

# The Limits to Growth: Sustainability and the Circular Economy

## Lecture 5 - Bonus: Catabolic Collapse

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# INTRODUCTION

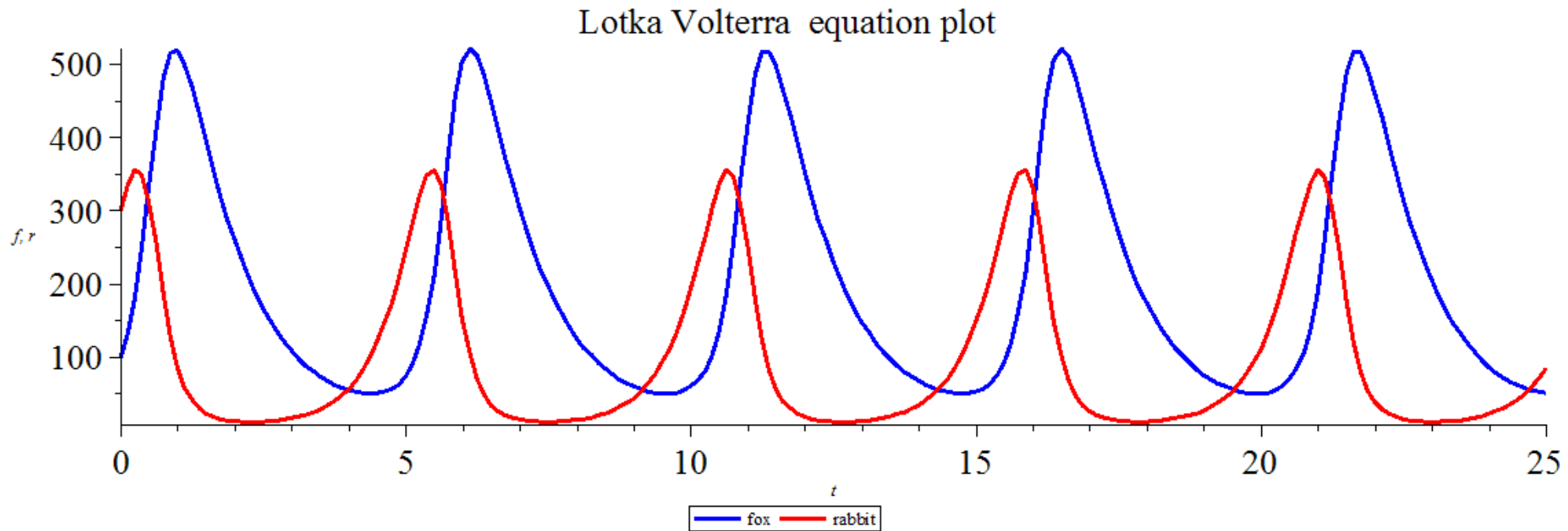
# Introduction

## Finite Systems - Sandbox / Playground



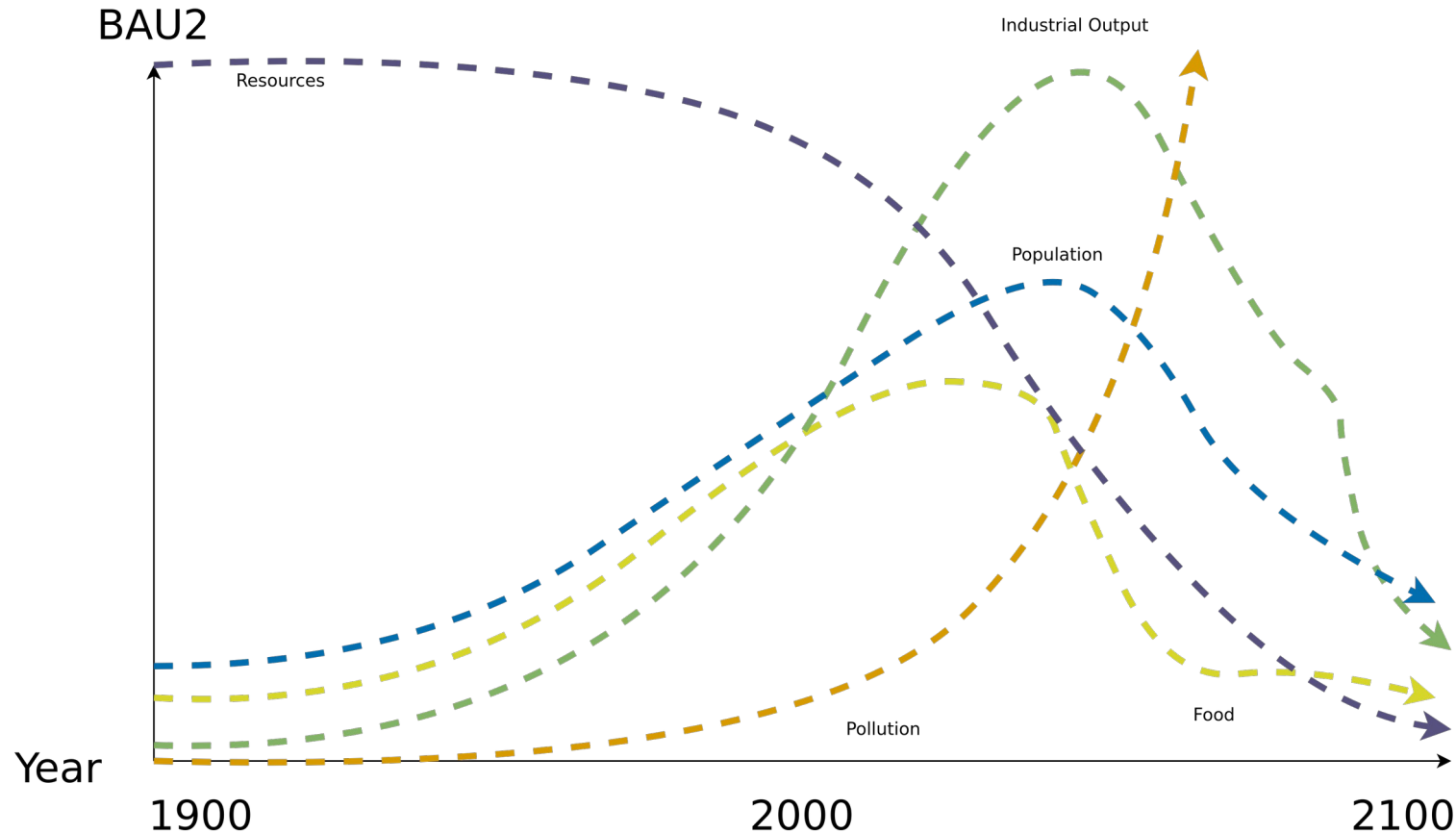
# Introduction

## Lotka-Volterra Equations (Predator-Prey Equations)



# Introduction

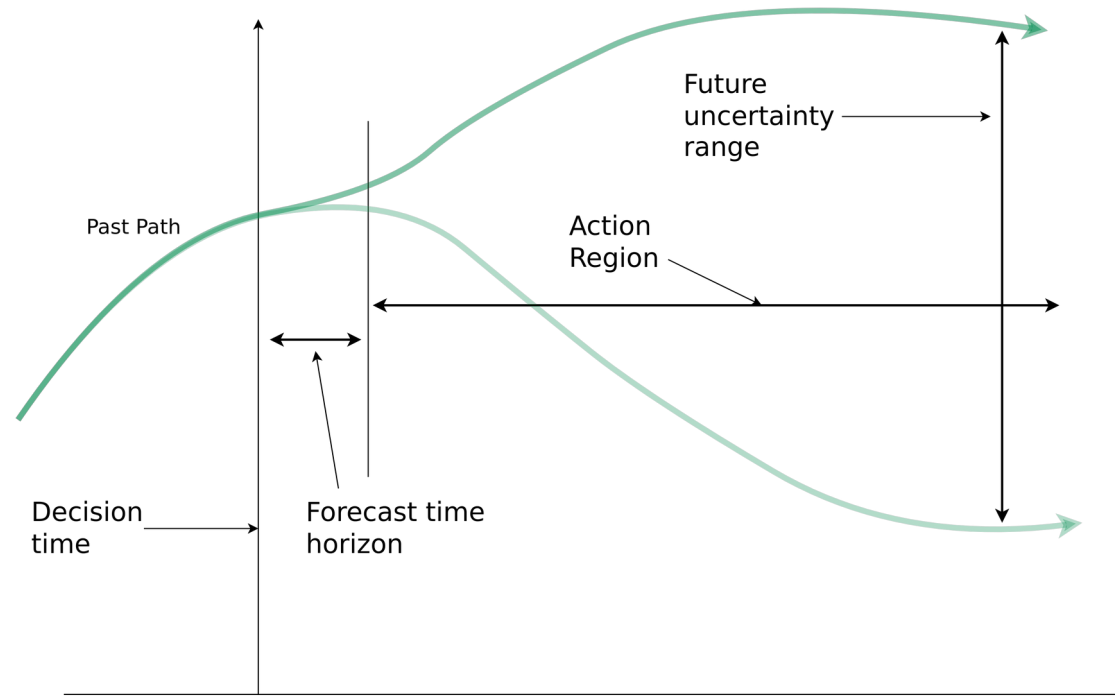
## World3 Standard Run - Business-as-Usual2 (BAU2)



→ Collapse due to pollution (climate change equivalent)

# 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*



## **TASK 1 – WHAT IS COLLAPSE GONNA LOOK LIKE? (10MIN)**





# CATABOLIC COLLAPSE

# Catabolic Collapse

## Collapse

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

# 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.”*

# 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

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# 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

## Theory - Replenishment vs. Depletion

- $r(R)$  → 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

- $C(p) < M(p) \rightarrow$  contraction, but also **maintenance crisis**
- $d(R) / r(R) > 1 \rightarrow$  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.”***



## TASK 2 – LESSONS LEARNED? (5 MIN)

# Catabolic Collapse

## Lessons Learned / Implications

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