

BUSH ENCROACHMENT AS A REGIME SHIFT: A REVIEW OF KEY FEEDBACKS AND DRIVERS

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INTRODUCTION

- As human activities have grown in magnitude, they have become increasingly interlinked with ecosystem dynamics creating social-ecological systems (SES).
- Human activities are also leading to an increased occurrence of **regime shifts**.
- As global changes accelerate, better understanding the drivers and risks of regime shifts is a key need.



Open Grassy Savanna

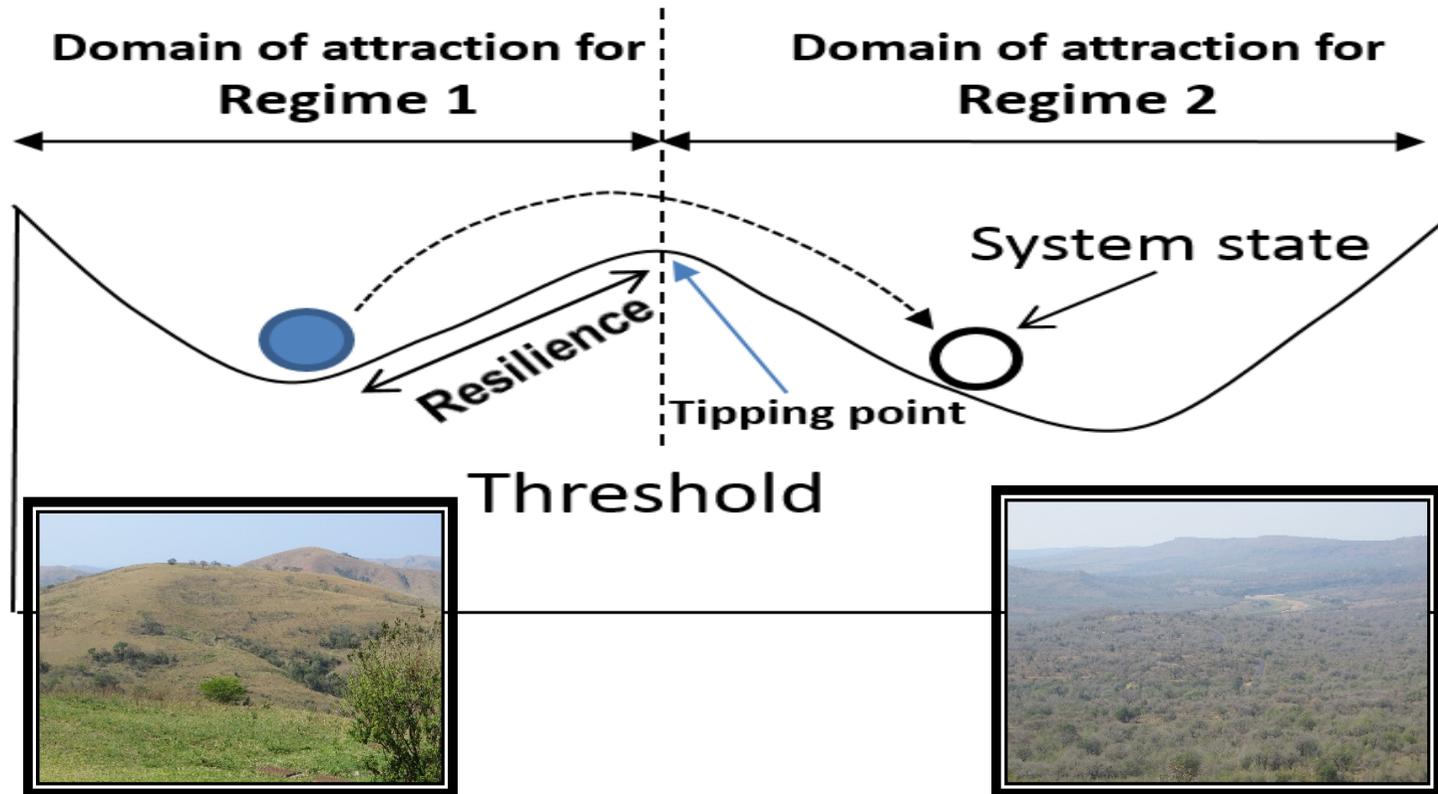


Woodland / Forest



WHAT ARE REGIME SHIFTS?

- **regime shifts:** large, persistent changes in the structure and function of SES.

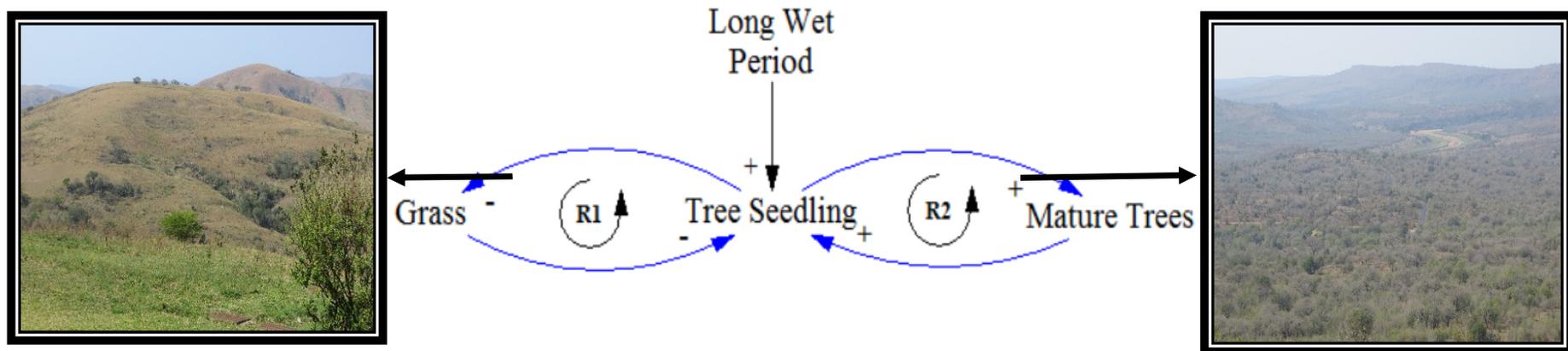


- **Resilience** is the degree of change that a system can absorb without undergoing a regime shift.



WHAT CAUSES REGIME SHIFTS?

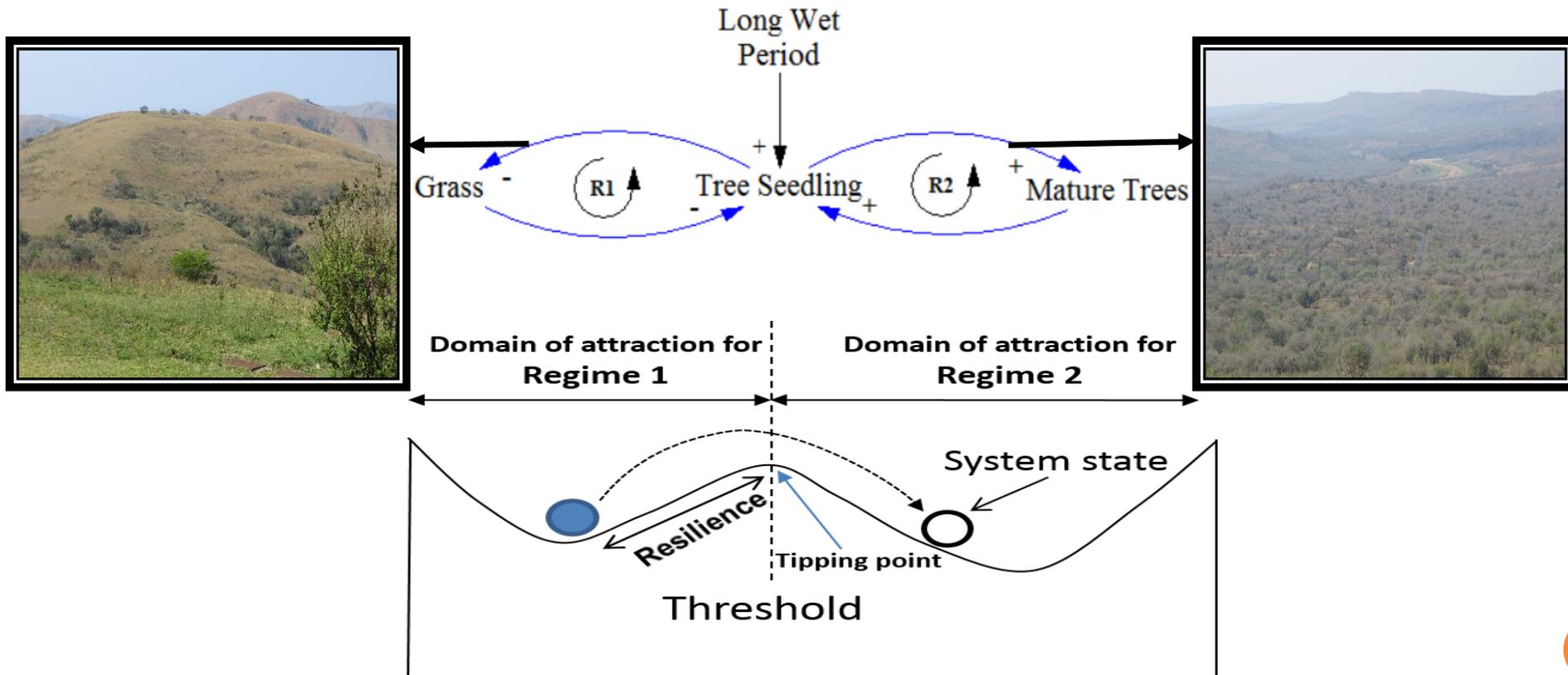
- Regimes are created by multiple systems interactions and feedbacks.
- Feedbacks occur when a change in a particular variable in the system leads to changes in the system that eventually loop back to affect the original variable.



- **Different feedbacks can dominate & structure the system**

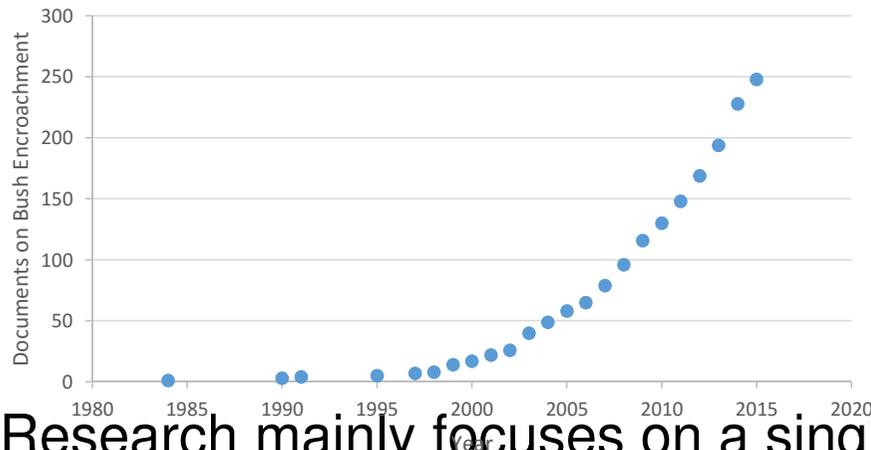
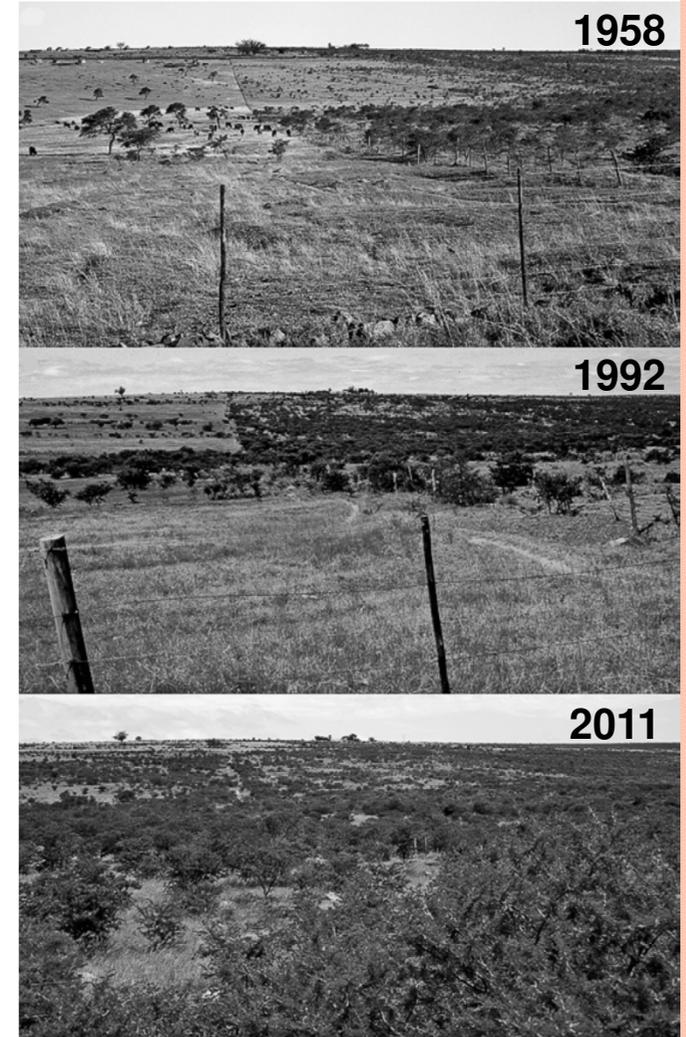
WHAT CAUSES REGIME SHIFTS?

- Different feedbacks can dominate & structure the system



WHY FOCUS ON BUSH ENCROACHMENT

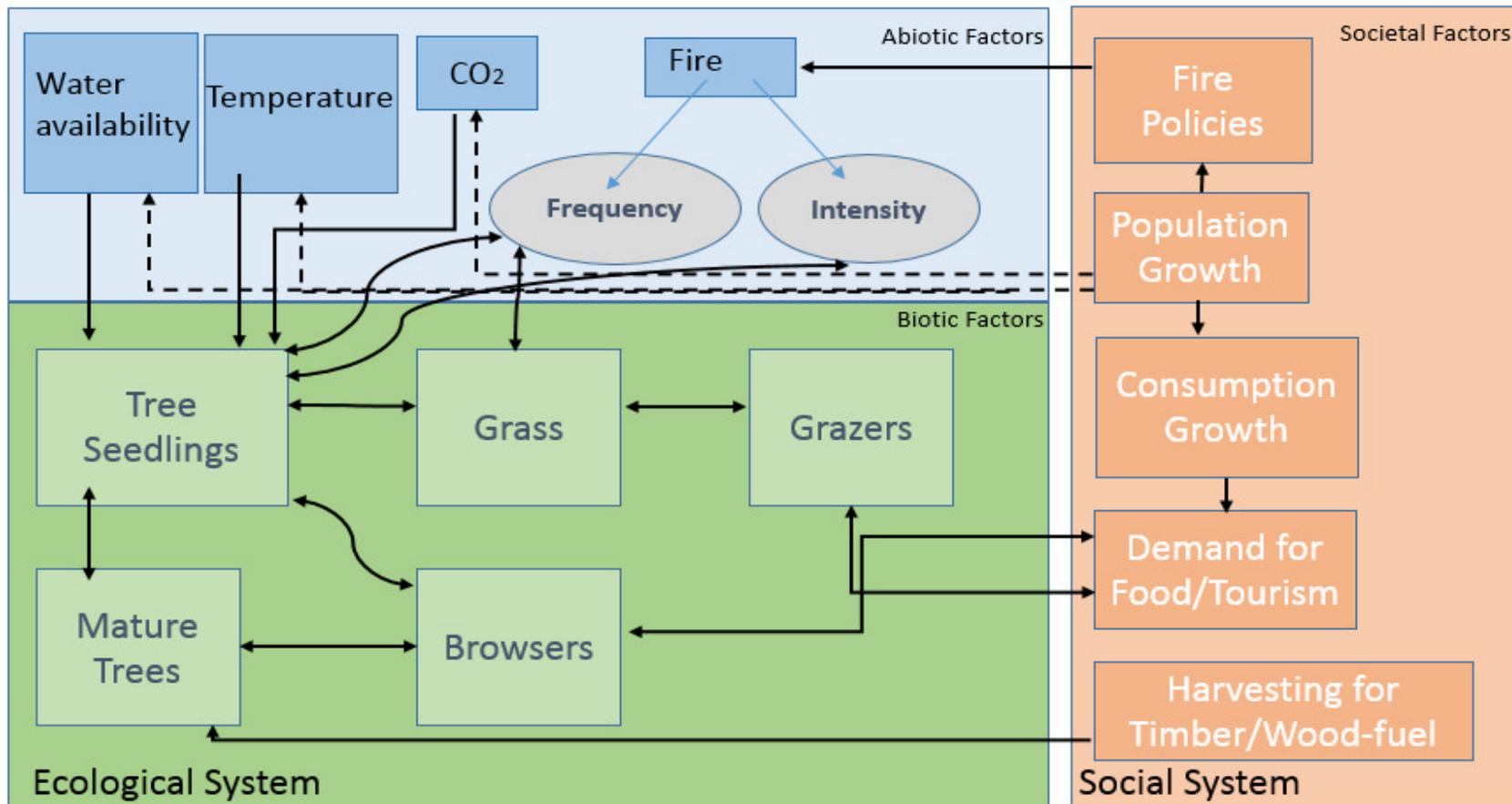
- A challenge in southern Africa for nearly a century, and becoming a global prevalence in savannas.
- Widely studied due to its economic, cultural and ecological implications.



- Research mainly focuses on a single effect of certain drivers, e.g fire, grazing, CO₂.

Pictures from O'Connor *et al.*, 2014

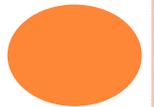
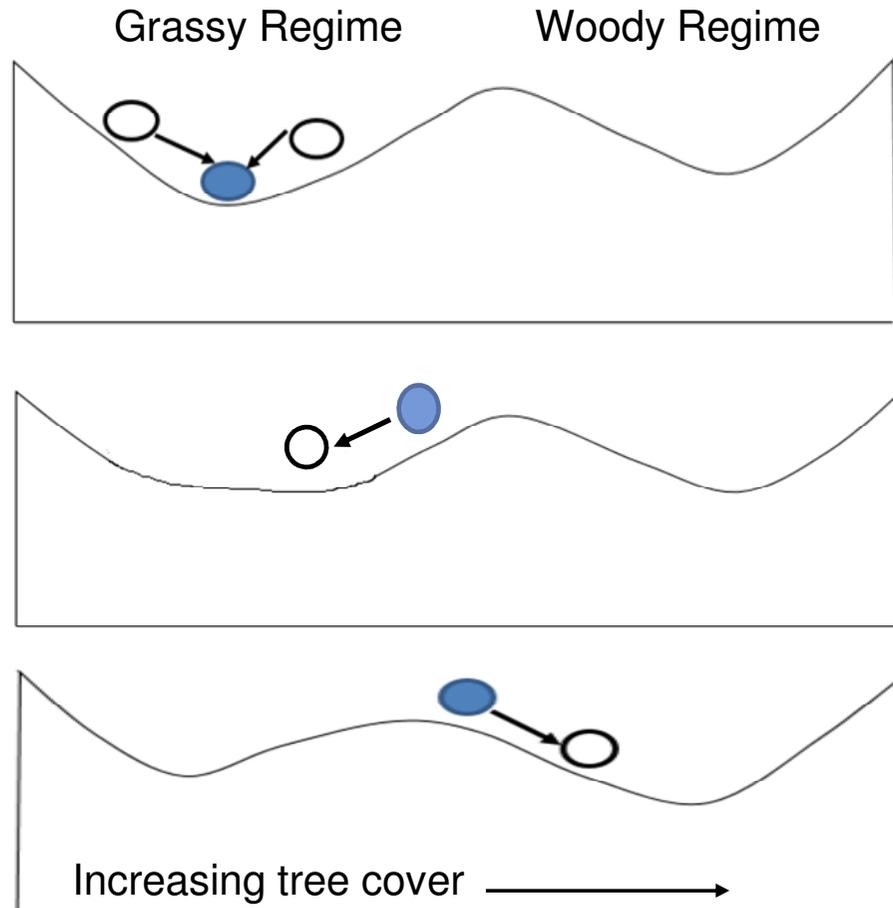
SAVANNA: COMPLEX, SOCIAL-ECOLOGICAL SYSTEMS



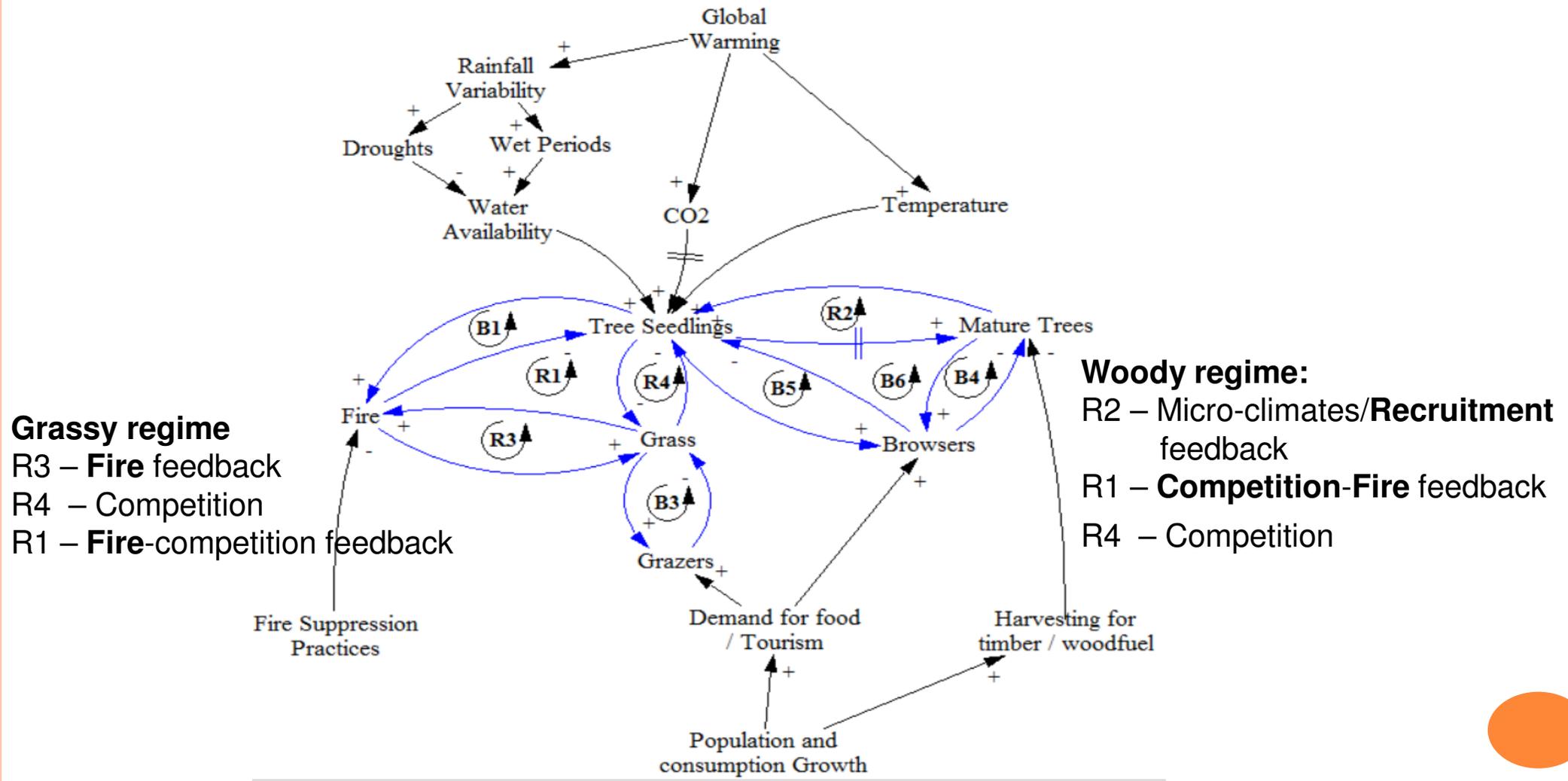
A simplified causal loop diagram illustrating the main processes and feedbacks that occur in a savanna social-ecological system.

BUSH ENCROACHMENT AS A REGIME SHIFT

- Savannas exist in two alternate self-reinforcing regimes: an **open, grass dominated** regime and a **closed, tree/shrub dominated** regime.



FEEDBACK MECHANISMS



Grassy regime
 R3 – **Fire** feedback
 R4 – Competition
 R1 – **Fire-competition** feedback

Woody regime:
 R2 – Micro-climates/**Recruitment** feedback
 R1 – **Competition-Fire** feedback
 R4 – Competition

Causal loop diagram illustrating bush encroachment regime shift in savanna systems



BENEFITS OF A REGIME SHIFT VIEW

- Holistic
- No single focus on driver, but on feedback loops
- Leverage points – which feedbacks should be strengthened or weakened considering further scenarios?

