Featured Investigator Vince Gutschick

Vince Gutschick is a professor of biology at New Mexico State University. His scientific roots go back to a Ph.D. in chemical physics from Caltech in 1971, followed by a relatively rapid conversion to plant physiology and ecology in the Theoretical Biology group at Los Alamos National Laboratory. His transition was completed following his arrival at NMSU in 1985. He joined the LTER program in its third incarnation in 1994. His research is focused on plant ecophysiology, particularly of resource use - water, light, nutrients - and the quantitative aspects of such use. Building on his mathematical training, he develops computational models of plant functions to generate hypotheses for field tests. In the process, he also developed leaf-mounted sensors to track light exposure of single leaves, plus photosynthetically active radiation sensors for weather stations, and image analysis for nondestructive measurement of leaf area. He and his group of students have tested physiological and developmental control of water use on the Jornada, as well as on the Bosque del Apache, the Harvard Forest, and a variety of agricultural fields. They have studied the consequences of altered microclimate, particularly on afforesting sites in Australia. More recently he and his group and his collaborators elsewhere have turned their attention to extreme events as they affect the physiology, ecology, and evolution of organisms. He and his colleague Hormoz BassiriRad presented a forward vision of the field in the New Phytologist (160 [2003]: 21-42). His group has elucidated how high soil temperatures, up to 72°C, kill parts of plant stems in summer heat, and how water stress and low temperature drive great changes in leaf area and function in creosotebush. They are currently studying nitrogen reallocation in shrubs upon defoliation and are preparing studies of elevated atmospheric CO_2 as a rapidly developing extreme event on the time scale of our ecosystems. His past collaborative studies on elevated CO_2 imply that shrubs with the C_3 photosynthetic pathway may have been given advantages over C_4 grasses in many aspects of their performance - photosynthesis, nitrogen-use efficiency, nitrogen-economy, and some degree of water-use efficiency. He hopes to test how competition has changed from pre-industrial levels of CO_2 to current levels.

The following are Dr. Gutschick's graduate and undergraduate students:

- Mohsen Mohseni - studying extreme soil temperatures that intermittently kill stems
- Randy Fowler - looking at nitrogen reserves in creosotebush and its fast remobilization upon defoliation
- Mark Robertson - looking at water redistribution by plant roots as affecting productivity of many plants
- Rami Al-Khatib - beginning studies of weather extremes that cause shifts in plant performance
- Shigang Liu - beginning work on CO_2 effects on plant competition plus water redistribution studied with remote sensing
- Nadir Siddiqu - working on agricultural development in Afghanistan (joint project with Agricultural Economics)
- Undergraduate Jeanne Tenorio - helping with all these projects

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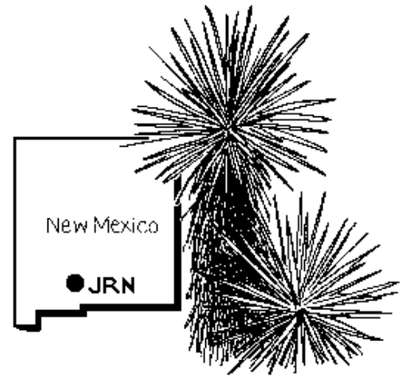
Integrating Two Remote Sensing-Based Hydrological Models to Improve Water Supply Forecasts in the Rio Grande Basin by Albert Rango

Information on snow water resources is a major concern in river basins where snowmelt runoff can be a significant contributor to total discharge. This information is especially important in basins of the southwest United States, such as the Rio Grande, where desert makes up much of the lower elevation area. Remotely-sensed data can be used with modern hydrological models to provide effective water supply forecasts and to evaluate water resource management options. Data from remotely sensed images are being used in the Upper Rio Grande basin to forecast snowmelt. MODIS, on both NASA TERRA and AQUA satellites, is likely the optimum sensor for snow mapping because it has a best resolution of 250 m (two bands), it passes over daily, it is free for downloading, and it provides a logical transition from previously used 1km NOAA-AVHRR data. Remote snow water equivalent site data are acquired through the Natural Resources Conservation Service SNOTEL system for early season (November-December-January) volumetric forecasts and allows for estimating water content of snow cover detected from satellite sensors. At the Jornada, we are using the MODIS-derived snow cover data as input to the Snowmelt Runoff Model (SRM) to generate daily streamflow forecasts over the entire melt season. Figure 1 shows the SRM forecast and measured (red line) daily flow in the Rio Grande at Del Norte, Colorado, for the 2004 snowmelt season. SRM outflow from snowmelt basins is used as an input to the Semi-distributed Land Use Runoff Process (SLURP) model. SLURP is a comprehensive distributed model operating on the entire basin to assist in water management decision-making today and to evaluate future scenarios for improving long range planning. SLURP also uses remote sensing inputs to establish current land cover throughout the basin, and to derive the Leaf Area Index for use in evapotranspiration algorithms. Please contact Al Rango (alrango@nmsu.edu) for additional information.



The Jornada Basin LTER Program is a National Science Foundation funded project.

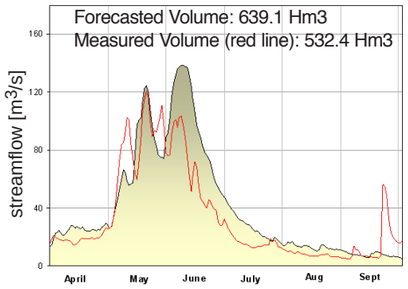


Figure 1. 2004 SRM Forecast - Rio Grande at Del Norte

Wind Interactions With Soil and Vegetation by Gregory S. Okin

Every spring, when the dust storms return to the Chihuahuan Desert, it is clear that the wind plays an important role in the way this ecosystem works. In March 2004, researchers from the University of Virginia came to Jornada Basin to establish an NSF-funded experiment to show just how wind impacts the soils and vegetation and how, in turn, vegetation change and associated land use impact the prevalence and magnitude of dust storms. In this experiment we removed grasses in specified amounts (from 100% to only 25% removal) from 12 areas that are 50 meters long and 25 meters wide. Heavy yard work indeed, but removing vegetation allows us to increase the amount of wind erosion that occurs on the plots and the amount of soil that is deposited immediately downwind of the treatments.

In addition to characterizing the experimental plots before the treatments, we instrumented the sites to characterize the effect of our treatments on wind erosion, dust emission, soils, and vegetation in and downwind of our treatments. The instrumentation also will allow us to test and improve models of wind erosion currently in the literature. We return to each plot twice a year – before and after the spring dust season – to characterize the soils and vegetation and to quantify how they've changed due to the increase in wind erosion.

This research is already providing important insights into the role of wind in the functioning of desert grasslands. We found that one year of increased wind erosion can significantly deplete the surface soil nitrogen and carbon content. We also confirmed that increased wind erosion has a significant impact on the vegetation on and downwind of the plots. Please contact Greg Okin (okin@virginia .edu) for more information.

North and South America Science Linkages

Brandon Bestelmeyer visited two labs in Argentina with funding from the USDA-ARS International Scientific Enhancement Program. The primary objective of the trip was to compare research activities on models of soil and vegetation dynamics and their application to land management. A second objective was to compare the Jornada with Argentine arid systems featuring similar floristic elements (e.g., creosotebush) and soils. The first stop was the Centro Nacional Patagonico (CENPAT) in Puerto Madryn, Chubut. The research group was very diverse and shared many of the research directions that are now being initiated at the Jornada, in particular a focus on within-patch function, patch spatial organization, and coupled vegetation-geomorphic dynamics. Their research is long-term and being carried out in privately owned estancias. The second stop was at the Reserva Nacuñan, which is run by the Instituto Argentino de Investigaciones de las Zonas Áridas (IADIZA) in Mendoza. The floristic parallels with the Jornada are astounding—such as a *Larrea cuneifolia* / *Scleropogon brevifolius* community occurring on a calcareous silt loam soil. The meetings were very productive and will result in continued interaction between the Jornada LTER and these groups.

Southwestern Ecological Observatory Network Proposal

The Southwestern Ecological Observatory Network (SWEON) is one of several organizations nationwide involved in the development of a National Ecological Observatory Network (NEON) (http://neoninc.org). The major purpose of NEON is to build a nationwide system for observing, measuring, and forecasting ecological information at regional through continental scales. NEON is being intended to address those information gaps which currently prevent accurate prediction of major droughts, floods, fires, disease outbreaks, and other ecological events with societal impacts. SWEON, the Southwestern NEON region, is loosely defined as the US portions of the Mojave, Sonoran, and Chihuahuan Deserts and associated elevational gradients (see http://sweon.org/sweon-home/index.htm). The Jornada LTER, with its extensive data sets describing Chihuahuan Desert ecology, is well suited to participate in SWEON. Some other members include, but are not limited to, universities, private, and government agencies throughout the region. Both traditional and nontraditional public education is important to NEON. Therefore, schools, museums, and non-profit organizations are also encouraged to participate and provide input as NEON evolves.

SWEON members met April 14-15 in Tempe, Arizona to learn about current developments in the NEON organization and to identify those infrastructure needs most crucial for ecological monitoring and forecasting in the Southwest. Discussion groups which focused on biodiversity, land use, and biogeochemistry all agreed that powerful computing capabilities, remote sensing devices in space as well as nearer to the ground, and high throughput sample processing centers for chemical and biochemical processing would be high priority needs. The technology for automated image analysis to determine morphology of small organisms such as insects for species identification is under development. This technology would also be invaluable for ecological monitoring. A summary of the regional meeting will be posted on the SWEON website and communicated to appropriate planning committees at NEON.

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Jornada Trails is a biannual publication of the Jornada Basin Long-Term Ecological Research (LTER) Program, sponsored by the National Science Foundation. Stories and story ideas are welcome. Send them to:

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Jornada Trails also appears on the Internet at http://jornada.nmsu.edu

Newsletter by Valerie K. LaPlante and Kris M. Havstad

LTER Student Collaborative Research Symposium

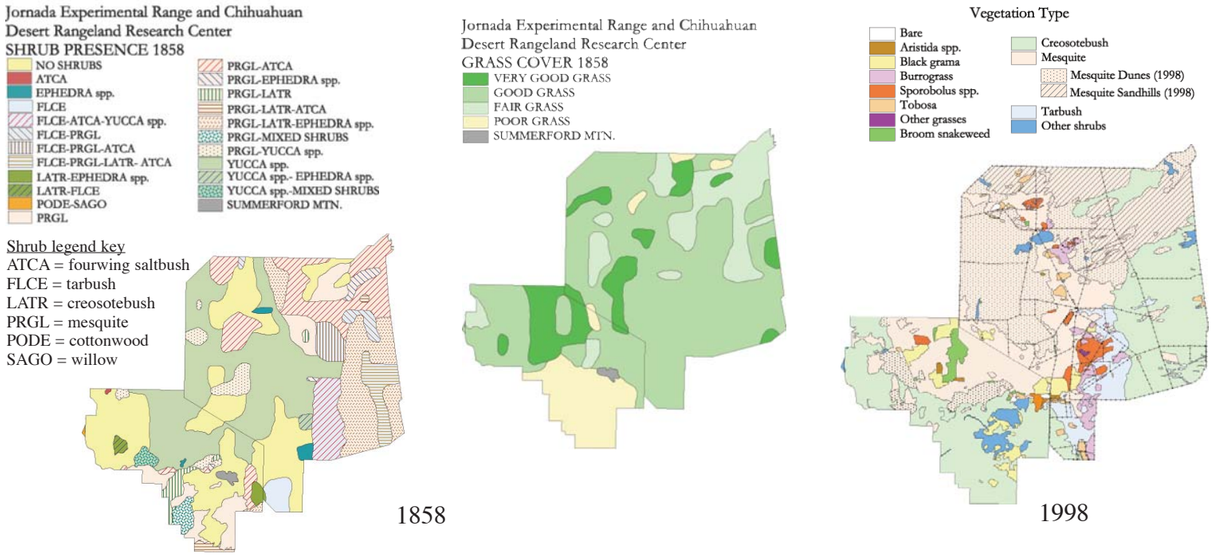
Two Jornada Basin LTER graduate students, Mike Duniway and Andrea Campanella, participated in the first LTER Student Collaborative Research Symposium. The meeting took place April 13-17 at the Andrews Experimental Forest in the Cascade Mountains of Oregon. The research symposium was designed to foster interactions among LTER graduate students to stimulate their engagement in comparative and collaborative research efforts. The symposium included synoptic talks focused on graduate student-led research at each of the 26 LTER sites, individual-based research talks, student-led workshops, and training sessions. Mike presented a review of the graduate student research at the Jornada LTER and Andrea gave a talk covering the beginning of his Ph.D. research project. Additionally, Mike presented a poster on his doctoral research project.

A Long-Term Hydrologic Observatory Proposal: The Upper Río Grande Basin

Water availability is critical in arid and semiarid regions, which comprise 35% of the land area of the globe. In the southwestern US, climate variability and landscape heterogeneity lead to strong gradients in hydrological processes, which in turn impact land-atmosphere interactions, ecological dynamics, biogeochemical cycles, and geomorphic change. An integrated group of researchers from southwestern universities and US government agencies are planning to study the interaction of climate-landscape-vegetation and water using a nested set of instrumented sites within the upper Río Grande, a continental-scale semiarid watershed. This complex watershed extends from the snow-dominated headwater basins in San Juan Mountains of southern Colorado, through the Chihuahuan Desert in New Mexico, Texas, and Mexico, to the desert valley alluvial basins southeast of El Paso, Texas. As part of a proposed network of Long-Term Hydrologic Observatories (LTHOs), the upper Río Grande would represent the combination of mountain landscapes, semiarid to arid alluvial basin aquifers, and riparian corridors that are characteristic of the Western United States. The upper Río Grande presents unique opportunities to test hydrologic hypotheses concerning surface water-groundwater interactions and their control on runoff response, solute transport and reactivity, and riparian ecological communities. The proposal to NSF is due to be submitted in June 2005.

Vegetation Changes in the Jornada Basin From 1858 to 1998

Robert (Bob) P. Gibbens, a retired scientist with the USDA, Agricultural Research Service at the Jornada Experimental Range is the lead author of a new publication (Journal of Arid Environments, 2005) that describes vegetation features over 84,000 ha of the Jornada basin in the mid 19th century. Bob and various colleagues, especially Rob McNeely of New Mexico State University, revisited land surveyor notes recorded in 1858 to estimate cover of shrubs and grasses. Their maps reflecting these notes are shown below as presented in this publication. The vegetation map created by Bob, Rob, and Barbara Nolen in 1998 to illustrate vegetation changes over 140 years is also shown below. Further information can be viewed at http://jornada-www.nmsu.edu/maps/JER_Map/viewer.htm.



Grassland, Shrubland and Savanna Ecosystems Monitoring Manual

The Jornada Experimental Range recently published the "Monitoring Manual for Grassland, Shrubland and Savanna Ecosystems". The manual provides scientists and land managers with field tools for monitoring changes in the status of key ecological properties and processes using soil and vegetation indicators. The manual includes existing and new methods based in part on Jornada Agricultural Research Service and LTER research. It is suitable for use in courses. Electronic (spreadsheet) versions of data forms with automated indicator calculations can be downloaded from the website below. A Microsoft Access database with a field data entry system for "tablet" computers is under development. See website for current status. Copies can be obtained online at usda-ars.nmsu.edu/JER/Monit_Assess/monitoring.htm or from the University of Arizona Press ($24.95) at www.uapress.arizona.edu or 800-426-3797.

Schoolyard LTER Expands to El Paso Schools

The Jornada Basin Schoolyard LTER program continues to expand, illustrating the immense need for quality K-12 science education efforts in our region. The latest expansion is into the El Paso Independent School District. Our schoolyard program (consisting of schoolyard investigations, classroom visits, field trips, and teacher workshops) is aligned with Texas science standards and fulfills the district's goals for increasing students' participation in inquiry-based, locally relevant science. The district, therefore, paid for a series of workshops for middle school science teachers to learn how to implement the program with their students.

So far, fifteen teachers from eight schools attended Schoolyard LTER workshops this spring where they learned about climate, microclimates, soil, and vegetation. The third workshop on April 16 will focus on arthropods and birds. Evaluations from the workshops have been overwhelmingly positive, and teachers immediately started using the schoolyard activities. Based on this response, the district has asked for another series of workshops in the 2005/06 school year.

We are excited about this new collaboration because it will increase the reach of the already successful Jornada Basin Schoolyard LTER program and bring hands-on science to more than 1,500 additional students in our region.

El Paso teachers graph monthly temperature and precipitation data from an LTER site in each biome as part of the Schoolyard LTER training. Photo by Donna Yargosz.