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AREA BASED RISK ASSESSMENT
TORETSK CITY COUNCIL
DONETSKA OBLAST, EASTERN UKRAINE

July 2020

Funded by
European Union
Civil Protection and
Humanitarian Aid

USAID
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IMPACT Shaping practices Influencing policies Impacting lives

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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

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

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).

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.

CONTENT

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KEY FINDINGS

Anthropogenic Hazards

Spoil tip in Toretsk. By Валерий Дед, CC BY 3.0, https://commons.wikimedia.org/w/index.php?curid=53849863

Discharge of untreated wastewater from coal mine
By ACTED

Incor & Co Phenol Plant
By Metinvest Novhorodske

Toretsk city council is located in the middle of Donetska oblast within 5 km of the contact line (CL) in Eastern Ukraine. It was once one of the largest coal mining areas in Eastern Ukraine. Currently 14 potentially hazardous facilities are within the area of Toretsk city council and 50 additional hazardous facilities are within 25 km of Toretsk city council, with some located in the non-governmental controlled area (NGCA) in Horlivka and Makiivka. These sites include chemical and coke industries, energy and power, mining, water supply infrastructure, tailings dams, spoil tips, machine building, and metallurgy. These facilities 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 the conflict or lack of maintenance.

The urban communities of **Toretsk, Zalizne, Pivdenne and Pivnichne have the highest exposure to hazardous facilities**. Coal mine networks of Toretsk and Horlivka areas only have three mines operating officially. There are concerns over methane gas and toxic liquid waste from tailings at these facilities becoming exposed to the surrounding environment and human population. **Incor & Co Phenol plant in Novhorodske** is one of the most hazardous facilities in the region, located in a residential area which is further discussed in the case study.

Toretsk city council witnessed 16 conflict incidents in the populated area during 2019 and 416 conflict incidents were recorded within 2 km of the settlements. In the first half of 2020 (January-June), 170 conflict incidents were recorded, indicating that this protracted crisis is still impacting the Toretsk area (INSO, 2020). **Zalizne, Pivdenne, Novhorodske and Shumy settlements were reported to have the highest exposure to conflict events**.

Coal mining and coke industries are also considered to be the main sources of air pollution in the region, **frequent maximum permitted concentration (MPC) overage are registered in the region**, in particular for aerosols, nitrogen dioxide, and sulfur dioxide. Chronic exposure to air pollution increases the mortality from stroke, heart disease, chronic obstructive pulmonary disease, lung cancer and acute respiratory infections (WHO, 2020).

Natural Hazards

Wildfires in grasslands near the Kreidova Flora natural reserve
By S.Limanskij

Landslides near mining areas
By ACTED

Water supply system damage due to shelling
By UNICEF

Conflict in the Toretsk municipality is considered an anthropogenic hazard, but also a trigger for other hazards, as well as impacting the coping capacity of the society.

The five communities with the highest numbers of satellite-detected fires were Novhorodske, Toretsk, Shcherbynivka, Zalizne and Pivnichne; 50% of all satellite-detected fires occurred near these settlements. In addition, significant fuel for wildfires was identified within proximity to these communities through land cover detection from satellite imagery. This is a concern given the number of conflict incidents in the area, which can be a trigger for wildfires thus resulting in a higher exposure to wildfire threats.

Available data on areas contaminated by landmines was found to be limited, with only one landmine field near Shcherbynivka marked on the map developed by the Ministry of Defense of Ukraine (https://mod-ukr.imsma-core.org). However, 11 mine-explosion events have been recorded in The Armed Conflict Location & Event Data Project (ACLED) database since 2017. Landmines are considered to be both a potential trigger for wildfires, as well as a coping capacity indicator for communities, complicating access by emergency response services. Snow, heavy rains, flooding and smog were mentioned in secondary data review as natural factors increasing the mine-explosion risk with the absence of visible warning signs.

During cold waves and heat waves, due to the ongoing conflict, there is potential for disruption to water supply, electricity, and heating supply infrastructure networks. If affected, the coping capacity of the population can be decreased significantly, thus increasing their risk to such natural hazards. **Shumy, Kurdiumivka, Pivdenne and Ozarianivka have higher risk to heat waves** and record around 30% of days during the summer months of June, July, and August (years 2000-2019), with land cover temperatures of +37°C or higher. **Shumy** also **has higher extreme cold exposure** with 18% of days during December, January, February, with land cover temperatures below -15°C as well as the highest risk to cold waves due to its higher vulnerability.

Rural communities within 5 km of the CL reported longer distances to key services such as health care facilities, social services, education facilities, and emergency response units, which influence the coping capacity of a community. Rural communities outside of the 5 km zone had the highest susceptibility, mainly because of higher dependency and unemployment rate.

INTRODUCTION

Background

Since 2014 Ukraine has been experiencing 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 local 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, the 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, heatwaves 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 Luhansk region experienced a 24-day heatwave 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.

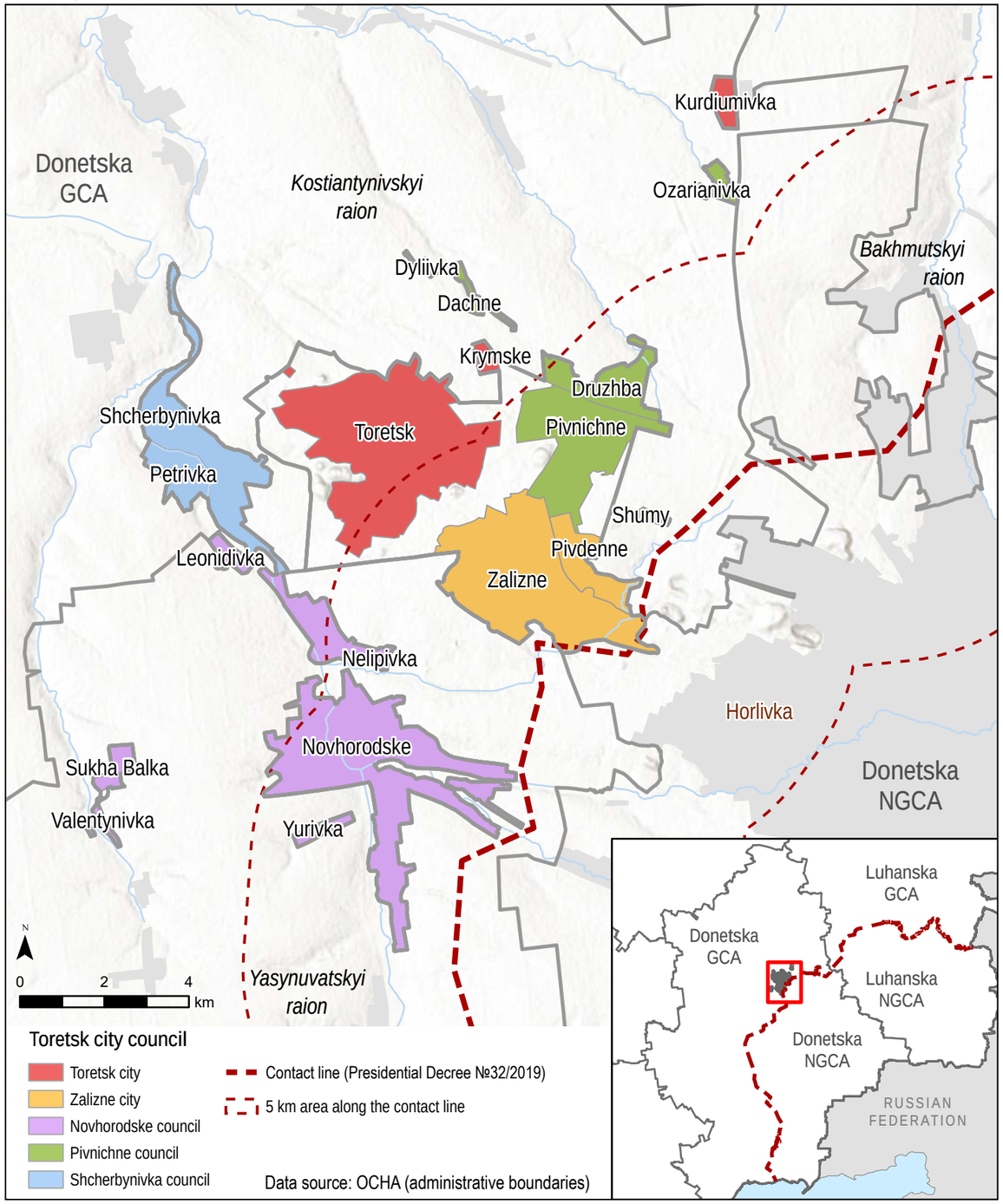
Overview of Assessed Area

Toretsk city council is located in the middle of Donetska oblast. It includes Toretsk city and Zalizne city councils, plus the three village councils of Novhorodske, Pivnichne and Shcherbynivka. These contain 19 settlements in total, of which 9 are urban and 10 are rural. Part of Zalizne area is situated in non-government control area (NGCA).

The most populated city is Toretsk, with 43,371 citizens from the last official census in 2001. However only 33,455 were reported during REACH assessments in 2018 and an additional 28,845 in the surrounding settlements for a total population of 62,300. Population decline is associated with low birth rates, increased mortality and migration, including those related to conflict. The area hosts 7,229 registered internally displaced persons (IDPs) in 2018 according to city council data.

Toretsk is associated with the discovery of the coal-rich Donets Basin and coal mining began in the 1720s. The city was developed as a heavy coal mining center and a former part of Horlivka-Yenakievo industrial agglomeration. The area of Toretsk city council is 6,189 ha, mainly presented by urban, built-up and industrial lands. Agricultural lands occupy only 416 ha (6.7% of the area).

Overview map for Toretsk city council



METHODOLOGY

Methodology overview

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

The ABRA aims to analyse 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. In 2019, there is no centralized and functional platform for open geospatial data access for the region which allows 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 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 a 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 higher 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, 2019).

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 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 Toretsk city council were; hazardous facilities from mine-related and chemical use, conflict, wildfires, and extreme temperature of cold waves and heat waves.

For each hazard, the approach was to identify where geographically there was potential for exposure within the Toretsk City Council. 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 (pp. 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 near to the CL or have experienced disruptions in maintenance and operations.

Conflict is both considered a direct hazard, 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 Toretsk city council. 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.

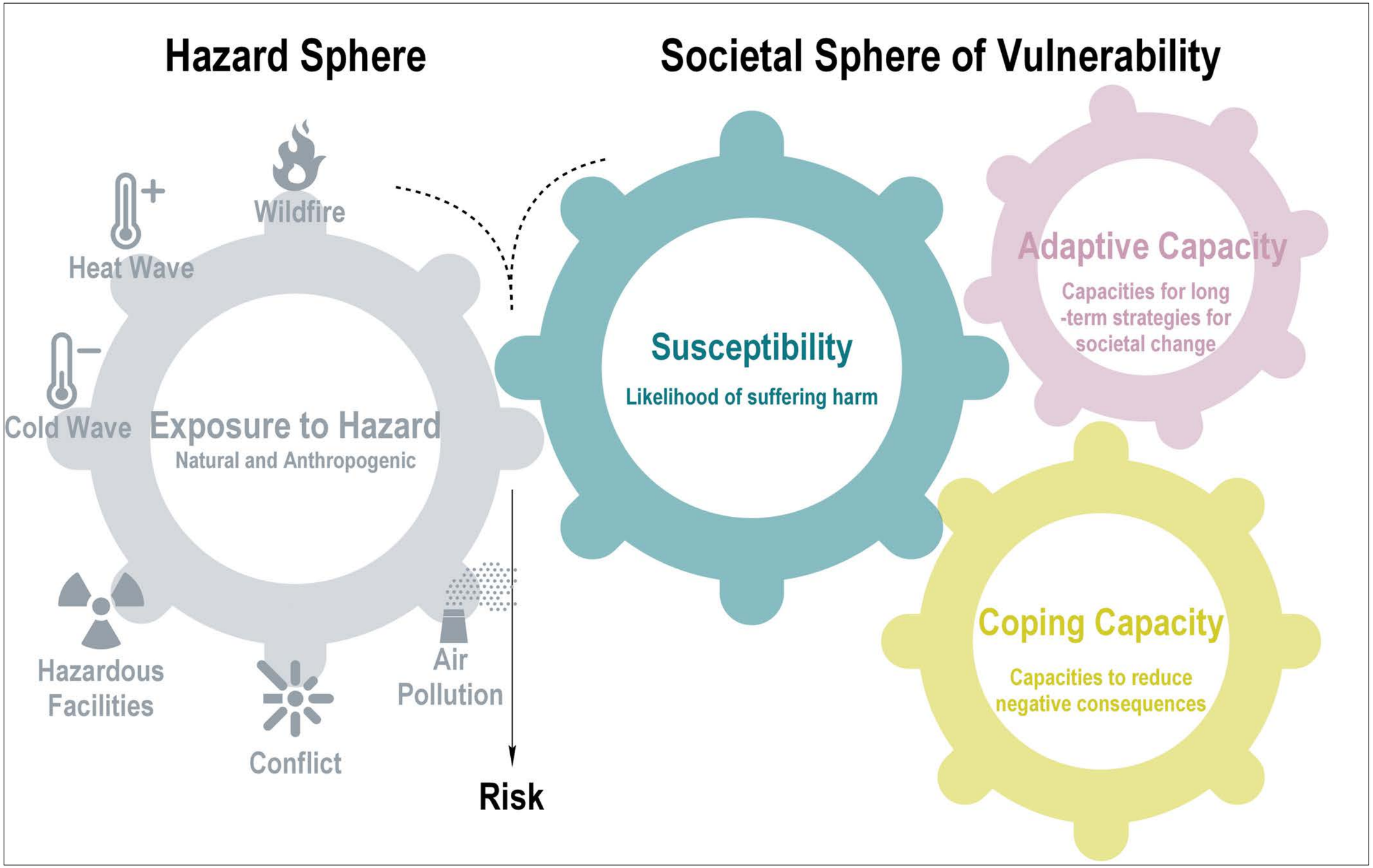
Susceptibility is the likelihood of suffering harm from one of the assessed hazards. Coping capacity refers to the capacities of the society to reduce negative consequences. Lastly, adaptive capacity, or capacity development are the societal capacities in place to develop and maintain long-term strategies 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 Toretsk city council 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 Toretsk city council 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 Toretsk city council was based on four stratas, urban settlements within 5km to 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.

METHODOLOGY: RISK EQUATION

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 localized 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).

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).

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 analysis)

Indicator 2.3: Air pollution

- 3-month averaged (January-March 2020) satellite data from Sentinel-5P on NO_2, SO_2, 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 influences 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: Head 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 the hazard
- Indicator: Proportion of the population who are not aware of the nearest bomb shelter

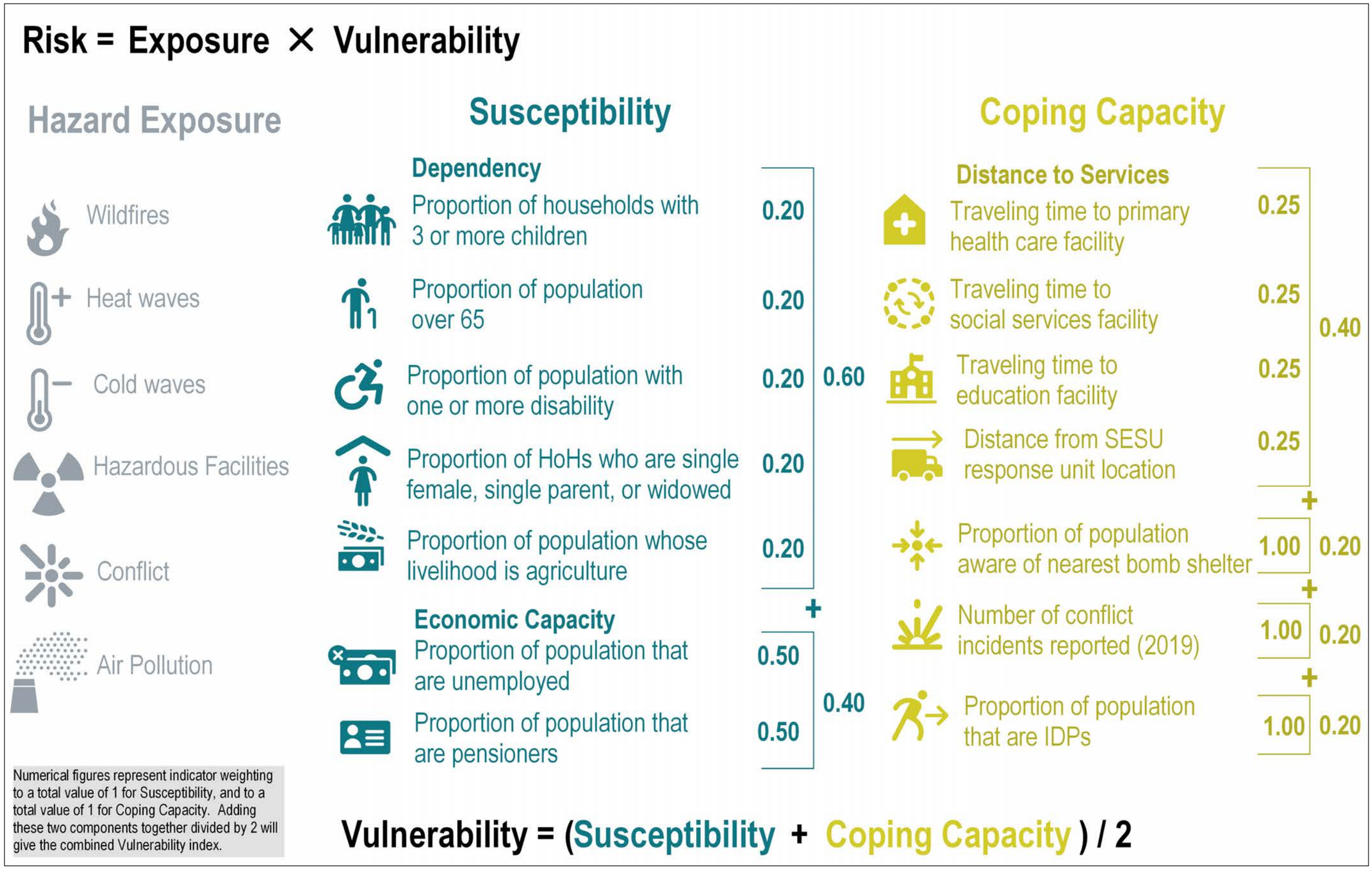
Indicator 7.1: Conflict

- 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: IDPs

- Relevance: IDPs depending on their current shelter status are usually more susceptible to the exposure of hazard, 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

Wildfire 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), destroy large swathes of natural habitat and man-made structures (houses, factories or utility infrastructure). With rising global temperatures and an increase in the frequency and severity of heatwaves, the number of fires over time is growing every year (IPCC, 2018).

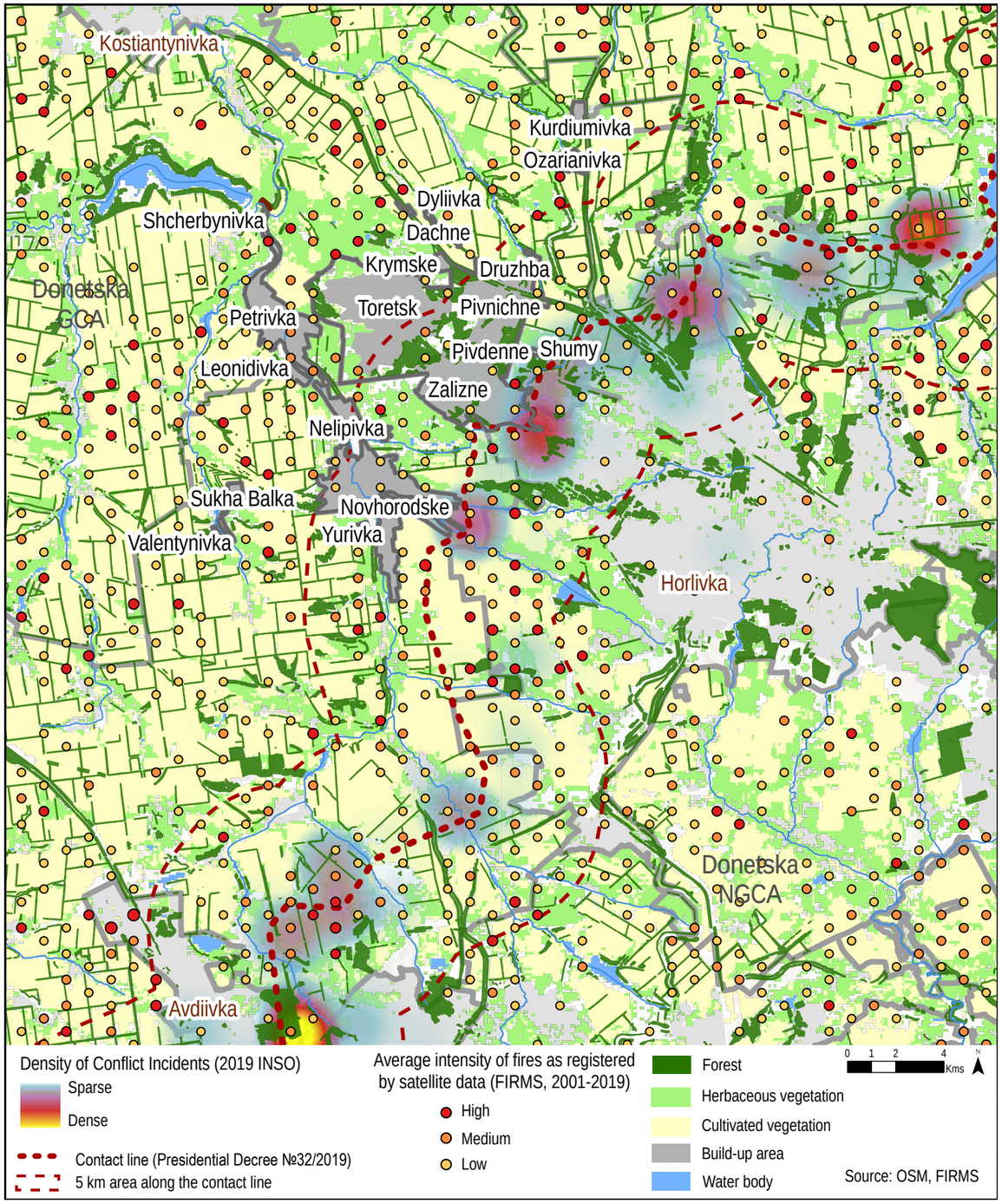
This review contains data on fires in Toretsk city council area from two sources: satellite data from the Fire Information for Resource Management System (FIRMS)[1] from the National Aeronautics and Space Administration (NASA) for the years of 2001-2019 and data provided by the State Emergency Service of Ukraine in Donetska oblast for the years 2015-2018 (SESU, 2019).

Many satellite detected fire events in the area are located in agricultural lands. This might be a result of common agriculture practice of stubble burning to prepare a field for sowing. In drought conditions, this not only increases the risk of uncontrolled spread of fire, but also leads to soil moisture loss, which is already in limited amount. However, the fires near Avdiivka, south of Toretsk, are located in the area of high density of conflict incidents, indicating a potential correlation with military activity.

Conflict incidents and landmine contamination were considered as triggers to wildfires. There is only one landmine field to the north of Shcherbynivka, registered on the map of mine-contaminated areas, developed by the Ministry of Defense of Ukraine (https://mod-ukr.ims-ma-core.org). As this information is considered to be

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 use to avoid conflating the numbers with heat signatures related to process on enterprises.

Map 1.1 Average Frequency and Intensity of Fires



Map 1.2 Regional Overview of Forest Land Cover

incomplete, ACLED data on landmine explosions within the settlement and its 2km buffer area was included as wildfire indicator component (https://acleddata.com).

Key takeaways

1. There is a need for an alert system (to be developed) and rapid-fire monitoring services, with the increase in wildfire frequency due to climate change.

2. Restoration of forest belts, fire-control measures in the forest areas and firebreak implementation between areas exposed to continuing conflict incidents.

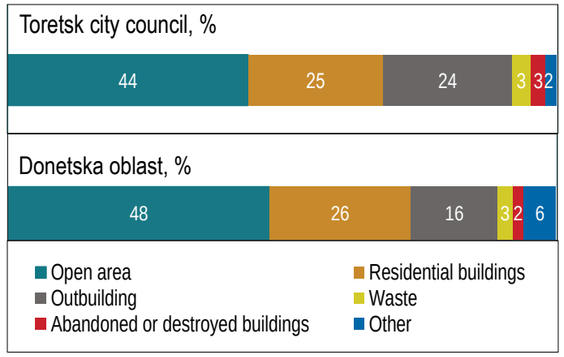
3. Control of agricultural stubble burning.

4. Landmine field detection, marking and the installation of warning signs followed then by de-mining activity is needed.

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

Table 1.1 Most Common Locations of Fires

Affected Area	2015	2016	2017	2018	Total
Open area	71	110	87	90	**358**
Residential buildings	54	35	48	64	**201**
Outbuilding	44	49	53	46	**192**
Waste	5	11	12	0	**28**
Abandoned or destroyed buildings	1	2	15	4	**22**
Buildings of enterprises	6	2	1	1	**10**
Motor transport	3	1	1	0	**5**
Municipal buldings and infrastructure	1	0	0	0	**1**

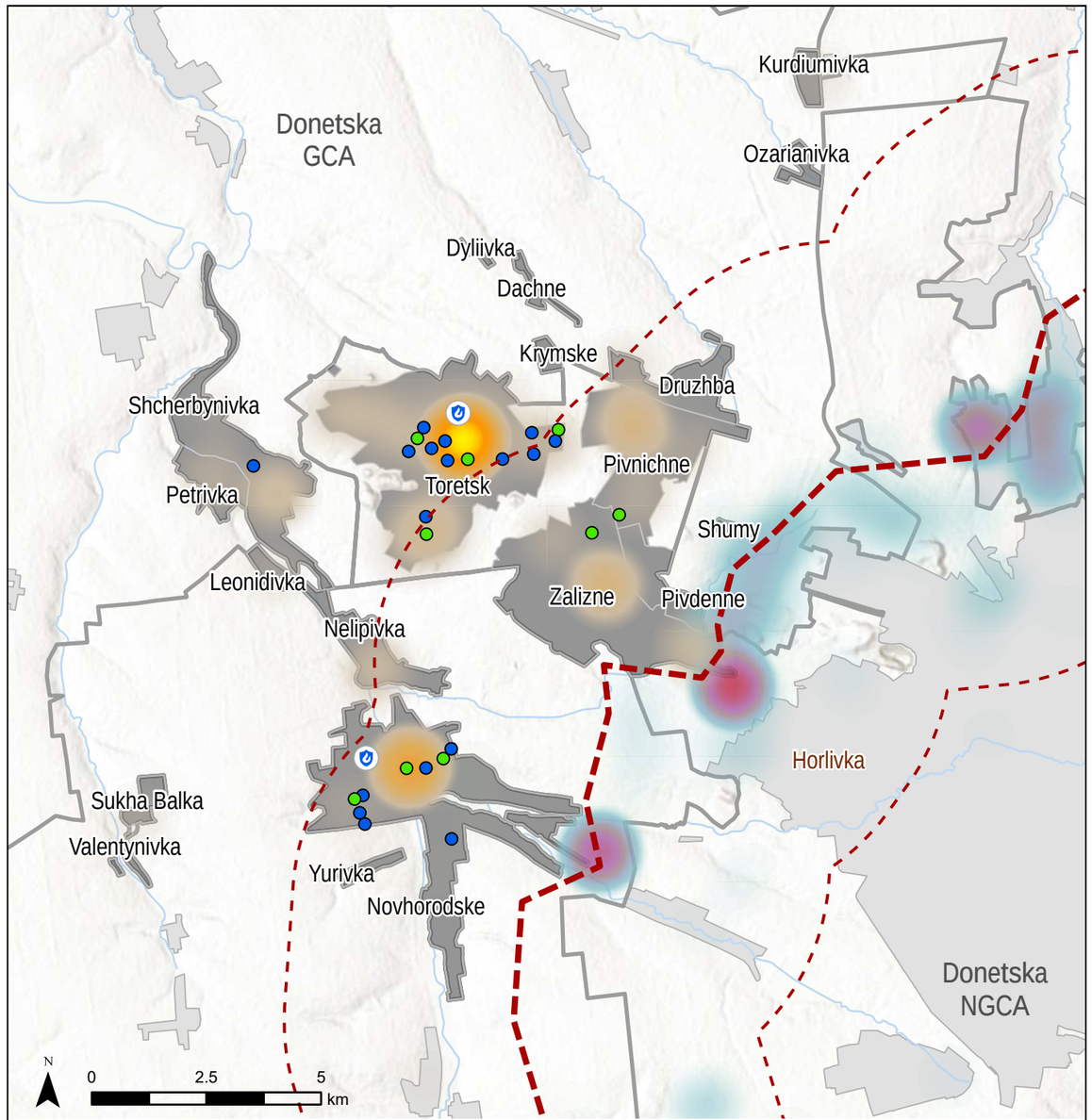


According to the SESU data, 44% of fires reported to SESU in Toretsk city council, started in open area, which includes both natural ecosystems and open urban areas, 22 fire events (3%) were detected in abandoned or destroyed buildings. There is a higher rate of fires in outbuildings in Toretsk city council (24%) compared to the same value in Donetska oblast in general (16%). These outbuildings might be a part of abandoned buildings, but not classified accordingly in the SESU reports on fires.

About half of the fire events of the area occur in Toretsk, in the central part of the city. Yellow color on the map represents the density of SESU trips to the area, based on the reported addresses.

State fire-rescue of SESU Department in Donetska oblast is located in Toretsk. Its service area includes surrounding settlements, some of them located at more than 10 km away. An additional fire station is located in Novhorodske.

Map 1.3 Toretsk alert system



Toretsk alert system development

In order to reduce the vulnerability of the population to emergencies and considering the close proximity of CL to Toretsk, city administration started the construction of a local automated centralized emergency warning system in Toretsk.

Toretsk alert system is planned to be used for timely notification to the population about large-scale wildfires, radiation, chemical incidents, nuclear, biological hazards and other types of hazards, as well as evacuation management in response to the emergency. Alarm units and information boards are currently planned to be installed in schools, hospital, and village councils' buildings. In addition, street loudspeakers will be installed in crowded places. The implementation of a warning system is an example of effective measures to improve the coping capacity of the community and to reduce vulnerability to hazards.

As seen on map 1.3 several settlements remain unserved by alarm units, the largest among them are Nelipivka, Druzhba and Pivdenne.

Table 1.2 Annual Number of SESU Trips To Report of Fires

Community	2015	2016	2017	2018	Total
Toretsk	100	117	88	93	398
Novhorodske	23	34	63	56	176
Zalizne	24	10	17	26	77
Pivnichne	22	18	19	9	68
Shcherbynivka	7	12	7	3	29
Nelipivka	2	6	5	7	20
Petrivka	1	4	6	2	13
Druzhba	2	1	2	3	8
Leonidivka	1	5	1	0	7
Sukha Balka	0	1	3	3	7
Kurdiumivka	2	0	2	2	6
Valentynivka	1	0	1	0	2
Yurivka	0	0	2	0	2
Ozarianivka	00	0	1	0	1

HAZARD - EXTREME TEMPERATURES: HEAT WAVES

Hazard Description

Extreme heat and hot weather over a prolonged period are referred to as heatwaves (IFRC, 2011) and are a significant hazard for populations, infrastructure and the environment. While the exact definition of a heatwave varies by country, it is usually measured by analysing temperatures against long-term averages and therefore focuses on temperature deviation rather than absolute temperature. They have a significant impact on society as they increase both mortality and morbidity, put strain on both infrastructure (water systems, healthcare) and ecosystems due to droughts and high probabilities of forest fires (C2ES, 2019).

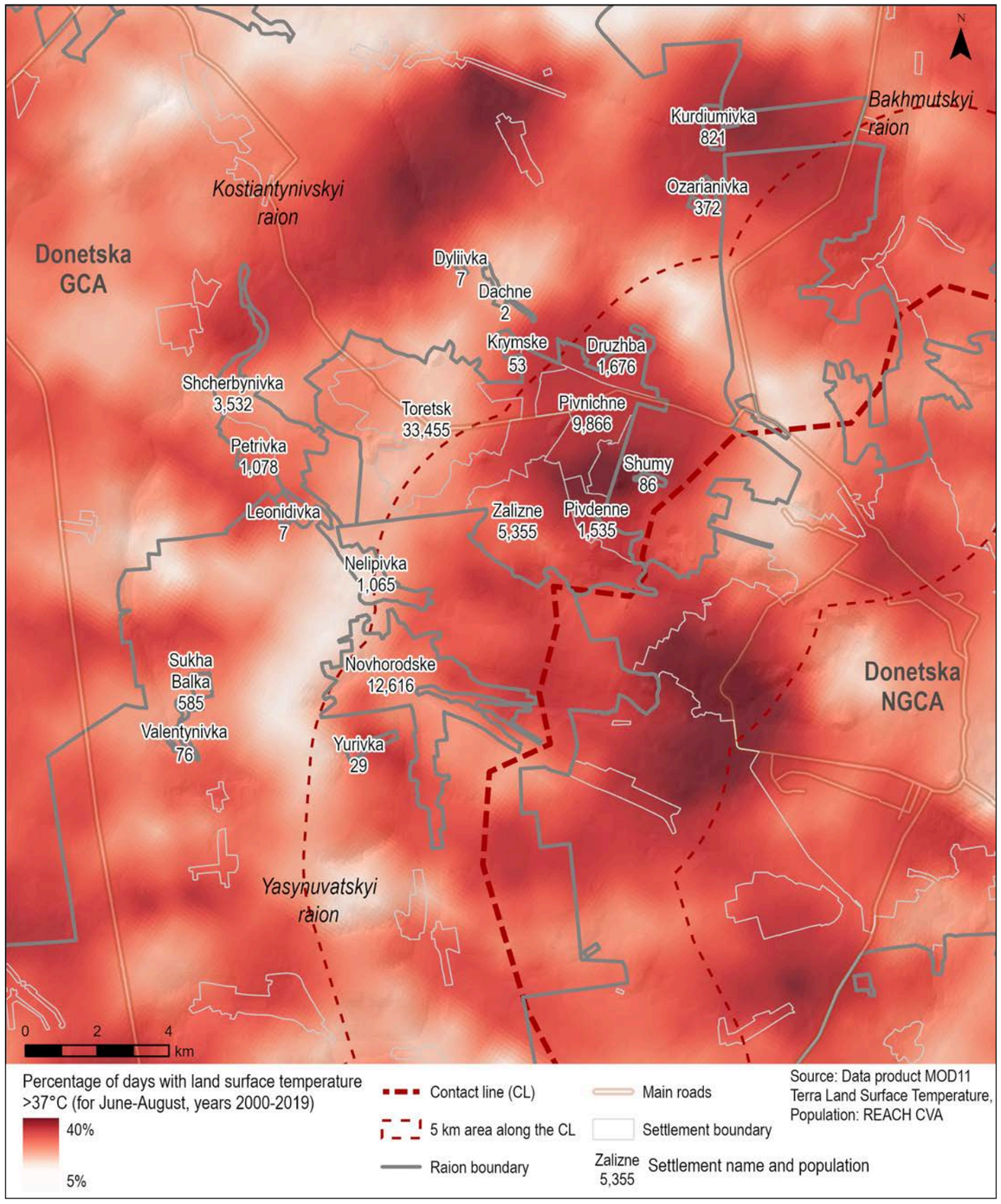
Extreme heat is a leading cause of disaster-related deaths. The 2010 northern hemisphere heatwave led to more than 15,000 indirect deaths globally, particularly affecting susceptible populations groups due to heat stroke and dehydration. The frequency and severity of heatwaves are also increasing over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

Information about abnormally high temperatures in Toretsk city council and adjacent territories was calculated using remote sensing methodologies from MODIS Land Surface Temperature and Emissivity[2] (MOD11) (Wan, Z., Hook, S., Hulley, G., 2015) based on temperature observations in the months of June, July and August. The temperature of +37°C was determined as the lower limit for abnormally high temperatures, which is one standard deviation above the observed mean during the study period (2000-2019).

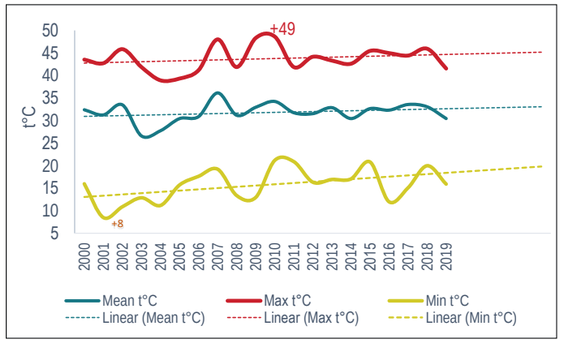
The map displays average proportion of days during the summer season when the land surface temperature exceeds the marginal value. Hot spots are evident near Pivnichne, Pivdenne and Shumy; these settlements are located within 5 km of the CL, which makes them also exposed to conflict events, especially shelling.

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

Map 2.1 Percentage of Days in Summer Season with Temperature >37°C



Graph 2.1 Mean, Min and Max Temperature in Summer **Months (June-August)**



Spoil tips of several closed coal mines are located in this hot spot area. Lack of vegetation causes intense warming of land surface, for instance in summer 2019 the mean temperature of land surface of spoil tips was up to +37°C, which is 12°C higher than in surrounding areas. The highest land surface temperatures (up to +48°C) were observed in August 2007, 2009 2010, and +46°C in August 2018. The 20-year-averaged land surface temperature during the summer is +32°C. In the last 10 years a continuous gradual increase of mean and maximum temperature has been observed (with a prognosis of +1°C in the next 5 years) and more rapid increase of minimum land surface temperature (with a prognosis of +3°C in the next 5 years according to linear trend).

The use of land surface temperature products such as MODIS helps authorities identify the 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 heatwaves, 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 warning system is in place to communicate heat forecasts.

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 instance of road 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).

Ukraine experienced two cold waves in 2006 and 2017. According to the IFRC in 2006 (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.

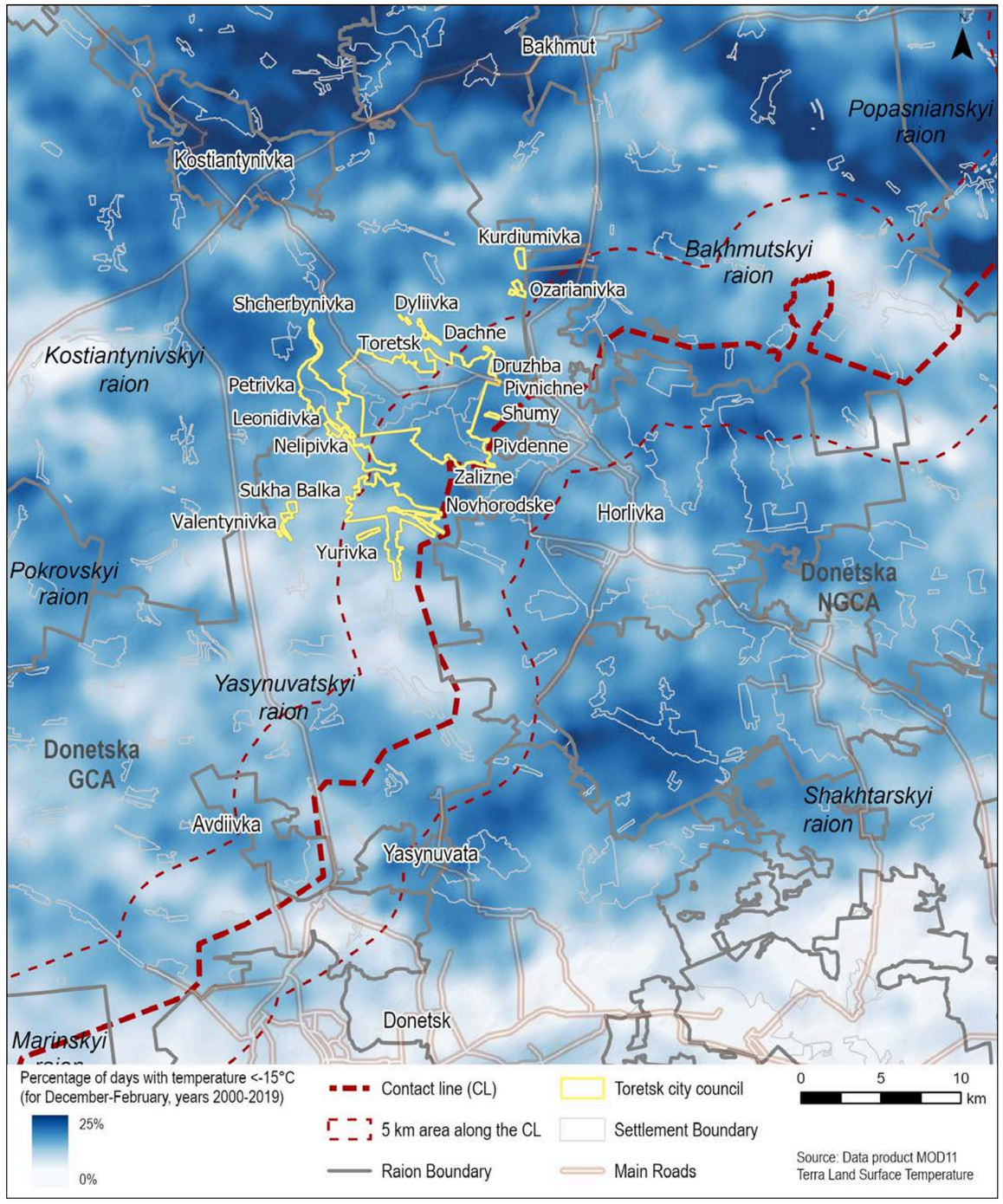
Information about abnormally low temperatures in Toretsk city council and adjacent territories was calculated using MOD11[3] based on temperature observations in December, January and February. Map 3.1 displays data for the winter season for the period of 2000-2019. It utilizes data from 835 satellite acquisitions and shows the percentage of days with temperature below -15°C.

The northern part of Shcherbynivka and eastern part of Toretsk city council, namely the settlements of Shumy, Ozarianivka, Druzhba, Zalizne, Pivnichne and Pivdenne are more exposed to cold waves. In the absence of warning signs near landmine contaminated areas, snow cover may be a natural factor increasing the risk of landmine explosions.

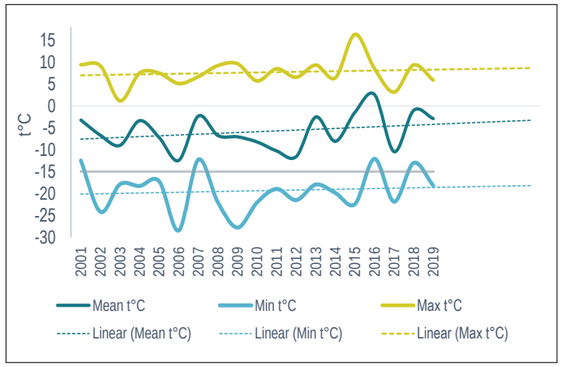
However, in general the area of Toretsk city council is less exposed to cold waves than neighboring Kostiantynivskyi and Bakhmutskyi raions.

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

Map 3.1 Percentage of Days in Season with Temperature < -15°C



Graph 3.1 Mean, Min and Max Temperature in December-February



The lowest temperatures (up to -28°C) were observed in 2006 and 2009. In the last 10 years a continuous gradual increase of mean winter temperature has been observed, but the trend of maximum and minimum temperatures rise is not evident.

While a range of infrastructure can be affected, the most exposed to low temperatures are water and heating infrastructures. Freezing of water pipes, damaging of power lines, and failure of heating systems can cause lasting shortages in access 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 if complete failure to heating supply,
1. Increase awareness on best practices to keep your shelter warm and safely heat your shelter during disruptions to conventional heating supply.
2. 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

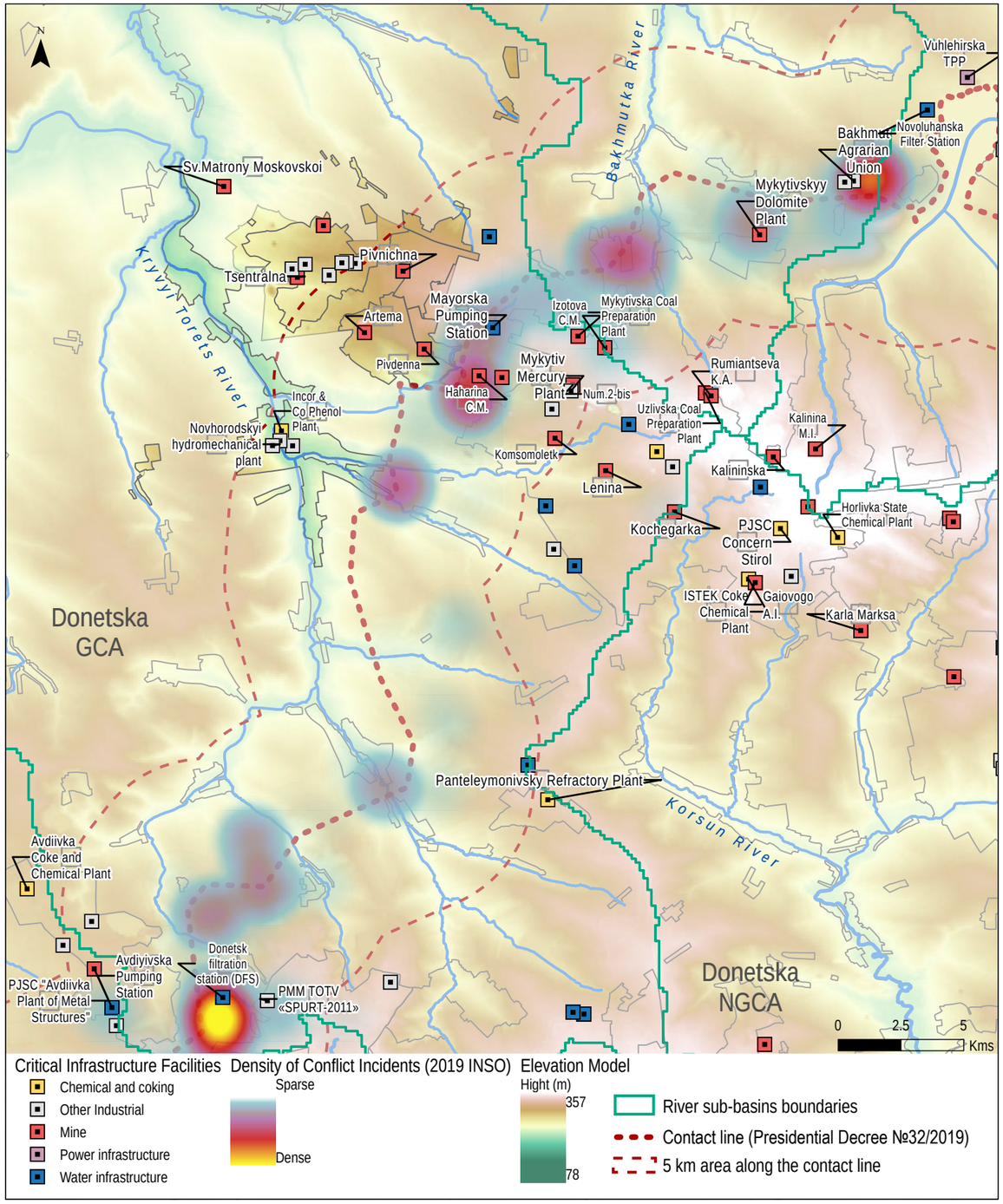
Hazard Description

Based on review from 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 an estimated 14 potentially hazardous facilities in Toretsk city council and 50 more within 25 km of Toretsk city council. 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.

Table 4.1 Reported conflict incidents by INSO during 2019 within 1 km of hazadous facilities

Facility name	Distance to settlement in Toretsk city council	2019	2020, January-February
Donetska water filtering station	Novhorodske (15 km)	333	63
Bakhmut Agrarian Union (water treatment facilities)	Ozarianivka (11 km)	222	37
Haharina C.M.	Zalizne (<1 km)	190	22
Mayorska Pumping Station	Shumy (<1 km)	68	13
Mykytivskyy Dolomite Plant	Ozarianivka (8 km)	67	23
Mykytivska Coal Preparation Plant	Shumy (3 km)	20	0
Horlivska Coal Preparation Plant	Zalizne (<1 km)	8	0
Kochegarka	Zalizne (7 km)	7	0
Izotova C.M.	Shumy (2 km)	4	1
Komsomoletk	Zalizne (2 km)	2	0
Horlivska Pumping Station	Zalizne (4 km)	2	0

Map 4.1 Major Hazardous Objects Location



Using the Flash Environmental Assessment Tool (FEAT) 2.0 Pocket Guide, key hazardous facilities within the region and their substances were cross-referenced to determine potential human and environmental exposure provided in distance (km) based on low and high substance quantities (kg) to provide insight to a minimum and maximum exposure. The FEAT methodology was developed by the National Institute for Public Health and the Environment (RIVM) for UNEP and UNOCHA and 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 MINES

Hazard substance #1: Methane (Globally Harmonized System (GHS) classification: Flammable, Flam Gas 1.) Exposure: channeled through air and dangerous to humans and critical infrastructure

- Human Health: 0.2 to 0.3km (1 million kg)

Hazard substance #2: Waste from tailings (GHS classification: Toxic Liquid Acute Tox 1, Aquatic Acute 1) Exposure: channeled through soil, groundwater, rivers and dangerous to the environment, fishing, agriculture, and human health.

- Lethal to Humans: 1km (20kg) to 5km (1,000kg)
- Human Health: >5km (20kg)
- Environment (soil): 2km (20kg) to >10km (5,000kg)
- Environment (river): 5km (20kg) to >10km (1,000kg)

- Coal mine Toretska (Toretsksvuhillya state-owned enterprise), monthly coal extraction rate is about 6,500 tons. On July 30, 2015 the mine was de-energized, as a result of electric inputs damage by shelling, 200 miners were evacuated.
- Coal mine Tsentralna (Toretsksvuhillya state-owned enterprise), the oldest mine in Ukraine, was opened in 1860. Several explosions were recorded in 2008-2009 due to methane leakage. Monthly coal extraction rate is about 12,100 tons.
- Coal mine Sv.Matrony Moskovskoii (mine in rent), on July 22, 2014 the mine was de-energized, as a result of electric inputs damage by shelling, 8 miners

were evacuated.

There are four coal mines that are in the process of liquidation:

- Coal mine Pivdenna was founded in 1877 and closed in 2016. In 2017-2018, seven conflict events were recorded within 1 km of the mine.
- Coal mine Pivnichna was closed in 2017. Seven conflict events were recorded within 1km of the mine between 2017 and 2019.
- Coal mine im. Artema and Coal mine Nova were closed in 2002.

In addition, nine coal mines are located in Horlivka (NGCA), Kazennyi Torets water basin, in close proximity to Toretsk city council.

- Coal mine im. Haharina was founded in 1963 and closed in 2004. In 1969, one of the largest methane and dust explosions ever recorded in global mining practice occurred. According to various sources, between 7,500 and 250,000 m3 of methane was released. It is located on the CL and 375 conflict eventswere recorded withing the distance of 1-km between 2017-2020 (22 conflict events occurred in January-February, 2020).
- Coal mine im. Izotova was closed in 1997. The mine was flooded in 2012 and in 2001 and mine stopes collapsed. Five conflict events were recorded near the mine in 2019-2020.
- Coal mine Lenina has been out of operation since 2014 and has been flooded with underground water.
- Coal mine Komsomolets was closed in 2007.
- Coal mine Kochegarka was closed in 1997.

2. CHEMICAL INDUSTRY

- Incor&Co Phenol plant

Hazard #1: Industrial site contains **toluene**, phenol, and naphthalene (Globally Harmonized System (GHS) classification: Toxic liquid Acute Tox. 1)

Hazard #2: Waste from tailing containing phenol, **sulfuric acid**, pyridine (GHS Classification: Toxic liquid Acute Tox. 1)

Exposure: channeled through air, soil, groundwater, rivers and dangerous to the environment, fishing, agriculture, and human health.

- Lethal to Humans: 1km (20kg) to 5km (1,000kg)
- Human Health: >5km (20kg)
- Environment (soil): 2km (20kg) to >10km (5,000kg)
- Environment (River): 5km (20kg) to >10km (1,000kg)

The phenol plant was built in 1916 near Fenolna train station. Plant processes coke-chemical oils (by-products of high-temperature coal coking) and produces technical and purified naphthalene, coal phenol, orthocresol, dicresol, tricresol, mixed fuels and corrosion inhibitors. Two tailing dams contain more than 900,000 tons of liquid waste. According to secondary data review, there was a dam break about 10 years ago, which flooded the Nelipivka village (RCUS field data). Ten conflict events were registered withing 1-km of the facility (INSO data, 2017-2019). On July 25, 2018 artillery shell hitted one of tailing dams, although no chemical leaks were recorded.

- Avdiivka Coke and Chemical Plant

Hazard #1: Industrial site contains **sulfur dioxide**, hydrogen sulfide, hydrogen cyanide, nitrogen oxides, carbon monoxide, phenols, ammonia and benzopyrene (GHS Classification: Health hazard, STOT SE 1)

Hazard #2: Waste from tailing containing phenols, ammonia and sulfuric acid.

Exposure: channeled through air and dangerous to the environment and human health.

- Lethal to Humans: >5km (any quantity has a potential impact)
- Human Health: >5km
- Environment (soil): >10km
- Environment (river): >10km

This plant was built in 1963 to produce coke to be used mainly in iron ore smelting or as a fuel. The plant halted operations more than 10 times as a result of conflict events and was shut down for 3 months in 2017. 35 conflict events were recorded by DEIS near the plant between 2014-2017.

Similar enterprises close to Toretsk city council are **Yasynuvatsky coke and chemical plant,** Makiivsky coke plant, and Horlivka Coke and chemical Plant (ISTEK), located in NGCA. Work at these plants was terminated due to the loss of control by management, but recent satellite images reveals the operations of blast furnaces.

- Concern Stirol

Hazard substance: ammonia (GHS Classification: Toxic Liquid Acute Tox.2, Aquatic Chronic 2)

Exposure: channeled through air, soil, groundwater and rivers. Dangerous to the environment, fishing, agriculture, and human health.

- Lethal to Humans: 0.3km (100kg) to >5km (5,000kg)
- Human Health: 2km (100kg) to >5km (5,000kg)
- Environment (soil): 4.3km (100kg) to 10km (5,000kg)
- Environment (river): >10km (100kg)

The plant was built in 1929 and produced organic fertilizers, ammonia, carbamide, granular ammonium nitrate, polystyrene, inorganic salts and organic resins. It is located in Horlivka (NGCA). On August 6, 2013, there was an accident that caused an ammonia release, leaving five dead and 20 injured.

Horlivka-Odesa branch of ammonia pipeline Toliati-Odesa entered operation in 1979 to transit liquid ammonia to Odesa port plant. Since May 2014, the beginning of the conflict, the plant has suspended production and ammonia transportation due to security reasons. There is still a risk that some amount of ammonia remains on the industrial site and along the pipeline which is crossing the CL (fig. 10.2).

- Mykytiv mercury plant

Hazard substance: mercury (GHS Classification: Toxic Liquid Acute Tox.2, STOT RE1, Aquatic Chronic 1)

Exposure: channeled through air, soil, groundwater and rivers. Dangerous to the environment, fishing, agriculture, and human health.

- Lethal to Humans: 0.3km (100kg) to >5km (5,000kg)
- Human Health: 2km (100kg) to >5km (5,000kg)
- Environment (soil): 4.3km (100kg) to 10km (5,000kg)
- Environment (river): >10km (100kg)

Mykytiv mercury plant was a non-ferrous metallurgy enterprise on the basis of Mykytiv mercury deposit. It was buid in 1927 and closed in 2014 with the beginning of conflict. **Mercury mine bis-2** is in the regime of dry close-down with a risk of flooding and dissemination to underground water.

3. WATER TREATMENT PLANTS (WATER FILTER STATIONS)

Hazard #1: Chlorine (GHS Classification: Toxic Gas, Acute Tox. 1.)

Exposure: channeled through air and dangerous to humans and critical infrastructure

- Lethal to Humans: 0.4km (10,000kg) to 1.3km (>1 million kg)
- Human Health: 2km (10,000kg) to 5km (>1 million kg)

Hazard #2: Chlorine (GHS Classification: Toxic Liquid, Acute Tox. 1)

Exposure: channeled through soil, groundwater and rivers. Dangerous to the environment, fishing, agriculture, and human health.

- Lethal to Humans: 1km (20kg) to 5km (1,000kg)
- Human Health: >5km (20kg)
- Environment (soil): 2km (20kg) to >10km (5,000kg
- Environment (river): 5km (20kg) to >10km (1,000kg)

- **Horlivska water filtering station #2**

Operation commenced in 1964. Station is located in NGCA and provides drinking water to Toretsk city council and part of Horlivka. Liquid chlorine, used in water purification, is stored in pressurized containers. There is a risk of explosions in case of damage or depressurization of containers. In April 16, 2018, the electric inputs to the station were damaged by shelling.

There are other water treatment plants within Kazennyi Torets water basin less than 25 km from Toretsk city council (fig.10.1), a distance to which the substances may spread:

- **Horlivska filtering stations #1** was constructed in 1958 and supplies drinking water to Horlivka.
- Makiivska filtering stations is located in NGCA and provides drinking water to Makiivka. In September 2018, more than 100 people were hospitalized due to poisoning caused by failure of water treatment systems (https://mtot.gov.ua).
- Donetska water filtering stations provides water to Avdiivka, Vehnetoretske and Vasylivka. In the first two months of 2020, 63 conflict events were detected near the station (1,462 since 2017) according to INSO data.

4. MECHANICAL ENGINEERING INDUSTRY

- Novgorodsky hydromechanical plant

Hazard substance: isopropyl alcohol (GHS Classification: Flammable Flam. Liq. 2)

Exposure: channeled through air and dangerous to humans and critical infrastructure

- Lethal to Humans: 0.4km (10 million kg) to 1.3km (>100 million kg)
- Human Health: 0.4km 10 million kg) to 1.3km (>100 million kg)

The plant is producing the spare parts and mining equipment for the coal industry. Ten conflict events were recorded near the plant in 2017-2020.

- **LP "Sensor - Universal" enterprise** is another machine-building industry, located in Toretsk.

INCOR & CO PHENOL PLANT CASE STUDY

Facility Description

Incor&Co Phenol Plant is located in Novhorodske, a part of Toretsk city council. The phenol Plant, previously called Dzerzhinsky, was built in 1917 for the production of coal phenol, a raw material for explosives manufacture. Coke-chemical raw materials production started in 1927, then naphthalene - in 1969, pyridine - in 1978.

According to FEAT, the hazardous substances of Incor & Co Phenol plant are classified as toxic liquid acute tox.1 and lethal to humans at a distance from 1 to 5 km.

The 1 km buffer area of Incor & Co Phenol Plant includes a residential zone (67 apartment buildings), 5 educational facilities (3 schools and 2 kindergartens), one hospital and 3 other industrial facilities, namely Novhorodsky hydro-mechanical plant, and two agrarian facilities: Novgorodsky grain receiving point, and New-York Agro Invest LLC. Almost the entirety of this area is within 5 km of the CL.

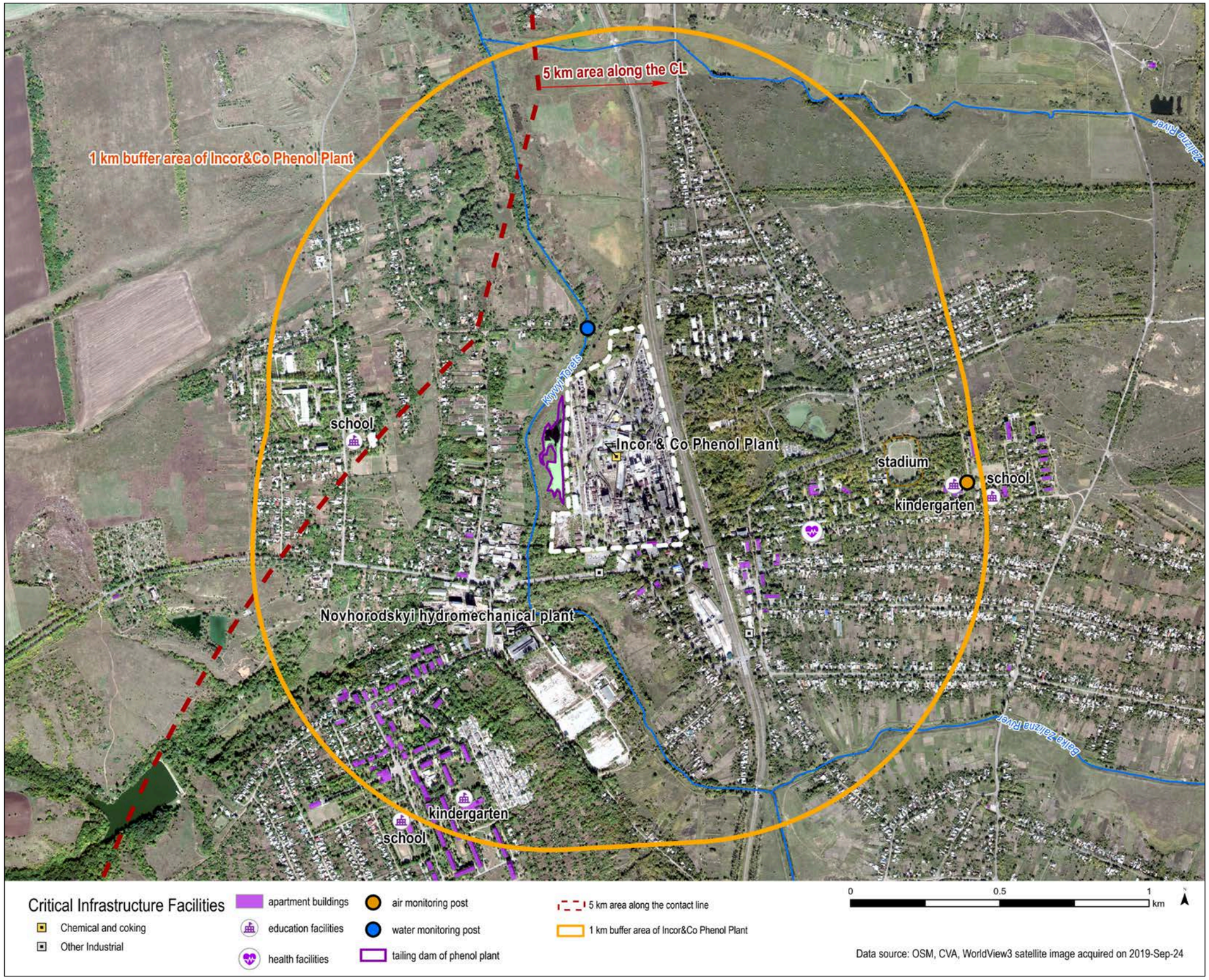
Two monitoring posts are located in the area: air monitoring post located in kindergarten near the phenol plant, and water monitoring post on Kryvyi Torets river located below the water discharge area of phenol plant (it collected data in 2019 only). Water samples included only suspended substances and dissolved oxygen and revealed slight MPC exceeding (1.3 and 2.2 MPC respectively)[4]. Data from from the air monitoring post in May 2020 indicates a significant exceeding of SO_2 MPC (in up to 10.8 times) and slight exceeding NO_2 MPC (in up to 1.5 times)[5].

Several critical conflict-related incidents occurred near the plant, with shelling of Novhorodske in close proximity to the plant recorded on May 11, 2016, and electricity network damages due to shelling in July 2016 and 2017, which caused the plant termination.

4) Water monitoring data is available from water monitoring system of State Water Agency of Ukraine

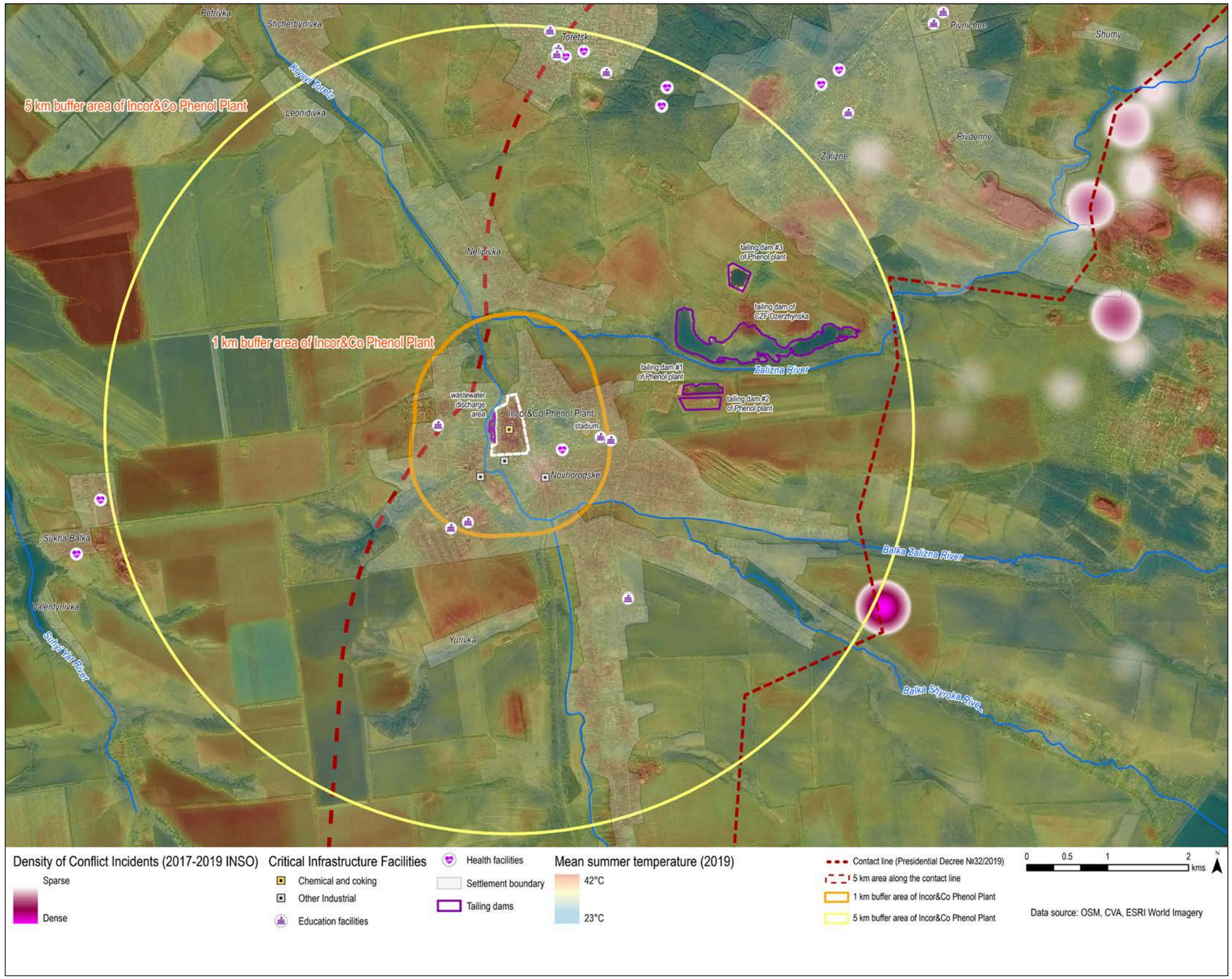
5) Air monitoring data is available from automated environmental monitoring system in Donetska oblast

Map 4.2 One-km buffer area of Incor & Co Phenol plant



INCOR & CO PHENOL PLANT CASE STUDY

Map 4.3 Five-km buffer zone of Incor & Co Phenol plant



The 5 km buffer area of Incor & Co Phenol Plant covers the area of Novhorodske, Nelipivka and Yurivka settlements, and parts of Zalizne, Toretsk, Leonidivka, and Shcherbynivka. It includes 10 educational facilities and 6 hospitals. Up to 15,000 people live in these settlements.

Incor&Co Phenol plant discharges wastewaters directly into Kryvyi Torets river. There are also two tailing dams (#1 and #3) for liquid hazardous substances, which are not directly connected to the riverbed, but may be channeled through air, soil, and groundwater. It is estimated to contain about 900,000 tons of toxic liquids in total, consisting of phenol, sulfuric acid and pyridine. Tailing dams are located between Novhorodske and Zalizne settlements, close to another tailing dam, containing discharged waters from enrichment plant Dzerzhynska. These tailing dams are in very close proximity to the CL as seen on map 4.3 (400 m from the tailing dam of enrichment plant Dzerzhynska and 1.7-2 km from tailing dams #3 and #1 accordingly). According to satellite land temperature datasets (map 2.1) the area of tailing dams is more exposed to high temperatures in summer season, increasing the evapotranspiration rate and toxic pollution concentration in the air.

Tailing dam #2 contains solid hazardous waste from Incor&Co Phenol plant. In August 2014, as a result of the shelling, tailing dam#2 caught fire, which lasted for several hours.

Mean summer temperature values of 2019, derived from Landsat-8 satellite data, are overlaid with a high-resolution satellite image to highlight the heating zones, particularly near industrial facilities, tailing dams and spoil tips.

Between 2017 and 2019, 23 conflict events were recorded within 2 km of the tailing dams (INSO data, 2017-2019). On July 25th 2018, an artillery shell struck one of the tailing dams, although no chemical leaks were recorded.

Incor&Co phenol plant requires the development of a waste management plant, including hazardous substances utilization from tailing dams as well as reconstruction and strengthening the walls of storage dams.

HAZARD - AIR POLLUTION

Hazard Description

As Donbas is a heavily industrialized region with a coal and metallurgical industry, it is also the region with the highest level of air pollution in Ukraine.

According to WHO, air pollution poses a major threat to health and climate and causes about seven million premature deaths annually, largely as a result of increased mortality from stroke, heart disease, chronic obstructive pulmonary disease, lung cancer and acute respiratory infections. Sources of air pollution include gases (such as ammonia, carbon monoxide, sulfur dioxide, nitrous oxides, methane and chlorofluorocarbons), particulates (both organic and inorganic), and biological molecules. Both human activity and natural processes can generate air pollution.

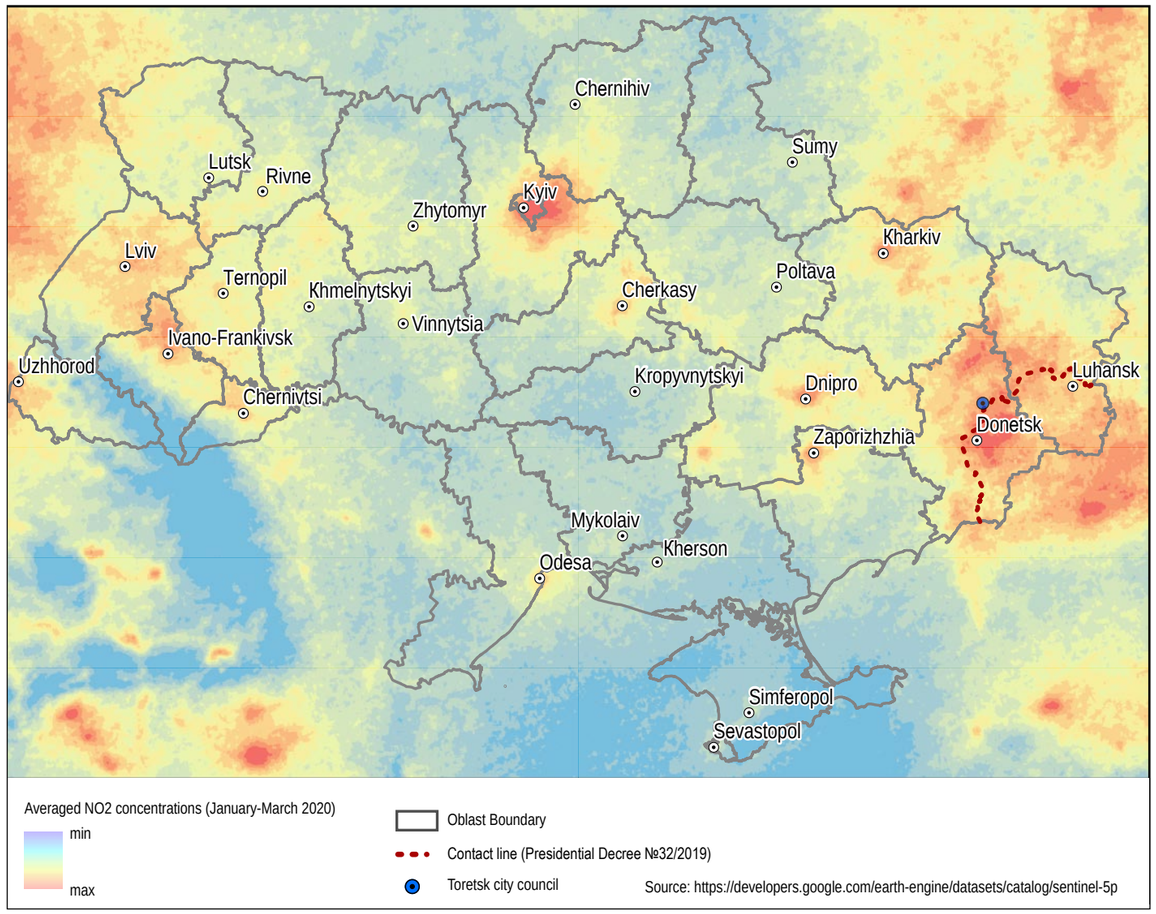
In order to fulfil Ukraine's obligations in the environmental part of the Association Agreement with the EU, in August 2019 the Cabinet of Ministers of Ukraine amended the Procedure for State Monitoring of Air Quality. For the implementation of the requirements of Directive 2008/50/EC and Directive 2004/107/EC,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

The automated environmental monitoring system of Donetska oblast was established in 2017. It is operated by the Department of Ecology and Natural Resources of the Donetsk Regional State Administration and SESU Department in Donetska oblast and includes 44 air pollution monitoring posts. Two posts are located in Toretsk city council, one of them near Centralna coal mine in Toretsk and the other ones near Incor & Co Phenol Plant in Novhorodske. On the maps 5.2-5.5, dot points represent the location of air pollution monitoring posts and dot size indicates the number of days during the first three months of 2020 when pollution rate exceeded the MPC.

Data from NGCA is not available. But according to satellite imagery (map 5.2) the area around Donetsk has a high rate of Nitrogen dioxide emissions, along with the area on the north of Kramators. Thus, satellite data can effectively contribute to the understanding of pollution spread over the whole region.

Since July 2018 the Sentinel-5P satellite mission of European Space Agency has been collecting global atmospheric data on Nitrogen dioxide (NO_2), Sulfur dioxide (SO_2), Carbon monoxide (CO) and aerosols concentrations in the atmospheric column. In combination with on-ground air monitoring posts, it is an effective tool to detect the main pollution sources and assess the pollution risk at a settlement level. 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 the constant emission sources in the region.

Map 5.1 NO_2 **emissions in Ukraine**

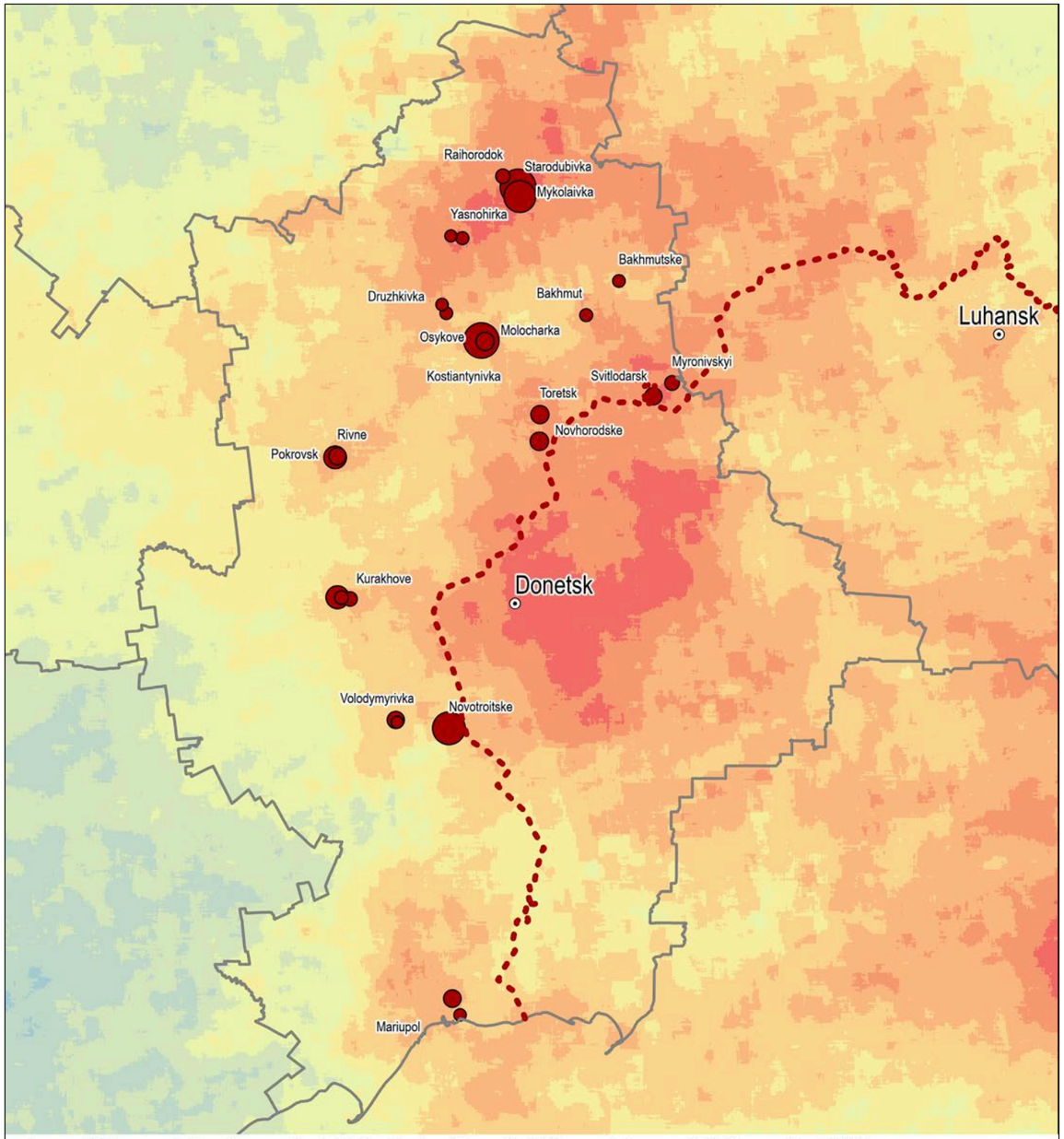


Graph 5.1 Seasonal dynamics of NO_2 concentration in the air in 2019

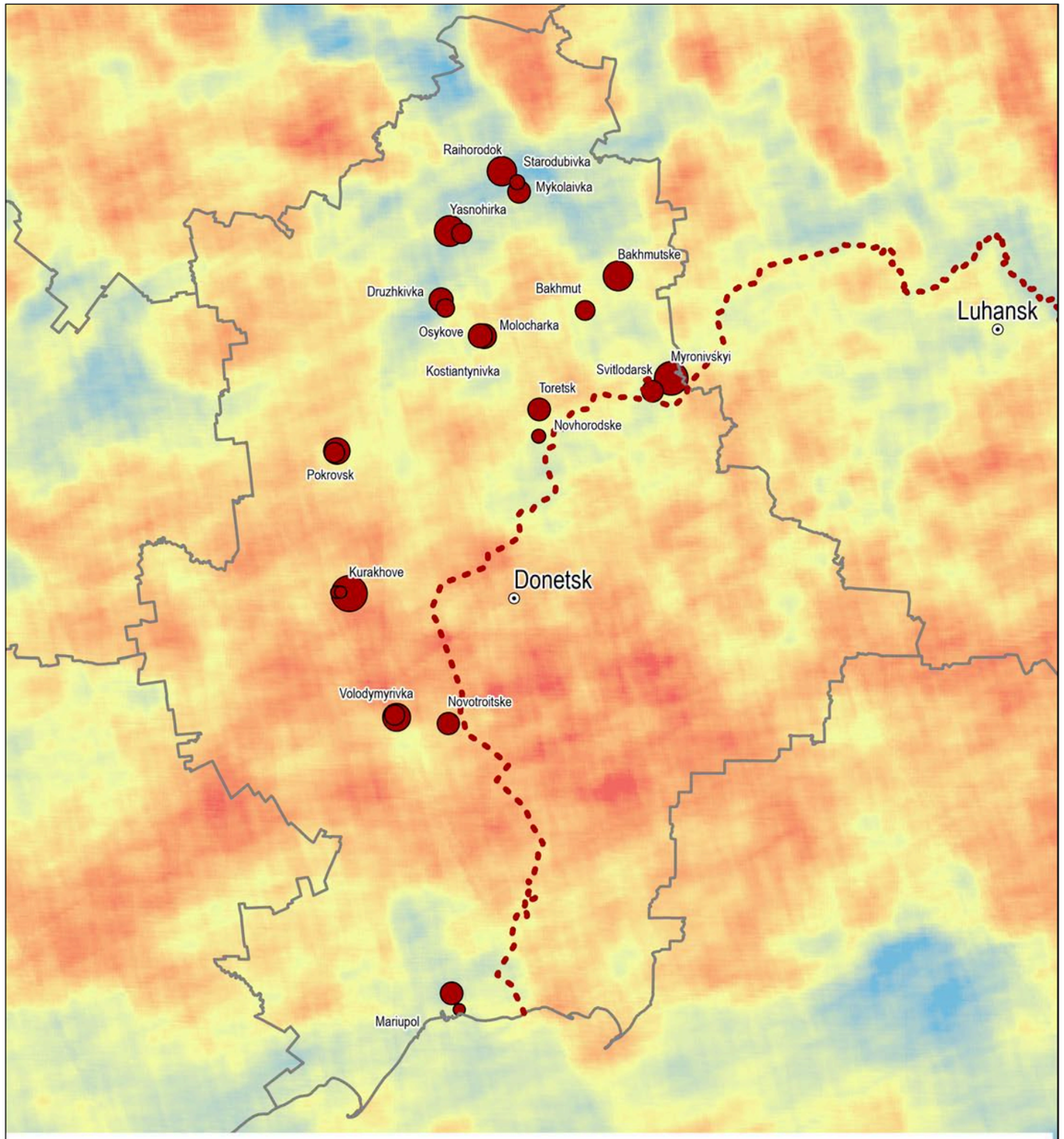
Settlement	Jan	**Feb**	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	**Yearly** mean
Avdiivka	1.72	1.23	0.97	1.19	0.92	1.02	0.97	0.95	0.94	0.98	0.81	0.74	1.04
Bakhmut	1.72	1.06	1.06	1.17	0.95	0.95	0.99	0.92	0.92	0.96	0.79	0.88	1.03
Horlivka	1.39	1.10	0.99	1.18	0.92	1.03	0.98	0.95	0.96	0.93	0.80	0.83	1.00
Kostiantynivka	1.84	1.10	1.02	1.13	0.88	1.02	0.98	1.01	0.94	0.95	0.74	0.81	1.04
Kramatorsk	2.24	1.06	0.97	1.19	0.99	1.01	0.98	1.04	1.13	0.84	0.76	0.82	1.09
Makiivka	1.43	1.12	0.96	1.20	0.91	1.03	1.02	0.98	0.97	1.08	0.86	0.86	1.03
Mariupol	0.89	0.89	0.78	0.97	0.86	1.00	0.97	0.95	0.90	0.91	0.71	0.76	0.89
Sloviansk	2.35	1.05	1.03	1.29	1.09	1.03	0.94	1.02	1.43	0.97	0.83	0.88	1.16
Toretsk	1.64	1.08	1.04	1.15	0.95	1.02	0.94	0.94	0.94	0.91	0.79	0.76	1.01
Yenakiivo	1.39	1.13	0.96	1.14	0.90	0.95	1.00	0.95	0.94	1.00	0.82	0.80	1.00

HAZARD - AIR POLLUTION

Map 5.2 NO_2 **emissions in Eastern Ukraine**



Map 5.3 Aerosols concentration in Eastern Ukraine



Toretsk city council air pollution

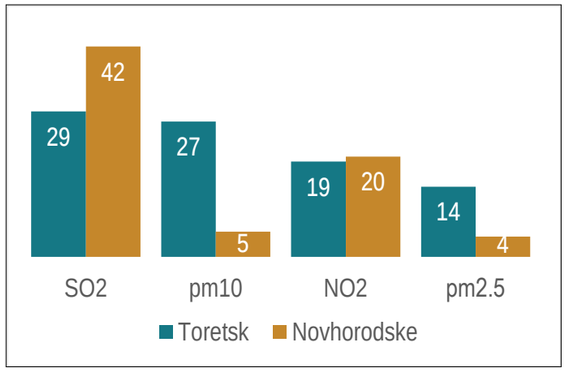
According to on-ground air monitoring posts, both Toretsk and Novhorodske are exposed to SO_2 pollution, 30% and 47% of the time respectively during January-March 2020 SO_2 concentration in the air exceeded MPC. High level of SO_2 concentration in Novhorodske compared to Toretsk is also visible on map 5.4.

The chemical and coal industries are the primary SO_2 polluters in the area. Incor & Co phenol plant and Avgiivsky coke and chemical plant are located in GCA and three more coke plants are located in NGCA in Horlivka and Makiivka. There is no official infromation about the plant operations and emissions in NGCA. Sentinel-2 satellite images, which might be used as a source of recent information, reveal blast furnaces operation at these plants (fig. 5.1-5.2).

Another source of air pollution in the area is evaporation from tailing dams, which 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.

NO_2 MPC overage was observed during 21-22% of days in the first 3 months of 2020 at both atmospheric posts in Toretsk and Novhorodske. Satellite data also confirms more or less even distribution of NO_2 concentration within the research area and higher concentrations compared to other territories of Ukraine. Chronic exposure to NO_2 and SO_2 can cause respiratory

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



Map 5.4 SO_2 concentration in Toretsk city council

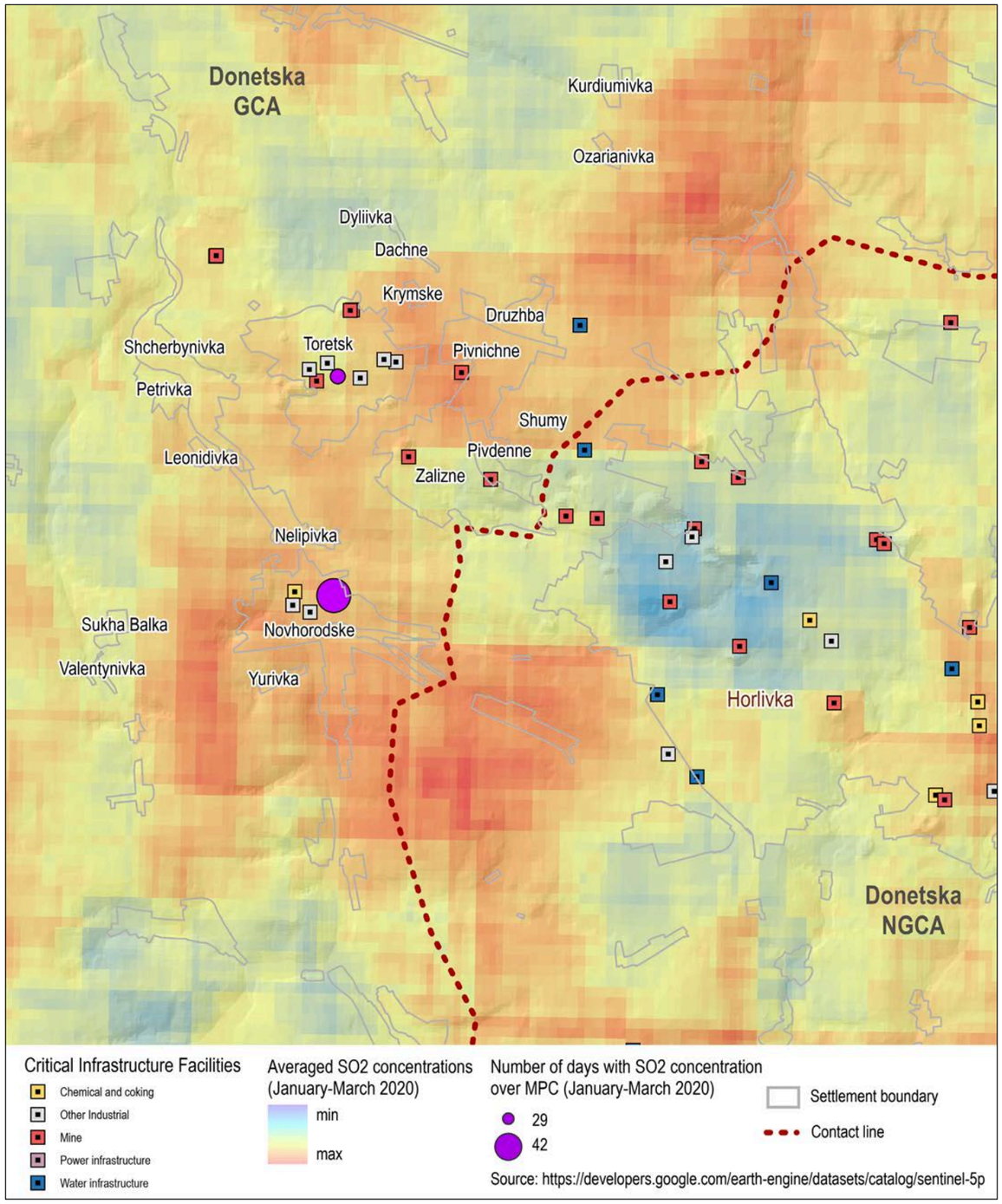


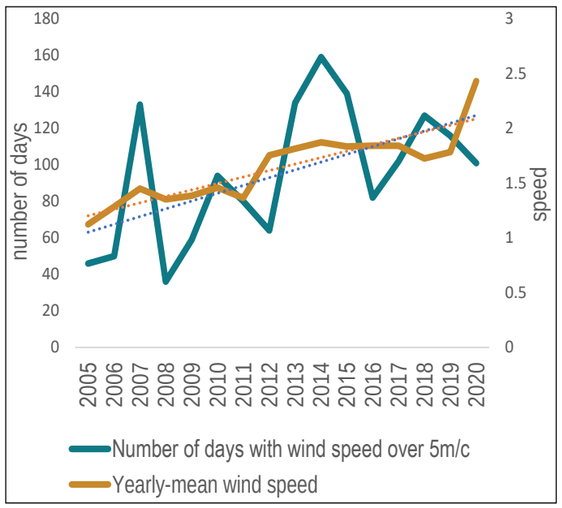
Figure 5.1. Blast furnace operations and dust cloud around **Avdiivka coke and chemical plant, on Sentinel-2 image,** April 13, 2020

Figure 5.2. Blast furnace operations and dust clouds of **Yasynivsky coke plants, on Sentinel-2 image, April 8, 2020**

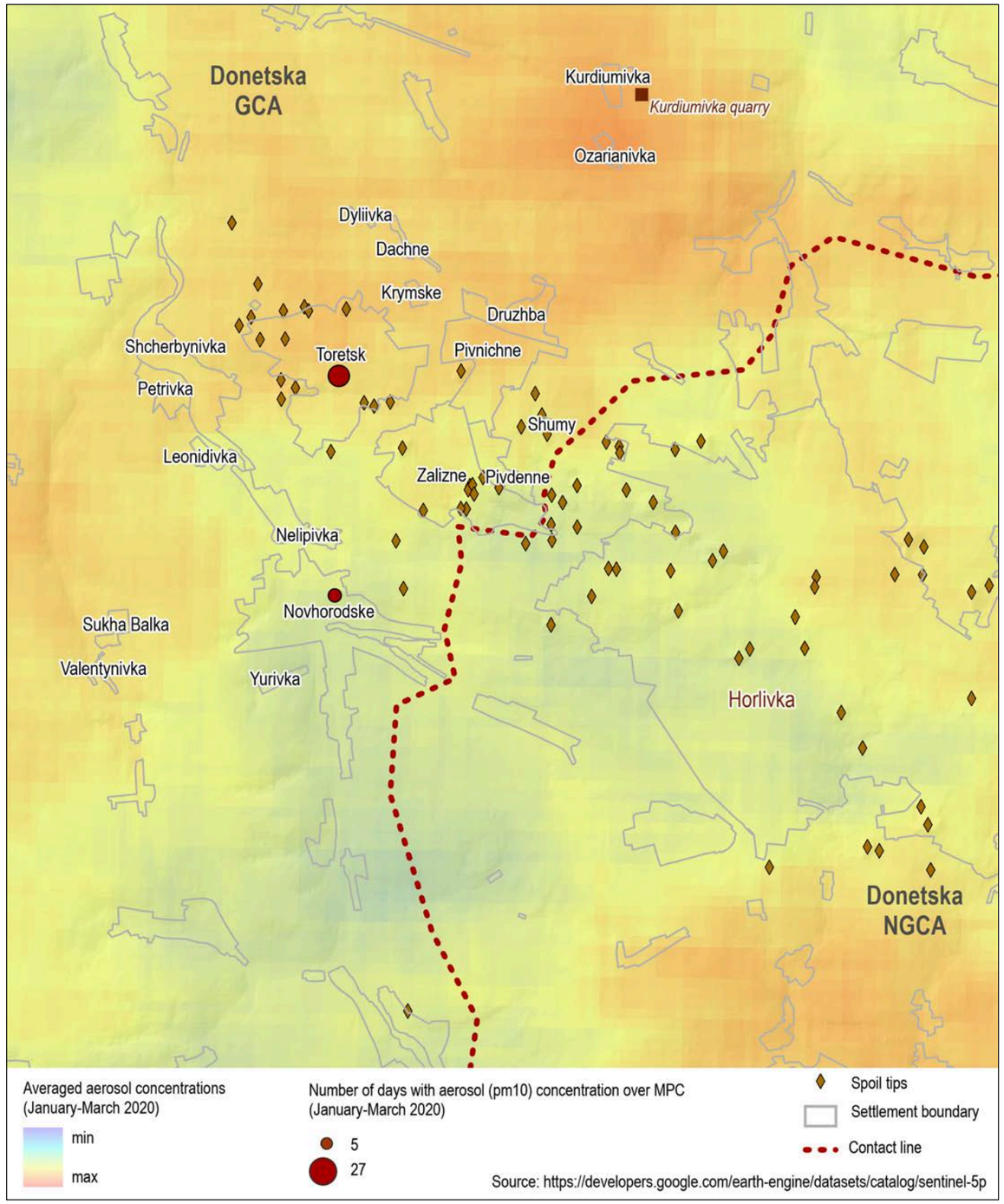
Figure 5.3. Blast furnace operations and dust clouds of **Makiivsky coke plants, on Sentinel-2 image, April 8, 2020**

Figure 5.4. Kurdiumivka clay quarry

Graph 5.2 Yearly-averaged wind speed dynamic



Map 5.5 Aerosol emissions in Toretsk city council



or lung diseases.

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.

According to data from air monitoring posts, Toretsk is more exposed to aerosols pollution. MPC overage for aerosol particles smaller than 10 μm in diameter were recorded during 27 days out of 90, and particles with a diameter smaller than 2.5 um were recorded on 14 days. On satellite images, the higher aerosol concentrations are evident in the northern part of the city in coal mining area and in the area with higher spoil tips density (map 5.5). Another area with a higher concentration of aerosols is close to Kurdiumivka. This might be related to Kurdiumivka clay quarry, which covers an area of more than 110 ha (fig. 5.4).

Storm winds can trigger the dispersion of aerosol 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 dispersing and polluting soils and water bodies. Increasing frequency of storm winds is one of the consequences of climate change, especially in the steppe zone, in which Toretsk city council is located (graph 5.2).

Key takeaways

1. Installation or repairs of filtration systems and air emission monitoring near all hazardous objects is needed.

2. Restoration of vegetation cover on the area of closed mines and spoil tips should decrease the wind erosion risk.

3. Include air pollution monitoring data into Toretsk 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.

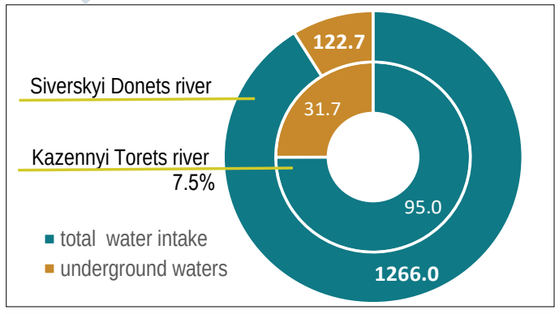
HYDROGRAPHY

River Basin Overview

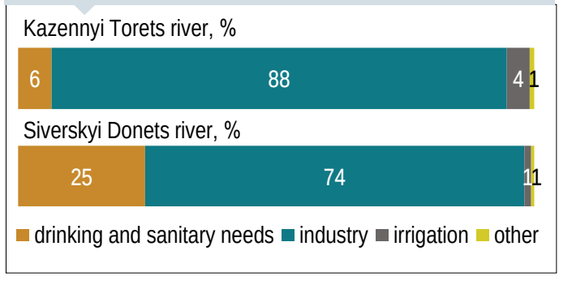
Hydrology and water basin mapping is an important tool to increase understanding of risks related to water contamination, which has cascading health consequences for domestic, commercial and industrial activities. Toretsk city council is located on the border of Donetsk ridge and Azov Upland, in Kazennyi Torets river sub-basin, which also includes the parts of Horlivka city with a coal mine network and Avdiivka city with a set of tailing dams from Avdiivka coke and chemical plant.

The main river in the area is Kryvyi Torets, which passes through Novhorodske, Nelipivka, Leonidivka, Petrivka, and Shcherbynivka and flows into Kazennyi Torets river. Kazennyi Torets river sub-basin of Siverskiy Donets (Don) river basin is located on the border with Dnieper river basin (Vovcha river sub-basin) and Azov sea basin (Krynka and Kovshyuh rivers). Siverskyi Donets river is a 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

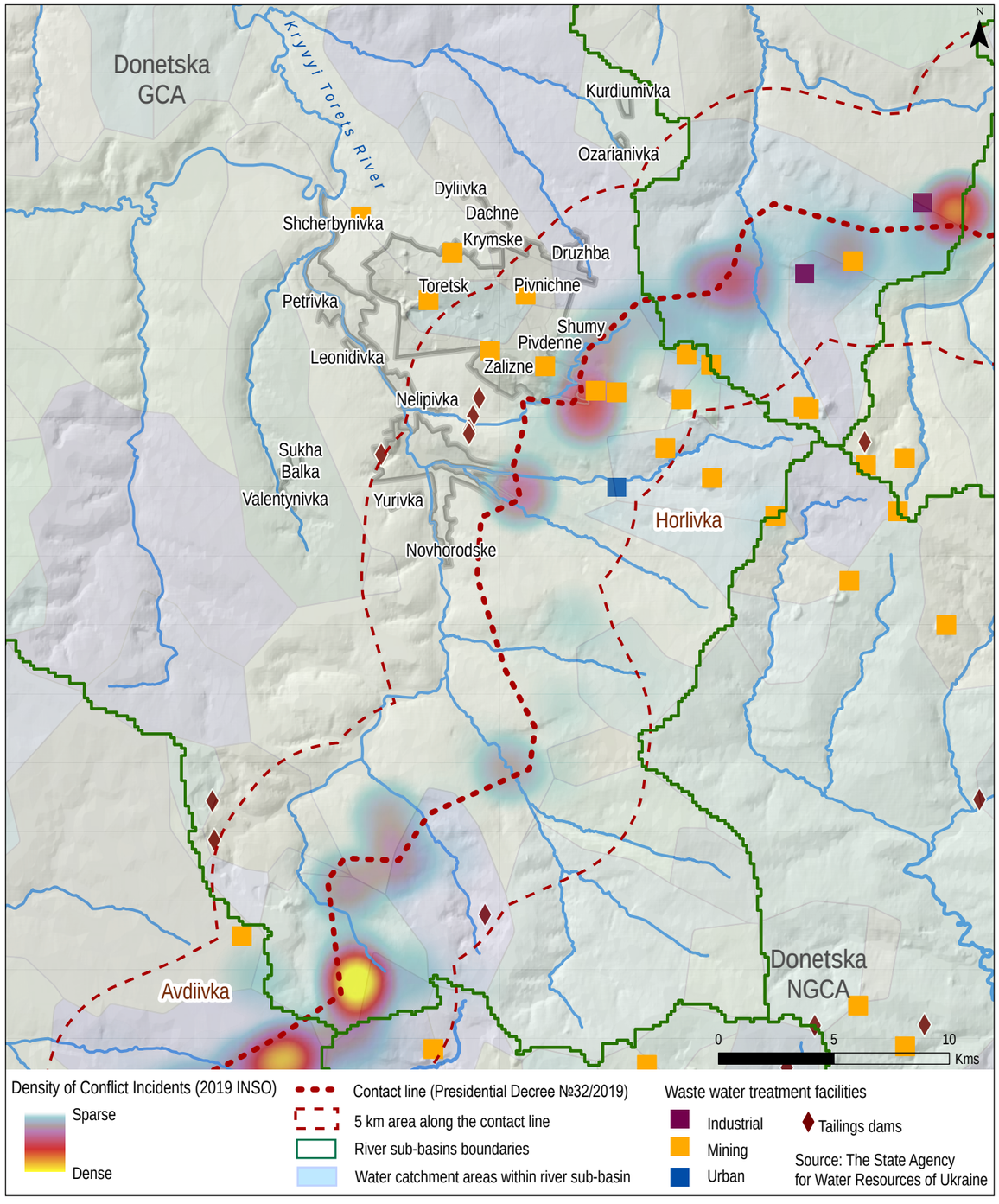
Graph 6.1. Water intake in the basin in 2018 (mln.m3)[6]



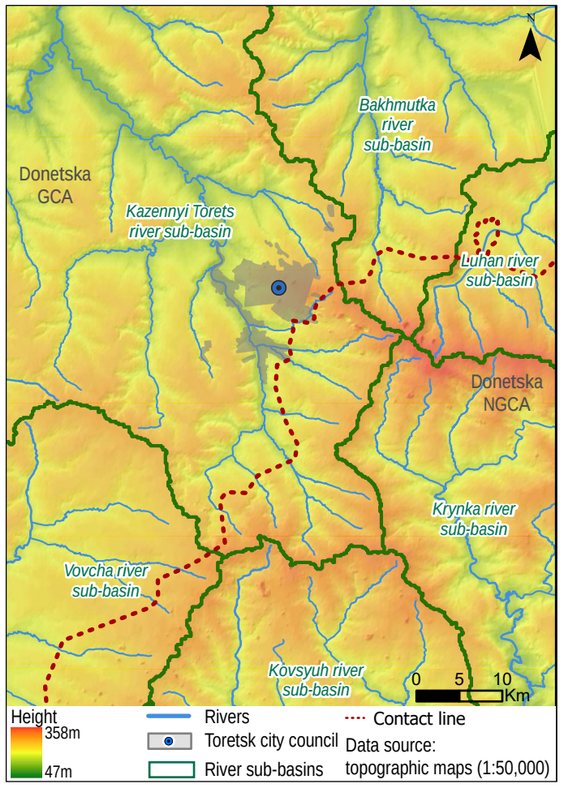
Graph 6.2. Water usage type in the basin in 2018[6]



Map 6.1 River Basins and Hazardous Facilities



Map 6.2 Regional Overview of Main Rivers



groundwater reserves. Water is supplied to the region through the Siverskyi Donets - Donbas channel, constructed in the 1950s, by which time internal water resources were exhausted by the coal industry.

Water intake within Kazennyi Torets river sub-basin was estimated at 7% of the total water intake of Siverskyi Donets river in 2018. The proportion of underground waters of total water intake in Kazennyi Torets river sub-basin is 33%, which is much higher, compared to 9% in Siverskyi Donets basin[6], indicating the importance of groundwater research, especially in coal mining areas. 88% of water intake of Kazennyi Torets river **sub-basin is used for industry**, compared to 75% in Siverskyi Donets basin in general.

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

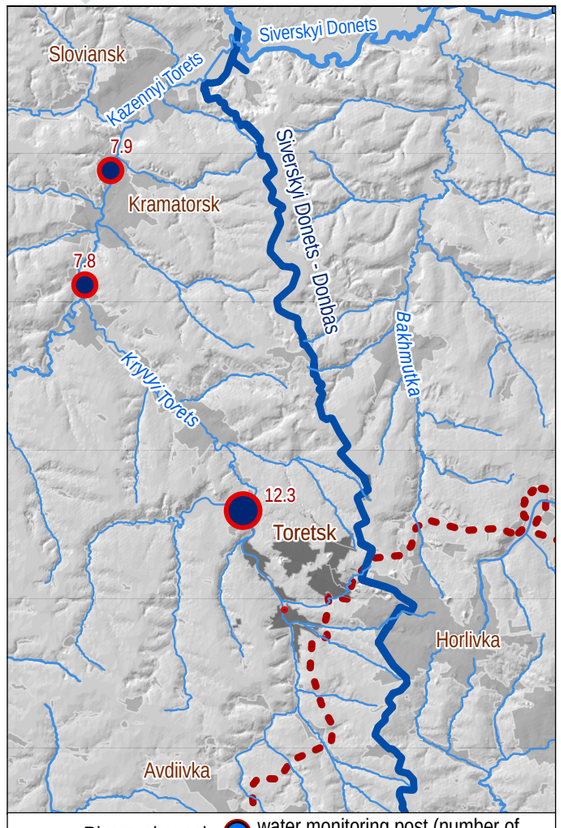
HAZARD - CONFLICT EXPOSURE TO WATER SUPPLY INFRASTRUCTURE

Water Network

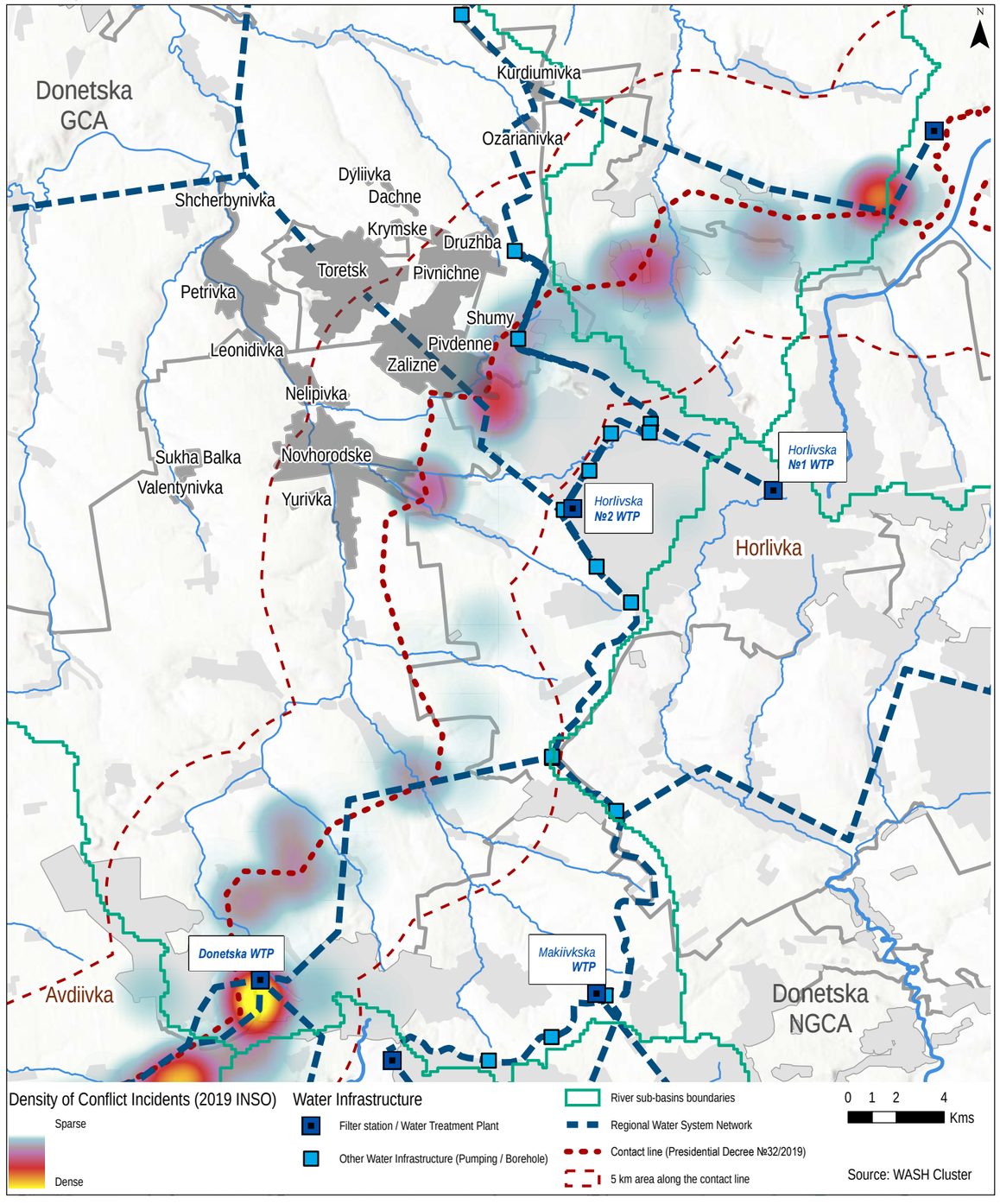
Functional water infrastructure is critical to ensure basic water and sanitation needs.

Toretsk receives water from the Horlivka filter station #2, which filters water from the Siverskyi Donets - Donbas channel and supplies water to parts of Horlivka and Toretsk. Novhorodske, partially Shcherbynivka and Petrivka recieve water from the Second Donetsk water supply system. The total length of water supply networks is 516.7 km; total length of sewerage networks is 116.8 km. The water network includes 3 water pumping stations, 3 sewage pumping stations and 2 sewage treatment plants.

Map 7.1 Regional Overview of Water Network



Map 7.2 Water Infrastructure



Surface waters along the Siverskyi Donets River in the Donetska oblast are mainly classified according to **the State water agency of Ukraine**[6] as satisfactory, slightly polluted (class III category 4). The most polluted tributaries are the rivers Kazennyi Torets and Bakhmutka, which are moderately polluted (class III category 5), due to high turbidity and mineralization. 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). Water samples were collected in 2018 at three monitoring posts along Kazennyi Torets River and revealed the overage of MPC in terms of sulfates (up to 12.3 MPC), chlorides (1.8 MPC), ammonium (2.3 MPC), and nitritei (5.5 MPC). In 2019-2020 samples were not collected. However, the importance of monitoring water quality in such cases is crucial to ensure access to safe drinking water for the populations.

The water supply system crossing the CL is frequently damaged due to shelling, obsolete equipment as well as due to subsidence of soils in the areas of coal mines, which leads to the interruption of the water supply for several days and weeks. Donetska filter station was the most critical facility in the region in terms of conflict exposure to infrastructure (table 4.1); 333 conflict incidents were recorded near the station in 2019 and 63 in the first two months of 2020, according to INSO data. Due to security reasons the operation of Donetska WTP was terminated on March 25-28, 2020. 68 conflict incidents occurred also near Mayorska Pumping Station, near Shumy in 2019. On 19 June 2020, as a result of shelling, two main canal conduits of Siverskyi Donets-Donbas channel were damaged near Shumy. As this site is close to the CL, repair work can begin only after approval, which may cause a delay of several days.

According to data from Toretsk city administration, about 40% of water supply and sewerage networks are in poor condition and need modernization. Water of Donbas Company reported 80 liquidations of breakthroughs on the Gorlovka-Toretsk water pipelines in May 2020 alone.

HAZARD - WASTEWATER MANAGEMENT

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, kitchen and showers), water from commercial establishments (restaurants) or institutions (hospital 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.

There are six enterprises in Toretsk city council discharging wastewater into surface and underground water bodies: Incor&Co phenol plant, Toretskvugillya (Tsentralna and Toretska coal mines), Sv. Matrony Moskovskoii coal mine, Dzerzhynska coal enrichment plant, SE OK Ukrvuglerestrukturyzatsia, Water of Donbas Company.

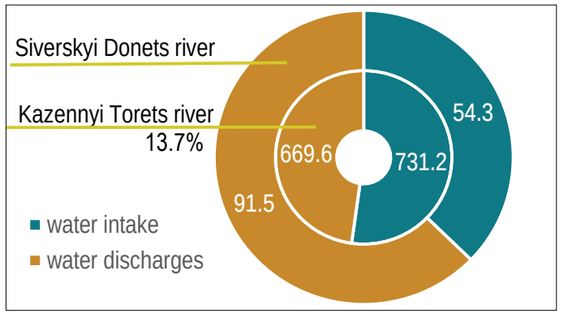
Water of Donbas Company carries out water extraction, distribution, transportation, supply and treatment in Donetska oblast within both GCA and NGCA. Map 8.1 shows that most of the treatment facilities are located within 5km of the CL.

In addition, due to the geological profile of the region, substantial amounts of wastewater are generated from mining activities as a result of 'dewatering'. Mine dewatering refers to the process of removing ground water from mines. This poses two main environmental threats: acid mine drainage and dispersal of contaminated water which leads to water pollution. Both threats are a hazard for the environment and residents dependent on water sources downstream from mines. In general, this water needs to be treated correctly before being released. However, due to the conflict and economic constraints (lack of funds to pay for electricity for pumps) this process is not systematically implemented.

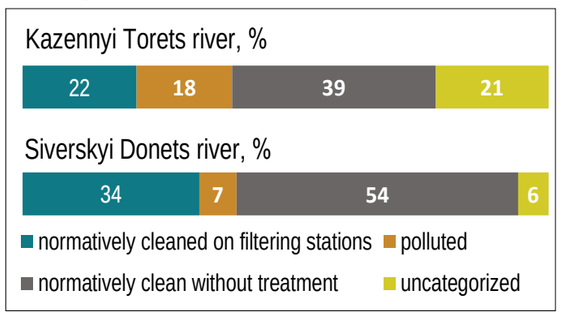
Key Takeaways:

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.

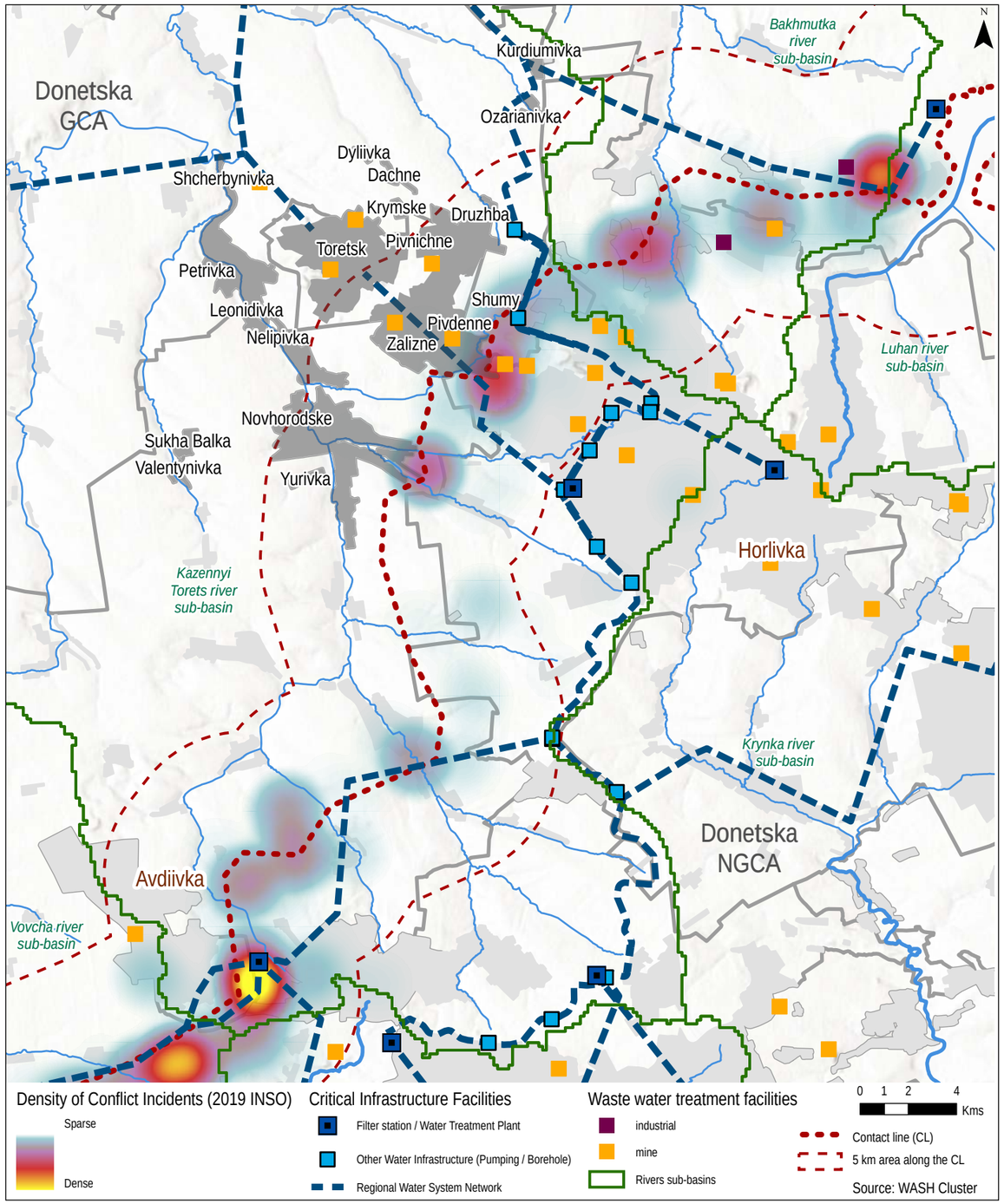
Graph 8.1. Water usage in the basin in 2018 (mln.m3)[6]



Graph 8.2. Water usage type in the basin in 2018[6]



Map 8.1 Wastewater Treatment Facilities Location



HAZARD - SPOIL TIPS AND TAILINGS DAMS

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.

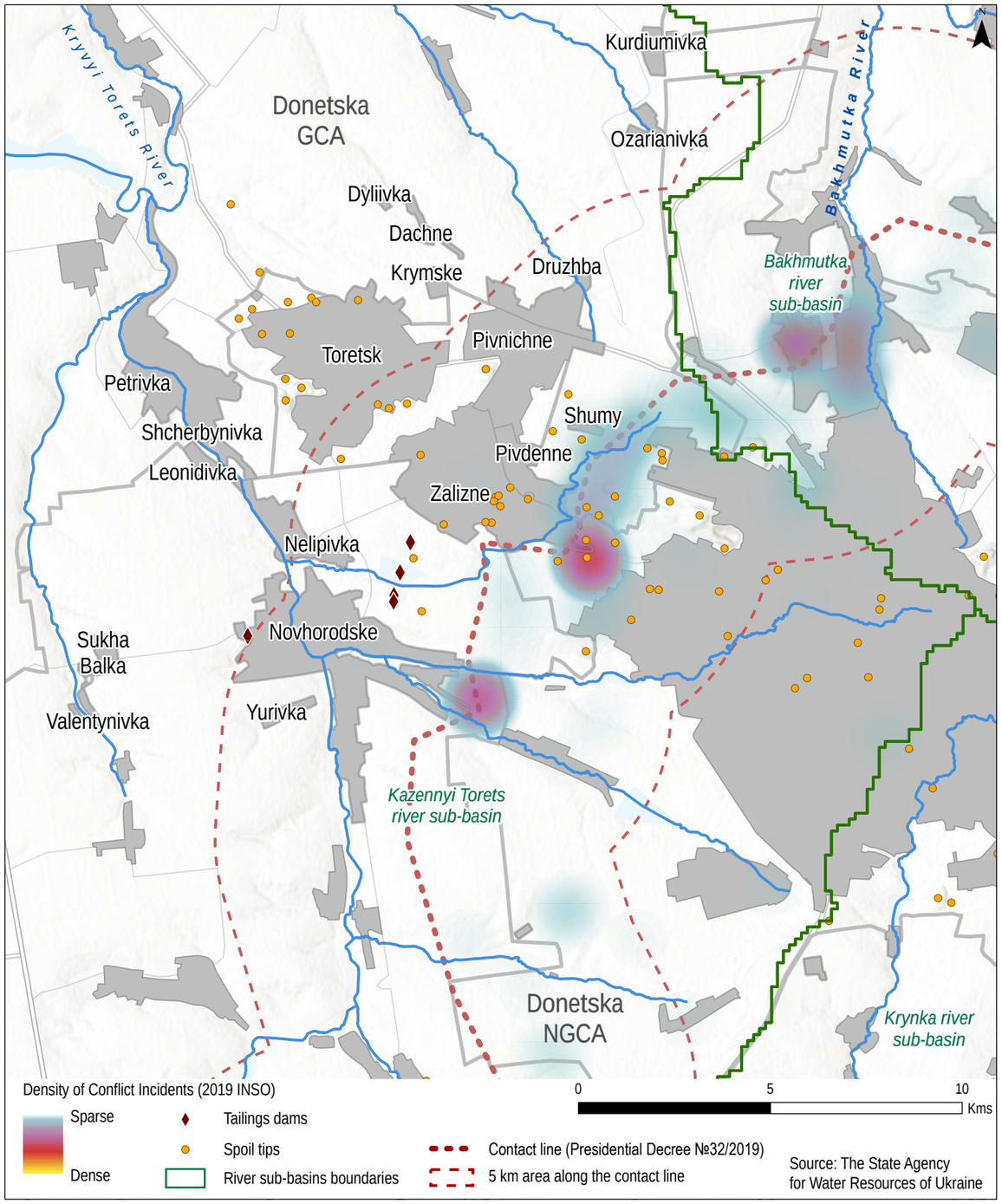
To assess the exposure of the population to spoil tips, their locations were identified in relation to settlements. Since no official geo-database of spoil tips existed, the mapping was carried out by IMPACT using open source data (OSM), cross-referenced with satellite imagery.

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 impact on the environment and population. 16 spoil tips are located within Toretsk, Zalizne and Pivdenne settlements, and 14 additional spoil tips are within 500m distance from the settlements boundaries.

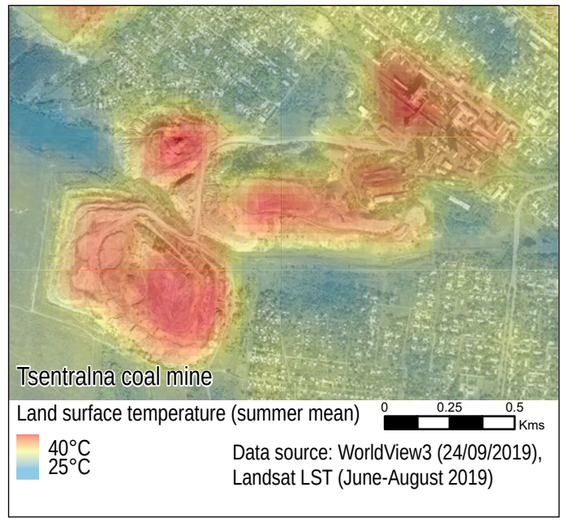
Tailings dams are a special hydro-technical construction designed to store by-products of industrial activity. The main hazards posed by tailing dams are dam failures, which represent low probability high impact events; and diffuse pollution, which has a higher probability but lower impact. Due to the proximity of tailing dams in Toretsk city council to the CL, there is a concern over regular maintenance and potential damage.

Map 9.1 displays tailings dams, conflict incidents in 2019, 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 the State Agency for Water Resources of Ukraine.

Map 9.1 Spoil Tips and Tailings Dams Location



Map 9.2 Mean land surface temperature in summer 2019



Key takeaways

1. The 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 must be undertaken to ensure proper maintenance of tailings dams and spoil tips and mitigation of their hazardous exposure.

HAZARD - CONFLICT EXPOSURE TO ELECTRICITY NETWORK

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 consequences on the ability of households to heat themselves and access water. This section provides a short overview of the electricity network and main electricity-related risks in the raion. The dataset was created from digitized satellite imagery, secondary data sources, and OSM contributors.

The electricity network of the area is a 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), based on water vapor (graph 10.1). Two TPSs, Vuglegirska and Myronovska, are located within 20 km and 25 km, respectively, of the Toretsk city council, and less than 5-km from the CL.

On March 29th 2013, a fire caused by ignition of coal dust, destroyed four turbines in Vuglegirska TPS.

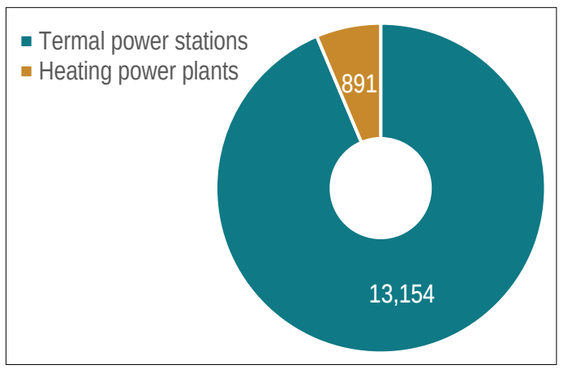
Since the beginning of the conflict in 2014, 11 shelling events were recorded near Vuglegirska TPS, which resulted in infrastructure damage and malfunction.

There are 18 electricity substations located within 25km of Toretsk city council, with 112 conflict incidents recorded in 2019 near substations or within 1km of power related objects.

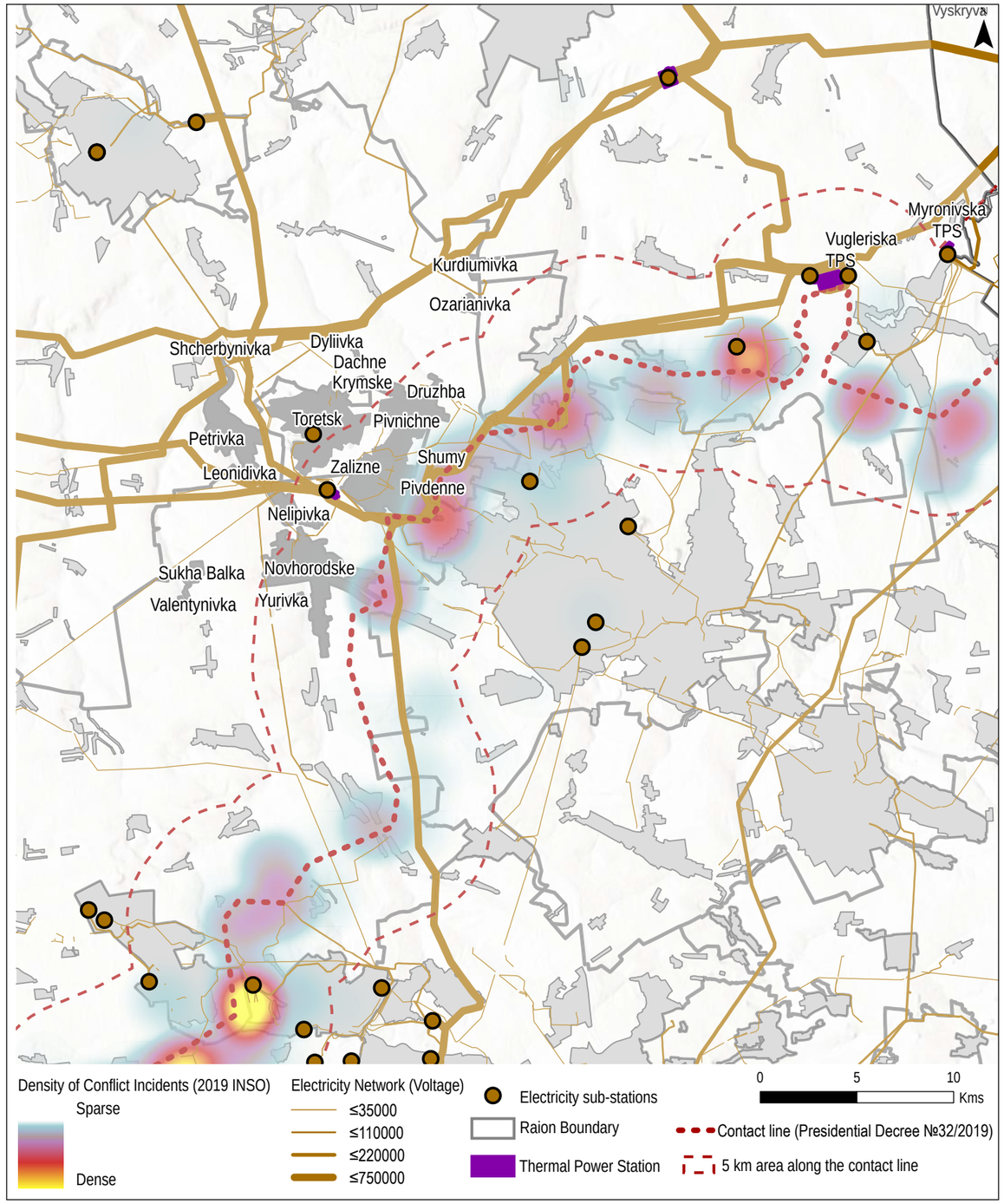
Interruption of electricity supply was the cause of disruption of other dangerous facilities, coal mines, water filtration and water pump stations, etc. This increases the risk of emissions of pollutants and hazardous substances into the environment.

Due to shelling near Shumy on June 19-20, 2020, two 110 kV power lines were damaged. The pumping station of the third rise remained on a single input of 35 kV, which does not allow to provide the 100% of water supply, needed in the region. As a result, there was a 50% reduction in water supply through the Siverskyi Donets-Donbas channel.

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



Map 10.1 Electricity Network



Key takeaways

1. Due to the conflict, and the possibility of network damage, a 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 will induce several severe cascading effects, the multi-stakeholders risk assessment must be conducted by local authorities, for specific response planning.

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

HAZARD - CONFLICT EXPOSURE TO GAS AND OIL SUPPLY INFRASTRUCTURE

Gas & Oil Pipelines

Similar to the electricity network, gas and oil pipelines are located in close proximity to the CL. In particular some 40 km of pipelines pass straight along the CL and 21 conflict incidents have occurred in several locations within a 500m radius of the pipelines (INSO, 2020). This infrastructure represents a disaster risk as damage can lead to oil or gas spills which can pollute both water and the atmosphere. In addition, both fuels are a major source of heating for the region, so damage could have critical consequences in the winter months.

There is also a Horlivka-Odesa branch of ammonia pipeline Toliati-Odesa, which crosses the CL and is within 3.5 km of Toretsk city and less than 700 m from Ozarianivka and Dylivka. This branch was built in 1979 to transit liquid ammonia, produced on Stirol plant, one of the biggest ferliziler manufacturers, to Odesa port plant in Yuzhne.

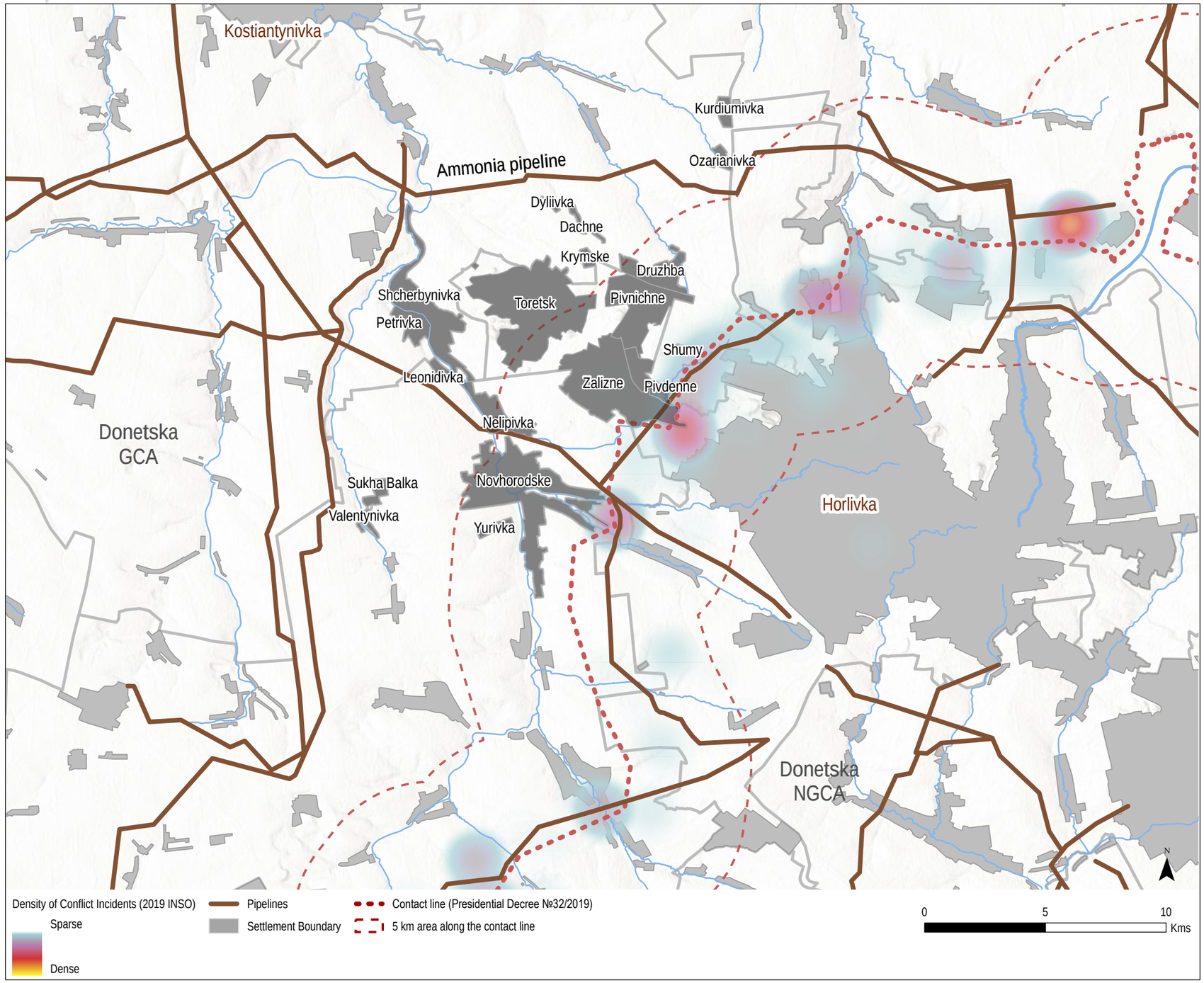
Since the beginning of the conflict in May 2014, the ammonia production and transit have been suspended due to security reasons. Despite the fact that Stirol plant management reported that all hazardous substances were removed from the industrial site, there is a concern that ammonia remains in the pipelines. That means that the northern part of Toretsk city council is exposed to risk of ammonia leakage, including Toretsk and Zalizne.

According to FEAT, ammonia is classified a toxic liquid and aquatic chronic and may be channelled through air, soil, groundwater and rivers. It poses a danger to the environment, fishing, agriculture and human health in an area from 2km to more than 10km from the source.

Key takeaways

1. Monitoring of ammonia contamination in areas close to the pipeline.
2. Raise awareness of residents on risks related to exposure to ammonia.

Map 11.1 Gas and Oil Pipeline Network



VULNERABILITY - SUSCEPTIBILITY AND COPING CAPACITY

Susceptibility & Coping Capacity

Based on the susceptibility indicators available from the REACH 2018 CVA, the most susceptible communities were Dachne, Dyliivka, Leonidivka, Sukha Balka, and Valentynivka. These are settlements classified as rural, and are located outside of 5 km area along the CL.

These communities ranked higher for susceptibility in both dependency and economic capacity. The households in these communities had the highest unemployment rate (8%) with 7% of the households whose main source of livelihoods is agriculture. In all other communities only 1% or less of the households reported being employed in agriculture.

The lowest unemployment level of 5% was found in the households in urban settlements outside of the 5 km area along the CL. At the same time, 29% of the households in these communities are 65 years or older, which is higher than in the households in rural settlements within 5km from the CL (26%).

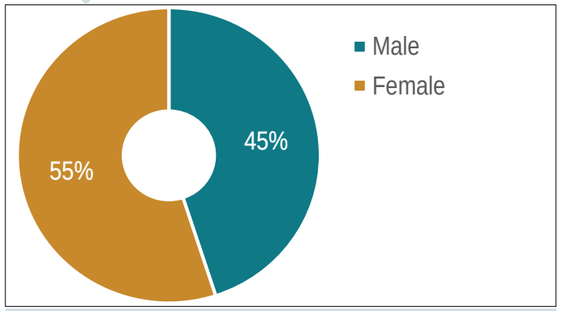
Eleven percent (11%) of the households in the rural communities within 5km of the CL reported **having one or more disability**, compared to the lowest rate of 7% of the households in urban settlements within the 5 km area along the CL.

The proportion of HoHs who are single females, **widows, or single parents was higher in urban** communities outside the CL (40%) as compared to 36% in urban areas within the 5 km area along the CL. The proportion of the households with 3 or more children was negligible across the assessment.

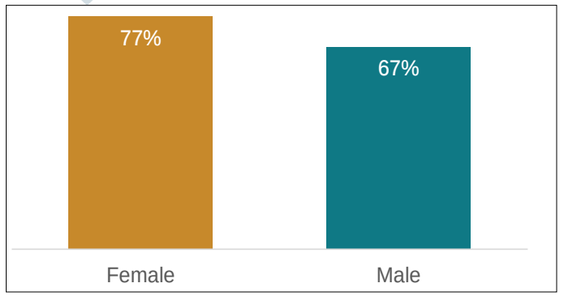
Distances to key services such as primary health care facilities, social services, education facilities, and SESU response units influence the coping capacity of a community. There are 21 education, 7 health and 4 social facilities in Toretsk city council, including one mobile administrative service centre.

From an education perspective, schools provide opportunities to communicate natural and anthropogenic hazards and the best preparedness and response mechanisms to follow. Schools are often used as a communal shelter or meeting point in the aftermath of a disaster to provide information or distribute aid. If a disaster strikes during a school day, they will also often be responsible for evacuating children to safe locations to ensure that they are not exposed to further hazards. Social facilities are primary providers of services and information to vulnerable groups such as persons with disabilities, the elderly and households with limited financial means. They are a primary source of information on the needs of vulnerable groups and can be used to communicate disaster preparedness and response information (REACH, 2018).

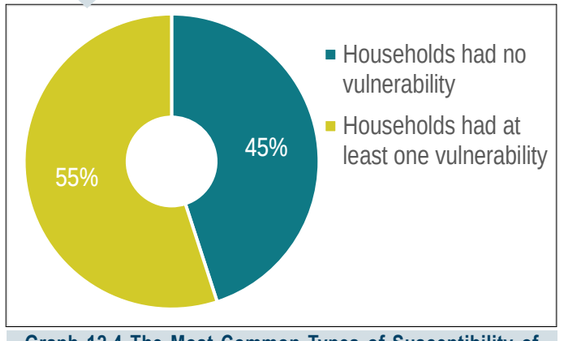
Graph 12.1 Gender Distribution of Heads of Households for Toretsk City Council



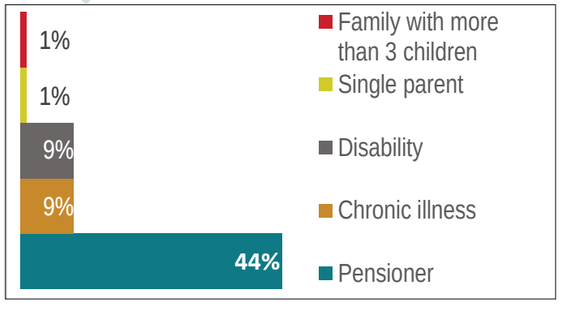
Graph 12.2 Gender Distribution of Heads of Households with Vulnerability for Toretsk City Council



Graph 12.3 Distribution of Households that had at Least One vulnerability for Toretsk City Council



Graph 12.4 The Most Common Types of Susceptibility of Households for Toretsk City Council



The households in rural communities within 5 km of the CL reported longer distances to four key services. The most evident was the difference in traveling time to primary health care facilities; 45% of the households reported greater than 30 minutes traveling time to a primary health care facility compared to 26% of the households in rural communities outside 5 km area along the CL. When taking further indicators into consideration such as proportion of the households aware of nearest bomb shelter, number of conflict incidents (2019), and proportion of IDPs, the main communities of concern for lack of coping capacity were: **Kurdiumivka, Ozarianivka, Shumy, Yurivka,** Valentynivka, and Pivdenne.

The majority of the vulnerability indicators combined and weighted come from the REACH CVA, which is representative of households not at the individual settlement level but at the stratification of Urban, Rural and 5 km area along the CL differentiation as shown in map 12.1 (confidence level – 95%, margin of error – 7%). Therefore, settlements across the research area have similar vulnerabilities based on the settlement stratification class. However, indicators on SESU response unit location distances, and 2019 conflict incidents from INSO, provide further individual insight into the community-level findings to distinguish further vulnerability within their strata. For example, whilst the households in Pivdenne, as an urban settlement within 5km of the CL, would report similarly to Nelipivka in terms of distance to services, the community of Pivdenne has witnessed 32% of the conflict incidents occured in the area of Toretsk city council in 2019. While rural settlements outside the 5km zone like Sukha Balka and Valentynivka have not reported any conflict incidents, their distances to a SESU response unit are almost twice as great as other settlements of the same strata, which increases their vulnerability.

The most vulnerable communities as seen on map 12.2 were found to be Sukha Balka, Valentynivka, **Kurdiumivka, Ozarianivka, Shumy, Yurivka, and** Pivdenne.

Table 12. 1 Travel Time to Education Facilities reported by Households

Time	>5km Rural	>5km Urban	5km Rural	5km Urban
< 30 min	90%	93%	86%	98%
30 min - 1 hour	10%	7%	14%	0%
1 - 1.5 hours	0%	0%	0%	2%

Table 12.2 Travel Time to Primary Health Care Facilities reported by Households

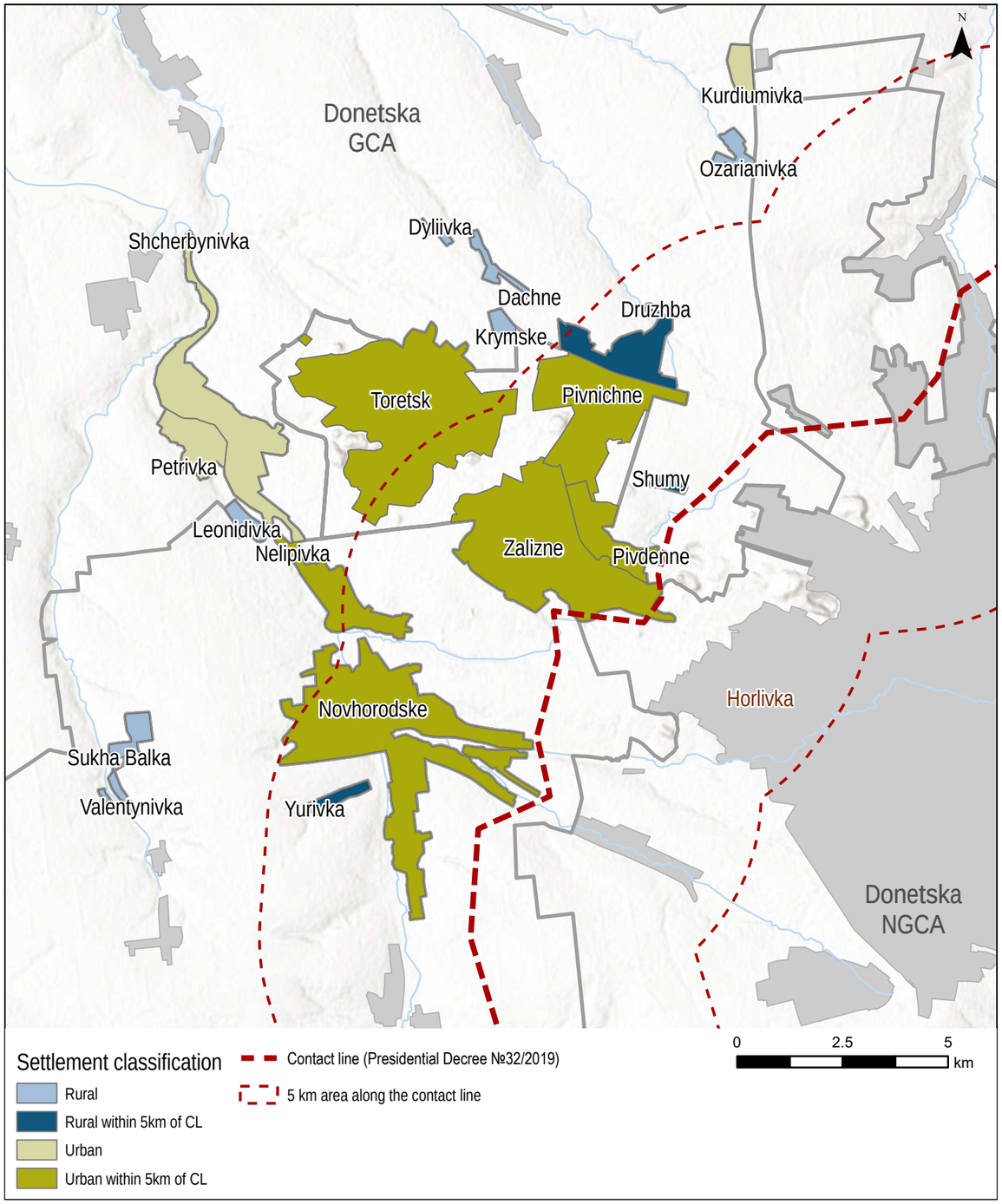
Time	>5km Rural	>5km Urban	5km Rural	5km Urban
<30 min	74%	78%	55%	78%
30 min -1 hour	24%	21%	41%	20%
1-1.5 hours	1%	1%	1%	1%
1.5 - 3 hours	1%	0%	1%	2%
> 3 hours	0%	0%	1%	0%

Table 12.3 Distance to Social Facilities reported by Households

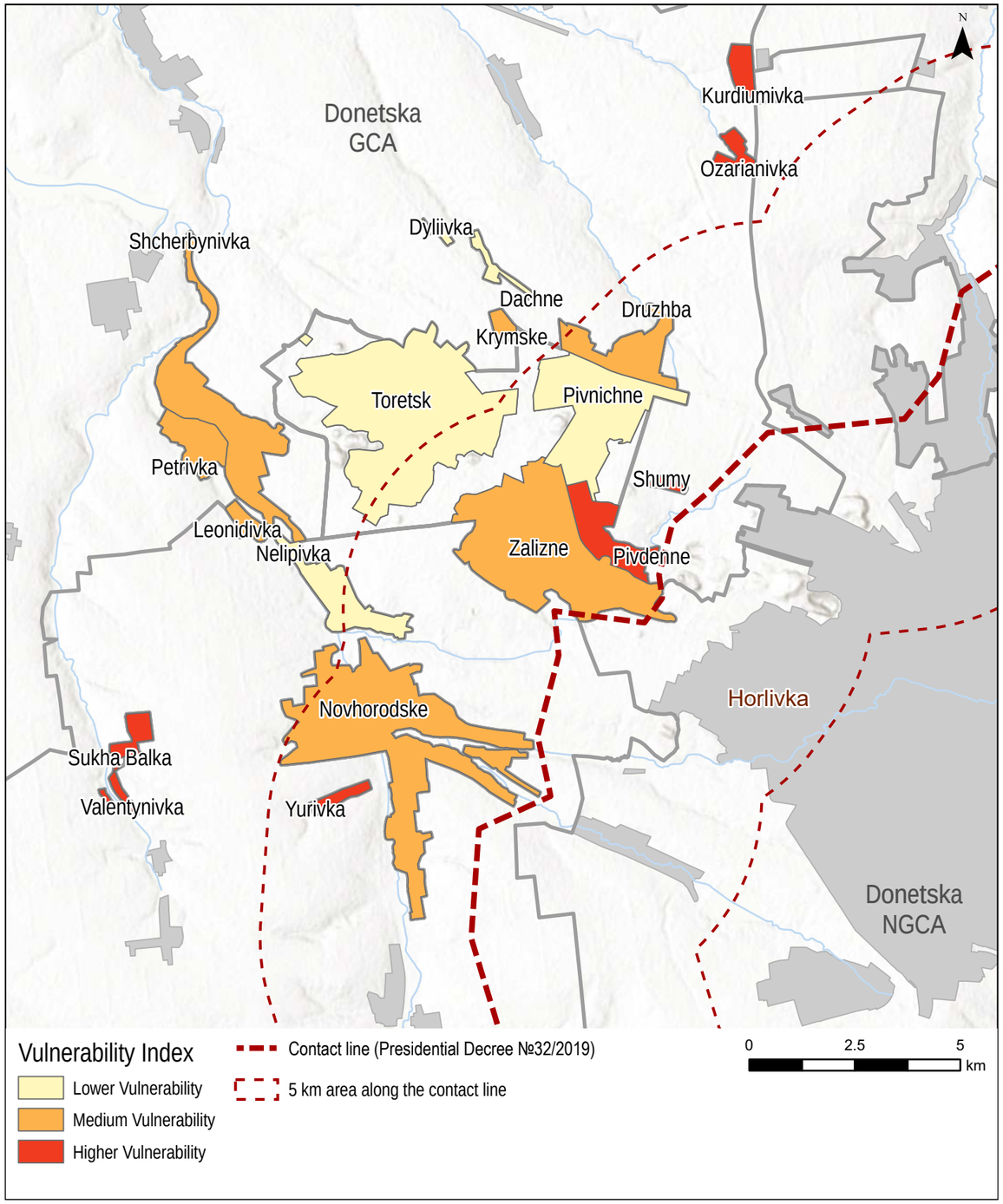
Time	>5km Rural	>5km Urban	5km Rural	5km Urban
< 1 km	0%	2%	0%	19%
1-5 km	4%	10%	15%	50%
5-20km	79%	75%	74%	24%
>20km	6%	8%	1%	1%
Don`t know	11%	5%	10%	6%

VULNERABILITY - SUSCEPTIBILITY AND COPING CAPACITY

Map 12.1 Toretsk City Council Settlement Classification from CVA Sampling Stratification



Map 12.2 Vulnerability Map (Toretsk City Council Settlements Only)



ANTHROPOGENIC MULTI-HAZARD EXPOSURE

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 within the settlement or within 2km was calculated for each settlement. This includes the DEIS identified hazardous critical infrastructure facilities, tailings dams, spoil tips, waste management, and filtering stations. The geospatial analysis was applied to summarize the number of reported INSO conflict incidents in 2019 within or near each settlement.

As multiple hazardous objects may have cumulative effects on the environment and population, the analysis took into account the number of hazardous objects within a 2km radius of a settlement. The distance of 2km was applied to all facility types as a rough indicator for human and environmental exposure. To better calculate hazard exposure, each facility should be assessed to determine present substances and quantity and the FEAT 2.0 Pocket Guide should be applied.

Tables 13.1, 13.2, and 13.3 list the most exposed settlements in the area of Toretsk city council to potentially hazardous facilities within a 1km and 2km distance of a settlement.

The analysis shows that **Zalizne and Pivdenne have the highest exposure to anthropogenic hazards**. Toretsk, Novhorodske and Pivnichne record a substantial number of hazardous facilities, 66% of the total facilities of this ABRA are located in Toretsk. But conserning the number of conflict incidents in 2019, **Zalizne and Pivdenne witnessed the majority of conflict incidents in the area**, therefore Zalizne's and Pivdenne had the highers anthropogenic hazard exposure in the region surpassing Toretsk. Rural communities located outside the 5 km area along the CL predominantly had the lowest anthropogenic hazard exposure. 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.

Map 13.1 Anthropogenic Multi-Hazard Exposure by Settlement

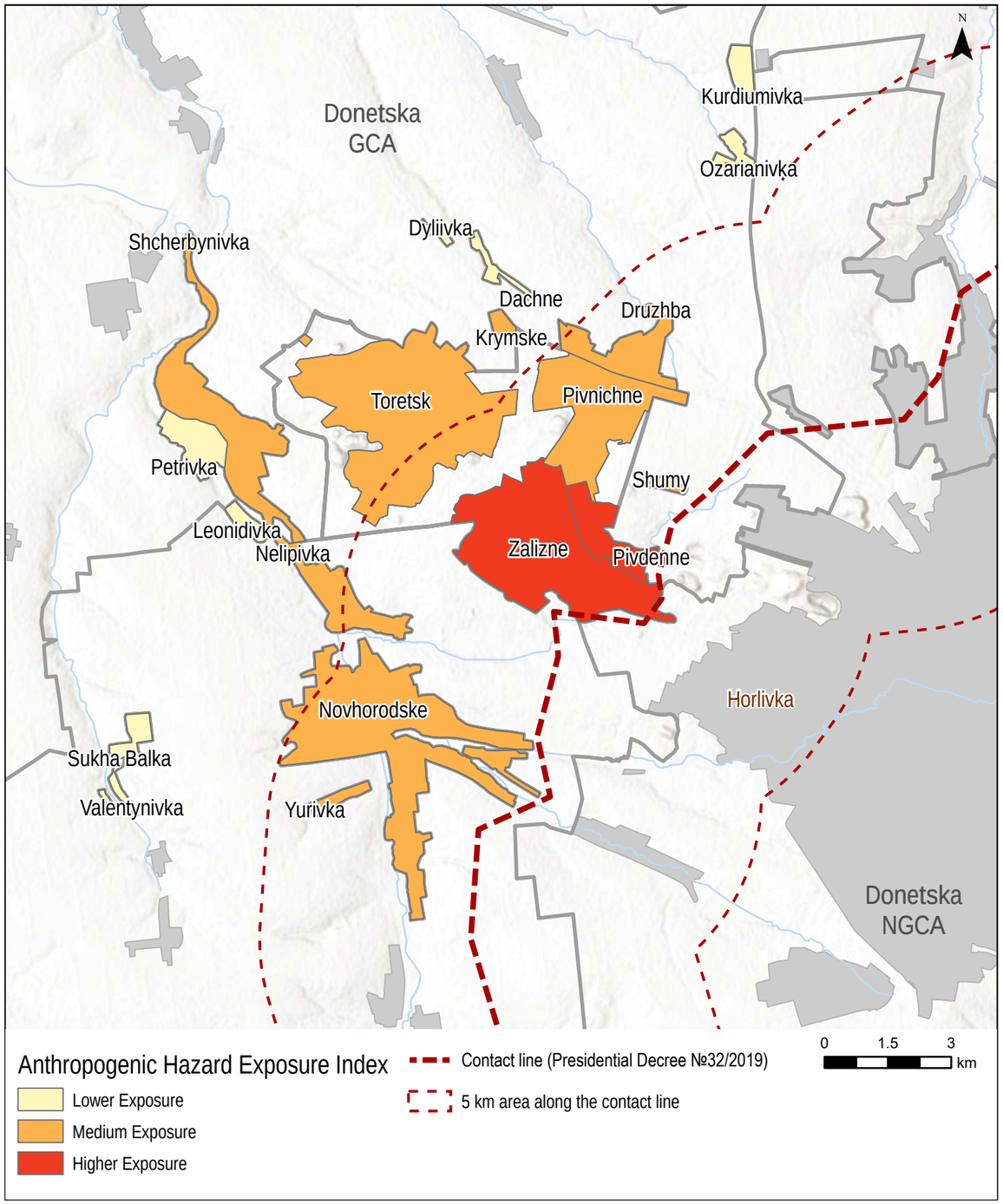


Table 13.1 Top 5 communities with the highest number of hazardous objects

Community	Within 1km	Within 2km
Toretsk	10	13
Novhorodske	4	4
Zalizne	4	10
Pivnichne	2	8
Pivdenne	2	6

Table 13.2 Top 5 communities with the highest number of spoil tips

Community	Within 1km	Within 2km
Zalizne	20	26
Toretsk	17	18
Pivdenne	10	20
Pivnichne	4	13
Shumy	4	9

Table 13.3 Top 3 communities with the highest number of tailing dams

Community	Within 1km	Within 2km
Novhorodske	4	2
Nelipivka	4	0
Zalizne	2	1

NATURAL MULTI-HAZARD EXPOSURE

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.

The urban community of Zalizne and Pivdenne also ranked the highest for exposure to the three natural hazards assessed. The urban communities of Novhorodske and Pivnichne, and rural community Shumy were also found to have higher natural multi-hazard exposure, with higher frequencies of extreme heat and extreme cold days.

The communities of **Novhorodske, Shcherbynivka,** Toretsk and Zalizne have high wildfire risk, as they had the highest number of historical fires recorded, according to satellite data (FIRMS).

Natural hazards are also considered as triggers for failure of infrastructure such as power supply, water supply, heating, as well as social infrastructure which makes these hazards a significant threat to the population. Tables 14.1, 14.2, and 14.3 present lists of settlements that historically were most exposed to the environmental hazards (during years 2001-2019).

Map 14.1 Natural Multi-Hazard Exposure by Settlements

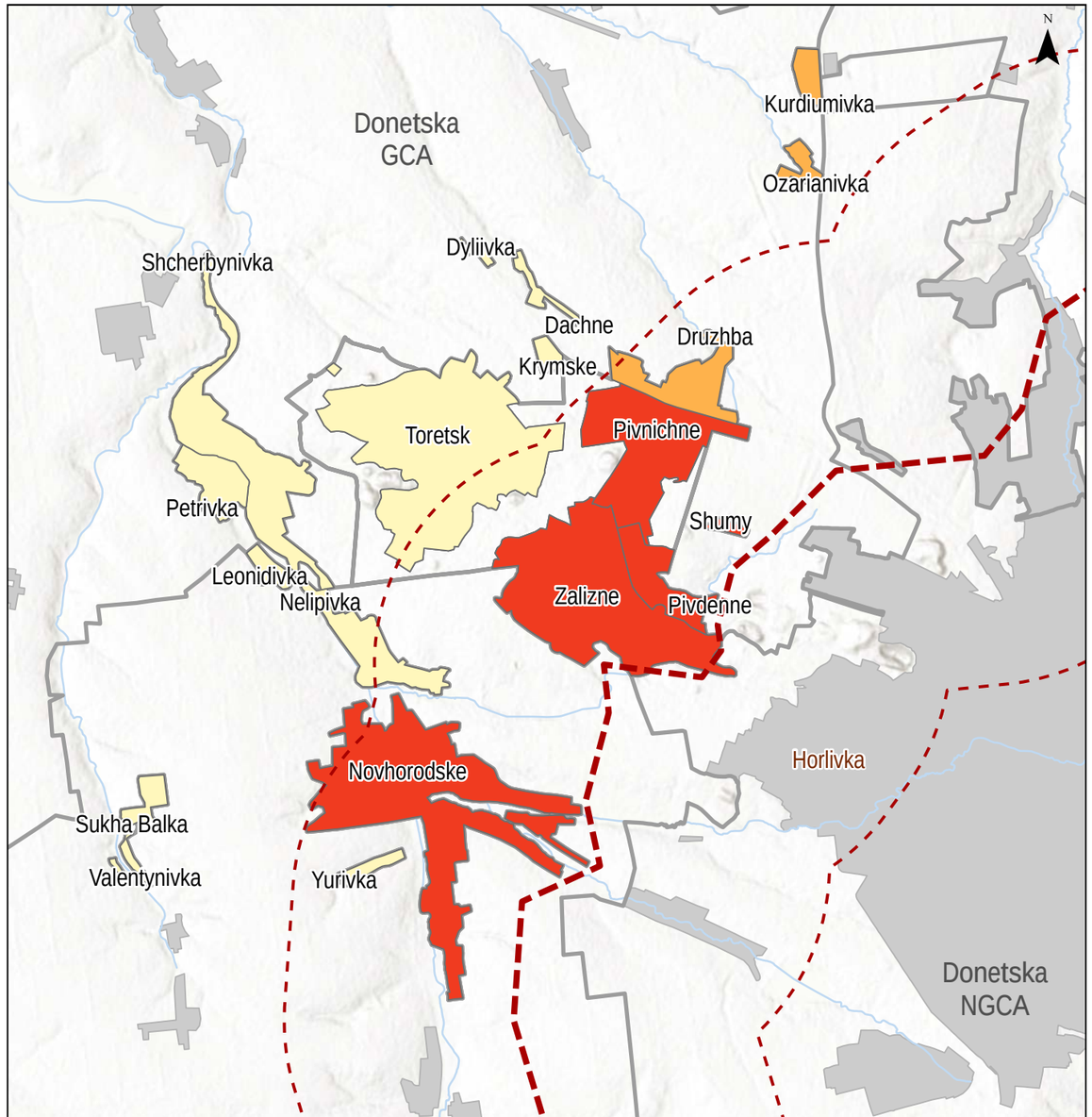


Table 14.1 Settlements with Highest Observed Frequency of Abnormally Low Temperatures during years 2001-2019

	Settlement	Mean number of days per year with cold waves
1	Shumy	18
2	Pivdenne	17
3	Ozarianivka	17
4	Pivnichne	17
5	Druzhba	17
6	Zalizne	17
7	Petrivka	16
8	Shcherbynivka	16
9	Kurdiumivka	16

Table 14.2 Settlements with Highest Observed Frequency of Abnormally High Temperatures during years 2001-2019

	Settlement	Mean number of days per year with heat waves
1	Shumy	32
2	Kurdiumivka	31
3	Pivdenne	30
4	Pivnichne	30
5	Druzhba	29
6	Ozarianivka	28
7	Zalizne	27
8	Yurivka	27
9	Krymske	26

Table 14.3 Settlements with Highest Observed Frequency of Fires during years 2001-2019

	Settlement	Number of fires (FIRMS data)
1	Novhorodske	70
2	Toretsk	62
3	Shcherbynivka	58
4	Zalizne	54
5	Pivnichne	42
6	Druzhba	32
7	Nelipivka	32
8	Pivdenne	27
9	Petrivka	26

MULTI-HAZARD RISK

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.

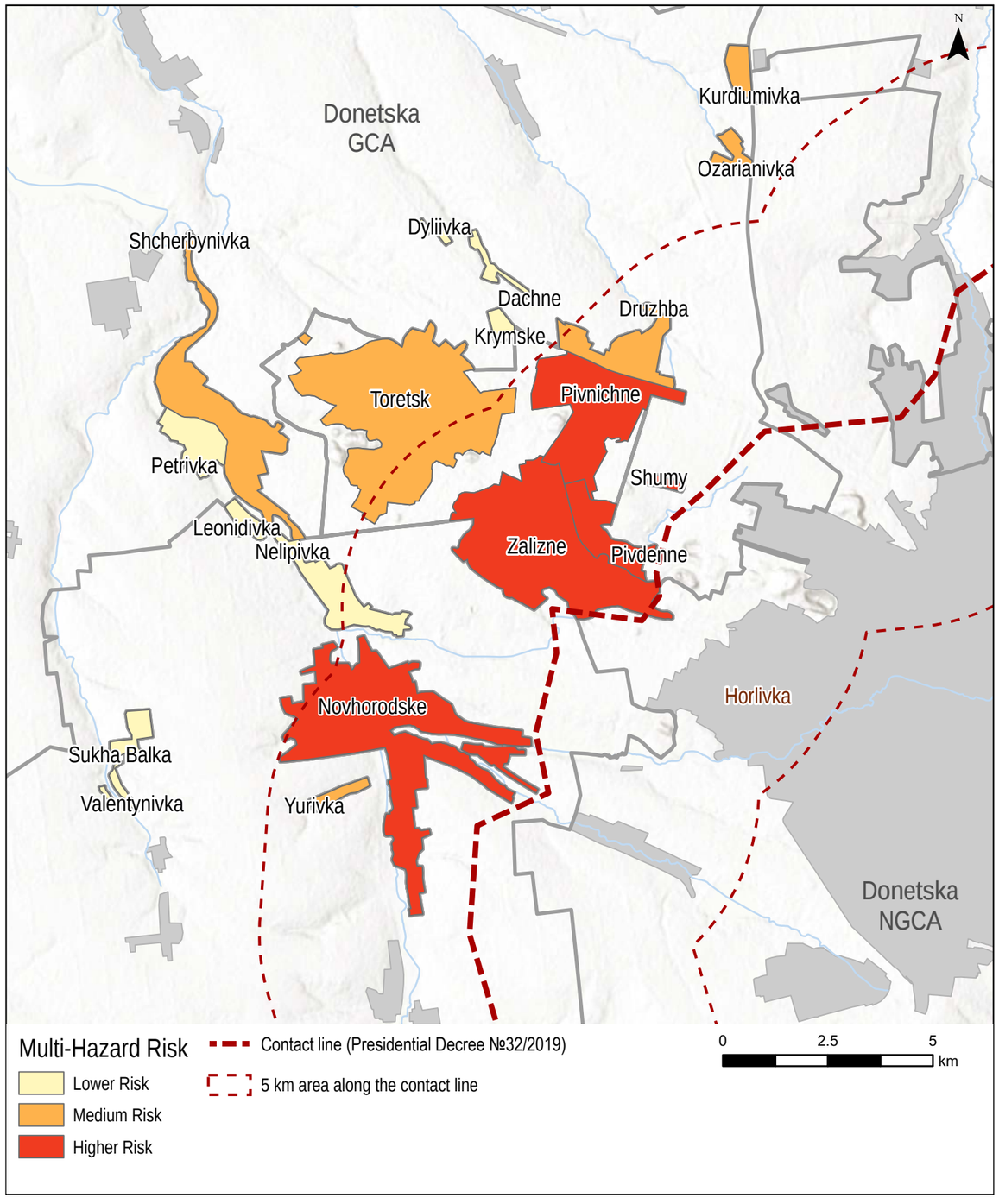
Zalizne and Pivdenne were found to have the highest multi-hazard risk out of the 19 settlements of Toretsk city council, based on both hazard and vulnerability data. This is explained by the fact that these settlements have a significant presence of hazardous facilities coupled with close proximity to the CL and high number of conflict incidents.

The five communities at greatest risk are communities within 5 km of the CL, four of which are urban communities. The third highest community at risk is rural settlement Shumy. The fourth and fifth are urban settlements Novhorodske and Pivnichne. Conflict is considered as 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.

Table 15.1: Community Multi-Hazard Risk

Settlement	Population (CVA, 2018)	Multi-Hazard Exposure	Vulnerability Index	Multi-Hazard Risk
Zalizne	5,355	22.19	0.20	4.52
Pivdenne	1,535	21.32	0.21	4.45
Shumy	86	14.97	0.22	3.32
Novhorodske	12,616	13.94	0.20	2.78
Pivnichne	9,866	12.03	0.17	2.06
Kurdiumivka	821	9.06	0.22	1.99
Yurivka	29	8.78	0.22	1.95
Ozarianivka	372	8.76	0.22	1.90
Druzhba	1,676	9.68	0.19	1.89
Toretsk	33,455	11.27	0.16	1.77
Shcherbynivka	3,532	9.07	0.19	1.74
Krymske	53	8.89	0.19	1.68
Petrivka	1,078	7.91	0.20	1.56
Valentynivka	76	7.01	0.22	1.53
Sukha Balka	585	7.01	0.21	1.49
Leonidivka	7	7.66	0.19	1.46
Nelipivka	1,065	7.95	0.18	1.42
Dyliivka	7	7.25	0.18	1.31
Dachne	2	6.92	0.18	1.24

Map 15.1 Multi-Hazard Risk By Settlements



HROMADAS - A NEW WAY FORWARD?

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).

Currently, Toretsk city council includes Zalizne city council and three village councils: Novhogordske, Pivnichne and Scherbynivka. There are 19 settlements in total, of which 9 are urban and 10 are rural. The formation of amalgamated territorial communities of Toretsk is still complicated by the proximity to the CL, which creates discontinuities in the territory.

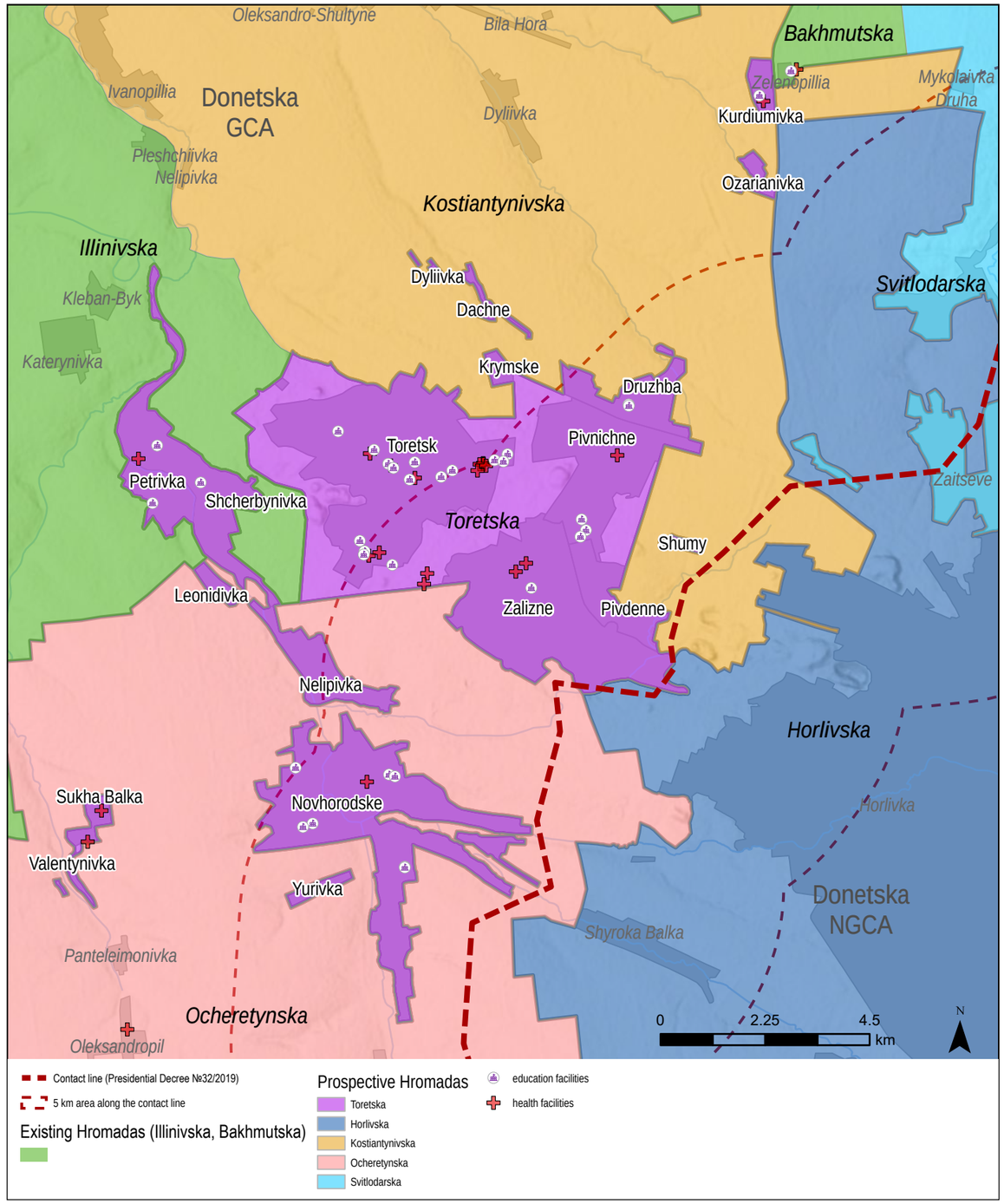
There are 21 education, 7 health and 4 social facilities within Toretsk city council including one mobile administrative service centre, which started to operate in early 2020 to cover the distant rural communities like Ozerianivka.

According to the requirements of the Methodology for Formation of Able Territorial Communities, the new administrative-territorial level - amalgamated territorial communities, should be formed taking into account the accessibility of public services; in particular the time of arrival of ambulance and fire aid in urgent cases should not exceed 20 minutes. Such measures might necessitate the relocation or creation of new stations and sub-stations for emergency services and should be guided through strong understanding of risks.

These changes will impact primarily the distances to access services for settlements that would see a change in administration. This is expected to have a positive impact on the coping capacity of communities to ensure no settlement is too far from their respective service area.

Based on the vulnerability assessment from the REACH 2018 CVA, more then 86% of households reported the distance to education facility was under 30 minutes for all rural and urban communities. However,

Map 16.1 Overview Map for Toretsk Hromadas



45% of respondents of rural communities within 5 km area along the CL and 26% of respondents in rural communities outside 5 km area along the CL reported greater than 30 minutes traveling time to a primary health care facility. This fact should be taken into account in the process of formation of amalgamated territorial communities of Toretsk to ensure that all the community members have access to health facilities. For example, new health facilities should be established or distant settlements should be united with other community centers.

To ensure comprehensive protection of the civilian population in newly created amalgamated communities, strong inter-departmental preparedness and mitigation planning process 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.

Conclusions

This ABRA for Toretsk city council aimed to analyse geospatial data on hazard exposure and community vulnerability to assess both natural and anthropogenic risks for each settlement in the area.

It is expected to 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 the hazard.

It was conducted at the sub-regional level, and relied 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 frames. Thus, this ABRA also serves as a demonstration tool for environmental and industrial risk at a local settlement level.

Community prioritization according to the hazard exposure and vulnerability is important to increase the awareness about the actual risks and a step in building capacity to the exposed hazards.