Preview of Award 1235828 - Annual Project Report

Cover

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Accomplishments

*** What are the major goals of the project?**

Chihuahuan Desert landscapes exemplify the ecological conditions, vulnerability, and management challenges in arid and semi-arid regions around the world. The goal of the Jornada Basin Long Term Ecological Research program (JRN LTER) established in 1982 is to understand and quantify the key factors and processes controlling ecosystem dynamics and patterns in Chihuahuan Desert landscapes. In collaboration with the Jornada Experimental Range (USDA ARS), studies initiated in 1915 have been incorporated into the JRN LTER program. Previous research focused on desertification, a state change from perennial grasslands to woody plant dominance that occurs globally. Based on findings from growing long-term databases, the breadth of studies in LTER-VI was expanded to include four additional state changes that occur in dryland systems worldwide: (1) a reversal to grassland states, (2) transitions among different states dominated by woody plants, (3) invasion by non-native grasses leading to novel states, and (4) transitions to human-dominated states. Processes of interest include water mediated plant-soil feedbacks, patch-scale contagion, landscape context, and time lags that are manifested as nonlinear dynamics and threshold behavior. The overall goal of Jornada LTER-VI (2012-2018) is to understand and quantify the mechanisms that generate alternative natural and human-dominated states in dryland ecosystems, and to predict future states and their consequences for the provisioning of ecosystem services. A modified conceptual framework and integrated research plan in LTER-VI is

being used to: (1) test specific elements by coupling existing long-term studies of patterns with new experiments aimed at elucidating processes, (2) integrate data from long-term studies in novel ways to address new questions, both at the JRN and in the surrounding region, and (3) forecast alternative future landscapes and consequences for ecosystem services under a changing environment. The proposed research is organized around two major geomorphic units that characterize the Chihuahuan Desert, and that contain on-going long-term studies and a sensor network. Long-term studies are being combined with new mechanistic experiments designed to identify dominant processes and drivers with a focus on pattern-process relationships that transcend scales. The generality of this framework is being assessed with cross-site and regional studies. Simulation modeling is being used to synthesize and integrate data, both to understand current patterns and to predict future dynamics. New socio-economic studies and scenarios based on the Ecosystem Millennium Assessment are placing Jornada research into a broader socio-economic-ecologic context. Proposed research is resulting in five major products: (1) new understanding of state changes, in particular in drylands, that lead to theory development, testable hypotheses, and new experiments; (2) accessible data and visualization tools applicable at multiple scales; (3) explanatory and predictive relationships between drivers, patterns, and processes that can be used to (4) develop scenarios of alternative human- and natural-dominated states with assessments of their impacts on ecosystem services; and (5) usable information transfer to a broad audience including K-12 students and teachers, and NGO and government agency land resource managers.

The major goals of our project are:

1. To provide new understanding of state changes within geomorphic units at the Jornada

2. To compare state change transitions among different geomorphic units at the Jornada

3. To provide a more mechanistic understanding of regional dynamics within the Chihuahuan Desert

4. To provide education and outreach programs across a range of scales, from local to global

5. To enhance the accessibility of Jornada data to a broad range of users.

*** What was accomplished under these goals (you must provide information for at least one of the 4 categories below)?**

Major Activities:

GOAL 1. to provide new understanding of state changes within geomorphic units at the Jornada

Grassland to shrubland transitions: this is the classic example of desertification dynamics found in arid and semiarid ecosystems globally. Most of LTER I-V research focused on these dynamics such that our current efforts emphasize specific remaining questions, and our efforts at the project-level are shifting to other types of transitions.

1. We collected and analyzed soil samples and remeasured vegetation from the NEAT study of wind erosion-deposition.
2. We planned the establishment of the Dune Development Study discussed in the LTER VI proposal.

Shrubland to grassland transitions: the recent increase in native perennial grasses in some desertified shrublands suggests that climate variability may initiate state change reversals (Peters et al. 2012), and long-term data show that the key recovery processes differ by grass species (Peters et al. 2013). The infrequent nature of exogenous phenomena, such as El Niño, requires long-term manipulative experiments.

1. We used a suite of long-term datasets (1990-present) to examine the perennial grass response to precipitation in wet (2004-2008), dry (2000-2003), and no trend years (1990-1999) for multiple locations in creosotebush, tarbush, and mesquite shrublands at the Jornada. (Peters et al. 2014).
2. An experiment of rainfall manipulations (80% reduced PPT, ambient, 80%

increased PPT) has been conducted for seven years for response variables that: (1) assess the effectiveness of the manipulations; (2) test hypotheses; (3) unravel the mechanisms behind hypotheses.

Shrubland to shrubland transitions: transitions between shrubland types suggest that shrub-dominated states are dynamic in the post-enchroachment phase. It is unknown if drought-avoiding mesquite will give way to creosotebush, a true xerophyte, on the sandy basin under future climatic conditions.

1. We are addressing seasonal patterns of soil water use for different shrub species (tarbush, creosote, mesquite) through the installation of a network of sapflow sensors at the Tromble weir watershed. This network is in close proximity to on-going phenological sampling, a phenocam, and an eddy covariance tower. Sapflow measurements will be related to soil moisture observations near target plants.
2. We are conducting Unmanned Aerial Vehicle (UAV) flights on a periodic basis over the same watershed to characterize seasonal and interannual differences in vegetation cover, shrub species distribution, and greenness in response to precipitation fluctuations.
3. We are developing techniques for partitioning evapotranspiration (ET) using a combination of eddy covariance measurements, sapflow sensors, and an empirical method based on soil moisture and temperature data. The spatial link between ET, soil moisture, and temperature is being determined through footprint analyses and a network of soil sensor profiles around the tower.

Transitions to novel states: The exotic grass, Lehmann's lovegrass, originally from South Africa has not been problematic across large areas of the Chihuahuan Desert. However, shifts towards more winter and spring rainfall with higher temperatures may promote expansion of this species.

1. We are using a soil water model (SOILWAT) to simulate establishment of lovegrass at the Jornada across a range of soils. We are simulating multiple climate change scenarios to examine their effects on the probability of recruitment of lovegrass.

GOAL 2: To compare state change transitions among different geomorphic units at the Jornada.

1. Fourteen meteorological stations were recently established, one at each of the long-term Net Primary Production sites. These stations measure wind speed, rainfall, solar radiation, humidity, light intensity, soil temperature, soil moisture, and phenological characteristics. Two stations will also measure soil carbon dioxide. These stations are providing locations-specific input data for our simulation models.
2. One NEON site on the basin floor and one NEON-like site on the piedmont slope continue to gather data, as do an additional flux tower and a station that is part of the Soil Climate Analysis Network (SCAN). Wind erosion is being measured at several sites across the basin floor and piedmont slopes.
3. Live-trapping grids and non-invasive camera traps across shrubland-grassland ecotones and in urbanized areas continue to determine if animal community dynamics differ among ecosystem states.

GOAL 3: To provide a more mechanistic understanding of regional dynamics within the Chihuahuan Desert.

1. We created a new data layer for the region by intersecting Bureau of Land Management (BLM) polygons with PRISM climate data, a spatial layer of general vegetation states, and soil survey data to provide a set of synthetic

biophysical variables generalized to the allotment level with which to evaluate the correlates of allotment turnover and interfamily transfers.
2. We developed a new project in collaboration with the Malpai Borderlands Group in southwestern New Mexico and southeastern Arizona to improve regional understanding of fire and drought effects on grasslands. We created new analyses of fire distribution across different land classifications and soil and climate variables in desert grassland-dominated ecoregions (Chihuahuan Desert, Madrean Archipelago, and Sonoran Desert).

GOAL 4: To provide education and outreach programs from local to global scales

We continued to leverage partnerships and non-NSF funding to support our education and outreach objectives through various activities. Specifically, we:

1. Ran a flexible science education program for K-12 students and teachers, including field trips, classroom/schoolyard science lessons, teacher workshops, and family education events based on JRN research.
2. Hosted a successful Data Jam competition using the EcoTrends web site for high school students in New Mexico, shared the Data Jam model with LTER Education and Outreach coordinators, and provided materials and advice to scientists and educators at FCE and BES who subsequently hosted three Data Jams in Florida, Maryland, and New York.
3. Developed cooperative agreements with numerous national and international organizations.
4. Led or co-led six 3-5 day rangeland monitoring and assessment workshops and training sessions for land management agency employees, contractors, land managers and the general public.
5. Worked with land management agencies to promote adoption of a common set of rangeland monitoring protocols based in part on JRN research.
6. Continued development of the JournalMap website and worked with multiple publishers to engage their participation in the project.
7. Initiated the development of a Land-Potential Knowledge System with USAID support.

GOAL 5: To enhance the accessibility of Jornada data to a broad range of users

1. Major activities included upgrades and enhancements to the Jornada website, Drupal Ecological Information Management System (DEIMS), and much of the computation infrastructure of the Jornada. Metadata and data stored within DEIMS dynamically power the data catalog, long-term data, and climate data web pages on the Jornada website.
2. The latest version of DEIMS dynamically generates PASTA-ready EML metadata that will be used to populate the LTER PASTA system in the coming year. In addition to EML metadata, the new version of DEIMS includes an ISO metadata module that Jornada plans on using to integrate with the geo-portal in the coming year.
3. An undergraduate student intern, Andrew Franke, worked with Ken Ramsey to further enhance DEIMS to add the capability to load research data files (csv) into relational database tables to power the new data explorer (MySQL) as well as the Jornada geodatabase (SQL Server). This will ensure that data within the data catalog, data explorer, geodatabase, and geoportal contain the same research data and associated metadata content.

Specific Objectives:

GOAL 1. to provide new understanding of state changes within geomorphic units at the Jornada

Grassland to shrubland transitions:

1. We are remeasuring soil and vegetation on the NEAT plot to determine how they have changed one decade after establishment.
2. The Dune Development Study will allow us to observe how plants and soils respond to increased aeolian transport. Our goal in this experiment is to kickstart the formation of a coppice dune system and to observe changes in soil, vegetation, and litter as this transition occurs. This is the type of research that can only be conducted in a longterm context.

Shrubland to grassland transitions:

1. We addressed the following questions for each ecosystem type: (1) how general are the unusual grass responses for other shrublands? (2) how long does an increase in water use efficiency persist at the end of the wet period? (3) what is the relative importance of abiotic and biotic explanatory variables to grass response in wet, dry, and no trend years?
2. This experiment is testing three **hypotheses**. (1) Both water availability and the time that the ecosystem has been exposed to the new condition result in changes in ecosystem functioning through endogenous mechanisms. (2) The ecosystem sensitivity to reduced precipitation is different from sensitivity to increased precipitation resulting in asymmetries in the ecosystem response to chronic disturbances. (3) The interaction between cumulative endogenous with stochastic exogenous phenomena results in thresholds in population, community and ecosystem processes.

Shrubland to shrubland transitions:

1. To determine the extent to which individual shrub species are utilizing similar or different water sources in space and time within the geomorphic template of the Tromble weir watershed, we are using several techniques for measuring soil moisture– a network of soil profile sensors, a cosmic-ray soil moisture observing system (COSMOS) station, and water balance estimates – and comparing these for storm events and monthly average conditions to eddy covariance and sapflow measurements.
2. To characterize the spatial distribution of individual shrubs as a baseline from which to quantify subsequent changes in time, we are combining species-level vegetation classifications obtained from UAV-based remote sensing with ground-based surveys of plant type and cover. These spatially-explicit surveys are registered on a topoedaphic template.
3. To study the impact of shrub-to-shrub transitions on hydrologic conditions, we are parameterizing and using a distributed ecohydrologic model that incorporates high-resolution species-level data. Alternative scenarios will be assessed once model confidence is built based on comparisons to instrumentation networks at the Tromble weir watershed.

Transitions to novel states:

1. To determine precipitation and temperature requirements for seedling establishment of the invasive Lehman's lovegrass on soils found at the Jornada.

GOAL 2: To compare state change transitions among different geomorphic units at the Jornada

1. We are measuring the degree to which the climatic drivers interact with topography and soil to explain shrubland-grassland dynamics at the ecophysiological to landscape scale.
2. Specific objectives for the animal ecology study are to (a) quantify

relationships among precipitation, ANPP, predator activity, and herbivore abundances, (b) determine if these relationships differ among ecological states, and (c) compare site occupancy by carnivores, herbivore abundance, and herbivory rates in relation to urbanization to evaluate top-down controls and trophic cascades.

GOAL 3: To provide a more mechanistic understanding of regional dynamics within the Chihuahuan Desert (includes BLM, LEK, future scenarios)

For the BLM analysis, we are examining relationships between ownership variables (allotment turnover rates and interfamily transfers) and biophysical variables. The broad goal is to understand how social and ecological processes interact to determine the distribution of ecological states regional scale. For the MBG project, our goal is to engage directly with a community of land managers (both federal and private) to ask and answer ecological questions of interest at the regional scale using geographic information systems analysis of large, spatial datasets and monitoring data gathered by the MBG. Based on meetings with MBG we determined that the use of fire and the effects of drought are the most important concerns, so we designed a project around that interaction.

GOAL 4: To provide education and outreach programs from local to global scales

1. Increase the ability of local school districts to help students improve ecological understanding, including understanding the causes and potential impacts of climate change on local ecosystems (Schoolyard LTER program coordinated by Asombro Institute for Science Education).
2. Provide support to other LTER sites interested in adopting and adapting strategies developed in cooperation with JRN, including Data Jams (Asombro Institute).
3. Increase the ability of individuals and organizations to access, share and interpret knowledge and information necessary for climate change mitigation and adaptation (Climate Data Initiative and Climate Hub).
4. Increase the number, strength and diversity of partnerships through the development and strengthening of specific cooperative agreements with national and international organizations.
5. Continue to support US land management agencies in the development, application and interpretation of rangeland monitoring and assessment protocols based on JRN science (workshops).
6. Achieve adoption of a common set of rangeland monitoring protocols based in part on JRN research.
7. Increase the number of citations that can be searched for geographically through the JournalMap website, the quality of the interface, and the number of users.
8. Initiate development of a system to provide global access to site-specific predictions of potential productivity and sustainability of natural and human-dominated ecosystems based on an understanding of soil and climate variability, and landscape connectivity.

GOAL 5: To enhance the accessibility of Jornada data to a broad range of users

The main objectives this year were to:

1. migrate the Jornada Basin LTER website to the combined Jornada website
2. migrate the Jornada website to Drupal 7 and DEIMS 2

3. redesign the Jornada website home page and add new features and functionality
4. generate PASTA-ready EML from the Jornada website
5. review gis data and associated metadata within the geodatabase for quality and accuracy
6. replace computer network, central storage, and backup equipment

DEIMS powers the Jornada data catalog, long-term data, and climate data web pages. A new version was recently developed jointly by multiple LTER sites and the LTER Network Office. The main reason for upgrading to Drupal 7 besides easier theming is that DEIMS 2 generates PASTA-ready EML that will be used to populate the LTER PASTA system. It also has many new features, including intuitive administration interfaces that dramatically improve the efficiency of maintaining research data and associated metadata within DEIMS over the old Drupal 6 based system. It includes a data explorer dashboard module that provides live data interaction, allowing users to query, subset, preview, and export data from live database tables. Additionally, it provides a workbench module that allows moderation of website content submission prior to publication to the website by authenticated users and a new ISO metadata module.

These improvements to Jornada infrastructure will improve stability, performance, and accessibility to Jornada research data by users as well as applications being developed at the Jornada and across the LTER Network.

Significant Results:

GOAL 1. to provide new understanding of state changes within geomorphic units at the Jornada

Grassland to shrubland transitions:

1. There was a significant decrease in soil organic carbon (SOC) and total nitrogen (TN) in the NEAT treatments compared to the control, and concentrations in the upwind treatments were less than in the downwind treatment. Compared to the initial 2004 values, upwind treatment SOC and TN concentrations have been reduced by 1/3. Values on the control plots haven't changed appreciably during this timeframe.

Shrubland to grassland transitions:

1. An unusually large grass response occurred in all shrublands during the wet period. It took at least three sequential wet years for this response to occur. The response persisted two to four years past the wet period. Neither biotic variables nor amount of rainfall was important in the dry period. Biotic variables were more important than amount of precipitation in explaining variation in grass ANPP during the wet period. Biotic variables and amount of rainfall were important in the post-wet period.
2. Results from the 7-year manipulations show that ecosystem responses depend on water availability and on time of exposure to chronic resource alterations. Difference in total aboveground net primary production (ANPP) among precipitation treatments increased within the first three years of manipulation. Grass ANPP showed a fast and substantial response while shrub ANPP had little or no response to changes in water availability. The year 2013 was wetter than the previous 4 years however grasses that have been exposed to drought for 7 years were not able to respond to this increase in soil water.

Shrubland to shrubland transitions:

1. Spatially-distributed modeling at the Tromble weir watershed has revealed the

spatiotemporal controls of soil moisture from the distribution of shrub species (mariola, tarbush, creosote and mesquite) derived from 1-m resolution imagery, terrain products and vegetation classifications from a fixed-wing UAV. Soil moisture results are consistent with measurements obtained from the network of soil moisture profile sensors in the watershed (Fig. 1 from Vivoni et al. 2014).
2. We determined the relative abundances of shrub species in the watershed through a combination of ground surveys and high-resolution (~5 cm) UAV images. The most numerous shrub species in terms of areal coverage is *Parenthium incanum* (mariola), and its spatial occurrence is primarily along hillslopes with relatively thin soils. Other shrub species (tarbush, mesquite and creosote) dominate deeper soils on level terrain. (Fig. 2 from Rango et al. 2014).

GOAL 2: To compare state change transitions among different geomorphic units at the Jornada

1. The banded vegetation zone at the SCAN site consists of three units: a tobosa grass zone, a linear dune, and a bare zone. The tobosa grass zone developed because the linear dune is perpendicular to runoff and forms a dam that collects water. Adjacent to the linear dune on the downslope side is a zone of bare soil. Measurements of soil moisture of these three side-by-side zones reveal the dune has lease soil moisture followed by the bare zone and the grass. Measurements of soil temperature shows the dune has the highest temperatures followed by the grass and bare zone. (Fig. 3).
2. The camera-trap system is successfully collecting novel data on the grassland and shrubland sites. It is also providing data to test the “urbanization-herbivory hypothesis” in that herbivory rates of seedlings are greater in high-density urban areas compared to low-density urban areas and undeveloped areas.

GOAL 3: To provide a more mechanistic understanding of regional dynamics within the Chihuahuan Desert (includes BLM, LEK, future scenarios)

1. We published a manuscript in Frontiers in Ecology and Environment (Sayre et al. 2013) that consolidates our thinking about how social-ecological interactions should guide ecosystem stewardship in rangelands/drylands. Our analyses of fire incidents shows that the annual area burned in the desert grassland ecoregions has been relatively high in the last decade, with 2011 an extreme year (Fig. 4).

GOAL 4: To provide education and outreach programs from local to global scales

1. A total of 16,207 K-12 students, 766 teachers, and 298 other adults participated in 32 field trips, 598 one-hour classroom/schoolyard lessons, 3 teacher workshops, and 4 family events, where they learned about JRN research by participating in hands-on, inquiry-based activities. Six graduate students contributed more than 75 hours to help provide background information and lead activities with students.
2. The 2014 Desert Data Jam competition was held in April 2014. In total, 34 students from southern New Mexico participated in the final competition. JRN staff also assisted other LTER site educators, who subsequently hosted spring 2014 Data Jam competitions in Florida, Maryland, and New York.
3. Over 250 individuals representing over 20 domestic and international organizations, received training in rangeland monitoring and assessment protocols.

4. NRCS and BLM adopted and are applying a common set of rangeland monitoring protocols based in part on JRN research.
5. As of September 5, 2014, JournalMap users can use geographic, including map-based, search tools and terms to access over 18,000 articles. Usability was increased through a complete overhaul of the interface, and the number of users increased from 280 per month in August 2013 to 1763 per month in August 2014.
6. A beta version of the Land-Potential Knowledge System (Herrick et al. 2014) app supported by cloud-based predictive models and simple analytics was successfully developed and tested at pilot locations in Kenya and Namibia. Over 150 individuals were trained.
7. Increase the number of graduate students conducting JRN related research through summer fellowship program and Desert Ecology Class [Savitos Sidhu (Monger); Josh Haussler (Sala); Kristen DaVanon (Bestelmeyer and Schooley); Laureano Gherardi (Sala); Nate Pierce (Archer and Bestelmeyer); Owen McKenna (Sala); Ella McKinney (Monger)].
8. Two undergraduate REU students (Jeremy Romero and Ruben Baca) from NMSU.

GOAL 5: To enhance the accessibility of Jornada data to a broad range of users

Website and geodatabase

1. Migrated Jornada Basin LTER website to Drupal
2. Migrated website to CentOS 6, Drupal 7, and DEIMS 2
3. Redesigned Jornada home page and add new features and sections to website
4. Deployed prototype Data Explorer that allows users to query, subset, preview, and export research data stored in database tables
5. Deployed Workbench that allows moderation of research data and metadata contributed to the Jornada data catalog, data explorer, and prototype research notification system
6. Enhanced DEIMS to improve parsing of csv data files to variables (data type, column width) and to populate database tables for use by data explorer and the geodatabase
7. Created DEIMS research notification content type and forms that will be used by researchers and site manager to request/authorize research at the Jornada, including site selection
8. Reviewed data and metadata quality and congruency for research datasets and gis layers

Infrastructure

1. Servers: consolidated production and development resource pools (XenServer), updated hypervisor servers to XenServer 6, and replaced old domain controller server
2. Networking equipment: JER replaced router and switches. Awaiting firewall
3. Central storage: migration of server operating systems and volumes to the new NetApp centralized storage appliance has begun. When complete and volumes have finished deduplication process, we anticipate significant savings in storage capacity by reducing redundant storage across servers
4. Backup equipment: JER purchased a new LTO5 fiber channel tape library to replace the LTO tape library that was failing

Key outcomes or Other achievements:

GOAL 1. to provide new understanding of state changes within geomorphic units at the Jornada

Grassland to shrubland transitions:

1. A paper is in preparation that outlines results from the NEAT reanalysis. Two UCLA undergraduates (Dylan Oliva and Galen Coppage) participated in independent research at UCLA with Professor Okin for University credit.

Shrubland to grassland transitions:

1. Understanding the general patterns and drivers of ecosystem dynamics in multi-year dry or wet periods is expected to improve predictions of ANPP under directional increases or decreases in rainfall that could alter state change transitions. 208 characters
2. Results suggest that grasses have crossed a threshold and lost their ability to respond to an increase in precipitation. The dominant grass, black grama, was more sensitive to both drought and wet conditions than other subdominant perennial grasses.

Shrubland to shrubland transitions:

1. We quantified the eddy covariance footprint for a range of seasonal conditions and sampled the soil moisture and temperature conditions in a grid pattern around the tower using twenty sensor profiles. We found that the footprint-average conditions of soil moisture and temperature were more closely related to measured ET and heat fluxes, than to the measurements at a single site near the tower. This finding has broad implications for land-atmosphere interaction studies across many ecosystems.
2. We established that unmanned aerial vehicles are useful tools for a new, self-service paradigm in remote sensing where individual investigators and small teams are empowered to obtain high-resolution imagery at low cost, required repeat times and with rapid product turnaround. The UAV imagery was shown to be useful for scientific data analyses and numerical modeling activities. This demonstration will have broad impacts on the ecological, remote sensing and hydrological communities.

GOAL 2: To compare state change transitions among different geomorphic units at the Jornada

1. Measurements of current climatic-soil relationships across the Jornada Basin LTER will improve predictions about which soils will have lower moisture and higher temperatures under different climate change scenarios. We hypothesize that changes in soil climate will have important feedbacks to vegetation and animal dynamics.
2. Predator-prey interactions across an urbanization gradient highlight the likely importance of trophic cascades within alternative states in the American Southwest.

GOAL 3: To provide a more mechanistic understanding of regional dynamics within the Chihuahuan Desert (includes BLM, LEK, future scenarios)

1. The results of the BLM study will advance our understanding of how social-ecological interactions impact the trajectories of Chihuahuan Desert landscapes. The MBG study provides 1) an example in which LTER engages with a land management community based on their interests and 2) an unprecedented regional view fire distribution, effects, and interactions with climate

GOAL 4: To provide education and outreach programs from local to global scales

1. 16,207 K-12 students with increased understanding of the Chihuahuan Desert and current research being conducted by LTER scientists.
2. More than 100 students who gained skills both interpreting and then communicating large, long-term, complex datasets to nonscientists through Data Jam competitions at their own schools.
3. Training on standard methods protocols increased the quality and consistency of rangeland monitoring and assessment data.
4. Significant cost savings were realized through the decision by NRCS and BLM to adopt a common rangeland monitoring manual developed by the Jornada instead of each agency developing its own. This also increases the future ability of the agencies to share and integrate their datasets.
5. The ability of scientists and other users to find studies based on geographic relevance was significantly increased.
6. Local awareness and understanding of how to generate and use an understanding of landscape-scale soil variability and connectivity was increased in pilot regions in Kenya and Namibia.

GOAL 5: To enhance the accessibility of Jornada data to a broad range of users

1. After upgrading the Jornada website to DEIMS 2, we are now ready to populate the LTER PASTA system with all long-term Jornada datasets, followed by remaining short-term datasets.
2. After replacing the tape library, we are now able to perform tape backups again.

*** What opportunities for training and professional development has the project provided?**

GOAL 1. to provide new understanding of state changes within geomorphic units at the Jornada

Grassland *to shrubland transitions:*

Galen Coppage: UCLA Undergraduate Student. 3 months.

Dylan Oliva: UCLA Undergraduate Student. 3 months.

Nate Pierce: UofA Graduate Students: 3 months

Shrubland to grassland transitions:

Jin Yao, NMSU, Staff, 1 month

Shrubland to shrubland transitions:

Cody Anderson, Arizona State University, graduate student, 6 months.

Adam Schreiner-McGraw, Arizona State University, graduate student, 12 months.

Federica Borio, Politecnico di Torino, visiting graduate students, 3 months.

Transitions to novel states:

Jin Yao, NMSU, staff, 1 month

Haitao Huang, NMSU, 1 month

GOAL 2: To compare state change transitions among different geomorphic units at the Jornada

Savi Sidhu, graduate student NMSU, 12 months

Ella McKinney, NMSU, Graduate fellowship, 3 months

Kristen DaVanon, NMSU, Graduate fellowship, 3 months

Jeremy Romero, NMSU, REU, 3 months

Ruben Baca, NMSU, REU 3 months

GOAL 3: To provide a more mechanistic understanding of regional dynamics within the Chihuahuan Desert (includes BLM, LEK, future scenarios)

Dr. Matthew Levi, USDA-ARS, postdoc, 6 months.

GOAL 4: To provide education and outreach programs from local to global scales

We continued our summer Desert Ecology short course with seven graduate students and two undergraduate students participating in the two-day course. The course consisted of lectures and field trips by the LTER PIs combined with IM training by our IM manager. The final day culminated in a seminar and book signing by Tim Egan, author of The Big Burn and The Worst Hard Time.

We awarded seven graduate student summer fellowships in 2014 to the following students. All of our students are participating in the Asombro activities as part of their fellowship requirements.

Savitos Sidhu (Monger, NMSU)
Josh Haussler (Sala, ASU)
Kristen DaVanon (Bestelmeyer and Schooley, NMSU)
Laureano Gherardi (Sala, ASU)
Nate Pierce (Archer and Bestelmeyer, UA)
Owen McKenna (Sala, ASU)
Ella McKinney (Monger, NMSU)

We also worked with two NMSU undergraduate students as part of the REU program (Jeremy Romero and Ruben Baca).

GOAL 5: To enhance the accessibility of Jornada data to a broad range of users

Andrew Franke - Undergraduate student (Minnesota State University; MNSU), 3 months

*** How have the results been disseminated to communities of interest?**

GOAL 1. to provide new understanding of state changes within geomorphic units at the Jornada

Grassland to shrubland transitions:

A manuscript is in preparation that will be the main vehicle for dissemination of the results.

Shrubland to grassland transitions:

Two papers were published in 2012-13, and results were presented at the 2013 and 2014 ESA mtgs.

Shrubland to shrubland transitions:

Two papers (Templeton et al., 2014; Vivoni et al., 2014) have been published or are in press in 2014. A chapter in the AGU book “Remote Sensing of the Terrestrial Water Cycle” is in press (Rango et al., 2014). An M.S. thesis was published (Anderson, 2013) in 2013. Results have been presented at the American Geophysical Union (2013, 2014) and Union Geofisica Mexicana (2014).

Two papers (Templeton et al., 2014; Vivoni et al., 2014) have been published or are in press in 2014. A chapter in the AGU book “Remote Sensing of the Terrestrial Water Cycle” is in press (Rango et al., 2014). An M.S. thesis was published (Anderson, 2013) in 2013. Results have been presented at the American Geophysical Union (2013, 2014) and Union Geofisica Mexicana (2014).

GOAL 2: To compare state change transitions among different geomorphic units at the Jornada

Results have been disseminated to scientific communities by conference presentations and to the general public by community lectures, magazine articles, and YouTube videos.

GOAL 3: To provide a more mechanistic understanding of regional dynamics within the Chihuahuan Desert (includes BLM, LEK, future scenarios)

This year we presented the project aims and initial literature analysis at the annual Malpai Borderlands science meeting. The Frontiers in Ecology and Environment paper was published in 2013.

GOAL 5: To enhance the accessibility of Jornada data to a broad range of users

DEIMS Repository: http://github.com/lter/deims

Jornada source code enhancements to DEIMS will be shared with the wider DEIMS and Drupal communities in the repo

DEIMS Project Page: http://www.drupal.org/project/deims

Jornada bug fixes and information related to DEIMS will be shared with wider DEIMS and Drupal communities within the page

LTER Data Catalog: http://metacat.lternet.edu/das/lter/browse.jsp#JRN

EcoTrends Data Portal: http://www.ecotrends.info

Jornada Data Catalog: http://jornada.nmsu.edu/data-catalogs/jornada

Jornada Data Explorer: http://jornada.nmsu.edu/data-explorer-dashboard

Jornada research data and metadata are made available from multiple portals

DrupalCon Austin - June 2014

DEIMS Workshop: http://austin2014.drupal.org/session/deims-drupal-profile-ecological-data

Presentation and discussion of DEIMS to wider Drupal community

Science on Drupal Workshop: http://austin2014.drupal.org/bof/science-drupal

Birds of a feather session on Drupal's role in supporting the sciences and how agencies and research groups can share challenges and successes and get wider participation in science related Drupal development efforts

Federation of Earth Science Information Partners (ESIP) Conference - July 2014

Security Lab: http://commons.esipfed.org/node/2558

Maps and Visualization Lab: http://commons.esipfed.org/node/2559

Drupal Working Group (hosted DrupalCon BOF session), hosted training labs and facilitated discussions begun at DrupalCon on how we can leverage one another's work within Drupal without reinventing the same wheels

*** What do you plan to do during the next reporting period to accomplish the goals?**

GOAL 1. to provide new understanding of state changes within geomorphic units at the Jornada

Grassland to shrubland transitions:

The Dune Development Study will be initiated, and field experiments quantifying: (a) grass effects on adult shrubs, (b) adult shrub effects on grasses and (c) shrub-shrub interactions along a grassland-to-shrubland gradient have recently been completed. These experiments were designed to elucidate mechanisms propelling state transitions. ***Grass effects on adult shrubs***. Growth of shrubs where grasses were removed in the area surrounding shrubs of different sizes will be analyzed to determine (i) at what stage of their life cycle, shrubs respond to the loss of grasses, and (ii) are shrub growth responses to reductions in grass biomass linear or exponential. ***Adult shrub effects on grass***. Data on herbaceous ANPP and diversity in grass patches with varying abundances of shrubs in their neighborhood will be analyzed to determine the critical size/density of shrubs required to influence grass ANPP. ***Shrub-shrub interactions***. Data on growth of target shrubs whose conspecific neighbors have been removed across a range of shrub densities will be analyzed to determine when shrub interactions become density-dependent and set a limit on maximum shrub cover and ANPP on sites formerly dominated by grasses.

Shrubland to grassland transitions:

1. We are comparing responses during the 2004-2008 wet period with a previous wet period (1984-1988), and testing hypotheses about factors controlling similar responses. We are examining factors that led to the mortality of perennial grasses in 1989. We continue to reuse long-term data from multiple datasets and studies at the Jornada as we test additional hypotheses.
2. We are continuing the long-term manipulation experiment.

Shrubland to shrubland transitions:

1. We will continue to monitor and analyze the sensor network observations from the Tromble weir watershed by quantitatively comparing: 1) different soil moisture measurement techniques at the watershed scale, 2) techniques for partitioning ET that account for individual shrub species and the spatial variability within the eddy covariance footprint, and 3) evaluating long-term simulations using the spatially-distributed approach that accounts for changes in shrub functional types.
2. We will continue to obtain imagery from unmanned aerial vehicles to quantify vegetation phenology, link these to phenological data (phenocams and sampling) and identify possible state transitions related to shrub-shrub interactions. The imagery will be processed for spatiotemporal analyses that can be used as inputs to the spatially-distributed modeling activities.
3. We will purchase a field portable laser spectrometer and undergo training to use this technology for determining the isotopic composition of water vapor at the Tromble eddy covariance tower. This method will complement the ET, sapflow and soil measurements to partition atmospheric water flux into evaporation and transpiration.
4. We will conduct vegetation surveys throughout the eastern bajada to document the historic shifts in dominant shrub species through time, and conduct a literature review to obtain species-level parameters for seed germination and seedling establishment in the SOILWAT model, and for plant competition and mortality in the Ecotone model. After the models have been verified, we will conduct simulations of historic climate and soils conditions to determine the sequence of events needed to result in today's landscapes, and then examine

scenarios under future climate.

Transitions to novel states:

1. We plan on running the Ecotone model to examine controls on the growth and expansion of these exotic grasses at the Jornada.

GOAL 2: To compare state change transitions among different geomorphic units at the Jornada

1. We are expanding our studies to include the Chihuahuan Desert Nature Park in the southern Jornada Basin. We will test hypotheses about how soils will respond to future change by investigating how they responded to past climate change using paleosols, erosion features, and carbon isotopes.
2. We will analyze data from our array of camera traps in conjunction with the Ecotone study to determine relationships among precipitation, ANPP, herbivore abundances, and mammalian carnivore densities. We will continue to expand our investigation of urbanization and trophic cascades by sampling additional sites across the gradient.

GOAL 3: To provide a more mechanistic understanding of regional dynamics within the Chihuahuan Desert (includes BLM, LEK, future scenarios)

1. Complete analyses of the relationships of desert grassland fire and biophysical variables at a regional scale.

GOAL 4: To provide education and outreach programs from local to global scales

1. The JRN K-12 team will continue to plan and conduct field trips and classroom/schoolyard programs focused on JRN research. We will host at least one teacher workshop, four family education events, and the 2015 Desert Data Jam competition. We will continue to involve JRN graduate students in developing and implementing new K-12 programs.

GOAL 5: To enhance the accessibility of Jornada data to a broad range of users

Infrastructure upgrades

1. Complete migration of central storage from old to new SAN

2. Complete upgrade of network equipment

1. Increase bandwidth to field headquarters
2. Expand wireless coverage (Wi-Fi, spread spectrum) to more research sites in the field
3. Web portal integration
4. Incorporate dataset contacts, originators, and responsible investigator roles within DEIMS, needed for differentiating dataset contact from the dataset originator. This ensures acknowledgement of the person that initiated the study, whether completed or ongoing, since the originators and current responsible investigators will be maintained separately.
5. Load PASTA with Jornada research datasets, beginning with long-term datasets
6. Integrate geoportal with DEIMS using the ISO metadata module
7. Update ClimDB harvest generation process to adjust to changes in NOAA NCDC data
8. Data Explorer and geodatabase population
9. Convert short-term data files to csv format for use by PASTA and data explorer
10. Create and populate relational database tables for Jornada research data stored in csv format (currently long-term data) for use by data explorer (MySQL) as well as the enterprise geodatabase (SQL Server) and geoportal
11. Deploy data explorer
12. Improve dataset classifications using the LTER controlled vocabulary to improve discovery of Jornada research data from the data catalog, data explorer, geodatabase, geoportal, and LTER data portal
13. Populate DEIMS with content from completed Research Notification forms and setup website to support user self-registration

Supporting Files

Filename	Description	Uploaded By	Uploaded On
Fig1.pdf	Example of high-resolution UAV products for watershed modeling studies.	Debra Peters	10/27/2014
Fig_2.pdf	Species-specific vegetation classification map for the region near the study watershed derived from the UAV imagery.	Debra Peters	10/27/2014
Fig_3.pdf	Soil moisture and temperature comparison between three adjacent soils: a siltysoil with no vegetation (bare), a sand dune with tarbush, and a siltysoil with tobosagrass.	Debra Peters	10/27/2014
Fig_4.pdf	Area burned in the Chihuahuan Desert and Madrean Archipeligo Ecoregions from 1980 to 2012.	Debra Peters	10/27/2014

Products

Books

Peters, DPC, Laney CM, Lugo AE, Collins SL, Driscoll CT, Groffman PM, Grove JM, Knapp AK, Kratz TK, Ohman MD, Waide RB, and Yao J (2013). *Long-term trends in ecological systems: a basis for understanding responses to global change.* U.S. Department of Agriculture. Washington, D.C., USA. Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Book Chapters

Driscoll, CT, Groffman PM, Blair JM, Lugo AE, Laney CM, and Peters DPC (2013). Cross-site comparisons of precipitation and surface water chemistry. *Long-Term Trends in Ecological Systems: A Basis for Understanding Responses to Global Change.* Peters DPC, Laney CM, Lugo AE, et al. United States Department of Agriculture. Washington, D.C., USA. 46. Status = PUBLISHED; Acknowledgement of Federal Support = Yes ; Peer Reviewed = Yes

Han, G, Liu T, Wang Z, Li Z, Zhao M, Havstad KM, Wu J, and Kemp D (2013). Adaptive management of grazing lands. *Dryland East Asia: Land Dynamics amid Social and Climate Change* Chen J, Wan S, Henebry G, et al.. Higher Education Press. Beijing, China. 447. Status = PUBLISHED; Acknowledgement of Federal Support = No ; Peer Reviewed = Yes ; ISBN: 978-7-04-037819-1..

Havstad, KM, and Brown JR (2013). Management and policy implications of cross-and within-site long-term studies. *Long-Term Trends in Ecological Systems: A Basis for Understanding Responses to Global Change* Peters DPC, Laney CM, Lugo AE, et al.. United States Department of Agriculture. Washington, D.C., USA. 206. Status = PUBLISHED; Acknowledgement of Federal Support = Yes ; Peer Reviewed = Yes

Knapp, AK, Smith MD, Peters DPC, and Collins SL (2013). Patterns of net primary production across sites. *Long-Term Trends in Ecological Systems: A Basis for Understanding Responses to Global Change* Peters DPC, Laney CM, Lugo AE, et al.. United States Department of Agriculture. Washington, D.C., USA. 42. Status = PUBLISHED; Acknowledgement of Federal Support = Yes ; Peer Reviewed = Yes

Laney, CM, Baker KS, Peters DPC, and Ramsey KW (2013). Recommendations for data accessibility. *Long-Term Trends in Ecological Systems: A Basis for Understanding Responses to Global Change* Peters DPC, Laney CM, Lugo AE, et al.. United States Department of Agriculture. Washington, D.C., USA. 216. Status = PUBLISHED; Acknowledgement of Federal Support = Yes ; Peer Reviewed = Yes

Laney, CM, Peters DPC, and Baker KS (2013). History and organization of the EcoTrends project. *Long-Term Trends in Ecological Systems: A Basis for Understanding Responses to Global Change* Peters DPC, Laney CM, Lugo AE, et

al.. United States Department of Agriculture. Washington, D.C., USA. 21. Status = PUBLISHED; Acknowledgement of Federal Support = Yes ; Peer Reviewed = Yes

Monger, HC (2014). Soils as generators and sinks of inorganic carbon in geologic time. *Soil Carbon.* Hartemink AE and McSweeney K. Springer International Publishing. Switzerland.. 27. Status = PUBLISHED; Acknowledgement of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 10.1007/978-3-319-04084-4_3.

Peters, DPC (2013). Long-term research across sites, ecosystems, and disciplines: synthesis and research needs. *Long-Term Trends in Ecological Systems: A Basis for Understanding Responses to Global Change* Peters DPC, Laney CM, Lugo AE, et al.. United States Department of Agriculture. Washington, D.C., USA. 226. Status = PUBLISHED; Acknowledgement of Federal Support = Yes ; Peer Reviewed = Yes

Peters, DPC, Archer SR, Bestelmeyer BT, Brooks A, Brown JR, Comrie A, Gimblett RH, Goldstein JH, Havstad KM, Lopez-Hoffman L, et al. (2013). Desertification of rangelands. *Climate Vulnerability: Understanding and Addressing Threats to Essential Resources* Pielke RA. Elsevier Inc., Academic Press. Waltham, MA, USA. 239. Status = PUBLISHED; Acknowledgement of Federal Support = Yes ; Peer Reviewed = Yes ; ISBN: 978-0-12-384703-4..

Peters, DPC, Fraser WR, Kratz TK, Ohman MD, Rassweiler A, Holbrook SJ, and Schmitt RJ (2013). Cross-site comparisons of state-change dynamics. *Long-Term Trends in Ecological Systems: A Basis for Understanding Responses to Global Change* Peters DPC, Laney CM, Lugo AE, et al.. United States Department of Agriculture. Washington, D.C., USA. 36. Status = PUBLISHED; Acknowledgement of Federal Support = Yes ; Peer Reviewed = Yes

Peters, DPC, Goslee SC, Collins S, and Gosz JR (2013). Landscape Diversity. *Encyclopedia of Biodiversity 2nd.* 4. Levin, S. Academic Press. Waltham, MA, USA. . Status = PUBLISHED; Acknowledgement of Federal Support = Yes ; Peer Reviewed = Yes

Peters, DPC, Laney CM, Lugo AE, Collins SL, Driscoll CT, Groffman PM, Grove JM, Knapp AK, Kratz TK, Ohman MD, et al. (2013). Long-term trends in precipitation and surface water chemistry. *Long-Term Trends in Ecological Systems: A Basis for Understanding Responses to Global Change* Peters DPC, Laney CM, Lugo AE, et al.. United States Department of Agriculture. Washington, D.C., USA. 115. Status = PUBLISHED; Acknowledgement of Federal Support = Yes ; Peer Reviewed = Yes

Peters, DPC, Laney CM, Lugo AE, Collins SL, Driscoll CT, Groffman PM, Grove JM, Knapp AK, Kratz TK, Ohman MD, et al. (2013). Long-term trends in human demography and economy across sites. *Long-Term Trends in Ecological Systems: A Basis for Understanding Responses to Global Change* Peters DPC, Laney CM, Lugo AE, et al.. United States Department of Agriculture. Washington, D.C., USA. 162. Status = PUBLISHED; Acknowledgement of Federal Support = Yes ; Peer Reviewed = Yes

Peters, DPC, Laney CM, Lugo AE, Collins SL, Driscoll CT, Groffman PM, Grove JM, Knapp AK, Kratz TK, Ohman MD, et al. (2013). Long-term trends in ecological systems: An introduction to cross-site comparisons and relevance to global change studies. *Long-Term Trends in Ecological Systems: A Basis for Understanding Responses to Global Change* Peters DPC, Laney CM, Lugo AE, et al.. United States Department of Agriculture. Washington, D.C., USA. 1. Status = PUBLISHED; Acknowledgement of Federal Support = Yes ; Peer Reviewed = Yes

Peters, DPC, Laney CM, Lugo AE, Collins SL, Driscoll CT, Groffman PM, Grove JM, Knapp AK, Kratz TK, Ohman MD, et al. (2013). Long-term trends in climate and climate-related drivers. *Long-Term Trends in Ecological Systems: A Basis for Understanding Responses to Global Change* Peters DPC, Laney CM, Lugo AE, et al.. United States Department of Agriculture. Washington, D.C., USA. 81. Status = PUBLISHED; Acknowledgement of Federal Support = Yes ; Peer Reviewed = Yes

Peters, DPC, Laney CM, Lugo AE, Collins SL, Driscoll CT, Groffman PM, Grove JM, Knapp AK, Kratz TK, Ohman MD, et al. (2013). Long-term trends in production, abundance, and richness of plants and animals. *Long-Term Trends in Ecological Systems: A Basis for Understanding Responses to Global Change* Peters DPC, Laney CM, Lugo AE, et al.. United States Department of Agriculture. Washington, D.C., USA. 191. Status = PUBLISHED; Acknowledgement of Federal Support = Yes ; Peer Reviewed = Yes

Peters, DPC, Lugo AE, Chapin FS III, Tepley AJ, and Swanson FJ (2013). Disturbance regimes and ecological responses across sites. *Long-Term Trends in Ecological Systems: A Basis for Understanding Responses to Global Change* Peters DPC, Laney CM, Lugo AE, et al.. United States Department of Agriculture. Washington, D.C., USA. 58. Status = PUBLISHED; Acknowledgement of Federal Support = Yes ; Peer Reviewed = Yes

Rango, A, Vivoni ER, Anderson CA, Pierini NA, Schreiner-McGraw A, Saripalli S and Laliberte A (2014). Application of high resolution images from unmanned aircraft systems for watershed and rangeland science. *American Geophysical Union Monograph on Remote Sensing of the Terrestrial Water Cycle* Venkataraman L, et al. American Geophysical Union. . Status = PUBLISHED; Acknowledgement of Federal Support = Yes ; Peer Reviewed = Yes

Sala, OE, Vivanco L, and Flombaum P (2013). Grassland ecosystems. *Encyclopedia of Biodiversity 2nd.* 4. Levin SA. Academic Press.. Waltham, MA, USA. . Status = PUBLISHED; Acknowledgement of Federal Support = Yes ; Peer Reviewed = Yes

Yao, J, Sala OE, and Peters DPC (2013). Cross-site studies "by design:" experiments and observations that provide new insights. *Long-Term Trends in Ecological Systems: A Basis for Understanding Responses to Global Change* Peters DPC, Laney CM, Lugo AE, et al.. United States Department of Agriculture. Washington, D.C., USA. 72. Status = PUBLISHED; Acknowledgement of Federal Support = Yes ; Peer Reviewed = Yes

Ye, J, Reynolds JF, Herrick JE, Reynolds JA, Chuluun T, Li F, and Long R (2013). New ecology education: Preparing students for the complex human-environmental problems of dryland East Asia. *Dryland East Asia: Land Dynamics amid Social and Climate Change* Chen J, Wan S, Henebry G, et al.. Higher Education Press. Beijing, China. 363. Status = PUBLISHED; Acknowledgement of Federal Support = No ; Peer Reviewed = Yes ; ISBN: 978-7-04-037819-1..

Conference Papers and Presentations

Herrick, JE, Urama KC, Karl JW, Boos J, Johnson MVV., Shepherd K, Hempel J, Bestelmeyer BT, Davies J, Guerra JL, et al. (2013). *A land-potential knowledge system (LandPKS) based on local and scientific knowledge of land productivity and resilience*. 2nd Scientific Conference, United Nations Convention to Combat Desertification (UNCCD). Bonn, Germany. Status = OTHER; Acknowledgement of Federal Support = Yes

Elias, E, Steele C, Rango A, and MeJia J (2013). *Assessing climate change impacts on water availability of snowmelt dominated watersheds of the Upper Rio Grande*. American Geophysical Union fall meeting. San Francisco, CA, USA. Status = OTHER; Acknowledgement of Federal Support = Yes

Browning, DM, Tweedie CE, and Rango A (2013). *Bridging estimates of greenness in an arid grassland using field observations, phenocams, and time series Umanned Aerial System (UAS) imagery*. American Geophysical Union fall meeting. San Francisco, CA, USA. Status = OTHER; Acknowledgement of Federal Support = Yes

Monger, HC, Feng Y, and Karnjanapiboonwang A (2013). *Carbon residence times in pedogenic carbonate pools*. American Geophysical Union fall meeting. San Francisco, CA, USA. Status = OTHER; Acknowledgement of Federal Support = Yes

Yao, J and Peters DPC (2014). *Climate change in the American Southwest deserts: Opportunities for invasion by exotic grasses?*. Ecological Society of America annual meeting. Sacramento, CA, USA. Status = OTHER; Acknowledgement of Federal Support = Yes

Monger, HC (2014). *Coevolution of soil genesis and life*. 20th World Congress of Soil Science. Jeju, Korea. Status = OTHER; Acknowledgement of Federal Support = Yes

Browning, DM, Duniway MC, and Tweedie CE (2014). *Cross-scale perspectives on patterns and environmental cues driving plant phenology in an arid upland grassland*. Ecological Society of America annual meeting. Sacramento, CA, USA. Status = OTHER; Acknowledgement of Federal Support = Yes

Peters, DPC, Yao J, and Sala OE (2014). *Disentangling climatic effects from biotic contingencies during extreme events: Chihuahuan desert responses to droughts and deluges*. Ecological Society of America annual

meeting. Sacramento, CA, USA. Status = OTHER; Acknowledgement of Federal Support = Yes

Svejcar, L, Bestelmeyer, BT, Peinetti, H, Adema, EO, Sosa, AA, Berterreix, GA, and Morici, EA. (2013). *Ecological site concepts for the Caldenal ecoregion*. Los Pastizales y el Hombre, producir y conservar. Santa Rosa, La Pampa, Argentina.. Status = OTHER; Acknowledgement of Federal Support = Yes

Sala, OE (2014). *Ecosystem services in arid regions: paradigm change from supply to demand*. Inner Mongolia University. Inner Mongolia, China. Status = OTHER; Acknowledgement of Federal Support = Yes

Sala, OE (2014). *Functioning of grasslands and savannas*. Columbia University. New York, NY. Status = OTHER; Acknowledgement of Federal Support = Yes

Sala, OE (2014). *Functioning of grasslands and savannas*. Beijing Normal University. Beijing, China. Status = OTHER; Acknowledgement of Federal Support = Yes

Sala, OE (2013). *Functioning of grasslands and savannas: productivity, water, space and time*.. Open Landscapes International Conference. Hildesheim University, Germany. Status = OTHER; Acknowledgement of Federal Support = Yes

Vivoni, E, Pierini N, Schreiner-McGraw A, Anderson C, Saripalli S, and Rango A (2013). *Fusing unmanned aerial vehicle imagery with high resolution hydrologic modeling*. American Geophysical Union fall meeting. San Francisco, CA, USA. Status = OTHER; Acknowledgement of Federal Support = Yes

Herrick, JE, Beh A, Beniston J, Urama K, and Van der Waal C (2014). *Global crowdsourcing of soil-specific woody plant encroachment patterns and management strategies*. Ecological Society of America annual meeting. Sacramento, CA, USA. Status = OTHER; Acknowledgement of Federal Support = Yes

Moran, MS, Ponce-Campos GE, Huete A, McClaran MP, Zhang Y, Hamerlynck EP, Augustine DJ, Gunter SA, Kitchen SG, Peters DPC, Starks PJ, Hernandez M, Hottenstein JD, and Ross ML (2014). *Grassland resilience during the warm drought of the early 21st century*. Ecological Society of America annual meeting. Sacramento, CA, USA. Status = OTHER; Acknowledgement of Federal Support = Yes

Sala, OE (2014). *Grasslands and savannas under climate change*. Lanzhou University. Lanzhou, China. Status = OTHER; Acknowledgement of Federal Support = Yes

Karl, JW (2013). *JournalMap: research reimagined*. International Association of Scientific, Technical and Medical Publishers 2013 Innovations Seminar. London, UK. Status = OTHER; Acknowledgement of Federal Support = Yes

Sala, OE, Gherardi LA, Reichmann LG, and Peters DPC (2014). *Lags in the response of ecosystems to directional changes in water availability.*. Ecological Society of America annual meeting. Sacramento, CA, USA. Status = OTHER; Acknowledgement of Federal Support = Yes

Cosentino, BJ, Schooley RL, Bestelmeyer BT, McCarthy AJ, and Sierzega K (2014). *Landscape restoration supports genetic connectivity among populations of a keystone species*. Ecological Society of America annual meeting. Sacramento, CA, USA. Status = OTHER; Acknowledgement of Federal Support = Yes

Vivoni, ER (2014). *Las interacciones atmósfera-tierra durante el monzón de América del Dorte: estudios ecohidrológicos de modelación y de campo*. Reunión Anual Union Geofísica Mexicana. Puerto Vallarta, Jalisco, Mexico. Status = OTHER; Acknowledgement of Federal Support = Yes

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OTHER; Acknowledgement of Federal Support = Yes

McCord, SE, Kachergis EJ, James D, Karl JW, and Wilson D (2014). *Multi-scale ecosystem monitoring: an application of scaling data to answer multiple ecological questions*. Ecological Society of America annual meeting. Sacramento, CA, USA. Status = OTHER; Acknowledgement of Federal Support = Yes

Rango, A, Elias E, Steele C, Mejia J, and Fernald A (2013). *Potential impacts of climate warming on runoff from snowmelt: a case study of two mountainous basins in the Upper Rio Grande*. American Geophysical Union fall meeting. San Francisco, CA, USA. Status = OTHER; Acknowledgement of Federal Support = Yes

Sala, OE (2013). *Social, ecological and economic drivers of abrupt grass-woodland transitions: scales and interactions*. Stockholm Resilience Centre. Royal Swedish Academy of Sciences, Sweden. Status = OTHER; Acknowledgement of Federal Support = Yes

Bestelmeyer, BT, Brown JR, Densambuu B, Havstad KM, Herrick JE, and Peinetti HR (2013). *State-and-transition models as guides for adaptive management: What are the needs?*. Los Pastizales y el Hombre. Santa Rosa, La Pampa, Argentina.. Status = OTHER; Acknowledgement of Federal Support = Yes

Ochoa, C, Guldan S, Fernald A, Tidwell V, Elias E, Gutierrez K, and Borman M. (2014). *Surface water and shallow groundwater interactions in semiarid agro-ecosystems of western USA*.. EGU General Assembly. Vienna, Austria. Status = OTHER; Acknowledgement of Federal Support = Yes

Vivoni, ER (2014). *Terrain-vegetation-atmosphere interactions during the North American monsoon*. American Geophysical Union Fall Meeting. San Francisco, CA. Status = OTHER; Acknowledgement of Federal Support = Yes

DaVanon, KA, Howard L, Bestelmeyer BT, Mabry KE, and Schooley RL (2014). *The effects of urbanization on state change mediated by predator-prey interactions.*. Ecological Society of America annual meeting. Sacramento, CA, USA. Status = OTHER; Acknowledgement of Federal Support = Yes

Previtali, MA, Milstead WB, Meserve PL, Mathenia M, Kelt DA, Campanella A, and Gutierrez JR (2014). *The influence of rainfall on small mammal demography: Differences among species and habitats of semiarid Chile*.. Ecological Society of America annual meeting. Sacramento, CA, USA. Status = OTHER; Acknowledgement of Federal Support = Yes

Chappell, A, Webb N, Butler H, Strong CL, McTainish G, Lleys J, and Rossel RV (2013). *The role of carbon dust emission as a global source of atmospheric CO2.*. Soil Carbon Sequestration for Climate, Food Security and Ecosystem Services International Conference. Reykjavid, Iceland. Status = OTHER; Acknowledgement of Federal Support = Yes

Monger, HC, Anjos LHC, Zhang G, Goryachkin SV, Harms B, Schad P, Fox C, Sonn Yeon-kyu G (2014). *Toward a global system of soil horizon nomenclature*. 20th World Congress of Soil Science. Jeju, Korea. Status = OTHER; Acknowledgement of Federal Support = Yes

Gillan, J and Karl JW (2014). *Using JournalMap to improve ecological knowledge discovery and visualization*. Ecological Society of America annual meeting. Sacramento, CA, USA. Status = OTHER; Acknowledgement of Federal Support = Yes

Rango, A, Browning DM, Vivoni E, Anderson CA, and Laliberte A (2013). *Utilization of unmanned aerial vehicles for rangeland resources monitoring in a changing regulatory environment*. American Geophysical Union fall meeting. San Francisco, CA, USA. Status = OTHER; Acknowledgement of Federal Support = Yes

Sala, OE (2013). *Woody-plant encroachment: degradation or a shift in the portfolio of ecosystem services?*. National Academies Keck Future Initiative. Chicago, IL.. Status = OTHER; Acknowledgement of Federal Support = Yes

Inventions

Journals

Anadón, JD, Sala OE, and Maestre FT. (2014). Climate change will increase savannas at the expense of forests and treeless vegetation in tropical and subtropical Americas. *Journal of Ecology*. . Status = AWAITING_PUBLICATION; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Anadón, JD, Sala OE, Turner BL II, and Bennett EM (2014). Effect of woody-plant encroachment on livestock production in North and South America.. *Proceedings of the National Academy of Sciences of the United States of America*. 11 12948. Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 10.1073/pnas.1320585111

Bagchi, S, Briske DD, Bestelmeyer BT, and Wu XB (2013). Assessing resilience and state-transition models with historical records of cheatgrass Bromus tectorum invasion in North American sagebrush-steppe. *Journal of Applied Ecology*. 50 1131. Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 10.1111/1365-2664.12128

Bestelmeyer, BT (2014). Deforestation of “degraded” rangelands: The Argentine Chaco enters the next stage of the Anthropocene. *Rangelands*. 36 36. Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 10.2111/Rangelands-D-14-00026.1

Briske, DD, Bestelmeyer BT, and Brown JR (2014). Savory’s unsubstantiated claims should not be confused with multipaddock grazing. *Rangelands*. 36 39. Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 10.2111/1551-501X-36.1.39

Briske, DD, Bestelmeyer BT, Brown JR, Fuhlendorf SD, and Polley HW (2013). The Savory Method can not green deserts or reverse climate change. *Rangelands*. 35 72. Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 10.2111/RANGELANDS-D-13-00044.1.

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Cosentino, B, Schooley RL, Bestelmeyer BT, and Coffman JM (2013). Response of lizard community structure to desert grassland restoration mediated by a keystone rodent. *Biodiversity and Conservation*. 22 921. Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 10.1007/s10531-013-0459-7.

Cosentino, BJ, Schooley RL, Bestelmeyer BT, Kelly JF, and Coffman JM (2014). Constraints and time lags for recovery of a keystone species (Dipodomys spectabilis) after landscape restoration. *Landscape Ecology*. 29 665. Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 10.1007/s10980-014-0003-5.

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elevated atmospheric CO2 impacts on biogeochemical cycling of carbon and nitrogen in shrub-dominated drylands. *Ecosystems*. 17 931. Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 10.1007/s10021-014-9764-6.

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Licenses

Other Products

Other Publications

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Kelly, EC (2014). *Examining ecosystems—Jornada the premier place for desert ecology research*. NMSU Research & Resources Magazine. p.9. University Communications and Marketing Services, New Mexico State University. Status = PUBLISHED; Acknowledgement of Federal Support = No

Peters, DPC, Scroggs SLP, and Yao J. (2014). *North American Biomes*. Oxford Bibliographies. http://dx.doi.org/10.1093/OBO/9780199830060-0099. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Bestelmeyer, BT. (2014). *Overgrazing - How far are we from passing the tipping point of turning our rangelands into desert?*. Mongolian Herder 16: 28. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Patents

Technologies or Techniques

Thesis/Dissertations

Smith, JG. *An exploration of the influence of animals on soil organic carbon dynamics in dryland ecosystems*. (2014). New Mexico State University. Acknowledgement of Federal Support = Yes

Anderson, CA. *Assessing land-atmosphere interactions through distributed footprint sampling at two eddy covariance towers in semiarid ecosystems of the Southwestern U.S.*. (2013). Arizona State University.. Acknowledgement of Federal Support = Yes

Hewins, DB. *Exploring the role of soil-litter mixing on decomposition in dryland ecosystems*. (2013). New Mexico State University. Acknowledgement of Federal Support = Yes

Goolsby, DP. *Heterogeneity in ecological state transitions at multiple spatial scales in the northern Chihuahuan Desert*. (2012). New Mexico State University. Acknowledgement of Federal Support = Yes

Parry, SF. *Impermanence factors and rangeland management in the desert southwest*. (2012). New Mexico State University. Acknowledgement of Federal Support = Yes

Klass, JR. *Plant-soil interactions associated with desertification of the Chihuahuan Desert*. (2012). New Mexico State University. Acknowledgement of Federal Support = Yes

Svejcar, LN. *Quantitative approaches to state-and-transition models at fine and broad spatial scales*. (2012). New Mexico State University. Acknowledgement of Federal Support = Yes

Rachal, DM. *Tracing the lateral movement of sediment through an arid landscape at seasonal, centennial, and millennial scales*. (2012). New Mexico State University. Acknowledgement of Federal Support = Yes

Websites

Participants/Organizations

Research Experience for Undergraduates (REU) funding

Form of REU funding support:	REU supplement
How many REU applications were received during this reporting period?	2
How many REU applicants were selected and agreed to participate during this reporting period?	2
REU Comments:	

What individuals have worked on the project?

Name	Most Senior Project Role	Nearest Person Month Worked
Peters, Debra	PD/PI	1
Bestelmeyer, Brandon	Co PD/PI	1
Bestelmeyer, Stephanie	Co PD/PI	4
Havstad, Kris	Co PD/PI	1
Monger, Hugh	Co PD/PI	3
Archer, Steve	Co-Investigator	1
Duniway, Michael	Co-Investigator	1
Herrick, Jeffrey	Co-Investigator	1
Okin, Gregory	Co-Investigator	2
Rango, Albert	Co-Investigator	1
Sala, Osvaldo	Co-Investigator	1
Sayre, Nathan	Co-Investigator	1

Schooley, Robert	Co-Investigator	1
Skaggs, Rhonda	Co-Investigator	1
Throop, Heather	Co-Investigator	1
Tweedie, Craig	Co-Investigator	1
Vivoni, Enrique	Co-Investigator	1
Levi, Matthew	Postdoctoral (scholar, fellow or other postdoctoral position)	6
Bailey, Donovan	Other Professional	1
Brown, Joel	Other Professional	1
Browning, Dawn	Other Professional	1
Buenemann, Michaela	Other Professional	1
Burruss, Nathan	Other Professional	1
Fernald, Sam	Other Professional	1
Haan-Amato, Stephanie	Other Professional	4
Harper, Paul	Other Professional	4
Keener, Anna	Other Professional	3
Mabry, Karen	Other Professional	1
Somerday, Marianne	Other Professional	3
AbuSaleh, Tayeen	Technician	6
Anderson, John	Technician	12
Chepsongol, Roxanne	Technician	12
Feng, Yanhua	Technician	12
Gamboa, Bernice	Technician	1
Harrison, Charlene	Technician	6

LaPlante, Valerie	Technician	4
Lenz, James	Technician	4
Ramirez, Gesuri	Technician	6
Ramsey, Kenneth	Technician	12
Schrader, Theodore	Technician	6
Yao, Jin	Staff Scientist (doctoral level)	12
Scroggs, Stacey	Statistician	12
Anderson, Cody	Graduate Student (research assistant)	6
DaVanon, Kristen	Graduate Student (research assistant)	12
Gherardi, Laureano	Graduate Student (research assistant)	6
Jaimes, Aline	Graduate Student (research assistant)	6
Laney, Christine	Graduate Student (research assistant)	6
McKenna, Owen	Graduate Student (research assistant)	6
McKinney, Ella	Graduate Student (research assistant)	3
Ortiz, Anna	Graduate Student (research assistant)	6
Pierce, Nate	Graduate Student (research assistant)	6
Ramirez, Geovany	Graduate Student (research assistant)	6
Schreiner-McGraw, Adam	Graduate Student (research assistant)	6
Singh Sidhu, Savitoz	Graduate Student (research assistant)	6
Svejcar, Lauren	Graduate Student (research assistant)	6
Franke, Andrew	Undergraduate Student	3
Baca, Ruben	Research Experience for Undergraduates (REU) Participant	3
Romero, Jeremy	Research Experience for Undergraduates (REU) Participant	3

Full details of individuals who have worked on the project:

Debra P Peters
Email: debpeter@nmsu.edu
Most Senior Project Role: PD/PI
Nearest Person Month Worked: 1

Contribution to the Project: Lead PI, leading overall synthesis activities

Funding Support: USDA and this project

International Collaboration: No
International Travel: Yes, Switzerland - 0 years, 0 months, 5 days; France - 0 years, 0 months, 5 days; China - 0 years, 0 months, 5 days

Brandon T. Bestelmeyer
Email: bbestelm@nmsu.edu
Most Senior Project Role: Co PD/PI
Nearest Person Month Worked: 1

Contribution to the Project: Leading Goal 1 activities in grassland to shrubland activities and participating in ecotone studies of animal dynamics (Goal 2), and regional dynamics (Goal 3)

Funding Support: USDA and this project

International Collaboration: Yes, Mongolia
International Travel: Yes, Mongolia - 0 years, 0 months, 14 days

Stephanie V Bestelmeyer
Email: stephanie@asombro.org
Most Senior Project Role: Co PD/PI
Nearest Person Month Worked: 4

Contribution to the Project: Director, Asombro Institute for Science Education

Funding Support: this project

International Collaboration: No
International Travel: No

Kris M Havstad
Email: khavstad@nmsu.edu
Most Senior Project Role: Co PD/PI
Nearest Person Month Worked: 1

Contribution to the Project: participating in animal studies, leading multi-stressor studies

Funding Support: USDA and this project

International Collaboration: Yes, China
International Travel: No

Hugh C Monger
Email: cmonger@nmsu.edu
Most Senior Project Role: Co PD/PI
Nearest Person Month Worked: 3

Contribution to the Project: leading geomorphology studies under Goal 2

Funding Support: this project

International Collaboration: No
International Travel: No

Steve Archer
Email: sarcher@ag.arizona.edu
Most Senior Project Role: Co-Investigator
Nearest Person Month Worked: 1

Contribution to the Project: Provides scientific expertise on grass-shrub interactions at individual plant scale with a focus on demography and physiology

Funding Support: this award

International Collaboration: No
International Travel: No

Michael C. Duniway
Email: mduniway@usgs.gov
Most Senior Project Role: Co-Investigator
Nearest Person Month Worked: 1

Contribution to the Project: Provides scientific expertise on plant-soil water relationships at individual plant scale with links to hydrology at patch to landscape scales

Funding Support: this award

International Collaboration: No
International Travel: No

Jeffrey E. Herrick
Email: jherrick@nmsu.edu
Most Senior Project Role: Co-Investigator
Nearest Person Month Worked: 1

Contribution to the Project: Provides scientific expertise on developing and using qualitative assessment and quantitative monitoring tools

Funding Support: this award

International Collaboration: Yes, Kenya
International Travel: Yes, Kenya - 0 years, 0 months, 14 days; Namibia - 0 years, 0 months, 7 days; China - 0 years, 0 months, 7 days

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Gregory S. Okin
Email: okin@ucla.edu
Most Senior Project Role: Co-Investigator
Nearest Person Month Worked: 2

Contribution to the Project: provides scientific expertise in dust and aeolian dynamics, both field studies and simulation modeling

Funding Support: this award

International Collaboration: Yes, Botswana
International Travel: Yes, Botswana - 0 years, 0 months, 14 days

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Albert Rango
Email: alrango@nmsu.edu
Most Senior Project Role: Co-Investigator
Nearest Person Month Worked: 1

Contribution to the Project: provides scientific expertise on snowmelt modeling, and collecting long-term climatic data relative to the water cycle

Funding Support: this award

International Collaboration: No
International Travel: No

Osvaldo E. Sala
Email: osvaldo.sala@asu.edu
Most Senior Project Role: Co-Investigator
Nearest Person Month Worked: 1

Contribution to the Project: provides scientific expertise in biodiversity, sustainability, and biogeochemistry of grasslands and shrublands

Funding Support: this award

International Collaboration: Yes, Argentina
International Travel: Yes, Argentina - 0 years, 1 months, 0 days; Uruguay - 0 years, 0 months, 7 days

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Nathan F. Sayre
Email: nsayre@berkeley.edu
Most Senior Project Role: Co-Investigator
Nearest Person Month Worked: 1

Contribution to the Project: provides scientific expertise on traditional ecological knowledge in rangelands

Funding Support: this award

International Collaboration: No
International Travel: No

Robert L. Schooley

Email: schooley@illinois.edu
Most Senior Project Role: Co-Investigator
Nearest Person Month Worked: 1

Contribution to the Project: Provides scientific expertise on small animal population dynamics and metapopulations

Funding Support: this award

International Collaboration: No
International Travel: No

Rhonda Skaggs
Email: rskaggs@nmsu.edu
Most Senior Project Role: Co-Investigator
Nearest Person Month Worked: 1

Contribution to the Project: Provides scientific expertise in agricultural economics

Funding Support: this award

International Collaboration: No
International Travel: No

Heather L. Throop
Email: throop@nmsu.edu
Most Senior Project Role: Co-Investigator
Nearest Person Month Worked: 1

Contribution to the Project: provides scientific expertise in litter decomposition processes and its importance in the carbon and water cycles

Funding Support: this award

International Collaboration: Yes, New Zealand
International Travel: Yes, New Zealand - 0 years, 0 months, 7 days

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Craig E. Tweedie
Email: ctweedie@utep.edu
Most Senior Project Role: Co-Investigator
Nearest Person Month Worked: 1

Contribution to the Project: provides scientific expertise on cyberinfrastructure (hardware, software) technologies for new uses in ecology

Funding Support: this award

International Collaboration: No
International Travel: Yes, Indonesia - 0 years, 0 months, 7 days; Australia - 0 years, 0 months, 10 days

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Enrique R. Vivoni
Email: vivoni@asu.edu

Most Senior Project Role: Co-Investigator
Nearest Person Month Worked: 1

Contribution to the Project: provides scientific expertise in ecohydrology and dynamics of watersheds

Funding Support: this award

International Collaboration: Yes, Mexico
International Travel: Yes, Mexico - 0 years, 0 months, 14 days; Spain - 0 years, 0 months, 7 days

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Matthew Levi
Email: mrlevi21@nmsu.edu
Most Senior Project Role: Postdoctoral (scholar, fellow or other postdoctoral position)
Nearest Person Month Worked: 6

Contribution to the Project: postdoc working with B. Bestelmeyer to examine relationships between ownership variables and biophysical variables across the Chihuahuan Desert region.

Funding Support: this award and BLM

International Collaboration: No
International Travel: No

Donovan Bailey
Email: dbailey@nmsu.edu
Most Senior Project Role: Other Professional
Nearest Person Month Worked: 1

Contribution to the Project: provides expertise in grass population genetics with a focus on black grama

Funding Support: this award

International Collaboration: No
International Travel: No

Joel R. Brown
Email: joelbrow@nmsu.edu
Most Senior Project Role: Other Professional
Nearest Person Month Worked: 1

Contribution to the Project: provides expertise on soils and national soils databases; key collaborator with the NRCS

Funding Support: this award

International Collaboration: No
International Travel: Yes, Australia - 0 years, 1 months, 0 days

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Dawn Browning
Email: dbrownin@nmsu.edu
Most Senior Project Role: Other Professional
Nearest Person Month Worked: 1

Contribution to the Project: provides expertise in remote sensing and plant phenology

Funding Support: this award

International Collaboration: Yes, China
International Travel: Yes, China - 0 years, 0 months, 14 days

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Michaela Buenemann
Email: elabuen@nmsu.edu
Most Senior Project Role: Other Professional
Nearest Person Month Worked: 1

Contribution to the Project: Provides expertise in GIS and spatial analyses

Funding Support: this award

International Collaboration: No
International Travel: No

Nathan Dylan Burruss
Email: dylanb@nmsu.edu
Most Senior Project Role: Other Professional
Nearest Person Month Worked: 1

Contribution to the Project: working with Peters on shrubland-shrubland transitions

Funding Support: this award

International Collaboration: No
International Travel: No

Sam Fernald
Email: afernald@nmsu.edu
Most Senior Project Role: Other Professional
Nearest Person Month Worked: 1

Contribution to the Project: provides expertise in hydrology of Rio Grande and acequias

Funding Support: this award

International Collaboration: No
International Travel: No

Stephanie Haan-Amato
Email: s.haan-amato@asombro.org
Most Senior Project Role: Other Professional
Nearest Person Month Worked: 4

Contribution to the Project: Science education specialist with Asombro Institute for Science Education

Funding Support: this award and Asombro

International Collaboration: No
International Travel: No

Paul Harper
Email: paul@asombro.org
Most Senior Project Role: Other Professional
Nearest Person Month Worked: 4

Contribution to the Project: Asombro site coordinator

Funding Support: this award and Asombro funding

International Collaboration: No
International Travel: No

Anna Keener
Email: akeener@nmsu.edu
Most Senior Project Role: Other Professional
Nearest Person Month Worked: 3

Contribution to the Project: Science education specialist with Asombro

Funding Support: this award and Asombro

International Collaboration: No
International Travel: No

Karen Mabry
Email: kmabry@nmsu.edu
Most Senior Project Role: Other Professional
Nearest Person Month Worked: 1

Contribution to the Project: provides expertise in small animal movement studies

Funding Support: this award

International Collaboration: No
International Travel: No

Marianne Somerday
Email: rink@asombro.org
Most Senior Project Role: Other Professional
Nearest Person Month Worked: 3

Contribution to the Project: Asombro program coordinator

Funding Support: this award and Asombro

International Collaboration: No
International Travel: No

Tayeen AbuSaleh
Email: tayeen@nmsu.edu
Most Senior Project Role: Technician
Nearest Person Month Worked: 6

Contribution to the Project: worked with Peters on the EcoTrends database

Funding Support: this award

International Collaboration: No
International Travel: No

John Anderson
Email: janderso@nmsu.edu
Most Senior Project Role: Technician
Nearest Person Month Worked: 12

Contribution to the Project: LTER site manager responsible for data collection, QA/QC, interactions with scientists and visitors on data issues

Funding Support: this award

International Collaboration: No
International Travel: No

Roxanne Chepsongol
Email: rofranke@nmsu.edu
Most Senior Project Role: Technician
Nearest Person Month Worked: 12

Contribution to the Project: member of LTER field crew

Funding Support: this award

International Collaboration: No
International Travel: No

Yanhua Feng
Email: yf@nmsu.edu
Most Senior Project Role: Technician
Nearest Person Month Worked: 12

Contribution to the Project: soils technician working with Monger

Funding Support: this award

International Collaboration: No
International Travel: No

Bernice Gamboa
Email: bgamboa@nmsu.edu
Most Senior Project Role: Technician

Nearest Person Month Worked: 1

Contribution to the Project: provides office support

Funding Support: this award

International Collaboration: No
International Travel: No

Charlene Harrison
Email: charhrsn@nmsu.edu
Most Senior Project Role: Technician
Nearest Person Month Worked: 6

Contribution to the Project: provides office support, budget and travel support

Funding Support: this award

International Collaboration: No
International Travel: No

Valerie LaPlante
Email: vlaplante@nmsu.edu
Most Senior Project Role: Technician
Nearest Person Month Worked: 4

Contribution to the Project: provides IT (software) and web page support

Funding Support: this award

International Collaboration: No
International Travel: No

James Lenz
Email: jlenz@nmsu.edu
Most Senior Project Role: Technician
Nearest Person Month Worked: 4

Contribution to the Project: IT specialist with the Jornada

Funding Support: this award

International Collaboration: No
International Travel: No

Gesuri Ramirez
Email: gesuri@gmail.com
Most Senior Project Role: Technician
Nearest Person Month Worked: 6

Contribution to the Project: worked with Tweedie on eddy flux tower calibration and testing

Funding Support: this award and UTEP

International Collaboration: No
International Travel: No

Kenneth Ramsey
Email: kramsey@nmsu.edu
Most Senior Project Role: Technician
Nearest Person Month Worked: 12

Contribution to the Project: Information manager for the Jornada Basin LTER

Funding Support: this award

International Collaboration: No
International Travel: No

Theodore Scott Schrader
Email: schrader@nmsu.edu
Most Senior Project Role: Technician
Nearest Person Month Worked: 6

Contribution to the Project: provides GIS and spatial analysis support

Funding Support: this award

International Collaboration: No
International Travel: No

Jin Yao
Email: jyao@nmsu.edu
Most Senior Project Role: Staff Scientist (doctoral level)
Nearest Person Month Worked: 12

Contribution to the Project: provides statistical analyses and QA/QC, updating on long term datasets

Funding Support: this award

International Collaboration: No
International Travel: Yes, China - 0 years, 1 months, 0 days

Stacey Scroggs
Email: stpeters@nmsu.edu
Most Senior Project Role: Statistician
Nearest Person Month Worked: 12

Contribution to the Project: provides statistical analyses and GIS analyses on longterm data; maintains EcoTrends web site and multi-media products

Funding Support: this award

International Collaboration: No
International Travel: No

Cody Anderson
Email: cody.anderson@asu.edu
Most Senior Project Role: Graduate Student (research assistant)
Nearest Person Month Worked: 6

Contribution to the Project: working with Vivoni on hydrology studies

Funding Support: this award

International Collaboration: No
International Travel: No

Kristen DaVanon
Email: kdavanon@gmail.com
Most Senior Project Role: Graduate Student (research assistant)
Nearest Person Month Worked: 12

Contribution to the Project: working with Bestelmeyer, Schooley, and Mabry on small animal studies in urban locations near the Jornada

Funding Support: this award

International Collaboration: No
International Travel: No

Laureano Gherardi
Email: lgherar1@asu.edu
Most Senior Project Role: Graduate Student (research assistant)
Nearest Person Month Worked: 6

Contribution to the Project: working with Sala on experimental rainfall plots

Funding Support: this award

International Collaboration: No
International Travel: Yes, Argentina - 0 years, 1 months, 0 days

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Aline Jaimes
Email: ajaimes@miners.utep.edu
Most Senior Project Role: Graduate Student (research assistant)
Nearest Person Month Worked: 6

Contribution to the Project: worked with Craig Tweedie on eddy flux tower at shrubland site

Funding Support: this award and UTEP funding

International Collaboration: No
International Travel: Yes, Mexico - 0 years, 1 months, 0 days

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Christine Laney
Email: christine.laney@gmail.com

Most Senior Project Role: Graduate Student (research assistant)
Nearest Person Month Worked: 6

Contribution to the Project: worked with Craig Tweedie on instrumentation and cyber infrastructure at eddy flux tower site in shrublands

Funding Support: this award and EPA STAR fellowship

International Collaboration: No
International Travel: Yes, Kenya - 0 years, 0 months, 14 days

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Owen McKenna
Email: omckenna@luc.edu
Most Senior Project Role: Graduate Student (research assistant)
Nearest Person Month Worked: 6

Contribution to the Project: working with Sala on carbon and nitrogen cycling in playas

Funding Support: this award

International Collaboration: No
International Travel: No

Ella McKinney
Email: ellamck@nmsu.edu
Most Senior Project Role: Graduate Student (research assistant)
Nearest Person Month Worked: 3

Contribution to the Project: summer fellowship GRA working with Monger on the effects of soil calcium carbonate on state change dynamics between geomorphic units

Funding Support: this award

International Collaboration: No
International Travel: No

Anna Ortiz
Email: anna.ortizc@gmail.com
Most Senior Project Role: Graduate Student (research assistant)
Nearest Person Month Worked: 6

Contribution to the Project: worked with Craig Tweedie on instrumentation at eddy flux tower site in shrublands

Funding Support: this award and UTEP funding

International Collaboration: No
International Travel: No

Nate Pierce
Email: npierce@arizona.edu
Most Senior Project Role: Graduate Student (research assistant)
Nearest Person Month Worked: 6

Contribution to the Project: working with Archer on grass-shrub interaction study

Funding Support: this award

International Collaboration: No
International Travel: No

Geovany Ramirez
Email: garamirez@miners.utep.edu
Most Senior Project Role: Graduate Student (research assistant)
Nearest Person Month Worked: 6

Contribution to the Project: worked with Craig Tweedie on cyberinfrastructure for eddy flux tower site

Funding Support: this award and UTEP funding

International Collaboration: No
International Travel: Yes, Mexico - 0 years, 1 months, 0 days

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Adam Schreiner-McGraw
Email: apschrei@asu.edu
Most Senior Project Role: Graduate Student (research assistant)
Nearest Person Month Worked: 6

Contribution to the Project: working with Vivoni on hydrology studies

Funding Support: this award

International Collaboration: No
International Travel: No

Savitoz Singh Sidhu
Email: savisdhu_pau@hotmail.com
Most Senior Project Role: Graduate Student (research assistant)
Nearest Person Month Worked: 6

Contribution to the Project: working with Monger on soil characterization studies at the Jornada

Funding Support: this award

International Collaboration: Yes, India
International Travel: Yes, India - 0 years, 1 months, 0 days

Lauren Svejcar
Email: svej8346@vandals.uidaho.edu
Most Senior Project Role: Graduate Student (research assistant)
Nearest Person Month Worked: 6

Contribution to the Project: Worked with Brandon Bestelmeyer on Stressor experiment

Funding Support: this award

International Collaboration: No
International Travel: No

Andrew Franke
Email: andrew.franke@mnsu.edu
Most Senior Project Role: Undergraduate Student
Nearest Person Month Worked: 3

Contribution to the Project: working with Ken Ramsey as part of Drupal working group

Funding Support: this award

International Collaboration: No
International Travel: No

Ruben Baca
Email: ruben05@nmsu.edu
Most Senior Project Role: Research Experience for Undergraduates (REU) Participant
Nearest Person Month Worked: 3

Contribution to the Project: REU working with Monger

Funding Support: this award

International Collaboration: No
International Travel: No
Year of schooling completed: Junior
Home Institution: NMSU
Government fiscal year(s) was this REU participant supported: 2014

Jeremy Romero
Email: jromer24@nmsu.edu
Most Senior Project Role: Research Experience for Undergraduates (REU) Participant
Nearest Person Month Worked: 3

Contribution to the Project: REU working with Monger

Funding Support: this award

International Collaboration: No
International Travel: No
Year of schooling completed: Sophomore
Home Institution: NMSU
Government fiscal year(s) was this REU participant supported: 2014

What other organizations have been involved as partners?

Name	Type of Partner Organization	Location
Arizona State University	Academic Institution	Tempe, AZ

Asombro Institute for Science Education	Other Nonprofits	Las Cruces, NM
University of California-Los Angeles	Academic Institution	Los Angeles
University of Illinois	Academic Institution	Urbana-Champaign
University of Texas-El Paso	Academic Institution	El Paso, TX
Bureau of Land Management	Other Organizations (foreign or domestic)	Las Cruces, NM
Center for Applied Remote Sensing in Agriculture, Meteorolog	Academic Institution	Las Cruces, NM
Institute for Natural Resource Analysis and Management	Academic Institution	Las Cruces, NM
US Geological Survey	Other Organizations (foreign or domestic)	Moab, UT
USDA ARS, Jornada Experimental Range	Other Organizations (foreign or domestic)	Las Cruces, NM
USDA NRCS	Other Organizations (foreign or domestic)	Las Cruces, NM
University of Arizona	Academic Institution	Tucson, AZ
University of California-Berkeley	Academic Institution	Berkeley, CA

Full details of organizations that have been involved as partners:

Arizona State University

Organization Type: Academic Institution
Organization Location: Tempe, AZ

Partner's Contribution to the Project:
Financial support
In-Kind Support
Facilities
Collaborative Research
Personnel Exchanges

More Detail on Partner and Contribution: ASU provides office and lab facilities for Sala and Vivoni and their students

Asombro Institute for Science Education

Organization Type: Other Nonprofits

Organization Location: Las Cruces, NM

Partner's Contribution to the Project:
Collaborative Research
Personnel Exchanges

More Detail on Partner and Contribution: Asombro operates the Jornada Basin schoolyard LTER program

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Bureau of Land Management

Organization Type: Other Organizations (foreign or domestic)
Organization Location: Las Cruces, NM

Partner's Contribution to the Project:
In-Kind Support
Facilities
Collaborative Research

More Detail on Partner and Contribution: BLM provides legacy data and photos of range sites near the Jornada

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Center for Applied Remote Sensing in Agriculture, Meteorolog

Organization Type: Academic Institution
Organization Location: Las Cruces, NM

Partner's Contribution to the Project:
In-Kind Support
Facilities
Collaborative Research

More Detail on Partner and Contribution: CARSAME provides imagery and analyses for remotely sensing applications

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Institute for Natural Resource Analysis and Management

Organization Type: Academic Institution
Organization Location: Las Cruces, NM

Partner's Contribution to the Project:
Facilities

More Detail on Partner and Contribution: INRAM provides equipment and supplies for soil analyses

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US Geological Survey

Organization Type: Other Organizations (foreign or domestic)
Organization Location: Moab, UT

Partner's Contribution to the Project:
Financial support
In-Kind Support
Facilities

Collaborative Research
Personnel Exchanges

More Detail on Partner and Contribution: USGS provides salary, office, and lab support for Duniway

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USDA ARS, Jornada Experimental Range

Organization Type: Other Organizations (foreign or domestic)
Organization Location: Las Cruces, NM

Partner's Contribution to the Project:
In-Kind Support
Facilities
Collaborative Research
Personnel Exchanges

More Detail on Partner and Contribution: Jornada Basin LTER office and numerous PIs' offices are housed in the USDA bldg. The Jornada land base is primary site for LTER research.

USDA NRCS

Organization Type: Other Organizations (foreign or domestic)
Organization Location: Las Cruces, NM

Partner's Contribution to the Project:
Collaborative Research
Personnel Exchanges

More Detail on Partner and Contribution: Supports collaborative research through Joel Brown, an NRCS employee

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University of Arizona

Organization Type: Academic Institution
Organization Location: Tucson, AZ

Partner's Contribution to the Project:
Financial support
In-Kind Support
Facilities
Collaborative Research
Personnel Exchanges

More Detail on Partner and Contribution: UA provides office and lab support and salary for Archer and his students

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University of California-Berkeley

Organization Type: Academic Institution
Organization Location: Berkeley, CA

Partner's Contribution to the Project:

Financial support
In-Kind Support
Facilities
Collaborative Research
Personnel Exchanges

More Detail on Partner and Contribution: UC-Berkeley provides office and lab support and salary for Sayre and his students

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University of California-Los Angeles

Organization Type: Academic Institution
Organization Location: Los Angeles

Partner's Contribution to the Project:
Financial support
In-Kind Support
Facilities
Collaborative Research
Personnel Exchanges

More Detail on Partner and Contribution: UCLA provides office and lab support and salary for Okin and his students

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University of Illinois

Organization Type: Academic Institution
Organization Location: Urbana-Champaign

Partner's Contribution to the Project:
Financial support
In-Kind Support
Facilities
Collaborative Research
Personnel Exchanges

More Detail on Partner and Contribution: University of Illinois provides office and lab support and salary for Schooley and his students

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University of Texas-El Paso

Organization Type: Academic Institution
Organization Location: El Paso, TX

Partner's Contribution to the Project:
Financial support
In-Kind Support
Facilities
Collaborative Research
Personnel Exchanges

More Detail on Partner and Contribution: UTEP provides office, lab, and salary support for Tweedie and his students

Have other collaborators or contacts been involved? No

Impacts

What is the impact on the development of the principal discipline(s) of the project?

The original resource redistribution framework for desertification that was articulated by Jornada researchers in the late 1980s has been a primary conceptual model for ecosystems research in arid and semiarid systems globally. The concept that shrub dominance in former grasslands can exacerbate patchiness in soil resources and provide a positive feedback to continued shrub dominance has stimulated research at the Jornada and other sites globally. More recently, our landscape linkages framework expands on the plant-interspace model to explicitly include a range of interacting spatial scales with a focus on transport processes that connect patches. This framework has been used to explain historic patterns that were unaccounted for by the single scale plant-interspace model of Schlesinger et al. (1990). The framework has also been applied to grass recovery in desertified shrublands following a 5-year wet period, and to explain long-term grass dynamics and threshold behavior following drought. The application of this cross-scale approach to broader scales has implications for continental-scale ecology and the development of environmental observatories and networks to address broad-scale questions. The Jornada Program has also pioneered a new paradigm for ecosystem services. Previously, ecosystem services were studied from the ability of ecosystems to supply them. The new paradigm focuses on reconciling supply and demand of ecosystem services.

What is the impact on other disciplines?

Jornada LTER research on state changes has promoted an understanding by soil scientists about the properties of soils, including soil moisture, temperature, and microbial dynamics, in aridlands that influence their resilience and resistance to future disturbance. LTER research has been particularly important in allowing geomorphologists, ecohydrologists, and soil scientists to explore the feedbacks between soil properties, terrain conditions, and vegetation cover across a range of temporal and spatial scales. Range managers are using LTER research findings to develop state-and-transition models for millions of acres of land in the western US and globally. The identification of early indicators of state changes for diverse terrestrial, aquatic, and marine ecosystems is being aided by Jornada long-term data and analyses. Jornada research is contributing to the development of Earth System Science and the understanding of phenomena that link ecosystems to global environmental change. Specific examples include interactions between desertification and the generation and export of dust to the atmosphere that feeds back to terrestrial ecosystem processes. Recent research on inorganic carbon at the Jornada is increasing knowledge of terrestrial biomineralization and the carbon cycle at the global scale. Jornada research is actively supporting the development of remote sensing technology and analysis. Remote sensing in aridlands has traditionally been constrained by technical difficulties (i.e., predominance of the bare soil surface signal), but the vast expanses of relatively inaccessible arid lands with significant large-scale variation is demanding better remote sensing technologies. Ground truth data and extensive process-level studies available at the Jornada allow cross-referencing with imagery from aerial, including drones and UAVs, and satellite platforms. There are few such well-studied locations in arid and semiarid regions of the world, and Jornada will continue to make important contributions to this field. The special issue in Frontiers in Ecology and Environment to be published in 2015 and led by the Jornada Program is an example of interdisciplinarity. For example, in this issue the Jornada Program describes a new framework for legacies that encompasses ideas from the geological sciences and plant physiology to the social sciences.

What is the impact on the development of human resources?

The Jornada program supports graduate and undergraduate students from numerous institutions and departments within those institutions, and attracts postdocs and visiting scientists from around the world. NMSU, UTEP, ASU, and UA are all minority, Hispanic-serving institutions, and we routinely include minority and female students in our program. In addition, Jeff Herrick has been an active mentor of the ESA SEEDS program for many years. This program recruits and supports students from under-represented minority groups in ecology.

What is the impact on physical resources that form infrastructure?

The Jornada Program has built a well-replicated rainfall manipulation facility, which is unique in the world and has attracted numerous scientists who took advantage of the facility and launched additional experiments. For example, Diana Wall and Zack Sylvain from Colorado State University studied the effects of our rainfall manipulations on nematode populations. This research was recently published in Global Change Biology. The Jornada Program has been successful in receiving resources to build additional facilities that gather and make data available online at the research site.Consequently, the use of the site has increased, both locally and by visiting scientists and classes. Activities at the Jornada have been leveraged extensively in other research projects that have helped to build new infrastructure, including instrumentation networks and coordinated observation sites.

What is the impact on institutional resources that form infrastructure?

The Jornada as a large research program on the campus of NMSU is able to have input on future faculty hires and expansion in the areas of ecology and environmental science by the university.

What is the impact on information resources that form infrastructure?

The Jornada was the co-founder of the EcoTrends Project where the goal is to make long-term data and derived data products from many sites easily accessible and usable by others. The Jornada maintains and upgrades the EcoTrends web site, and has focused on making the long-term data easily used by high school students.

What is the impact on technology transfer?

The Jornada Program has developed the Automatic Rainfall Manipulation System (ARMS), which is a system that includes rainout shelters that intercept 50 or 80% of incoming PPT, store water temporarily in tanks connected to irrigation systems and transfer the water to the +50 or +80% of ambient PPT water-addition treatments. The ARMS system has been patented by ASU. The Jornada established formal, individual state agreements with Cooperative Extension Services in New Mexico, Nevada, Utah, Arizona and Hawaii to specifically collaborate to deliver science-based information to private land managers through Extension-led workshops across these 5 states. An agreement through the ARS based in Davis, California, and linked to the University of California system accomplishes a similar goal for people managing agricultural lands in California. The Jornada established a specific cooperative agreement with the Bureau of Land Management to transfer science-based assessment, monitoring and inventory methods for monitoring hundreds of millions of acres of arid and semi-arid public rangelands across the western US, including Alaska.

What is the impact on society beyond science and technology?

LTER research findings have been used in the development of assessment and monitoring methods to evaluate the status of arid and semiarid land, and the ability of this land to provide food and fiber to humans. Much of the American West is composed of these lands, thus there is substantial debate about the appropriateness of particular land uses and their impacts on ecosystem and economic sustainability. Our applications provide tools that are used by regulatory and land management agencies as well as by private land owners.

Human populations and land use patterns are changing rapidly. Jornada research provides a basic understanding of the limits to management of livestock in these systems. Moreover, Jornada research on changing land use patterns, biodiversity, air and water quality, climate change, and other aspects of human-environment interactions are being used in regional to global efforts to understand and manage for human activities in arid systems beyond livestock production.

Our highly successful schoolyard LTER program works to increase local K-12 science literacy while also providing models of K-12 science education that can be applied more broadly. We operate in a region of the US with a largely poor, minority population - Las Cruces public schools are 50-80% Hispanic with 60-90% of the students qualifying for free or reduced lunches. Thus, our program addresses scientific literacy at early stages for a diverse, under-served population. Our middle and high school Data Jam competition is now being replicated at several other sites, thus increasing K-12 science literacy well beyond our region. These programs include both classroom and field

investigations of basic ecological principles and the effects of past and present climate change.

Research approaches to characterize alternative states based on Jornada research have been applied throughout Mongolia and adopted by government ministries as a basis for interpreting land condition and recommending management strategies. In addition, these approaches are being applied in certain areas within Argentina.

Restoration actions carried out by the Bureau of Land Management in southwestern New Mexico now include experimental designs and monitoring procedures developed by the Jornada to test restoration effects and as a basis for adaptive management.

These types of tools are already widely applied by land managers and policymakers in the US. We have also obtained funding from USAID to develop a Land-Potential Knowledge System (LandPKS), which will eventually allow these types of site-specific assessments and predictions to be made globally. Finally, we are leading development of a United Nations report to increase awareness and understanding of including resilience in land potential assessments.

Changes/Problems

Changes in approach and reason for change
Nothing to report.

Actual or Anticipated problems or delays and actions or plans to resolve them
Nothing to report.

Changes that have a significant impact on expenditures
Nothing to report.

Significant changes in use or care of human subjects
Nothing to report.

Significant changes in use or care of vertebrate animals
Nothing to report.

Significant changes in use or care of biohazards
Nothing to report.