

RECOMMENDATIONS FOR ACTION

from the WKR Initiative – Wildfires · Climate · Resilience

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Recommendations for Federal and State Governments: Fire Management on Lands Contaminated by Unexploded Ordnance (UXO) (Case of Germany)

From the 1,000-Meter Safety Distance Doctrine to an Actionable Strategy: Unmanned Direct Firefighting, Control Lines, and Preventive Fire Management

As of July 2026 · Based on the WKR UXO Fire Toolbox · www.waldbrand-klima-resilienz.com/uxofiretoolbox



Photo: N. Barth, 2025. Deployment of the MVF-5, Gorischheide, Brandenburg, Germany

1 Background and Problem Statement

Germany bears a heavy legacy: After more than 150 years of use of military training areas and the events of World War II, large parts of the country are contaminated with unexploded ordnance (UXO), with the result that fire departments treat these areas as restricted zones in the event of a wildfire. The state of

Brandenburg alone is the hardest hit, with approximately 560,000 hectares of land suspected of containing unexploded ordnance (about 20% of the state's total area); about 290,000 hectares of this are forest.

According to an analysis by the Thünen Institute, the ten largest wildfires in Brandenburg since 2002 have *all* occurred on areas contaminated with munitions, covering a total of over 3,300 hectares. In 2019, 851 hectares of forest were lost solely due to the spontaneous combustion of old munitions. This accounted for just under 63% of the state's total wildfire area that year. The link between the presence of munitions and large-scale fires is clear. Former military training areas with pine stands, heathland, and grass also provide vegetation structures that facilitate rapid fire spread. Comparable problems exist in Mecklenburg-Western Pomerania, Saxony, Saxony-Anhalt, and Lower Saxony— and on a dramatically larger scale in post-conflict areas such as Ukraine and Syria.

The tactical response to date has essentially consisted of a passive standdown and defensible approach: When UXO contamination is suspected, emergency responders maintain a safety distance of 1,000 meters. Under “cover”—a term that has never been clearly defined in tactical terms—approaches of up to 500 meters are permitted. In practice, this leads to two equally unsatisfactory responses: Either fire departments stand on the sidelines and wait until the fire spreads to an uncontaminated area, or emergency responders break the distance rule and put themselves in unacceptable danger. Neither is a strategy. With the *UXO Fire Management Toolbox*, the WKR Initiative has developed a catalog of measures and strategies that resolves this dilemma through procedures and technology that function without putting people in the danger zone.



Photo: L. Pronto, 2022, Gorischheide, Brandenburg, and the Free State of Saxony (signage in the burned area indicates “**Danger of Death – Do not Enter!**”)

2 Legal and Operational Framework

This technical recommendation deliberately operates *within* the existing legal framework in Germany. Fire protection and emergency response are matters of state jurisdiction; the relevant regulations are the state fire and disaster protection laws, the ordnance regulations or decrees, the jurisdiction of the ordnance

disposal services (KMBD), as well as the accident prevention regulations (DGUV) and fire department service regulations, in particular *FwDV 500*, for hazardous situations involving explosives. These regulations unequivocally stipulate: People must not be deployed in fire areas suspected of containing unexploded ordnance. This safety doctrine is not to be undermined.

The key premise is understanding that where people are not permitted to work, does not mean that *nothing* can be done, but rather that work must be carried out **unmanned** or from **armored** vehicles. Remote-controlled systems do not violate safety distances; the operator remains outside the danger zone or from a protected vantage point, while the machine operates in the contaminated area. Tactical burning is also legally feasible but requires approval or coordination with lower-level forestry, nature conservation, and law enforcement authorities in accordance with state law.

UAV-assisted ignition also fits within this framework: Aviation law already provides for exemptions for drone flights conducted on behalf of or under the supervision of authorities and organizations with security responsibilities (BOS), and the use of tactical fire is within the authority of the incident commander when deployed. No new legal foundations are required; rather, coordinated operational procedures, approval processes, and qualified personnel are needed.

3 Critical Assessment of Current Practice

The WKR initiative expressly acknowledges the dedication, efforts and achievements of emergency responders who improvise under the most difficult conditions. Criticism is not directed at fire departments, but rather at strategic disincentives and resource allocation. Three points deserve honest consideration:

3.1 Use of Helicopters: High Costs, Limited Effect

In UXO-contaminated areas, aircraft problematically are often seen as one of the only remaining options making them a default response, even though their effectiveness is very limited. They are also beholden to the same 1000m safety radius. External buckets holding a few hundred to 1,000 liters of water can temporarily dampen advancing fire fronts and provide localized protection, but they neither extinguish deep-seated smoldering fire embers in the duff layer nor sustainably halt the spread of fire. A significant portion of the water dropped from high up evaporates or fails to reach the ground in quantities sufficient to extinguish the fire (e.g., and/or fails to penetrate the canopy). Helicopters are dependent on weather and daylight, logistically complex, and extremely expensive, with flight hour costs in the four- to five-digit euro range per hour. Without ground forces or equipment to convert the time gained into a containment line, the effect is wasted. The operation becomes an expensive delaying tactic with high symbolic value to the public but little contribution to actual fire control. Air support has its place as a precisely deployed tool to support ground operations, not as a substitute for them. Airborne firefighting offers real added value particularly in the context of a very rapid initial response to a fire in its early stages—that is, within the first few minutes, not on the third day of the operation.

See also the WKR Technical Recommendation: ***Aerial Wildfire Suppression***.

3.2 Sprinkler Lines and Firebreaks: Water as a Scarce Resource

Stationary circular sprinkler lines and sprinkler corridors have proven effective as defensive measures to protect specific assets (e.g., infrastructure corridors) and can continue to operate even if ground crews must withdraw. However, they are unsuitable as a widespread strategy against large-scale fires. They tie up enormous amounts of water and require extensive logistics (long transport distances, buffer tanks,

pump chains) in landscapes such as in Brandenburg's sandy pine forests far from the water sources, where firefighting water is already the limiting factor. Furthermore, wind, high temperatures, low humidity, and readily available fuel further limit the effectiveness of indiscriminate wetting of the vegetation. The protective effect ends where the irrigation ends; the fire is at best diverted or delayed, not stopped. In dry years, the massive use of water also competes with drinking water supplies, agriculture, and the natural ecosystem. Water should not be used on UXO sites as a blanket substitute for a containment strategy, but rather in a targeted and economical manner to secure control lines and protect specific objects.

3.3 Misallocation of Public Funds

In recent years, substantial public funds have been channeled into reactive firefighting capabilities such as flight hours, vehicle fleets, and large-scale exercises, while measures with the proven best cost-benefit ratio remain chronically underfunded: addressing the shortage of skilled workers, nature-based approaches, proactive fuel load management, firebreaks and buffer zones, explosive ordnance disposal along strategic lines, and unmanned technology. A single major fire on contaminated land often results in operational, recovery, and ecosystem costs running into the tens of millions. Investing a fraction of that amount in prepared control lines and *UXO Fire Toolbox* technology prevents major disasters from occurring in the first place or shortens their duration from weeks to days. Prevention and preparedness over expensive traditional firefighting equipment must be a priority dictated by both economic and operational necessity.

4 The WKR UXO Fire Management Toolbox

The UXO Fire Toolbox is a modular, predominantly unmanned suite of measures for proactive fire management in areas contaminated with unexploded ordnance. It has been under development since 2015 and assembled through the WKR Initiative in collaboration with partners, notably *DOK-ING – Rheinmetall Unmanned Vehicles*, demonstrated live in Croatia in 2022, in Brandenburg in 2023, partially adopted by the State of Brandenburg (procurement of mine clearance vehicles, firefighting armored vehicles, and command vehicles), and presented internationally, including in Kyiv in 2025, and in 2026 at *Interschutz* in Hanover, at the Ukraine Mine Action Partner Coordination Workshop in Geneva, and at the NATO EnviroSec Conference in Sofia. It combines high-tech and low-tech solutions throughout the entire prevention–preparation–response chain:

- **Risk and fire analysis:** Prioritization of prevention, analysis of at-risk areas, and prediction of fire behavior based on fuel, topography, and fire weather data; satellite-based information systems (e.g., OroraTech) and fire spread simulations provide the situational picture for resource-efficient decisions such as which lines to hold and which areas to abandon, before and during suppression operations.
- **Remote-controlled multi-purpose mine-clearing vehicles (e.g., MV-4):** Establishment of explosive-cleared, mineralized control lines and anchor points in the contaminated area; the core tool for direct attack through unmanned fireline construction in the danger zone (see Section 5).
- **Remote-controlled fire trucks / tracked firefighting vehicles (e.g., MVF-5):** Armored, unmanned water delivery to secure the lines and protect critical objects within the danger zone.
- **Armored command vehicle (e.g., Triton):** Mobile, protected command-and-control station at the edge of or inside the hazard area — operator station for the remote-controlled clearance and firefighting units (MV-4, MVF-5) and communications hub integrating live UAS feeds. Enables command of the unmanned operation from a protected position, shortens remote-control distances and allows line-of-

site where feasible. This closes the gap between mandatory stand-off distances and effective on-scene incident command.

- **Airborne reconnaissance (drones / UAS with live video and thermal sensors):** Real-time situational awareness, detection of smoldering hot spots, and monitoring of fire suppression effectiveness, without endangering personnel above or on the ground.
- **Tactical Fire (Counterfire / Burn-out):** From the secured control line, fuel is systematically deprived from the fire through tactical fire; the combination of the control line and fuel deprivation is the only reliably effective tactic. This can be achieved through precise, GPS-guided aerial ignition (*UAV-based Aerial Ignition*) along predefined control lines.
- **Prepared Infrastructure:** Pre-cleared anchor points and line corridors (e.g., every 50 to 500 hectares, depending on the area), up-to-date operational maps with fire risk zoning, water intake points for firefighting, and defined handover points to the appropriate authorities like UXO-clearance.
- **Preventive fuel load management (prescribed burning, grazing, mechanical maintenance, rewetting, forest restructuring, etc.):** Reduction of fuel load in strategic areas (see Section 6).

5 Direct Attack: Control Lines with the MV-4

A wildfire is most effectively stopped once its fuel source has been removed. Water cools and slows the fire, but a line cleared down to the mineral soil **stops** its spread. On uncontaminated areas, this is accomplished by plows, bulldozers, or manual crews; on UXO-contaminated areas, however, this crucial step has been impossible until now. The remote-controlled mine clearer DOK-ING MV-4 closes this gap:

- **Built for the worst conditions:** Weighing only about 6 metric tons, this tracked vehicle is designed to withstand detonations from antipersonnel mines and similar munitions and has been proven to survive the detonation of anti-tank mines. Detonations during fire suppression operations need not lead to aborting the mission as this equipment is designed to withstand them. The MV-4 has proven itself for years in Ukraine, Iraq, Azerbaijan, Saudi Arabia, and across 40 other countries.
- **Unmanned and therefore compliant with regulations:** Remote control over distances of up to 1,000–2,000 m keeps the operator outside any danger zone. The 1,000-m safety distance for people is maintained while work is being carried out within the no-go area.
- **High-performance:** A flail works the soil to a depth of approximately 30 cm across a width of 1.8 m, destroying and or detonating ordnance in a controlled manner without damaging the machine. In a single pass, the MV-4 creates a fuel-free strip to mineral soil and has an area coverage of up to 2,200 m² per hour.
- **Quick to Deploy:** Transport via standard truck; no special permits required. The equipment can be deployed across state lines to the site within a few hours if logistics are arranged in advance.

This makes a **direct attack** on areas contaminated with munitions possible for the first time. The machine operates from an anchor point along the flank working toward the head of the fire and establishes a *containment line* where the spread stops, rather than merely slowing it down with water or hoping for favorable weather. In combination with tactical fire (burning out the space between the line and the main fire) and unmanned water delivery (MVF-5) to secure the line, a closed, unmanned operational chain is created. This combination that was demonstrated in Brandenburg in 2023 and led to the state's procurement of the remote-controlled, protected technology. The recommendation of the WKR Initiative is clear: The MV-4 should be a standard component of hazard mitigation planning in every region with a relevant UXO landscape, complete with clear deployment, alert, and training concepts.



Photos: N. Barth. Preventive establishment of control lines by the MV-4, Brandenburg, 2025.

Rule of Thumb

Water slows it down. Depriving it of fuel stops it. Every tactic employed in UXO areas must be evaluated based on whether it contributes to a robust, cleared control line. Measures that do not do so are merely timesaving and must be planned, justified, and limited as such.

6 Acting Before the Crisis: Controlled Burning in Strategic Areas

The most effective firefighting, however, takes place well before a fire breaks out. On areas contaminated with munitions, layers of litter, grass, heathland, as well as deadwood, accumulate over decades due to a lack of management which create enormous fuel loads that can turn any small low-intensity fire into a major incident. Mechanical maintenance across huge areas is generally not feasible on contaminated areas, and clearing the entire area is financially unfeasible for generations. **Prescribed burning** is one option among many, but most often the most effective scalable tool for reducing fuel loads.

Under defined weather and fuel conditions, with proper authorization, qualified personnel, and safety measures provided by unmanned “Toolbox” technology, strategic areas, linear corridors, buffer zones around settlements and infrastructure, and firebreak areas can be burned in a targeted and low-intensity manner. The result is a reduced fuel load, well-maintained open-land and heathland habitats (nature conservation synergy), and, in the event of a fire, prepared areas where fire intensity is reduced. This effect

has been demonstrated repeatedly, for example during the fires near Jüterbog, where fires in low-fuel buffer strips extinguished themselves. Fire use for the purpose of nature conservation, has been conducted on contaminated sites across Germany since 2010, and several states have demonstrated that this approach is permissible and can be safely implemented. The WKR Initiative recommends transitioning this practice from pilot projects to a systematic, cross-state program with a solid legal and financial foundation, including training aligned with international standards (*“Ignition Specialist”* and *“Burn Boss”*) and firm integration into the states’ wildfire protection strategies.



Photo: L. Pronto, 2022. Controlled burning in Gartow, Lower Saxony.



Photos: L. Pronto (left), 2025; J. Baumann (right), 2026; targeted grazing in Brandenburg

7 Recommendations for Action

- 1. Mandatory mapping and zoning of UXO areas:** Uniform contamination zoning across states as the basis for all operational and prevention planning. Keep operational maps digital and up-to-date at command centers, fire departments, forestry agencies, and demining authority. Link these maps to satellite-based situational data and fire spread simulations, so that munitions contamination, fuel, topography, weather, and expected fire behavior are integrated into a single situational overview.
- 2. Establish control line infrastructure in advance:** Create anchor points and line corridors cleared of explosive ordnance at intervals of 50 to 500 hectares, prioritizing areas along paths, buffer strips, and around settlements and infrastructure; ensure long-term funding for maintenance.
- 3. Procure and deploy unmanned ground technology:** Remote-controlled clearance vehicles (MV-4 class), unmanned fire extinguishing vehicles, and command units as state or federal resources with a regulated supraregional alert system, following the Brandenburg model. Enable interagency use in both prevention and suppression operations.
- 4. Update the operational doctrine:** Retain the 1,000-meter rule for people but supplement it with a mandatory unmanned operational concept. “Keeping a safe distance” must no longer mean “doing nothing.” Institutionalize training and continuing education (operators, tactical firefighting, drone operation etc.).
- 5. Establish controlled burning and grazing as standard tools:** Establish legally sound procedures in the states, qualified personnel, and a fixed land-use program for strategic fuel reduction on UXO sites.
- 6. Reallocate funds and measure impact:** Subject public spending on aircraft and water logistics to an honest cost-benefit analysis and redirect the freed-up funds toward prevention, frontline infrastructure, and unmanned technology. Metrics for success must move away from how much water was supplied and concentrate on preventing disaster fires and deploying effective fire suppression measures when needed. Fire spread simulations and fire weather forecasts form the basis for decision-making regarding a resource-efficient deployment strategy and inform which lines can be held and where the effort, benefit, and risk are disproportionate.



Photos: Drone Amplified. Precise, GPS-guided aerial ignition with *Ignis Drone Amplified*.

8 Conclusion

Wildfires in UXO-contaminated areas are the unresolved core problem of German wildfire prevention and response, as nearly all problematic fires over the past two decades fall into this category. The tools to break this deadlock exist, have been demonstrated, and, in some cases, have already been procured. What is missing is a consistent strategic decision: moving away from a purely reactive, costly approach of slowing fires with water and helicopters, toward stopping fires through munitions-cleared control lines, unmanned technology, and preventive, proactive fuel load management. Every summer without deploying international good-practice and proven technology will result in lost forest cover, infrastructure, extremely high costs, and, in the worst case, human lives.

Key messages of these recommendations for action

- At least **700,000 hectares** of forest and open land in Germany are considered so contaminated with unexploded ordnance that, in the event of a fire, they are effectively off-limits to emergency responders. The standard operating procedure is, in effect, a “let it burn” protocol: a 1,000-meter safety distance, or a loosely defined 500 meters with “effective cover”.
- **Prioritization requires assessing risk:** Satellite-based situational data, fire weather conditions, and fire spread simulations determine which lines to hold and which areas to abandon—they form the basis of any resource-efficient deployment strategy, both before and during the operation.
- Water-based tactics (helicopters and largescale sprinkler systems) can **slow** fires in UXO-contaminated areas **but cannot stop them**. A vegetation fire can only be reliably stopped by removing the fuel source.
- Remote-controlled mine-clearing vehicles such as the **DOK-ING MV-4** make it possible for the first time to directly tackle areas contaminated with munitions: They establish munitions-cleared, mineral soil control lines, without putting people in the danger zone. Armored command platforms and other unmanned vehicles or drones can expand tactical suppression options.
- **Fire management must not begin only after an incident occurs: prescribed burning and targeted grazing** in strategic areas reduce the fuel load and are already proven practices in several federal states and is international good practice. Site adapted targeted grazing, rewetting, burning, and forest restructuring all enable active fire management and safer operational conditions.
- Public funds must be directed where they have the greatest impact: toward building technical expertise, prevention, fire control infrastructure, and unmanned ground technology— not primarily toward media-friendly but largely ineffective flight hours and water logistics.



Photo: L. Pronto, 2022. Post-fire regeneration—Jüterbog Military Training Area, Brandenburg.

Sources and further information

- at-fire: *Technical Recommendations*. <https://www.at-fire.de>
- Cimolino, U. (2019): *Operations in Areas Suspected of Containing Munitions*. BRANDSchutz, 11/2019, W. Kohlhammer. <https://shop.kohlhammer.de/einsatze-bei-munitionsverdachtsflächen-978-3-00-424239-3.html>
- DBU Naturerbe (2023): *Controlled Burning for Heathland Management on an Area Contaminated with Munitions, Marienfließ*. <https://www.dbu.de/en/news/heidepflege-auf-munitionsbelasteter-flaeche/>
- European Commission (2026): *Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee, and the Committee of the Regions: Integrated Wildfire Risk Management*. COM (2026) 330 final, Brussels, March 25, 2026. https://ec.europa.eu/echo/files/civil_protection/communication_on_integrated_wildfire_risk_management.pdf
- European Union (2019): *Implementing Regulation (EU) 2019/947 on rules and procedures for the operation of unmanned aircraft*. https://eur-lex.europa.eu/eli/reg_impl/2019/947/oj
- FNR Forest Thematic Portal (2025): *Unexploded Ordnance and Wildfires—An Explosive Challenge / ERWIN Project*.
- Forst & Technik (FT) (6/2023): *Remote-Controlled*. Available online as a PDF via the WKR Initiative – Fire · Climate · Resilience. https://www.waldbrand-klima-resilienz.com/files/ugd/bf6978_5eb82ed415874f14acf7bfb1b6769f4b.pdf
- Goldammer, J. G., Brunn, E., Held, A., et al. (2012): *Controlled burning for the management of dwarf shrub heaths (Calluna vulgaris) on areas contaminated with munitions—pilot project at the “Heidehof-Golmberg” nature reserve, Teltow-Fläming district*. <https://gfmcc.online/globalnetworks/seeurope/Prescribed-Burning-on-UXO-terrain-Germany-2012.pdf>
- Held, A. (2025): *Forest Fires on Areas Contaminated with Explosive Ordnance – The Hidden Danger*. Security Network, Interview.
- Held, A. and Pronto, L. *Remote-controlled*. Forst & Technik (FT) (6/2023): Available online as PDF via WKR-Initiative – Fire · Climate · Resilience. https://www.waldbrand-klima-resilienz.com/files/ugd/bf6978_5eb82ed415874f14acf7bfb1b6769f4b.pdf
- Brandenburg State Explosive Ordnance Disposal Service / Central Police Service: *Annual Reports on Explosive Ordnance Contamination*.
- State Forestry Competence Center Eberswalde (LFE): *Forest Fire Statistics for the State of Brandenburg*. <https://forst.brandenburg.de/lfb/de/ueber-uns/landeskompetenzzentrum-lfe/>
- Rheinmetall Unmanned Vehicles (Doc-Eng): *Technical information on the MV-4 and MVF-5*. <https://dok-ing.hr>
- Thünen Institute (n.d.): *Forest Fires and the Role of Military Contaminated Sites in Forest Areas*.
- UAG Training and Tactics of the BLoAG National Forest Fire Protection. *Recommendation on Training Content for Vegetation Firefighting*. May 2026 version. https://www.waldbrand-klima-resilienz.com/files/ugd/bf6978_b49cebc81aa7471fb5c1bc470ca0f250.pdf
- WKR Initiative – Fire · Climate · Resilience: *UXO Fire Toolbox*. <https://www.waldbrand-klima-resilienz.com/uxofiretoolbox>
- WKR Initiative – Fire · Climate · Resilience (7/2023): *Resilience Through Wildfire Prevention in Forest Management. Practical Guide*. https://www.waldbrand-klima-resilienz.com/files/ugd/bf6978_0d327ce13dad4dae8d814e8ea4b06382.pdf
- WKR Initiative – Wildfire · Climate · Resilience: *Technical Recommendations*. <https://www.waldbrand-klima-resilienz.com/fachempfehlung>
- WKR Initiative – Fire · Climate · Resilience: *Supplementary PDF Document*. https://www.waldbrand-klima-resilienz.com/files/ugd/bf6978_5d4d45bd7762419ba7a9c68eba22aed4.pdf

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Disclaimer

These recommendations are intended to provide technical guidance and do not replace a situation-specific risk assessment, operational planning, official decision, or legal review. Their application is the sole responsibility of the competent authorities, incident commanders, and decision-makers. In areas suspected of containing munitions, the applicable legal requirements, safety distances, operational regulations, and the directives of the responsible explosive ordnance disposal services and hazard mitigation authorities are binding. This recommendation does not constitute official guidance over operational measures, procurements, or cost decisions by relevant authorities.

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Appendix – Operational Strategy

