

Soil after War as a Configurational Object of the Military Ecotone

Protocol for Developing a Theory for the Study of Soil Transformed by War

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Protocol status

This document records the development of a theory for studying soil transformed by war from the position of the theory of military ecotones. It continues two previous protocols. The first explained why a conference on war, soil, and freshwater contained no independent papers on affected soil. The second showed how a theory's right to empirical testing is limited by the organisation of science, standards, and access to territory, data, and laboratory infrastructure. This third protocol turns to the object itself: what the soil of a military ecotone is, when it arises, which processes must be seen within it, and how its study should be organised.

The document is neither a transcript nor a conventional scientific article. It preserves the development of thought, concepts introduced, long operational lists, examples, rejected substitutions, transitions between questions, boundaries of the theory, and questions that remain open. Its purpose is not to reduce the discussion to a convenient format, but to create a detailed foundation for future articles, talks, presentations, field programmes, and information systems.

Language of the discussion

The original discussion and the approved protocol were prepared in Russian. The present version is the closest possible English translation and preserves the meaning without academic normalisation. The translation must not change the object, soften conclusions, remove inconvenient concepts, or replace direct formulations with familiar academic fog.

Abstract

The protocol defines soil after war as a configurational object and as a component of a military ecotone. Soil becomes the soil of a military ecotone not when a particular military pollutant is detected in a laboratory, but when a war-induced change in the regime of a territory alters the conditions of its functioning, development, use, observation, and relations with other natural and anthropogenic systems. Military chemical pollution is an important but particular case of this transformation. The object is formed by the combination of pre-war history, military activity, functional inversion of the territory, addition of new substances and energy, destruction, cessation of previous impacts, reorganisation of land use, changes in water, biota, and human presence, and the subsequent trajectory. The protocol introduces a system of concepts for describing this object, proposes eight groups of indicators, a polygon-based research architecture, hypothesis–evidence relations, experimental and field testing tracks, and a specialised expert–AI information system. The final research result is defined as an open dynamic profile of soil as a component and active medium of the military ecotone. Standards, administrative permissions, and public perception are treated as separate layers that must not replace the real condition of the object.

Keywords

soil after war; theory of military ecotones; configurational object; soil science of military ecotones; infectious soil science; change in territorial regime; functional inversion; war-induced discontinuity; accumulated soil transformation; taxonomic inertia; pollution stratigraphy; parametric asynchrony; critical residual parameter; polygon; micropolygon; hypothesis–evidence relation; environmental causal chain; open dynamic profile; expert–AI

1 The place of the third protocol in the overall sequence

The earlier materials on war and soil contained a strong core. They already included object-oriented reconstruction of knowledge, a distinction between publications and knowledge, an understanding of war as a regime of transformation, four elementary types of change, the evidentiary statement as the

unit of analysis, and the idea of an open knowledge architecture. The weakness was not an absence of content, but an absence of introduction. They did not show why the object almost disappears from open scientific discussion or why a familiar discipline receives the right to define in advance the boundaries of what exists.

The first protocol established the institutional problem. The scientific community may be prepared to carry out funded projects but not to discuss openly whether the object has been defined correctly. The second protocol established the metascientific problem. A theory may be declared unproven while being denied access to the conditions of testing. The present protocol uses these conclusions but does not repeat them in place of studying soil. Its task is to define the object and construct a research logic.

The first protocol explains why the object is hidden. The second explains why a new theory may be denied the right to testing. The third defines the object itself and the way to study it.

2 Initial theoretical position

The initial position is declared openly: soil affected by war is considered through the theory of military ecotones. This position narrows the view but makes it consistent and testable. It is not declared neutral or final. Other theories have the right to construct their own models and conduct their own research. Theoretical diversity means not equality of truth, but the right of a formulated theory to receive its own empirical testing.

A military ecotone is understood as a natural–anthropogenic system arising from a change in the regime of a territory initiated by war. A human starts the process, but the subsequent transformation develops within natural and human-made systems and does not fully obey human intentions. The theory does not address the moral justification of war, motives for using weapons, or distribution of political blame. It describes the object that has arisen in reality.

Nature does not read human books. It is indifferent to how the scientific community classifies a process and what it prefers not to discuss.

3 When soil becomes the soil of a military ecotone

Soil becomes a component of a military ecotone at the moment the territorial regime changes. Its beginning is not defined by the mandatory presence of a particular substance. War changes the functions of the territory, the character of human presence, land use, mechanical impacts, the water regime, vegetation, biological communities, sources of substance input, transfer pathways, and the possibilities of observation and control.

The soil of a military ecotone is soil whose development, functioning, or use has been incorporated into a new territorial regime created by war.

Military chemical pollution is possible but not obligatory. A population may leave agricultural land because of shelling, occupation, or the threat of violence. Cultivation stops, reclamation systems cease to be maintained, artificial water bodies become overgrown, and vegetation and the water regime change. Soil develops differently even if no specific military pollutant has yet been detected.

Four dates must be distinguished: the beginning of the wartime change in regime; the appearance of a particular transformation; the moment of scientific recording; and the moment of administrative recognition. They almost never coincide. The object arises before science begins to see it.

War first changes the territorial regime. Soil processes then change. Still later, the scientific community records individual consequences. The beginning of observation is not the beginning of the object.

4 Soil is never empty at the outset

Research never begins with virgin soil. By the beginning of a war, a territory already has a long natural and human history. It may include natural geochemical heterogeneity, long-term agriculture, fertilisers, pesticides and herbicides, industrial pollution, land reclamation, erosion, compaction, urbanisation, construction, and traces of earlier wars.

The detection of a substance after war begins therefore does not yet prove its military origin. But the absence of a completely new substance also does not prove the absence of military transformation. War may change the concentration of an existing substance, its chemical form, mobility, bioavailability, spatial distribution, transfer pathway, or incorporation into the food chain.

Accumulated soil transformation

Accumulated soil transformation is the cumulative result of successive natural, economic, industrial, and military changes that form the present condition of the soil system. A new war does not erase earlier layers. It enters an existing configuration and creates new interactions.

Taxonomic inertia of soil

Taxonomic inertia of soil is the retention of an earlier classification name after substantial change in the real characteristics, functions, and trajectory of the soil system. A territory continues to be called chernozem although the actual object has changed for decades under the effects of agriculture, erosion, chemicals, changes in water, industry, and wars. The name conveys origin and taxonomic position but does not guarantee preservation of the present condition and functions.

A similar problem is known in landscape science. A map marks forest-steppe, while in reality the researcher sees fields, roads, settlements, industrial infrastructure, and altered vegetation. The formal category continues to exist after the object has been transformed. For soil this substitution is especially dangerous because the word ‘chernozem’ creates a false sense that the object is already understood.

5 Soil as a configurational object

Soil after war is not defined by one pollutant or one indicator. Its condition is formed by a configuration of pre-war history, military activity, change of functions, addition of substances, structural destruction, cessation of previous impacts, reorganisation of land use, changes in water, biota, and human presence, and subsequent use.

Configurational object is an object whose condition is determined by a historically formed combination of impacts, relations, functions, and trajectories rather than by one isolated indicator.

Physically, the same genetic soil may remain before the researcher. The scientific object becomes different because the system of impacts and relations has changed. War does not necessarily create a new natural body. It creates a new condition and a new configuration of the soil system.

6 Soil as part of a military ecotone

A military ecotone cannot be reduced to polluted soil. Soil likewise cannot be dissolved into an excessively broad concept of the military ecotone. The relation can be formulated more precisely: a military ecotone is a system created by a change in the regime of a territory, while soil serves as one of its material carriers, archives, active media of transformation, and channels of subsequent transfer.

Soil simultaneously performs several roles:

- the space in which a military event occurs;

- a material carrier of the military trace;
- an archive of successive natural, economic, industrial, and military impacts;
- a medium of chemical, physical, and biological transformation;
- a component of a causal ecological relation;
- an accumulator and secondary source of substances;
- an intermediary between a pollutant, water, plant, animal, and human;
- a source of future exposure when land use changes;
- a medium in which a process remains latent and may be reactivated.

Soil is the stage on which the process unfolds, but at the same time it changes the process itself.

7 Soil science of military ecotones

The study of soil in a military ecotone is not an expanded version of traditional soil science. It is an interdisciplinary study of a complex ecological process in which soil is one of the main material carriers and active participants.

Soil science of military ecotones is a problem-oriented field that studies soil as a component, carrier, and active medium in the transformation of processes initiated by a change in the territorial regime during war.

This field uses methods of ordinary soil science but does not inherit its subject boundaries. Its questions are not limited to soil type, fertility, conformity with standards, or the possibility of returning land to agricultural use. It asks what role soil plays in the military ecotone, what it preserves, what it transforms, what it transfers to other media, which processes remain latent, and under which conditions they are reactivated.

By origin, this is not a continuation of classical genetic soil science. It may use accumulated knowledge and methods, but it has a different object and a different logic. Research begins where the exclusive competence of traditional soil science ends.

Infectious soil science

Infectious soil science is considered a field within infectious ecology. Its object is not only the presence of pathogenic microorganisms in soil. It studies soil as a natural environment of microorganisms with pathogenic properties; physicochemical signals capable of changing their state; the emergence of pathogenic ecotones; interactions between pollutants and microorganisms; the spatiotemporal dynamics of dangerous configurations; and the path from environmental change to an infectious process.

Hydrology requires an analogous reconstruction. Water in a military ecotone is considered not only as a resource or a solution containing a concentration of a substance, but as a carrier, a medium of chemical transformation, an environment of microorganisms, a physicochemical signal, and a connecting link between soil and organism.

8 Change of regime and four elementary transformations

War creates its own logic of territory. Military effectiveness is connected with destruction, disruption of functions, and maximisation of harm. This logic collides with the logic of former development: growing food, living, production, water supply, transport, and protection of health.

Functional inversion

Functional inversion is a change in the primary function of a territory under the influence of a military regime. A field becomes a defence line, a road becomes a military logistics route, an

enterprise becomes a target, a reservoir becomes an instrument of impact, and a settlement becomes a territory of fear. Some military facilities are created but never used. Their existence still changes access to and the regime of the territory.

War-induced discontinuity

War-induced discontinuity is an abrupt change in the developmental regime of a territory and soil system that is causally connected with war. It may be expressed in destruction, pollution, cessation of land use, change in water, depopulation, or a combination of these processes.

Addition

New substances or energy enter the system: products of explosions and combustion, metals, fuel, technical fluids, debris, construction material, displaced sediment, and heat.

Destruction

Existing structures and processes are damaged: craters form, horizons are mixed, and compaction, fire, loss of vegetation, and destruction of drainage, canals, dams, and infrastructure occur.

Cessation

Previous impacts stop: cultivation, application of fertilisers and herbicides, irrigation, drainage, grazing, maintenance of water bodies, monitoring, and control. Cessation is not absence of a process. It initiates its own trajectory.

Reorganisation

Relations among people, land, and processes change: a territory is abandoned, militarised, made inaccessible, used differently, subjected to emergency recovery, or returned to economic use without understanding continuing relations.

9 How to demonstrate the inclusion of soil in a military ecotone

The date of a war establishes the moment of a possible regime change, but by itself it does not explain the condition of a particular soil. A relation must be demonstrated: war – change in the territorial regime – change in impacts and relations – observable soil transformation.

Membership is confirmed neither by the number of recorded changes nor by the obligatory presence of a unique pollutant. A demonstrable configuration of one or more significant parameters may be sufficient if their origin, temporal sequence, and role in changing the object are shown.

A military ecotone is confirmed not by the number of recorded changes, but by a demonstrable relation among war, regime discontinuity, and subsequent transformation.

10 System of indicators

Research requires an open set of indicators. It is not a universal normative list. Its composition is determined by the morphology of military activity, pre-war history, proposed relations, and the results of preliminary research. Eight groups form the initial system and may be expanded.

10.1 Change in land use

- cessation of cultivation;
- change in crops grown;
- cessation of grazing;
- relocation of agricultural production;

- mining;
- construction of defensive works;
- movement of heavy machinery;
- creation of depots, training grounds, and temporary roads;
- withdrawal of a territory from use;
- return of land to use without full investigation;
- change in ownership and actual control;
- uncontrolled or informal use.

10.2 Appearance and alteration of pollutants

- substances previously absent from the territory;
- increased concentrations of pollutants already present;
- change in chemical form;
- change in mobility and bioavailability;
- appearance of new mixtures;
- residues of explosive compounds;
- metals;
- fuel and technical fluids;
- combustion products;
- construction and military debris;
- substances whose origin has not yet been established;
- products of interactions between military and pre-war pollution.

10.3 Physical transformation of soil

- formation of craters;
- mixing of horizons;
- compaction;
- destruction of the profile;
- change in porosity;
- erosion;
- damage to vegetation cover;
- artificial microrelief;
- removal, displacement, or burial of the top layer;
- filling with debris;
- change in temperature and the freezing regime of local sites.

10.4 Change in the freshwater regime

- cessation or alteration of irrigation;
- destruction of canals, dams, and pumping stations;
- waterlogging or drainage;
- change in groundwater level;
- salinisation;
- entry of polluted water;
- cessation of drainage;
- transfer of pollutants between water and soil;
- overgrowth of artificial water bodies;
- change in water availability;
- emergency water supply and new water sources.

10.5 Biological changes

- change in soil microbiota;
- disappearance or appearance of organisms;
- change in vegetation cover;
- spread of invasive species;
- change in the pathogenic properties of microorganisms;
- disruption of organic matter decomposition;
- change in the interaction of soil with plants and animals;
- change in the abundance of vectors and reservoirs;
- appearance of new biological configurations.

10.6 Change in flows of substances

- new pathways of input;
- transport by wind and water;
- vertical migration through the profile;
- horizontal redistribution;
- incorporation into plants;
- transfer into feed and food;
- accumulation in organisms;
- secondary transfer during cultivation;
- re-release during fire, flooding, construction, or change in moisture.

10.7 Change in human presence

- depopulation;
- return of the population;
- change in settlement density;
- restriction of access;
- cessation of monitoring;
- disappearance of specialists and service organisations;
- change in methods of land use;
- appearance of military personnel, temporary workers, or new user groups;
- emergence of a territory of fear in which economic activity ceases without visible destruction.

10.8 Change in control and observability

- cessation of regular sampling;
- destruction of archives and laboratories;
- loss of pre-war time series;
- change in methods;
- closure of information;
- politically motivated classification of territory;
- study only of accessible sites;
- change in standards;
- exclusion of inconvenient indicators;
- loss of data provenance;
- replacement of a missing measurement with an administrative assumption.

The eighth group describes not the soil directly, but society's ability to know what is happening to it. Without this group, the origin of knowledge and ignorance cannot be understood.

11 Comparison before and after

The comparison must cover territorial regimes, not two accidental samples. It is necessary to distinguish the long pre-war history, the condition immediately before war, active wartime transformation, the period after hostilities cease, and the later trajectory when land use returns or changes.

The pre-war condition must not be idealised. An image of the territory as environmentally sound may be used to increase compensation from the aggressor. This does not remove responsibility for military impact. It requires demonstrating precisely what war changed without creating a convenient myth of lost perfection.

Empirical, documented, and normatively assumed conditions

When reconstructing the ‘before’ condition, it is necessary to distinguish:

- empirical condition – characteristics actually measured;
- documented condition – information preserved in reports, registers, archives, and publications;
- administratively recorded background – the condition recognised by regulatory bodies;
- normatively permissible condition – conformity with selected limits;
- unknown condition – characteristics for which reliable data do not exist.

Presumption of normative well-being

Presumption of normative well-being is an assumption that the condition of a territory is acceptable, based on the absence of officially recorded violations rather than on sufficient empirical research. Absence of claims, complaints, or prohibitions may be interpreted as evidence of conformity with standards even though no studies were conducted.

Normative reconstruction of the pre-war condition

Normative reconstruction of the pre-war condition is the replacement of missing or incomplete data about real soil with a normatively permissible image of its condition. The logical chain ‘no violation was recorded – no exceedances existed – the soil complied with standards – the condition was satisfactory’ is incorrect.

The absence of a recorded violation characterises the recording system, not necessarily the condition of the soil.

If pre-war measurements are absent, conformity with standards remains a hypothesis. Reconstruction must use old analyses, the history of production and land use, enterprise archives, remote-sensing materials, geochemical analogues, local studies, and residents' testimony. The unknown must remain unknown rather than be replaced by a standard.

12 Pollution stratigraphy

Pollution stratigraphy of a military ecotone is the reconstruction of successive layers and regimes of pollution superimposed on one territory. Before 2014, Donbas already had a long industrial and military history. New military pollution cannot be understood without earlier sources, transfers, control, and land use.

The destruction of an industrial source can simultaneously create acute military pollution and terminate chronic industrial pollution. War therefore does not merely add pollution. It changes the existing system of sources, transfers, control, and observation. The final indicator may increase, decrease, or change its origin.

13 Boundaries of the soil of a military ecotone

The boundary of a military ecotone is determined not by distance from the site of military action, but by the limits of the functional transformation it caused. Soil may have precise territorial boundaries: the outline of a crater, trench, minefield, fuel spill, destroyed enterprise, vehicle corridor, flooded site, or land parcel removed from use.

A precise boundary of an individual impact is not the complete boundary of the object. Substances, water, eroded material, biological changes, economic restrictions, and food spread from the local site. One object therefore has a set of boundaries:

- physical – the outline of direct mechanical change;
- chemical – the spread of a substance or mixture;
- hydrological – connection through surface water and groundwater;
- biological – transfer through microorganisms, plants, and animals;
- economic – change or cessation of use;
- boundary of human exposure – transfer through dust, water, food, and feed;
- informational – the limit of observation and documentation;
- normative – a line of permission or prohibition created by the regulatory system.

Carrier-dependent boundary

Carrier-dependent boundary of a military ecotone is the spatiotemporal limit of a process determined by a particular material carrier. Boundaries differ for soil, water, plant, animal, food product, and human. Ukrainian grain can carry consequences of a soil military ecotone far beyond the original territory.

Boundaries are dynamic and multidimensional. Some are recognised only after a long delay. Some may never be recognised because of the complexity of the ecological relation. They must be modelled rather than represented by one stable line on a map.

14 Time of the soil military ecotone

A soil military ecotone has no single universal end date. Physical, chemical, water-related, biological, economic, and informational parameters change at different rates. The end of hostilities, restoration of economic function, conformity with standards, and completion of an ecological process are different events.

Parametric asynchrony

Parametric asynchrony of a soil military ecotone is the mismatch in the rates and directions of change among different soil characteristics after the territorial regime changes. Visible destruction may be removed and yields restored while a persistent substance continues to remain and enter biological relations.

Critical residual parameter

Critical residual parameter is an indicator that continues to determine the environmental, functional, or sanitary significance of a territory after most other characteristics have normalised. Dioxin pollution is an example of a possible situation in which most of a territory appears restored while one class of compounds retains long-term significance.

A critical parameter must have a demonstrable relation to the wartime regime change, retain a significant effect, participate in continuing transfer or transformation, require special observation, or have the capacity for reactivation. Not every microscopic residue makes a military ecotone eternal.

States over time

- active state – military activity directly changes the soil;
- continuing transformation – the active impact has ended, but the processes initiated continue to develop;
- declining intensity – some parameters approach their former range;
- relict state – most signs have disappeared, but critical parameters remain;
- latent state – consequences exist but do not appear under current use or are not recognised;
- reactivated state – new land use, change in water, fire, construction, or a climatic event restarts the process;
- completed state – changes connected with war no longer determine the functions, exposure, and trajectory of the territory at the accepted scale of study.

Normalisation of most indicators does not mean that the soil military ecotone has ended.

15 Morphology of military transformation

Research parameters can be determined in advance in most cases. Military activity is usually documented: the locations of shelling, explosions, fires, destruction, flooding, vehicle movement, fuel storage, and defensive works are known. Substantial knowledge has accumulated about explosion products, munition materials, combustion products, mechanical changes, and transfer pathways.

The morphology of military transformation is constructed as a sequence: type of activity – source of change – form of input – spatial structure – transformation in soil – transfer pathway – possible exposure.

A programme does not begin from zero and must not be limited to a normative list. It is constructed from four sources: the morphology of military activity, accumulated knowledge, a preliminary model of the particular territory, and exploratory research. Uncertainty remains for new weapons, new mixtures, unexpected interactions with pre-war pollution, atypical migration, and new biological reactions.

The theory of military ecotones makes it possible to narrow the field of study on reasoned grounds without treating the initial narrowing as a final description of the object.

16 Polygon-based research architecture

Polygon-based research architecture for a soil military ecotone is a system of spatially and functionally connected polygons and micropolygon sites selected on the basis of the reconstructed morphology of military activity and intended to test specific causal relations.

Polygon

Research polygon is a territory containing a particular configuration of military activity, pre-war condition, land use, and subsequent transformation. It may be a site of intensive strikes, a fortification system, a destroyed enterprise, a flooded territory, an abandoned agricultural system, a fuel storage site, a minefield, or a territory of renewed land use.

Micropolygon

Micropolygon of a soil military ecotone is a local site within a polygon where detailed repeatable study of soil, water, biota, land use, and substance transfer is conducted. Scale is determined by the process, not by an administrative standard.

At a micropolygon, different depths can be studied, observations repeated, the centre and periphery of an impact compared, migration tracked, a laboratory indicator connected with a military event, and transfer into plants and products studied. A control site is likewise not automatically declared clean. Its history must be reconstructed.

Passport of micropolygon representativeness

- soil type and actual condition;
- pre-war history;
- morphology of military activity;
- proposed source;
- time interval;
- water regime;
- land use;
- substances measured;
- biological characteristics;
- conformity with experimental conditions;
- significant differences from the experimental model;
- permissible limits of extrapolation.

17 Information system of soil military ecotones

Research must be supported by a specialised relational database and GIS. AI is needed here not to write abstracts, but as a component of research infrastructure. The information system unites territorial history, military activity, polygons, micropolygon sites, observation points, samples, laboratory results, spatial models, hypotheses, and changes over time.

Units of the system

One universal unit is impossible. A linked set of several units is required:

- micropolygon – the primary spatial unit;
- military event or sequence of events – the historical unit of process origin;
- observation point – the precise location;
- sample – the unit of measurement;
- transformation process – the dynamic unit;
- hypothesis–evidence relation – the primary cognitive unit;
- evidentiary status – a characteristic of each link;
- model version – the history of changes in interpretation.

A sample without context states where, when, at what depth, by which method, and what value was obtained. It does not explain origin, boundaries, trajectory, relation to war, or significance for other media. A sample must therefore always belong to a micropolygon, a temporal section, and a relation being tested.

Functions of the expert–AI system

- integration of maps, images, data on munitions and destroyed facilities, photographs, testimony, and archives;
- formation of hypotheses about relations among source, substance, change, and exposure;
- identification of polygons and micropolygon sites;
- design of sampling points, depths, and timing;
- search for insufficiently represented variants;
- comparison of periods, horizons, territories, and methods;
- detection of gaps, contradictions, and anomalies;
- preservation of the reason for selecting each indicator;
- retention of rejected alternatives and reasons for rejection;
- recording refusals to conduct an experiment;
- maintenance of model versions;
- preparation of data for independent verification.

The expert defines the problem and is responsible for the theoretical position, quality of initial data, fieldwork, and conclusions. AI holds a large array of relations, detects contradictions, proposes tests, and preserves research memory.

The expert is responsible for meaning and the decision. AI ensures completeness of comparison, transparency of logic, and preservation of research memory.

18 From event to process

A military event initiates reflection but quickly ceases to be a sufficient unit of description. After an explosion or destruction, chemical transformations, migration, accumulation, decomposition, changes in biota, reorganisation of land use, latent persistence, and reactivation occur. Documentary information is partly lost, while the material trace passes into an altered form.

Material memory of a military event

Material memory of a military event is the preservation of information about military activity in altered properties of soil, relief, water, biota, and the spatial organisation of a territory after the original documents have been lost or become incomplete. Soil is an archive, but not an archive with ready-made labels. The trace must be interpreted.

Latent integration of the military trace

Latent integration of the military trace is the incorporation of consequences of military activity into the ordinary condition of a territory, in which the material effect remains but its origin disappears from observation and explanation. Over time, military transformation begins to be perceived as a natural background.

19 Hypothesis–evidence relation

A hypothesis–evidence relation is a formalised sequence of proposed processes in which each link has its own empirical foundation, evidentiary status, and method of testing. The primary object of testing in a complex process is not a publication or a sample, but the relation among source, medium, transformation, transfer, and consequence.

Example of an environmental causal chain: dioxin source – entry into soil or water – distribution and persistence – change in bioavailability – transfer into plants or animals – accumulation in an organism – impact on the reproductive process – developmental disruption – manifestation in offspring.

Each link has its own boundaries and may be established with a different degree of reliability. A researcher is not obliged to prove the entire chain at once. The researcher must show which links are supported, where a break exists, and which observation or experiment can change the status.

Environmental causal chain

Environmental causal chain is a sequence of transformations through which an initial substance or impact passes through natural media and leads to a remote ecological, infectious, physiological, or hereditary consequence. Soil and water are universal media through which a military event becomes a long-term process. They are not passive channels: they retain, transform, redistribute, and sometimes amplify an impact.

20 Field and experimental tracks

A complete body of information about a complex ecological process is unattainable. Even the amount of information lost is unknown. A hypothesis therefore does not arise from complete knowledge. It is

formed from recorded events, spatial coincidences, recurring morphology, known properties of a substance, anomalies, and gaps in the existing explanation.

Field track

The field track detects morphology, spatial relations, and real configurations. Polygons reflect the diversity of soil types and actual conditions, histories of land use, hydrology, and types of military activity.

Experimental track

The experimental track tests individual causal mechanisms under controlled conditions. For dioxin, it is possible to study persistence in different soils, changes in availability, transfer into water and plants, accumulation, dependence on dose and time, effects during critical periods of development, and manifestation of consequences in offspring. For the hypothesis of a physicochemical signal, changes in microorganism properties and virulence under particular environmental compositions can be tested.

An experiment does not reproduce the entire military ecotone. It tests the possibility of a particular mechanism and the conditions of its manifestation. The result returns to the GIS, is compared with micropolygon sites, and forms a testable expectation for a particular configuration.

Domain of transfer of an experimental relation

Domain of transfer of an experimental relation is the set of soil, hydrological, climatic, biological, and economic conditions within which a laboratory-established mechanism may reasonably be used to explain a field process.

An experiment establishes a mechanism. The system of polygons and micropolygon sites determines where and in what form this mechanism operates in a real military ecotone.

21 The right of a hypothesis to an experiment

Many causal hypotheses can technically be tested by ordinary means of chemistry, microbiology, toxicology, genetics, and experimental ecology. The principal barrier may lie not in the cognitive task but in the scientific community. If a relation contradicts the dominant paradigm, the experiment may be prevented from being set up.

Right of a hypothesis to an experiment

Right of a hypothesis to an experiment is the possibility of conducting a methodologically correct test of a theoretically grounded causal relation regardless of its conformity with the dominant paradigm. It is not a right to be recognised as true. It is a right to obtain data that allow the hypothesis to be confirmed, limited, or rejected.

Institutionally produced untestedness

Institutionally produced untestedness is a condition in which a testable hypothesis remains untested for a long time because of a disciplinary prohibition, lack of access to infrastructure, denial of funding, or prior classification of the question as unscientific.

Absence of confirmation after an experiment must be distinguished from absence of evidence caused by a prohibition on the experiment. Identifying them creates the paradox of forbidden evidence: the hypothesis is not recognised because it is unproven, and the evidence is absent because the hypothesis is not allowed to be tested.

22 Disciplinary assignment and interdisciplinary object

The problem of soil after war is usually assigned to soil scientists. The boundaries of their discipline are then turned into the boundaries of the object itself. A soil scientist may competently investigate part of a causal chain but does not have exclusive competence to assess a relation among a substance, microorganism, pathogenicity, disease, and hereditary consequence.

The place where a process is recorded does not determine the discipline with the exclusive right to explain it.

Research requires the participation of geochemistry, hydrology, microbiology, toxicology, epidemiology, medicine, genetics, geography, remote sensing, GIS, the history of military activity, and information systems. Organisation must follow the relation, not the administrative boundaries of faculties and institutes.

The paradox of disciplinary assignment is that a problem is given to soil specialists, while a hypothesis extending beyond soil science is declared meaningless not after testing but because it does not conform to the subject of the discipline. The object is again replaced by the subject.

23 Open dynamic soil profile

The final scientific result is an open dynamic profile of soil as a component and active medium of the military ecotone. This formula requires detailed operational content. The profile must include:

- the precise location and scale of the object studied;
- soil type and a description of its actual, not merely classificatory, condition;
- the long pre-war history of the territory;
- available empirical pre-war indicators;
- the boundaries of the unknown pre-war condition;
- the history of land use, industry, reclamation, and earlier wars;
- pollution stratigraphy;
- the date and content of the wartime regime change;
- the morphology of military activity;
- sources of physical, chemical, biological, and hydrological impact;
- addition, destruction, cessation, and reorganisation;
- functional inversion of the territory;
- change in human presence and access;
- physical transformation of profile and relief;
- chemical indicators and forms of substances;
- mobility and bioavailability;
- the condition of water and hydrological relations;
- biological communities and microbiota;
- change in pathogenic properties where such a hypothesis exists;
- pathways of transfer into air, water, plants, animals, and humans;
- the condition of land use and agricultural products;
- the boundaries of every process and every carrier;
- temporal trajectories of indicators;
- parametric asynchrony;
- critical residual parameters;
- latent processes;
- conditions of possible reactivation;
- hypothesis–evidence relations;
- results of field observations;
- results of laboratory and field experiments;

- domains of transfer of experimental relations;
- alternative explanations;
- the evidentiary status of each claim;
- data provenance and quality;
- methods and their limitations;
- information gaps;
- tests not conducted, rejected, or impossible;
- the history of revision of conclusions;
- the relation between the current version of the profile and earlier versions.

The profile remains open because the object continues to change, new data and methods appear, and individual hypotheses are confirmed or rejected. It is dynamic because it records not only a condition but also a trajectory.

24 Standards, the state, and public perception

Standards are established for a particular purpose and have their own aim and logic. They may be used as a separate layer of interpretation, but not as a replacement for the object. Reality is primary. Information is collected about reality and only about reality.

A standard is superimposed on the profile. It must not replace the profile.

The same empirical profile may be assessed differently under the standards of different states. The information system may show conformity with the standards of Ukraine, Czechia, Vietnam, or the absence of a standard, but the original indicators must remain unchanged. A change in law does not retroactively change the condition of the soil.

A state may adopt a standard and forget it, conceal data, change an admissible value, permit use of a territory, or commission a convenient expert assessment. This is political, legal, and institutional practice. The theory of military ecotones does not correct it and does not promise to do so.

Social normalisation of danger

Social normalisation of danger is the transformation of a long-term dangerous condition into a perceived everyday norm without an obligatory change in the natural process. Ideas about ‘splendid life’ in the Chernobyl zone, cheap land, or restored nature may exist independently of the empirical profile.

Becoming accustomed to danger does not mean that danger has diminished.

25 What the theory does and does not do

The theory does

- define the object;
- organise observation;
- formulate testable relations;
- establish a polygon-based architecture;
- connect fieldwork and experiment;
- create an open dynamic profile;
- preserve uncertainty;
- change the model when new data appear;
- make independent verification possible.

The theory does not

- establish standards;
- issue permission to use a territory;
- determine compensation amounts;
- guarantee enforcement of laws;
- replace public administration;
- fight corruption;
- correct public mythology;
- force people to make rational decisions;
- promise universal recommendations for all states and territories.

The theory of military ecotones creates an open dynamic profile of a real process. A state may use it, distort it, ignore it, or replace it with a normative fiction. These actions change nothing in the object itself and are not part of the theory.

26 Rejected substitutions

- a military ecotone is identical to military chemical pollution – rejected because regime change includes cessation, depopulation, changes in water and land use, and other processes;
- anything detected after war was automatically created by war – rejected because reconstruction of pre-war history and stratigraphy is required;
- absence of a recorded violation proves pre-war well-being – rejected as a presumption of normative well-being;
- soil type fully describes the present object – rejected because of taxonomic inertia and accumulated transformation;
- one sample describes a territory – rejected because a sample is a subordinate unit of measurement;
- one line defines the boundary – rejected because of carrier-dependent dynamic boundaries;
- normalisation of most indicators ends the ecotone – rejected because of parametric asynchrony and the critical residual parameter;
- a laboratory effect can be transferred universally to the field – rejected because a domain of transfer and a passport of representativeness are required;
- a soil scientist has the exclusive right to assess the entire process – rejected as a disciplinary substitution of the object by the subject;
- an untested hypothesis deserves no attention – rejected where the absence of testing is institutionally produced;
- a scientific result must end with the word safe or dangerous – rejected because this is already a decision within a particular regulatory regime.

27 System of concepts

Soil of a military ecotone. Soil whose functioning, development, use, observation, or relations are incorporated into a territorial regime created by war.

Configurational object. An object whose condition is determined by a historical combination of impacts, functions, relations, and trajectories.

Functional inversion. Change in the primary function of a territory under a military regime.

War-induced discontinuity. An abrupt disruption, causally connected with war, of the former developmental regime of a territory.

Accumulated soil transformation. The cumulative result of successive natural, economic, industrial, and military changes.

Taxonomic inertia of soil. Retention of a classification name after substantial change in actual characteristics and functions.

Pollution stratigraphy. Reconstruction of successive layers and regimes of pollution in one territory.

Profile of war-induced transformation. A documented configuration of changes in soil, water, land use, biota, and human presence after a regime change.

Carrier-dependent boundary. The spatiotemporal limit of a process determined by a particular material carrier.

Parametric asynchrony. A mismatch in the rates and directions of change among different parameters.

Critical residual parameter. An indicator that retains significance after most other characteristics have normalised.

Relict military ecotone. A condition in which most initial signs have disappeared but individual military processes continue.

Reactivation of a military ecotone. Renewal or intensification of a latent process when land use, water, climate, or another configuration changes.

Polygon-based architecture. A system of polygons and micropolygon sites selected according to the morphology of military activity.

Micropolygon. A local spatial unit of repeatable detailed research.

Passport of representativeness. A description of micropolygon conditions and limits on transferring results.

Hypothesis–evidence relation. A formalised causal sequence in which each link has its own status and test.

Environmental causal chain. The pathway of transformation of an impact through natural media to a remote consequence.

Material memory of a military event. Preservation of information about war in altered properties of a territory after documents have been lost.

Latent integration of the military trace. Incorporation of a consequence into the ordinary background while recognition of its origin is lost.

Domain of transfer of an experimental relation. The conditions within which an experimental mechanism applies to a field object.

Right of a hypothesis to an experiment. The possibility of methodically testing a grounded relation regardless of its conformity with the dominant paradigm.

Institutionally produced untestedness. Absence of testing caused by the organisation of science rather than technical impossibility.

Presumption of normative well-being. An assumption of good condition derived from the absence of recorded violations.

Normative reconstruction of the pre-war condition. Replacement of missing data with a normatively permissible image of the past.

Social normalisation of danger. Transformation of a dangerous condition into a perceived norm without a change in the process.

Open dynamic soil profile. A versioned system of empirical knowledge about the condition, relations, boundaries, and trajectory of the soil of a military ecotone.

28 Main conclusions

1. Soil becomes part of a military ecotone from the moment the territorial regime changes, not from the moment a particular pollutant is detected.
2. Military chemical pollution is a particular case of a broader transformation.
3. Soil after war is a configurational object formed by pre-war history, war, and the subsequent trajectory.
4. The name of a soil type does not replace research into its actual condition.
5. Soil is simultaneously a natural body, a medium of process, a material memory, and a link in a causal chain.
6. The study of soil in a military ecotone extends beyond traditional soil science.
7. A before-and-after comparison requires real data and reconstruction, not a normative image of pre-war well-being.
8. The boundaries of the object are multiple, dynamic, and carrier-dependent.
9. Different parameters recover asynchronously. One critical residual parameter may retain significance after most signs have disappeared.
10. The morphology of military activity makes it possible to select a substantial part of the research parameters in advance on reasoned grounds.
11. Polygons and micropolygon sites translate theory into precise, repeatable fieldwork.
12. The hypothesis–evidence relation, not a publication or individual sample, is the primary cognitive unit.
13. An experiment establishes a mechanism, while a system of micropolygon sites determines its domain of operation in reality.
14. A specialised expert–AI system must preserve data, relations, decisions, contradictions, and the history of changes in the model.
15. The final result is an open dynamic profile, not the administrative word safe or dangerous.
16. Standards, state decisions, and public mythology do not determine the properties of the object.

29 Open questions

- How can the transition from active to relict and completed states be described formally without an arbitrary date?
- How can the passport of representativeness be standardised without turning it into a new closed standard?
- Which minimum fields should the relational database and GIS of the first practical project contain?
- How should hypothesis–evidence relations be versioned and rejected explanations preserved?
- How should an institutional refusal of an experiment be documented as part of the history of knowledge?
- Which soil types and morphologies of military activity should be selected for the first pilot polygons?
- How should the soil profile be connected with profiles of water, biota, food, and health without losing the boundaries of evidence?
- How should international verification be organised when national standards do not coincide?
- Which elements of infectious soil science can be tested first?
- How should bodies of expert–AI protocols be published together with data without compromising the safety of people and territories?

30 Next stage

The next stage is not the immediate reduction of the text to an article. The author first reviews the present protocol and makes corrections. Separate publications may then be prepared from it: a theoretical article on the soil of a military ecotone; a method for polygons and micropolygon sites; a

specification for an expert–AI information system; a study on infectious soil science; a study of normative reconstruction of the past; and a conference abstract, presentation, and talk.

The earlier materials on war and soil are not discarded. They receive a new introduction and a new theoretical framework. Their object-oriented architecture, four elementary transformations, evidentiary statements, and knowledge statuses can be reworked on the basis of the present protocol.

Sources used directly in the discussion

Nikolaenko, Dmitry. 2024. Microelement Research of Pathogenic Ecotones as the Basis for a Scientific Explanation of Fatal Mass Infectious Processes in Keystone Biological Species. *Environmental Epidemiology* 18(3): 4–67. DOI: 10.13140/RG.2.2.26425.79209.

Nikolaenko, Dmitry. 2024. Why *S. t. Tatarica* and *Loxodonta africana* Periodically Die in Large Numbers from Pasteurellosis? Part 1. Morphological Hypothesis. *Environmental Epidemiology* 18(3): 4–30. DOI: 10.13140/RG.2.2.10512.83204.

Nikolaenko, Dmitry. 2024. Why *S. t. Tatarica* and *Loxodonta africana* Periodically Die in Large Numbers from Pasteurellosis? Part 2. Six Elephants and Two Paradigms. *Environmental Epidemiology* 18(3): 31–70.

Nikolaenko, Dmitry. 2024. Why *S. t. Tatarica* and *Loxodonta africana* Periodically Die in Large Numbers from Pasteurellosis? Part 3. The Theoretical Geography of Infectious Diseases. *Environmental Epidemiology* 18(3): 71–143. DOI: 10.13140/RG.2.2.20477.58085.

Protocol: Why Were There No Papers on War-Affected Soil at a Conference on War, Soil, and Freshwater Systems? Russian version 1.0, 2026.

Protocol: The Right of a Theory to Empirical Testing. Organisational and Metascientific Constraints on Research into Soil after War. Russian version 1.1, 2026.

Protocol for the Development of the Theory of Military Ecotones. Version 1.2, 2026.

War and Soil Systems: An Object-Centred Reconstruction of Knowledge. Conference abstract, analytical brief, presentation and twenty-minute script, 2026.

Changes from the previous version

First published version. The protocol was created as the third part of a sequential study of the institutional, metascientific, and specifically theoretical foundations for studying soil after war.

Statement of responsibility for the protocol

Artificial intelligence supported the discussion, proposed questions, formulated concepts, structured relations, and prepared the protocol text. The human author defined the initial theoretical position, provided examples and publications, accepted or rejected proposed concepts, refined the conclusions, and determines the final content after review. Responsibility for the published version of the protocol rests with the author.

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