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WAR IN THE AIR, MATH ON THE GROUND: ECOLOGICAL MODELING OF DRONE–FIGHTER JET ENGAGEMENTS

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Abstract: *In recent decades, assessments of military capability in armed conflicts have increasingly relied on intelligence gathered by specialized structures on both sides to estimate the probability of operational success. This study explores the application of the Lotka–Volterra differential equations to a contemporary configuration of modern warfare: drone–aircraft confrontation. The central hypothesis asserts that success in large-scale operations is significantly influenced by direct investments in drone and aircraft production capacities. The objective is to evaluate the relevance of the Lotka–Volterra framework in analyzing how these production and interaction dynamics affect operational outcomes. Although traditionally employed to model predator–prey systems, these equations can be adapted to describe the evolution of military capabilities in armed conflict and to support parameter-based strategic recommendations.*

Keywords: *Lotka–Volterra, drones, aircraft, armed conflict, models, equations.*

1. INTRODUCTION

In the context of emerging hybrid conflict configurations, military strategists seek to estimate the likelihood of success by leveraging technological advancements and securing resources through innovation. The effectiveness of military operations increasingly depends on integrating modern technologies, such as drones, alongside traditional assets like aircraft.

The application of the Lotka–Volterra differential equations, originally inspired by biological systems, offers an innovative perspective on the dynamics of these antagonistic interactions. Initially developed to model predator–prey relationships, these equations can be adapted to describe the interaction between two opposing military forces with distinct characteristics, providing a mathematical framework for predicting capability evolution and estimating operational success probabilities.

2. ANALYSIS OF THE CURRENT STATE OF RESEARCH

The current geopolitical context requires advanced computational methods to accurately determine the personnel and military equipment necessary to maximize operational success. In this regard, theories developed more than a century ago—such as the Lotka–Volterra differential equations—remain relevant due to their capacity to model natural fluctuations in antagonistic systems. Recent studies (Pandey, 2024) confirm the applicability of these models in military contexts, emphasizing their potential to estimate both the probability of neutralizing an adversary and the expected losses.

Contemporary research trends often focus on historical conflicts and established tactics. However, integrating mathematical models such as the Lotka–Volterra framework provides a predictive approach that can enhance strategic planning and decision-making in modern warfare scenarios.

3. ACHIEVEMENTS AND GAPS

The Lotka–Volterra differential equations have been widely applied beyond biology, including in economics, social systems, and military studies. In economics, they have modeled competitive market dynamics by conceptualizing the economy as a self-regulating ecosystem [3]. Similar predator–prey analogies have been used in resource management and demographic analysis.

In the military domain, these models have been applied to force interaction analysis, personnel policy dynamics, and information warfare, including insurgent–counterinsurgent and attacker–defender scenarios [5]. Despite this broad interdisciplinary use, their application to real kinetic armed conflict remains limited. In particular, the interaction between drone systems and fighter aircraft—an increasingly central feature of modern warfare—has received little direct analytical attention within the Lotka–Volterra framework.

4. RESEARCH METHODOLOGIES: COMMON METHODS, ADVANTAGES, AND LIMITATIONS

The research methodology adopted is a mixed-methods approach that combines two complementary techniques: qualitative and quantitative analysis. This approach is appropriate for studies of this nature because it integrates numerical data, statistical analysis, and significance testing with qualitative observations, case studies, and content analysis. Such integration allows for a more comprehensive interpretation of results and enhances analytical robustness.

Although the analytical core of this study is quantitative—based on the Lotka–Volterra system of differential equations—the selection and interpretation of model coefficients were informed by qualitative observations derived from recent drone-intensive conflicts. The mixed-methods approach therefore operates on two complementary levels:

Qualitative level – identification of operational patterns from recent conflicts, including high drone replacement rates, vulnerability of drone swarms to air superiority platforms, logistical bottlenecks in aircraft maintenance, and the scalability of low-cost UAV production.

Quantitative level – formal translation of these observed patterns into parameter structures within the Lotka–Volterra model.

Specifically:

The coefficient **a** (drone production or maintenance rate) reflects the empirically observed scalability and rapid replacement capacity of drone systems in modern conflicts.

The coefficient **b** (aircraft effectiveness against drones) reflects qualitative evidence indicating the high lethality of advanced fighter aircraft against unmanned aerial systems under air superiority conditions.

The coefficient **c** (aircraft attrition or maintenance limitations) captures documented logistical constraints, such as spare-parts dependency, maintenance complexity, and limited sortie regeneration rates.

The coefficient **d** (drone effectiveness against aircraft) reflects asymmetric strategies, including saturation attacks, infrastructure targeting, and runway denial operations [2].

Table 1

Table -Qualitative–Quantitative Parameter Mapping

C	Mathematical Role	Qualitative Observation from Modern Conflicts	Operational Interpretation
a	Intrinsic growth of drones	Rapid production scalability and low unit cost	High regeneration capacity
b	Aircraft suppression of drones	Air superiority platforms effectively neutralize UAVs	High aerial lethality efficiency
c	Aircraft attrition/maintenance decay	Logistical fragility, spare-parts dependence	Slower regeneration cycle
d	Drone suppression of aircraft	Saturation attacks, infrastructure strikes	Asymmetric pressure effect

5. MAJOR FINDINGS FROM PREVIOUS RESEARCH

The Lotka–Volterra equations, originally developed to model predator–prey interactions, have been extended to sociology, economics, and military studies, where they capture adaptive and competitive dynamics among interacting forces. In military research, their application has typically focused on abstract force attrition and generalized attacker–defender frameworks, without distinguishing between logistical sustainability and kinetic engagement processes [8].

This study advances the literature by introducing a dual-layer operational interpretation tailored to drone–fighter aircraft confrontation, separating maintenance-driven readiness from direct combat interaction. The model operationalizes its parameters within a framework of technological asymmetry characteristic of drone-intensive warfare, reflecting production scalability, maintenance fragility, and asymmetric engagement efficiency. The originality of this contribution lies not in modifying the mathematical structure of the Lotka–Volterra system, but in extending its interpretative application to contemporary aerial conflict, thereby linking nonlinear dynamical modeling with strategic military assessment.

6. IDENTIFIED GAPS AND CHALLENGES

The military domain has attracted scholarly attention since ancient times, with numerous studies examining the relationships between allies and adversaries, often seeking to answer a fundamental question: What are the chances of victory?

In contemporary conflicts, however, a new dimension has emerged—the widespread use of combat drones, reconnaissance drones, and other unmanned systems for diverse military purposes. Despite their growing strategic importance, this area remains insufficiently explored in the context of ongoing conflicts. One of the most significant research gaps concerns the comparative effectiveness of drones versus fighter aircraft in combat scenarios [12].

By applying differential equation models, researchers can generate analytical insights that enhance understanding of the interaction dynamics between these two modern combat capabilities.

7. IMPLICATIONS FOR THE FIELD AND FOR THIS RESEARCH

The implications for the field are significant. The Lotka–Volterra equations could be integrated into a user-friendly interface (UI), allowing for rapid application without requiring direct knowledge of their mathematical solutions. Beyond maintenance and combat modeling, these equations could also be applied to logistical planning, thereby streamlining decision-making processes [1].

Currently, at least within the Romanian Armed Forces, logistical and operational decisions are often made slowly and on the basis of non-transparent or insufficiently structured algorithms. The implementation of such models could accelerate decision-making processes and, at a minimum, broaden strategic planning perspectives.

8. MAIN OBJECTIVE OF THE ARTICLE

The primary objective of this research is to demonstrate the feasibility of integrating Lotka–Volterra equations into conflict modeling algorithms to estimate force success probabilities. Such models can support scenario-based simulations and enhance strategic planning in military operations. In general terms, the differential equations described by Lotka and Volterra take the following form:

$$\frac{dX}{dt} = \alpha X - \beta XY$$
$$\frac{dY}{dt} = \gamma XY - \delta Y \quad (1)$$

Where:

- **X** – represents the prey;
- **Y** – represents the predator;
- **α** – represents the prey's growth rate;
- **β** – represents the rate at which predators consume the prey;
- **γ** – represents the predator's mortality rate;

- **δ** – represents the predator's growth rate based on prey consumption.

Knowing the original formula and its coefficients, we can apply these differential equations to an industrial system of type **drones** versus fighter aircraft. By doing so, we can attempt to determine the impact of specific factors within these systems.

First case study:

The first case study consists of applying these formulas to highlight the influence of **maintenance** on sustaining the operational readiness of drones or aircraft.

The original formula is expressed as follows:

$$\frac{dX}{dt} = \alpha X - \beta XY$$
$$\frac{dY}{dt} = \gamma XY - \delta Y \quad (2)$$

We will replace the original coefficients **α, β, γ, δ** with **a, b, c, and d** for simplicity in tracking calculations, where:

- **X(t)** – number of drones at time $t > 0$;
- **Y(t)** – number of aircraft at time $t > 0$;
- **X₀** – number of drones at time $t = 0$;
- **Y₀** – number of aircraft at time $t = 0$;
- **t** – time;
- **a** – rate at which drone maintenance is performed;
- **b** – rate at which aircraft become operational faster than drones;
- **c** – rate of inability to maintain aircraft operational (due to lack of specialists, spare parts shortages, long delivery times, etc.);
- **d** – rate of aircraft operational readiness depending on the number of operational drones (if restoring drones takes longer, then $Y > X$).

Assuming that the companies responsible for drone and aircraft maintenance belong to different countries—for example, drones belong to the "Green" country and aircraft to the "Red" country—but some maintenance materials that positively influence operational readiness are sourced from the same international supplier, we start from the following premise:

We assume that material resources are unlimited for drones in the absence of aircraft ($Y = 0$). In this case, the drone maintenance system develops according to Malthus' mathematical model, with a positive rate $a > 0$:

$$x' = a * x, a > 0. \quad (3)$$

We assume that the materials required to keep aircraft operational are produced by the same manufacturer as those for drones. This means that, in the absence of these necessary materials, the number of aircraft evolves according to Malthus' model, but with a negative growth rate, $-c < 0$, that is:

$$y' = -c * y, c > 0. \quad (4)$$

When materials are predominantly available for aircraft, the number of drones is limited by a factor proportional to the number of material orders. If, at time t, we have $x$drones and $y$aircraft, the total interaction is represented by the term $x \cdot y$, according to the following equation:[21]

$$x' = a \cdot x - b \cdot x \cdot y, a, b > 0 \quad (4)$$

When materials are predominantly available for drones, the number of operational aircraft decreases according to the following equation:

$$y' = -c \cdot y + d \cdot x \cdot y, c, d > 0 \quad (5)$$

Thus, we obtain the **maintenance model for drones and aircraft**, represented by the system:

$$\begin{cases} x' = a \cdot x - b \cdot x \cdot y \\ y' = -c \cdot y + d \cdot x \cdot y \end{cases} \quad (6)$$

where $a, b, c, d > 0$. This system is known as the **Lotka–Volterra system**. It is a planar system of autonomous differential equations of the form:

$$\begin{cases} x'(t) = f_1(x, y) \\ y'(t) = f_2(x, y) \end{cases} \quad (7)$$

where:

$$f_1(x, y) = a \cdot x - b \cdot x \cdot y,$$
$$f_2(x, y) = -c \cdot y + d \cdot x \cdot y \quad (8)$$

Equilibrium Points

The equilibrium points are the real solutions of the system:

$$\begin{cases} f_1(x,y)=0 \\ f_2(x,y)=0 \end{cases} \Rightarrow \begin{cases} x(a-by)=0 \\ y(-c+dx)=0 \end{cases} \quad (9)$$

From the first equation, we deduce:

$$x(a-by)=0 \Rightarrow x=0 \text{ or } a-by=0. \quad (10)$$

If $x=0$, then from the second equation we obtain:

$$x=0 \Rightarrow y(-c)=0 \Rightarrow y=0. \quad (11)$$

Thus, the first equilibrium point is:

$$X_1^*(0,0).$$

If:

$$a-by=0 \Rightarrow y=\frac{a}{b}, \quad (12)$$

and from the second equation:

$$\frac{a}{b}(-c+dx)=0 \Rightarrow x=\frac{c}{d}. \quad (13)$$

(13)

Therefore, we obtain the second equilibrium point:

$$X_2^*\left(\frac{c}{d},\frac{a}{b}\right). \quad (14)$$

Stability of the Equilibrium Points

To study the stability of the equilibrium points $X_1^*(0,0)$and $X_2^*\left(\frac{c}{d},\frac{a}{b}\right)$, we apply the First Approximation Stability Theorem (linearization). We compute the Jacobian of the vector function $f=(f_1,f_2)$:

$$J_f(x,y)=\begin{pmatrix} \frac{\partial f_1}{\partial x}(x,y) & \frac{\partial f_1}{\partial y}(x,y) \\ \frac{\partial f_2}{\partial x}(x,y) & \frac{\partial f_2}{\partial y}(x,y) \end{pmatrix} \quad (15)$$
$$=\begin{pmatrix} a-by & -bx \\ dy & -c+dx \end{pmatrix}.$$

At the equilibrium point $X_1^*(0,0)$is unstable of saddle type.

At the equilibrium point $X_2^*\left(\frac{c}{d},\frac{a}{b}\right)$:

Therefore, Re $\lambda_{1,2}=0$. Because the system is nonlinear, the First Approximation Stability Theorem does not allow us to conclude the stability of $X_2^*\left(\frac{c}{d},\frac{a}{b}\right)$. To determine stability, we must study the orbits generated by the predator–prey system.

The orbit equation for the predator–prey system is derived by solving the differential relation of the orbits:

$$\frac{dx}{dy}=\frac{f_1(x,y)}{f_2(x,y)} \quad \Rightarrow \quad \frac{dx}{dy}=\frac{x\,(a-by)}{y\,(-c+dx)}. \quad (16)$$

Applying the exponential function, we obtain the **second form** of the orbit equation:

$$y^{\,a}\,e^{-by}=C\,x^{-c}\,e^{dx}, \text{with } C=e^{C}. \quad (17)$$

From this relation, it follows that the orbits of the predator–prey system are closed curves (see the phase portrait in the illustrative figure), which implies that the system's solutions are periodic. A more rigorous proof of the local stability of X_2^*can be obtained using Lyapunov's theorem.

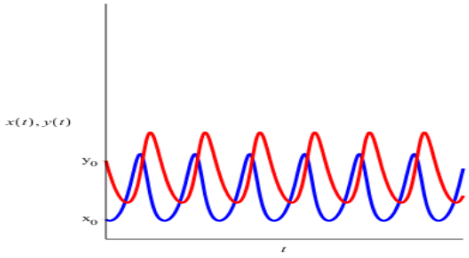


Fig.1. Phase portrait of the system (source: https://math.ubbcluj.ro/~mserban/Laboratoare/SistemeDinamice/curs10.pdf)

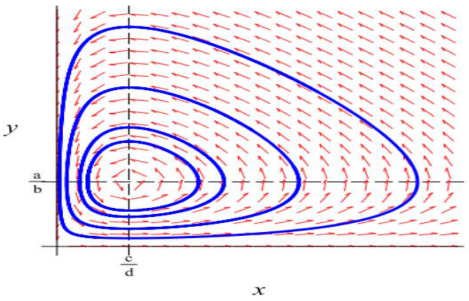


Fig. 2. Graphical form of the system solutions (source: https://math.ubbcluj.ro/~mserban/Laboratoare/SistemeDinamice/curs10.pdf)

8.1 Case Study No. 1

To visualize the **phase portrait** and the solutions of the drone-aircraft maintenance model using the given theoretical values:

$X_0 = 100$ (drones),
$Y_0 = 10$ (aircraft),
$t = 30$ days,
$a = 1.5, b = 0.4, c = 0.4, d = 0.1,$

we will generate a **phase portrait** and **time evolution plots** for the Lotka–Volterra system

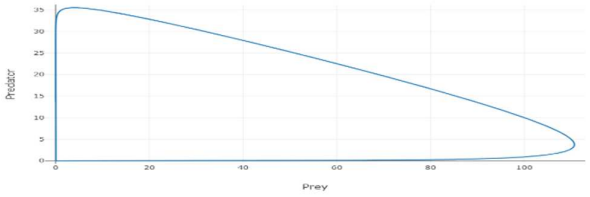


Fig. 3. Maintenance-Oriented Phase Portrait of the Drone–Jet System

Here are the computed solutions of the system based on the given parameters, represented graphically:

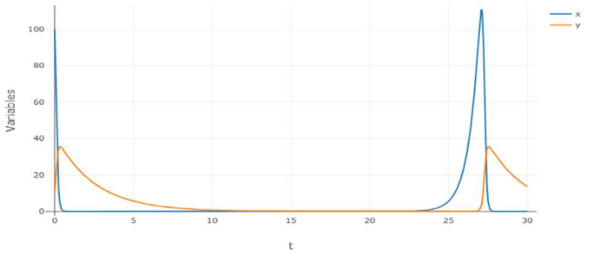


Fig. 4. Graph of the Solutions of the Drone–Aircraft System Considering Maintenance Factors

The graphs illustrate the interaction between drone and aircraft maintenance under shared material constraints. The results indicate a higher maintenance rate for drones, granting them faster regeneration and greater operational availability. This accelerated recovery cycle may provide a deployment advantage and potentially influence conflict outcomes in favor of drone-intensive forces.

In addition, I conducted a one-at-a-time sensitivity analysis by perturbing each coefficient (a, b, c, d) by ±20% and ±30% while holding the remaining parameters fixed. The resulting dynamics remain oscillatory, but the location of the non-trivial equilibrium shifts predictably with parameter changes: a and b directly reshape $y^* = a/b$, while c and d reshape $x^* = c/d$. In the 30-day window, the peak aircraft availability $y_{\max}$ and the end-of-window values $(x(T), y(T))$ show noticeable phase-dependent variation, consistent with periodic Lotka–Volterra trajectories. Overall, the maintenance scenario is most sensitive (in equilibrium terms) to changes in the ratios $\frac{a}{b}$and $\frac{c}{d}$, confirming that relative regeneration and constraint intensities—rather than absolute levels—govern the model's long-run balance.[22]

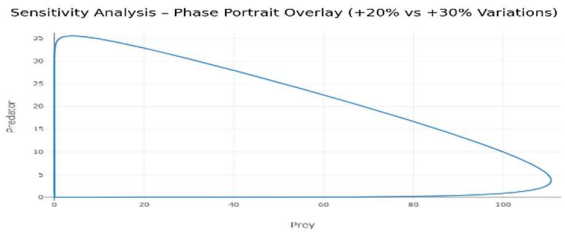


Fig. 5. Maintenance-Oriented Phase Portrait of the Drone–Jet System after new data

Here are the computed solutions of the system based on the given parameters, represented graphically:

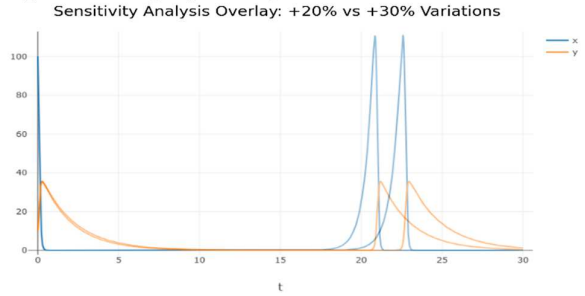


Fig. 6. Graph of the Solutions of the Drone–Aircraft System Considering Maintenance Factors after new data

8.2 Case Study No. 2

This case study applies the model to examine the combat effectiveness of drones against aircraft. The simulation aims to identify the factors that most strongly influence the outcome of the engagement. Knowing the initial formula, which is expressed as:

$$\frac{dX}{dt} = \alpha X - \beta XY, \frac{dY}{dt} = \gamma XY - \delta Y, \qquad (18)$$

we replace the original coefficients $\alpha, \beta, \gamma, \delta$with $a, b, c,$and $d$for simplicity in tracking calculations, where:

- $X(t)$– number of drones at time $t > 0$;
- $Y(t)$– number of aircraft at time $t > 0$;
- X_0– number of drones at time $t = 0$;
- Y_0– number of aircraft at time $t = 0$;
- t– time;
- a– rate at which drones are produced;
- b– rate at which aircraft destroy drones;
- c– rate of aircraft becoming unavailable due to external factors;
- d– rate of aircraft production depending on drone attacks.

Assuming that the two states in conflict, hereafter referred to as country **BLUE** and country **RED**, have the following capabilities: BLUE possesses 150 drones, while RED has 10 fighter aircraft. We start from the following premise:

- We assume that drones are produced without disruptive factors, in the absence of aircraft ($y = 0$), and drone production follows **Malthus' mathematical model** with a positive rate $a > 0$:

$$x' = a \cdot x, a > 0. \quad (19)$$

- We assume that aircraft attack drone deployment sites without being intercepted by drones; the number of aircraft evolves according to Malthus' model but with a negative growth rate, $-c < 0$, that is:

$$y' = -c \cdot y, c > 0. \quad (20)$$

- When maintenance takes longer than planned and aircraft cannot perform combat actions, if at time $t$we have $x$drones and $y$aircraft, the total interaction is represented by the term $x \cdot y$, according to the equation:

$$x' = a \cdot x - b \cdot x \cdot y, a, b > 0. \quad (21)$$

- When drones succeed in an attack, the number of fighter aircraft decreases, according to the equation:

$$y' = -c \cdot y + d \cdot x \cdot y, c, d > 0. \quad (22)$$

Thus, we obtain the **drone–aircraft combat model** represented by the system:

$$\begin{cases} x' = a \cdot x - b \cdot x \cdot y, \\ y' = -c \cdot y + d \cdot x \cdot y, \end{cases} \quad (23)$$

where $a, b, c, d > 0$, known as the **Lotka–Volterra system**. It is a planar system of autonomous differential equations of the form:

$$\begin{cases} x'(t) = f_1(x, y), \\ y'(t) = f_2(x, y), \end{cases} \quad (24)$$

where:

$$\begin{cases} f_1(x, y) = a \cdot x - b \cdot x \cdot y \\ f_2(x, y) = -c \cdot y + d \cdot x \cdot y. \end{cases} \quad (25)$$

To obtain the **phase portrait of the interactions** in the drone–aircraft combat model and the solutions of the system, we introduce theoretical values (selected based on publicly available data) for the coefficients as follows:

$$X = 150 \text{ drones}, Y = 10 \text{ aircraft},$$
$$t = 48 \text{ hours}, a = 1.5,\ b = 0.6,\ c = 0.2,\ d = 0.1.$$

Thus, we obtain the phase portrait of the interactions as follows:

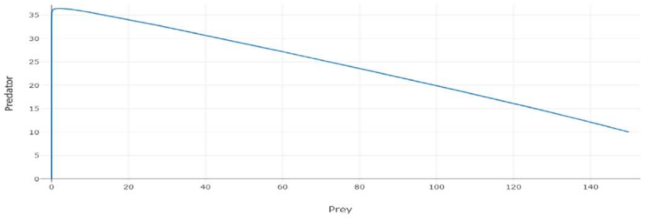


Fig. 7. Combat-Oriented Phase Portrait of the Drone–Aircraft System

Next, we obtain the solutions of the system as illustrated in the graph.

According to the two graphs presented, we can observe that the combat capabilities of aircraft are superior. After the deployment of 150 drones, the first hour shows a rapid decrease in the number of drones, indicating that aircraft are more effective.

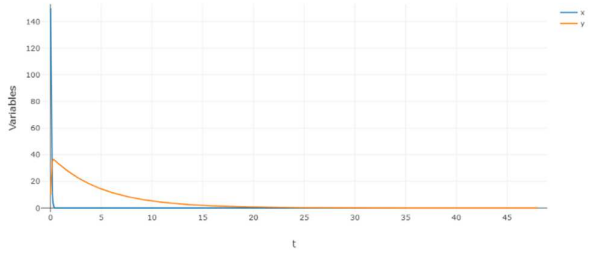


Fig. 8.Combat-Oriented Graph of the Drone–Aircraft

In addition, for the combat scenario, we applied the same one-at-a-time perturbations (±20%, ±30%) around the baseline coefficient set. The equilibrium again responds deterministically: changes in a and b primarily shift y^*, while changes in $c$and d shift x^*. Over the 48-hour horizon**,** the peak aircraft levels $y_{\max}$ remain relatively stable, while drone peaks $x_{\max}$ increase meaningfully for higher a(stronger drone production). The end-of-window values $(x(T), y(T))$ remain small in most configurations, reflecting the strong interaction-driven suppression under the chosen baseline conditions and the fact that instantaneous "final values" depend on the oscillation phase. These results support the paper's claim that relative effectiveness parameters (production vs. suppression) shape short-horizon outcomes and that small coefficient changes can materially alter predicted trajectories.[22]

9. RESULTS AND DISCUSSION

The application of the Lotka–Volterra framework to drone–aircraft interaction provides a structured interpretation of how maintenance sustainability and combat effectiveness jointly shape modern aerial conflict. The simulations indicate that force dynamics are governed less by numerical superiority than by the interaction among production rates, regeneration capacity, and engagement efficiency.

In the maintenance-focused model (Case Study No. 1), drones exhibit higher operational elasticity, recovering availability more rapidly than aircraft. This reflects structural characteristics associated with drone systems-modularity, lower technical complexity, and scalable production.

In contrast, the combat interaction model (Case Study No. 2) demonstrates early tactical dominance by aircraft despite their numerical inferiority. The rapid decline in drone numbers during the initial engagement phase reflects greater suppression efficiency under the selected parameters. However, the system does not converge toward permanent dominance. Instead, periodic dynamics indicate that relative advantage evolves over time and remains sensitive to production and attrition parameters. Tactical superiority in the early phase does not necessarily imply long-term structural control.

Absolute force levels are therefore less decisive than relative interaction efficiencies than the comparative efficiency of regeneration and neutralization mechanisms. Increasing drone numbers alone does not ensure advantage if counter-drone effectiveness scales proportionally. The contrast between the two case studies underscores an important doctrinal distinction: logistical superiority does not automatically translate into kinetic superiority. A system capable of rapid regeneration may still suffer disproportionate losses during high-intensity engagement if confronted with technologically superior platforms. Conversely, aircraft dominance depends not only on lethality but also on sustainability and maintenance resilience. The temporal dimension further refines this interpretation. Short-duration engagements favor high-performance aircraft systems, whereas prolonged conflicts may favor scalable and replaceable platforms. Campaign duration thus becomes a strategic variable influencing force effectiveness. Sensitivity to interaction coefficients confirms the importance of technological adaptation: improvements in counter-UAS capabilities increase suppression efficiency, while advances in swarm tactics and saturation strategies intensify asymmetric pressure on aircraft operations. Innovation therefore alters the structure of the interaction system rather than merely adjusting force quantities.

The aircraft decay parameter, representing maintenance burden and downtime, highlights

sustainability as a strategic determinant alongside lethality. Even technologically advanced platforms may lose operational relevance if regeneration cycles are insufficient relative to adversarial production rates.

Overall, the results support a hybrid force architecture rather than a substitution paradigm.

Table 2

Comparative analysis table

Aspect	Case Study 1: Maintenance Model	Case Study 2: Combat Model
Objective	Analyze maintenance efficiency for drones vs. aircraft	Analyze combat effectiveness of drones vs. aircraft
Initial Conditions	$X_0 = 100$ drones, $Y_0 = 10$ aircraft	$X_0 = 150$ drones, $Y_0 = 10$ aircraft
Time Frame	30 days	48 hours
Coefficients	a = 1.5, b = 0.4, c = 0.4, d = 0.1	a = 1.5, b = 0.6, c = 0.2, d = 0.1
Key Observation	Drones recover operational status faster due to higher maintenance rate	Aircraft dominate in combat; drones decrease rapidly in first hour
Outcome	Drones gain logistical advantage	Aircraft maintain tactical superiority
Implication	Faster drone maintenance can shift operational readiness	Aircraft efficiency can determine conflict outcome

10. CONCLUSIONS AND FUTURE RESEARCH DIRECTIONS

Recent conflicts have intensified efforts to quantify force potential and assess the probability of success in large-scale operations. Given the complexity of such evaluations, mathematical modeling provides a structured means of refining intelligence-based decision-making. Applying the Lotka–Volterra framework to the emerging drone–aircraft confrontation offers insight into how technological innovation and production capacity shape combat dynamics. The analysis indicates that, under the selected parameters, aircraft demonstrate superior early-phase combat effectiveness, while drones exhibit greater vulnerability during initial engagement. Although based on publicly available and incomplete data, the simulations underscore the strategic importance of parameter calibration and sensitivity analysis. Refining these coefficients through expert input and operational data could enhance predictive accuracy and support more informed decision-making in contemporary military planning.

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Războiul în aer, matematica pe pământ: modelarea bazată pe dinamica sistemelor, a confruntărilor dintre drone și avioane de vânătoare

Rezumat: În ultimele decenii, evaluarea forței militare în cardul conflictelor armate s-a bazat pe informațiile obținute de structuri specializate ale ambelor părți, cu scopul de a anticipa probabilitatea de succes a fiecărui actor implicat. Studiul de față cercetează aplicarea ecuațiilor diferențiale Lotka-Volterra într-o configurație specifică războiului modern: confruntările dintre drone și avioane. Ipoteza centrală susține că succesul operațiilor de amploare este influențat semnificativ de investițiile directe în capacitățile de producție pentru aeronave și drone. Obiectivul articolului este de a evalua aplicarea ecuațiilor diferențiale Lotka-Volterra în analiza impactului acestor dinamici asupra performanței operaționale. Deși utilizate tradițional pentru a modela interacțiuni de tip pradă-prădător în diferite ecosisteme, aceste ecuații pot fi aplicate pentru a descrie evoluția capabilităților militare într-un conflict armat și se pot fundamenta recomandări privind ajustarea parametrilor esențiali pentru îmbunătățirea rezultatelor luptei.

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