Strategies For Adapting FLR To Climate Change

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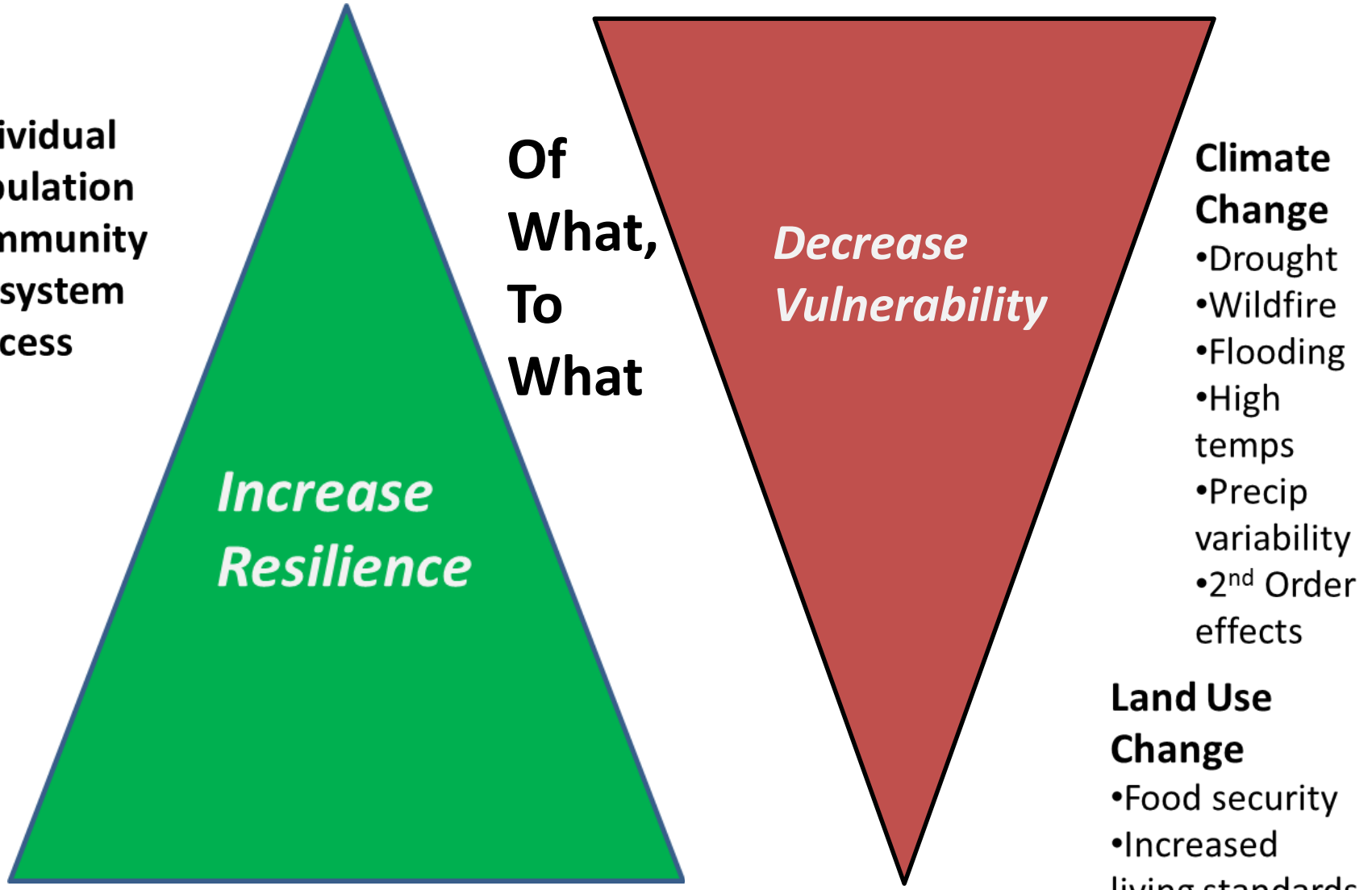
Key Points

- **Need for restoration will increase due to extreme climatic events, altered climate means, and land use change**
- **Goal of adaptation is to decrease vulnerability and increase resilience to global change**
- **Adaptation strategies are incremental, anticipatory, or transformational**
- **Strategies differ in their tolerance of novelty**
- **Common themes are adapted genotypes, resistance to pathogens, manage herbivory to ensure adequate regeneration, species and structural diversity at stand and landscapes levels, and connectivity and reduced fragmentation**

Restoration Under Global Change



FLR Climate Change Adaptation Strategies

- Incremental
  - No-regrets approaches; benefits under current climate (but not Business as Usual)
- Anticipatory
  - Uses the same techniques but future-climate oriented
- Transformational
  - Proactive approaches to future climate conditions
- **When to Act(Adapt) harder to determine than what to do**

Commonality Among Adaptation Approaches

- Favor genotypes adapted to future conditions
- Resist pathogens
- Manage herbivory to ensure adequate regeneration
- Encourage species and structural diversity at stand and landscapes levels
- Provide connectivity and reduce fragmentation

10 years, taungya system, Ghana (photo: J. Stanturf)

Adaptation Strategies—Different Tolerances of Ecological Novelty

- Novelty Defined:
  - "…the degree of dissimilarity of a system, measured in one or more dimensions relative to a reference baseline…novelty varies in degree, it is multidimensional, can be measured, and requires a temporal and spatial reference." Radeloff et al. 2015 *Ecological Applications*
- Incremental
  - Novelty Intolerant
- Anticipatory
  - Intermediate Novelty Tolerance
- Transformational
  - Novelty Tolerant

(photo: R. Harper)

	Adaptation Strategies		
Features	Incremental	Anticipatory	Transformational
Vulnerability Target	Reduce vulnerability to current stressors	Reduce vulnerability to current and future stressors	Reduce vulnerability to current and future stressors
Restoration Paradigm	Ecological restoration: historic fidelity	Functional restoration	Intervention ecology
Species	Native	Native, or exotic with functional equivalencies	Native, exotic, or designer species
Genetics	Local sources, natural evolution	Conventional breeding or biotechnology for clones or provenances with adaptive traits	Transgenic for keystone species, cloning extinct species
Assisted Migration	Assisted population migration (native species within historic range)	Assisted range expansion (source or receiving)	Assisted migration (species translocation: outside native range; source or receiving)
Novel Ecosystems	Prevent or avoid	Accept and manage neo-native (emergent) assemblages	Manage novel and emergent ecosystems (exotics dominate)

Adapted from Stanturf 2015 New Forests.

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Which Strategy?

	Short- to Medium-Term	Medium- to Long-Term
Stable climate, land use	Incremental to Anticipatory	Anticipatory
Dynamic but predictable change in climate, land use	Anticipatory	Anticipatory to Transformational
Spatio-temporal chaos	Anticipatory to Transformational	Transformational

Incremental and Anticipatory Adaptation Opportunites in FLR

Objective	Mechanism	Activity	Level
Maintain forest area	Reduce deforestation drivers	Prevent agricultural encroachment	T=stand L=landscape N=national
Maintain carbon stocks	Reduce or avoid degradation	Policy reforms to avoid clearing native forests	LN
Maintain or improve other forest functions	Biodiversity	Silvicultural interventions to increase species diversity	S=species TL
Reduce vulnerability	Increase resistance and resilience to stressors	Introduce new species or more climate-adapted provenances	STL

Transformational Adaptation Opportunities in FLR

Objective	Mechanism	Activity	Level
Manage novel ecosystems	Manage spontaneous ecosystems	Manage new species combinations that emerge	STLN
 (photo: T. Waldrop)	Create novel ecosystems	Policy that allows planting non-native species or transgenic trees	SN
		Assisted long distance species migration	STLN


THANKS!!!
Gracias!