AREA BASED RISK ASSESSMENT
VOLNOVAKHA RAION
DONETSKA OBLAST, EASTERN UKRAINE

October 2020

3P Consortium PREVENT PREPARE PROTECT
ACTED • IMPACT Initiatives • Right to Protection • Danish Red Cross • Austrian Red Cross • Ukrainian Red Cross Society

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The 3P Consortium: Prepare, Prevent and Protect civilian populations **from disaster risks in conflict-affected areas**

The 3P Consortium, created in 2019, is funded by the Directorate-General for European Civil Protection and Humanitarian Aid Operations (DG ECHO) and USAID/OFDA

On the occasion of the International Day for Disaster Risk Reduction, the 3P Consortium (ACTED, IMPACT Initiatives, Right To Protection, the Austrian Red Cross, the Danish Red Cross and the Ukrainian Red Cross) launched its programme to reduce vulnerability to disaster risks in Eastern Ukraine by preparing, preventing and protecting civilian populations who are at risk of major disasters.

Civilians continue to bear the brunt of the ongoing conflict in Eastern Ukraine. Shelling, landmines, unexploded ordnances, frequent water and electricity cuts: this is daily life for people living close to the contact line, which splits government controlled areas from non-government controlled areas and where armed fighting continues to take place.

Natural, industrial and ecological hazards present in conflict-affected areas also pose a significant risk to the life and health of millions, and to the resilience of essential service delivery systems. Flooding coal mines, factories exposed to shelling, toxic landfills, chemical spills: these are yet another aspect of daily reality in Eastern Ukraine.

It is to raise awareness about these risks that the 3P Consortium – a group of Ukrainian and international NGOs, was formed in 2019 with financial support from the Directorate-General for European Civil Protection and Humanitarian Aid Operations (DG ECHO) and the United States Agency for International Development (USAID) / Office of Foreign Disster Assistance (OFDA)

In 2019 on October 13th, celebrated as the International Day for Disaster Risk Reduction, the 3P Consortium introduces its programme which aims at supporting the Government of Ukraine fulfill its commitment under the Sendai Framework for Disaster Risk Reduction 2015-2030. The 3P programme aims to reduce vulnerability to disaster risks in Eastern Ukraine by preparing, preventing and protecting civilian populations who are at risk of a major disaster.

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KEY FINDINGS

Anthropogenic Hazards

Velykoandalsky Refractory Plant, 21.04.2020.
By PJSC VARP.

Liquidation of ammunition storage from Second World War near Olhynka, 31.10.2018.
By SESU.

Residential buildings damaged by shelling in Hranitne, 28.05.2016.
By Police Department of Volnovakha Raion.

Volnovakha Raion is located in the southern part of Donetska Oblast in Eastern Ukraine. This is a heavily industrialised part of the country and the contact line (CL) passes directly through the eastern part of the raion. Currently, around **11 potentially hazardous facilities are located within Volnovakha Raion**, whilst within Donetska Oblast there are **78 facilities within 25km of the raion.** Many of these are located in neighboring Mariupol and in Donetsk, in the non-governmental controlled area (NGCA).

These facilities include thermal power stations, petroleum facilities, coal mines, quarries, water supply infrastructure, tailing dams, spoil tips, machine-building facilities, and iron and steel works. They are considered to pose both an environmental and human risk due to the hazardous substances present and the threat of disruptions or malfunctions due to conflict or neglect.

The settlement of Olhynka in the north of the raion has the highest exposure to hazardous facilities, with 3 in immediate proximity. Novotroitske meanwhile, located close to the CL, has 4 facilities and 9 spoil tips within 5km. Whilst there are relatively few in Volnovakha Raion itself, there are **over 300 spoil tips located within 25km, predominantly in Donetsk City.** Several tailing dams are also located in the raion and in neighboring Mariupol.

Coal mining and the mechanical engineering industry are major sources of air pollution in and around the raion. Frequent maximum permitted concentration (MPC) overage is registered, in particular for aerosols, methane, nitrogen dioxide, hydrogen sulfide and sulfur dioxide. Chronic exposure to air pollution increases mortality from stroke, heart disease, chronic obstructive pulmonary disease, lung cancer and acute respiratory infections (WHO, 2020).

With 319 events within 2km, Shyrokyne experienced the most conflict incidents between July 2019 and June 2020. This was followed by Pikuzy, Novotroitske and Vodiane, all of which recorded over 150 incidents during the same period. In addition to being an anthropogenic hazard, conflict in Volnovakha Raion acts as a trigger for other hazards and impacts societies' coping capacity.

The settlements with the highest numbers of satellite-detected fires between 2001 and 2019 were Volnovakha, Novotroitske and Olhynka. **Significantly more fires were detected in Volnovakha than any other settlement in the raion.** In addition, land cover mapping from satellite imagery identified significant fuel for wildfires within proximity to these settlements. This is a concern given the number of conflict

Natural Hazards

Quarry of the Dokuchaievsk Flux and Dolomite Industrial Complex, 24.04.2014.
By Anastasia Fedorenko, Wikipedia.

Damage of high-voltage power line near Granite, 27.11.2015.
By Ministry of Defence of Ukraine.

Repair works on the water supply system in Volnovakha Raion, 31.07.2020.
By Voda Donbass Company.

incidents in the area, which can be a trigger for wildfires.

According to the Armed Conflict Location & Event Data Project (ACLED) database, **7 settlements across the raion have been affected by landmine explosions since 2017.** Taking into account the known landmine field location, the most at risk were Pavlopil, Lebedynske and Orlovske, all in the south of the raion close to the CL. In addition to acting as a potential wildfire trigger, landmines reduce coping capacity of communities and complicate access by emergency response services. Snow, heavy rains, flooding and smog were mentioned in secondary data sources as natural factors increasing mine-explosion risk with the absence of visible warning signs.

This region of Ukraine often experiences extreme weather. During cold waves and heat waves, there is potential for disruption to water, electricity and heating supply infrastructure, which is exacerbated by the ongoing conflict. If affected, the coping capacity of the population can be decreased significantly, increasing vulnerability to these extreme weather events. **Based on 2000 to 2019 data, 77 settlements in Volnovakha Raion experienced an average of 30 days or more per year where temperatures exceeded +37°C.** The settlements most at risk from heat waves included Peredove, with an average of 42 days, and Vilne, Novoselivka Druha and Kyrylivka with 41 days each. Droughts are becoming increasingly common in the region and present a further compounding factor.

As for cold waves, **Viktorivka experienced 12 days on average where temperatures fell below -15°C**, making it the most at risk from cold waves. Twelve further settlements experienced an average of 10 or more days below this temperature.

Vulnerability was calculated based on susceptibility and coping capacity, accounting for factors such as conflict exposure, employment, dependency and distance to key services. **Rural settlements were found to be more vulnerable to natural and anthropogenic hazards**, in particular those <5km from the CL. Shyrokyne, a rural settlement <5km from the CL, had the highest overall vulnerability.

Predictably, settlements closer to the CL were more exposed to conflict. **Urban settlements had the highest proportion of the population that were vulnerable heads of households** including widows, single parents or single women. In addition, distance to key services affects coping capacity. For example, it was found that populations in **settlements <5km from the CL generally had to travel further to reach an education facility***.

* Data for this overview was gathered from different secondary sources. For more details, please see the methodology section here

INTRODUCTION

Background

Since 2014 Ukraine has been affected by conflict, and civilians continue to experience the negative effects of the crisis. Since April 2014, the United Nations Office for the Coordination of Humanitarian Affairs (UNOCHA) reported that more than 3,000 civilians have died, 9,000 have been injured and an estimated 1.5 million people have been internally displaced. Today, despite the Minsk agreements, the conflict continues to affect 5.2 million people, of whom 3.5 million are in urgent need of protection and humanitarian assistance (UNOCHA 2019). In parallel, the population remains vulnerable to pre-existing natural and anthropogenic hazards such as extreme weather events and hazardous critical infrastructure failure. Systems in place to cope with these hazards are becoming increasingly vulnerable due to lack of maintenance and continued conflict, limiting local capacity to prepare, prevent, and protect their communities.

Populations living closest to the CL also face conflict-related hazards including: regular shelling; high mine and unexploded ordnance (UXO) contamination; and frequent utility cuts, which are particularly dangerous in harsh winters. Moreover, conflict exacerbates risks posed by pre-existing anthropogenic hazards, both directly through shelling of critical infrastructure and indirectly due to poor maintenance or abandonment.

The conflict also exacerbates the risks of natural hazards. Eastern Ukraine has a humid continental climate characterised by large seasonal temperature differences, with hot summers and cold winters. Extreme weather events are not uncommon in this region. Severe winters coupled with poor or damaged shelter infrastructure or heating services can increase the risk of hypothermia and carbon monoxide poisoning. In 2006, 60,000 residents in the city of Alchevsk were left without heating for weeks due to a heating system failure during a severe cold spell, resulting in the evacuation of all children until heating was restored (2006, February 11, *The Guardian*). This scenario was repeated to a lesser extent in February 2017 when electricity and water infrastructure in Avdiivka was extensively damaged and led to a significant decrease in capacity of the heating system for several weeks, prompting local authorities and humanitarian actors to set up communal heating points (2017, February 1, *UNICEF press release*).

In summer months, heat waves pose a threat of heat stroke, particularly to the elderly and other vulnerable populations. Due to the conflict, access to safe drinking water may be disrupted if water supplies are damaged or halted. In addition, Eastern Ukraine is susceptible to wildfires during hot summer months and conflict-related explosions only increase the likelihood of wildfires due to proximity to the CL. In 2010, the region experienced a 24-day heat wave which triggered hundreds of wildfires.

This Area Based Risk Assessment (ABRA) aims to highlight the multiple hazards settlements are exposed to, both natural and anthropogenic, and their risks to such hazards.

Overview of Assessed Area

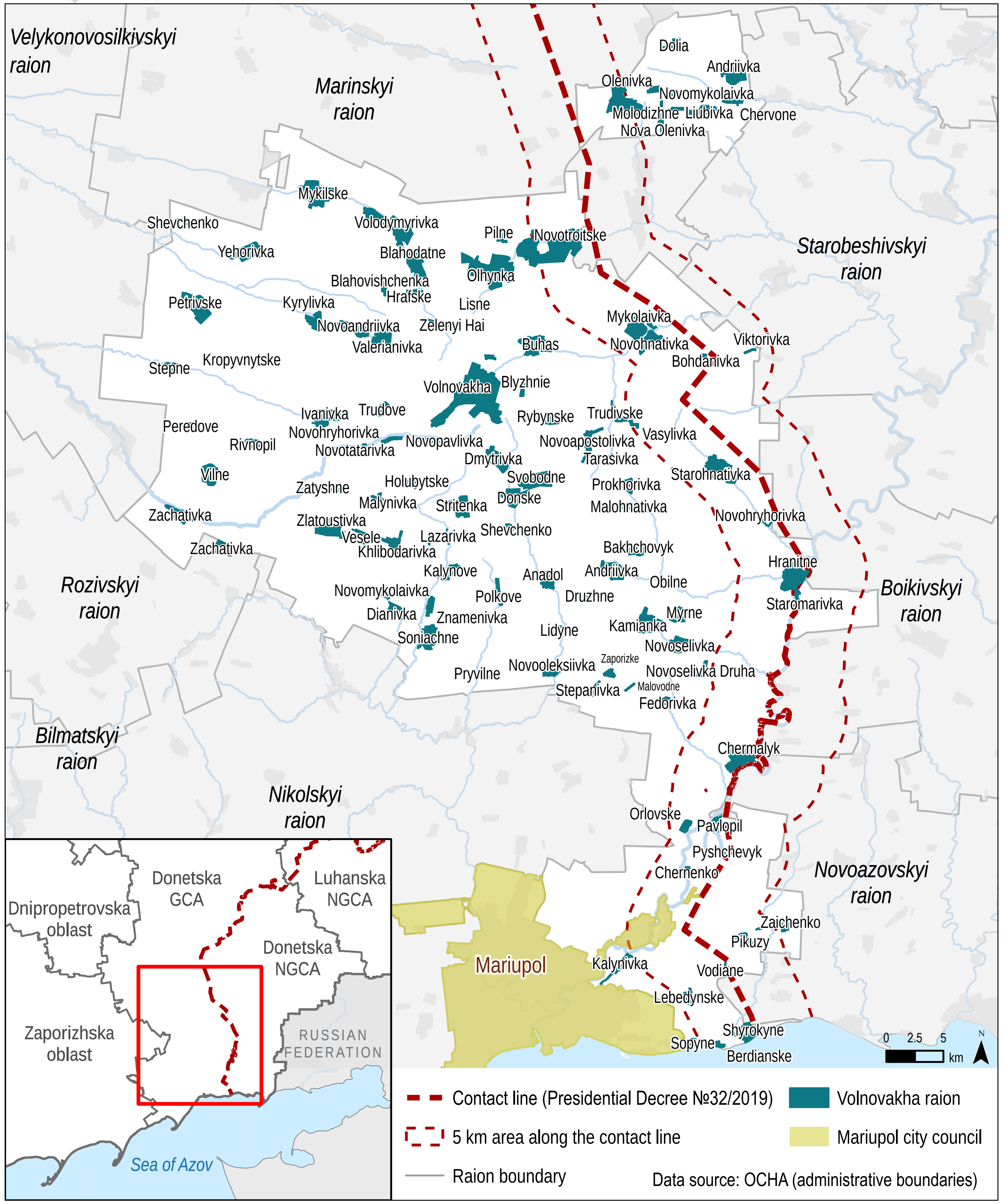
Volnovakha Raion is located in the southern part of Donetska Oblast in Eastern Ukraine, a steppe climatic zone with low precipitation. The area of Volnovakha Raion is 254,944 ha, including 157,800 ha of agricultural land (62% of the raion area). The total population is 95,181 (2020) and the administrative center is Volnovakha City, with an estimated population of 23,305 (CVA, 2018).

Volnovakha Raion includes 1 city council (Volnovakha), 8 urban-type councils and 35 village councils, with 103 settlements in total. Twelve settlements have been divided by the CL and are outside of the GCA, whilst 22 are located within a 5 km strip area along the CL.

According to the new prospective plan of administrative division, the raion includes seven hromadas; namely: Khlibodarivska, Myrnenska, Olhynska, Volnovaska, Vuhledarska, Sartanivska and Dokuchaivska.

There are deposits of various minerals (granite, kaolin, clay, sand, rubble) in the raion, and mining along with agriculture are the main industries of the area. Two large metallurgical plants are located in a neighboring area of Mariupol City Council; Azovstol Iron and Steel Works and Illich Iron and Steel works, both operated by Metinvest. These plants are considered to be the largest polluters in the region.

Overview map for Volnovakha Raion



METHODOLOGY

Methodology Overview

This ABRA for Volnovakha Raion aims to develop a disaster risk profile by assessing the vulnerability and hazard exposure of communities. This is calculated using a risk equation, which assesses several indicators for hazard, exposure and vulnerability.

The ABRA analyses geospatial data on hazard exposure and community vulnerability to assess both natural and anthropogenic risks. It is conducted at the sub-regional level, and relies on both locally available data and global datasets. As of 2020, there is no centralized and functional platform for open geospatial data access for the region, requiring disaster risk practitioners to seek information from a variety of sources.

Global datasets were also used during the assessment wherever possible. However, due to the localised area of the research, it was only possible to use datasets where the resolution was high enough to be appropriate.

Methodological approaches used within this work fall within the framework of The Global Facility for Disaster Reduction and Recovery (GFDRR), which is a global partnership that helps countries better understand and reduce their vulnerability to natural hazards and climate change (GFDRR, 2019).

For anthropogenic hazards, the Flash Environmental Assessment Tool (FEAT) 2.0 Pocket Guide was used to highlight human and environmental exposure to hazardous substances. The FEAT methodology was developed by the National Institute for Public Health and the Environment (RIVM) for the United Nations Environment Programme (UNEP) and UNOCHA. The FEAT Pocket Guide helps to support initial emergency actions and is seen as the entry point for more comprehensive expert assessments. The FEAT process can also be used in preparedness and community awareness efforts, which is the approach taken in this risk profile and the case studies.

The risk profile is based on available secondary data review and it was not possible to include all relevant indicators to determine risk. However, this risk analysis can serve as an useful indication of which settlements to prioritize for implementing risk reduction programmes, as well as evidence for further primary data collection to support DRR initiatives in areas of greater concern.

Risk

According to the United Nations Office for Disaster Risk Reduction (UNDRR), "disaster risk" is defined as "the potential loss of life, injury, or destroyed or damaged assets which could occur to a system, society or a community in a specific period of time, determined probabilistically as a function of hazard, exposure, vulnerability and capacity." (UNDRR, 2017).

The World Risk Index, developed by the United Nations University's Institute for Environment and Human Security (UNU-EHS) and Alliance Development Helps (Bündnis Entwicklung Hilft), calculates disaster risk based on the exposure to key natural hazards as well as social vulnerability in the form of the population's susceptibility and their capacity for coping and adaptation (Bündnis Entwicklung Hilft, 2019). The ABRA takes this approach for assessing disaster risk, through assessing the multiplication of a settlement's hazard exposure and its vulnerability. The specific indicators and their weighting used in the risk calculation is further illustrated in figures 1.1 and 1.2.

It is important to highlight that the objective was to assess risk to the main hazards of the region, but is not inclusive of all natural and anthropogenic hazards. Inclusion was based on consultations with local authorities and 3P Consortium members and hazards exacerbated by the state of industrial objects and conflict dynamics throughout 2019-2020 were prioritized.

Hazard

Hazards refer to the “probability of a potentially destructive phenomenon” (World Bank, 2014). The main hazards that were identified during consultations and secondary data review for Volnovakha Raion were: hazardous facilities from mine-related and chemical use, conflict, wildfires, and extreme temperature from cold waves and heat waves.

For each hazard, the approach was to identify where geographically there was potential for exposure within Volnovakha Raion. Exposure is not limited to human population exposure, but also refers to ‘the location, attributes and values of assets that are important to communities’ (World Bank, 2014).

For hazardous facilities, community exposure is the only component considered in the risk equation, although it is important to further calculate the specific human health exposure and environmental exposure to soil and rivers as highlighted in the FEAT analysis (p.14 -15). However, this requires an individual assessment of each hazardous site, its substances and quantities present. This further analysis is recommended for sites that are close to the CL or have experienced disruptions in maintenance and operations.

As well as posing a direct hazard, conflict is a trigger for wildfires, and also as a variable that hinders coping capacity of the society when coupled with another hazard. Conflict as a hazard looks both at the exposure of the population to conflict incidents, but also exposure of critical infrastructure such as the water network, gas and oil pipelines, and the electricity network.

Cold waves and heat waves are a risk to the population in Volnovakha Raion. This risk can be exacerbated by conflict-related disruption to gas, electricity and water infrastructure, due to the impact on the affected population's coping capacity.

Vulnerability

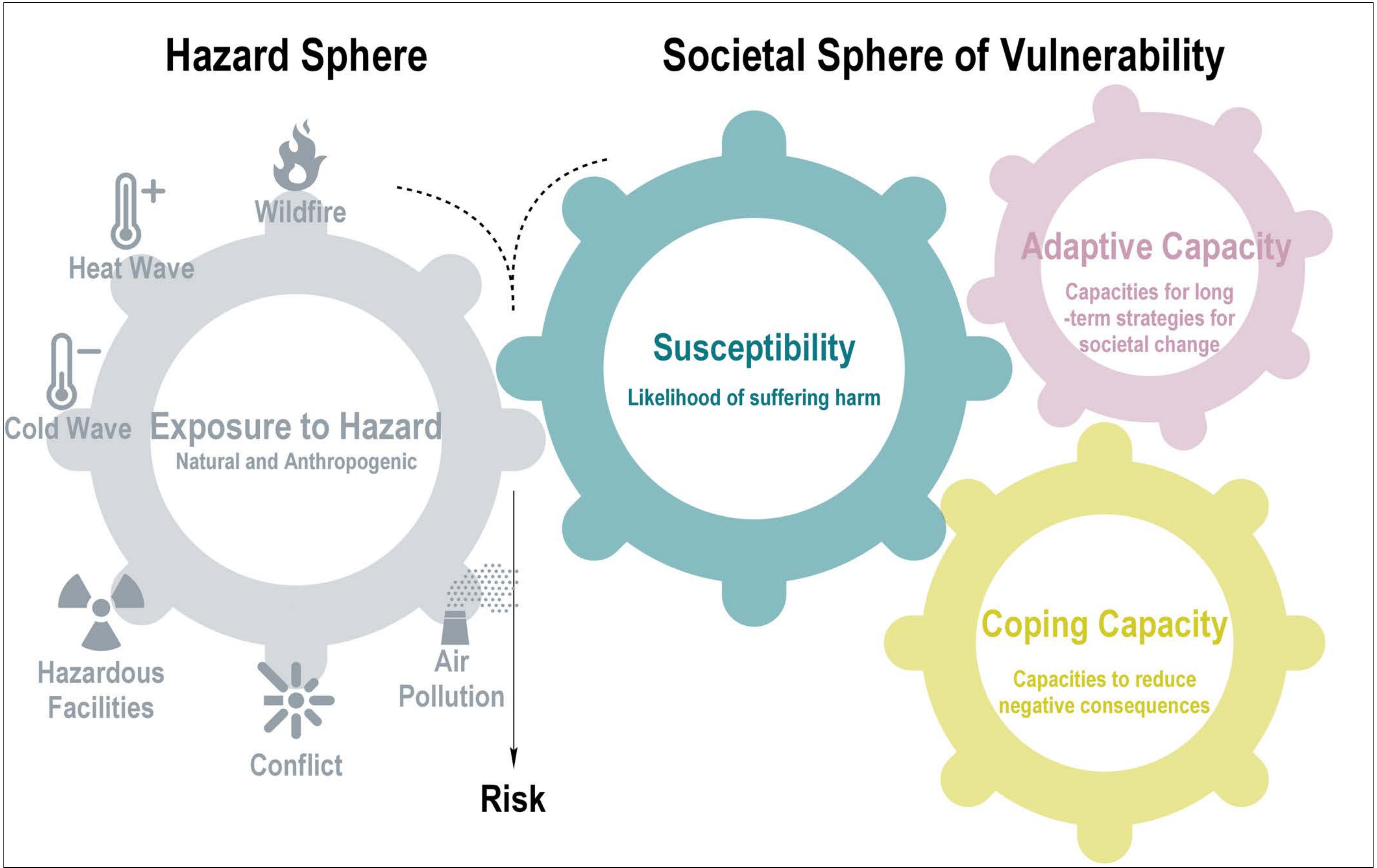
Vulnerability refers to the societal sphere, and its spatial interaction to a hazard is what defines disaster risk. Without societal exposure to a hazard, there is no risk, and where there is exposure to a hazard but low societal vulnerability there is low risk. The societal sphere of vulnerability is a crucial component to defining disaster risk. The societal sphere of vulnerability is comprised of three components that interact with each other: susceptibility, coping capacity, and adaptive capacity as depicted in figure 1.1.

Susceptibility is the likelihood of suffering harm from one of the assessed hazards. Coping capacity refers to the capacities of the society to reduce negative consequences. Lastly, adaptive capacity, or capacity development are the societal capacities in place to develop and maintain long-term strategies to ensure social resilience to hazards and shocks, which includes various types of training, continuous efforts to develop institutions, political awareness, financial resources, technological systems and the wider enabling environment.

The most recent data available for Volnovakha Raion which assesses vulnerability was a 2018 household Capacity and Vulnerability Assessment (CVA) conducted by REACH (REACH, 2018). Several indicators from this CVA conducted on susceptibility and coping capacity were available to be extracted to calculate vulnerability to the hazards assessed and highlighted further in figure 1.2. Data for adaptive capacities was not accessible, and therefore not included into this analysis for the Volnovakha Raion risk profile. However, it is an important variable and indicators should be further researched to form a more comprehensive picture of societal vulnerability.

The household sample from the CVA for Volnovakha Raion was based on four stratas, urban settlements within 5km of the CL, urban settlements further than 5km from the CL, rural settlements within 5km of the CL, and rural settlements further than 5km from the CL. Therefore societal vulnerability indicators will be representative not to the individual settlement but to the settlement classification.

Figure 1.1. Risk diagram



METHODOLOGY: RISK INDICATORS

Hazard Exposure

The exposure of communities to these multiple hazards is something that needs to be better understood at the local level with proper response and contingency plans in place. This analysis hopes to raise awareness to hazard exposure at the local level.

Natural Hazards

Indicator 1.1: Wildfire

- Proximity of settlement to fuel (forest landcover); number of satellite-detected fires (2000-2019) from NASA's Fire Information for Resource Management System (FIRMS) which includes all fires in urban, agricultural and forest land cover types; the number of landmine areas still contaminated and number of conflict incidents in 2019 within a settlement or within 2km of a settlement, as a trigger for more frequent wildfires.

Indicator 1.2: Heat wave

- Percent of days settlement experiences land cover temperature of +37°C or higher during June, July and August (2000-2019) using remote sensing methodologies from MODIS Land Surface Temperature and Emissivity (MOD11) datasets.

Indicator 1.3: Cold wave

- Percent of days settlement experiences land cover temperature below -15°C during December, January and February (2000-2019) using remote sensing methodologies from MODIS Land Surface Temperature and Emissivity (MOD11) datasets.

Anthropogenic Hazards

Indicator 2.1: Hazardous Facilities

- Number of hazardous facilities within a settlement or within 2km of settlement. Geospatial data from the Donbas Environment Information System and WASH Cluster.

Indicator 2.2: Conflict

- Number of conflict incidents within a settlement or within 2km of a settlement. Conflict incidents collected by the International NGO Safety Organization (INSO) for the period of 2019 were used for this analysis.

Indicator 2.3: Air pollution

- 6-month averaged (January-June 2020) satellite data from Sentinel-5P on NO_2, SO_2 and aerosols.

Susceptibility

Population groups that are more susceptible to a hazard have increased vulnerability. Susceptibility is driven by many components but two components the REACH CVA provides data on that influence susceptibility are dependencies and economic capacity.

Dependency

Indicator 3.1: Households with high number of children

- Relevance: Children are more susceptible to hazards as they have higher dependency on others and may be unable to protect themselves or evacuate if necessary. Children are particularly sensitive to changes in climate, because their developing systems limit their ability to adapt to extreme heat and cold. Therefore, households with more children are more susceptible.
- Indicator: Proportion of households with three or more children.

Indicator 3.2: The Elderly

- Relevance: Similarly to children, the elderly are more susceptible to hazards as they have higher dependency on others and may be unable to protect themselves or evacuate if necessary.
- Indicator: Proportion of the population 65 years or older.

Indicator 3.3: Disability

- Relevance: Apart from the potential physical inability to evacuate during a disaster, their reliance upon others to ensure their evacuation to safety may involve reliance upon public services.
- Indicator: Proportion of the population with one or more disability.

Indicator 3.4: Heads of Households (HoH) who are widows, single parents, or single female HoH

- Relevance: Single female HoHs, widows, and single parents are found to be disproportionately affected by disasters due to their compounded vulnerabilities and thus this group is considered more susceptible to the shocks of hazards.
- Indicator: Proportion of HoHs who are either a widow, a single parent, or single female HoH.

Indicator 3.5: Farmers

- Relevance: Farmers are included here as a susceptible group because their livelihood is heavily dependent on agricultural land and the environment, something that is extremely exposed to hazards arising from conflict, hazardous chemical facilities, wildfires and extreme temperature.
- Indicator: Proportion of the population whose livelihood is agriculture.

Economic Capacity

Indicator 4.1: The Unemployed

- Relevance: Unemployment hinders the economic capacity for preparedness mitigation measures as well as the financial ability to cope during and after the shock of the hazard.
- Indicator: Proportion of the population that are unemployed.

Indicator 4.2: Pensioners

- Relevance: Those whose economic capacity is dependent on access to their pensions are more susceptible due to the low financial amount and benefits received.
- Indicator: Proportion of the population who are pensioners.

Coping Capacity

The ability of a population to cope after a hazard occurs is crucial in reducing negative consequences and influences one's vulnerability and risk level to a hazard. The REACH CVA and State Emergency Services of Ukraine (SESU) provide data on distances to key services. Data is also available on preparedness awareness, conflict incidents, and displacement status. These are all factors that drive coping capacity.

Distance to Services

- Relevance: Distance to services affect coping capacity, both in terms of accessing important networks of information regarding preparedness and early warning, but also as a response mechanism during the shock of a hazard.

Indicator 5.1: Distance to health care facility

- Indicator: Proportion of population that reports greater than 30 minutes traveling time to a primary health care facility.

Indicator 5.2: Distance to social services facility

- Indicator: Proportion of population that reports greater than 20km traveling distance to a social services facility.

Indicator 5.3: Distance to education facility

- Indicator: Proportion of population that reports greater than 30 minutes traveling time to an education facility.

Indicator 5.4: Distance from a State Emergency Services of Ukraine (SESU) unit

- Indicator: Settlement distance from nearest SESU response unit location.

Indicator 6.1: Bomb shelter awareness

- Relevance: Bomb shelters are common in Eastern Ukraine and can provide temporary safe shelter during the shocks of a hazard.
- Indicator: Proportion of the population who are not aware of the nearest bomb shelter.

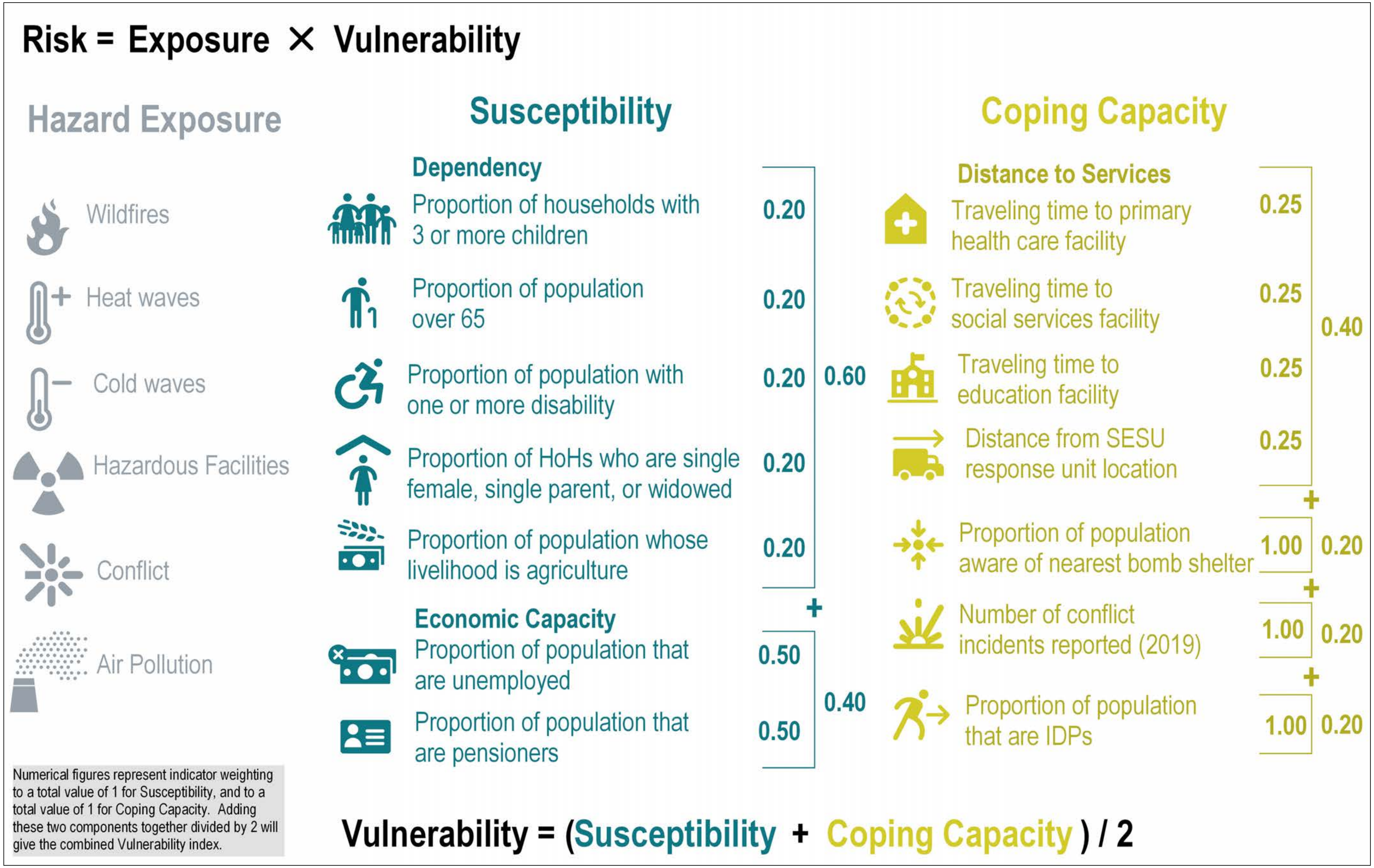
Indicator 7.1: Conflict

- Relevance: Conflict is both relevant as a direct hazard but also something that hinders the coping capacity of communities to other natural and anthropogenic hazards.
- Indicator: Number of conflict incidents reported by INSO in a settlement or within a 2km radius.

Indicator 8.1: Internally Displaced People (IDPs)

- Relevance: IDPs, depending on their current shelter status, are usually more susceptible to the exposure of hazards, but also IDPs lack coping capacities due to limited social networks in their new place of residence.
- Indicator: Proportion of the population that are IDPs.

Figure 1.2 Risk indicator diagram



HAZARD - WILDFIRES

Hazard Description and Findings

Wildfires and urban fires are a major hazard to the environment, populations and infrastructure. Triggered by a variety of natural and anthropogenic activities, they can lead to both direct (severe burn, smoke inhalation) and indirect mortality (longer term health hazards) and destroy large swathes of natural habitat and manmade structures (houses, factories or utility infrastructure). With rising global temperatures and an increase in the frequency and severity of heat waves, the frequency of fires globally is growing every year (IPCC, 2018).

This review contains data on fires in Volnovakha Raion from two sources: satellite data from the Fire Information for Resource Management System (FIRMS)[1] from the National Aeronautics and Space Administration (NASA) for the years of 2001-2019 and data provided by the State Emergency Service of Ukraine in Donetska Oblast for the years 2015-2018 (SESU, 2019). According to SESU data, most of the fire events occurred in Volnovakha, Novotroitske, Volodymyrivka, Olhynka and Andriivka.

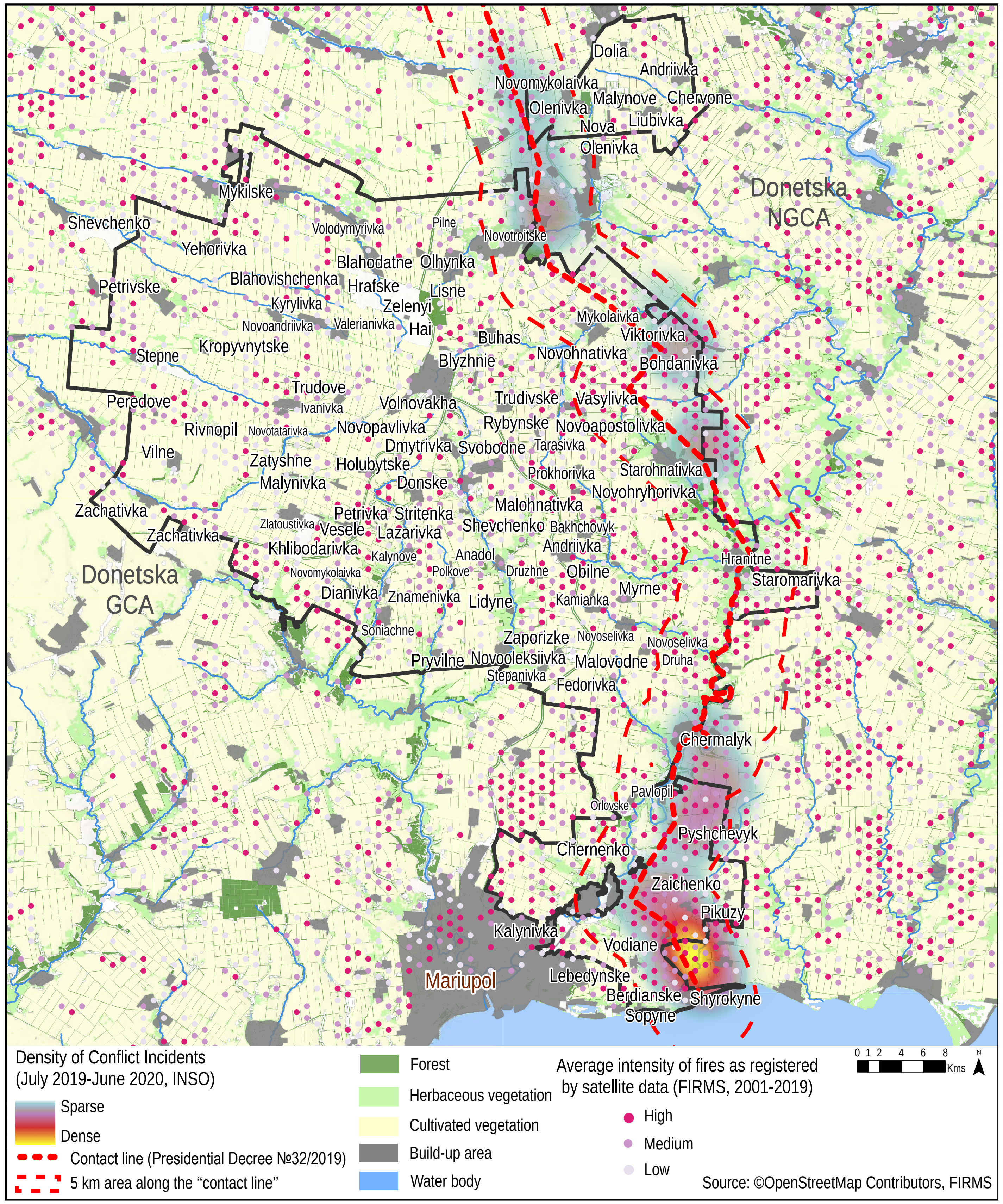
FIRMS satellite data on the other hand indicates that the highest fire frequency was observed near Volnovakha, Novotroitske, Olhynka, Volodymyrivka, Olenivka, Mykilske, Starohnatyvka, Hranitne and Kalynivka. Five of these settlements are located along the CL in an area of high conflict density, which may have caused many of the detected fire events.

Along with conflict incidents themselves, landmine contamination is a potential trigger for wildfires. Landmine fields have been registered[2] near 12 settlements (Pavlopil, Lebedynske, Orlovske, Blahodatne, Rybynske, Chernenko, Volnovakha, Blyzhnie, Pyshchevyk, Blahovishchenka, Hrafske, and Sopyne). In addition, landmine explosions have been recorded by ACLED within 2km of Olenivka, Hranitne, Zlatoustivka, Pikuzy, Staromarivka, and Zaichenko. ACLED data on landmine explosions was included in the wildfire indicator component.

1) FIRMS dataset is based on satellite observations by MODIS (Moderate Resolution Imaging Spectroradiometer) and includes data regarding the time, location, and intensity of fires. Dataset excludes fires on industrial land to avoid conflating the numbers with heat signatures related to process on enterprises.

2) Map of mine-contaminated areas by the Ministry of Defense of Ukraine (https://mod-ukr.imsma-core.org).

Map 1.1 Average frequency and intensity of fires



Map 1.2 Regional overview of forest land cover

Many satellite detected fire events in the area are located on agricultural land. This might be a result of the common agriculture practice of stubble burning to prepare a field for sowing, which can lead to the uncontrolled spread of fire, but also leads to soil moisture loss, which is already limited in the area.

Key takeaways

1. With the increase in wildfire frequency due to climate change, there is a need for an alert system and early warning approach in fire monitoring services.
2. Restoration of forest belts, fire-control measures in the forest areas and firebreak implementation between areas exposed to continuing conflict incidents.
3. Control of agricultural stubble burning.
4. Landmine field detection, marking and installation of warning signs followed by de-mining operations should be carried out.

FIRES (all classifications): STATE EMERGENCY SERVICES OF UKRAINE DATA

Map 1.3 SESU trips to reports of fires

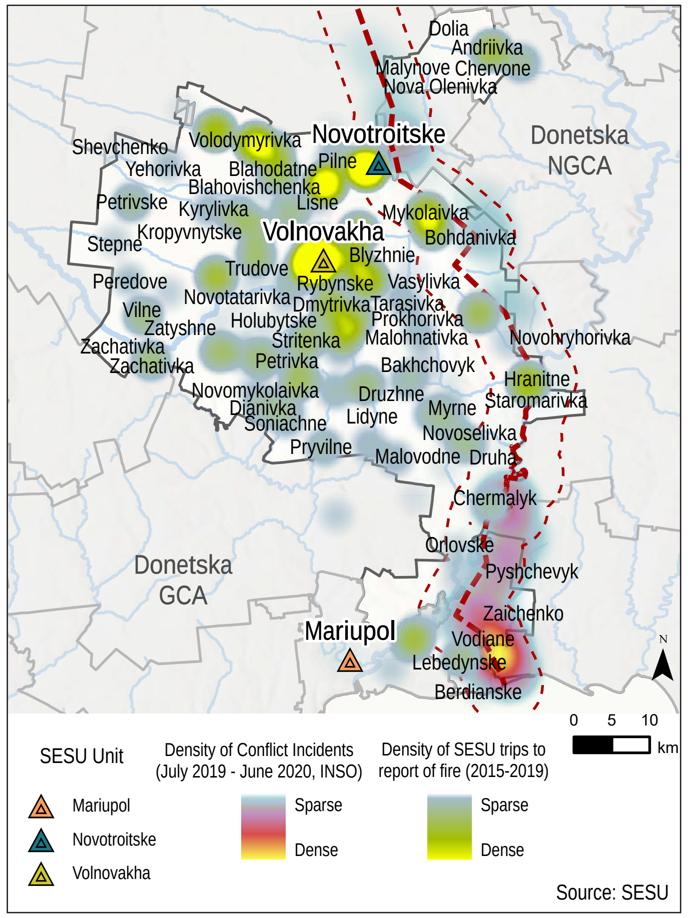
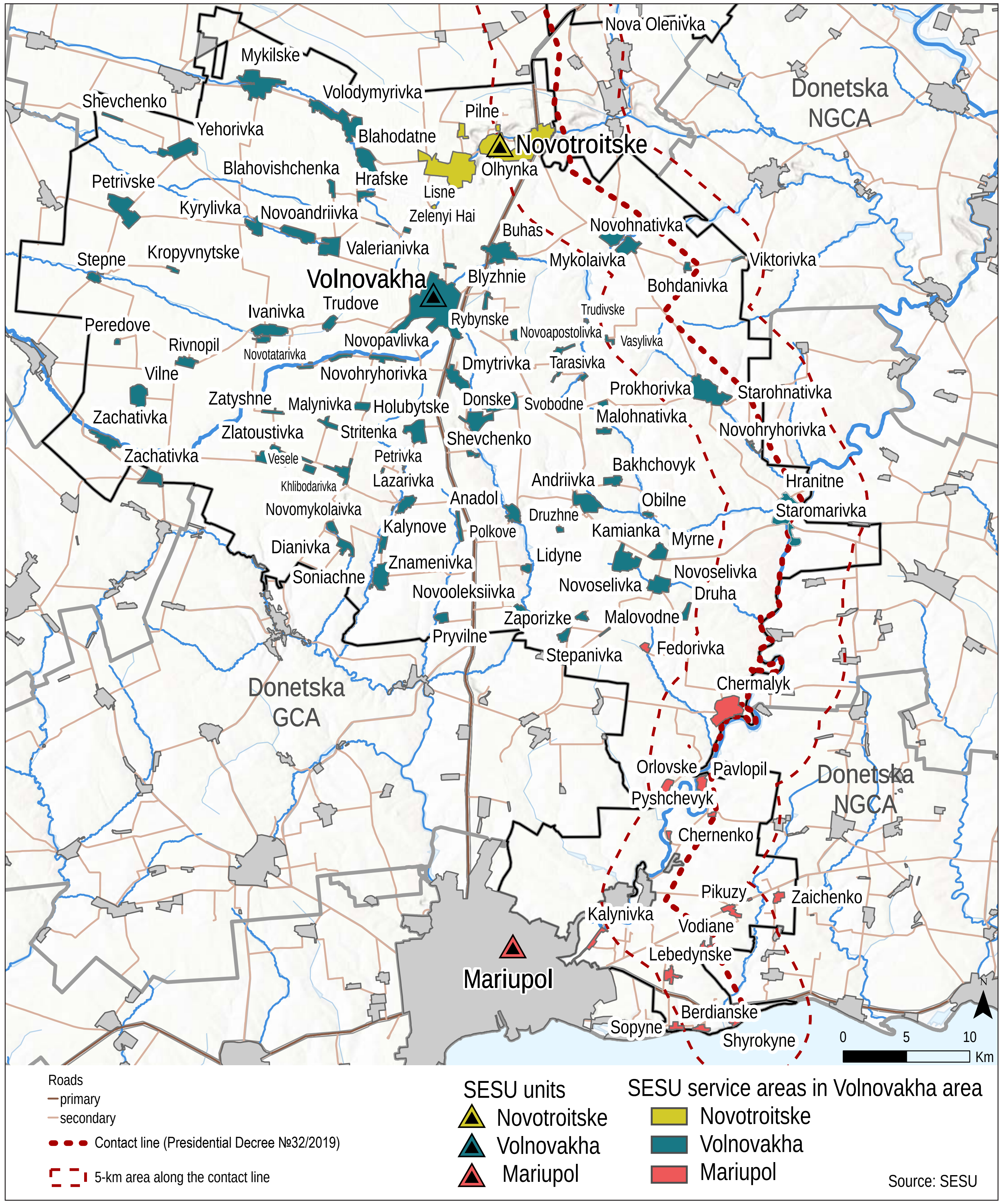


Table 1.1 Annual number of SESU trips to reports of fires

Settlement	2015	2016	2017	2018	Total
Volnovakha	38	63	41	43	185
Novotroitske	23	11	23	22	79
Volodymyrivka	14	11	14	12	51
Olhynka	11	9	19	8	47
Andriivka	6	12	3	2	23
Rybinske	2	6	10	6	24
Hranitne	3	11	8	1	23
Mykoloivka	3	7	9	3	22
Ivanivka	5	4	7	3	19
Mykilske	2	5	5	7	19
Blyzhniie	1	10	3	5	19

Map 1.4 SESU unit location and service area for Volnovakha Raion



Map 1.5 Regional overview of average annual number of SESU trips to reports of fires

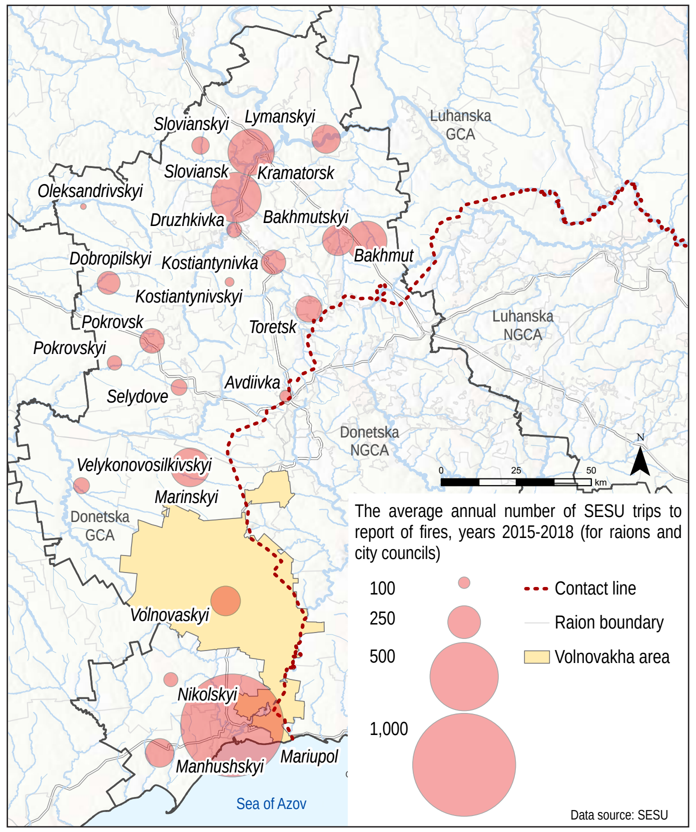
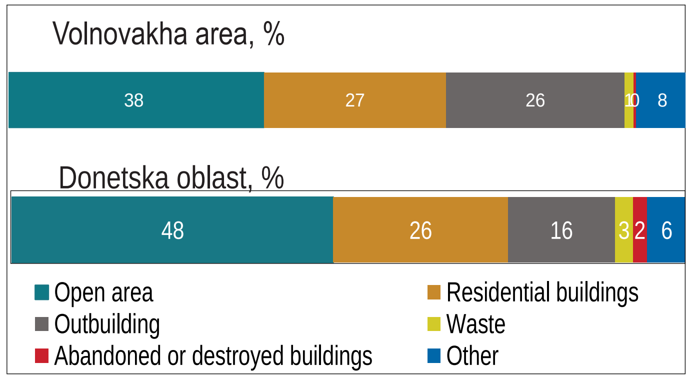


Table 1.2 Most common locations of fires

Affected Area	2015	2016	2017	2018	Total
Open area	59	116	97	76	348
Residential buildings	54	50	49	79	232
Outbuilding	65	50	72	58	245
Buildings of private and municipal enterprises	8	13	7	10	38
Motor transport	10	10	12	1	33
Waste	2	6	4	0	12



HAZARD - EXTREME TEMPERATURES: HEAT WAVES

Hazard Description

Prolonged periods of extreme heat are referred to as heat waves ([IFRC, 2011]) and are a significant hazard for populations, infrastructure and the environment in this part of Ukraine. Whilst the exact definition varies by country, heat waves are usually defined by a signifcant and prolonged deviation from the long-term average temperature. They have a significant impact on society, increasing both mortality and morbidity, as well as increasing strain on both infrastructure and ecosystems.

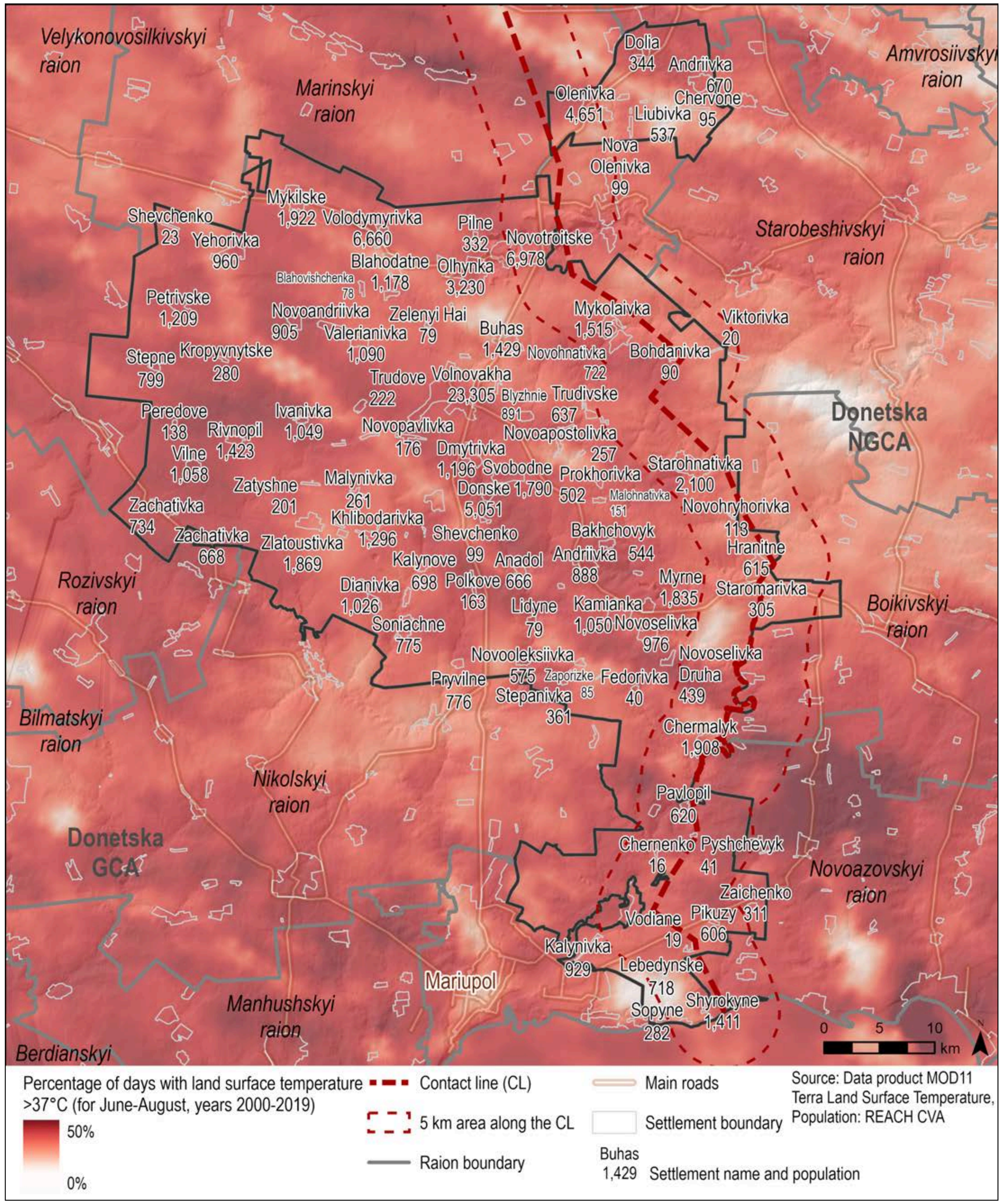
Extreme heat is a leading cause of disaster-related deaths. The 2010 northern hemisphere heat wave led to more than 15,000 indirect deaths globally due to heat stroke and dehydration, particularly affecting susceptible groups. The frequency and severity of heat waves are also increasing over time ([IPCC, 2019]) and will become increasingly difficult to address.

Data on abnormally high temperatures in Volnovakha Raion and adjacent territories was acquired from MODIS Land Surface Temperature and Emissivity[3] (MOD11) ([Wan, Z., Hook, S., Hulley, G., 2015]), using temperature observations in June, July and August. A temperature of +37°C was determined as the lower limit for abnormally high temperatures, one standard deviation above the observed mean during the study period (2000-2019). Several heat wave hot spots are visible on map 2.1; in particular in the south of the raion near Pavlopil, and around Rivnopil in the northwest of the raion.

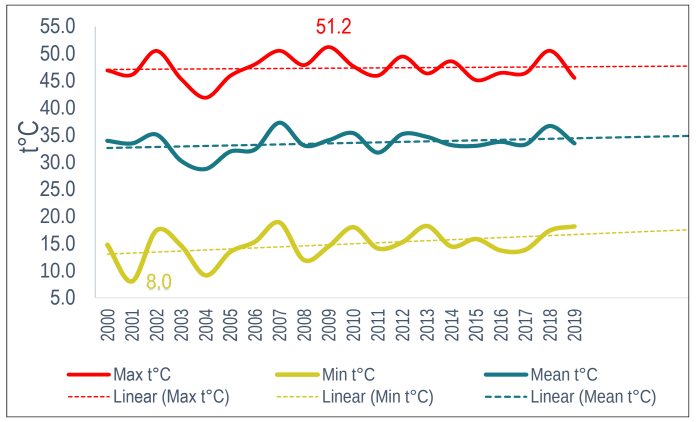
As indicated in Graph 2.1, the highest land surface temperatures (+51.2°C) were observed in June 2009, whilst temperatures reached +50.5°C in July 2002, July 2007 and June 2018. The 20-year averaged land surface temperature during the summer is +33.5°C. In the last 10 years, a continuous gradual increase of mean temperatures has been observed (with a prognosis of +1°C in the next 5 years) and a more rapid increase of minimum land surface temperature (with a prognosis of +2.5°C in the next 5 years according to linear trend).

3) MODIS Land Surface Temperature (LST) and emissivity daily data are estimated from land cover types, atmospheric column water vapor and lower boundary air surface temperature and separated into tractable sub-ranges for optimal retrieval.

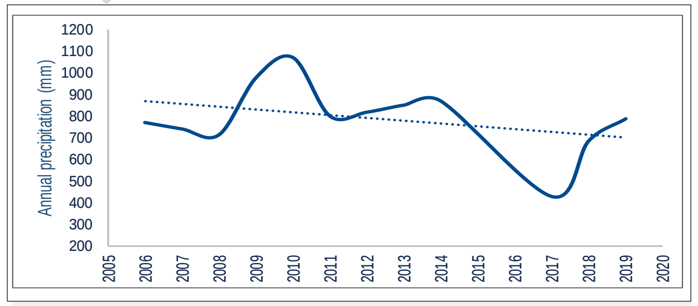
Map 2.1 Percentage of days in summer season with temperatures >37°C



Graph 2.1 Mean, max & min temperature in summer months



Graph 2.2 Annual precipitation



It is also worth mentioning that heat waves can be interlinked with droughts and extreme temperatures can exacerbate drought impacts. Graph 2.2 shows annual precipitation at Volnovakha Weather Station and the average trend has clearly been declining, reaching just 430mm in 2017. Drought conditions can dry out vegetation, providing ample fuel for wildfires (Centre For Climate and Energy Solutions, 2019).

The use of land surface temperature products such as MODIS helps authorities identify areas and periods in which abnormally high temperatures can affect the health of residents, in order to support preparedness and response mechanisms. Coupled with societal data on vulnerable groups, particularly those who are more susceptible to heat waves, authorities can better inform targeting of risk reduction initiatives within communities that see more frequent exposure to abnormally high temperatures.

Key takeaways

1. Inform community and vulnerable groups on [WHO recommended practices during heat waves]
2. Ensure adequate warning system is in place to communicate heat forecasts.

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HAZARD - EXTREME TEMPERATURES: COLD WAVES

Hazard Description

Extreme cold or cold waves are weather conditions defined by either a rapid drop in air temperature or a sustained period of excessively cold weather (IFRC, 2018). Severe cold is a threat to human health as prolonged exposure can lead to hypothermia, frostbite and cardiac arrests which tend to lead to increased mortality (Wang, 2016). Deterioration in transport conditions also leads to higher instances of road traffic accidents (Hayat et al, 2013) and affects utility networks such as water and heating systems (Anel et al, 2017). In addition, extreme cold severely damages crops, affecting food production and livelihoods (Massey, 2018).

In recent years, Ukraine has experienced two cold waves, one in 2006 and one in 2017. According to the IFRC (IFRC, 2006), 884 people died as a result of the extremely low temperatures. Cold waves most commonly cause fatalities due to hypothermia, but also carbon monoxide poisoning in attempts to heat shelters.

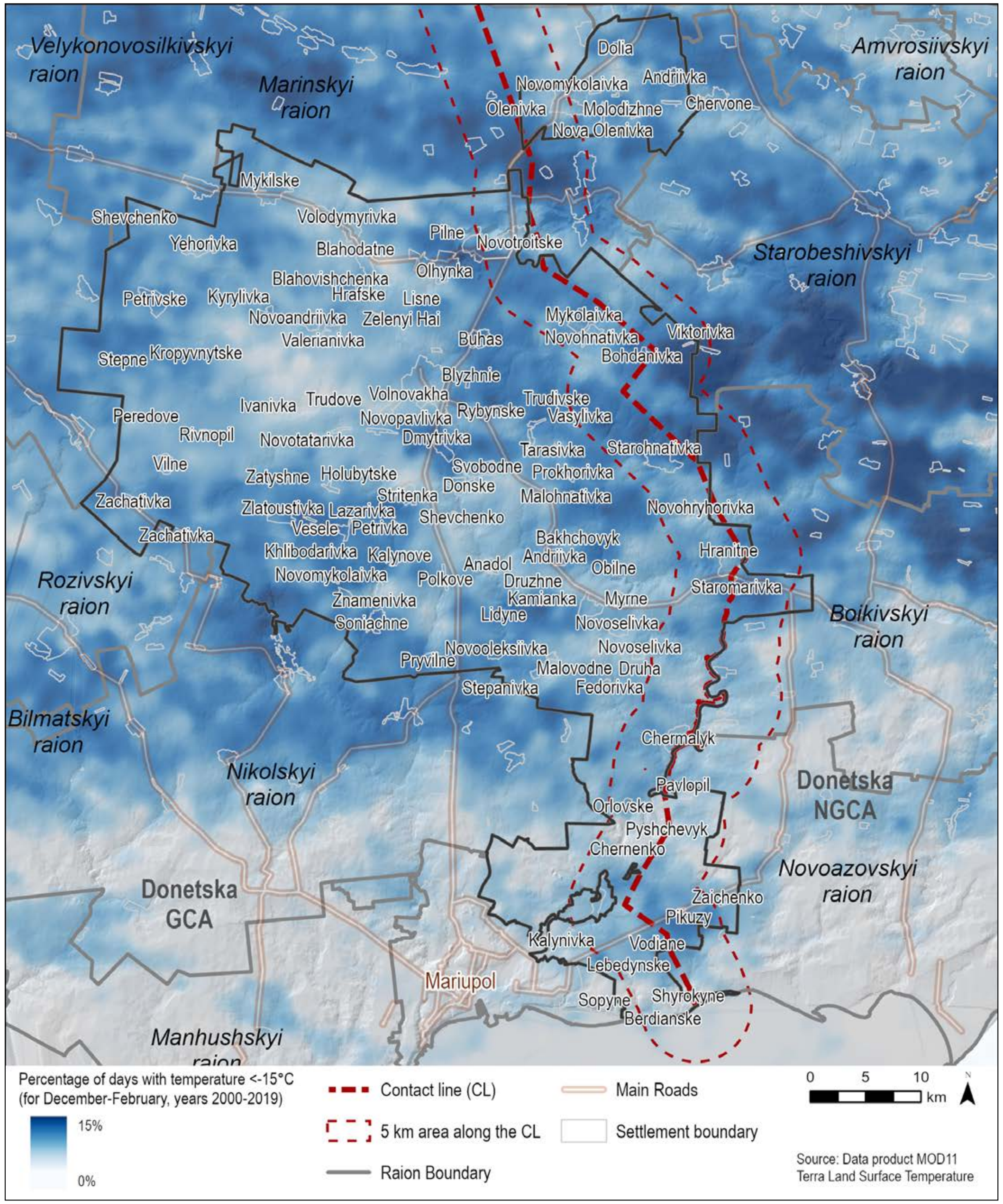
Information about abnormally low temperatures in Volnovakha Raion and adjacent territories was calculated using MOD11[4], based on temperature observations in December, January and February between 2000 and 2019. Utilizing data from 835 satellite acquisitions, Map 3.1 shows the percentage of days with temperature below -15°C during the study period.

Higher frequency of days with extremely low temperatures can be observed in the northeast of Volnovakha Raion near Viktorivka and Bohdanivka, and in the southwest near Vesele. Compared to other raions along the CL, Volnovakha Raion experienced relatively lower frequencies of days with extreme cold.

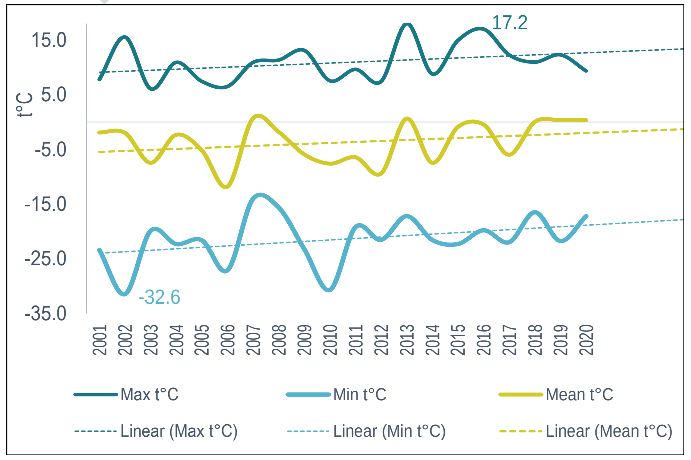
The lowest temperatures recorded throughout the study period (up to -32.6°C) were observed in January 2002 and in winter 2010 (-30.7°C). The highest land surface temperatures in winter (+17.2°C) were observed in 2016. The 20-year-averaged land surface temperature during the winter is -3.7°C. In the last 10 years, a continuous gradual increase in maximum, mean, and minimum winter temperature is evident.

4) The Land Surface Temperature (LST) and Emissivity daily data are estimated from land cover types.

Map 3.1 Percentage of days in season with temperature < -15C



Graph 3.1 Mean, max & min temperature in winter months



While a range of infrastructure can be affected, the most exposed to low temperatures is water and heating infrastructure. Freezing of water pipes, damage to power lines, and failure of heating systems can cause lasting damage to water, power, and heating supplies, putting populations at further risk.

Key takeaways

1. Ensure vulnerable groups in areas that experience the most extreme weather can access financial support to cover basic expenses for heating.
2. Increase awareness of initiatives for communal hot spot locations in the case of complete failure of heating supply.
3. Increase awareness on best practices to keep shelter warm and safely heat shelter during disruptions to conventional heating supply.
4. Local responders to identify the most susceptible populations groups in the community, especially those that may require assistance and develop contingency plans for this population (the elderly, those with a disability, or young children).

HAZARDOUS CRITICAL INFRASTRUCTURE FACILITIES

Hazard Description

Based on review of the Humanitarian Needs Overview (HNO) and the Donbas Environment Information System (DEIS) developed by the Organization for Security and Co-operation in Europe (OSCE) as part of the Environmental Impact Assessment in Eastern Ukraine (commissioned by the Ministry of Ecology and Natural Resources of Ukraine), there are around 11 potentially hazardous critical facilities in the raion and 80 within 25km.

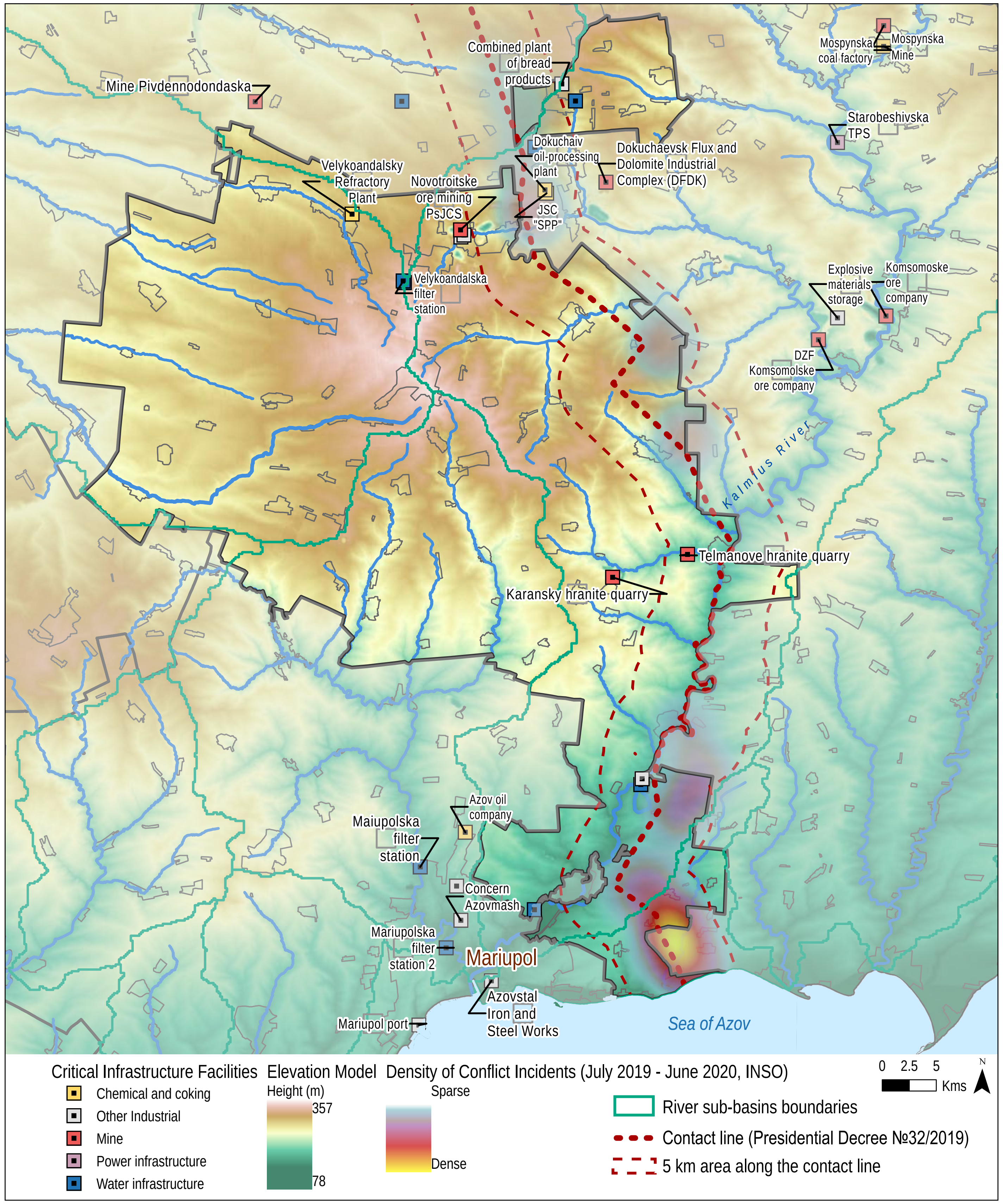
These sites include chemical and coke industries, coal mining, water supply infrastructure, machine building, and metallurgy. These facilities are considered to pose both an environmental and human risk due to the hazardous substances present and threat of disruptions or malfunctions due to the conflict.

Using the Flash Environmental Assessment Tool

Table 4.1 Hazardous facilities within 1km of conflict incidents reported during 2019-2020 (INSO)

Facility name	Distance to settlement in Volnovakha area	2019	2020 January-June
5-bis Coal Mine	Olenivka (13.8 km)	11	28
4-21 Coal Mine	Dolia (9.9 km)	7	13
Krasnohorivsky Refractory Plant	Olenivka (20.1 km)	8	7
Donetsk Plant of Chemical Materials	Dolia (17.7 km)	0	7
Pavlivska Pumping Station	Pavlopil (0.1 km)	9	6
Oktyabrskyi Rudnik Coal Mine	Dolia (19.3 km)	11	5
Trudivska Electrical Sub-station	Dolia (11.4 km)	0	5
17/17-bis Coal Mine	Dolia (11 km)	2	1
Buran Machinery Plant	Dolia (10.8 km)	2	1
Dokuchaivsky Wastewater Treatment Plant	Olenivka (3.4 km)	0	1
Chekist Coal Mine	Dolia (13.7 km)	0	1
Asphalt Concrete Plant	Olenivka (15.8 km)	0	1
Mariupol Water Filter Station	Kalynivka (8.2 km)	14	0

Map 4.1 Locations of major hazardous objects in Volnovakha Raion



(FEAT) 2.0 Pocket Guide, key hazardous facilities within the region and their substances were cross-referenced to determine potential human and environmental exposure in distances (km) based on low and high substance quantities (kg) to provide insight into minimum and maximum exposure. Facilities within 25km of the raion and in the same sub-basins are also included as they may also have environmental impacts here.

The FEAT methodology was developed by the National Institute for Public Health and Environment (RIVM) for UNEP and UNOCHA, based on EU Directives on hazardous substances. Harmonization of Ukrainian legislation with European regulations on handling hazardous substances is one of the priorities in European integration in the field of health and environmental protection.

1. COAL MINING

Coal mining poses many environmental and health risks and frequent explosions of methane have been reported. Meanwhile, many mines are now abandoned, posing serious environmental hazards as mines can become flooded, contaminating groundwater and soil.

High concentrations of radon and methane in the air present an air pollution issue and pose a potential risk of explosions at both operational and abandoned mines. Whilst there are no coal mines within Volnovakha Raion itself, many are located in the surrounding area, potentially impacting populations and the environment in Volnovakha Raion. These include:

- **Pivdennodonbaska Mine №1 (Ugledar):** the mine is periodically de-energised due to electricity debts owed to DTEK, often leading to flooding and potentially causing toxic substances to spread. For example, the power supply was cut off on April 2, 2020 during a period of quarantine due to the COVID-19 pandemic. However, due to the Cabinet of Ministers decree №255, which banned critical infrastructure from being shut down during quarantine, the power supply was restored the following day (Hromadske, 2020).

Within 25km of Volnovakha Raion, there are 14 further coal mines in Donetsk, of which 12 are operational; 3 operational coal mines in Makiivka; 2 in Yasynuvata Raion and 1 in Marinskyi Raion.

Hazardous substance #1: Methane (GHS classification: Flammable, Flam Gas 1.)

Receptors: air, humans. *Exposure distance table:*

IMPACT Shaping practices Influencing policies Impacting lives

Receptor	Distance (km)	Quantity (kg)
Humans (health)	0.2 - 0.3	1 million

Hazardous substance #2: waste from tailings (GHS classification: Toxic Liquid Acute Tox. 1, Aqu. Acute 1). Receptors: soil, groundwater, rivers, humans.
Exposure distance table:

Receptor	Distance (km)	Quantity (kg)
Humans (lethal)	1 - 5	20 - 1000
Humans (health)	> 5	20
Environment (soil)	2 - > 10	20 - 5000
Environment (river)	5 - > 10	20 - 1000

2. QUARRYING

A number of quarries are located in and around the raion, used for the extraction of various minerals and aggregates. One of the main impacts of these sites is the production of large quantities of dust and suspended particulate matter (SPM) which can be carried by wind, causing respiratory problems for nearby populations. The material may also cover soil and vegetation and affect water quality.

- Novotroitsky Quarry: both calcite and quartz ore are extracted and processed here. See detailled case study on pages 16-17.
- Dokuchaevsk Flux & Dolomite Industrial Complex (DFDK): located in adjacent Dokuchaievsk Raion, the plant is used for extraction of calcite, dolomite, quartz, pyrite and limonite. A major fire occurred in 2014, destroying a 35m cable and 50m2 bitumen roof. In July 2014, an unknown party blew up the support to the Obzhig-Vinogradnaya railway bridge, belonging to the plant. Also in July 2014, the power substation at the site was the target of a shelling attack.
- Telmanove Granite Quarry: in December 2014, shelling struck warehouses, offices, roads, railways and other key infrastructure at the facility. Work at the plant has since been suspended.
- Karan Granite Quarry: operations ceased in January 2014 and today the site is abandoned, whilst the quarry itself is flooded, posing a risk of groundwater contamination. Shelling occurred in 2015 at Karan Station, which is used for the transportation of dangerous goods.
- Komsomol Crushing and Processing Plant
- Khlibodarivskyi Aggregrates Quarry

Haz. subs. #1: Cyanide (see case study)
Haz. subs. #2: Ammonium nitrate (see case study)

3. PETROLEUM INDUSTRY

- Azov Oil Company LLC Oil Depot
  Manufacturer of refined petroleum products. The company became bankrupt in August 2020 (Finbalance, 2020) .
- Dokuchaevsk Oil Refinery Plant, located in Dokuchaievska Raion. There is also an oil depot located in Donetsk.

Hazardous substance #1: petroleum - crude oil (GHS classification: Flammable, Flam. Liq. 1)
Receptors: humans, soil, rivers. *Exposure distance table:*

Receptor	Distance (km)	Quantity (kg)
Humans (lethal)	0.4	10 million
Humans (health)	0.6	10 million

4. COAL POWER STATIONS

There are two coal-powered electricity stations within 25km of Volnovakha in adjacent raions.

- **Starobeshivska Thermal Power Station:** Located in Starobeshivskyi Raion (NGCA), the TPS has been operational since 1958. As of 2011, it was one of the largest polluters in Ukraine. The operating company, Donbasenergo, lost control of the plant in 2017 due to the conflict (Kyiv Post, 2017).
- **Kurakhivska Thermal Power Station:**
  Located just 10km from the CL in Marinskyi Raion, this key facility is at high risk from conflict incidents. In 2014-2015 several disruptions were recorded at the station connected to conflict.

Hazardous substance #1: Sulfur Dioxide (GHS classification: STOT SE1). Receptors: air, humans.
Exposure distance table:

Receptor	Distance (km)	Quantity (kg)
Humans (health)	> 5	Any quantity has an impact
Humans (lethal)	> 5	

5. MECHANICAL ENGINEERING INDUSTRY

Many mechanical engineering plants are located within 25km of Volnovakha Raion, particularly in Mariupol and Donetsk. This facilities are worth mentioning here due to their far-reaching environmental impacts, predominantly due to air pollution.

Two of the largest plants in the area are the Azovstal and Illich Iron and Steel Works, operated by Metinvest, in Mariupol. The city has been a frequent target during the conflict and was attacked several times, and has been in the NGCA for 3 months in 2014. However, operations continued throughout the conflict. Both plants suffer from outdated equipment and lack environmental safety controls.

Air pollution is a major issue and the vast majority of emissions in the city are produced by Metinvest steelworks. Some equipment has since been updated, leading to some air quality improvements (Arnika, 2017). There is however also a risk to groundwater and surface waters due to tailing waste (Dan et al., 2017), whilst spoil heaps also cause extensive dust pollution.

Hazardous substance #1: emissions are high in pm2.5 and pm10 particles and contain toxic substances such as hydrogen sulfide, carbon monoxide, phenol and formaldehyde. For example, **Hydrogen Sulfide:** (GHS classification: Toxic gas, Acute Tox. 1).
Receptors: air, humans.
Exposure distance table:

Receptor	Distance (km)	Quantity (kg)
Humans (health)	2-5	10,000 -> million
Humans (lethal)	0.4-1.3	10,000 -> million

Haz. subs. #2: Waste from Tailings (see above).

Other mechanical engineering facilities include Concern Azovmash in Mariupol and nine in Donetsk including Tochmash Machinery Plant and Nord Machinery Plant in Donetsk.

6. WATER TREATMENT PLANTS

Velykoandolska Filtering Station is in the raion. There are also 2 in Mariupol and 2 in Yasynuvata.
Hazardous substance #1: Chlorine (GHS Classification: Toxic Gas, Acute Tox. 1.)
Receptors: air, humans, critical infrastructure.
Exposure distance table:

Receptor	Distance (km)	Quantity (kg)
Humans (lethal)	0.4 - 1.3	> 1 million
Humans (health)	2 - 5	10,000 - >million

Hazardous substance #2: Chlorine (GHS Classification: Toxic Liquid, Acute Tox. 1)
Receptors: soil, groundwater, rivers, humans.
Exposure distance table:

Receptor	Distance (km)	Quantity (kg)
Humans (lethal)	1-5	20- 1000
Humans (health)	> 5	20
Environment (soil)	2 - > 10	20 - 5000
Environment (river)	5 - > 10	20 - 1000

Wastewater treatment plants include Olenivska sewage treatment plant in Volnovaskyi Raion and Dokuchaevskaya wastewater treatment plant in Dokuchaievsk.

Hazardous substance #1: Methanol (GHS Classification: Health Hazard, STOT SE1)

Receptors: soil, groundwater, rivers, humans.

Exposure distance table:

Receptor	Distance (km)	Quantity (kg)
Humans (lethal)	> 5	Any quantity has an impact
Humans (health)	> 5	
Environment (soil)	> 10	
Environment (river)	> 10	

7. AGRICULTURE

- Russia LLC, Zlatoustivka: farm keeps animals, processes meat, and grows and processes cereals.
- Volnovaska Poultry Breeding Farm: sewage is discharged into a pond near a tributary of the Dnieper River Basin, important for fisheries. Biological oxygen demand (BOD5) is 31.03mg/dm3, significantly exceeding MPC (3mg/dm3). Wastewater treatment plants also require reconstruction.

Hazardous substance #1: Disinfecting agents, antibiotic and hormonal products, pesticides and animal Waste (GHS Classification: Aqu. Acute 1)
Receptors: soil, groundwater, rivers.
Exposure distance table:

Receptor	Distance (km)	Quantity (kg)
Environment (soil)	2.8 - > 10	100 - 5000
Environment (river)	> 10	100

8. OTHER FACILITIES

- Explosives storage, Starobeshivskyi Raion: this facility poses a threat to nearby populations in case of unintented explosions due to neglect or poor maintenance.

NOVOTROITSKE ORE MINING PrJSC CASE STUDY

Facility Description

Novotroitske Ore Mining Private Joint-Stock Company (PrJSC) is the largest producer of limestone in Ukraine, with a production volume of 4 million tons per year. Whilst local people have been mining limestone since 1908, mines have only been in constant operation since 1933.

According to secondary data review and the results of field surveys conducted under the 3P Consortium project by the Red Cross (2019) and based on interviews of residents of Novotroitske area, there are over 50 sources of atmospheric pollution connected with Novotroitske Ore Mining PrJSC. The explosions occur every Tuesday in the Quarries of the complex. In August 2019, debris from the blasted rocks reached the outskirts of Novotroitske village, although there were no casualties. Wastewater from mine operations is discharged into the Sukha Volnovakha River, part of the Kalmius River Basin. The discharged water tends to be of higher salinity.

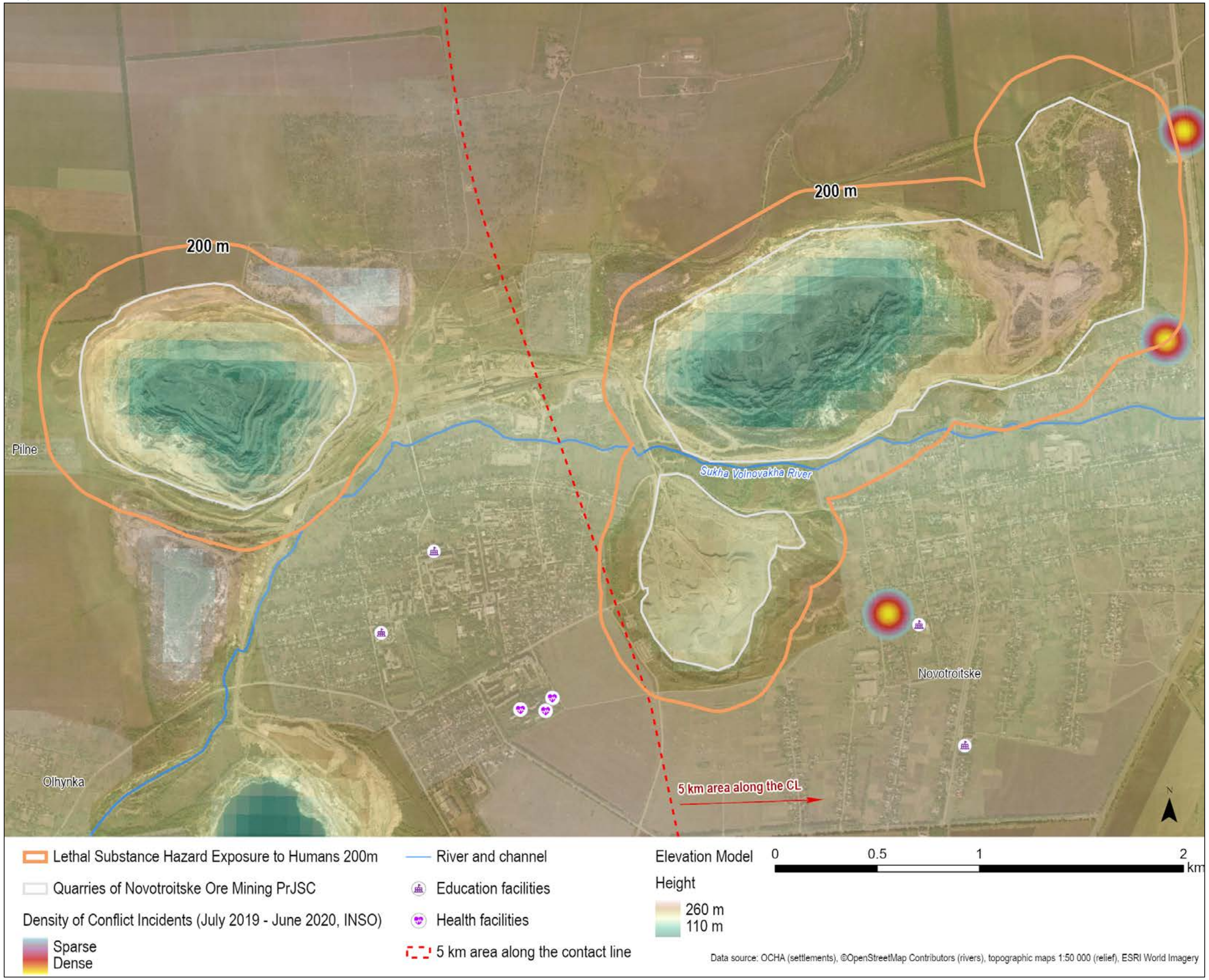
Open-pit mining promotes the activation of exogenous geological processes, changes in the physical and mechanical properties of soils, and affects groundwater and surface waters. Drilling and blasting operations are a significant source of environmental pollution, in particular for waterbodies. Explosives used for blasting contain ammonium nitrate and nitrogen compounds (NH_4^+, NO_2^-, NO_3^-), which may be released into the evironment through wastewater discharge[1].

The explosives such as grammonite 79/21; 50/50; and granulotol are used at Novotroitske Ore Mining for the efficiency of blasting operations. Granulotol, both in pure form and when mixed with ammonium nitrate, is very toxic. According to Efimov et al.[2], when carrying out mass explosions, a large amount of dust and toxic gaseous products is emitted and is harmful to humans when exceeding a quantity of 275 g / kg.

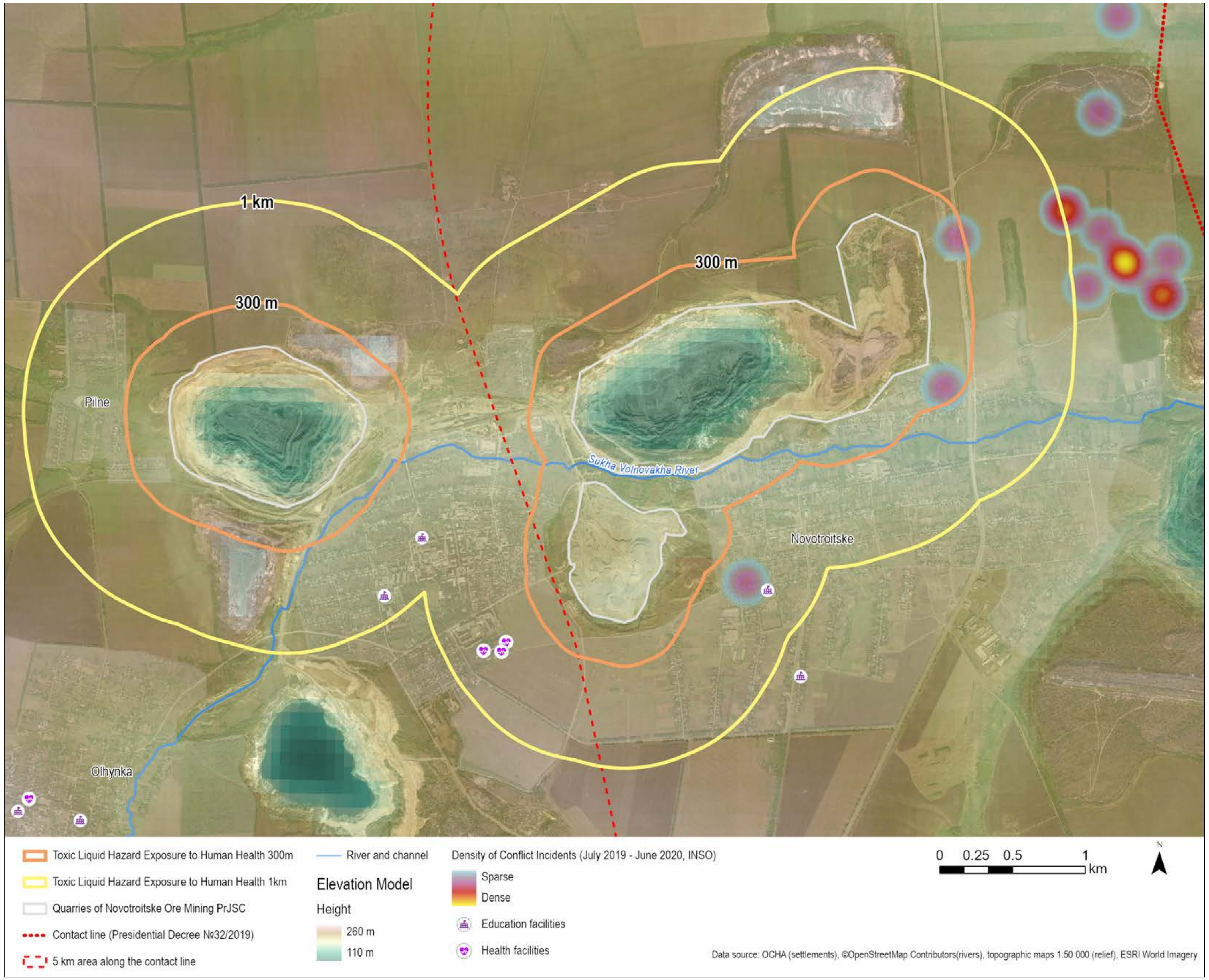
1. Khokhriakov A.V., Studeniuk A.H., Olkhovskyi A.M. & Studeniuk H.A., 2005. Quantitative assessment of the contribution of blasting operations to the pollution of drainage waters of quarries with nitrogen compounds. Gorny Zhurnal, 2005, No. 6, pp. 29-31.

2. Efimov V.G., Baikov A.V., Donchenko M.S. Characteristics of the impact of opencast mining of the non-metallic deposit on the natural environment of Priazov - http://kadastr.org/conf/2019/pub/monitprir/harakteristika-vozdeistviya-otkrytoi-razrabotki-me.htm.

Map 4.2 Buffer area of 200 metres around Novotroitske Ore Mining PrJSC



Map 4.3 One km buffer area of Novotroitske Ore Mining PrJSC



Based on the FEAT 2.0 Pocket Guide, **ammonium nitrate** is an explosive substance classified under the GHS as an oxidising solid (Ox. Sol. 1). It is dangerous and can be lethal to human health, according to the exposure distance table below.

Receptor	Distance (km)	Quantity (kg)
Humans (lethal)	0.2	100,000
Humans (health)	0	

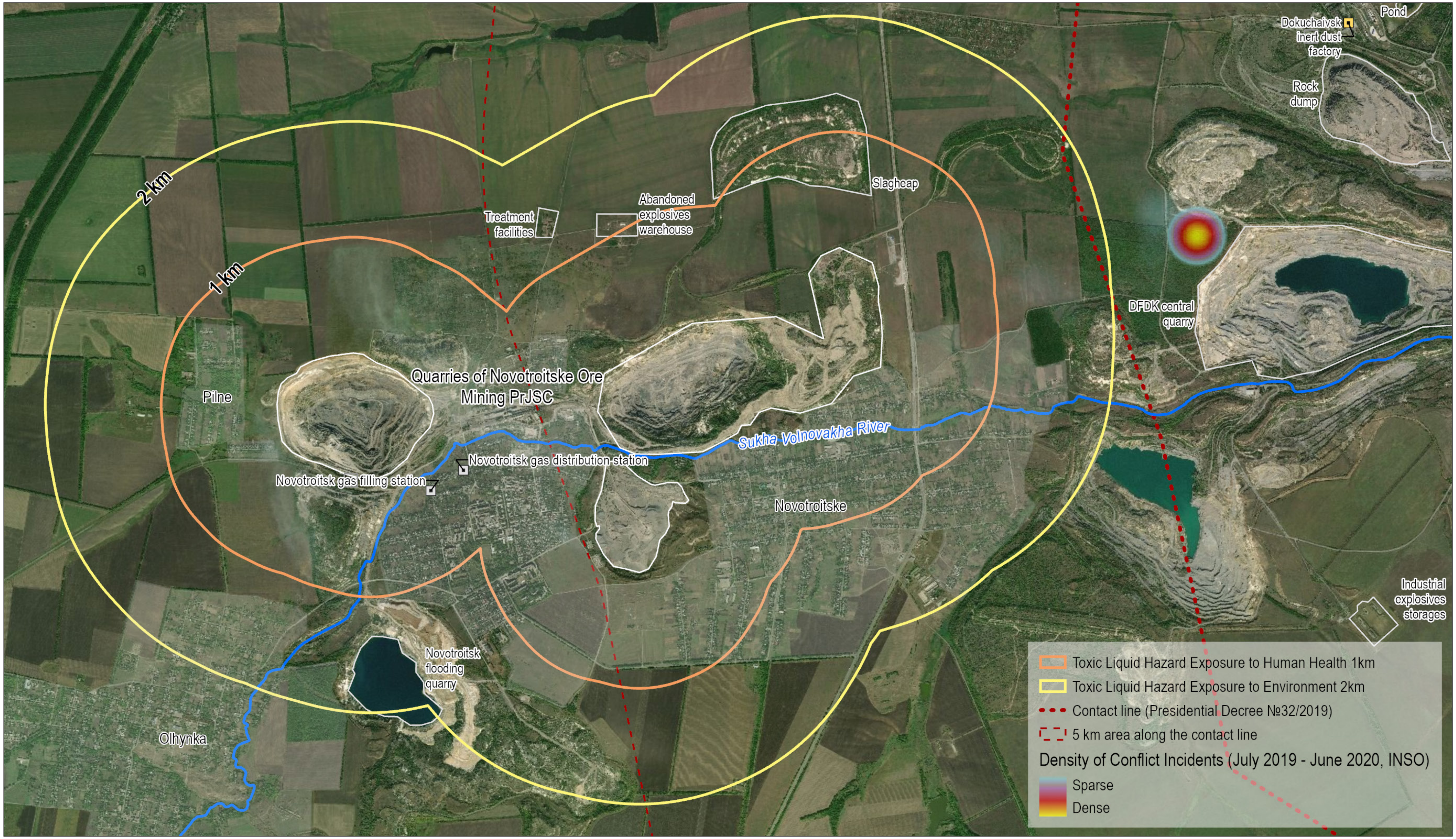
Cyanide meanwhile is cited as the most common substance related to mining and ore processing. It is labeled as a toxic liquid under the GHS classification (Acute Tox. 1) and is fatal when inhaled. The following exposure distance table indicates the hazard posed to humans.

Receptor	Distance (km)	Quantity (kg)
Humans (lethal)	0.4 - 1.3	10,000 - >1,000,000
Humans (health)	2 - 5	

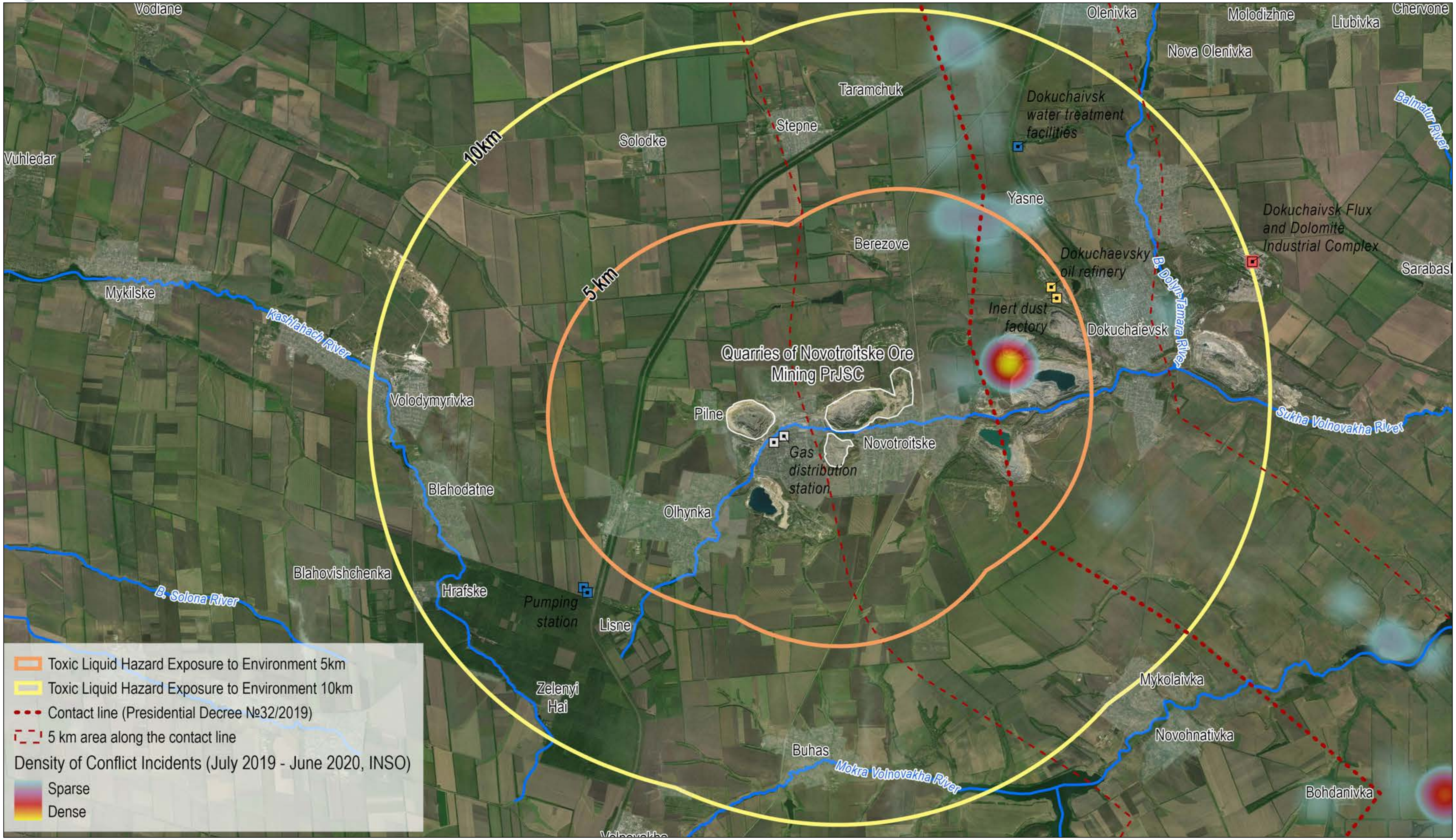
Located in adjacent Dokuchaievska Raion, Dokuchaievska Flux & Dolomite Industrial Complex also causes significant anthropogenic pressure both on surface watercourses and on groundwater. The plant discharges untreated wastewater into the Sukha Volnovakha and Mokra Volnovakha rivers[3].

3. Ermakova E. V. The complex appreciation of the environment`s state in the region of Dokuchaevsk Flux & Dolomite plant`s situation and elaboration of measurses of its improvement - http://masters.donntu.org/publ2002/feht/ermakova.pdf.

Map 4.4 Two km buffer area of Novotroitske Ore Mining PrJSC



Map 4.5 Ten km buffer area of Novotroitske Ore Mining PrJSC



Hazard Description

Because Donbas is a heavily industrialized region with a large coal and metallurgical industry, it suffers from the highest levels of air pollution in Ukraine. According to WHO, air pollution poses a major threat to the climate and human health, causing around seven million premature deaths annually, primarily due to stroke, heart disease, chronic obstructive pulmonary disease, lung cancer and acute respiratory infections.

Air pollution sources include gases (e.g. ammonia, carbon monoxide, sulfur dioxide, nitrous oxides, methane and CFCs), particulates and biological molecules. Both human activity and natural processes generate air pollution.

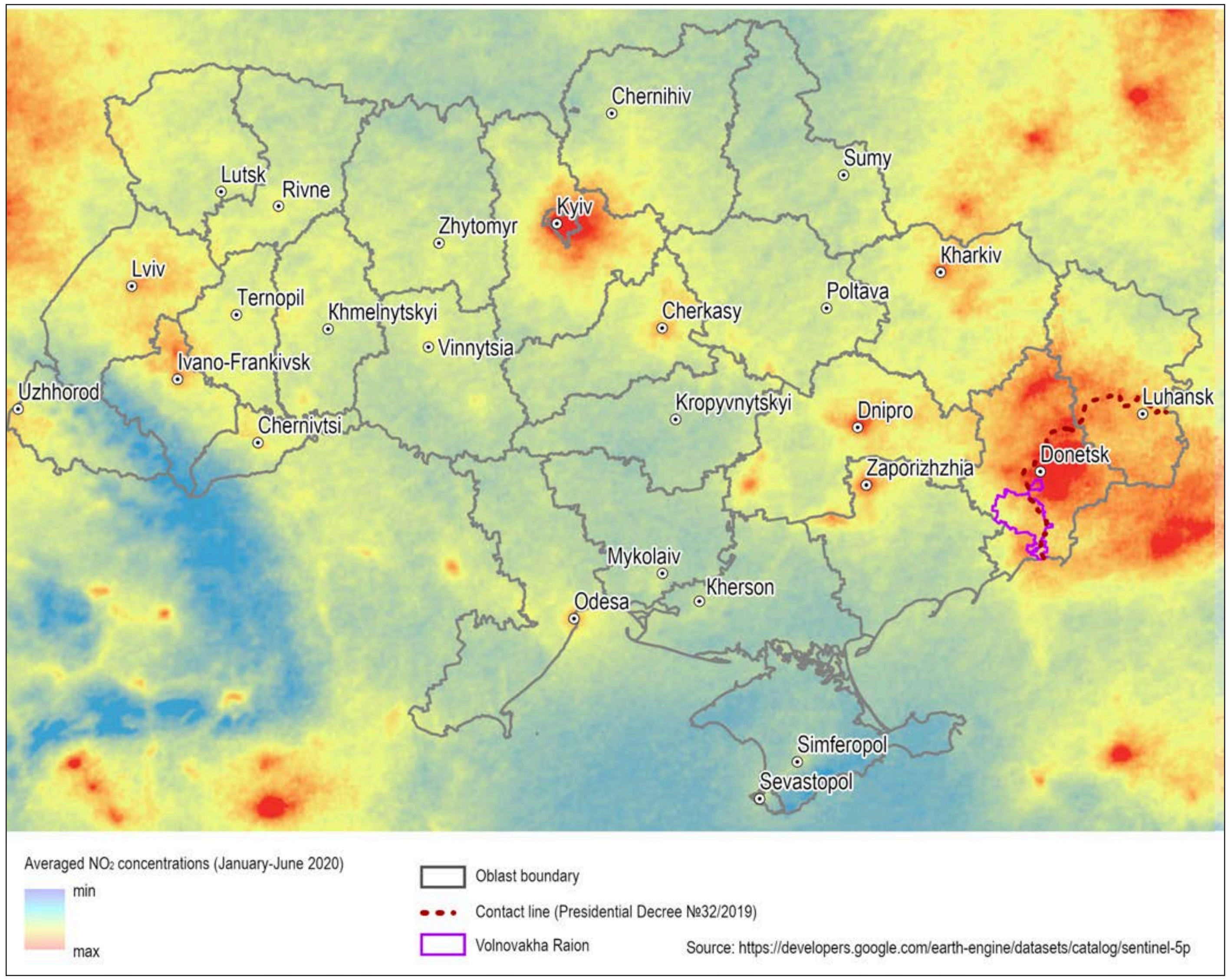
To fulfil Ukraine's obligations in the EU Association Agreement, the Ukraine Cabinet of Ministers amended the Procedure for State Monitoring of Air Quality in August 2019. To implement the requirements of Directive 2008/50/EC & Directive 2004/107/EC, the list of pollutants that must be monitored was defined and maximum permissible concentrations (MPC) of airborne substances was set according to EC Directives.

Donetska Oblast Automated Environmental Monitoring System includes 44 air quality monitoring posts and was established in 2017. It is operated by the Department of Ecology and Natural Resources of the Donetsk Regional State Administration and Donetska SESU Department.

According to data from the three air monitoring posts in Volnovakha area, sulfur dioxide (SO_2) concentrations exceeded MPC on more than 77% of days during the observation period from January 1 to June 30, 2020. The highest rates were 100% of days at Volodymyrivka (APS-37) and 95% days at Novotroyitske (APS-35). The highest rate where nitrogen dioxide (NO_2) concentrations exceeded MPC, at 95% of days, was recorded at Novotroyitske. Regarding the days with aerosol concentration exceeding MPC (pm10 and pm25), rates ranged between 64-72% and 43-60%, respectively.

Although data from the NGCA is unavailable, satellite imagery (map 5.2) shows that the area around Donetsk has a high rate of NO_2 emissions, along with the area north of Kramatorsk. Thus, satellite data can effectively contribute to understanding regional pollution dynamics.

Map 5.1 NO_2 emissions in Ukraine



Graph 5.1 Seasonal dynamics of NO_2 concentration in the air in 2019

Raion Name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Yearly mean
Bakhmutskyi	1.64	1.03	1.01	1.08	0.92	0.95	1.07	0.93	0.94	1.01	0.79	0.85	1.02
Dobropilskyi	1.70	0.95	0.87	1.02	0.90	0.98	0.91	0.93	0.89	0.85	0.73	0.64	0.95
Lymanskyi	2.07	0.94	0.96	0.93	0.93	0.89	0.94	0.90	0.92	0.88	0.76	0.79	0.99
Manhushskyi	0.81	0.70	0.70	0.87	0.81	0.93	0.88	0.89	0.83	0.79	0.67	0.64	0.79
Oleksandrivskyi	1.87	0.92	0.84	1.03	0.90	0.95	0.87	0.93	0.95	0.80	0.71	0.61	0.95
Pokrovskyi	1.47	0.99	0.87	1.09	0.93	1.00	0.92	0.94	0.93	0.89	0.76	0.63	0.95
Slovianskyi	2.12	1.00	0.94	1.13	0.97	0.98	0.94	0.98	1.11	0.95	0.82	0.73	1.06
Velykonovosilkivskyi	1.01	0.85	0.79	0.99	0.86	1.04	0.88	0.88	0.93	0.83	0.70	0.62	0.86
Volnovaskyi	1.00	0.93	0.79	0.98	0.85	0.99	0.92	0.90	0.88	0.88	0.72	0.66	0.88
Yasynuvatskyi	1.66	1.16	0.98	1.16	0.95	1.02	0.96	0.95	0.94	0.97	0.82	0.73	1.02

Since July 2018, the European Space Agency Sentinel-5P satellite mission has been collecting global atmospheric data on NO_2, SO_2, Carbon monoxide (CO) and aerosol concentrations. In combination with ground-based air monitoring posts, it is an effective tool to detect primary pollution sources and assess settlement-level pollution risk. As atmospheric emissions can spread over large areas, 3-month averaged satellite data from January-March 2020 were used as anthropogenic hazard exposure indicator 2.3 to identify protracted emission sources in the region.

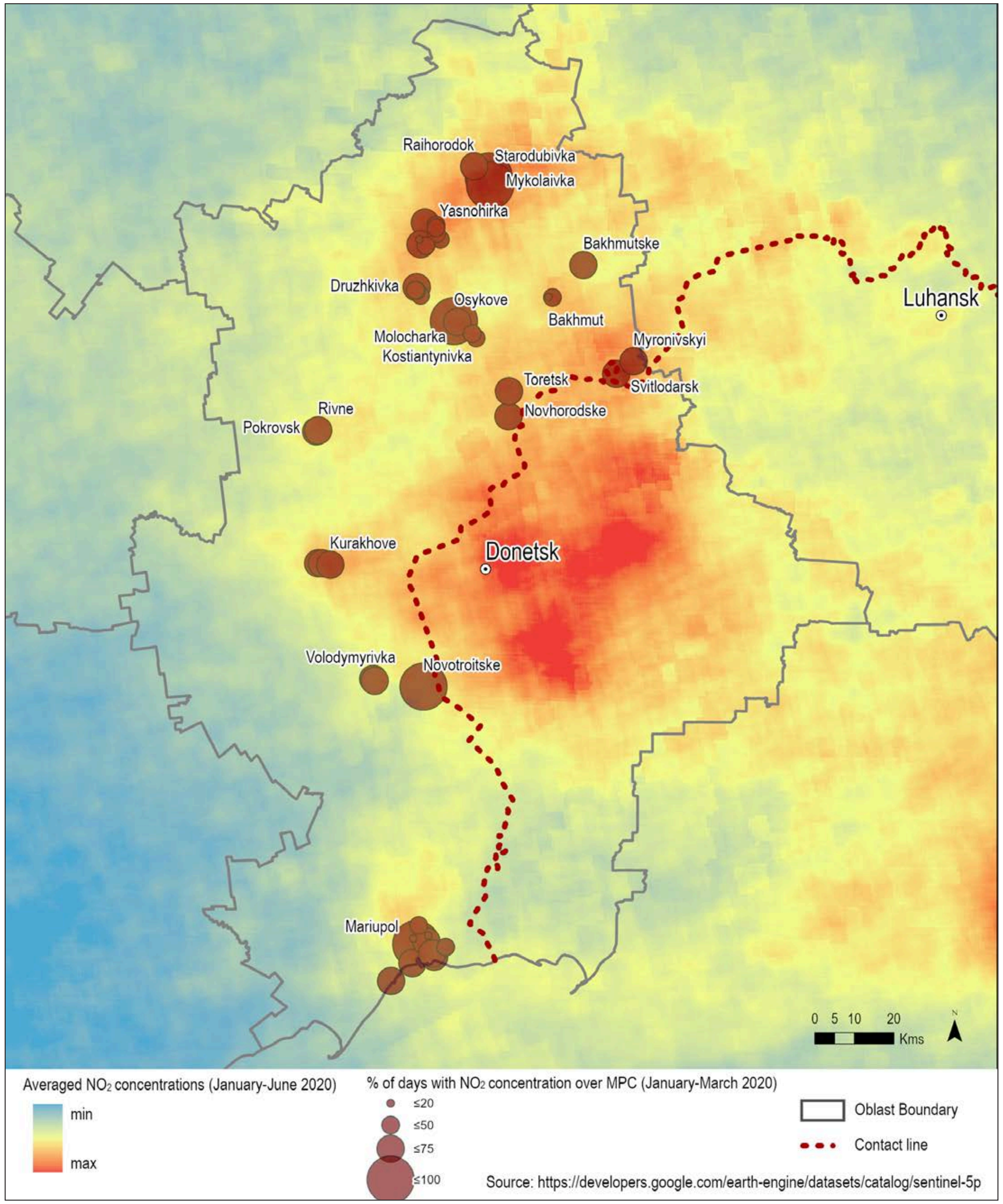
SO_2 MPC was exceeded on >50% of days at all observation points in the Donetsk region throughout the study period. At Pokrovsk and Volodymyrivka, SO_2 MPC exceedance was recorded on 100% of days, and on >90% of days in 7 settlements (Svitlodarsk, Mariupol, Soledar, Bakhmut, Mykolaivka, Novotroitske and Kurakhove).

Slovyanska TPP (Wastewater Treatment Plant) in Mykolayivka recorded NO_2 MPC exceedance on all days, whilst exceedance on > 88% of days was recorded in Kostiantynivka, Mykolaivka, Novotroitske and Mariupol. Overall, 27 of 42 observation points recorded >50% of days with NO_2 MPC exceedance.

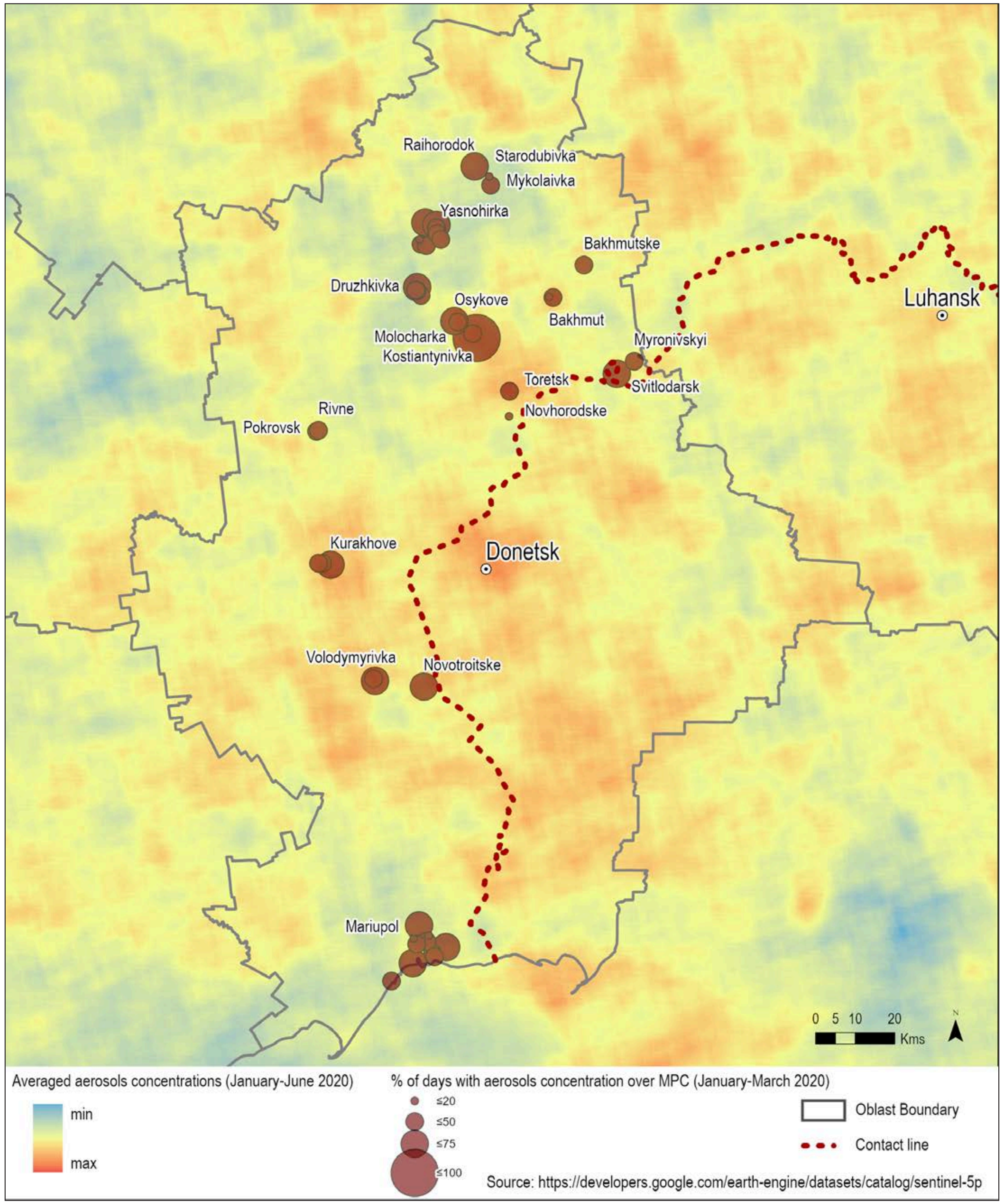
Regarding pm10 fraction, 32 of 42 observation points recorded MPC exceedance on >50% of days. At air monitoring posts in Mariupol and Kostiantynivka, MPC exceedance was recorded on all days, whilst Kurakhove recorded exceedance on >85% of days.

At 14 of 42 observation points, >50% of days recorded pm25 MPC exceedance. The highest percentage of days with exceedance (77%) was observed at Kostiantynivka and 71% in Yasnohirka.

Map 5.2 NO_2 emissions in Eastern Ukraine



Map 5.3 Aerosols concentration in Eastern Ukraine



Volnovakha Raion Air Pollution

The chemical, coal, coke and metallurgy industries, are the primary SO_2 polluters in the area. Plants include Velykoandalsky Refractory Plant, located in Volnovakha Raion and such facilities as Illich Steel and Iron Works, Concern Azovmash and Azovstal Iron and Steel Works, located in Mariupol. Additionally, Dokuchaievsk Flux and Dolomite Industrial Complex (including JSC SPP) and Starobeshivska TPS, located in the NGGA, contribute to SO_2 emmisions across the region. Sentinel-5P satellite data reveals higher SO_2 concentration within the research area and also higher concentrations of SO_2 and NO_2 compared to other territories of Ukraine (map 5.4). Chronic exposure to NO_2 and SO_2 can cause respiratory or lung diseases.

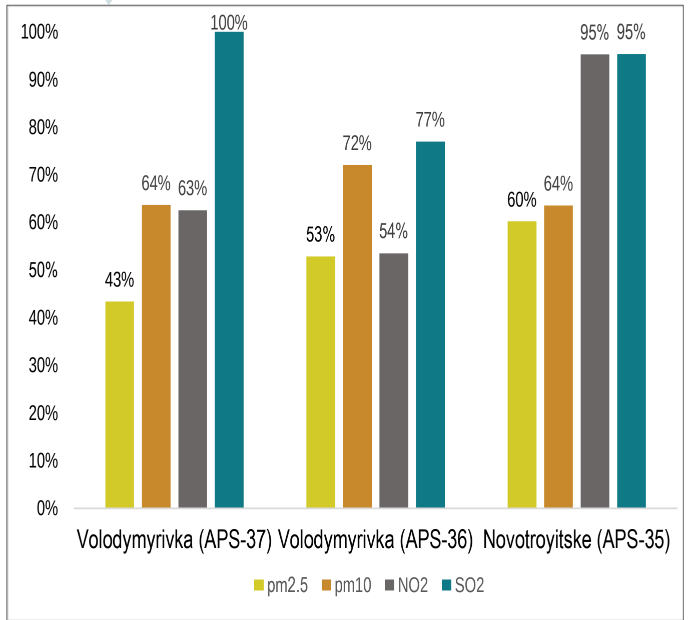
As seen on the Sentinel-2 satellite image in fig. 5.1, a dust cloud from blast furnace operations of industrial facilities in Mariupol has spread over a 1 km area around the plants. The figure is a false-colour composite based on Sentinel-2 bands 4, 8 and 12; the red, IR and SWIR bands respectively. In the images, vegetation shows up as bright green, whilst industrial sites are brown. The red spots indicate the working blast furnaces.

Another source of air pollution in the area is evaporation from tailing dams of coal mines and industrial quarries. This is especially acute during heat waves or prolonged periods of high temperatures. Evaporation leads to the accumulation of dry residues around tailing dams, which is then distributed by wind over long distances.

Aerosol particles with an effective diameter smaller than 10 μm can enter the bronchi, while those with an effective diameter smaller than 2.5 μm can enter as far as the gas exchange region in the lungs, which can be hazardous to human health.

Storm winds can trigger the dispersion of aerosol

Graph 5.1 Number of days with MPC overage (January-June, 2020)



Map 5.4 SO_2 concentration in Volnovakha area

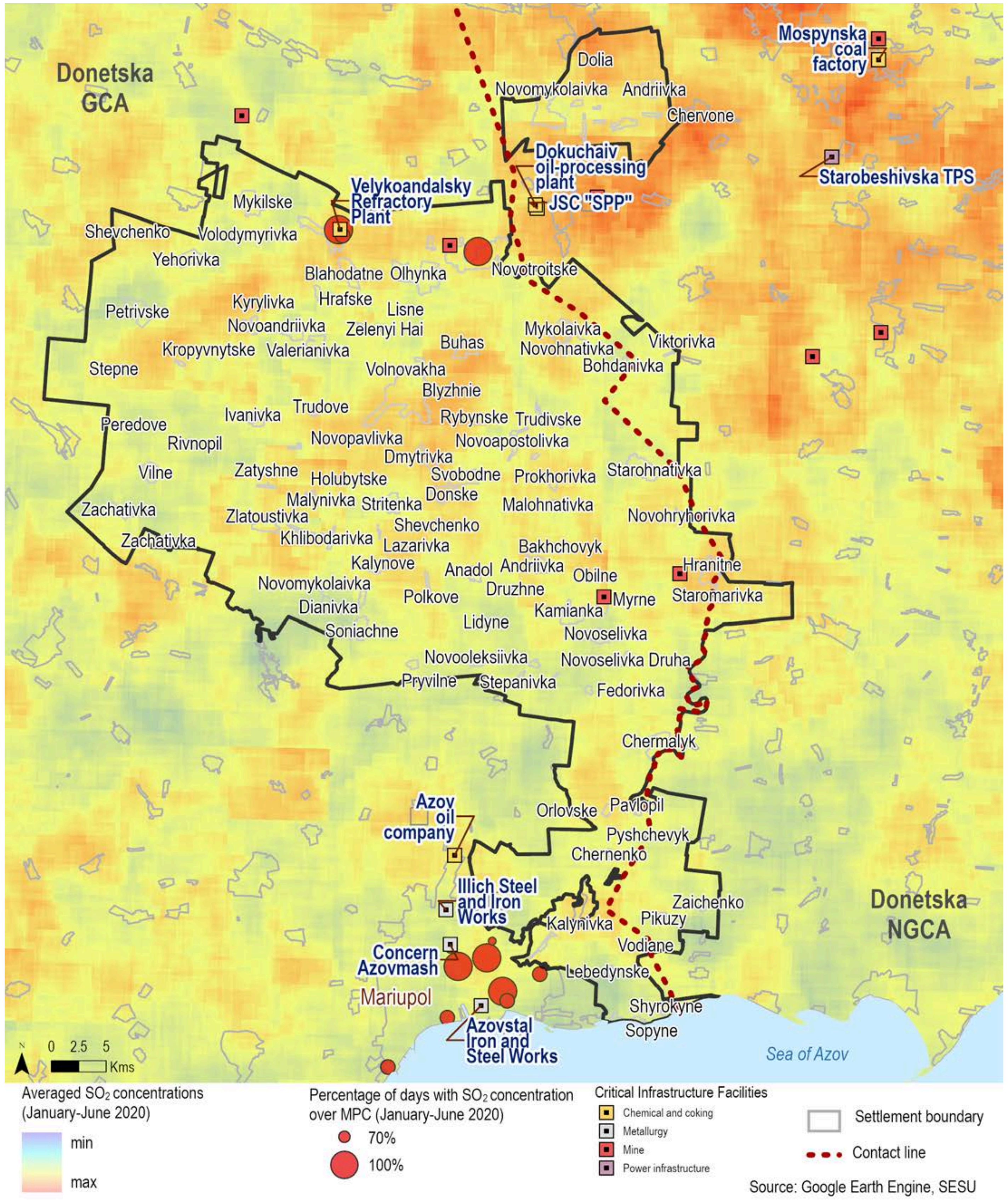
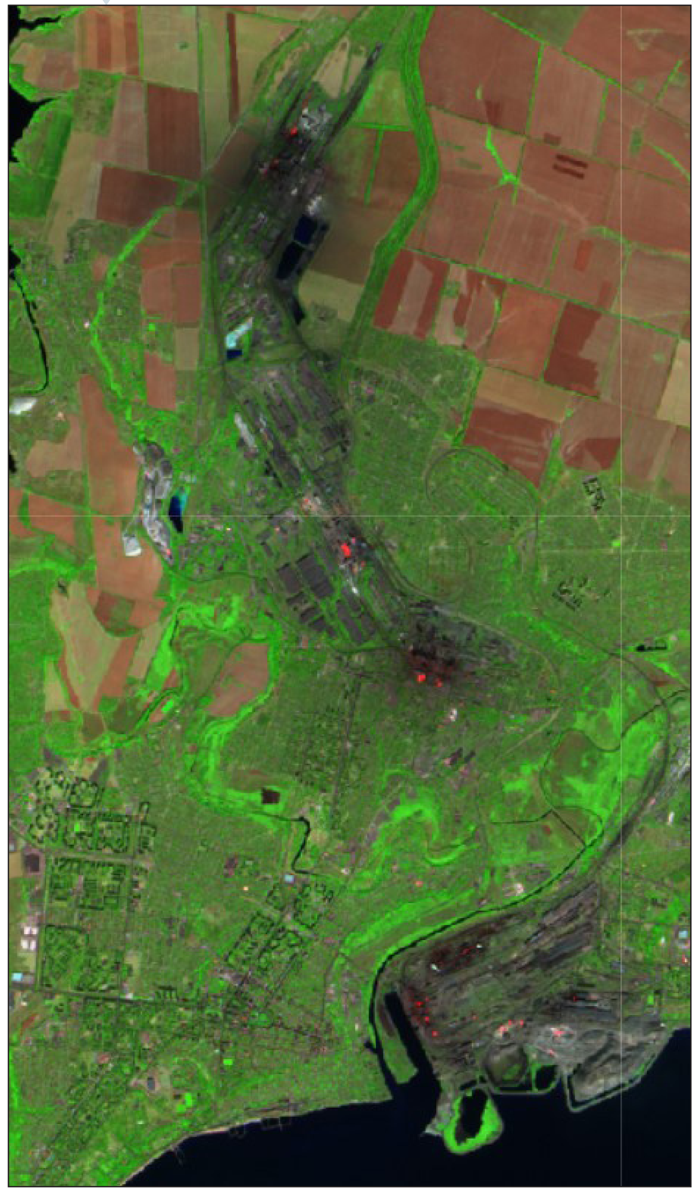
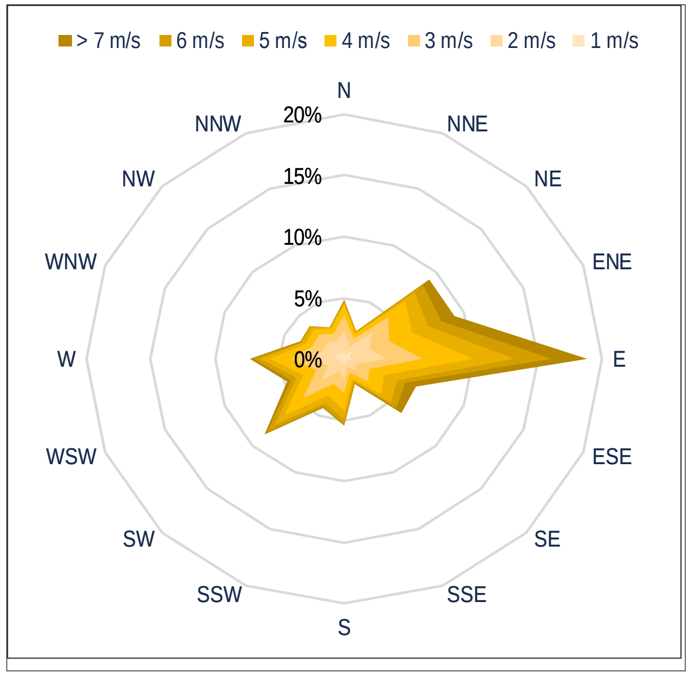


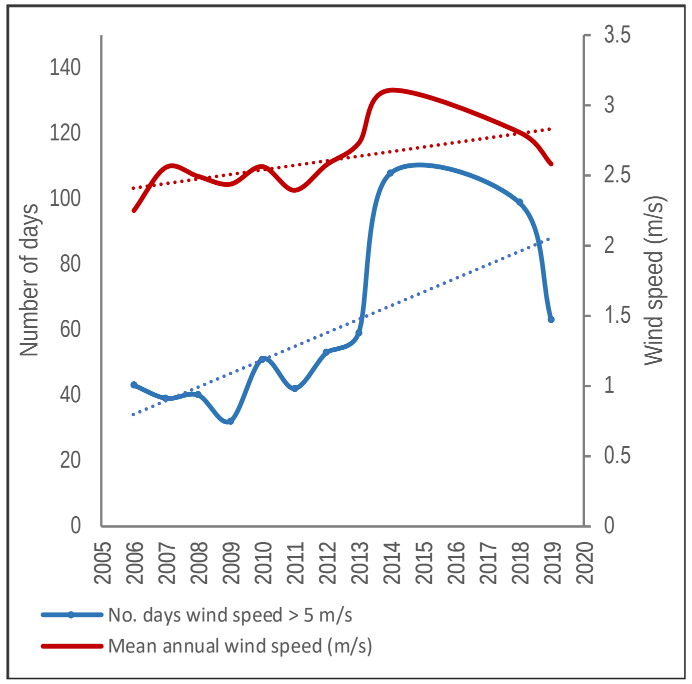
Figure 5.1. Blast furnace operations and dust cloud around coke and chemical plants of Mariupol, on Sentinel-2 image, September 20, 2020



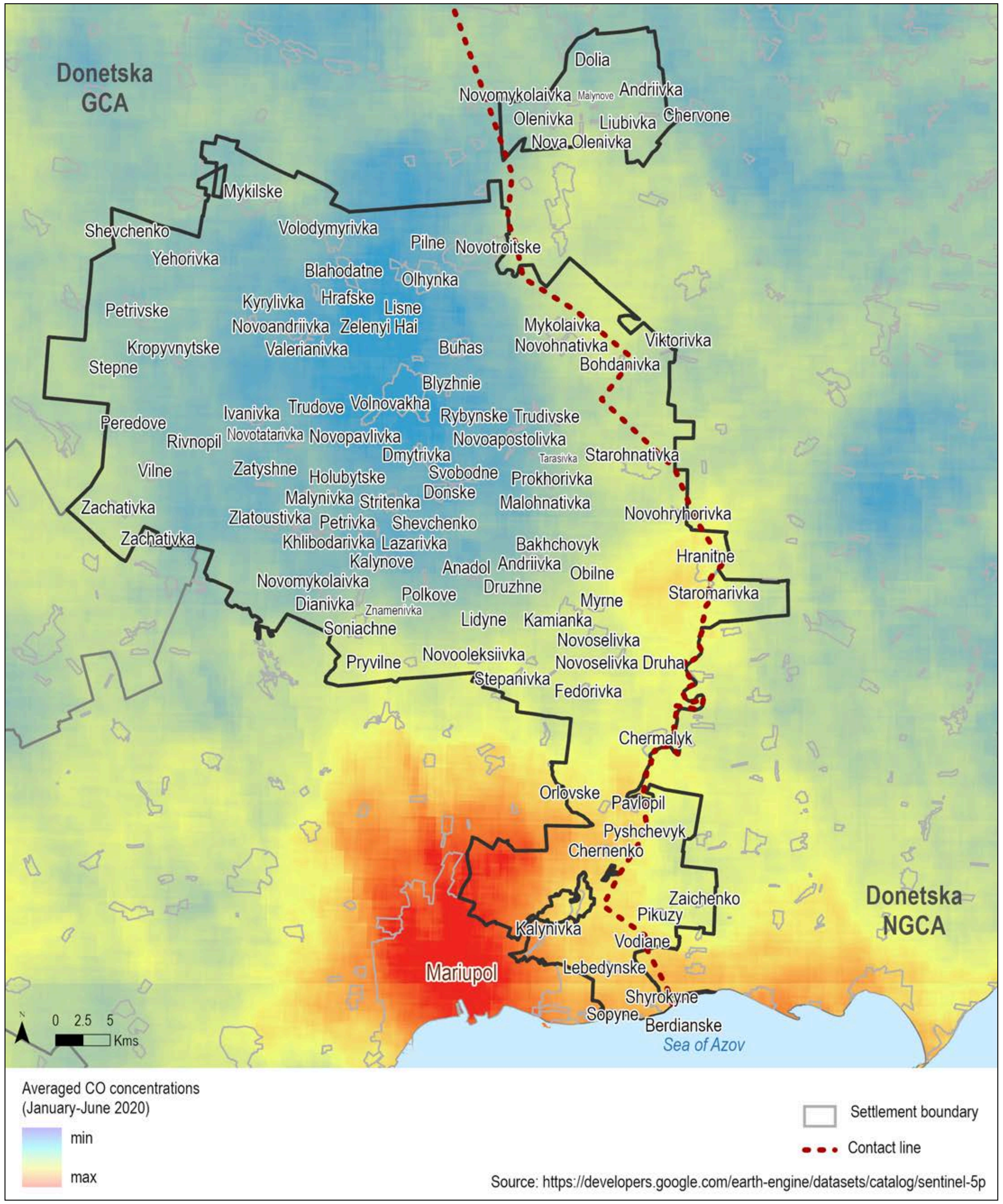
Graph 5.2 Average wind direction



Graph 5.3 Yearly-averaged wind speed dynamic



Map 5.5 CO emissions in Volnovakha Raion



pollutants across a wider area. Above wind speeds of 5 m/s, dust and ash from bare and degraded lands can become disturbed through wind erosion (deflation), potentially polluting nearby soils and water bodies.

Graph 5.3 and 5.4 summarise average wind direction and speed between 2006 and 2019 using records from Volnovakha weather station. Despite insufficient data in 2015-2017, the number of days with wind speeds above 5m/s shows an increasing trend, peaking in 2014 and 2018. There is however a significant drop in 2019. Average wind speeds also increased over this period, although a notable drop is also seen in 2019. Increasing frequency of storm winds is one of the consequences of climate change, especially in the steppe zone, in which Volnovakha area is located.

Wind direction is important in determining trends in air pollution dynamics. As Graph 5.2 shows, there is a significantly higher proportion of winds from the east, which may lead to more dispersion of pollutants from factories in the NGCA towards Volnovakha.

Key takeaways

1. Installation or repair of filtration systems & air emission monitoring near hazardous objects should be carried out.

2. Restoration of vegetation cover on closed mine and spoil tip areas should decrease wind erosion risk.

3. Include air pollution monitoring data into Volnovakha alert system, increase the awareness and usage of air monitoring systems, including mobile Apps like IQAir or SaveEcoBot, to plan daily activities, especially outdoor activities in schools.

Hazard Description

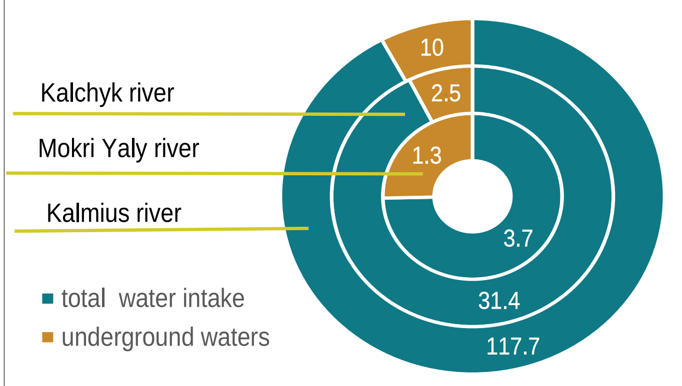
Hydrology and water basin mapping is an important tool to increase understanding of risks related to water contamination, which can have cascading negative health consequences for domestic, commercial and industrial activities.

The area of Volnovakha Raion is divided between Kalchyk, Kalmius and Mokri Yaly river sub-basins. Siverskyi Donets river is the main source of water resources in Donetska Oblast. It collects surface waters, including inflow from Dnieper-Donbas Channel, local river runoff, sewage, coal mine and spoil tip waters, and groundwater reserves.

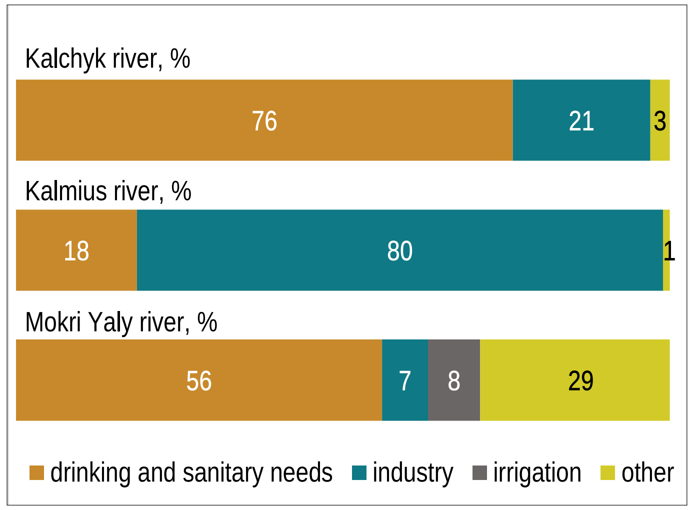
Thirty-five percent of the total water intake in Mokri Yaly River sub-basin is from groundwater, compared to just 8% in Kalchik and Kalmius river sub-basins. 76% and 56% of water intake of Kalchik and Mokri Yaly river sub-basin respectively are used for drinking and sanitary needs, compared to 18% in Kalmius river sub-basin. This indicates the importance of the establishment of water monitoring posts and groundwater research.

Eighty percent of water intake is used for industry in Kalmius river sub-basin, mostly connected with highly water-intensive metallurgy industries, located in the area.This is much higher compared to 21% in Kalchik river sub-basin and just 7% in Mokri Yaly river sub-basin.

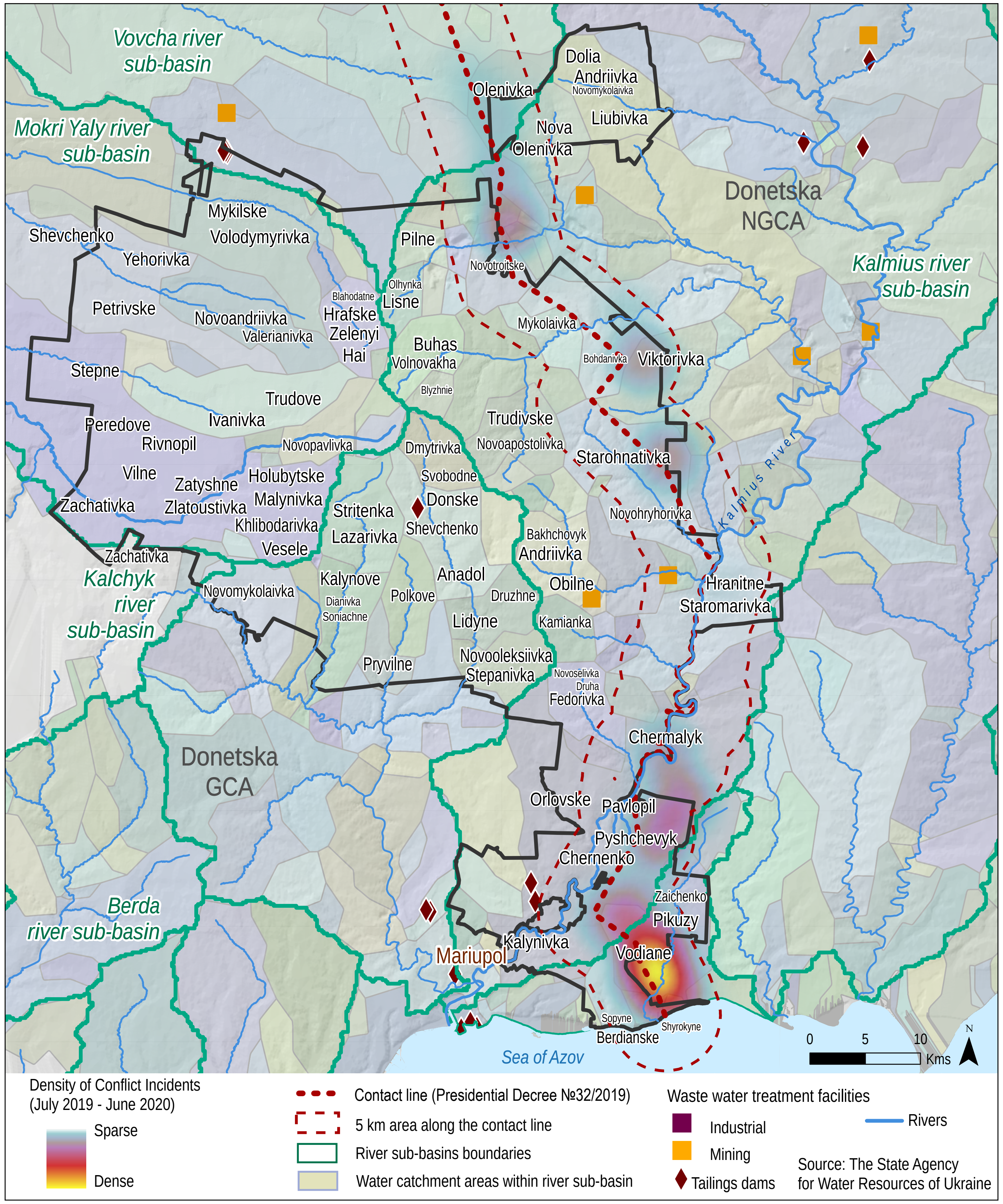
Graph 6.1. Water intake in basins in 2018 (mln.m3)[6]



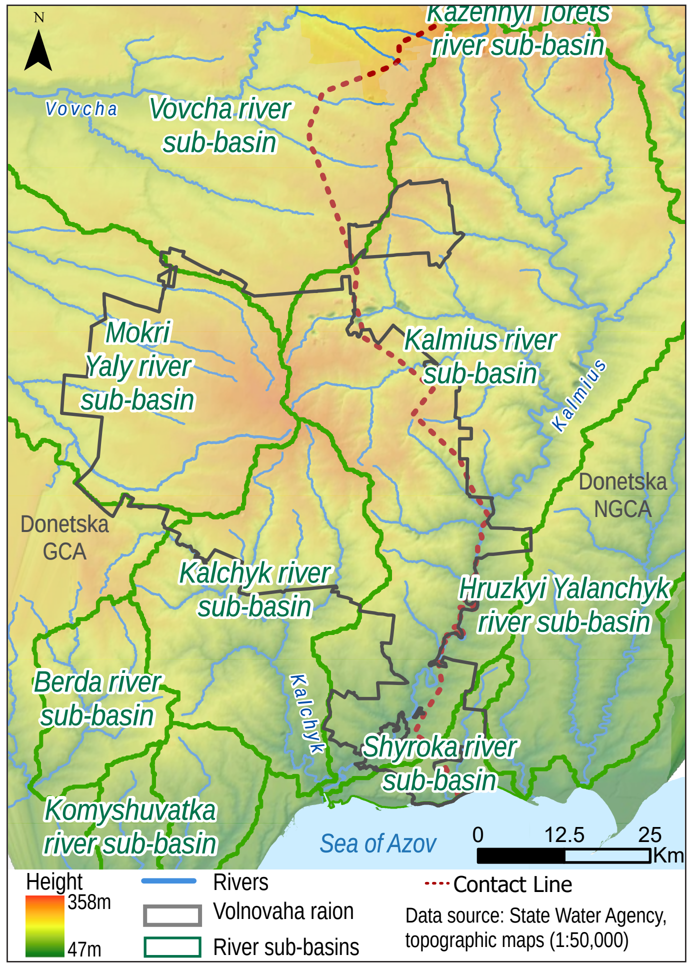
Graph 6.2. Water Usage Type in Basins in 2018[6]



Map 6.1 River basins and hazardous facilities



Map 6.2 Regional overview of main rivers



6) Water intake and quallity data from the State water agency of Ukraine (https://www.davr.gov.ua/)

IMPACT Shaping practices Influencing policies Impacting lives

HAZARD - EXPOSURE OF WATER SUPPLY INFRASTRUCTURE TO CONFLICT

Water Network

Functional water infrastructure is critical to ensure basic water and sanitation needs. Water is supplied to the region through the Siverskyi Donets - Donbas Channel to Donetsk and then through Southern-Donbas Channel to Mariupol. The network includes 17 water tanks and 18 water filter stations (water treatment plants). One water filter station (Velykoanadolska TPS) and 3 pumping stations are located in Volnovakha Raion.

Surface waters along the Siverskyi Donets River in Donetska Oblast are mainly classified according to the State Water Agency of Ukraine[6] as satisfactory, slightly polluted (class III category 4). The average yearly MPC was exceeded in Siverskyi Donets in 2018 for ammonium nitrogen (up to 2.4 MPC) iron (2.2 MPC), manganese (2.7-11.3 MPC), copper (2.5-4.6 MPC), petroleum products (2.5 MPC), nitrites (5.5 MPC), chromium (3.8-7.7 MPC) and zinc (2.6 MPC).

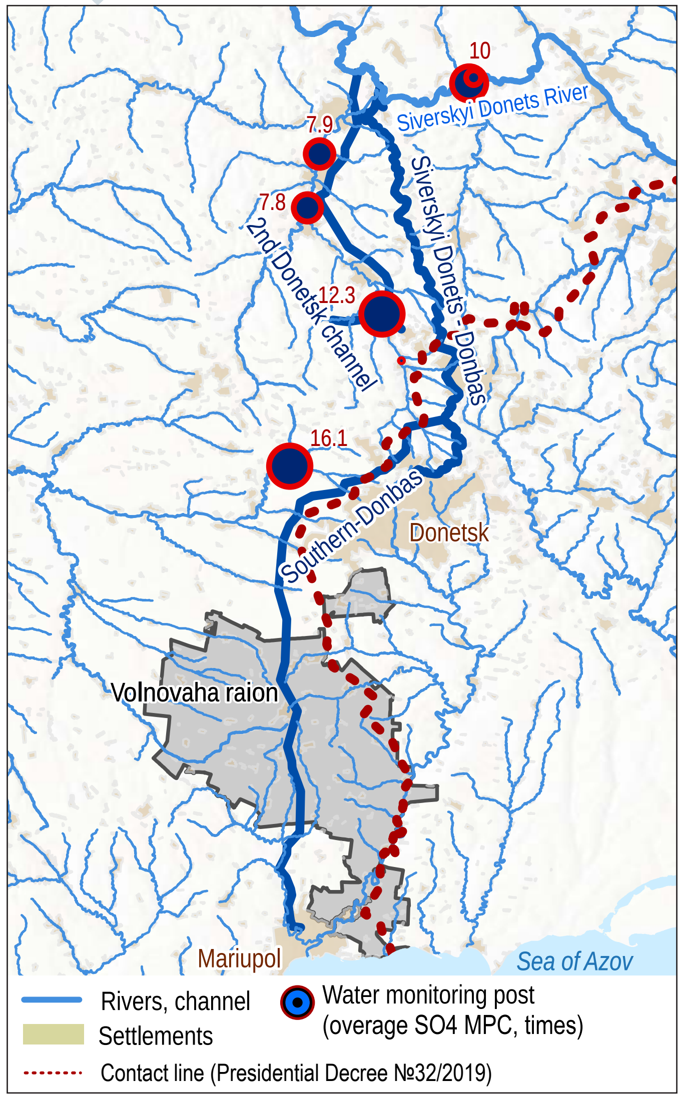
The water supply system crossing the CL is frequently damaged or disrupted due to shelling, obsolete equipment, and soil subsidence close to coal mines. Often the water supply can be interrupted for several days or weeks. Velykoanadolska Filter Station is the most critical facility in the region. The supply of water to five filter stations, including Velykoanadolska, depends on the operation of 1-3 canal rises and the South Donbas (Pivdennodonbaska) Water Pumping Station of the first ascent, located between Vasylivka and Kruta Balka (near the CL). DEIS recorded 14 incidents near Velykoanadolska Filter Station between 2014-2017.

On February 2, 2017, the Velykoanadolska Filter Station, which supplies water to four cities and several villages in the Volnovakha area, received only 20% of the required volume due to damage to the South Donbas (Pivdennodonbaska) water pipeline. On September 17, 2018, the station stopped working due to repair work to restore the integrity of pipeline No.1 in the Avdiivka industrial zone, which was damaged as a result of conflict incidents in January 2017.

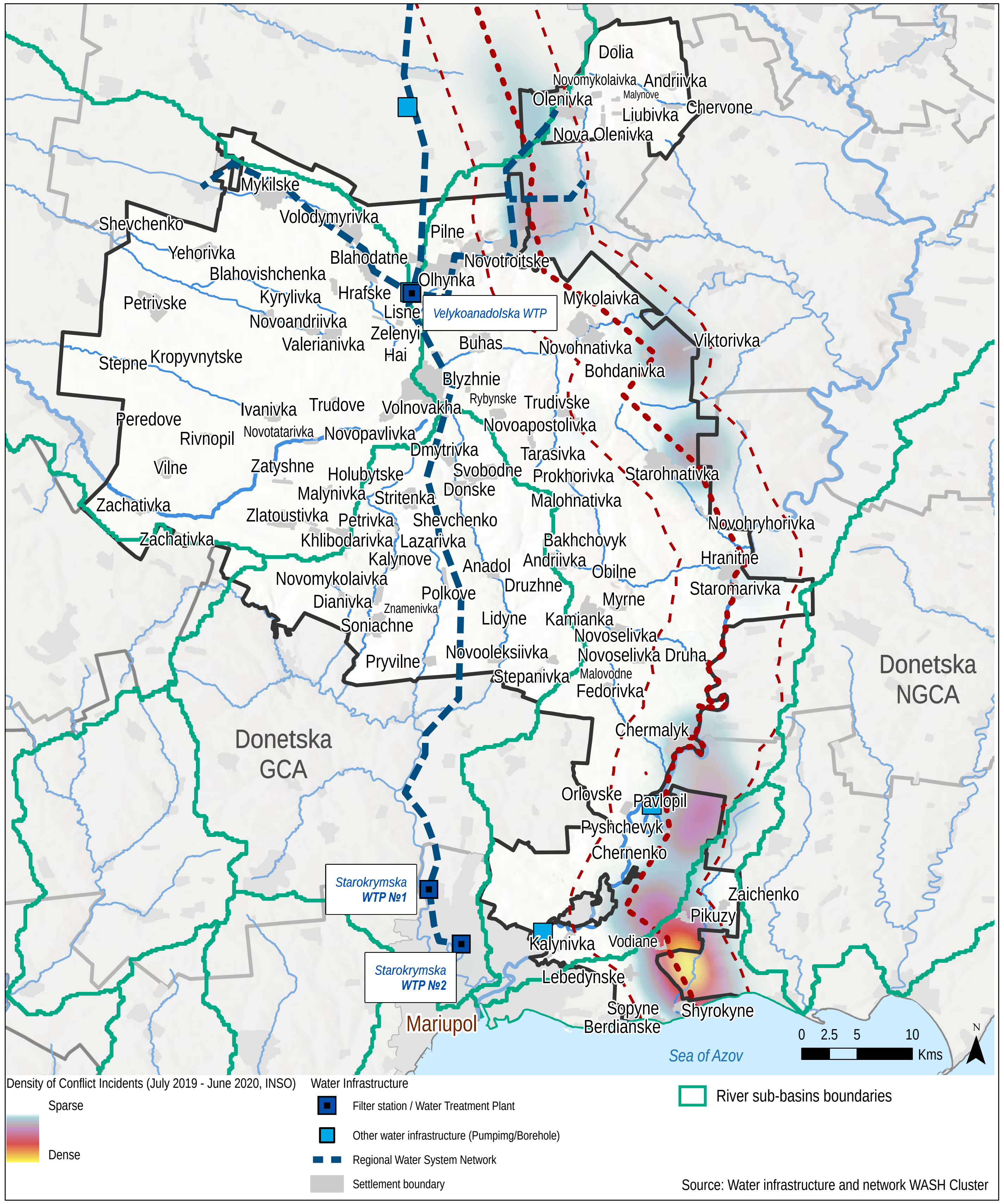
On August 6, 2019, as a result of night-time conflict incidents, two power supply lines were taken out of service, through which electricity is supplied to the pumping station of the third canal rise of the South Donbas (Pivdennodonbaska) water pipeline. For this reason, the Velykoanadolska Filter Station stopped working. From 15 to 17 June 2020, the pumping station of the second rise of the South Donbas (Pivdennodonbaska) water supply system was de-energized in connection with the reconstruction of the 110 kV high-voltage line "Vugledar - South Donbas (Pivdennodonbaska) water supply system".

On August 12, 2015, as a result of shelling, two pumping stations and the first and second rises of the Pavlopolsky water pipeline were stopped due to damage to the 110 kV power line.

Map 7.1 Regional overview of water network



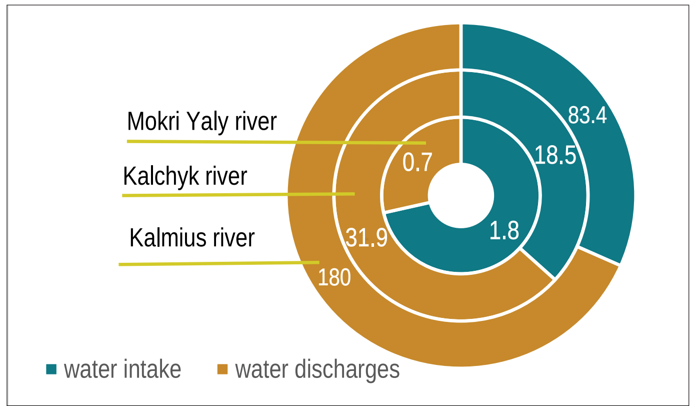
Map 7.2 Water infrastructure



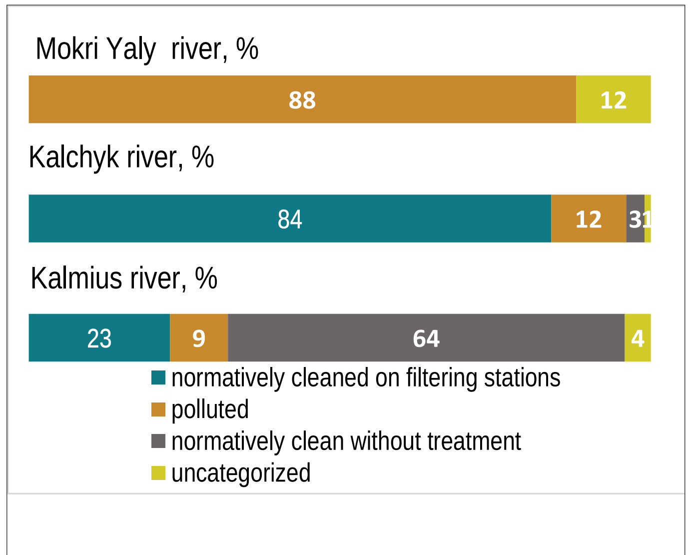
Hazard Description

Wastewater is broadly defined as water that has been contaminated by human use. United Nations Water identifies the following sources of wastewater: domestic water used for sanitation purposes (toilets, kitchens and showers), water from commercial establishments (restaurants) or institutions (hospitals or schools), water from industrial and agricultural activities, storm-water and other urban run-off water. Wastewater management can be potentially hazardous as flammable liquids, acids, and solvents are often used in such facilities ([OCHA/UNEP, 2016]) and inadequate treatment can lead to contamination of ground water sources.

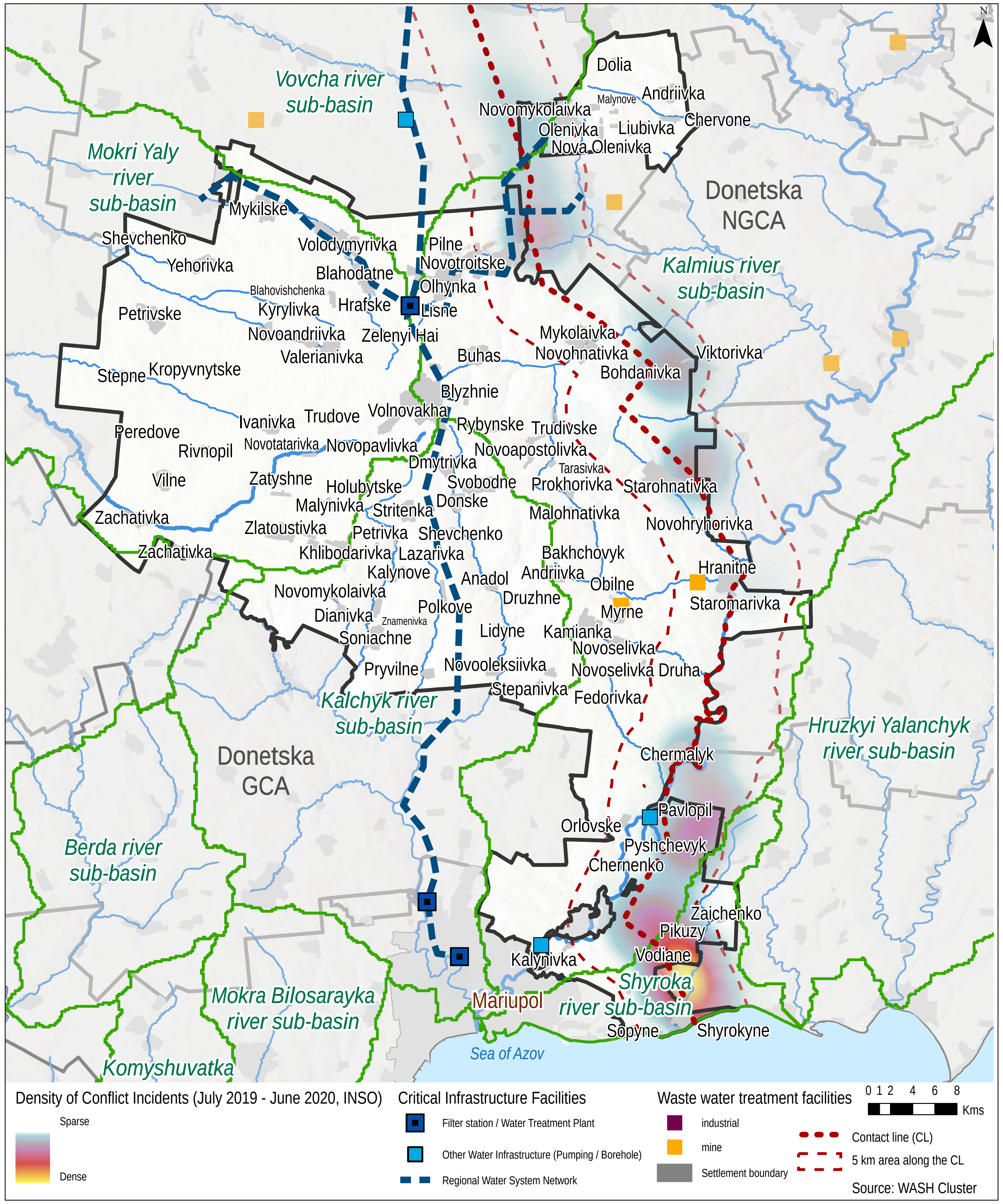
Graph 8.1. Water discharges in the basin in 2018 (mln.m3)[6]



Graph 8.2. Water quality in the basin in 2018[6]



Map 8.1 Locations of wastewater treatment facilities in Volnovakha Raion



According to data on water treatment provided by the State Water Agency of Ukraine, there is a water discharge surplus from the water intake in Kalchik and Kalmius river sub-basins, where most industrial facilities of the area are located. At the same time, water treatment is not applied for water discharges in Morki Yaly sub-basin, where 88% of the water supply is polluted.

Water of Donbas Company carries out water extraction, distribution, transportation, supply and treatment in Donetska Oblast within both the GCA and NGCA. There have been various interruptions to the water treatment facilities in Dokuchaivsk and Olenivka, which are connected with conflict incidents.

In times of accidents on the South Donbas (Pivdennodonbaska) water supply system, Volnavakha and Dokuchaivsk are at risk, because they do not have backup water reservoirs. When the water supply is cut off, people resort to using alternative water sources, relying on bought bottled water, trucked water supply, or on local wells. Attempts to fix power lines or pipes often fail as windows of peace do not hold, and there have been occasional incidents of technicians being fired upon. For example on March 5, 2019, repair crew from Water of Donbas were fired upon during their work to eliminate an outburst of water between Berezovo and the pumping station near Olenivka. In that case, supporting windows of peace become the main priority, to enable critical demining, electrical repairs, and water pipeline repairs. Damage to sewage pumping stations exposes people to additional environmental risks.

Key Takeaways:

1. Military activity in proximity to critical wastewater treatment facilities should be avoided to minimize the risk of wastewater contamination to water sources.
2. Monitoring of water quality at all stages of the water system is important to ensure that contaminated water does not jeopardize access to water or harm the environment.
3. Dialogue on sustainable solutions for the maintenance of these critical water systems should be reinforced.

Hazard Description

Donbas is a coal-producing region mined since the first half of the 19th century. As a heavily industrialized area, industrial waste management from resource extraction is a continuous challenge. Two types of industrial waste storage are spoil tips and tailings dams. A spoil tip consists of accumulated waste material removed during the mining process, whilst a tailing dam is an earth-filled embankment dam used to store by-products of mining operations. Both are hazardous sites as they are storage locations of chemically dangerous substances.

To assess the exposure of the population to spoil tips, their locations were identified in relation to settlements. Since no official geo-database of spoil tips existed, the mapping was carried out by IMPACT using open source data (OSM), cross-referenced with satellite imagery.

According to the Ministry of Health Protections' Decree №173, spoil tips should be located at a safe distance (300m or 500m depending on spoil tip height) from populated places and be cultivated (such as planting grass seeds on the slopes) to minimize the visual impact on the environment and population. One spoil tip is located within the boundaries of Pryvilne settlement near a populated area and 6 more are located within 500m distance from the boundaries of Donske, Volnovakha, Volodymyrivka and Novotroitske settlements. In total, more than 20 spoil tips are located in Volnovakha Raion.

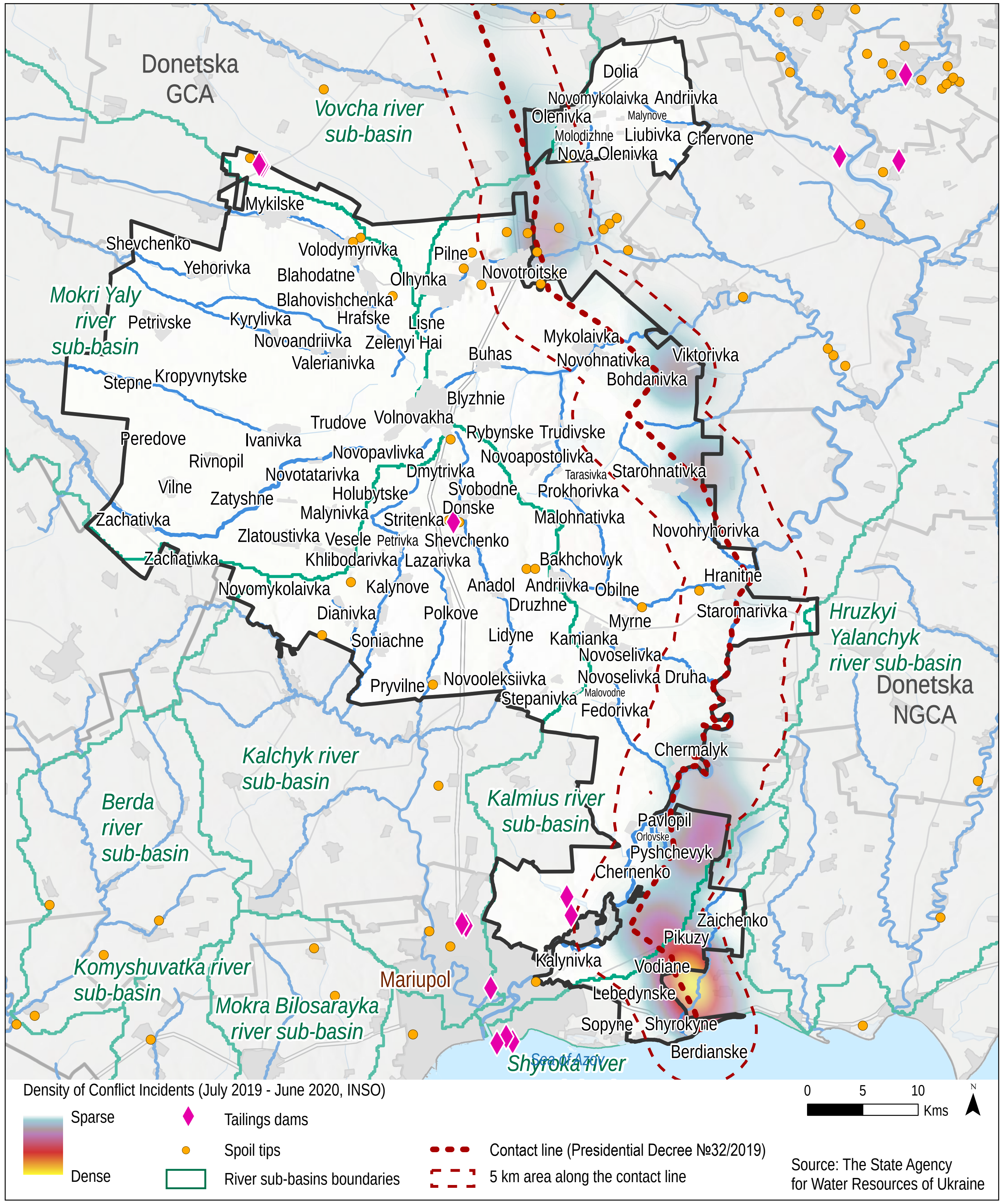
Tailings dams are hydro-technical constructions designed to store by-products of industrial activity. The main hazards posed by these structures are dam failures, which represent low probability high impact events; and diffuse pollution, which has a higher probability but lower impact. Due to the proximity of tailing dams in the raion to the CL, there is a concern over regular maintenance and potential damage. Six tailing dams are registered within Volnovakha Raion.

Map 9.1 displays spoil tips, tailings dams, conflict incidents (July 2019 - June 2020), and rivers which may be exposed to contamination in the case of liquid waste discharge. Data indicating tailing dam locations was collected by satellite imagery digitization and review of data from the State Agency for Water Resources of Ukraine. Between July 2019 and June 2020, conflict events occurred close to tailing dams in the south of the raion and those of Illich Steel and Iron Works Plant in Mariupol.

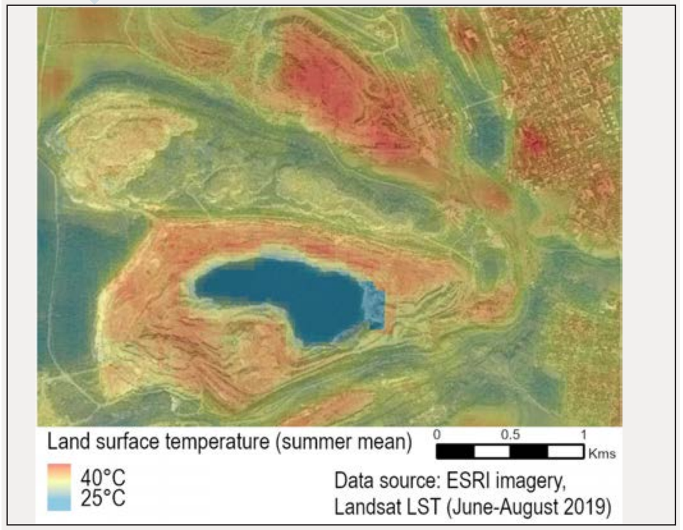
Between 2017 and 2019, 12 conflict events were recorded within 2km of tailing dams, and 27 within 5 km (INSO data, 2017-2019). Many incidents occurred close to Mazurivske tailing dam, 600m from Donske. Since 1967, the tailings dams from Mazurivske deposit have not been in operation. Up to 1.3 million m^3 (2 million tons) of waste deposits are stored there[7]. The eastern part of the waste storage facility is located in the Demenikova gully, close to the River Kalka confluence (M. Kalchyk). The sludge storage extends along the gully for 1km. Groundwater chlorine concentrations are high in the area due to contamination from the former industrial site[7].

In terms of spoil tips, very high surface temperatures can lead to hazardous microclimates and increase heat wave risk. In Map 2, derived from 2019 Landsat 8 data, spoil tips can clearly be seen due to the much higher surface temperatures compared to their surroundings.

Map 9.1 Location of spoil tips and tailings dams in Volnovakha Raion



Map 9.2 Mean LST, Dokuchaievsk Flux & Dolomite Ind. Complex



Key takeaways

1. FEAT 2.0 guide and the Ministry of Health Protections' Decree should be utilized to better understand the human and environmental exposure for each site of concern.

2. Further investigation should be undertaken to ensure proper maintenance of tailings dams and spoil tips and mitigation of their hazardous exposure.

7) Environmental Impact Assessment Report, 2019 (http://eia.menr.gov.ua/uploads/documents/1871/reports/e37046ddd47cfc13ed82a59d7eeaa428.pdf)

Electricity

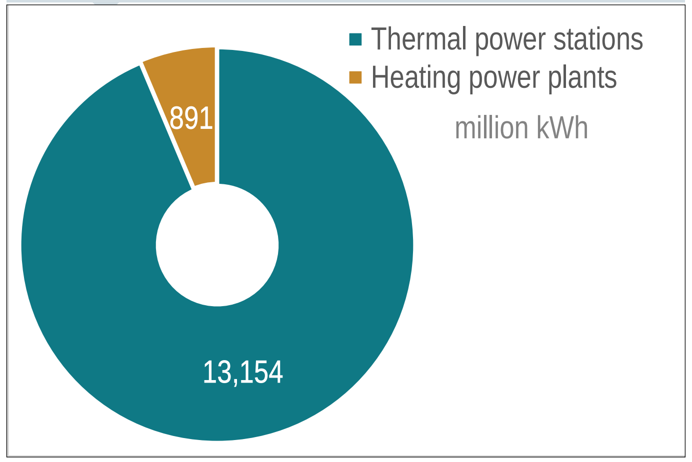
Electricity is critical for both domestic and industrial activities. Because of the linkages between electricity, heating and water supply systems, electricity shortages can have cascading negative consequences for households, inhibiting their ability to heat their homes and access water.

The electricity network of the area is part of the Unified Energy System of Ukraine, which unites 8 regional power systems (including Donbas power system), interconnected with domestic and interstate high-voltage power lines. The main energy sources in the Donbas region are thermal power stations (TPS), which utilise fossil fuel, and heating power plants (HPP), which are based on water vapor (graph 10.1).

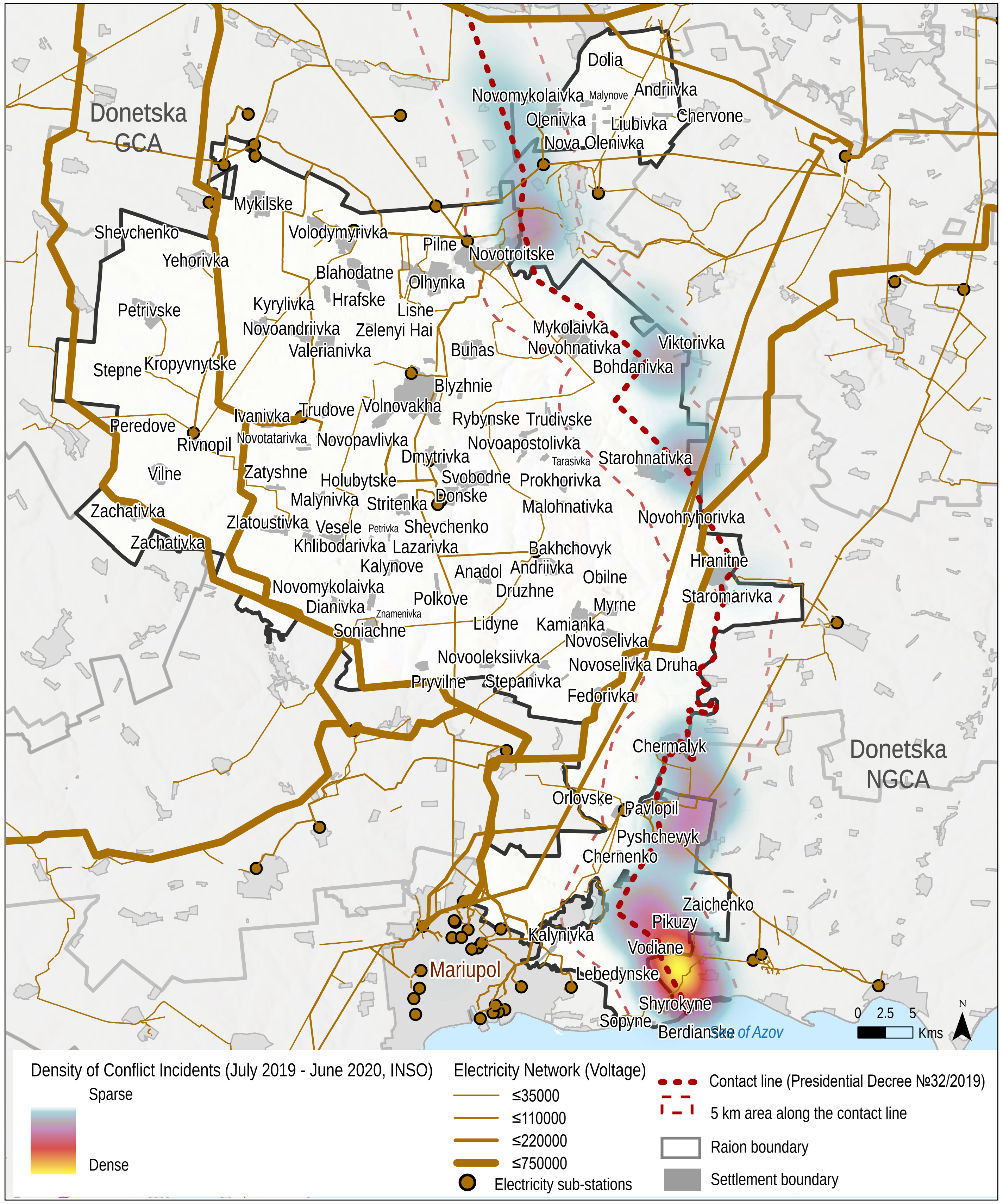
Kurahivska TPS and Starobeshivska TPS are the closest power stations to the Volnovakha area, located 22km and 24km away respectively, and 15km from the NGCA. In 2014 and 2015, several disruptions were reported at Kurahivska TPS in connection with the conflict. Starobeshivska TPS meanwhile provided electricity to Mariupol and Volnovakha before the conflict. It has been located in the NGCA since March 2017 and currently runs at half capacity.

Since 2014, the electricity line between the villages of Myrne and Hranitne in the Volnovakha area remains destroyed. In April 2020, police detained three men who stole nearly a kilometer of aluminum wire from this line, causing damage amounting to about one million hryvnias.

Graph 10.1 Production and source of energy in 2018[7]



Map 10.1 Electricity network



Residents of Hranitne are constantly at risk of emergency shutdowns as a result of damage to electricity lines due to shelling. The last time the line was damaged was on December 24, 2019. It was restored on January 6, 2020 by DTEK Donetsk Electricity Networks. Since the beginning of the conflict in Donbas, DTEK Donetsk Electric Networks has restored power supply at substations and power lines more than 16,000 times (DTEK, 2020). Seasonal squally winds also often damage electricity lines, particularly near the villages of Prokhorivka, Mykolaivka and Chermalyk.

Electricity supply interruption has caused disruption to other dangerous facilities such as coal mines, water filtration systems, pump stations and sewage treatment plants. This increases the risk of pollutants and hazardous substances being released into the environment.

According to the DEIS, about 14 incidents of station stoppage have been recorded at Velykoanadolska Filter Station since June 2014 as a result of damage to electricity lines due to shelling on the Siversky Donets-Donbas channel. This has led to repeated water supply shortages for about 100,000 people in Volnovakha area, including for the settlements of Volnovakha, Dokuchaievsk, Vuhledar, Novotroitske, Volodymyrivka, Oktiabrske and Olhynka.

Interruption of electricity supply was the cause of disruption to other dangerous facilities, coal mines, water filtration and water pump stations and more. This increases the risk of emissions of pollutants and hazardous substances into the environment.

Key takeaways

1. Due to the conflict and the possibility of network damage, diversification of power sources or improved connection for communities to the Ukrainian network would minimize the risk of large scale power outages.

2. Considering that an electrical critical infrastructure failure could induce several severe cascading effects, a multi-stakeholder risk assessment should be conducted by local authorities for specific response planning.

3. Finding methods to support and develop projects on solar panel installation by private households.

7) Data provided by the Main Department of Statistics in Donetska Oblast, http://donetskstat.gov.ua/statinform1/energy.php)

HAZARD - EXPOSURE OF GAS AND OIL SUPPLY INFRASTRUCTURE TO CONFLICT

Gas & Oil Pipelines

Similar to the electricity network, gas and oil pipelines are located in close proximity to the CL. This infrastructure represents a disaster risk as damage can lead to oil or gas spills which can pollute both water sources and the atmosphere.

In 2015, a shell struck a Mariupol-bound gas pipeline between the villages of Krasnohorivka and Novokalynove. This caused a large fire and the entire village of Krasnohorivka was covered by combustion by-products. In June 2015, the Kramatorsk-Donetsk gas pipeline broke near the village of Ocheretyne and residents of Volnovakha, Mariupol and Berdiansk cities were left without gas for several days. Gas supply to metallurgical plants in Mariupol was also limited in this time.

There is no gas heating in Granitne village near to the CL. The majority of the population heat their homes with coal, but this is very unaffordable as a ton of coal costs more than an ordinary citizen's monthly salary. Lack of coal, increasing cost of firewood and lack of gas heating force the population to harvest wood in nearby plantings, exposing themselves to the threat of blasting.

Key takeaways

1. Prioritize the demining operations along the pipeline routes.

2. Raise awareness of residents on risks related to ammonia exposure and natural gas leaks.

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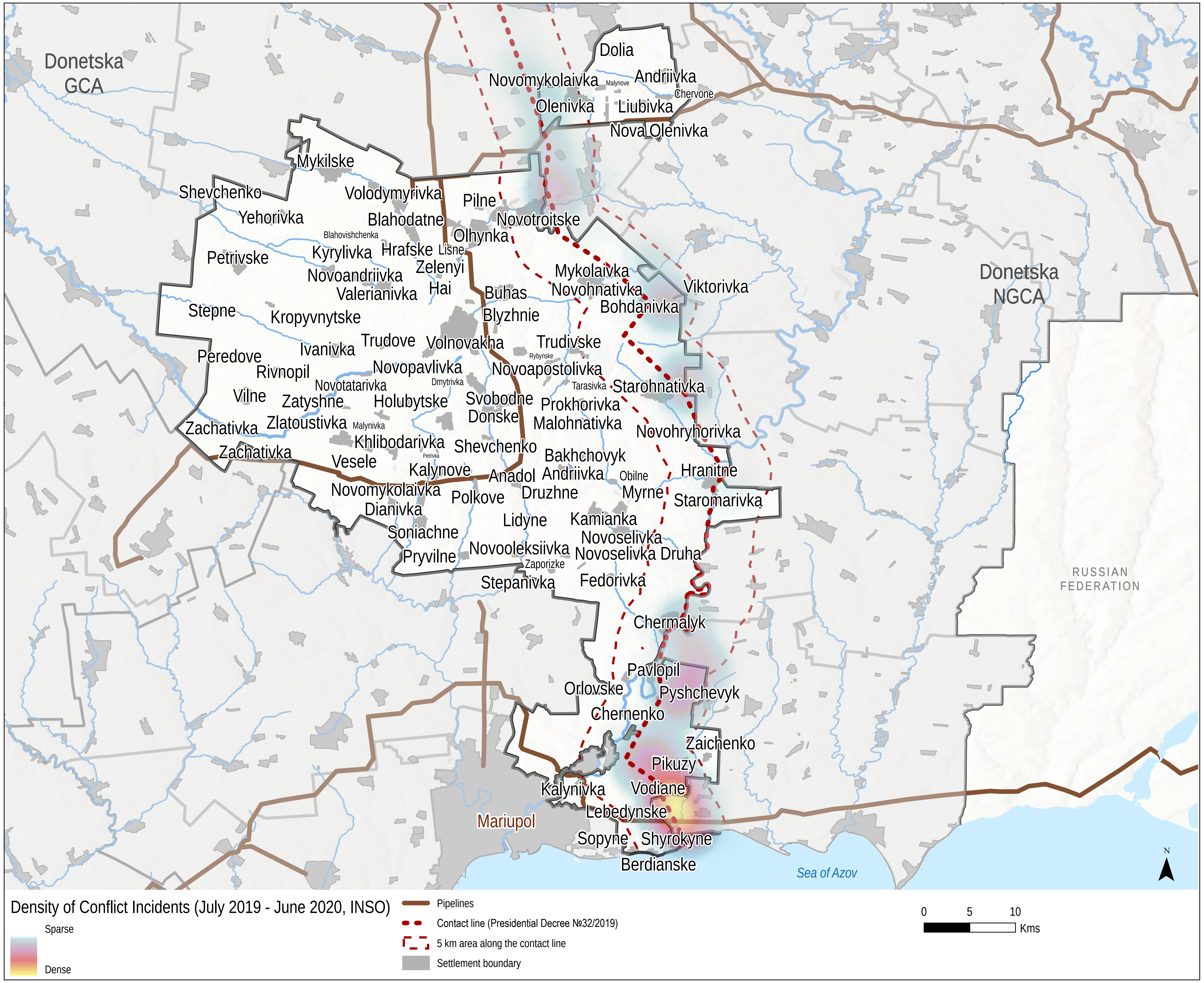
9) PJSC Donetskoblgaz, http://oblgaz.donetsk.ua/hazoprovid-ocheretyne-avdiivka

10) Ukrainian Red Cross Society field reports

Map 11.1 Gas and oil pipeline network in Volnovakha Raion



Susceptibility & Coping Capacity

The majority of vulnerability indicators were derived from the REACH 2018 CVA, which represents households stratified by urban, rural and within/beyond 5km of the CL, as shown in map 12.1 (confidence level 90%, margin of error 7%). As mentioned in the methodology, vulnerability was calculated based on susceptibility and coping capacity. The most susceptible communities were rural settlements located <5km from the CL. This strata also had the highest dependency and lowest economic capacity, the two factors used to calculate susceptibility.

Economic capacity was based on unemployment rate and proportion of pensioners. As Graph 12.4 shows, pensioner status was the most common susceptibility in the raion. Urban settlements had the highest proportion of pensioners, at 55% for Novotroitske, the one urban settlement located <5km from the CL, and an average of 52% for those >5km from the CL. Unemployment was highest in rural settlements <5km from the CL (19%), compared with just 6% in Novotroitske.

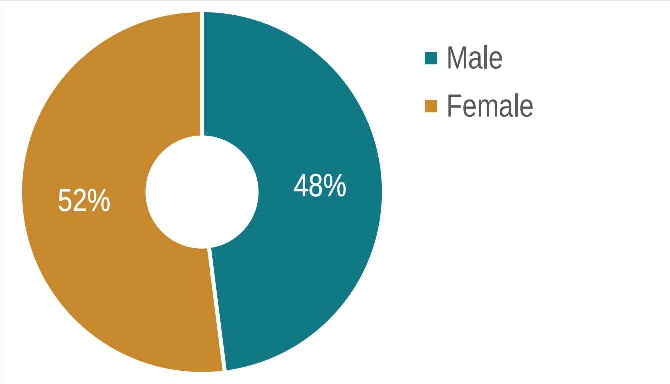
Dependency was based on proportion of population 65+; those with ≥ 1 disability; households with ≥ 3 children; those whose livelihood is agriculture; and where the head of household (HoH) was a widow, single female or single parent. As Graph 12.1 shows, there is an uneven HoH gender distribution at 52% female, and these are disproportionately affected by dependencies (Graph 12.2). In total, over half of households have one or more dependencies (Graph 12.3).

Urban settlements >5km from the CL had the highest proportion of population aged 65+ (28%), whilst the lowest (23%) was found in rural settlements <5km from the CL. Novotroitske and rural settlements <5km from the CL had the highest proportion of households with 1 or more disability (5% and 12% respectively).

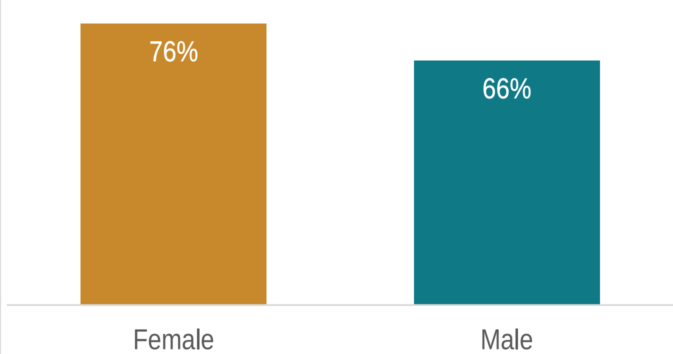
Urban settlements had the highest proportion of HoHs with dependencies, with an average of 48% for settlements >5km from the CL, whilst rural settlements had an average of 29%. As expected, rural settlements had a higher proportion of households whose livelihood is agriculture.

Coping capacity was calculated based on service access, bomb shelter awareness, IDPs and recent conflict

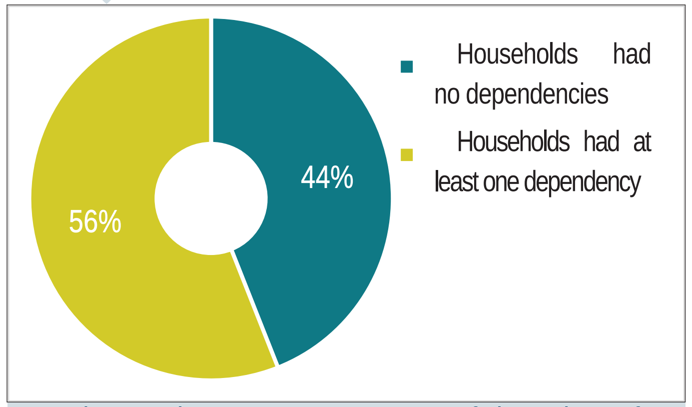
Graph 12.1 Gender distribution of heads of households for Volnovakha Raion



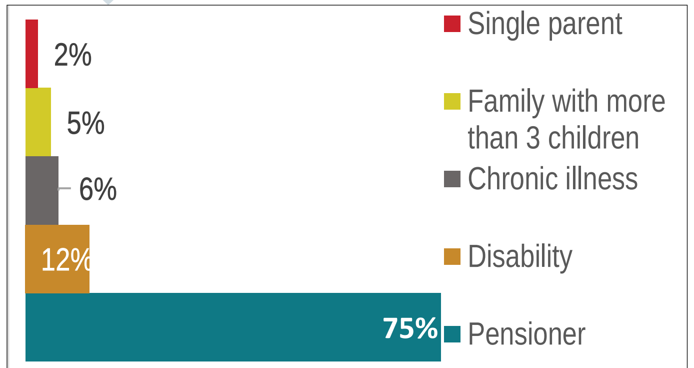
Graph 12.2 Gender distribution of heads of households with dependencies for Volnovakha Raion



Graph 12.3 Distribution of households that had at least one dependency for Volnovakha Raion



Graph 12.4 The most common types of dependency for Volnovakha Raion



events. Rural settlements generally had lower coping capacity, in particular those <5km from the CL, whilst urban settlements >5km from the CL had the highest.

Access to key services contribute to coping capacity. On average, settlements in the raion had poor access to health care, with just 47-61% of households reporting <30 minutes travel time to the nearest facility. Urban settlements >5km from the CL experienced better access, with 39% experiencing >30 minutes travel time.

Schools provide useful opportunities to communicate hazard preparedness and response and are often used for shelter and aid distribution following disasters. Educational facility access was relatively good across all strata, with 95% of rural and urban settlement households >5km from the CL reporting less than 30 minutes travel time to the nearest facility. Access was lowest in Novotroitske, the single urban settlement <5km from the CL, where only 74% of households reported less than 30 minutes travel time.

Social service facilities provide essential services to vulnerable groups and can be used to communicate disaster preparedness and response information (REACH, 2018). The greatest proportion of households >20km from a facility were in settlements <5km from the CL (63-70%). Beyond 5km from the CL, access was generally better. Andriivka and Dolia (both in the NGCA); Staromarivka, Novoselivka Druha and Hranitne were located furthest from a SESU unit, each at over 30km.

With 319 recorded events, Shyrokyne, a rural settlement <5km from the CL, experienced the most conflict incidents between January 2019 and June 2020 as reported by INSO. Pikuzy (NGCA), Novotroitske and Vodiane (<5km from CL) each experienced 150+ incidents. The highest proportion of IDPs was in rural settlements <5km from the CL (8%), whilst the lowest was in urban settlements >5km from the CL (3%). Awareness of the nearest bomb shelter was poor across all strata, ranging from 49% of households in Novotroitske to 68% in rural settlements >5km from the CL.

Because the majority of indicators used to calculate vulnerability were collected at strata level, settlements across the research area have similar vulnerabilities based on settlement stratification. However, SESU unit distance and 2019 INSO conflict incidents provide insights into individual community-level findings. For example, within rural <5km from CL strata, Shyrokyne recorded the most conflict incidents in the raion (319), whilst Orlovske recorded 0. This highlights the importance of settlement-specific details in the analysis.

Overall vulnerability was highest in settlements <5km from the CL, in particular in rural areas. Shyrokyne, which fits into this strata, had the highest vulnerability overall. However, because the CVA only targeted households within the GCA, it was not possible to fully compare vulnerability with settlements in the NGCA such as Pikuzy, despite it experiencing 18% of conflict events recorded in the raion by INSO between January 2019 and June 2020.

Table 12. 1 Traveling time to education facilities

Time	>5km Rural	>5km Urban	5km Rural	5km Urban
< 30 min	95%	95%	87%	74%
30 min - 1 hour	5%	5%	13%	26%

Table 12.2 Traveling time to primary health care facilities

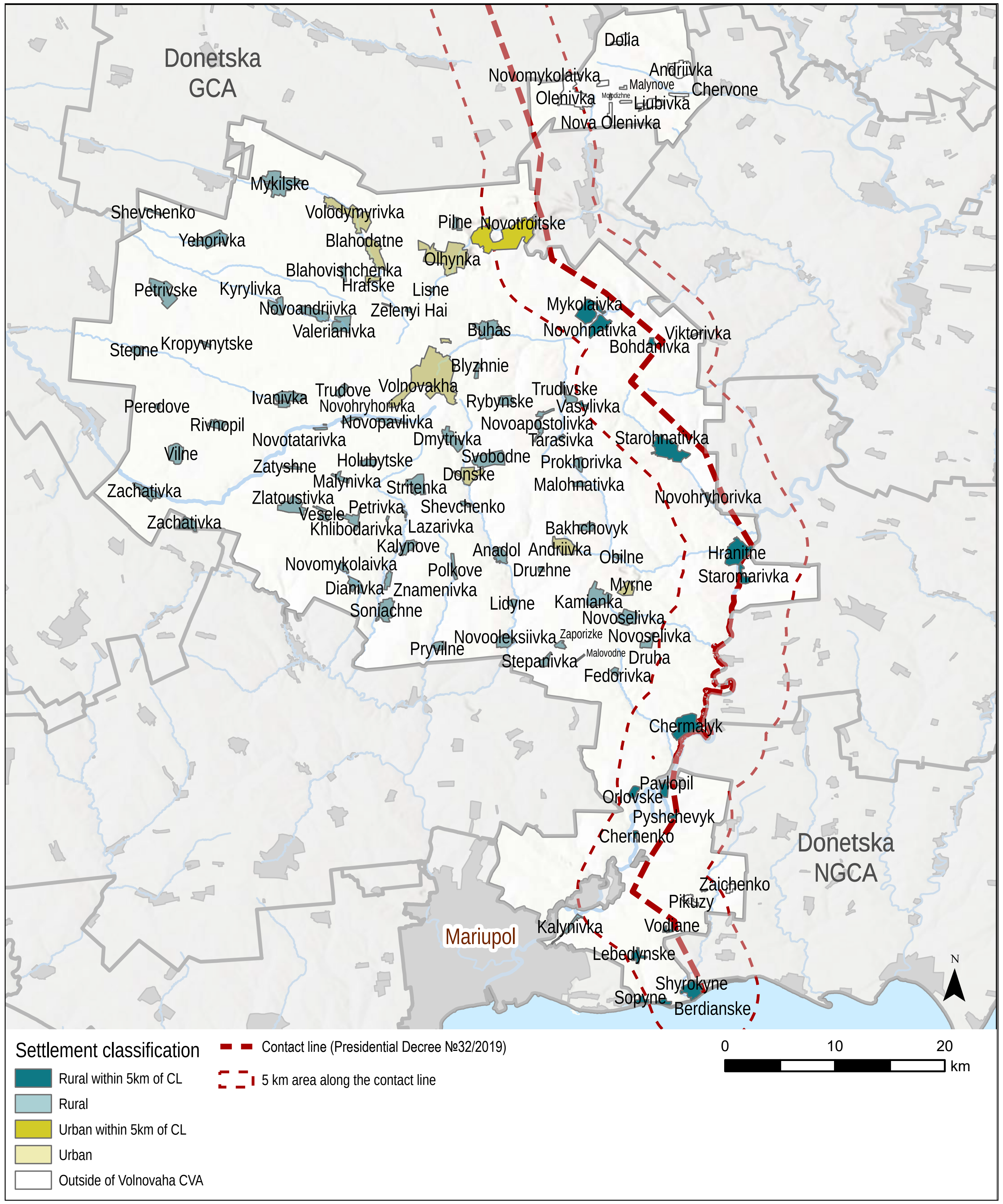
Time	>5km Rural	>5km Urban	5km Rural	5km Urban
<30 min	47%	61%	50%	51%
30 min -1 hour	39%	27%	33%	37%
1-1.5 hours	8%	4%	13%	6%
1.5 - 3 hours	5%	2%	3%	4%
> 3 hours	1%	6%	3%	2%

Table 12.3 Traveling distance to social service facilities

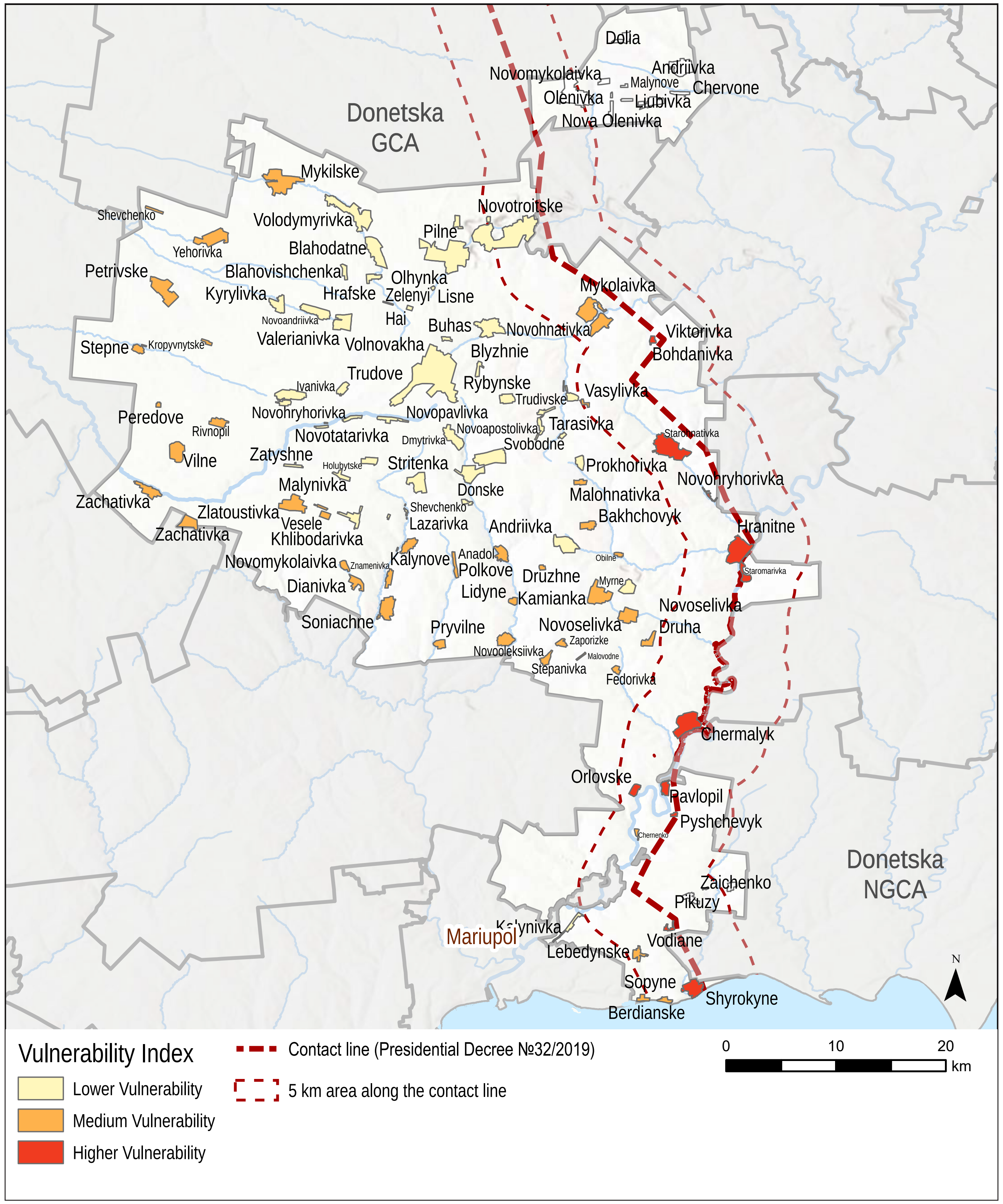
Time	>5km Rural	>5km Urban	5km Rural	5km Urban
< 1 km	9%	10%	3%	0
1-5 km	3%	28%	1%	1%
5-20km	33%	32%	7%	34%
>20km	55%	27%	70%	63%
Don`t know	0	2%	0	2%

VULNERABILITY - SUSCEPTIBILITY AND COPING CAPACITY

Map 12.1 Volnovakha Raion settlement classification from CVA sampling stratification



Map 12.2 Volnovakha Raion vulnerability map



Anthropogenic Multi-Hazard Exposure

The anthropogenic multi-hazard exposure analysis was calculated from the combination of hazard indicators 2.1 hazardous facilities, 2.2 conflict incidents and 2.3 air pollution.

The number of hazardous facilities located within 2km was calculated for each settlement and is shown in Tables 13.1, 13.2 and 13.3. This includes the DEIS identified hazardous critical infrastructure facilities, tailing dams, spoil tips, waste management facilities and filtering stations.

The tables indicate all communities with facilities within 2km as a rough indicator for human and environmental exposure. As multiple hazardous facilities/objects may have cumulative impacts on humans and the environment, the number of facilities are shown, also within 5km to represent the wider-reaching impacts.

Olhynka, in the north of the raion, approximately 10km from the CL, is most exposed to hazardous facilities, with 3 facilities located within 2km of the settlement and 4 within 5km. Novotroitske, also in the north of the raion, but within 5km of the CL, is the most exposed to spoil tips, with 5 located within 2km and 9 within 5km. There are no settlements in the raion located in the immediate vicinity of tailing ponds. However, Mykilske, in the northwest of the raion, has 3 tailing ponds within 5km and Kalynivka, close to Mariupol, has 6 within 10km.

A detailed analysis of each hazardous facility, their substances, their exposure, and transfer pathway through soil, groundwater, and rivers, is needed to highlight whether exposure would increase. To improve calculations of hazard exposure, facilities should be individually assessed to determine types and quantities of substances, and The FEAT 2.0 Pocket Guide can also be applied.

Due to heavy industry in the region, many settlements face high levels of air pollution. Settlements located towards the centre and north experienced poorer air pollution, with Blyzhnie having the worst based on averaged measurements from January-June 2020.

As mentioned previously, Shyrokyne, Pikuzy, Novotroitske and Vodiane experienced the highest number of conflict events. Settlements located closest to the CL had the highest anthropogenic hazard exposure overall. As Map 13.1 shows, Novotroitske, Chermalyk and Shyrokyne are amongst the most at risk from anthropogenic hazards.

Map 13.1 Anthropogenic multi-hazard exposure by settlement

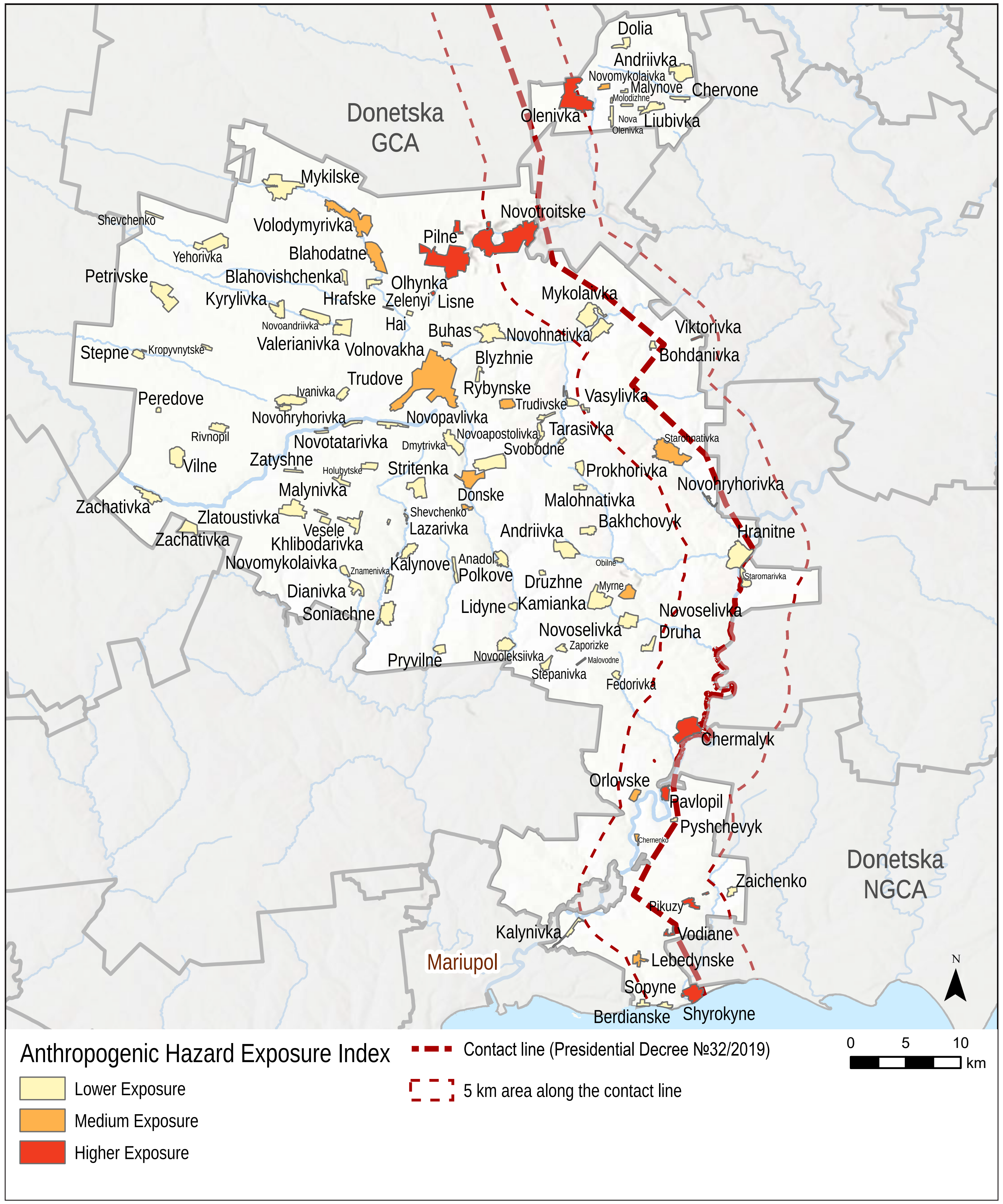


Table 13.1 Settlements most exposed to hazardous facilities

Settlement	Within 2km	Within 5km
Olhynka	3	4
Pavlopil	2	2
Olenivka	2	3
Novotroitske	2	4
Lisne	2	2
Myrne	1	1
Novomykolaivka	1	2
Pilne	1	2

Table 13.2 Settlements most exposed to spoil tips

Settlement	Within 2km	Within 5km
Novotroitske	5	9
Donske	2	2
Volodymyrivka	2	2
Shevchenko	2	2
Andriivka	1	2
Kalynivka	1	2
Myrne	1	1

Table 13.3 Settlements most exposed to tailing dams

Settlement	Within 5km	Within 10km
Mykilske	3	3
Kalynivka	2	6

Natural Multi-Hazard Exposure

The natural multi-hazard exposure analysis was calculated from the combination of hazard indicators 1.1 wildfires, 1.2 heat waves and 1.3 cold waves. Tables 14.1, 14.2, and 14.3 indicate settlements that historically have been most exposed to these environmental hazards (during years 2001-2019).

Rural communities generally had the greatest natural multi-hazard exposure and in general, settlements located towards the centre and west of the raion were most exposed. The three most exposed settlements were Orlovske, Peredove and Vilne. All of these settlements are classified as rural, with Orlovske located <5km from the CL and the other two settlements located greater than 5km from the CL.

Volnovakha settlement experienced the highest number of fire events within a 2km radius, based on FIRMS data between 2001 and 2019. And based on a combination of percentage forest cover, number of recorded fires from FIRMS data between 2001-2019, and number of INSO recorded conflict events in 2019, Volnovakha (an urban settlement greater than 5km from the CL), followed by Olhynka and Novotroitske (both urban communities, greater than and less than 5km from the CL respectively) may be most at risk from wild fires in the future.

As for heat waves, Peredove, located to the west of Volnovakha Raion, was the most exposed, experiencing an average of 42 days where the temperature exceeded 37° between June and August based on observations from 2000 to 2019.

In general, settlements in Volnovakha Raion were less exposed to cold waves compared to raions to the north. Viktorivka, located across the CL in the NGCA, was the most exposed, with an average of 12 days where the temperature dropped below -15° between December and February, also based on observations between 2000 and 2019.

Natural hazards are also considered as triggers for failure of infrastructure such as power and water supply, heating and social infrastructure, which makes these hazards a significant threat to the population.

Map 14.1 Natural multi-hazard exposure by settlements

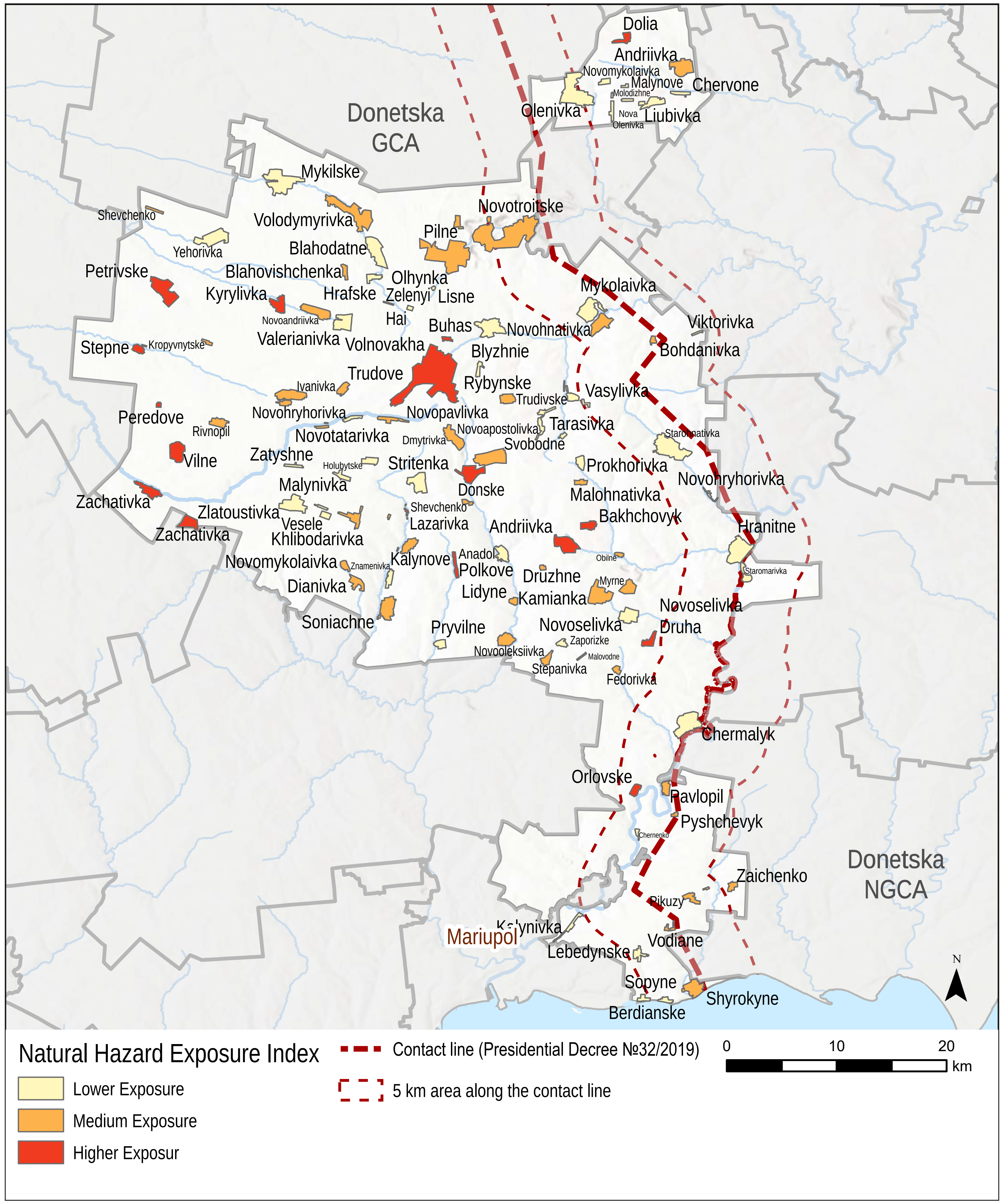


Table 14.1 Settlements with highest observed frequency of abnormally low temperatures

	Settlement	Mean number of days per year with cold waves
1	Viktorivka	12
2	Vesele	11
3	Dmytrivka	11
4	Bohdanivka	11
5	Soniachne	11
6	Novomykolaivka	11
7	Khlibodarivka	11
8	Staromarivka	10
9	Rybynske	10

Table 14.2 Settlements with highest observed frequency of abnormally high temperatures

	Settlement	Mean number of days per year with heat waves
1	Peredove	42
2	Vilne	41
3	Novoselivka Druha	41
4	Kyrylivka	41
5	Orlovske	40
6	Polkove	40
7	Donske	40
8	Pyshchevyk	39
9	Zachativka	39

Table 14.3 Settlements with highest observed frequency of fires during years 2001-2019

	Settlement	Number of fires (FIRMS data)
1	Volnovakha	64
2	Novotroitske	48
3	Olhynka	40
4	Volodymyrivka	35
5	Olenivka	34
6	Mykilske	30
7	Starohnativka	29
8	Hranitne	26
9	Kalynivka	26

Multi-Hazard Risk (Anthropogenic & Natural)

Multi-hazard risk was calculated based on the equal weighting of the five hazard exposure indicators of wildfires, heat waves, cold waves, hazardous facilities, and conflict incidents, against the societal vulnerability indicators applied to the settlements. This provides insight not just to multi-hazard exposure, but also considers the vulnerabilities of the settlements assessed.

Conflict is considered both a hazard and a trigger for other hazards in this analysis, as well as a factor reducing the coping capacity of communities and significantly increasing multi-hazard risk.

Map 15.1 shows the broad pattern of overall risk to anthropogenic and natural hazards across the raion. It is clear that risk is greatest close to the CL, as well as to the west of the raion. Conversely, settlements in the centre of the raion generally experience low to medium risk.

Settlements shaded in grey on the map are located in the NGCA. Because the REACH 2018 CVA did not cover this area, it was not possible to collect all of the data necessary to calculate accurate risk scores for these settlements.

Table 15.1 lists all of the settlements in Volnovakha Raion, ranked by their overall risk to anthropogenic and natural hazards. The rural settlement of Shyrokyne, located less than 5km from the CL, had the highest multi-hazard risk of all the 103 settlements in the raion, excluding those located in the NGCA.

This was closely followed by the urban settlement, Novotroitske, also located less than 5km from the CL. This was predominantly due to high risk of anthropogenic hazards in the settlement, mainly related to the high number of conflict events as recorded by INSO, as well as high natural risk in the case of Novotroitske, due to relatively high exposure to extreme weather and risk of wild fires. Shyrokyne is also the most vulnerable settlement in the raion, increasing the overall risk.

The top six most at-risk settlements are located within 5km of the CL, indicating the disproportionately high anthropogenic risk these settlements experience due to proximity to the conflict.

Additionally, five of the six aforementioned settlements are also rural and this strata has the highest vulnerability overall due to reasons such as poor access to key services, vulnerable heads of households, reliance on agriculture and other factors as summarised previously.

The most at-risk urban settlement was Novotroitske, which suffers from high exposure particularly to anthropogenic hazards, despite having relatively lower vulnerability than rural settlements the same distance from the CL. This is followed by Olhynka, which has a considerably lower overall multi-hazard risk.

Settlements beyond 5km from the CL generally had lower multi-hazard risk and the rural settlement of Lebedynske had the lowest risk overall. Settlements far from the CL that were at a higher risk, such as Vilne and Peredove, generally faced higher risk to natural hazards rather than anthropogenic hazards.

Blahodatne, in the north of the raion, over 10km from the CL, was the least at risk urban settlement. This is mainly due to low vulnerability and low overall exposure to hazards. However, there is a risk of landmines in this settlement, so multi-hazard risk should not be considered alone as settlements may have an elevated risk only to specific hazards.

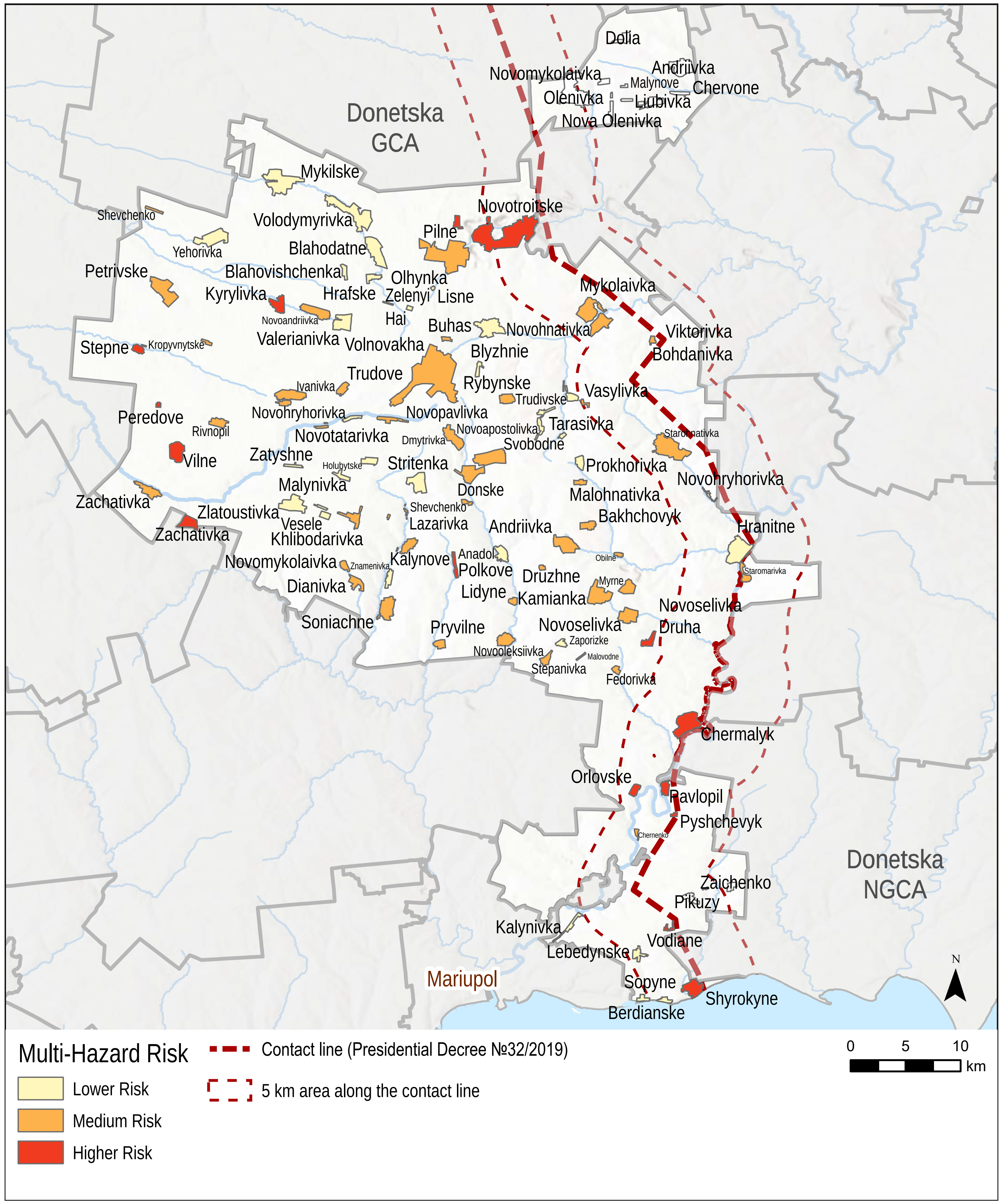
Key takeaways

1. Settlements closest to the CL have the highest overall multi-hazard risk. This is due to high frequency of conflict incidents and high vulnerability.

2. Rural settlements close to the CL faced the most vulnerability, increasing their overall risk.

3. Multi-hazard risk should be considered in parallel with specific hazards that might occur in a settlement and vulnerability to those specific hazards.

Map 15.1 Multi-hazard risk by settlements



MULTI-HAZARD RISK

Table 15.1: Settlement multi-hazard risk

Settlement	Population	Multi-Hazard Exposure	Vulner-ability Index	Multi-Hazard Risk
Shyrokyne	1411	12.16	29.58	3.60
Novotroitske	6978	14.21	24.79	3.52
Pavlopil	620	10.63	27.24	2.90
Vodiane	19	9.87	28.14	2.78
Orlovske	0	10.05	27.03	2.72
Chermalyk	1908	9.08	28.18	2.56
Pilne	332	9.58	24.98	2.39
Vilne	1058	9.17	25.94	2.38
Peredove	138	9.13	26.00	2.37
Novoselivka Druha	439	8.92	26.30	2.35
Polkove	163	9.10	25.59	2.33
Stepne	799	8.91	26.06	2.32
Kyrylivka	732	9.11	25.46	2.32
Zachativka	668	8.91	26.03	2.32
Pyshchevyk	41	8.52	27.20	2.32
Olhynka	3230	10.50	21.74	2.28
Zachativka	734	8.70	26.12	2.27
Bohdanivka	90	8.29	27.23	2.26
Starohnativka	2100	8.23	27.41	2.26
Bakhchovyk	544	8.74	25.70	2.25
Novomykolaivka	193	8.72	25.72	2.24
Rybynske	1390	8.95	25.05	2.24
Petrivske	1209	8.61	25.95	2.23
Obilne	159	8.57	25.91	2.22
Dmytrivka	1196	8.87	25.01	2.22
Chernenko	16	8.22	26.97	2.22
Lazarivka	65	8.73	25.38	2.22
Kropyvnytske	280	8.60	25.76	2.22
Shevchenko	99	8.72	25.36	2.21
Stepanivka	361	8.44	26.13	2.20
Rivnopil	1423	8.52	25.71	2.19
Khlibodarivka	1296	8.49	25.48	2.16
Soniachne	775	8.38	25.80	2.16
Svobodne	1790	8.58	25.18	2.16
Novopavlivka	176	8.61	25.02	2.15
Novohnativka	722	8.00	26.86	2.15
Andriivka	888	9.56	22.44	2.15
Donske	5051	9.76	21.97	2.15
Lidyne	79	8.29	25.85	2.14
Ivanivka	1049	8.35	25.34	2.12
Mykolaivka	1515	7.84	26.82	2.10
Pryvilne	776	8.09	25.98	2.10
Novooleksiivka	575	8.08	25.99	2.10
Vasylivka	91	7.80	26.85	2.09
Myrne	1835	9.16	22.80	2.09
Druzhne	90	8.10	25.76	2.09
Novotatarivka	78	8.25	25.29	2.09
Trudove	222	8.27	25.14	2.08
Dianivka	1026	8.03	25.77	2.07
Fedorivka	40	7.92	26.06	2.06
Petrivka	19	8.10	25.45	2.06
Volnovakha	23305	9.57	21.50	2.06
Malohnativka	151	8.05	25.55	2.06
Shevchenko	23	7.86	26.16	2.06
Kalynove	698	8.04	25.53	2.05
Staromarivka	305	7.35	27.86	2.05
Kamianka	1050	7.88	25.95	2.04
Novoandriivka	905	7.99	25.26	2.02
Novoselivka	976	7.70	26.13	2.01
Hranitne	615	7.20	27.78	2.00
Blahovishchenka	78	7.89	25.29	2.00
Mykilske	1922	7.74	25.76	1.99
Lisne	101	7.90	25.19	1.99
Zatyshne	201	7.79	25.50	1.99
Yehorivka	960	7.68	25.83	1.98
Novohryhorivka	113	7.15	27.47	1.96
Volodymyrivka	6660	8.82	22.18	1.96
Trudivske	637	7.64	25.37	1.94
Prokhorivka	502	7.56	25.49	1.93
Anadol	666	7.51	25.60	1.92
Kalynivka	929	7.67	25.01	1.92
Zelenyi Hai	79	7.64	25.00	1.91
Blyzhnie	891	7.65	24.91	1.91
Znamenivka	172	7.35	25.69	1.89
Holubytske	378	7.44	25.23	1.88
Novoapostolivka	257	7.39	25.24	1.86
Malynivka	261	7.34	25.37	1.86
Zlatoustivka	1869	7.24	25.60	1.85
Vesele	413	7.20	25.57	1.84
Valerianivka	1090	7.25	25.15	1.82
Buhas	1429	7.18	24.97	1.79
Novohryhorivka	133	6.93	25.14	1.74
Berdianske	228	6.36	26.95	1.71
Zaporizke	85	6.55	26.10	1.71
Sopyne	282	6.35	26.85	1.70
Stritenka	838	6.74	25.23	1.70
Hrafske	521	7.71	21.96	1.69
Malovodne	98	6.30	26.20	1.65
Tarasivka	13	6.26	25.38	1.59
Blahodatne	1178	7.05	21.99	1.55
Lebedynske	718	5.44	26.80	1.46
Pikuzy	606	11.41	/	
Viktorivka	20	9.24	/	
Dolia	344	8.99	/	
Andriivka	670	7.96	/	
Zaichenko	311	7.97	/	
Olenivka	4651	9.35	/	
Nova Olenivka	99	7.63	/	
Molodizhne	157	6.51	/	
Liubivka	537	3.97	/	
Chervone	95	6.17	/	
Novomykolaivka	49	7.44	/	
Malynove	92	6.17	/	

Hromada Proposed Administration

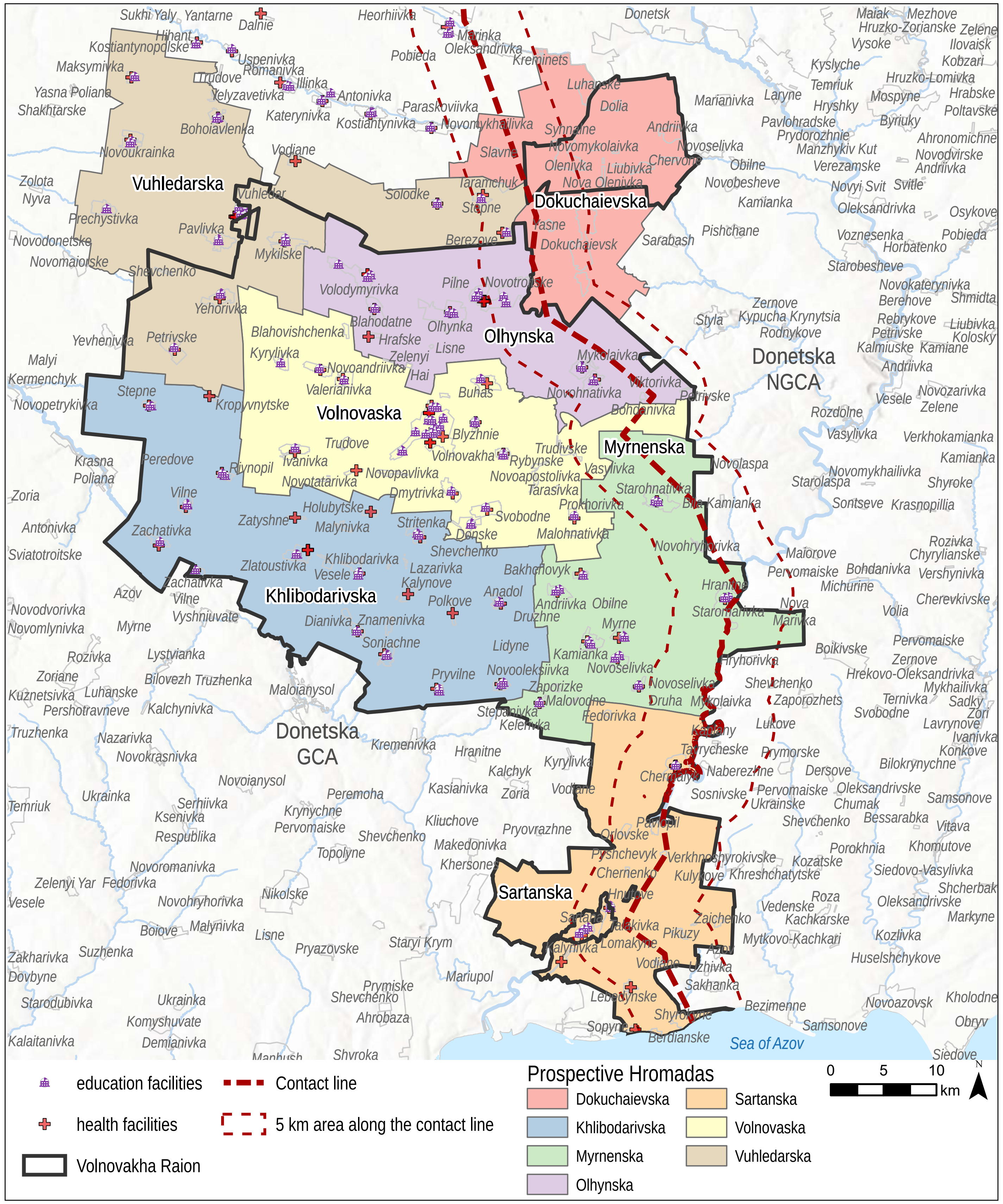
The state policy of Ukraine in the area of local self-government is based, primarily, on the interests of residents of territorial communities. The decentralization reform provides for significant and systemic changes through decentralization of power - that is, transfer of a significant proportion of power, resources, and responsibility from the executive branch of the government to the bodies of local self-government (hromadas).

According to the new prospective plan of administrative division, the current Volnovakha Raion will be divided between 7 hromadas; namely: Khlibodarivska, Myrnenska, Olhynska, Volnovaska, Vuhledarska, Sartanska and Dokuchaievska as indicated in Map 16.1. All these hromadas, except for Khlibodarivska are partly located in the 5km area along the CL, with Dokuchaievska mostly located in the NGCA. Frequent conflict incidents, landmine contamination and lack of transportation connections are the main challenges facing citizens of these hromadas.

Also, according to the new adminstrative divisions, Donetska Oblast will consist of 8 raions. However, it is important to note that 3 raions out of 8 will be located in the NGCA: Horlivska, Donetska and Kalmiusky. Map 16.2 shows an overview of the proposed raions. To comply with prospective hromadas structure, the area of the prospective Volnovakha Raion will include 8 hromadas: hromadas of Komar, Staromlynivka and Velyka Novosilka will be added to Volnovakha Raion, and Dokuchaievska hromada is planned to be included in Kalmiusky Raion, whilst Sartanivska hromada is to be included in Mariupolsky Raion.

When considering the formation of new amalgamated territorial communities in Volnovakha area, it will be important to ensure that all the community members have access to healthcare, social services and other critical facilities. Based on the vulnerability assessment from the REACH 2018 CVA, more than 55-70% of households in all rural and urban settlements within 5km of the CL reported a distance to their nearest social services facility of greater than 20km. Such a

Map 16.1 Overview map for Volnovakha Raion hromadas



situation might be improved by the creation of a mobile social services center in the raion.

In addition, between 27 and 39% of households in all settlements reported greater than 30 minutes travel time to their nearest primary healthcare facility. To improve this situation, new health facilities could be established or distant settlements could be united with other community centers.

Under the decentralization reform, a new citizen safety center was created in September 2019 in Novotroitske, maintained by SESU. The main purpose of the citizen safety centers are to provide a full range of security services. This includes a fire and rescue unit, emergency medicine units and a pyrotechnic unit, which is important due to the close proximity of these areas to the CL. The construction of a new citizen safety center for Khlibodarivska hromada is ongoing as of Septermber 2020.

To ensure comprehensive protection of the civilian population in these newly-created amalgamated communities, strong inter-departmental preparedness and mitigation planning processes led by a Civil Protection specialist is recommended. In line with global best practices and guidance such as the Sendai Framework, newly-created hromadas should pay particular attention to developing data-driven Disaster Risk Reduction strategies, for which this analysis can serve as a first step.

Map 16.2 Overview map of prospective raions

Conclusions

This ABRA for Volnovakha Raion aims to analyse geospatial data on hazard exposure and community vulnerability to assess both natural and anthropogenic risks for each settlement in the area.

This was done using a combination of socioeconomic assessments based on a 2018 CVA undertaken by REACH and geospatial data analysis. Settlements were stratified into rural and urban, and whether the settlement was located less than or more than 5km from the CL.

It is expected that the ABRA will be used by the communities and local authorities as a background for risk management plan development that will address the local communities' vulnerability and needs to respond effectively to hazards.

The study has been conducted at the sub-regional level, and relies on both locally available data, global datasets, and satellite imagery. Most of these datasets are open access and constantly updated and may be used to reproduce the analysis for other areas or time periods. Thus, this ABRA also serves as a demonstration tool for environmental and industrial risk at a local settlement level.

Community prioritization according to the level of hazard exposure and vulnerability is important for increasing the awareness about the actual risks and an essential step in building capacity to the exposed hazards.