The Maya and the Systemic Awakening

🟩 Abstract

The collapse of the Classic Maya civilization has long intrigued scholars, with leading theories pointing to uncontrolled population growth, environmental overuse, ecosystem fragility, and resource depletion. This article reinterprets these factors through a systemic thinking lens, examining how demographic pressure, intensive agriculture, deforestation, and climatic shifts interacted to destabilize both ecological and social systems. Beyond collapse, the Maya story offers both a warning and a learning opportunity: to understand planetary boundaries and redesign our systems to avoid repeating similar mistakes. The systemic awakening lies in realizing that in a deeply interconnected world, there are no isolated solutions.

Oasis Incubator Online	**Autores:** **Pedro Dagoberto Almaguer Prado** pedro@oasis-io.com **+52(81)17588310** **Ramiro Luis Almaguer Navarro** ramiro@oasis-io.com **+52(81)43966945** https://oasis-io.com

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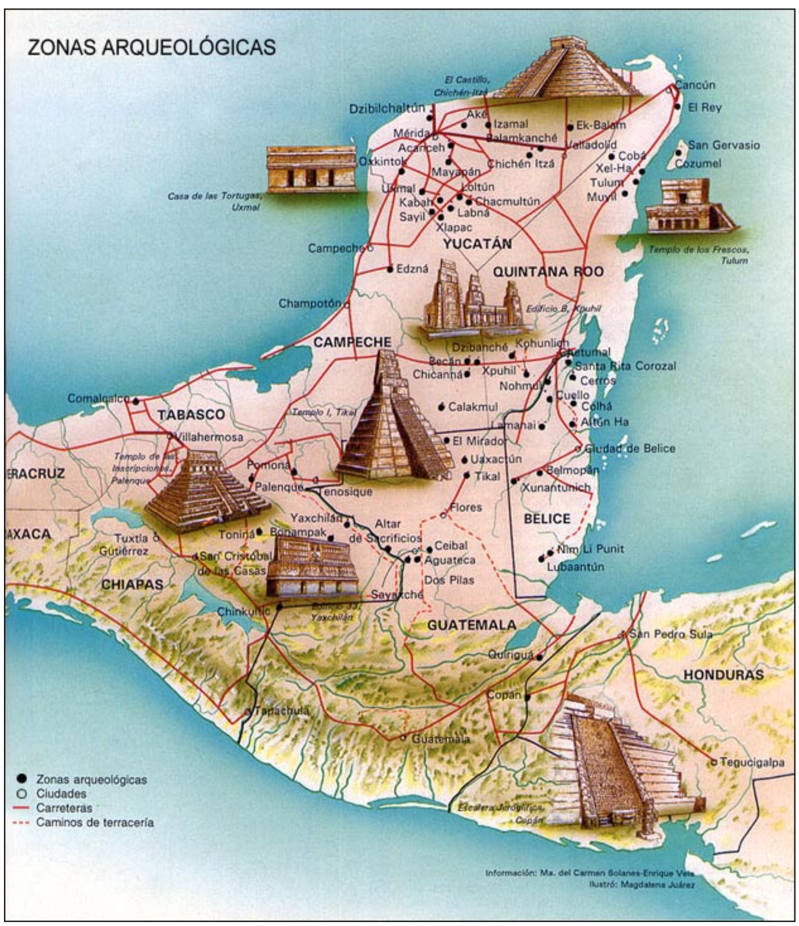
Keywords

Systemic thinking, Maya collapse, sustainability, ecological resilience, social dynamics, climate change, historical lessons, planetary boundaries, feedback loops.



ZONAS ARQUEOLÓGICAS
El Castillo, Chichén-Itzá
Cancún
El Rey
Dzibilchaltún
Aké
Izamal
Ek-Balam
Mérida
Balamkanché
Valladolid
San Gervasio
Acanceh
Cozumel
Oxkintok
Chichén Itzá
Cobá
Xel-Ha
Mayapán
Tulum
Uxmal
Loltún
Muyil
Kabah
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Casa de las Tortugas, Uxmal
Sayil
Labná
Xlapac
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Templo de los Frescos, Tulum
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Escalera Jeroglífica, Copán
Información: Ma. del Carmen Solanes-Enrique Vela
Ilustró: Magdalena Juárez

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📚 Introduction

What led one of the most advanced civilizations in the Americas to such a dramatic collapse? The Maya built sophisticated social, astronomical, and agricultural systems, yet their downfall suggests that technical knowledge alone was not enough to sustain the balance between human growth and ecological capacity. Through systemic thinking, we can understand how resource depletion, political fragmentation, and negative feedback loops—such as the loss of arable land and water stress—amplified internal tensions. This approach allows us to move beyond linear explanations and connect the past to today's global challenges.

🟠 Case Description

This article explores the following key areas:

1. **The Maya System as a Complex Network**
   – Explains how the Maya operated within an interconnected tropical ecosystem, with flows of energy, information, and resources.
2. **Feedback Loops and System Imbalance**
   – Analyzes how short-term solutions (like expanding farmland) triggered long-term effects that destabilized the system.
3. **Collapse as a Systemic Outcome**
   – Shows that the collapse was not caused by a single factor but by the cumulative interaction of multiple pressures.
4. **Parallels with the Present**
   – Reflects on how today's societies face similar pressures: climate change, urbanization, and excessive consumption.
5. **Call for a Systemic Awakening**
   – Concludes by proposing that we must view the world as a web of interdependent systems and design policies that honor these connections.

The Legacy of the Maya: A Systemic Tale of Brilliance and Warning

In the heart of the Mesoamerican jungle, one of the most brilliant civilizations in human history built temples that still defy time, developed calendars with astronomical precision, and organized complex social and agricultural structures. The Maya knew how to read the stars, but they did not know how to read the limits of their own environment.

Their growth was exponential. City-states like Tikal, Calakmul, and Copán flourished, fueled by agricultural ingenuity and regional trade. But as the population, constructions, and rituals increased, so did the pressure on the forests, the overexploitation of the soil, and the vulnerability to increasingly intense droughts. The collapse was not a lightning bolt in a clear sky; it was a long structural unraveling, caused by a systemic blindness to the signs of deterioration.

In this systemic narrative, we will understand how the very system that sustained the Maya's splendor contained within its structure the seeds of its collapse. And we will do so through the lens the modern world needs: a vision of circular causality, feedback loops, and invisible limits that—when ignored—lead to crisis.

This is a journey to learn to think differently—beyond history—toward the structures that govern us today. Because the business, political, environmental, and educational worlds are full of modern Maya systems: brilliant, ambitious... and fragile.

The Pulse of Collapse: Population and Environment in Dynamic Tension

In this first stage of the model, we identify two core elements at the heart of the Maya collapse story: **Population** and the **Environment**. These two *stocks* interact through their respective flows:

- **Population** increases through **births** and decreases through **deaths**.
- The **Environment** regenerates through natural **recovery processes** and deteriorates through **damage** caused by human activity.

The **normal fractions** of births and deaths define the expected dynamics under stable conditions. However, these can be altered by external drivers such as environmental degradation or population policies. The resulting **actual fractions** determine the real inflows and outflows that shape population dynamics.

Simultaneously, **environmental damage** is directly affected by **population density** — more people mean more pressure on ecosystems and faster degradation. On the other hand, the **regeneration time** of the environment is slowed as the damage accumulates, reducing the system's capacity to heal.

This structure reveals how the tension between population growth and environmental stress generates complex feedbacks, potentially leading to sustainable balance — or systemic collapse — depending on the choices made.

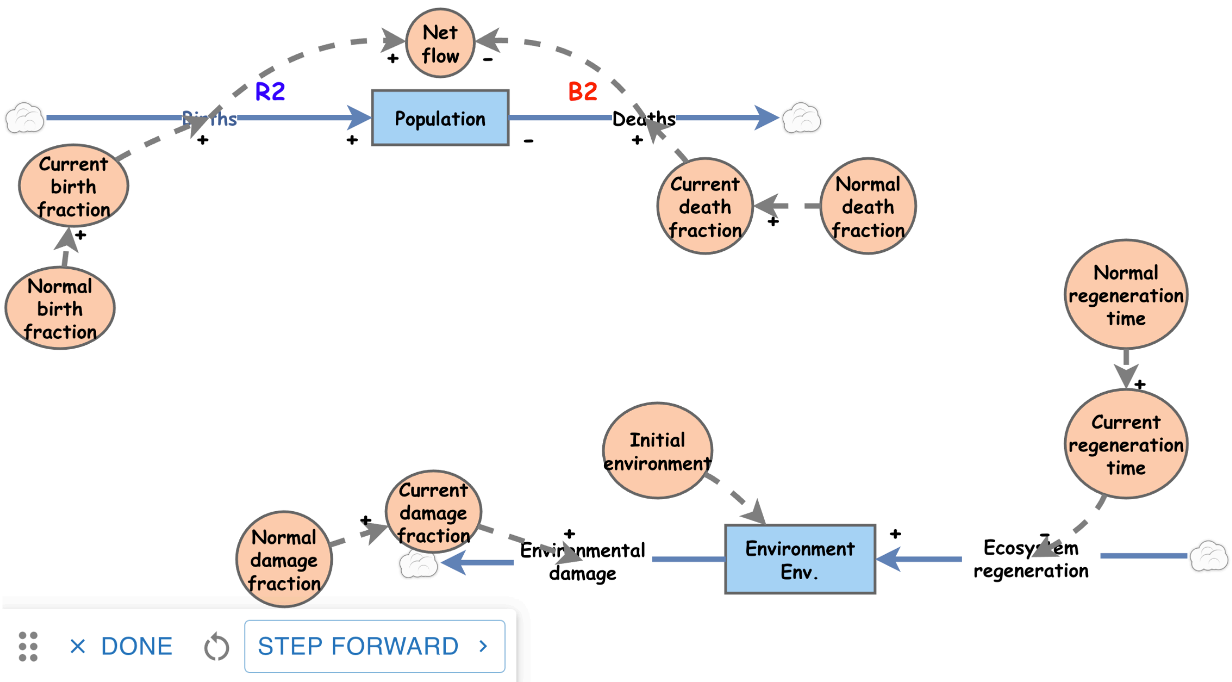

Figure 1: System dynamics model showing the interaction between population growth and environmental degradation. The population is governed by births and deaths; the environment by regeneration and damage. Their interplay creates feedback loops that determine the system's long-term sustainability.

🔁 Key Comment on Feedback Loops:

This base model already reveals the first two essential **feedback cycles**:

1. **(R2) Reinforcing loop** in the **births** flow: More population leads to more births, which in turn increases the population — a classic exponential growth mechanism.
2. **(B2) Balancing loop** in the **deaths** flow: As the population grows, so does the number of deaths, providing a counterforce that seeks to stabilize the population, albeit typically at a slower pace.

These feedback loops act simultaneously and are strongly influenced by the state of the environment, making early systemic intervention essential for sustainability.

Reinforcing Loop R1: When the Environment Heals Itself

📝 **Description:**

In this second stage of the systemic model, we discover a virtuous cycle: **Reinforcing Loop R1**, tied to the environment's inherent ability to regenerate.

This loop begins with the **Environment stock**, which increases through the **regeneration flow**. This flow depends on the **Current Regeneration Time**, which is based on a reference value called the **Normal Regeneration Time**.

However, the **Current Regeneration Time** is dynamic. It changes depending on the **Effect of the Environment on Regeneration**, which in turn is determined by the **Environmental Index (MA Index)**. If the MA Index is high (indicating a healthy environment), the regeneration time shortens — **allowing the environment to recover faster**.

As the environment regenerates, its stock grows, improving the MA Index further. This creates a **positive feedback loop (R1)**: **better environment → faster regeneration → healthier ecosystem → better environment**.

It's a loop of hope — but also of vulnerability: if the environment declines, the regenerative capacity fades with it.

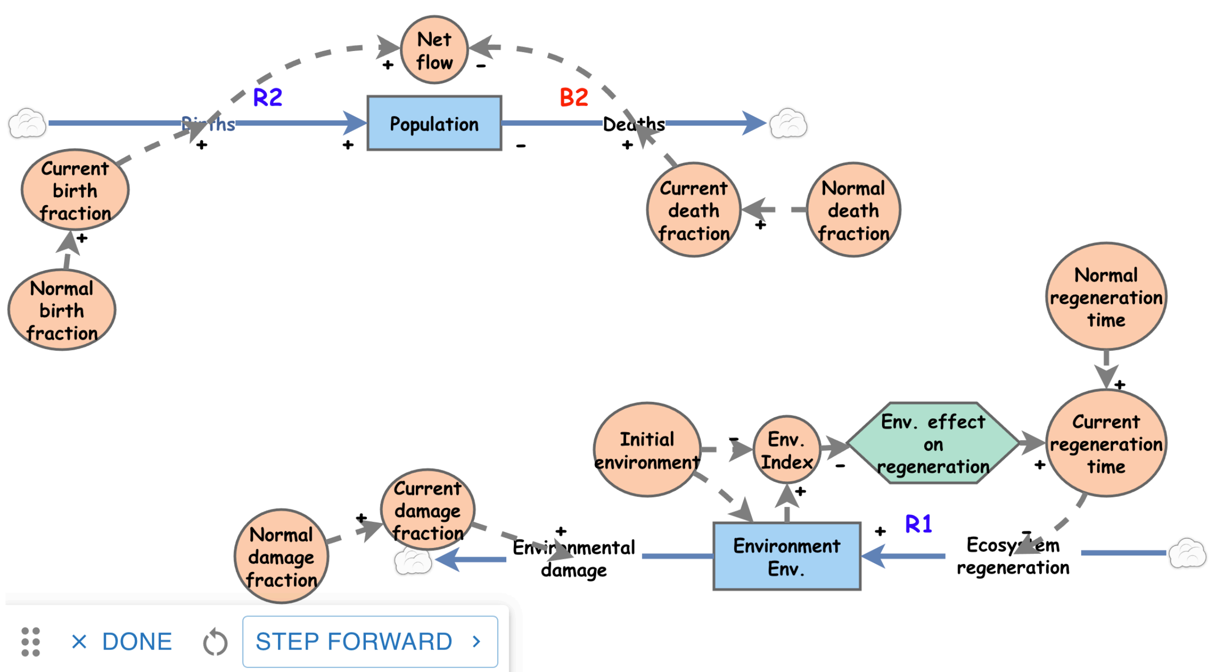

Figure 2: Reinforcing loop R1 shows how the environment can heal itself if it remains in good condition. A higher environmental index shortens the regeneration time, increasing recovery and strengthening the ecosystem's health in a virtuous cycle.

🔁 Systemic Insight:

Loop R1 embodies one of the most powerful ecological dynamics: **self-healing**. Yet it also highlights the nonlinear nature of collapse. As the MA Index drops, regeneration slows, and the loop weakens. This is a loop that can sustain life — or fade silently without intervention.

Balancing Loop B1: The Silent Limit of Growth

📝 **Description (ENGLISH):**

In this third step of the model, the system unveils a quiet form of wisdom: **Balancing Loop B1**, designed to resist unchecked population growth.

This loop begins with the **population stock**, which impacts the system in two crucial ways:

1. The state of the **environment** influences the **death fraction** through the **Environmental Effect on Deaths**. If the MA Index is high (healthy environment), this effect is low and mortality remains minimal. But when the ecosystem degrades, **mortality increases** as living conditions worsen.
2. At the same time, **rising population density** stresses the environment, influencing the **Current Damage Fraction** via the **Density Effect on Damage**. The more people, the faster the ecosystem deteriorates.

This closes the loop: **population growth harms the environment**, and a degraded environment **increases death rates**, slowing population growth. B2 is nature's subtle attempt to restore balance — but **if ignored, the correction comes brutally**.

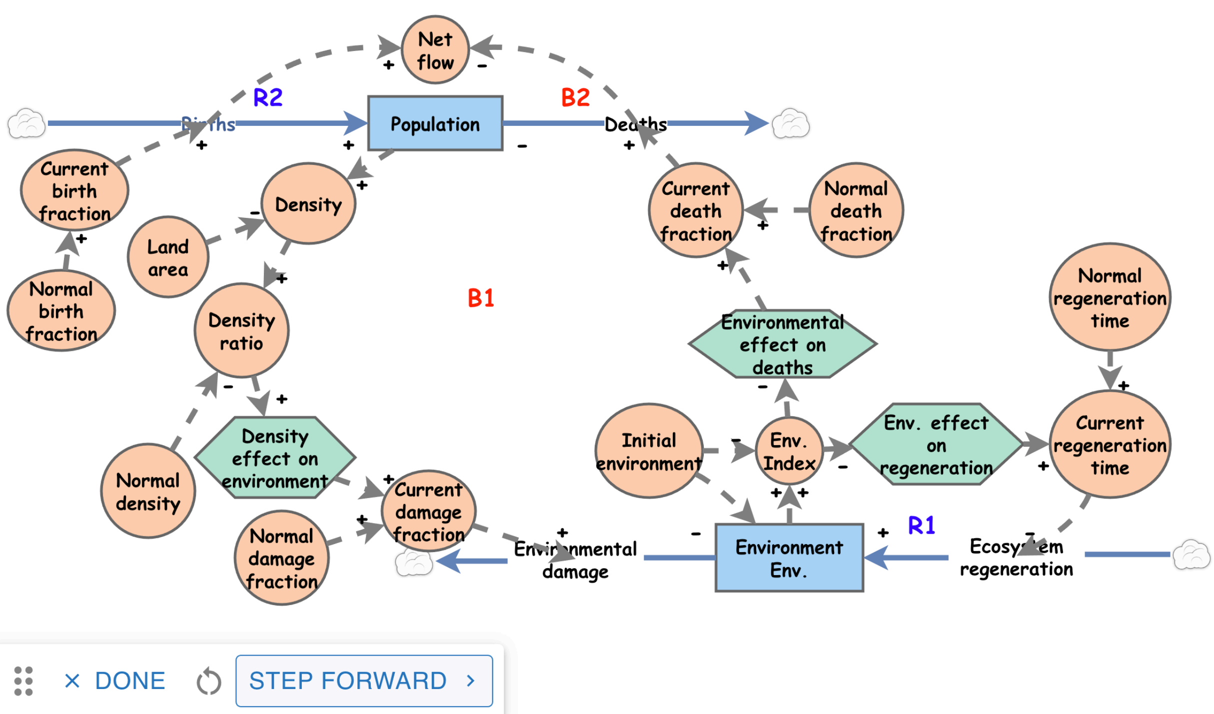

Figure 3:Balancing Loop B2 acts as a natural brake on population growth. Human pressure damages the environment, and a deteriorated ecosystem increases mortality. The system self-regulates — unless it's pushed beyond its limits.

Systemic Insight:

Loop B1 is quiet but essential: it reminds us that **every system has limits**. Sustained growth without regard for environmental capacity leads to self-correcting responses. Too often, these only become visible **once collapse has begun**.

Step 4. Intervening Before Collapse: Policy Design

Narrative Description:

At this stage, the model becomes a decision-making lab. Every "normal" parameter of the system —such as the **Normal Birth Fraction**, **Normal Death Fraction**, **Normal Regeneration Time**, **Normal Damage Fraction**, **Land Area**, or **Normal Density**— can be adjusted through predefined policy controls.

All policies activate at **time 5**, and they allow either an **increase** or a **decrease** in the base parameter value. For instance, if **Pol Births** is active and **Pol Births UP** is selected, the **Normal Birth Fraction** (set to 2) will rise by 10%, becoming 2.2. If **Pol Births UP** is not selected, the value drops to 1.8.

This logic applies to all policy levers. The combination of **activation** and **direction** (UP or not) enables the model to test policy decisions **before irreversible damage occurs**.

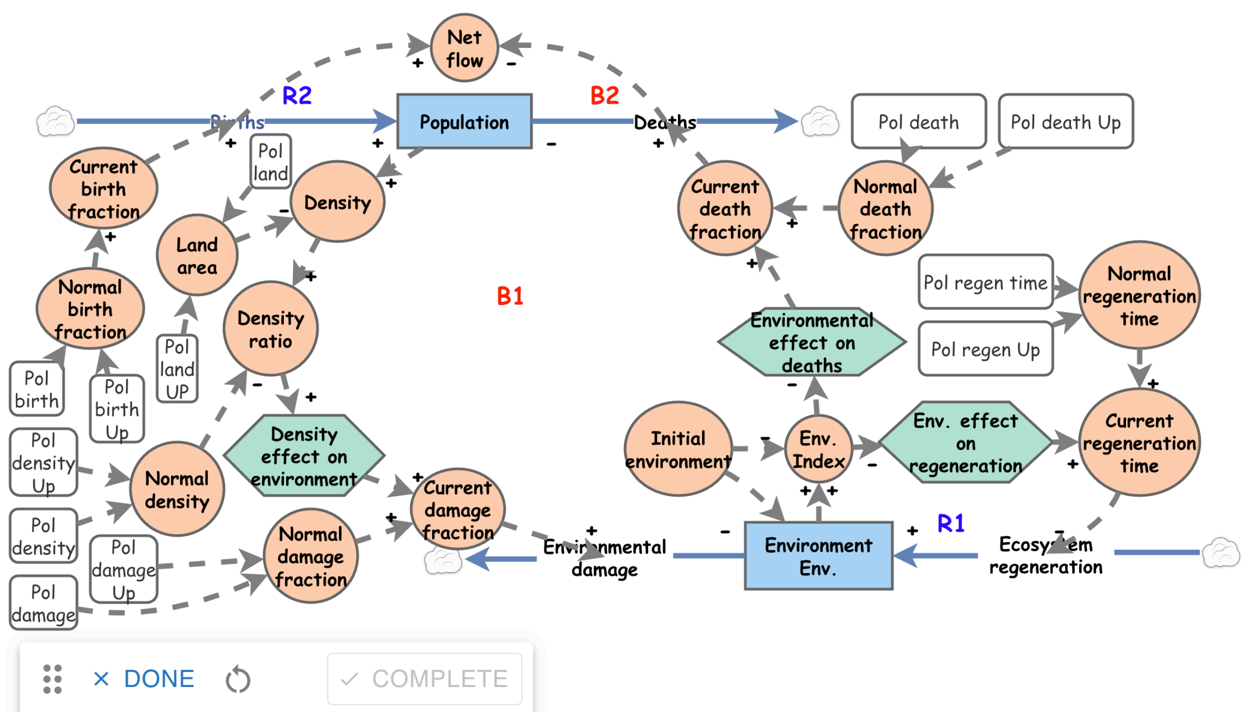

Figure 4: Policies allow key system parameters to be adjusted. Each one can be activated or not, and directed to either increase or decrease the target value. The goal: test our decisions before consequences become irreversible.

🔁 Systemic Insight:

This is one of the most powerful capabilities of systems thinking: **simulate interventions before applying them in real life**. A well-timed, well-designed policy can prevent collapse. But late or uninformed action only reinforces the problem. Designing policies means **imagining the future without paying the price of error**.

The Complete Maya Model: Population Dynamics, Environment, and Policy Design

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📝 **Narrative Description:**

This is the full model that simulates the complex interaction between population growth, environmental health, and human decisions. At the system's core are two major *stocks*: **Population** and **Environment**. Each is shaped by its flows: births and deaths for population; regeneration and damage for the environment.

The system's feedback loops reveal its hidden dynamics:

- A **reinforcing loop (R1)** boosts regeneration when the environment is healthy.
- Two **balancing loops (B1 and B2)** try to stabilize the system via mortality and the impact of population density on environmental degradation.

Built on this structure is a set of **public policy levers**. These allow decision-makers to intervene before collapse by modifying parameters such as birth and death fractions, regeneration time, and damage rates—making it possible to simulate the consequences of different decisions over time.

This model is not just a window into the Maya past. It's a warning and a tool for the present. Collapse is not sudden—it's the slow accumulation of overlooked systemic feedbacks. This model teaches us to see them before it's too late.

🟨 Additional Note on Systemic Analysis

A key feature of the model is the ability to simulate real-world policy tendencies—such as **expanding cultivated land area** to offset environmental damage, or **modifying the "normal" population density** to recalibrate thresholds. While these policies may seem effective, they can unintentionally amplify system pressure if implemented without systemic awareness.
Another important component is the variable called **Net Flow**, which reflects the difference between births and deaths. This serves as a potential **early warning indicator** of systemic imbalance—signaling whether the population is growing uncontrollably or stabilizing. Tracking this variable could be crucial for informed, preventative decision-making.

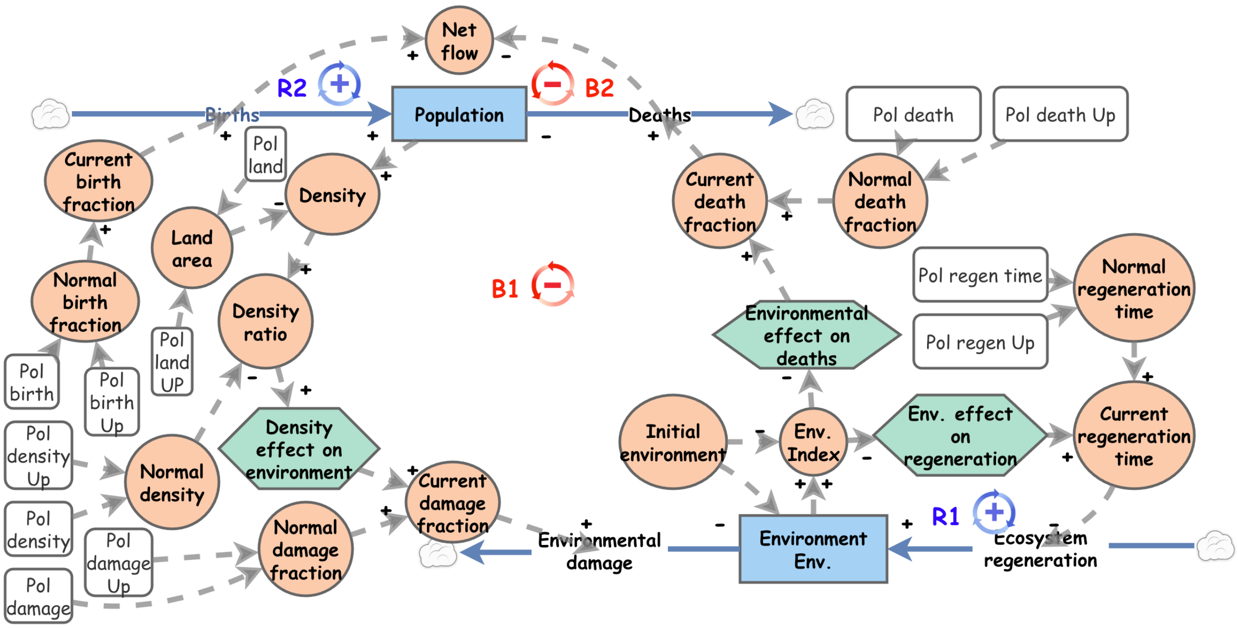


Figure 5: Complete Maya system model: interaction between population, environment, and policy decisions. A tool to visualize the power—and danger—of decisions in complex systems.

Model Documentation

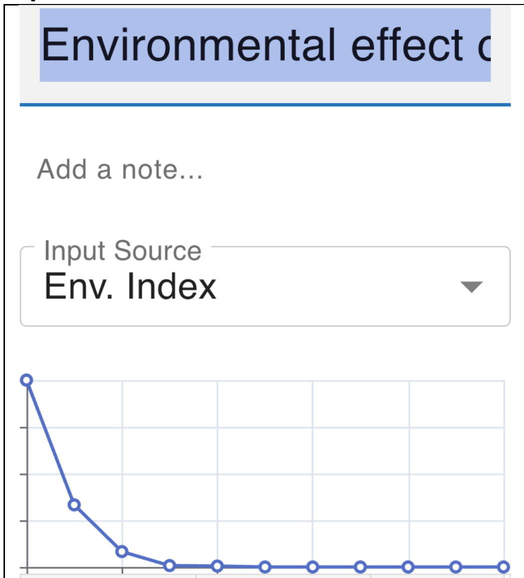
Model Table

No	Type	Name	Formula / Value	Units
1	Stock	Population	Initial value: 200000	People
2	Stock	Environment Env.	Initial value: [Initial environment]	EU
3	Flow	Births	[Population]*[Current birth fraction]	People/ centuries
4	Flow	Deaths	[Population]*[Current death fraction]	People/ centuries
5	Flow	Environmental damage	[Environment Env.]*[Current damage fraction]	EU/ centuries
6	Flow	Ecosystem regeneration	[Environment Env.]/[Current regeneration time]	EU/ centuries
7	Variable	Initial environment	100	EU
8	Variable	EU Index	[Environment Env.]/[Initial environment]	Unitless
9	Variable	Normal regeneration time	1*(1+Ifthenelse([Pol regen Up],1,-1)*Ifthenelse([Pol regen time],1,0)*step(5,10/100))	centuries
10	Variable	Current regeneration time	[Normal regeneration time]*[Env. effect on regeneration]	centuries

11	Variable	Normal death fraction	1.82*(1+Ifthenelse([Pol death Up],1,-1)*Ifthenelse([Pol death],1,0)*step(5,10/100))	1/ Centuries
12	Variable	Current death fraction	[Normal death fraction]*[Environmental effect on deaths]	1/ Centuries
13	Variable	Net flow	[Births]-[Deaths]	People/ centuries
14	Variable	Normal birth fraction	2*(1+Ifthenelse([Pol birth Up],1,-1)*Ifthenelse([Pol birth],1,0)*step(5,10/100))	1/ Centuries
15	Variable	Current birth fraction	[Normal birth fraction]	1/ Centuries
16	Variable	Land area	10000*(1+Ifthenelse([Pol land UP],1,-1)*Ifthenelse([Pol land],1,0)*step(5,10/100))	Area
17	Variable	Density	[Population]/[Land area]	People/ Area
18	Variable	Normal density	20*(1+Ifthenelse([Pol density Up],1,-1)*Ifthenelse([Pol density],1,0)*step(5,10/100))	People/ Area
	Variable	Density ratio	[Density]/[Normal density]	Unitless
19	Variable	Normal damage fraction	1*(1+Ifthenelse([Pol damage Up],1,-1)*Ifthenelse([Pol damage],1,0)*step(5,10/100))	1/ Centuries
20	Variable	Current damage fraction	[Normal damage fraction]*[Density effect on environment]	1/ Centuries
21	State	Pol birth	False - Show value toggle (Active)	Unitless
22	State	Pol birth Up	true - Show value toggle (Active)	Unitless
23	State	Pol death	False - Show value toggle (Active)	Unitless
24	State	Pol death Up	False - Show value toggle (Active)	Unitless
25	State	Pol land	False - Show value toggle (Active)	Unitless
26	State	Pol land Up	True - Show value toggle (Active)	Unitless
27	State	Pol density	False - Show value toggle (Active)	Unitless
28	State	Pol density Up	True - Show value toggle (Active)	Unitless
29	State	Pol damage	False - Show value toggle (Active)	Unitless
30	State	Pol damage Up	False - Show value toggle (Active)	Unitless
31	State	Pol regen time	False - Show value toggle (Active)	Unitless
32	State	Pol regen Up	False - Show value toggle (Active)	Unitless

Name: Environmental effect on deaths

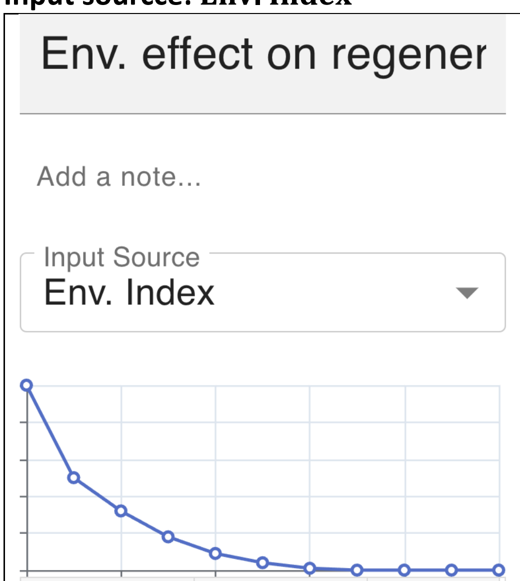
Type: Converter
Ubterpolation: Linear
Unit: Unitless
Input sourcce: Env. Index



Env. Index	Environmental effect on deaths
0	5
0.1	2.33
0.2	1.33
0.3	1.03
0.4	1.02
0.5	1
0.6	1
0.7	1
0.8	1
0.9	1
1	1

Name Env. effect on regeneration

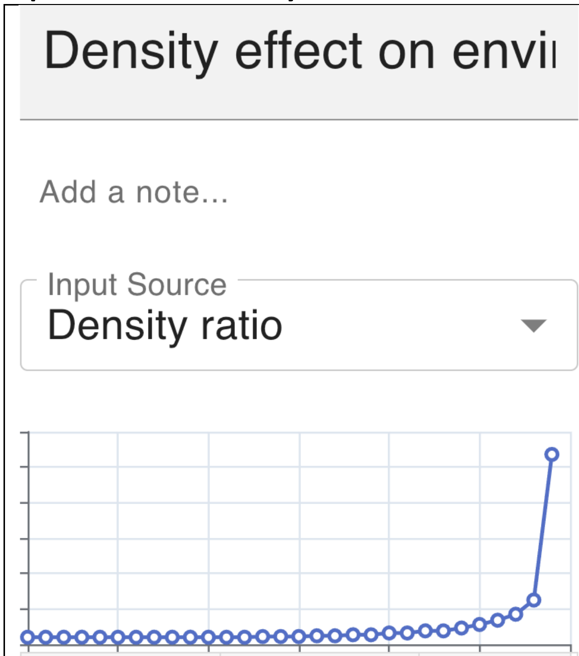
Type: Converter
Ubterpolation: Linear
Unit: Unitless
Input sourcce: Env. Index



Env. Index	Env. effect on regeneration
0	2
0.1	1.5
0.2	1.32
0.3	1.18
0.4	1.09
0.5	1.04
0.6	1.01
0.7	1
0.8	1
0.9	1
1	1

Name: Density effect on environment

Type: Converter
Ubterpolation: Linear
Unit: Unitless
Input sourcce: Density ratio



Density ratio	Density effect on environment
0	1
1	1
2	1
3	1
4	1
5	1
6	1
7	1
8	1
9	1
10	1
11	1
12	1
13	1.1
14	1.1
15	1.1
16	1.2
17	1.2
18	1.35
19	1.35
20	1.6
21	1.6
22	1.9
23	1.9
24	2.3
25	2.8
26	3.4
27	4.25
28	6.25
29	26.8

The Illusion of Growth: When It's Already Too Late

🟥 **Description:**

For decades, even centuries, everything seems fine. The population rises, public policies boost productivity, and the curve points upward. What remains hidden—or ignored—is the slow and cumulative erosion of the environment. When collapse finally begins, it is systemic, rooted… and irreversible.

This dynamic applies not only to ancient civilizations like the Maya, but also to **modern organizations, industries, and governments**. Many companies, for instance, focus on scaling without assessing the sustainability of supply chains, staff burnout, or declining product quality. Collapse may not be environmental, but it can be **organizational, reputational, or financial**.

This model challenges us to identify **early signals**, monitor **invisible indicators**, and adopt a **systemic mindset** before feedback loops turn catastrophic.

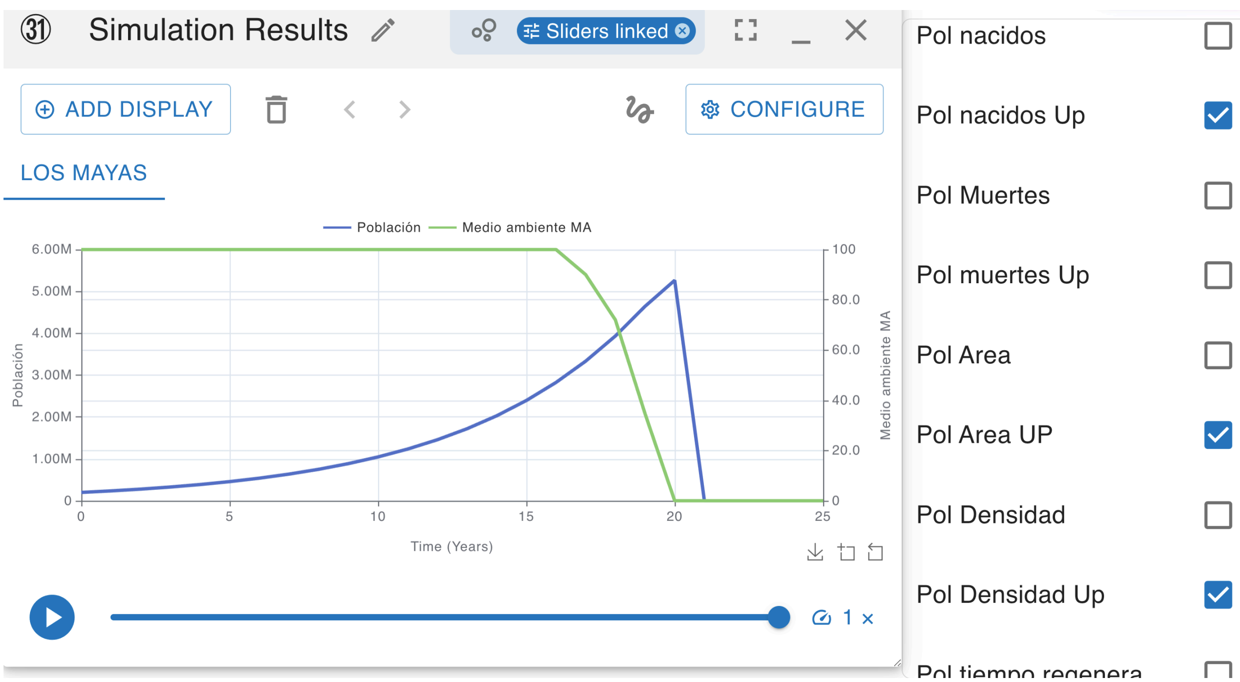


Figure 6: System behavior over time: Population growth (blue line) conceals the silent collapse of the environment (green line). When collapse hits, it is sudden and unstoppable, taking the entire system down.

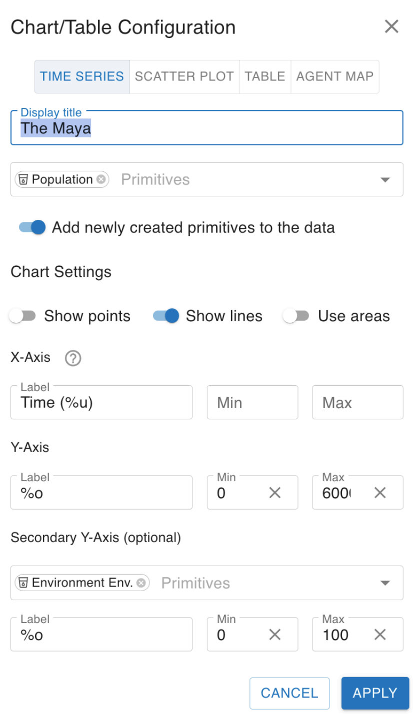


Figure 7: Graph settings: axes and ranges defined to display the epidemic's progression.

Model Registration & Settings

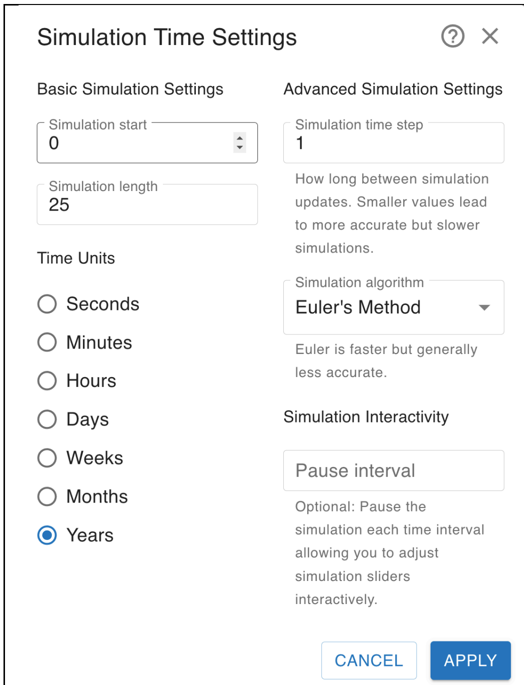


Figure 8: Model settings: Temporal and simulation parameters (duration, time steps, and interactivity options) that govern the run.

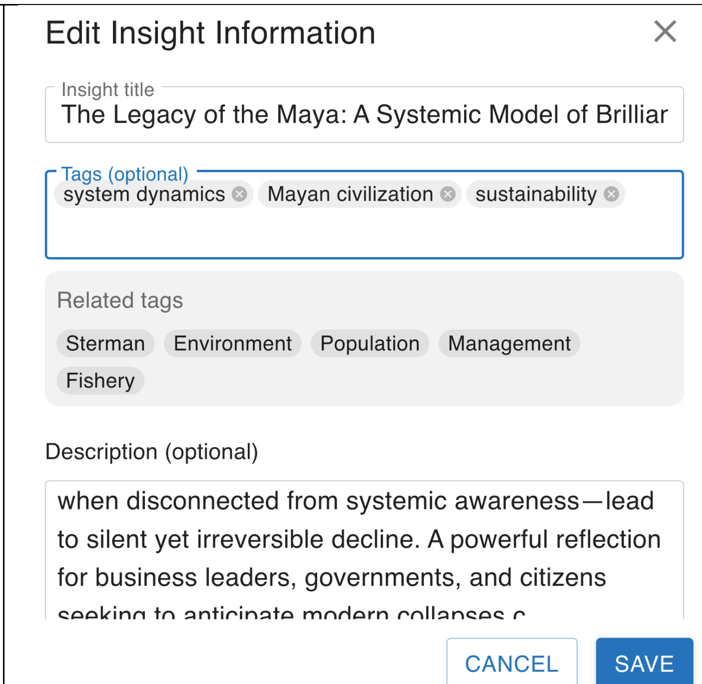


Figure 9:Model registration: Key metadata (title, author, date, and keywords) to categorize and locate the model.

🟩 Conclusion

Collapse never comes with thunder. It arrives silently—after years of disconnected decisions.
Just like the ancient Maya built one of the most brilliant—and most fragile—civilizations, **today we are designing business, political, and social systems that appear successful… until they aren't.**
When decisions are made without understanding the structures that sustain or erode a system, collapse is seeded from within. **Even a well-intentioned policy can accelerate decline if its systemic consequences are ignored.**
Now more than ever, organizations must **think in cycles, trace invisible causes, and identify structural limits**. They must model, simulate, and anticipate. Not as a trend, but as a matter of survival.
Because when collapse begins, **no strategic plan, crisis committee, or motivational speech can stop it.**
But there is hope: the same models that reveal collapse can guide us to redesign systems that are resilient, regenerative, and truly sustainable.
The future belongs to those who learn to think systemically.

🟦 Metadata in English

- **Project Title:**
  The Legacy of the Maya: A Systemic Model of Brilliance and Collapse
- **Abstract:**
  This project explores the rise and collapse of the Mayan civilization through a systemic lens. Using simulation models, it reveals feedback loops, structural limits, and public policy decisions that—when disconnected from systemic awareness—lead to silent yet irreversible decline. A powerful reflection for business leaders, governments, and citizens seeking to anticipate modern collapses.
- **Keywords:**
  systems thinking, system dynamics, Mayan civilization, collapse, sustainability, simulation models, public policy, organizational learning, feedback loops, growth limits
- **Author(s):**
  Pedro D. Almaguer Prado, Ramiro Luis Almaguer Navarro – Escuela Sistémica / Oasis Incubator Online
- **Date of Publication:**
  June 2025
- **Target Audience:**
  Decision-makers, executives, academics, sustainability students, public policy leaders, and innovation professionals.

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    iv. Las ciudades perdidas de los Mayas (Parte 2)
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    vii. Las siete profecías Mayas (Parte 2)
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