Sustainable Land Management in Northern Namibia:

Opportunities to Integrate Local and Scientific Knowledge Based on an Understanding of Land Use Potential

Polytechnic of Namibia
Windhoek, Namibia
23 May, 2012

Jeff Herrick
Jornada Experimental Range
Agricultural Research Service
US Dept. of Agriculture (USDA)
Las Cruces, NM USA
1. US experience: 1880’s and 1930’s
2. Global challenge
3. (Parts of) northern Namibia at a tipping point?
4. Elements of a (local to global) solution
   - Integrating and sharing scientific and local knowledge
   - Land Potential Knowledge System
How can rangelands on resettlement farms be improved? (production and condition)
Southwest US Experience: 1880’s-present (Kunene climate)
Southwest US Land Management 1880-1934

• **Objective:** reduce poverty and increase agricultural production

• **Strategy:** cheap (or free) access to grazingland

• **Other factors:**
  – US and British capital rapidly increased livestock herds
  – Migration of entrepreneurs (US Civil War veterans)
  – Native invasive species (mesquite and creosote)
Result: overgrazing + drought = grass mortality. Invasive shrubs now dominate.
Ecologists’ role: documented degradation, recommended preventive measures (too late -- Wooton publishes “The Range Problem in New Mexico” in 1908)
(Quote and photo June 1910 near Newell SD by A.C. Dillman, USDA) (from K.D. Kephardt, SDSU)
US Experience 1930’s “Dust Bowl”
1. US experience: 1880’s and 1930’s

2. **Global challenge**

3. (Parts of) northern Namibia at a tipping point?

4. Elements of a (local to global) solution
   - Integrating and sharing scientific and local knowledge
   - Land Potential Knowledge System
Global Challenge

“... we will need the equivalent of two planets by 2030 to meet our annual demands...” (WWF Living Planet Report 2012)

... but this is based on ‘business as usual’ production systems and land use patterns...
"...grain prices are ‘screaming’ for more acres which will push farmers to convert pasture used for grazing animals to cropland and consider planting in questionable weather conditions..."
High Prices Sow Seeds of Erosion

When prices for corn and soybeans surged last fall, Bill Hammitt, a farmer in the fertile hill country of western Iowa, began to see the bulldozers come out, clearing steep hillsides of trees and pastureland to make way for more acres of the state’s staple crops. Now, as spring planting begins, with the chance of drenching rains, Mr. Hammitt worries that such steep ground is at high risk for soil erosion...
Global Challenge

Drylands, including northern Namibia, are often at greater risk of degradation due to frequent drought, leaving soil exposed to erosion, intense storms even without climate change, and poor inherent soil quality.
Typical semi-arid soil: shallow soil over calcium carbonate ‘pan’ (Mexico)
Similar soil (Kenya)
Similar soil (Kunene)

- 20 cm remains
- 10-20 cm soil lost
Similar soil (Kunene)
Deep, coarse-textured soils with low fertility and low water-holding capacity (Bolivia)
Similar soil (Kavango)
Increased Demand for Food + Energy Production

Expansion onto Less Resilient Lands

Increased Probability of Sub-optimal Tillage + Planting Conditions

Reduced Production per Unit Area

Increased Rate of Land Degradation
What is land potential? The potential of the land to support particular types and amounts of plant production, and to resist and recover from degradation.
Land classification based on the land’s potential: soils + climate.
Soils affect potential grass (forage) production

Soils affect grass (forage) resilience

Grass dynamics

Eliminated (non-resilient)

Resilient

Stable

Soils affect grass (forage) resilience

- **Hills**: 50% Eliminated, 50% Resilient
- **Gravelly**: 25% Eliminated, 75% Resilient
- **Sandy**: 25% Stable, 75% Resilient

Grass dynamics: Eliminated (non-resilient), Resilient, Stable

Land use plan for Chihuahuan Desert grasslands: drought
- Remove livestock early in drought
- Minimize pressure on highly erodible sandy soils, especially during early drought recovery period
- Control shrubs

Hills - More Resilient

Sandy - Less Resilient (in this agroecosystem)
Resilience of newly converted land

Potential production of newly converted land

Land conversion over time

1st land converted

Last land converted

Resilience of newly converted land
Resilience of newly converted land

Potential production of newly converted land

Last land converted

1st land converted

Land conversion over time

Resilience of newly converted land

(a) Lower production on unexploited lands reduces ROI

(b)
Resilience of newly converted land

(a) Lower production on unexploited lands reduces ROI

(b) Lack of negative economic feedbacks encourages encroachment on increasingly less resilient lands

(c) Last land converted

Potential production of newly converted land
1. US experience: 1880’s and 1930’s
2. Global challenge

3. (Parts of) northern Namibia at a tipping point?

4. Elements of a (local to global) solution
   - Integrating and sharing scientific and local knowledge
   - Land Potential Knowledge System
Kunene: shallow soils
Kunene: shallow soils
Kunene: shallow soils
Kunene: highly erodible soils
Kunene: highly erodible soils
Kunene: shallow, highly erodible soils
CIMG0885 35 years ago was perennial grass.MOV
Potential for similar soil in SW US -- 250mm ppt, flat, loamy sand over sandy loam:
- **Plant community**: grassland, ~600 kg/ha
- **Hydrology**: no runoff
- **Soil**: weak intact A horizon, no erosion
Kavango: low fertility, erodible soils
Kunene: erodible soils with shallow chemistry/texture change
Kunene: erodible soils with shallow chemistry/texture change
Kavango: high fertility, resilient soil
Kunene soil: ???
1. US experience: 1880’s and 1930’s
2. Global challenge
3. (Parts of) northern Namibia at a tipping point?

4. Elements of a (local to global) solution
   - Integrating and sharing scientific and local knowledge
   - Land Potential Knowledge System
Using local and scientific knowledge to predict and avoid degradation thresholds and develop sustainable management systems

- Fertility thresholds in Kavango
- Salinity/hydrology/fertility thresholds in Omusati, Oshana, Oshikoto?
- Erosion thresholds in Kunene
WP43 - HARD SOIL
LAND THAT WILL
BE CROPPED*
1st YEAR - NO MAJOR NITROGEN
THEN EVEN DRY YEARS "MAKES IT"
CROPPED 1994

WP44 LIGHT SOILS
NOT GOOD FOR CROPPING
UNLESS HIT YEAR AND
APPLY MANURE
1. US experience: 1880’s and 1930’s
2. Global challenge
3. (Parts of) northern Namibia at a tipping point?
4. Elements of a (local to global) solution
   - Integrating and sharing scientific and local knowledge
   - Land Potential Knowledge System
What is land potential? The potential of the land to support particular types and amounts of plant production, and to resist and recover from degradation.
Ecological Site: Group of Soils with Similar Potential Resistance to Degradation and Potential Capacity to Recover from Degradation.

Potential Production

Potential Resistance to Degradation

Potential Capacity to Recover from Degradation

Resilience
LPKS based on potential production (based on soil profile characteristics) + resilience
Existing systems (FAO AEZ and USDA LCC) don’t include resilience.
Ecological Site: Group of Soils with Similar Potential Resistance to Degradation

Potential Capacity to Recover from Degradation

Resilience

High resilience soils → Low resilience soils

Crop: conservatively managed
Minimum tillage
Residue conservation

Livestock
Careful utilization
Early drought destock

Conservatively managed

Low resilience soils

Conservatively managed

Minimum tillage
Residue conservation

Crop

Potential Production

Potential Production
Planned grazing + combined herds + drought response (destocking/restocking) to change timing, intensity and frequency of grazing, and distance walked

1-3 years (treatment/short-term impact indicators)

Soil surface disturbance

1-5 years (short-medium-term impact indicators)

Foliar cover, litter cover, bare ground, and intercanopy gap size

Herbivory (especially increased recovery time)

Soil aggregate stability

1-10 years (medium-long-term impact indicators)

Soil erosion

Infiltration capacity/runoff

Water: amount and duration available

Plant vigor, and production

Plant establishment

Species composition and plant (grass) density

DRAFT conceptual process diagram illustrating potential effects of management change on animal performance as a consequence of changes in vegetation and soil. Green indicators measured on all plots. Blue measured only on plots in Demo GA’s. Notes: (1) Not all feedbacks shown. (2) This model focuses on water. Similar relationships for nutrients not shown. Indicators chosen are the same. (3) Theft/predation are not part of the grazing response, but are affected by livestock management.
Salud de Pastizales

Salud de Comunidades
Un Sistema para el Manejo de Pastizales en el Contexto del Paisaje y la Aptitude de Suelos para Actividades Pecuarias

Land Use Plan (with resilience)

Pasture/forest

Forest

Pasture

Crops

Soil depth

Slope (erosion risk)

Best soils are deep, low slope with sandy surface and loamy subsurface
Land Potential Knowledge System: Implementation

• Data collected using gps-enabled camera phones + shovel in course of daily work
• Supplemented with targeted, intensive sites (e.g. for soil salinity)
• Fed into central database with knowledge system (matching soil, topography)
• As system grows, feeds information on sustainable land management for that type of land back to user).
Why LPKS?

- **Increased productivity and sustainability**
- **Improved targeting** of investments in food security, watershed management and natural resource conservation
- **Reduced flooding** and **increase perennial stream flow** by focusing efforts to increase infiltration on areas with the greatest potential for significant improvement.
- **Reduced siltation** of dams by focusing erosion control efforts on critical areas.
- Increased probability of **success of management and restoration** efforts by focusing efforts on area most likely to respond.
- Provide a method for assessing risk of treatment options based on the ability of a site to respond to various alternative treatments.
- Provide a standard to judge the **effectiveness of management** and other treatment actions.
- Increase the utility and cost-effectiveness of **monitoring**.
- Improve ability to focus **market development** on those areas with a greater potential to sustain increased agricultural production.
- Collect and store **local knowledge** about land management in a way that it can be easily accessed and used by future generations.
Planned grazing + combined herds + drought response (destocking/restocking) to change timing, intensity and frequency of grazing, and distance walked

1-3 years (treatment/short-term impact indicators)

1-5 years (short-medium-term impact indicators)

1-10 years (medium-long-term impact indicators)

Soil surface disturbance

Foliar cover, litter cover, bare ground, and intercanopy gap size

Herbivory (especially increased recovery time)

Soil aggregate stability

Infiltration capacity/runoff

Water: amount and duration available

Herbivory

Soil erosion

Plant vigor, and production

Plant establishment

Species composition and plant (grass) density

Animal performance (weight at sale)

Risk, wealth, social stability

Theft, predation

DRAFT conceptual process diagram illustrating potential effects of management change on animal performance as a consequence of changes in vegetation and soil. Green indicators measured on all plots. Blue measured only on plots in Demo GA’s. Notes: (1) Not all feedbacks shown. (2) This model focuses on water. Similar relationships for nutrients not shown. Indicators chosen are the same. (3) Theft/predation are not part of the grazing response, but are affected by livestock management.
Example: Android App for MCA CBRLM Project (May 2012)
LKPS: Next Steps

- Funding
- Database, knowledge system and field app development
- Pilot implementation
- Full implementation
- Refinement
Thank you...

All Participants

Ms. Akwenye
MCA

Dr. Tjivikua
Polytechnic of Namibia

Jeff Herrick
jherrick@nmsu.edu - jornada.nmsu.edu – landscapetoolbox.org
Jornada Experimental Range ~ Agricultural Research Service ~ US Dept. of Agriculture (USDA)
Las Cruces, NM USA
References


