Extracting the truth about the war in Ukraine

Ben Dando
Head of Department – Test Ban Treaty Verification
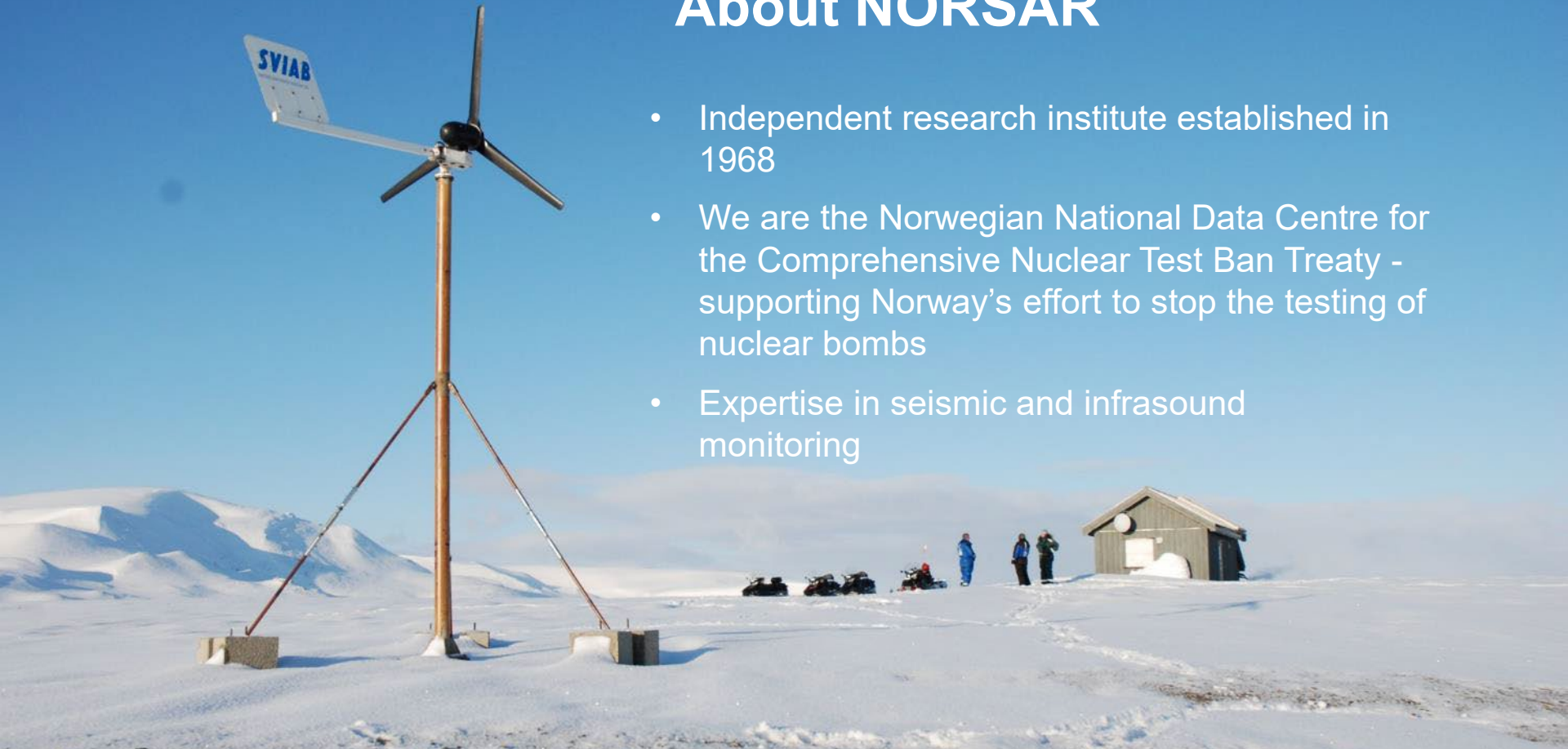
Presentation, Polyteknisk forening, November 2022

About NORSAR

- Independent research institute established in 1968

- We are the Norwegian National Data Centre for the Comprehensive Nuclear Test Ban Treaty - supporting Norway's effort to stop the testing of nuclear bombs

- Expertise in seismic and infrasound monitoring

Information sources
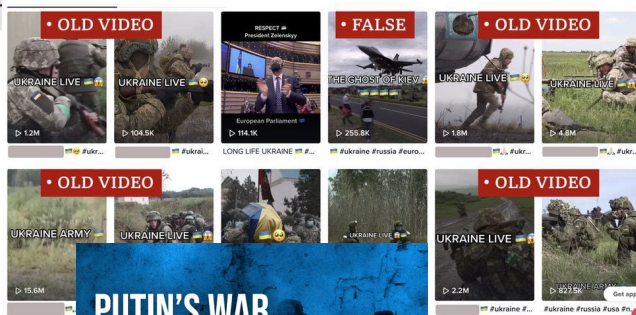
How can technology help?

- **Where, when, and what happened (and by whom)**
- Provide objective data free from (subjective) bias
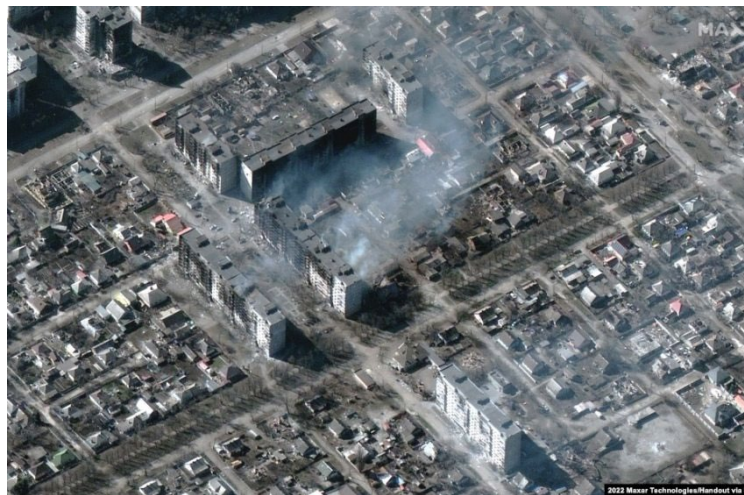- Verify personal/anecdotal accounts

Some existing technologies:
- Satellite imagery
- Videos
- Photographs
- Artificial Intelligence analysis (e.g. of social media)

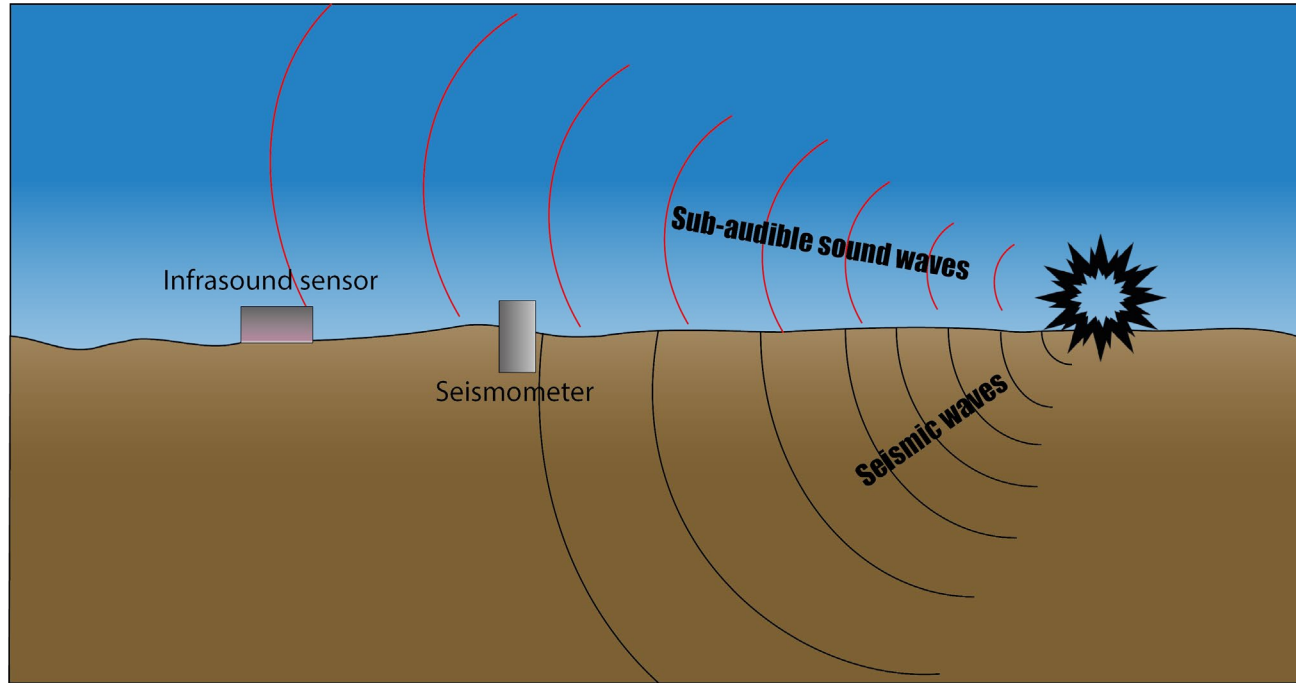What about seismic and infrasound monitoring?

Source: Maxar Technologies
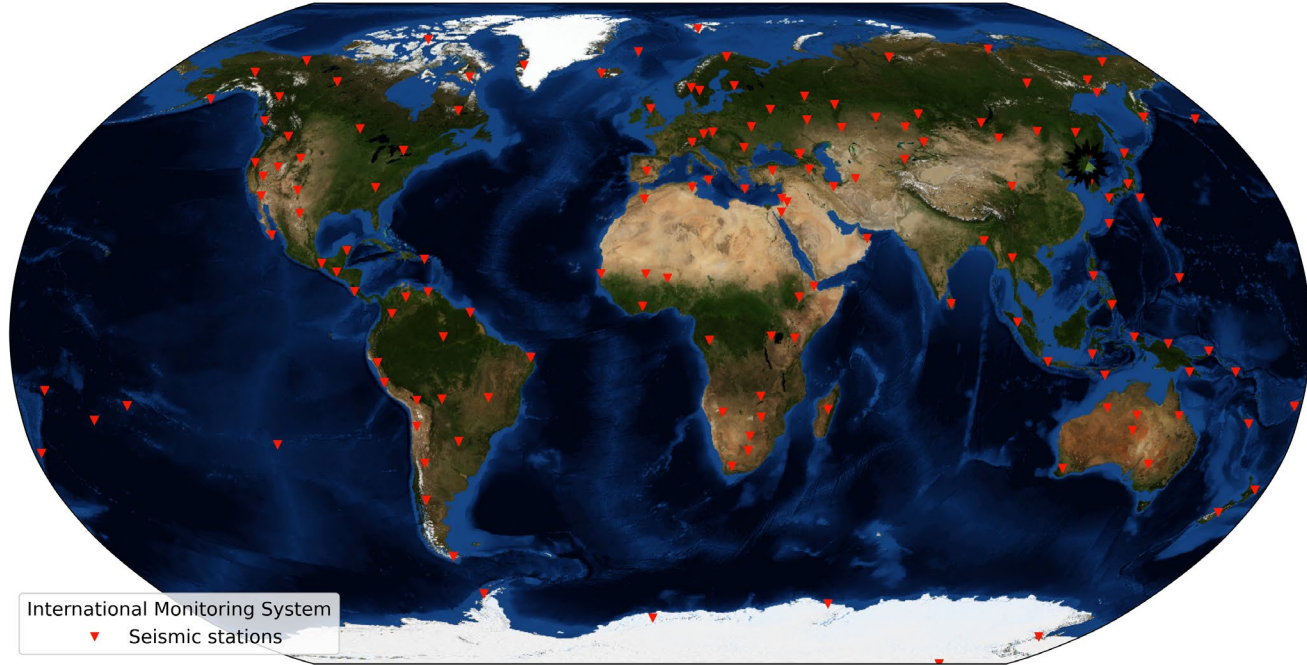
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Energy propagation from an explosion

Detecting nuclear explosions

Seismic stations in the International Monitoring System (IMS) of the
Comprehensive Nuclear Test Ban Treaty Organisation (CTBTO)

0 minutes

International Monitoring System
▼   Seismic stations

Nuclear test-ban monitoring to conflict monitoring

- Military sized explosions are significantly smaller than nuclear tests
- Detection of smaller explosions requires nearby sensors
- Locating explosions (or earthquakes) requires signals from multiple sensors

| Explosion type	Explosive yield - TNT equivalent
Typical rocket propelled grenade	~0.001 tonnes (1 kg)
Nordstream pipeline explosions (2022)	~0.2 tonnes (200 kg)
Tomahawk cruise missile	~0.5 tonnes (500 kg)
Oslo terrorist attack (2011)	~0.9 tonnes (950 kg)
Oklahoma City bomb (1995)	~1.8 tonnes (1800 kg)
First North Korean nuclear test (2006)	~500 tonnes (0.5 kt)
Hiroshima bomb (1946)	~15 000 tonnes (15 kt)
Last North Korea nuclear test (2017)	~200 000 tonnes (200-300 kt)

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Monitoring Ukraine using the IMS

- Stations from the International Monitoring System (IMS) (seismic & infrasound) around Ukraine
- Will **reliably** detect explosions (seismically) with magnitudes > 2.8-3.0
- Equivalent of ~60-101 tonnes TNT (i.e. very large explosions)

Reference event	Explosive yield - TNT equivalent
~~Typical rocket propelled grenade~~	~~~0.001 tonnes (1 kg)~~
~~Nordstream pipeline explosions (2022)~~	~~~0.2 tonnes (200 kg)~~
~~Tomahawk cruise missile~~	~~~0.5 tonnes (500 kg)~~
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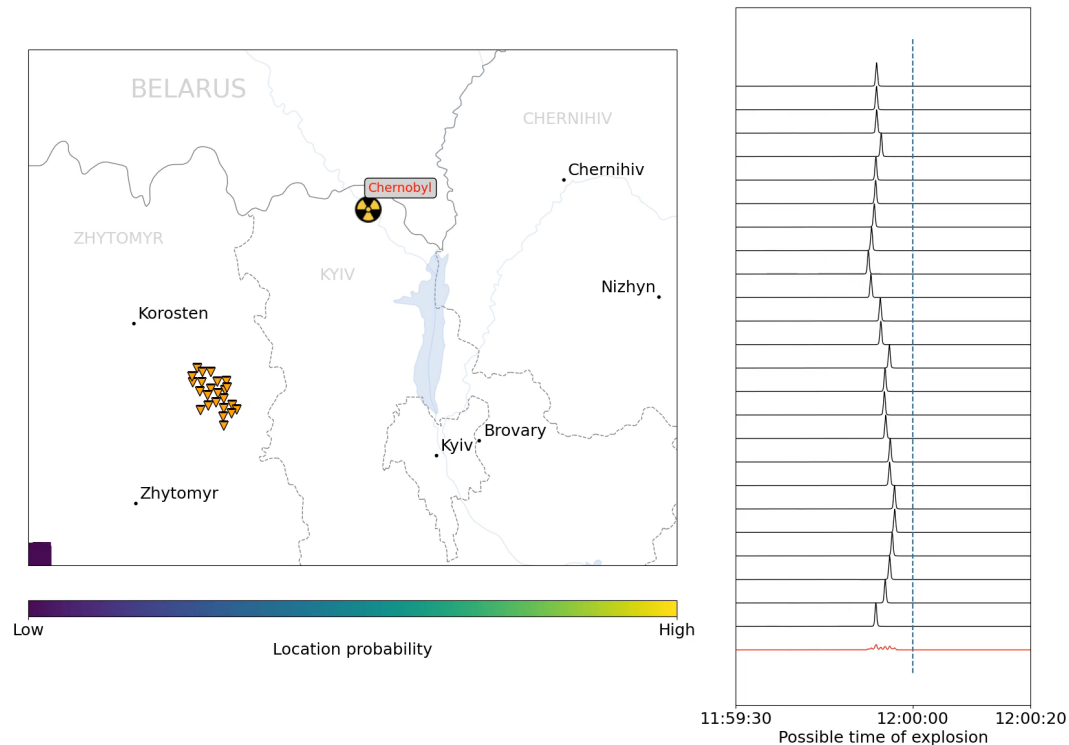## IMS stations around Ukraine
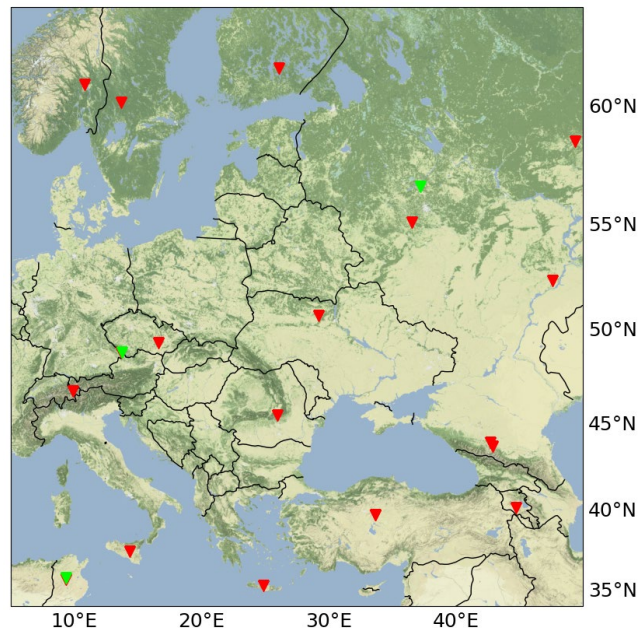

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The Malin seismic array
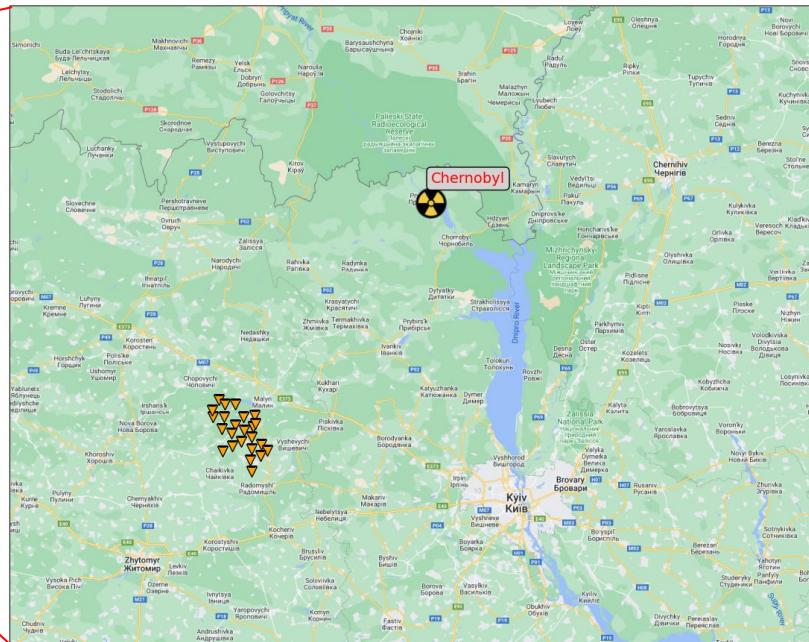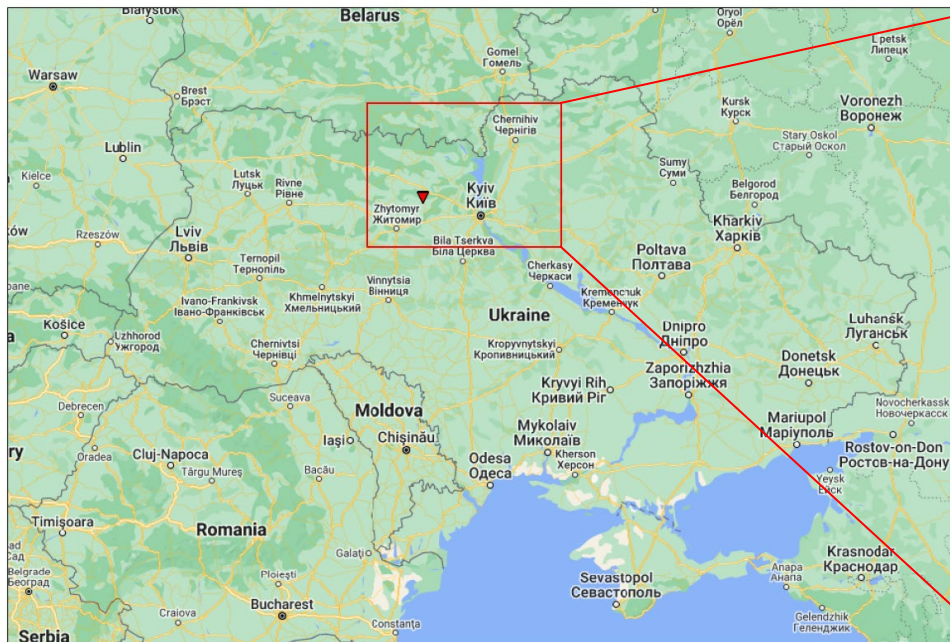
Real-time monitoring of Kyiv region

- Data continuously transferred to NORSAR
- Processed automatically
- Can detect small explosions close to the seismic array
- Less precise at greater distances

Location probability — Low / High

Possible time of explosion

Example: Malyn train station attack

- 20th May 2022 – Russian attack on Malyn train station at 05:40 UTC
- NORSAR's automatic detectors alerted us within 15 minutes of the attack
  - Data transferred to Norway
  - Automatically processed
  - Alert sent out
- 3 explosions within 25 seconds
- Magnitude 0.8 (~300 kg TNT)
- Attack reported by Mayor at 09:37 UTC – four hours later
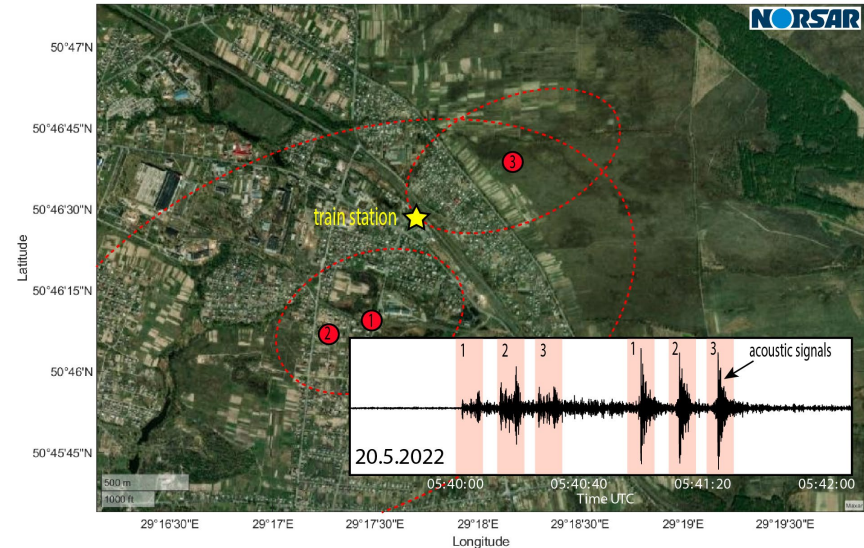
Example: Malyn train station attack

From Al Jazeera:

"The mayor of Malyn, Oleksandr Sytaylo, announced in a video message that day that about 100 houses near the station had been damaged. **The Malyn attack and others are being investigated as possible war crimes**.

The attack had left a large crater, about four metres deep and eight metres wide (13 by 26 feet....

...Russia claimed they had hit a large delivery of weapons from the United States and Europe in the attack.
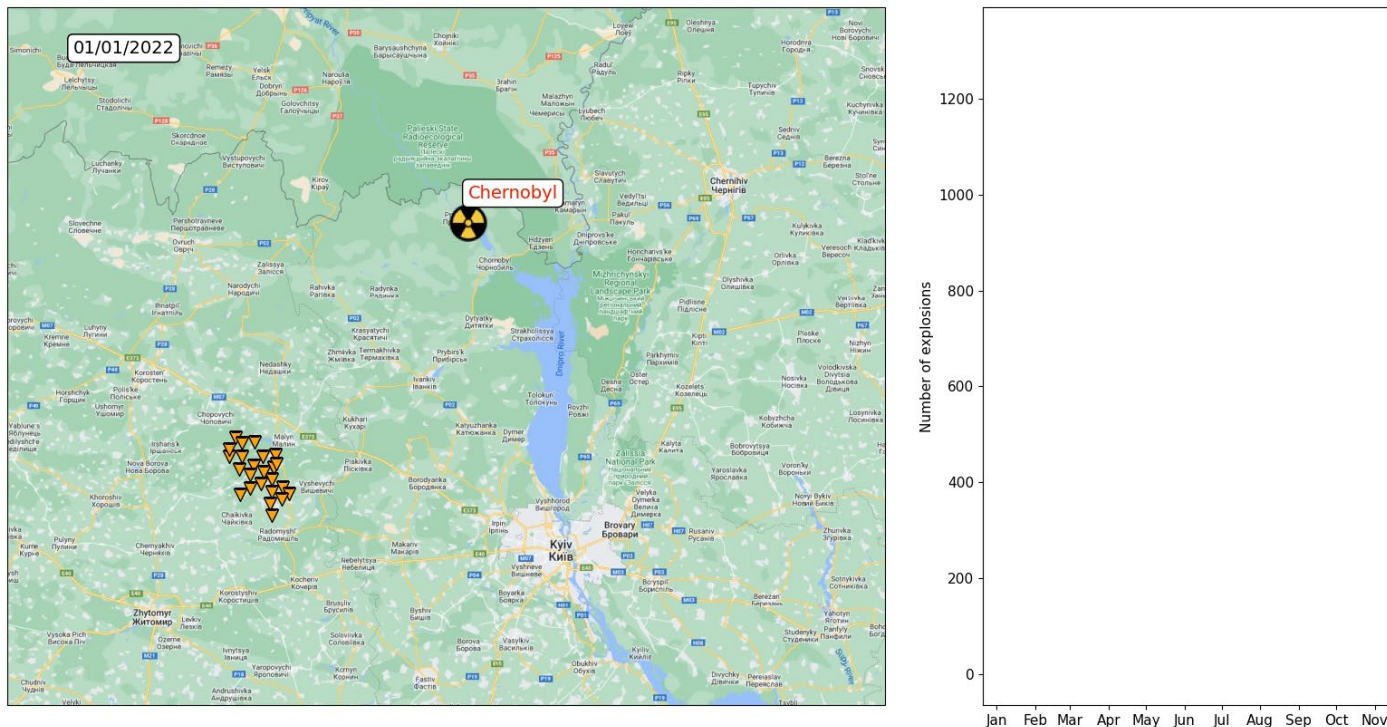
According to [Kulish], there was no weapons delivery, "only a civilian train full of civilians parked here before the missile attack".

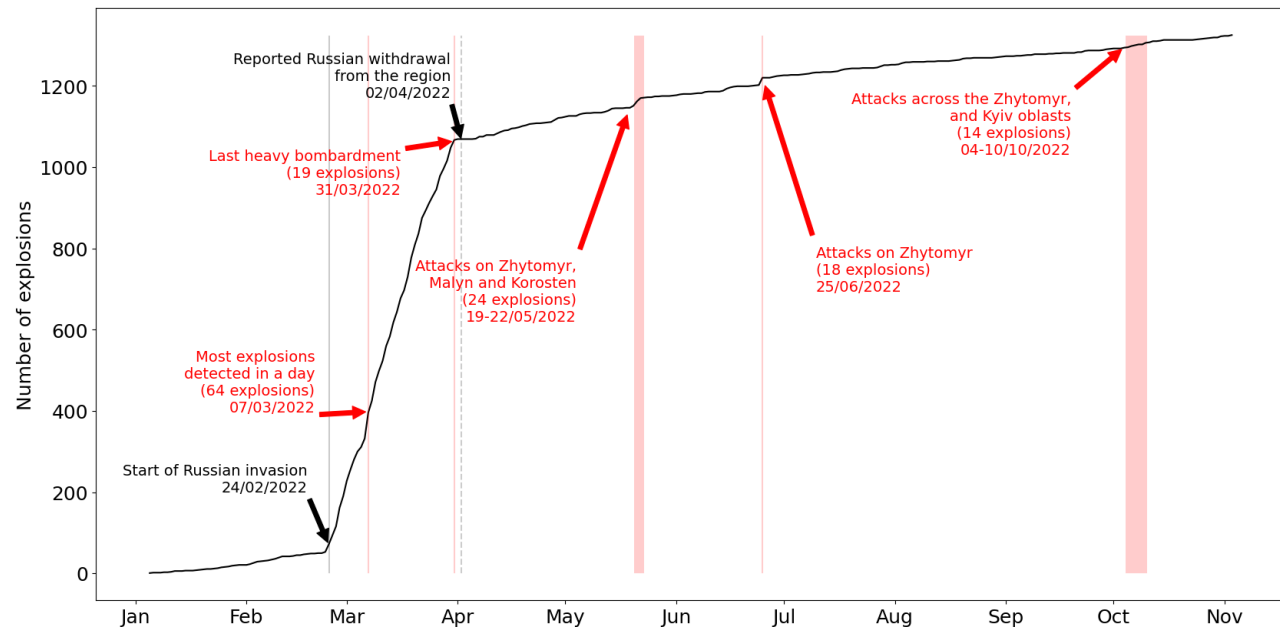*Source: Nils Adler/Al Jazeera*

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# Detecting explosions around Kyiv

Timeline and key events detected

- Ca. 2 explosions/day from quarries/mines
- Average of 28 explosions day after the invasion and before the main withdrawal

Detections vs reported attacks

- Live universal awareness map (liveuamap.com)
- Uses AI webcrawlers to gather reports in Ukraine
- Fact checked by analysts and published online
- Can compare our detections to reports from this region
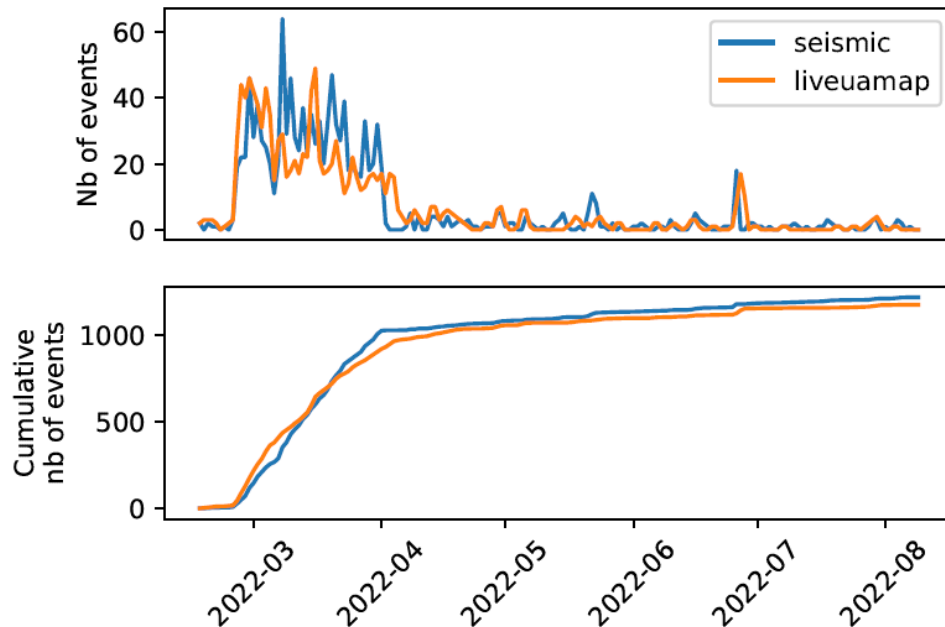

http://liveuamap.com
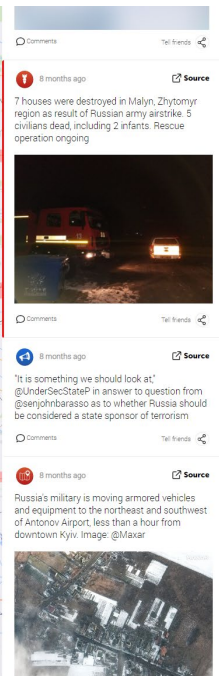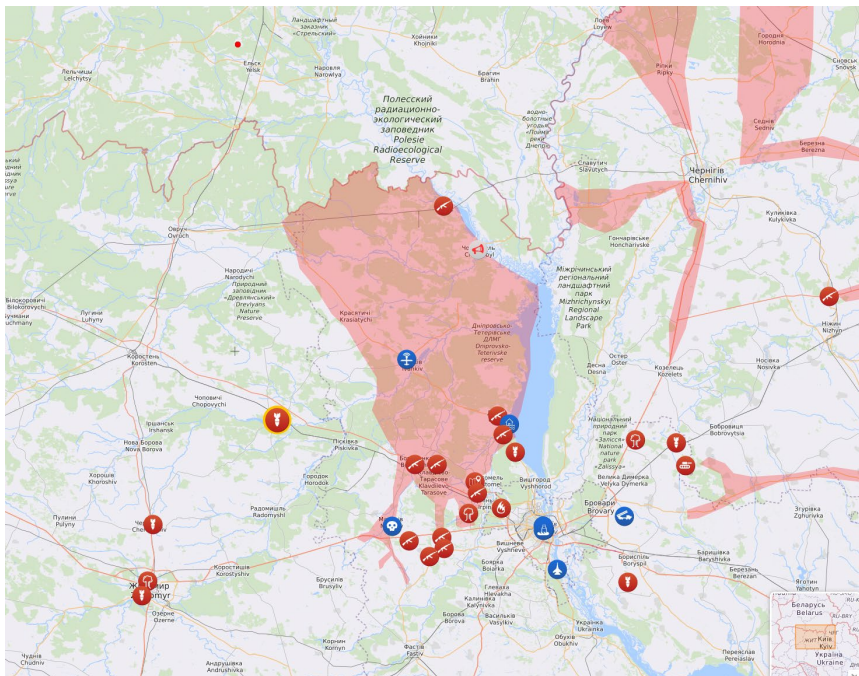
Detections vs reported

- NORSAR detections generally match number of reported attacks
- Reports at the start of the invasion outnumber detections
- Number of seismic detections overtakes number of reported attacks
- Neither reports nor detections are comprehensive

Challenges & opportunities

Reported attacks are not comprehensive
- We do not automatically detect all explosions
- Explosions can be
  - Too far away
  - Too small
  - Simultaneous with complex signals
- We do observe more than is reported
- The Malin array shows what can be achieved by deploying a network of seismic sensors to a conflict zones
- Future opportunity for rapid deployments: seismic and infrasound

Russian-controlled Ukrainian Territory before February 24
Assessed Russian Advances in Ukraine
Assessed Russian-controlled Ukrainian Territory
Claimed Ukrainian Counteroffensives
Reported Ukrainian Partisan Warfare
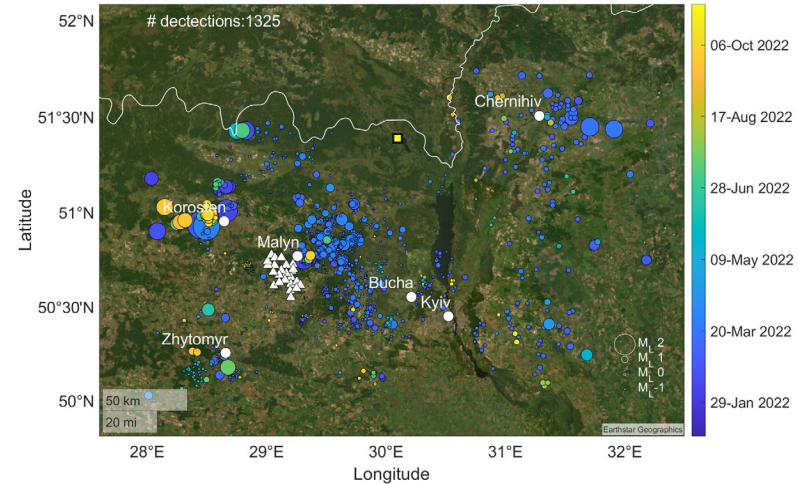Claimed Russian Control over Ukrainian Territory

Source: understandingwar.org - Institute for the Study of War

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Summary

- More information than ever is available for conflict monitoring
- Deciphering the truth remains a challenge
- Technology and data can help provide the objectivity required
- Having a network of seismic sensors (such as the Malin array) in an active conflict zone is unprecedented.
- We have demonstrated for the first time the level of monitoring that can be achieved in an active conflict zone using seismic data
- Deploying seismic and infrasound sensors in conflict zones would significantly boost our monitoring capabilities

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Acknowledgements

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