The Limits to Growth: Sustainability and the Circular Economy

Lecture 11 – Complex Societies and Technologies

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NEWS/UPDATES

Course Evaluation

- Link: Click Me

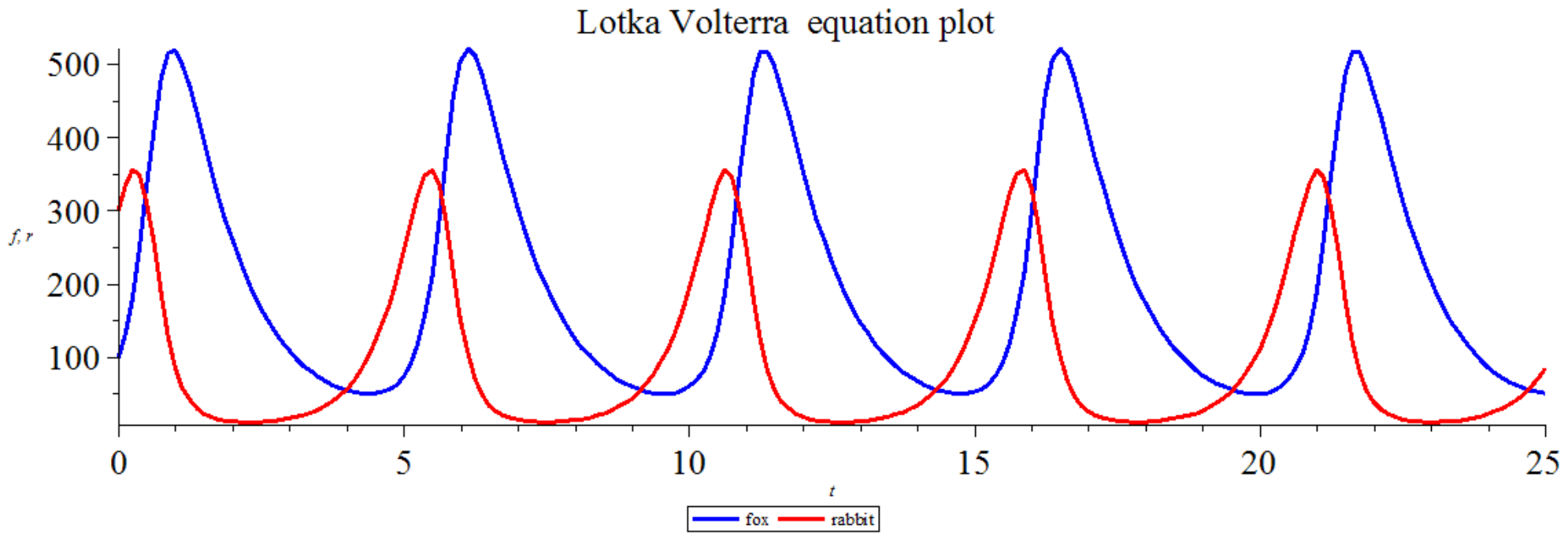
INTRODUCTION

Introduction

Finite Systems – Sandbox / Playground

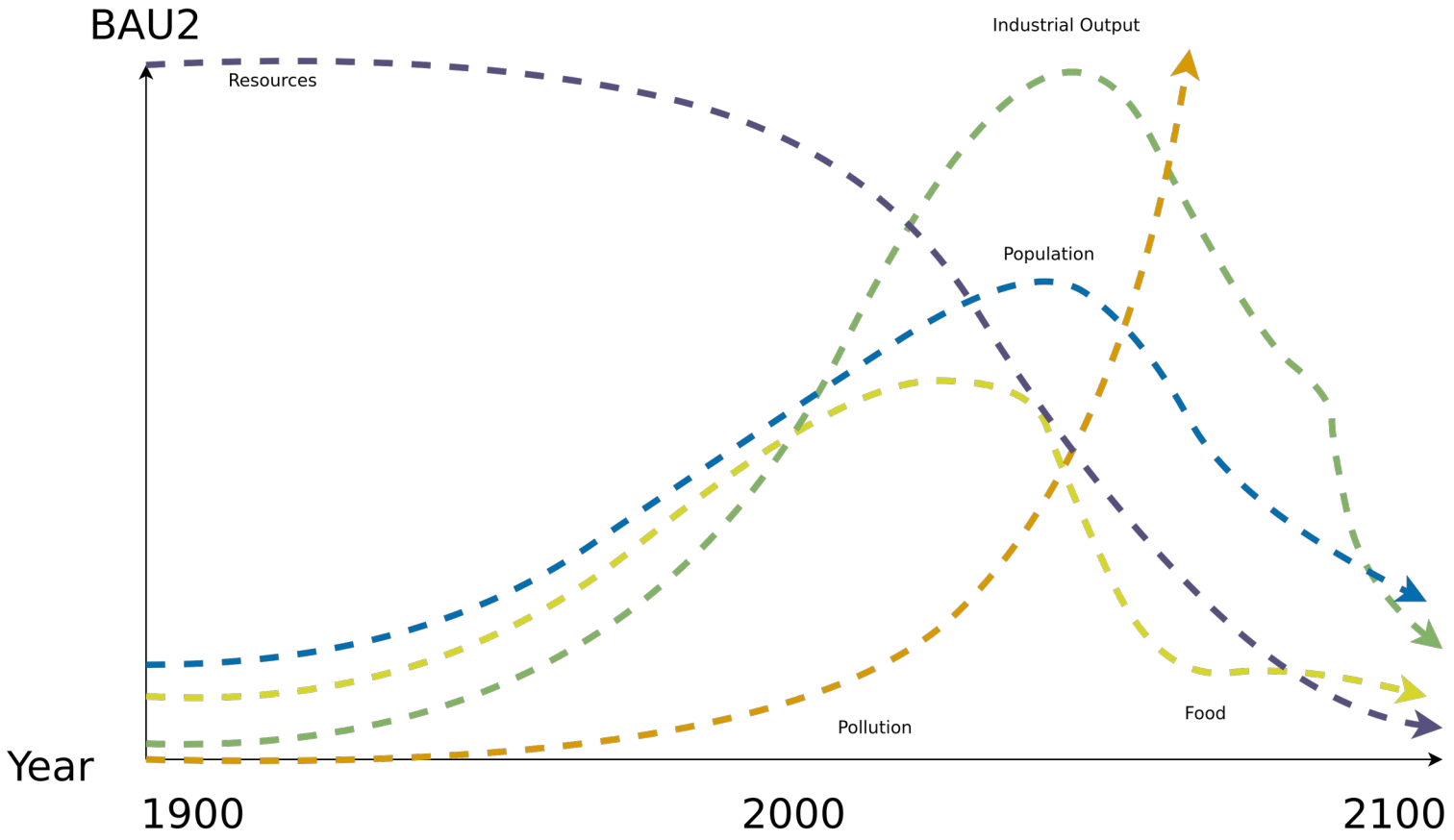
Introduction

Lotka–Volterra Equations (Predator–Prey Equations)



Introduction

World3 Standard Run – Business-as-Usual2 (BAU2)

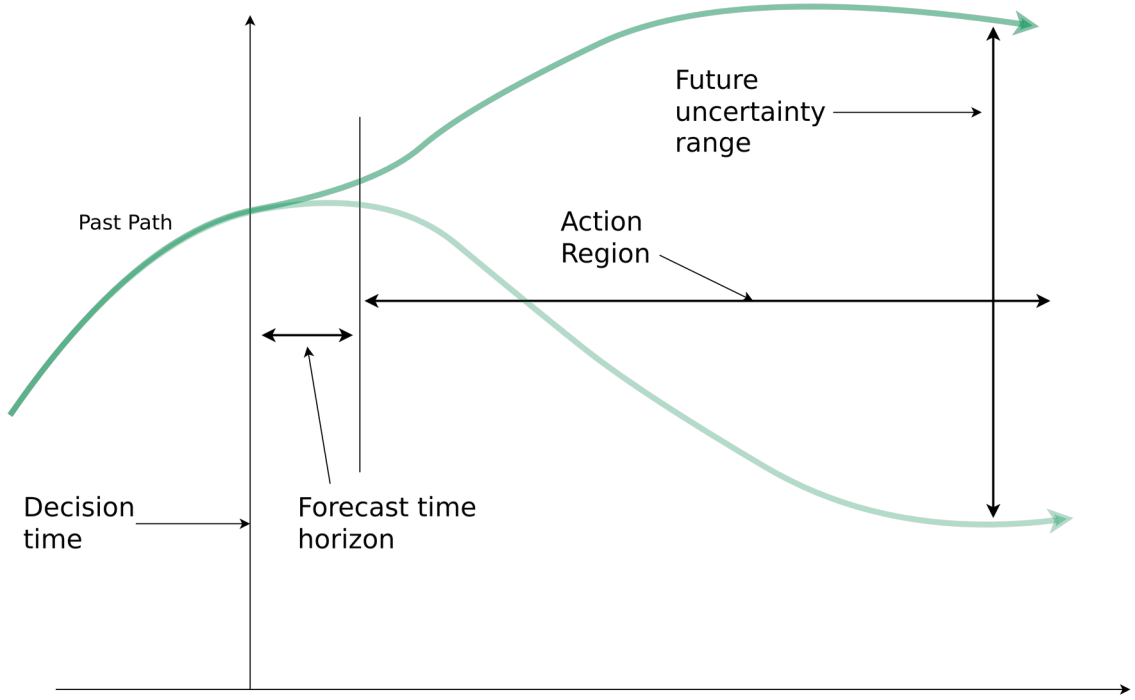


→ Collapse due to pollution (climate change equivalent)

Image recreated from: Gaya Herrington (2020) – Update to limits to growth: Comparing the World3 model with empirical data – Link

Introduction

Forrester's Dilemma



"One can forecast future conditions in the region where action is not effective, and one can have influence in the region where forecasting is not reliable." – Forrester, 2007

Image recreated from: Brian Hayes (2012) – Computation and the Human Condition (Harvard SEAS) – Link

Introduction

Ancient Civilizations

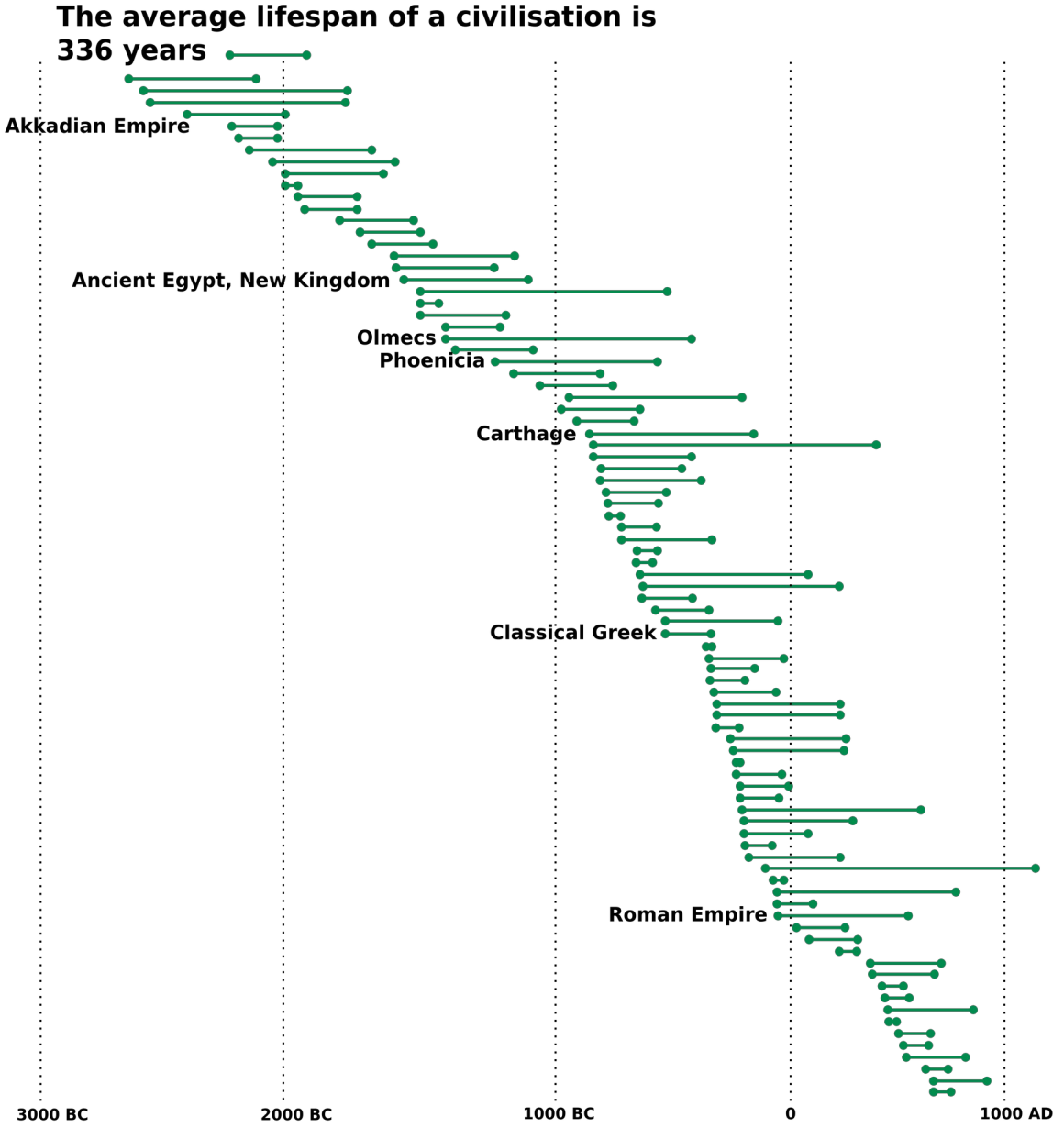


Image recreated from BBC (2019) — Link

Age of Empires

How do History's empires compare?

Empires don't grow and collapse at a steady rate; they grow in hops and jumps and frequently collapse all at once (there's often blood involved). This chart shows peak size, start and end dates, and symbolic rise and decline.

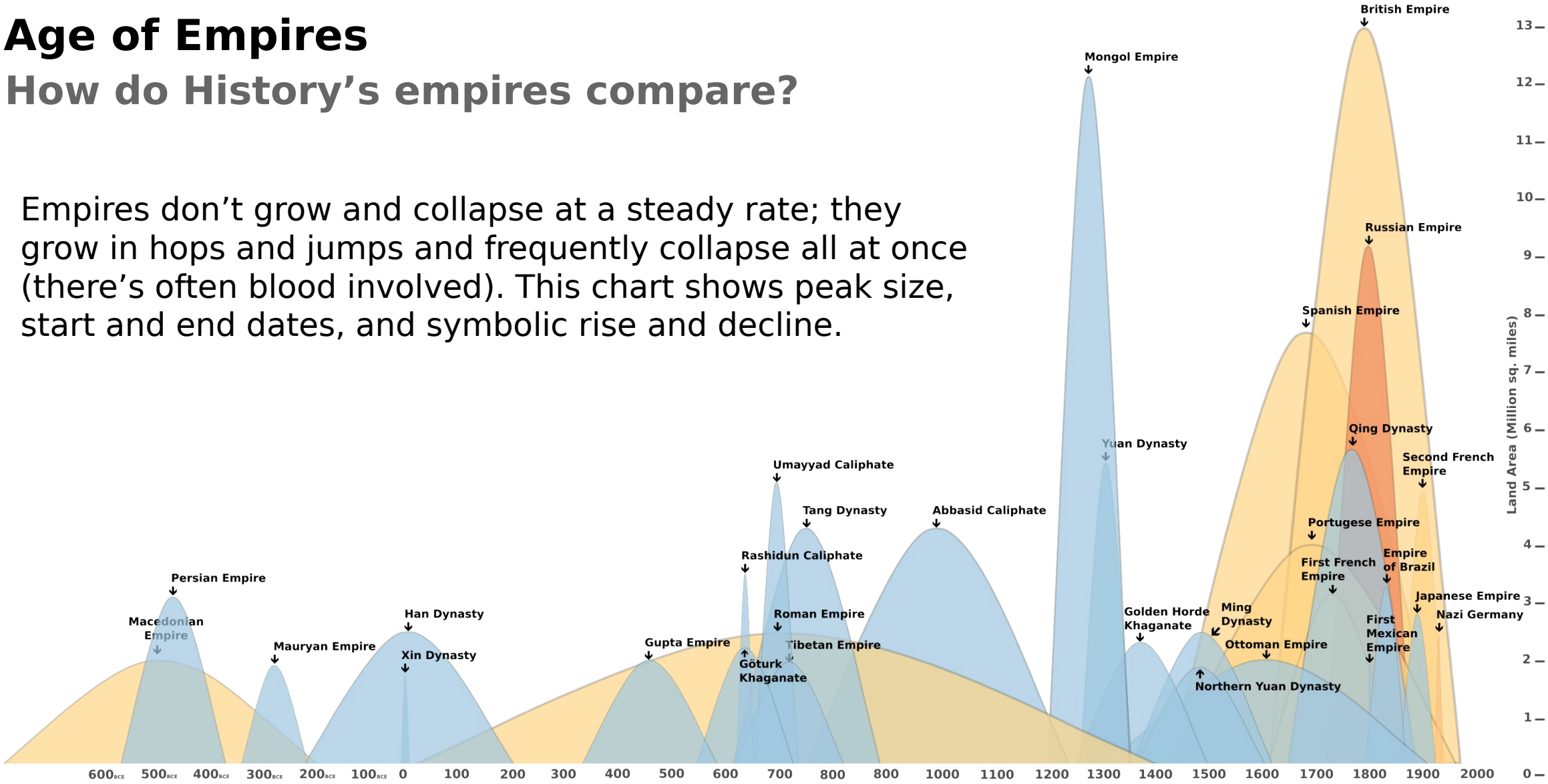


Image recreated from Brian Hay From J. Schwochow's 'The World Explained in 264 Infographics' (2021)

TASK 1 – WHAT IS COLLAPSE GONNA LOOK LIKE? (20MIN)

CATABOLIC COLLAPSE

Catabolic Collapse

Collapse

“A society has collapsed when it displays a rapid, significant loss of an established level of sociopolitical complexity”

Joseph Tainter (1988) – The Collapse of Complex Societies. Cambridge University Press.

Catabolic Collapse

Definition

*"Relationships among **resources**, **capital**, **waste**, and **production** form the basis for an ecological model of **collapse** in which production fails to meet maintenance requirements for existing capital. **Societies** facing such crises after **having depleted essential resources risk catabolic collapse**, a self-reinforcing cycle of contraction converting most capital to waste."*

John Michael Greer (2015) – How Civilizations Fall: A Theory of Catabolic Collapse

Catabolic Collapse

Theory – Resources and Capital

- **Resources (R)**
  - Naturally occurring exploitable factors in the environment
  - Not (yet) extracted/incorporated into the society's flows of energy and material
  - E.g., not yet mined minerals, soil fertility, human resources (not yet working), etc.

- **Capital**
  - All factors from whatever source that have been incorporated into the society's flows of energy and material but are capable of further use.
  - E.g., food, tools, buildings, human capital (labourers), etc.

Catabolic Collapse

Theory – Waste and Production

- **Waste (W)**
  - Energy and material that have been incorporated into society but are now exploited to the point that they are incapable of further use.
  - Also → pollution

- **Production (P)** is the process by which existing capital and resources are combined to create new capital and waste.

Catabolic Collapse

Theory – Production vs. Maintenance

- C(p) = M(p)
  - C(p) is new capital produced
  - M(p) is maintenance of production

Catabolic Collapse

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- C(p) = M(p) = W(p) + W(c) == steady state
  - W(p) is existing capital converted to waste in the production of new capital
  - W(c) is existing capital converted to waste outside of production

Catabolic Collapse

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- C(p) > M(p) == expansion

Catabolic Collapse

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- C(p) > M(p) == expansion
- C(p) < M(p) == contraction

Catabolic Collapse

Theory – Replenishment vs. Depletion

- r(R) → replenishment rate
- d(R) → depletion rate

- d(R) / r(R) > 1 → resources become depleted

Catabolic Collapse

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- r(R) → replenishment rate
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- Liebig's law of the minimum:
  - Essential resource with the highest value for d(R)/r(R) may be used as a working value of d(R)/r(R) for resources as a whole

Catabolic Collapse
Theory

- C(p) < M(p) → contraction, but also **maintenance crisis**
- d(R) / r(R) > 1 → contraction, but also **depletion crisis**

Catabolic Collapse

Theory – Catabolic Cycle

*"**A self-reinforcing process in which C(p) stays below M(p) while both decline**. Catabolic cycles may occur in maintenance crises if the gap between C(p) and M(p) is large enough, but tend to be self-limiting in such cases. **In depletion crises, by contrast, catabolic cycles can proceed to catabolic collapse**, in which C(p) approaches zero and most of a society's capital is converted to waste."*

John Michael Greer (2015) – How Civilizations Fall: A Theory of Catabolic Collapse

Collapse

Causes of Collapse

- Resource scarcity
- Large-scale catastrophic events (e.g., pandemics)
- Inadequate institutional responsiveness (e.g., insufficient speed or adaptability)
- Inter-societal conflict among complex polities (e.g., interstate warfare)
- External incursions (e.g., raids by non-state or peripheral groups)
- Governance failures and administrative mismanagement
- Social fragmentation and dysfunction (e.g., intensified intra-familial conflict)
- Cascading systemic failures (i.e., sequential, compounding disruptions)
- Economic collapse or severe fiscal distress

TASK 2 – LESSONS LEARNED? (15 MIN)

Catabolic Collapse

Lessons Learned / Implications

- “Technology is gonna safe us” vs. maintenance cost/crisis
- Minimize use of resources
  - Sufficiency
  - Consume less
- Less complex societies → The earlier we adapt, the better
- What else?