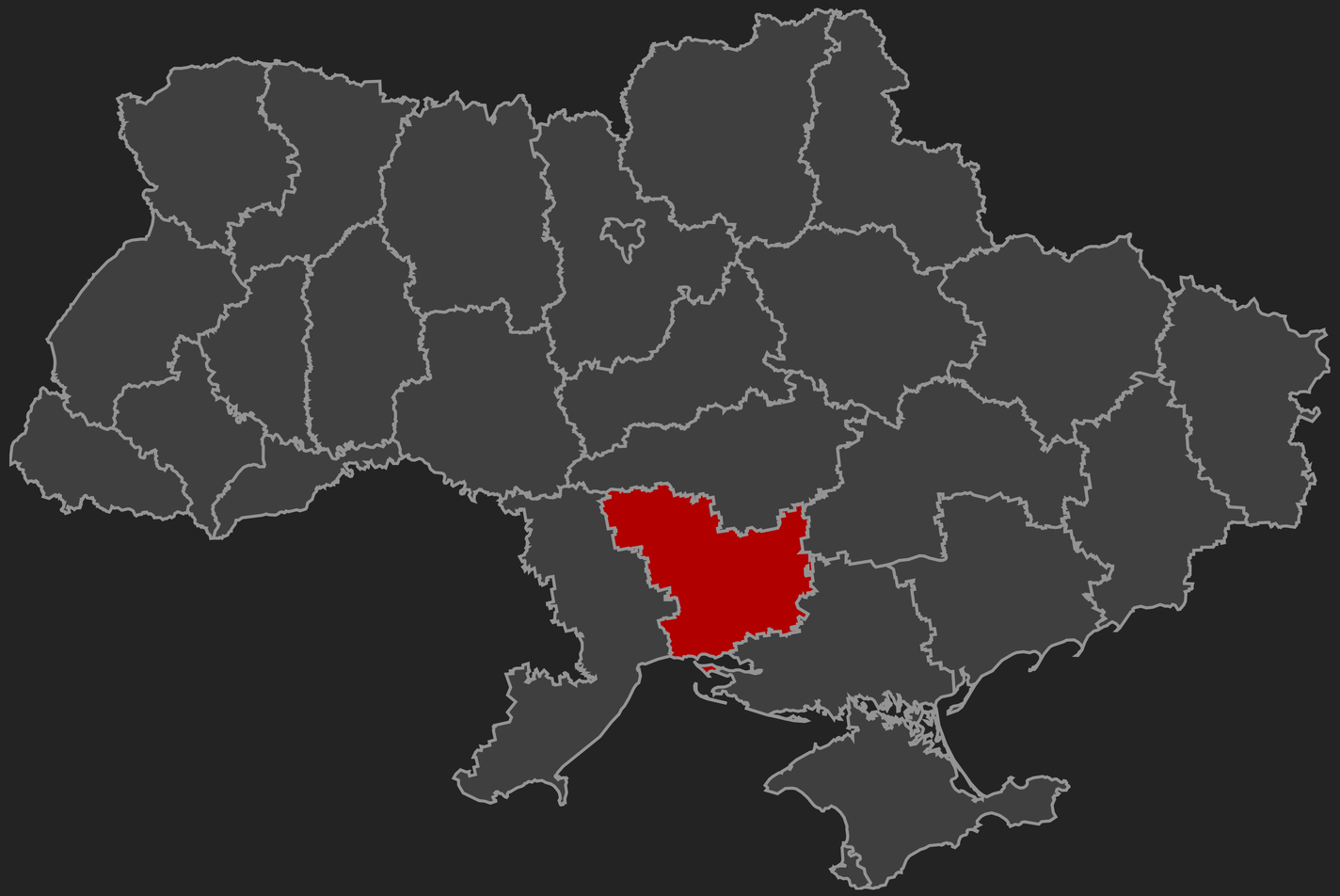
Mykolaiv region

Background



About Mykolaiv

Mykolaiv Oblast is a region in Ukraine. It was created on 22nd September, 1937. It is located in the south of the country, within the Black Sea Lowland in the basin of the lower reaches of the Southern Bug River. In the south, it is bordered by the Black Sea. The area is 24.6 thousand km². The center of the region is the heroic city Mykolaiv.

Agriculture is the second largest sector of material production in the region and the first in terms of employment. Agricultural land in the region exceeds two million hectares, of which almost 85% is arable land (more than 5% of Ukraine), 13.7% are pastures and hayfields, and 2% are fruit and berry plantations.

Blazon

Flag

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History of invasion

History

- **February 24**

  From the very beginning of the Russian invasion on the night of February 24th Ukraine started to burn. The list of Ukrainian cities and airports were under strong bombing by Russian missiles and aviation. Invasion started in a list of Ukraine regions including Mykolaiv region.

- **March 16-17**

  On March 16-17 2022 more than 800 km2 was unoccupied, including all strategic roads and area around Mykolaiv city.

- **November 10**

  As a result of a successful counteroffensive, the Armed Forces of Ukraine liberated the main part of the Mykolaiv region. With this huge feat, Ukraine showed its ability to win the war, which inspired the faith of its partners in victory and contributed to the allocation of investments for the restoration of unoccupied territories.

- **December 22**

  Since the beginning of the full-scale Russian invasion, 14 319 civilian objects have been partially or completely damaged in the Mykolaiv Oblast. The Mykolaiv regional state administration has announced about the latest figures of damaged objects:

  - Housing stock objects – 9 291
  - Medical institutions – 92
  - Educational institutions – 390
  - Cultural institutions – 184
  - Objects of industrial enterprises – 189
  - Life support facilities:
    - Gas – 1 032
    - Electricity – 895
    - Water – 32
    - Heat supply – 96
  - Other non-military objects – 2 118

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The social aspect of reconstructing Ukraine

Mission

Our joint mission is to restore Ukraine after the total destruction of buildings and infrastructure by the occupiers. In the tri-party between Mission East, Neo-Eco Ukraine and UADamage, we have combined international humanitarian aid experience, circular economy principles and artificial intelligence technologies. We have created an interactive, multi-layered analytical platform, and offer effective tools for large-scale restoration of territories in the shortest possible time.

UA Damage

Our mission is to build the toolchain which gives the Ukrainian government and its people all the required and valid data about the full picture of the destruction suffered in the war so far. We provide a full transparent picture of the damage and use it for reconstruction purposes. Every Ukrainian should have support and visibility for the rebuilding process of their homes and costs tracing: Repairs, investments, suppliers and reporting.

Neo-Eco Ukraine

Bart Gruyaert, Vice-President of Neo-Eco Ukraine, noted that thanks to the partnership with Mission East, UADamage, Neo-Eco Ukraine will be able to implement its innovative damage assessment strategy in Mykolaiv: This will allow us and others to contribute to strengthening Ukraine's circular economy approach, therefore, to a more affordable, climate-sensitive and sustainable recovery

Mission East

As a humanitarian actor engaged in the rebuilding efforts, Mission East sees a clear need for open-source data on the levels of destruction and debris availability for both planning and accountability purposes. Knowledge allows for better choices, and awareness of circular economy benefits needs to increase.

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The invasion in the Mykolaiv region

153

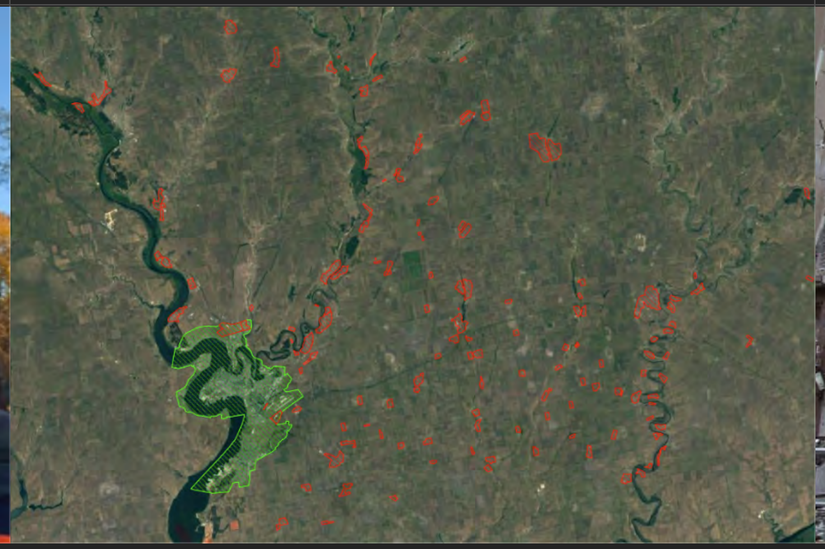
SETTLEMENTS WERE OCCUPIED

2,842

KM2 AREA WAS SHELLED

1.12

MILLION PEOPLE AFFECTED



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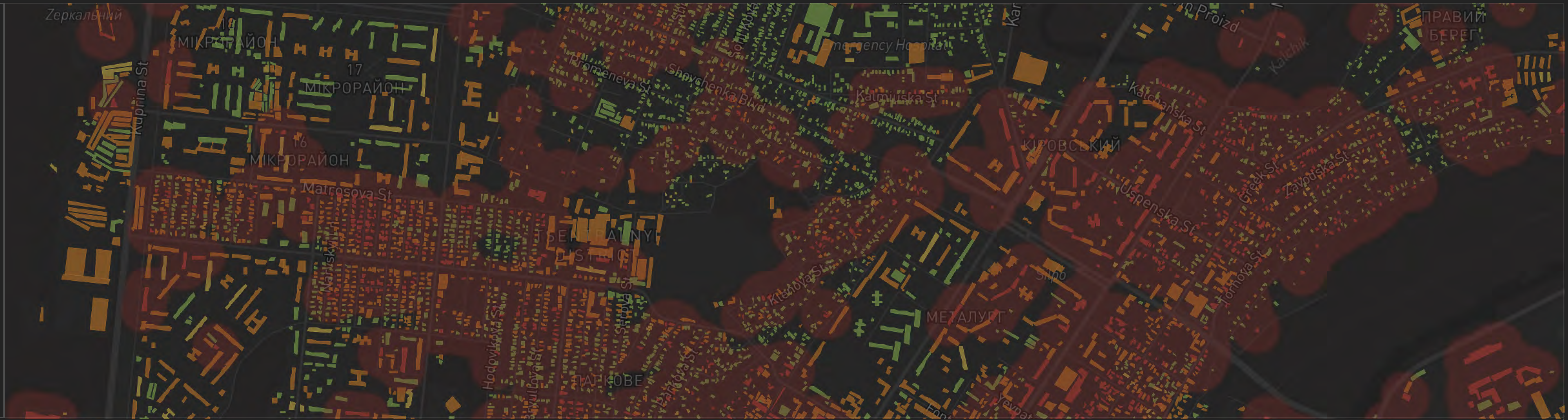
Images from the ground

02.

Methodology



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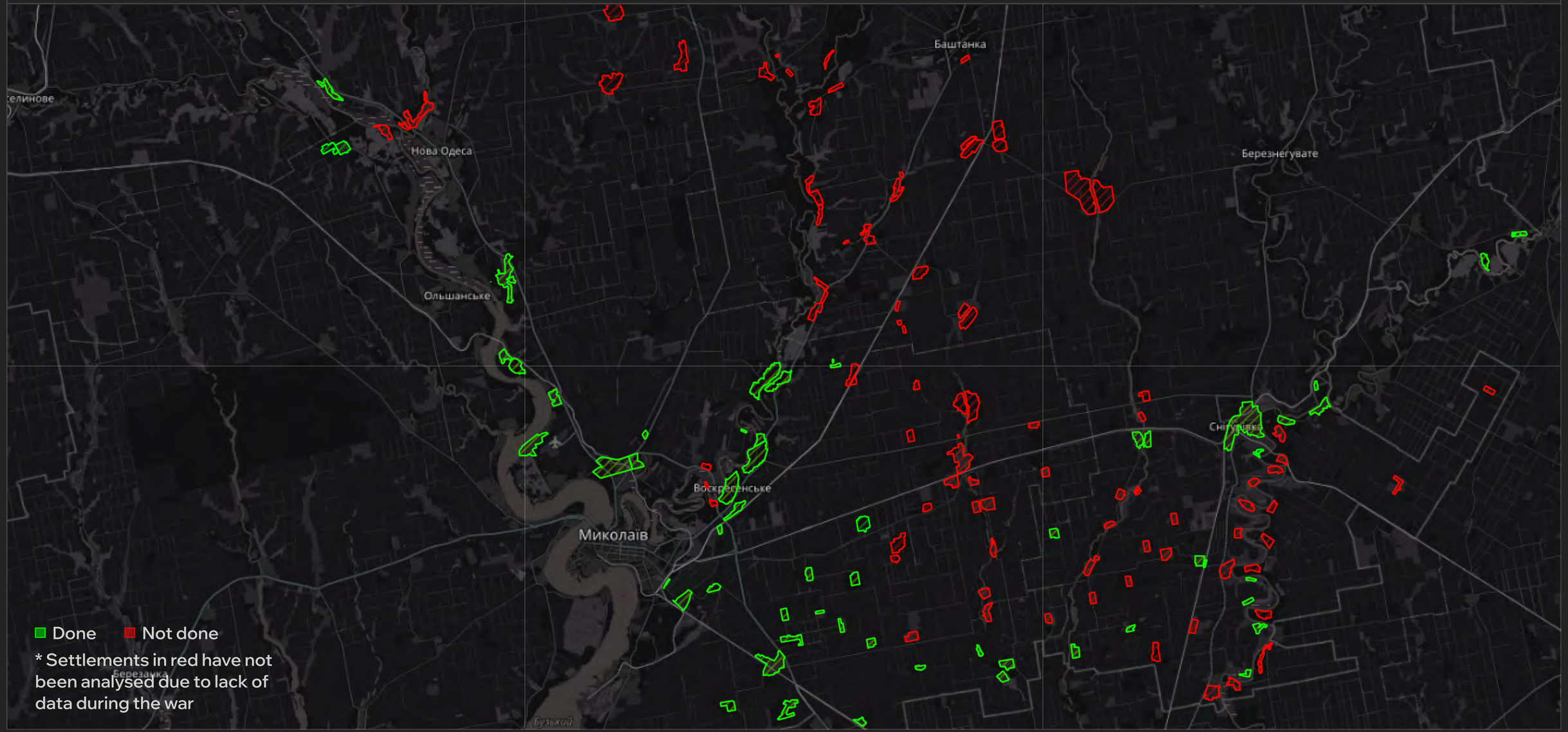
70 settlements analysed

VIEW DETAILS



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Drone flight missions

Shevchenkova Hromada

We acquired the highest quality datasets (2-5 cm/pixel) for two settlements in the Shevchenkova hromada, using monowing drone SKIF by operators from Culver Aviation. These images were used for additional training at Neural Networks. Algorithms were adopted to work on local construction architecture and automatically classify the destruction of buildings.

500

FLIGHT ALTITUDE, M

5

GDS, CM/PX

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Satellite data processing

Settlements in Shevchenkova Hromada

We processed satellite images using a list of Neural Networks which works in one pipeline executing following functions:

1. Buildings footprints detection
2. building damage segmentation inside the footprint
3. Classify damage into four categories: Destroyed, major and minor damage, no visible damage
4. Linking buildings to the geographical coordinates
5. Obtain additional building data: Address, size, mass of debris, type of building

50

GDS, CM/PX

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Debris calculation approach

1 STEP Classifying damaged buildings

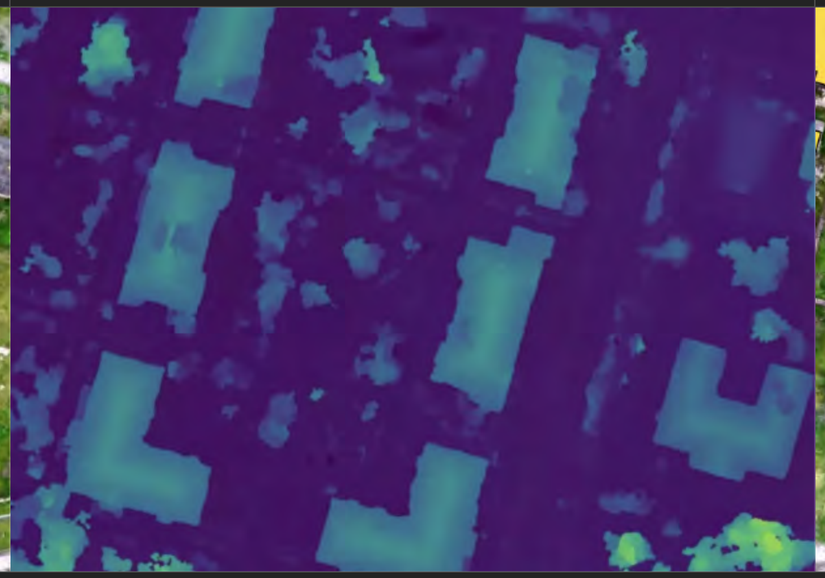
Using computer vision, we detected buildings footprint and analysed the level of destruction by segmenting each dot on the drone/satellite image

2 STEP Generation of height map

Determining building height is clearly a major technical step forward. We relatively calculate the height of each pixel on the image inside the building footprint

3 STEP Volume of the destroyed building

According to the category of damage, each pixel height parameter and building square allows us to calculate the volume of each separate construction



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The digitalisation process

No Visible Damage

Structures with no visible damage from the photos, will be assigned to the structures that appear to have complete structural integrity, i.e. when the walls intact and the roof is virtually undamaged. It is important to note that this class doesn't exclude the presence of structural damage. For example, the building may have suffered damage that can't be assessed

45 782

WITHOUT VISIBLE DAMAGE

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The digitalisation process

Minor damage

Minor damage is the category for buildings whose interpretation is uncertain, due to lower image quality, or to the presence of possible damage proxies such as small traces of debris, rubble or sand deposits around the building. This class attribution can be given by inferring the state of the building from surrounding features. Small damage to the roof and traces of impact, small traces of debris, rubble or sand deposits around the building.

4 774

BUILDINGS

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The digitalisation process

Major damage

Major visible damage is the category assigned to structures with some or part of the roof collapsed and serious damage to walls. This category will be used for buildings with a largely intact roof characterized by the presence of partial damage (collapse of chimneys or roof tiles detached) or surrounded by large debris/rubble or sand deposits.

875 122

VOLUME, M3

688

MAJOR DAMAGE

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The digitalisation process

△ Completely destroyed

This type of classification is assigned to structures that are total or largely destroyed (>50%). This category shall also be used when only a portion of the building has collapsed to the ground floor. In these cases, the original building structure is no longer distinguishable.

884 040

VOLUME, M3

974

DESTROYED

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Find each object on the map

GO TO MAP

How it works

We process each object separately to give maximum accuracy and transparency in our reports. Using the UADamage platform, you can find any building with all the necessary metrics for the future work.
SECURITY CONCERN: Due to the conditions during the war, the list of available data is protected. Please contact vl@neuromarket.ai directly with your data sharing request.

81%

CLASSIFICATION OF BUILDING DAMAGE

The value of Neural Network prediction accuracy, which was corrected by data engineers

90%

HEIGHTS MAP GENERATION

Height maps contain trees which stand over the buildings in the spring and summer which affect calculations

03.

Volumes

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Recycling metrics

1.8 T/M3 is the average for mixed building debris

2.3 T/M3 for reinforced concrete

1.8 T/M3 for bricks, plaster and breeze blocks

0.8 T/M3 for wood, plastics, and various bulky items

Due to the list of construction practical demolition in Ukraine, Neo-Eco Ukraine material specialists converted the next figures of debris transformation from cubic meters to tons

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Debris statistics and analysis

VIEW DETAILS

Calculation

12.33% of buildings across the 70 settlements have experienced some level of damage, in the 12.86% of the settlements which experienced the highest level of damage: More than 50% of buildings are either damaged or destroyed

70 SETTLEMENTS	**52 219** BUILDINGS	**1.7 mln** DEBRIS VOLUME, M3
7 343 AREA, HA	**6 436** DESTROYED / DAMAGED	**2.5 mln** DEBRIS WEIGHT, TON

04.

Costs

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Reconstruction cost

Damage estimation

The damage estimation was carried-out by an expert method, taking into account the area and nature of the damage based on the construction cost of €600/m2

€383 817 164

COST OF THE CONSTRUCTION OF NEW BUILDINGS

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Recycling cost efficiency

Cost of debris removal

Residential buildings: €4/t
Industrial building with a lot of metal: €3/t
Buildings with adjacent structures: €8/t

Cost of transformation

This includes all costs (direct and indirect costs)including: Fuel, labour, people, insurance, and logistics

Concrete waste: €5.50/t
Bricks and breeze blocks: €3.80/t

Mykolaiv market values

Average price of aggregates: €14/t
Average price of sand: €5/t
Price of coarse aggregates from brick: €9/t

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Debris statistics / Spending

VIEW DETAILS

€23 432 038

MARKET VALUE OF RAW MATERIALS
WHICH WILL BE CREATED THANKS TO RECYCLING

€11 779 349

THE COST OF RECYCLING CONCRETE WASTE (FINE CRUSHING AND SCREENING), BRICKS AND BREEZE BLOCKS (COARSE CRUSHING)

€10 132 773

COST OF DEMOLISHING CONSTRUCTION AND REMOVING DEBRIS. THIS COST APPLIES WHETHER OR NOT THE REBUILDING IS DONE THROUGH BY RECYCLING

€11 652 689

TOTAL SAVINGS FROM USING RECYCLED MATERIALS
COMPARED TO MARKET PRICE

05.

Potential

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The Circular Economy and Employment

Solve and avoid

We can solve and avoid environmental pollution and create jobs at the same time. What we need is a change in mindset and behaviour, through training, inspiration, examples, innovation and policy push are needed. Investing in people and in the environment is the only way to invest in our future!

Clearing the rubble will employ about 400 people over two years. The circular economy will add approximately 600 people over three years.

CLEARING THE RUBBLE

400

PEOPLE OVER TWO YEARS

CIRCULAR ECONOMY

600

PEOPLE DURING 3 YEARS

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CO2 emissions

1.78 kg of CO2 eq avoided per tonne recycled

Aggregates have to be crushed, which produces 0.69 kg of CO2 eq per tonne for recycling. The emissions avoided, which correspond to the manufacture of new aggregates in quarries and transport, is 2.47 kg of CO2 eq per tonne

4 509

CO2 AVOIDING, TONS

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Debris dumped in fields

5+

HECTARES OF FIELD POLLUTED BY 1 DUMP IN BUCHA (SEE IMAGE)

180K

TONS OF BUILDING WASTE DURING OVER ONE YEAR IN 1 OF 7 DUMPS IN BUCHA

€837 000

TO RECYCLE THIS 1 OF 7 DUMPS

Waste recycling benefits

Utilising building waste as a resource in the rebuilding of Ukraine will contribute to preventing debris from being dumped in the forest, with disasterous consequences to the environment, not least due to hazardous waste. The potential for recycling decreases as the materials deteriorate, while the cost of removal remains the same. Now is the time to act.

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Next steps in asbestos recycling

The recycling solution costs €250/t

Exposure to asbestos fibres causes mesothelioma (cancer of the mesothelial cells), asbestosis (fibrosis of the lung), various cancers including lung, ovary and larynx, in addition to benign pleural diseases such as pleural plaques.

Asbestos is estimated to be responsible for the largest number of deaths of all occupational carcinogens (63%) globally. Countries that had higher historical asbestos consumption rates per capita have recorded a higher rate of deaths from ARDs (Acute respiratory distress syndrome) than countries with lower historical asbestos consumption.

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AMOUNT OF ASBESTOS
IN MYKOLAIV REGION

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Calculation of asbestos in roofs

Recognition approach

Our research shows that asbestos roofing recognition for all Ukraine is possible by using convolutional neural networks and high-resolution aerial imagery.

Different remote sensing data have been successfully used for this purpose. RGB and thermal data have yet to be investigated. Our next goal is to investigate the classification of roofs containing asbestos using RGB and airborne thermal data and state-of-the-art machine learning (ML) classification techniques.

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3D Building Reconstruction

GO TO MAP

Improving Accountability

1. The potential of 3D imaging is automatic calculation the type of building materials, amount of components which need repair: Windows, roofs, walls and so on.

2. The Luch settlement has been piloted for the increasing transparency in the rebuilding process, using smart architecture planning for the reconstruction of the whole settlement.

3. Our longer term plans is to process each settlement which has been partly destroyed (<50%), with the goal of attracting new investment for rebuilding the whole Mykolaiv region.

???

THE COST OF RECONSTRUCTING PARTIALLY DESTROYED BUILDINGS

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Thank you!

P.S.: Special thanks to Danida

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