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Rangeland Management in the 21st Century

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X CONGRESO INTERNACIONAL DE MANEJO DE PASTIZALES

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Rangeland Management 20th Century

Management and regulations needed to reduced overgrazing and rangeland degradation; goal to maintain sustainable forage and livestock production.

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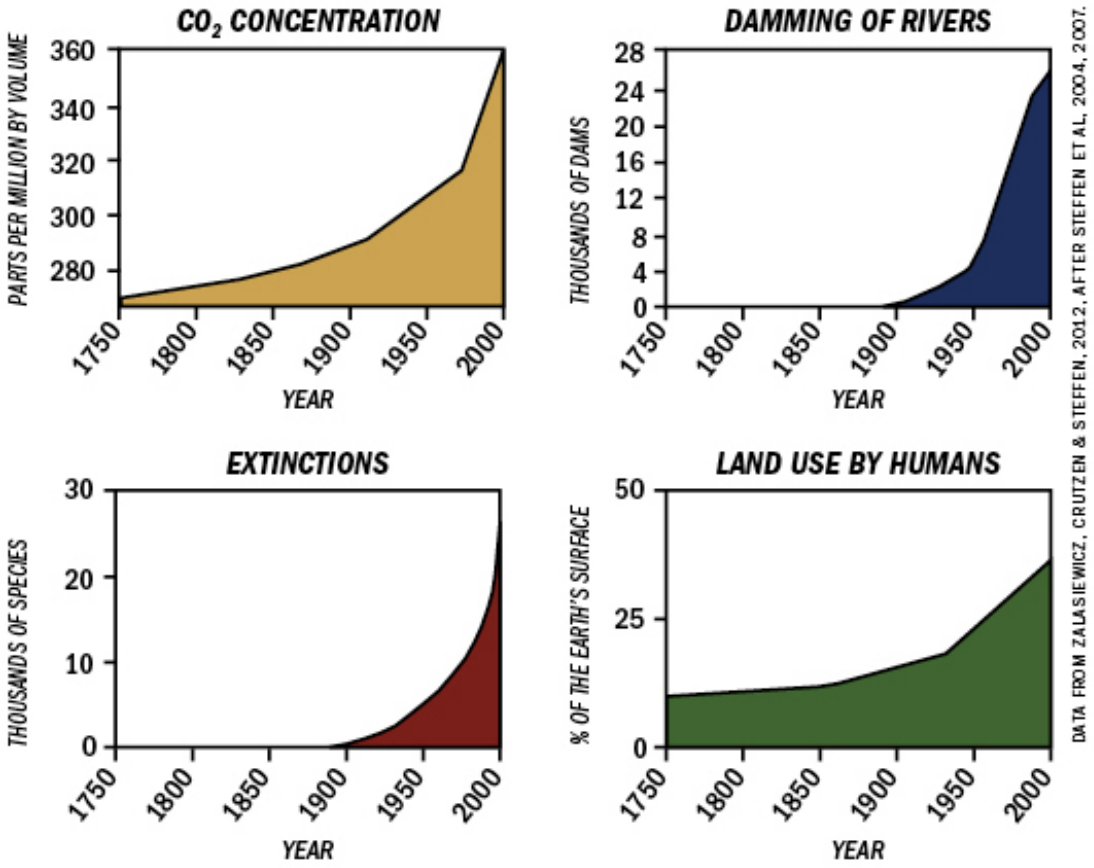
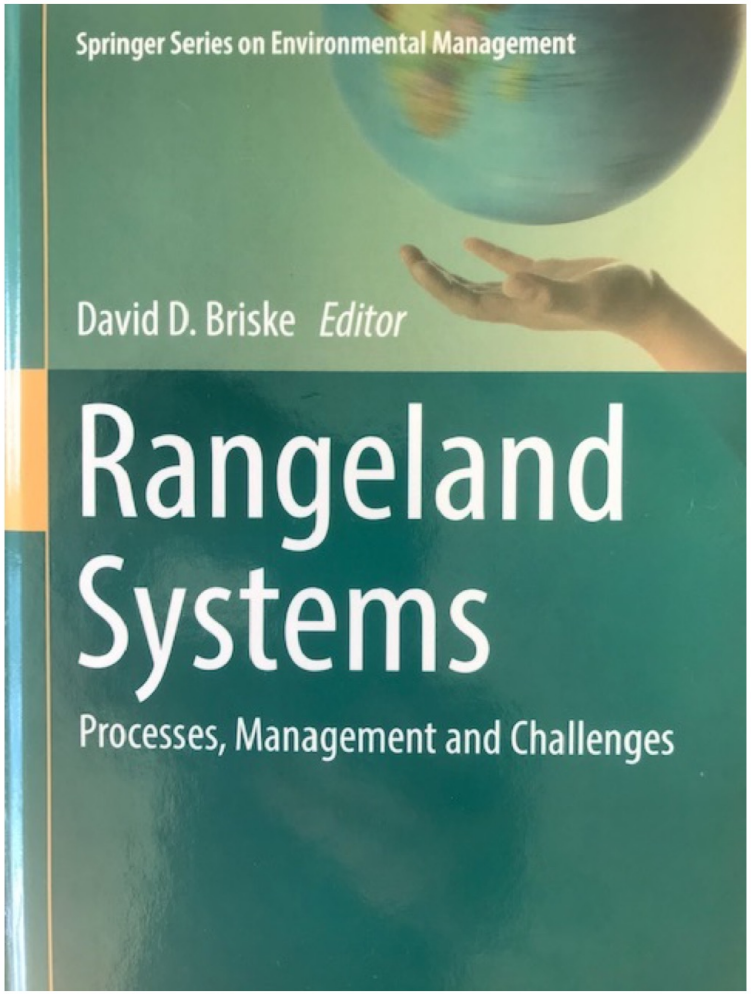
Anthropocene Epoch

Human domination of the Earth System

Began 1950
Atomic Age



Rangeland Science



Rangeland science has advanced rapidly in the past 25 years

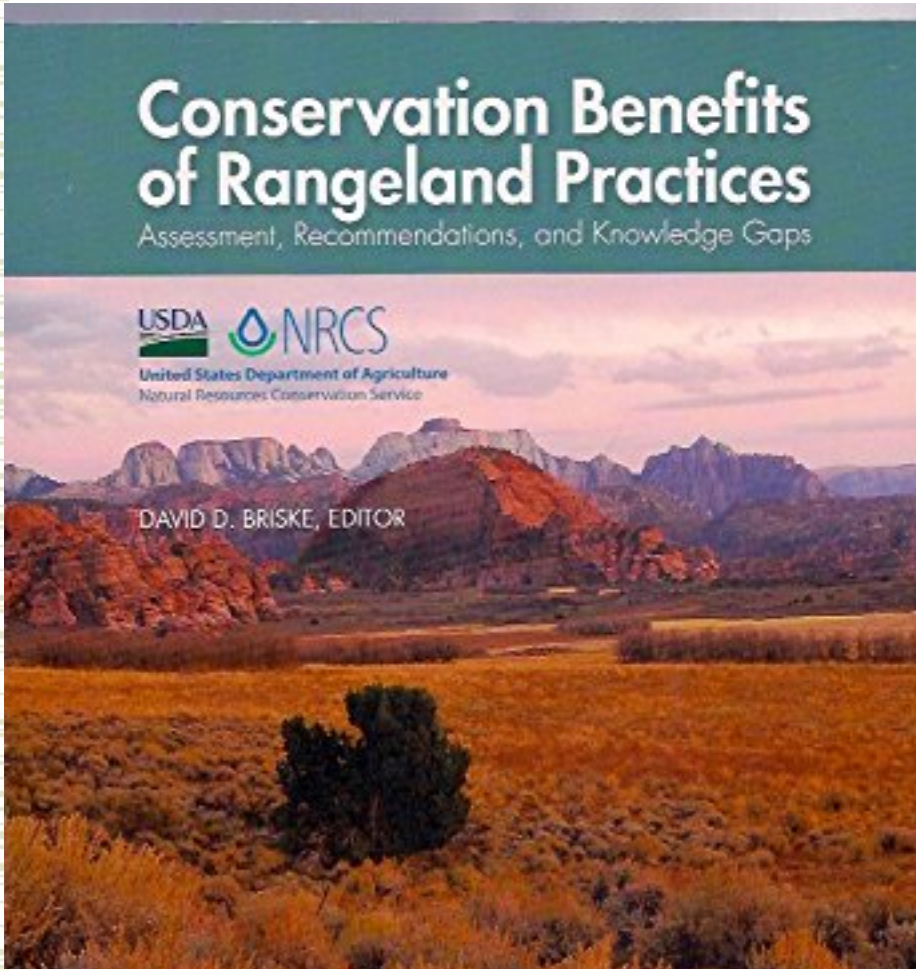
- State-and-transition models
- Monitoring methodologies
- Social-ecological systems

Has rangeland management advanced equally rapidly?

- Drought planning
- Adaptive management
- Policies and incentives

Has management kept pace with science?

Rangeland Management



Benefits of major conservation practices can ***not*** be confirmed.

- Grazing management systems
- Invasive plant management
- Prescribed burning
- Riparian management

Insufficient monitoring has been conducted.

- Only direct effects assessed
- Ecosystem services overlooked

How effective is current management?

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Rangeland Management: Past and Future

- **Past management approaches**
  - ✓ Emphasize simple problems
  - ✓ Optimal forage and animal production
  - ✓ Minimize production variability
- **Future management needs**
  - ✓ Address complex problems
  - ✓ Multiple ecosystem services valued
  - ✓ Optima rangeland service for society

Bestelmeyer & Briske 2012

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Presentation Objectives

New approaches for 21st century range management

- ✓ Redefining rangeland systems
- ✓ Address rangeland marginalization
- ✓ Adapt to a changing climate
- ✓ Participatory research programs

Bestelmeyer & Briske 2012

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I. Redefining Rangeland Systems

Rangeland – 300 published definitions (Lund 2007).

Land supporting native vegetation that is used for grazing and browsing animals.

- A pasture or paddock perspective has prevailed.
- Contributed to reductionist science at small scales.
- Forage and livestock production dominant focus
- Humans considered to be outside the system.

Briske 2017;Bestelmeyer & Briske 2012

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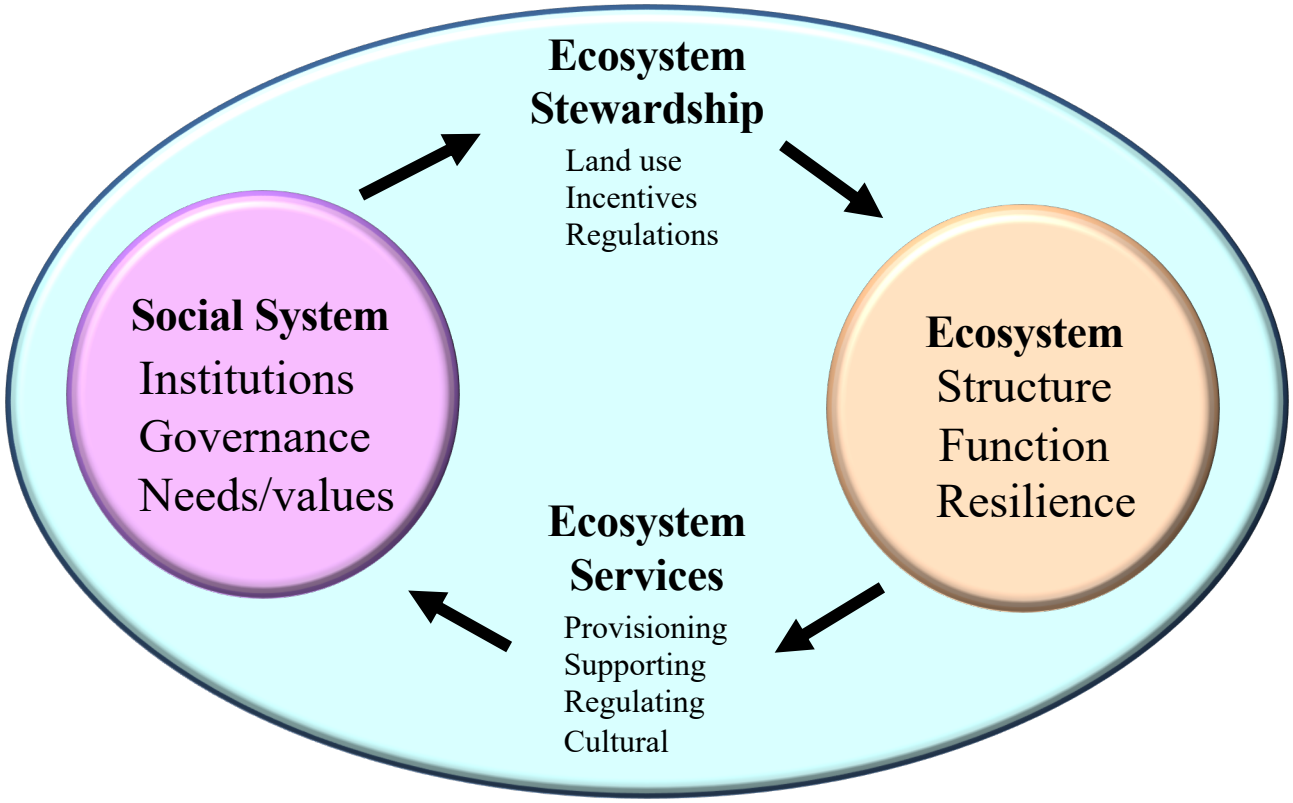
Rangeland: Alternative Vision

Ecological systems supporting native vegetation that are managed as adaptive social-ecological systems to provide multiple ecosystem services for human well-being.

- Landscape or regional perspective
- Multiple stakeholder perspective
- Diverse ecosystem services valued
- Humans exist within rangeland systems

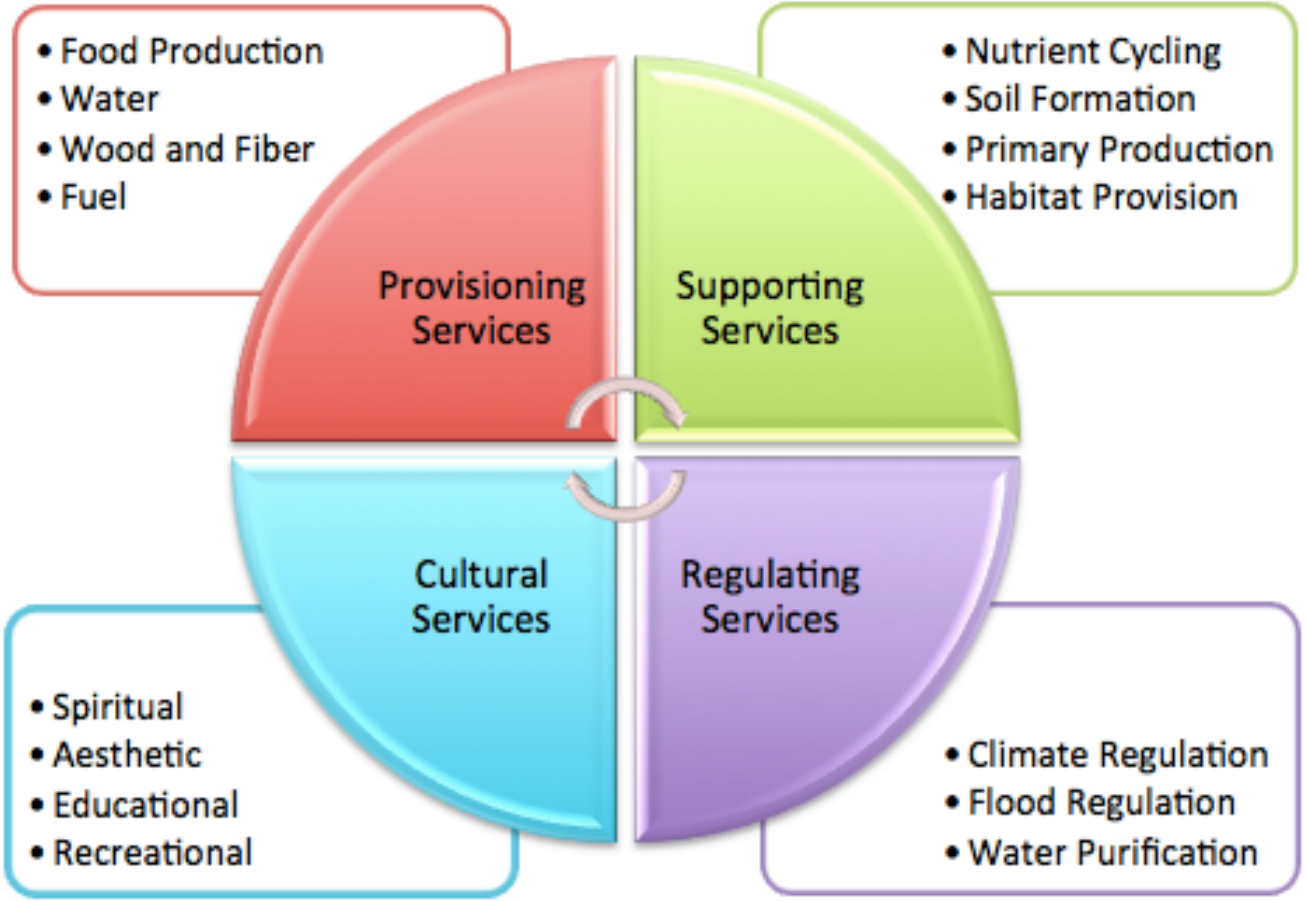
Briske 2017; Bestelmeyer & Briske 2012

Social-Ecological Systems



Ecosystem Services

Benefits humans derive from ecosystems



Source: Millenium Ecosystem Assessment, 2005.

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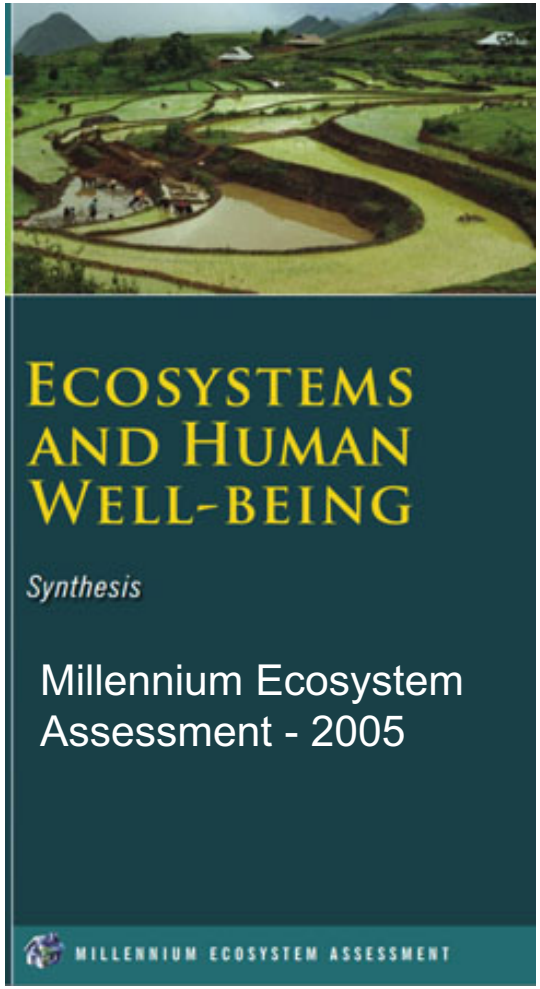
Ecosystem Services Declining

20 of 24 ecosystem services degraded in past 50 years

- Biodiversity loss
- Water quality and quantity
- Soil protection
- Disease & pest regulation
- Climate regulation
- Recreational activities



II. Rangeland Marginalization

Rangelands marginalized throughout modern history following European settlement

- Crop and Forage Systems
- Woody Plant Encroachment
- Energy Production/Mining
- Urban Development

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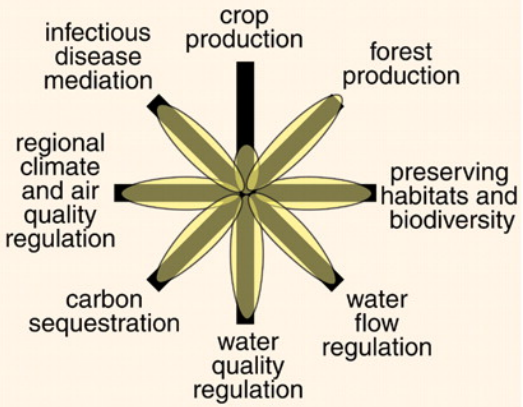
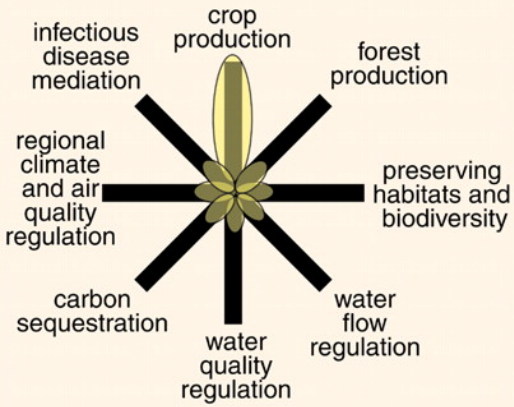
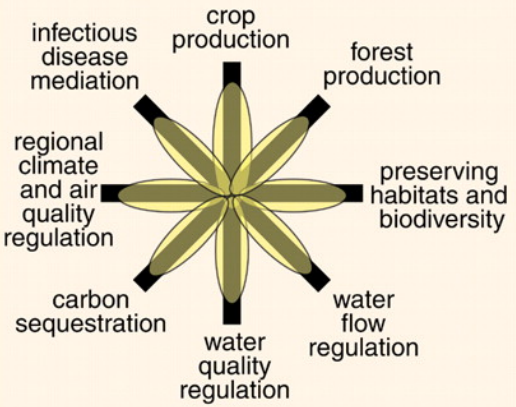
Land Use - Service Tradeoffs



natural ecosystem



intensive cropland



cropland with restored ecosystem services

Increase in one service decreases the supply of others.

Foley et al. Science 2005

Private vs. Public Goods

- Economic markets value ***goods***, but not the ecosystems that supply them.
- ***Private*** goods are provisioning services, while ***public*** goods represent the other categories of services – regulating, cultural and supporting.
- Provisioning services are ***internal*** to markets, while other ES categories are often ***external*** to markets.
- ***External*** ESs are frequently perceived to have limited value in land use decisions - externalities.

Jack et al. PNAS 2008

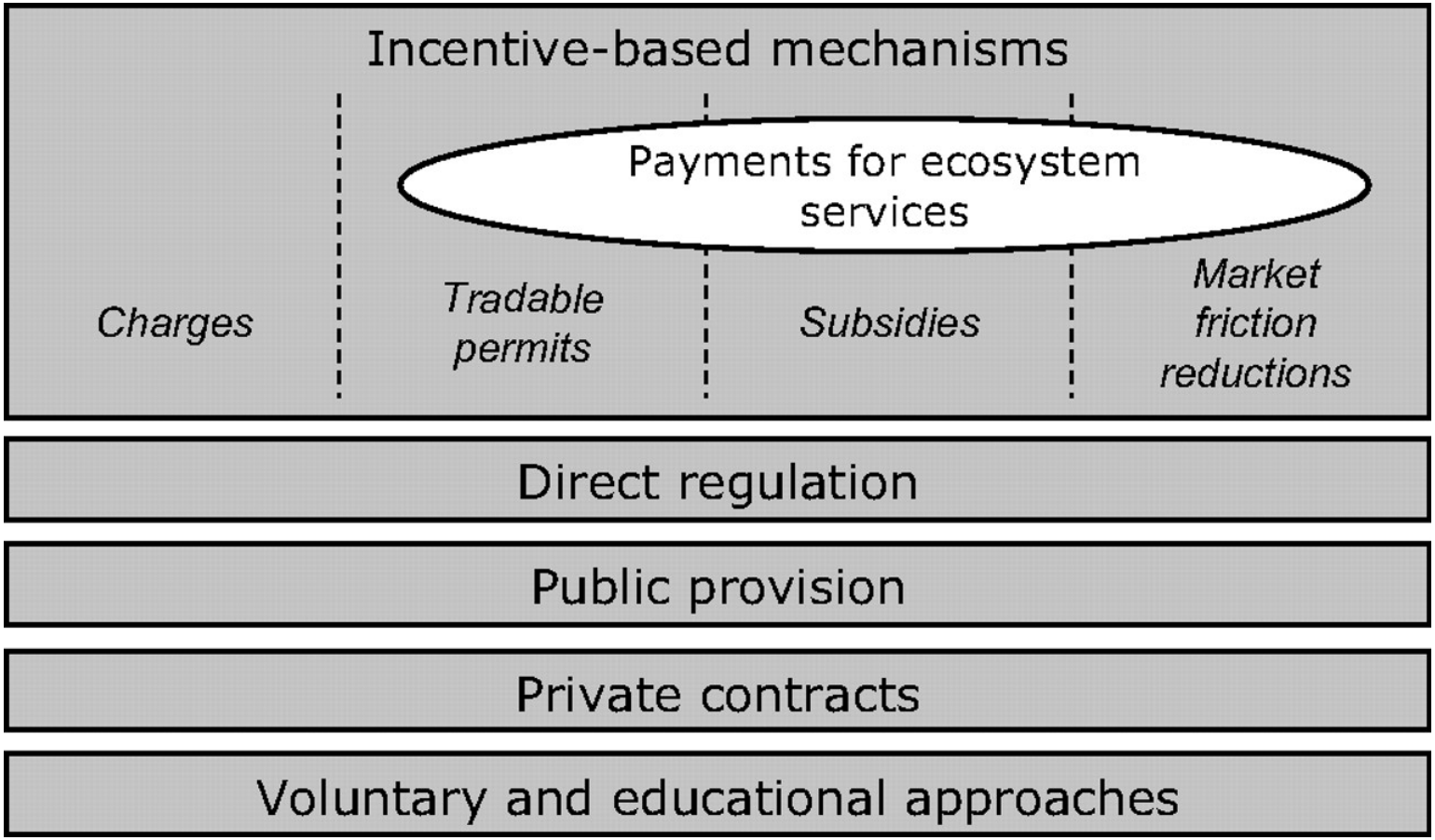
Private vs Public Benefits

	Extensive Management	Intensive Management
Private Benefits	$20/ha	$40/ha
Public Benefits	$40/ha	$10/ha
Total Benefits	$60/ha	$50/ha

Private Benefits = Positive $20; land use change beneficial
Public Benefits = Negative $30; land use change detrimental

Public benefits become an ***externality*** – transaction costs that no one pays for in the short term.

Balance Private and Public Benefits

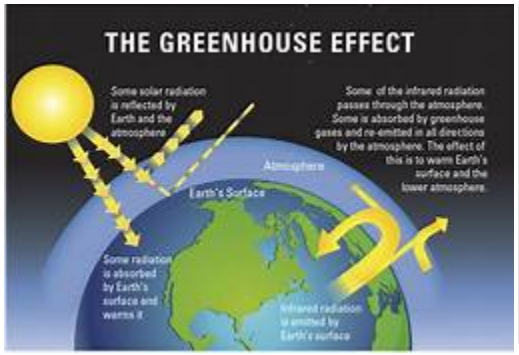


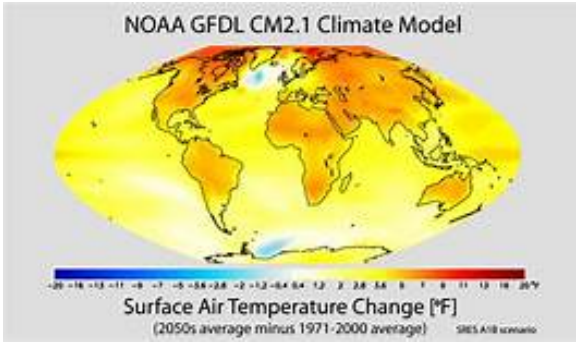
Jack et al. PNAS 2008

III. Climate Change

Previous climate projections are being realized.

- Warming, especially at high latitudes.
- Drying low and mid-latitudes; wetter at high latitudes.
- Fewer, but more intense rain storms.
- Greater variability and more extreme events.





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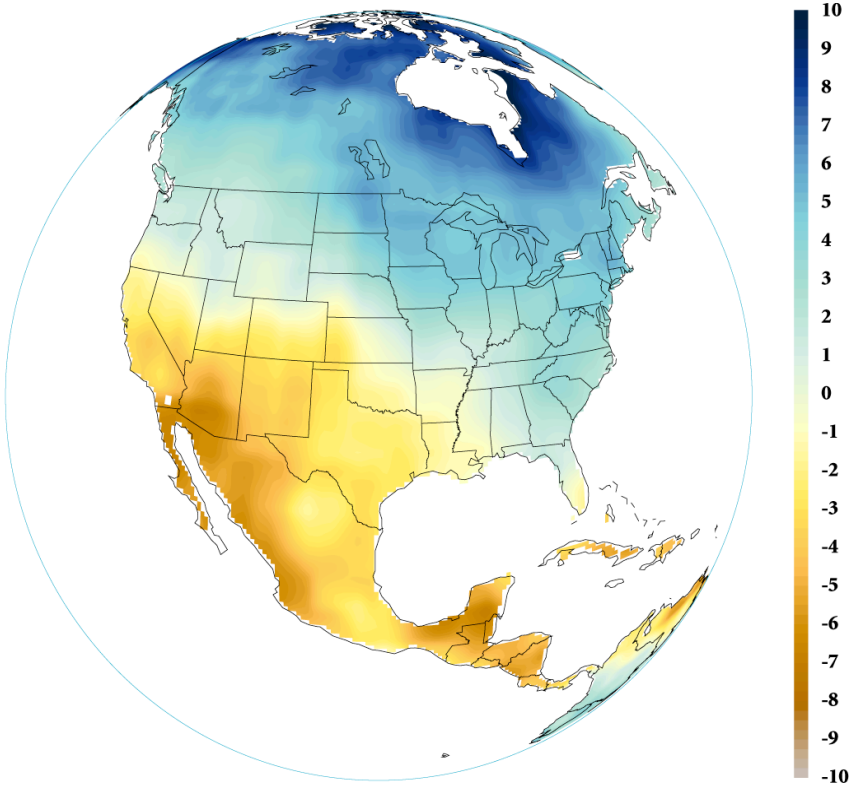
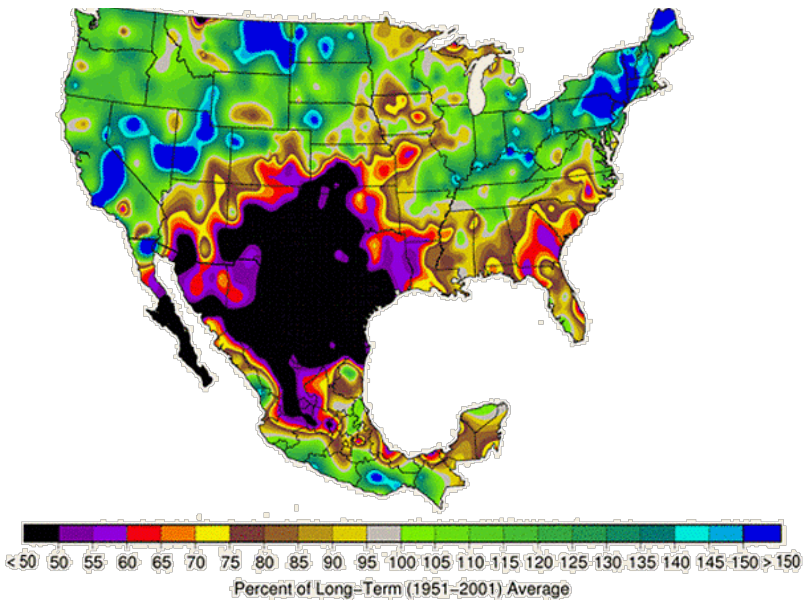
Climate Change Projections

Precipitation 1950-2000 vs 2000-2040



Precipitation 10/10-9/11



Warming will increase drying

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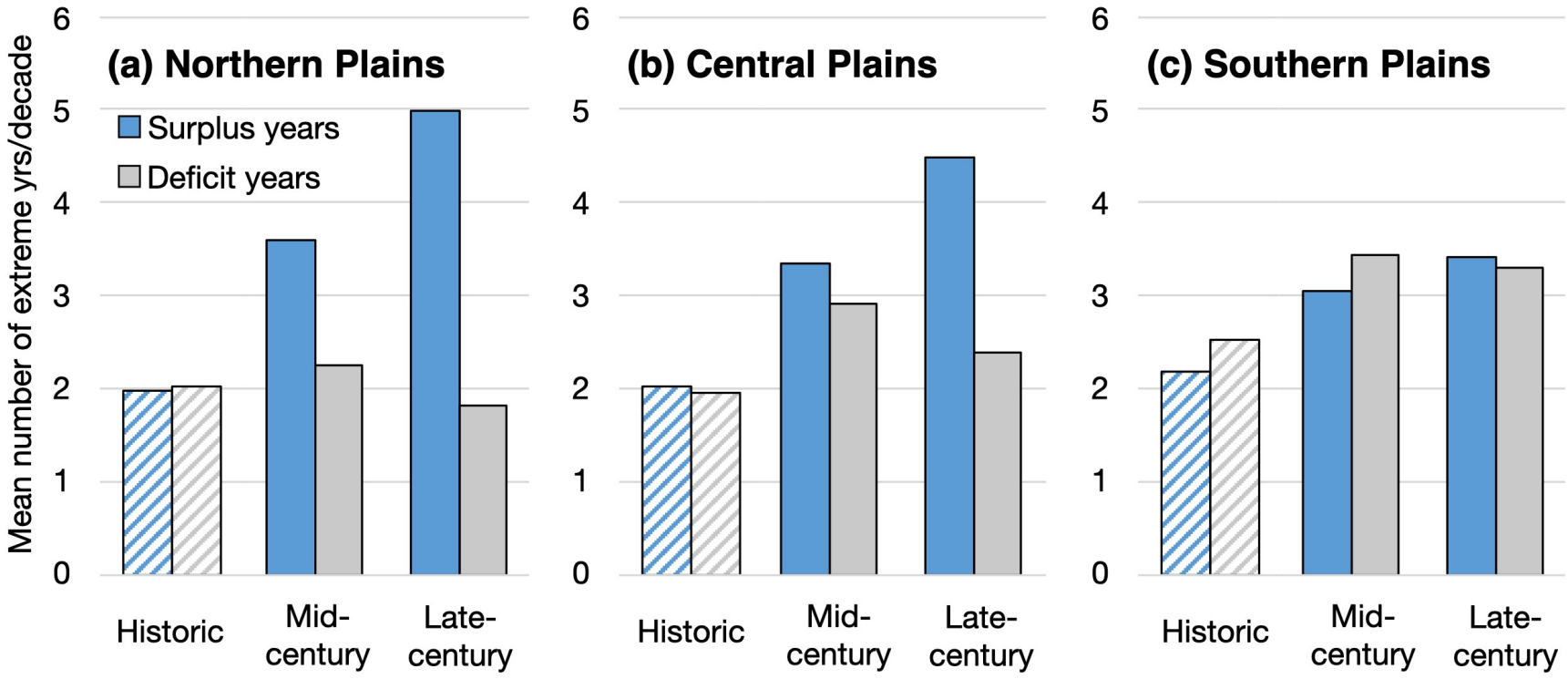
Interannual Precipitation Variability



Klemm et al. 2020 GCB

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Rangeland Implications

- Variable forage production
- Reduced forage quality
- Modified species composition
- Invasive species expansion
- Reduced animal nutrition
- Increased wildfire potential
- Drying riparian systems

Polley et al. 2013 REM

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Adaptation Deficit

- Insufficient adaptation to ***current*** environmental variation and hazards.
- Ranchers remain in perpetual 'drought trap' with limited capacity to cope with recurring drought .
  - ✓ Economic loss i.e., low sale prices and high feed costs
  - ✓ Potential rangeland degradation during drought
- ***Will ranching remain viable with greater climatic variability and extremes?***
  - ✓ 80% of 340 ranchers, Utah U.S.A (Peterson & Coppock 2001)
  - ✓ 80% of 240 ranchers, North Australia (Marshall et al. 2014)

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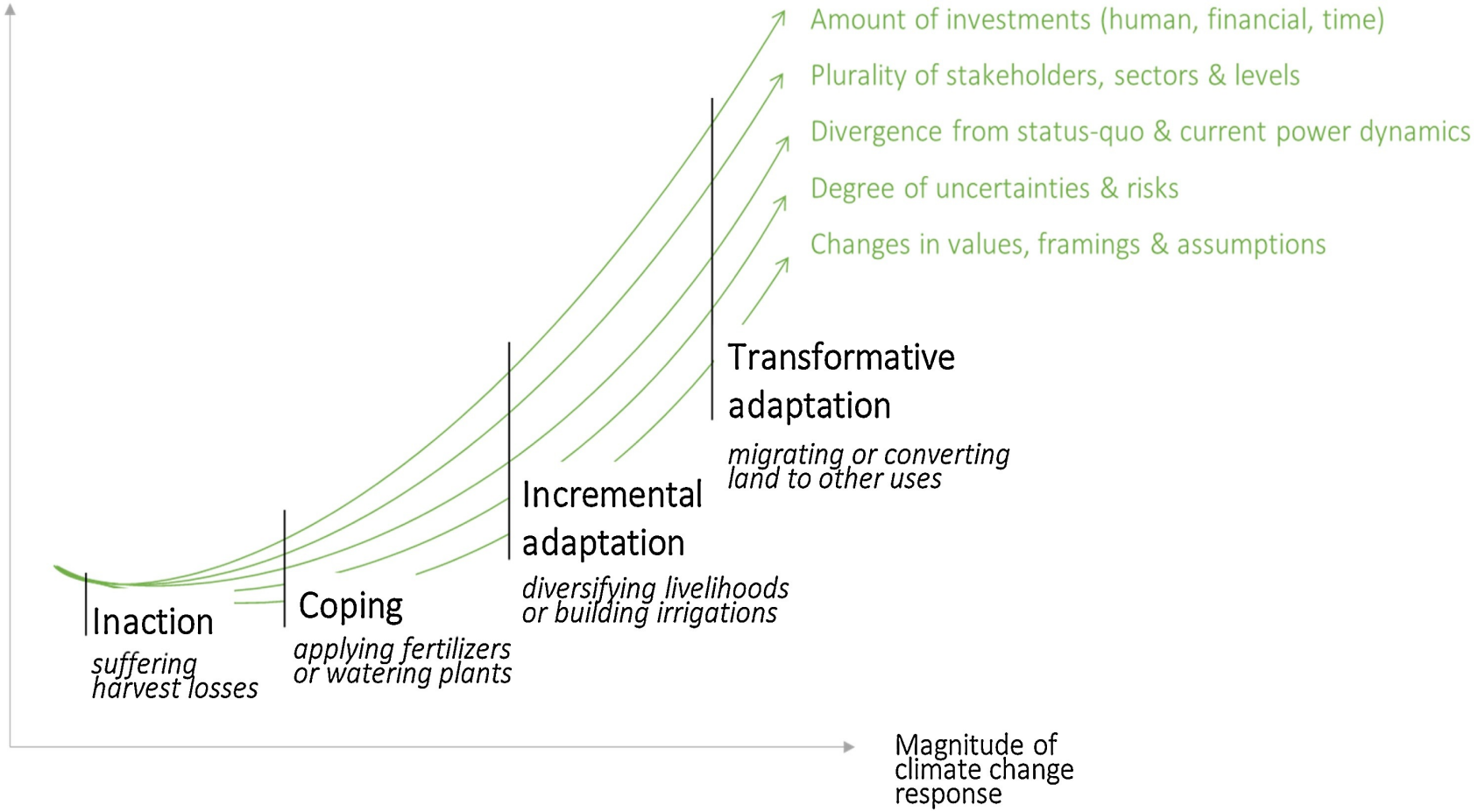
Adaptation Strategies Continuum



Fedele et al. 2019

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Incremental Adaptations

- Drought planning
- Grass banking
- Flexible stocking strategies
- Livestock breeds and species
- Ectoparasite control
- Fire – fuel management
- Income diversification

Derner et al. 2017

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Transformation

- What happens when incremental adaptation is no longer sufficient to maintain viable beef cattle production?
- Current social-ecological system becomes ***unsustainable***.
- ***Alternative system*** with different livelihoods and management strategies will be needed.
  - ✓ When is a system no long sustainable?
  - ✓ What alternative systems exist?
  - ✓ Who makes and implements these decision?

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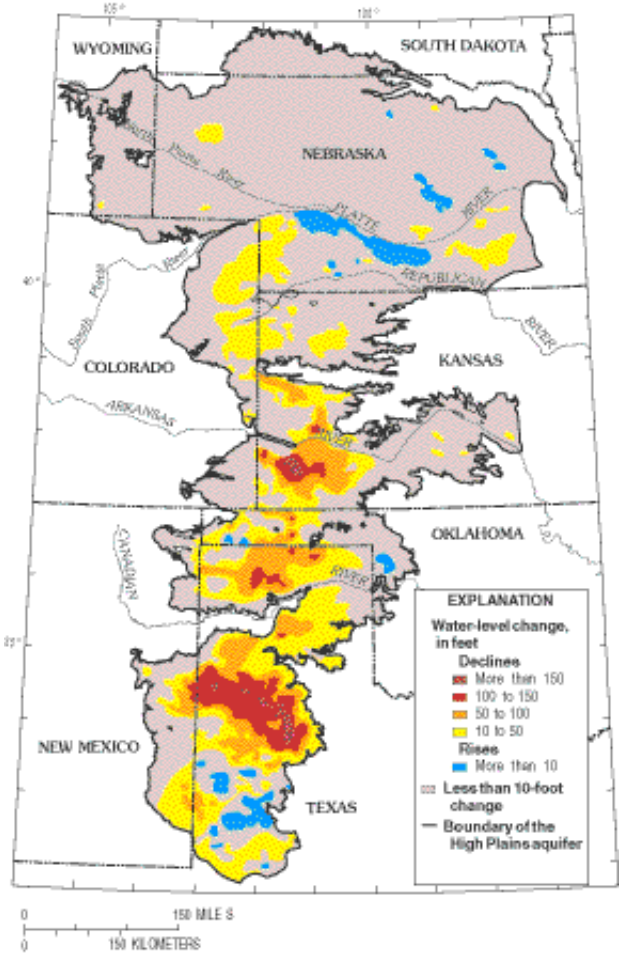
Transformation: Texas High Plains

- Recharge minimal – playa lakes
- Rapid depletion since 2000
- 300 foot decline since 1950
- Some areas depleted by 2030
- Dryland crops vs. grassland

Ogallala Aquifer



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Climate Adaptation is Complex

Involves many sectors of society at multiple scales.

- Human perception/capacity
  - ✓ Risk perception
  - ✓ Age and education
- Enterprise modifications
  - ✓ Financial resource availability
  - ✓ Flexibility and diversification
- Policy and programs
  - ✓ Technical and financial support
  - ✓ Markets and trade

Joyce et al. REM 2013

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IV. Participatory Programs

- ***Partnerships*** among diverse stakeholders that share common interest in natural resource management.
- Scientists/extension specialists are one of several stakeholders exchanging ideas to create solutions.
- Management decisions treated as experiments that are monitored to increase knowledge of ***both*** the system and management success.

Williams 2011 JEM

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Participation Benefits

Benefits of participatory management and research.

- Problem is more accurately identified and addressed
- More relevant and actionable knowledge produced
- Land owner acceptance and application enhanced

Time intensive and social skills are essential.

- Often viewed an inefficient and unnecessary
- Scientific/technical authority continues to dominate.

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Rancher Decision Making Environment

Grazing management strategies vary greatly among ranches in eastern Colorado.

- Size and number of paddocks
- Number of livestock herds
- Livestock rotation periods
- Seasonal use of paddocks

Yet, many ranches were sustainable through time.

What important management variable did not vary?

Wilmer et al. 2018 REM

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Total Ranch Stocking Rate Similar

What has been the focus of grazing management?

- Size and number of paddocks
- Number of livestock herds
- Livestock rotational periods
- Seasonal use of paddocks

These variables represent a small portion of the decision making environment of ranchers!

Wilmer et al. 2018 REM

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Rancher Decision Making Environment

Decisions occur in complex, dynamic social-ecological systems that extend beyond the individual ranch.

- ✓ Financial considerations
- ✓ Commodity markets
- ✓ Policy and programs
- ✓ Societal values and perceptions

20th century range management approaches can not address these complex challenges.

Wilmer et al. 2018 REM

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Future Trajectories

"The challenge is **not** finding ways to know the future, but to find ways to live **without** knowing the future".

- Where are current trends leading?
- Is this creating a future we want?
- How do we attain desired futures?
- Who should make these changes?

Miller 2011; Bia et al. 2016