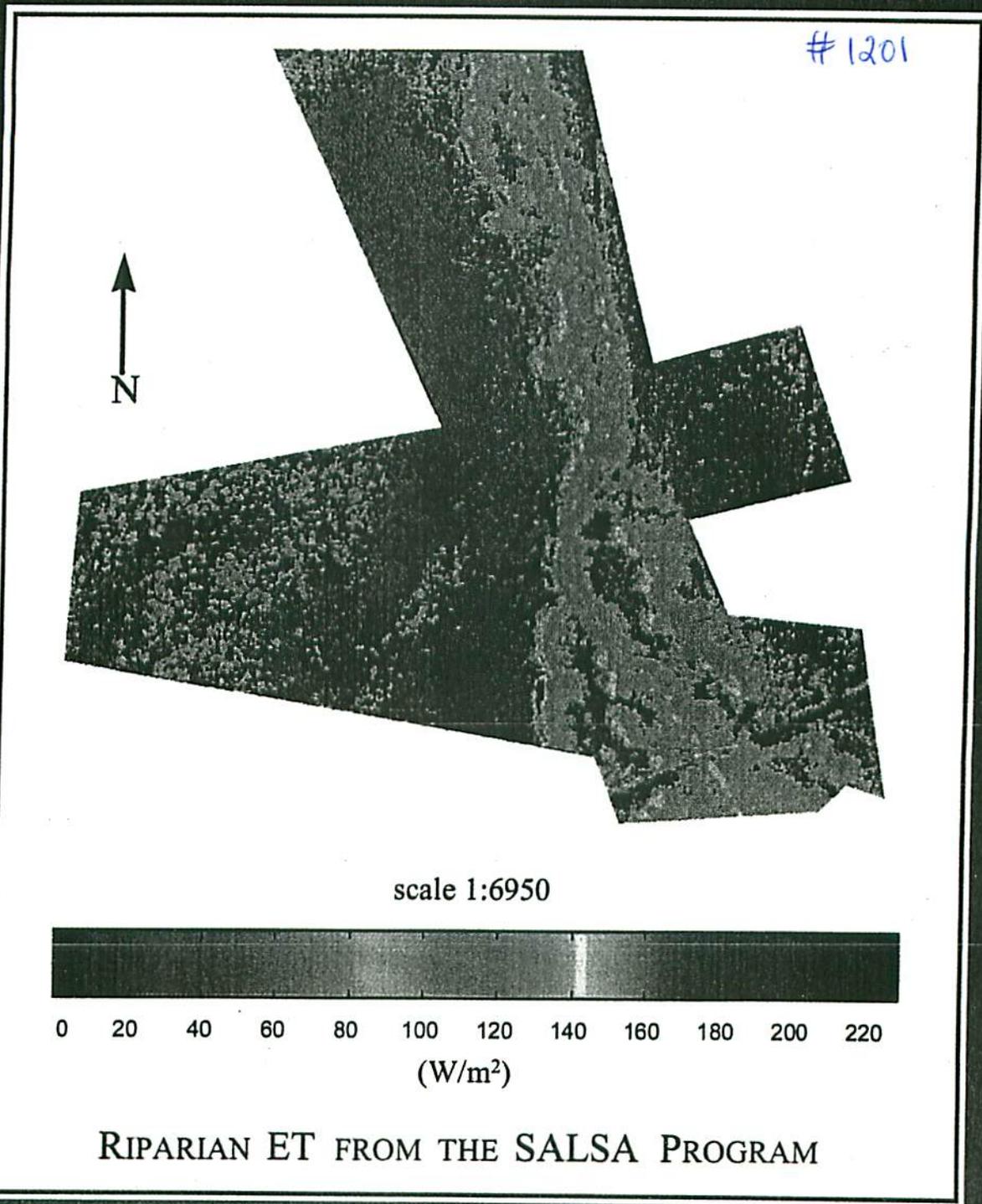




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RIPARIAN ET FROM THE SALSA PROGRAM

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THINK GLOBALLY, ACT LOCALLY: COMMUNITY PARTICIPATION
IN "SALSA" GLOBAL CHANGE RESEARCH

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1. INTRODUCTION.

In the 1970s, scientist and philosopher Rene Dubos counseled us to "think globally, act locally" in addressing environmental problems. Some two decades later, scientists and lay persons alike are keenly aware of the interconnectedness of the Earth's environmental systems and the potential adverse consequences of global change. Yet, whereas people may conceive of environmental change as taking place globally, they perceive environmental change locally, that is, within the context of their personal or community experience.

It might be said that all environmental change, like all politics, is local. Like politicians, global change scientists are wise to address local needs while pursuing their larger research agenda. This approach to global change research has three advantages: society gets a higher return on its investment in research; the local community has a stake in the outcome of the research and therefore a willingness to support it financially and politically; and local participants learn about global change issues and share this knowledge with the community. An added benefit is that interaction among scientists and citizens promotes better understanding and appreciation for each other's needs and intentions.

The Semi-Arid Land-Surface-Atmosphere ("SALSA") Program is a multidisciplinary, multi-agency, multi-national global change research effort led by the Agricultural Research Service (ARS) of the US Department of Agriculture. The scientific objectives and methodology of SALSA, as well as preliminary results, are described in greater detail elsewhere in this issue (Goodrich et al., this issue). Briefly, SALSA is a long-term research, monitoring, and modeling effort designed to examine the consequences of natural and human-induced change on the water balance

and ecological stability of semi-arid river basins from event to decadal timescales. SALSA research is focused on the upper basin of the San Pedro River in southeastern Arizona, USA and northeastern Sonora, Mexico (Figure 1). The "community" referred to in this paper is Cochise County which encompasses most of the upper basin on the US side of the border. This designation is for convenience only, however, as the actual community includes affected citizens and governments throughout the southwestern US, northern Mexico, and beyond.

The purpose of this paper is to describe our experience in working with a community to help resolve a local environmental problem while at the same time achieving scientific objectives of a global change research program. The paper provides background to the problem and summarizes community participation in the SALSA Riparian Campaign, the principal experimental activity on the US portion of the basin in 1997. We present this example to illustrate the benefits of cooperative research and participatory science, and hope our experience and recommendations might serve other global change research programs in similar circumstances.

2. ENVIRONMENTAL SETTING

From a local community perspective, the Upper San Pedro Basin is a broad, high-desert valley bordered by scenic mountains and cut by a green ribbon of riparian vegetation sustained by a small stream. The valley is home to a major US Army installation and a number of prospering and growing communities (City of Sierra Vista, 1997). Although often viewed by newcomers as "pristine," the upland and riparian environments of the San Pedro valley have been radically altered over the past hundred years by human activities

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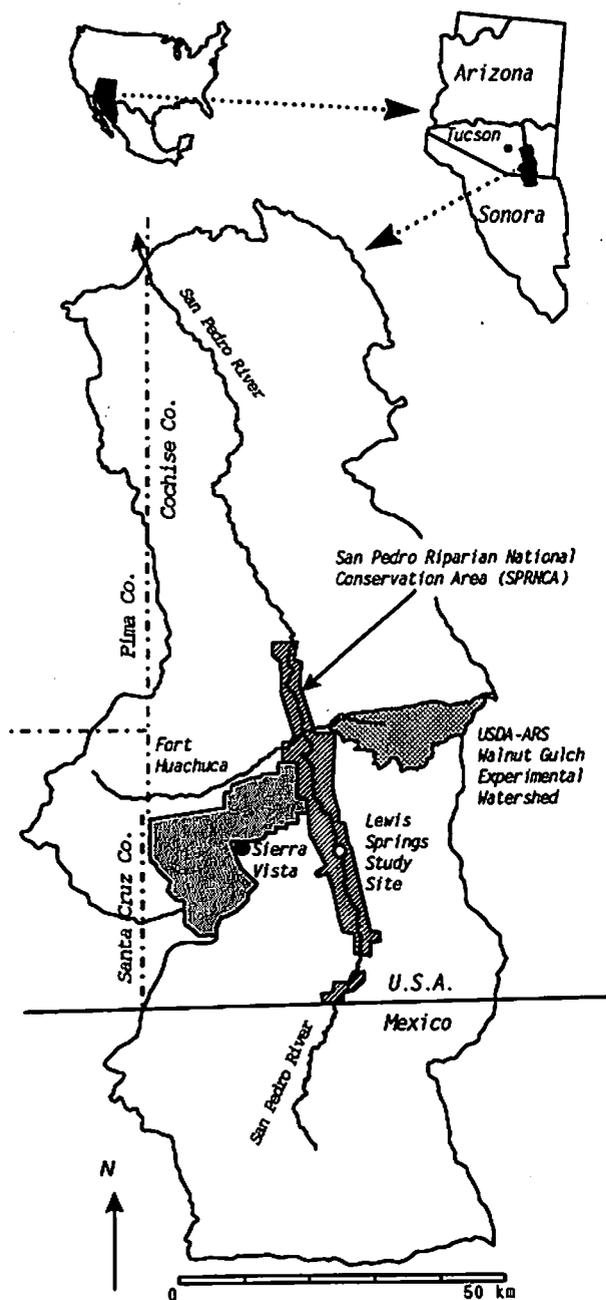


Figure 1. Upper San Pedro Basin of Arizona, USA and Sonora, Mexico.

(Bahre, 1991). Still, the extant cottonwood-willow riparian forest supports a great diversity of species, some endangered with extinction, and is widely recognized as a regionally and globally important ecosystem. The San Pedro River has been proclaimed one of America's most threatened rivers by American Rivers, one the world's Eight Last Great Places by the Nature

Conservancy, one the world's Birding Hot Spots by Birding Magazine, and a Globally Important Bird Area by the American Bird Conservancy (World Rivers Review, 1997). Most residents of the community appreciate the unique quality of their local environment but differ on how, and to what extent, it should be preserved.

From the global change research perspective of SALSA, the Upper San Pedro Basin represents an ideal outdoor laboratory, containing diverse topographic, climatic, vegetative, and landuse features within a well-defined drainage system about 40 km across and 150 km long. These characteristics will be useful in developing and testing land-surface-atmosphere process models, and calibrating and validating satellite-based Earth observation systems (Wallace, 1995). The basin contains riparian and upland ecosystems that exhibit evidence of historic human impact on the vegetation of the region; changes that continue today (Kepner et al., 1995). The study area also includes the ARS Walnut Gulch Experimental Watershed, a densely instrumented facility that has served as a center for research in the hydroclimatology of semi-arid lands for over 30 years (Goodrich and Simanton, 1995).

3. LOCAL PROBLEMS, GLOBAL SIGNIFICANCE

In 1988, the United States Congress established the San Pedro Riparian National Conservation Area (SPRNCA), the first of its kind in the nation, to protect riparian resources along 60 km of river north of the US-Mexico border (BLM, 1989). The US Bureau of Land Management (BLM) administers the conservation area in a manner that conserves, protects, and enhances its riparian values. A number of factors outside the control of the BLM make protection of the SPRNCA problematic: mine-related pollution, surface diversions, and groundwater pumping in Mexico; potential water-rights claims by downstream users; and increased water use by communities near the conservation area (Jackson et al., 1987). By far, the biggest concern is excessive groundwater pumping by Fort Huachuca and the City of Sierra Vista which has resulted in a large "cone-of-depression" between the groundwater recharge area of the Huachuca Mountains to the west and the river to the east (ADWR, 1991). Several hydrogeologic studies indicate that the cone-of-depression is intercepting groundwater that would otherwise contribute to river baseflow (USAG, 1997).

If pumping is diminishing groundwater flow to the floodplain aquifer, the resultant drop in the water table could kill riparian phreatophytes (Stromberg, 1993) and destroy protected habitat within the SPRNCA. This possibility has alarmed environmentalists, provoking calls for government to correct or mitigate the situation (Davis, 1995). In response, Fort Huachuca, the City of Sierra Vista, and Cochise County have undertaken programs to conserve water, recharge municipal effluent, and enhance natural recharge (City of Sierra Vista, 1997). However, some critics view these measures as insufficient. Pro-environmental groups have sued the US Army in an attempt to limit water use in the basin (Silver, 1994). They have also prompted the tri-national Commission on Environmental Cooperation (CEC) to study the potential transborder impact of habitat loss on migratory birds (Earthlaw, 1997). Pro-development groups counter that growth and habitat protection are compatible using the proposed technological solutions. The overall effect has been to polarize segments of the community, confuse others, and increase distrust in government efforts to resolve the problem.

4. THE RIPARIAN CAMPAIGN

The lack of conclusive scientific information about basin hydrology has contributed to the discord, as each side interprets or misinterprets what information is available to support their own position. The Arizona Department of Water Resources (ADWR), as well as other researchers, have been attempting to develop computer models of the basin that will accurately simulate the effect of groundwater withdrawal and recharge on baseflow in the river (Corell et al., 1996). Results thus far indicate that additional data on seasonal evapotranspiration processes within the basin are needed to improve model performance. SALSA researchers had also identified evapotranspiration as a critical yet poorly understood process in semi-arid systems and had included it in their overall research plans (Wallace, 1995). This common research objective was pursued by the interagency San Pedro Technical Review Committee (SPTRC) and became the impetus for SALSA "Riparian Campaign."

With the support and cooperation of SPTC members, including the University of Arizona (UA), ADWR, BLM, US Geological Survey (USGS), Cochise County Highway and Flood Control Department, and the US Army-Fort Huachuca, along with funding by ARS, NASA, and

other research agencies, SALSA initiated the Riparian Campaign, a year long experiment to quantify and characterize evapotranspiration and stream-aquifer interactions along the riparian corridor in the Upper San Pedro Basin. The results of this experiment will contribute to a better overall understanding of the riparian system within the SPRNCA and generate information needed to improve the ADWR basin model. The results will also provide SALSA scientists with data needed in developing larger scale models of the land-surface-atmosphere system.

In 1996-1997, SALSA researchers established a study site along the San Pedro River (near Lewis Springs) within the SPRNCA. The site was equipped with automated sensors for measuring atmospheric and hydrologic variables, as well as other instruments that required periodic manual measurement. Intensive measurements were taken of all experimental variables during five 48-hour "synoptic runs," conducted at different times of the year. Staff and students from the ARS, UA, and USGS participated in all synoptic runs, and during August were joined by scientists from Los Alamos National Laboratory (LANL), Jet Propulsion Laboratory, Utah State University, University of Iowa, the French science agency ORSTOM, and the Sonoran environmental agency IMADES, among others.

5. COMMUNITY SUPPORT

It became apparent early in the 1997 field season that SALSA researchers would need assistance in taking the many around-the-clock measurements required during a synoptic run. In response, several members of the local community, in addition to UA hydrology students, volunteered their time to help in the field. Under the supervision of SALSA researchers, volunteers measured depth-to-water in piezometers, recorded stream stage, collected stream water samples for dye tracer analysis, and performed other basic tasks. The initial group of volunteers was trained during a pre-synoptic orientation session; later groups received "on-the-job" training while working with veteran volunteers. The hours were long and hard, the conditions sometimes harsh, and the compensation meager (sodas and snacks); still, many volunteers returned for subsequent synoptic runs.

Some volunteers were affiliated with local organizations, including Cochise County, City of Sierra Vista, San Pedro Technical Review Committee, Huachuca Audubon Society, and

Friends of the San Pedro; others participated as individuals. They included technical and clerical professionals, a county attorney, a city councilman, an accountant, an electrician, homemakers, and retirees, who brought with them a wide range of a knowledge and experience. UA staff and students from disciplines as diverse as entomology and planetary science also volunteered to help. Between measurement circuits and work shifts, groups of volunteers had time to interact with each other and SALSA researchers, exchange ideas and establish useful contacts. Most local volunteers had a personal interest in the future of the San Pedro River and appreciated the opportunity to participate in research that might affect its fate.

Local officials and the media were invited to visit the study site to observe SALSA Riparian Campaign activities. Newspapers and television provided some coverage of the August synoptic run which included several aircraft overflights, high-tech equipment from LANL, visiting scientists from other parts of the US and abroad, as well as the involvement of local volunteers. Members of a CEC study panel also visited the site and were briefed on SALSA's role in investigating the cause of environmental change on both the US and Mexico side of the San Pedro Basin. The news coverage gave more local residents an opportunity to learn about the Riparian Campaign, which had previously received only minor attention.

6. DISCUSSION

Community participation played a crucial role in SALSA's success during 1997. Funding and logistical support from local agencies, as well as volunteer labor, contributed significantly to the research effort. SALSA provided a high return on investment to researchers and supporters alike. The cooperative nature of the program allowed participants to leverage their funds to the maximum extent, achieving multiple research objectives at no extra cost. Research funded by one agency benefited all agencies.

Local officials have voiced support of SALSA's role in helping to resolve local environmental concerns. Many view SALSA as a moderating influence in a contentious situation that sometimes pits citizen against citizen, and even government agency against government agency. SALSA is considered to be an unbiased, results oriented, research program that will be fair and open with its findings. Local officials have

cited SALSA (though not always correctly) when answering critics who complain that government is doing little to resolve the water problem in the Upper San Pedro Basin. They are encouraged by SALSA's cross-border component because they feel it can address questions about water use on the Mexican side of the basin. Although there has been little interest by the general public in the global change aspect of SALSA, one official did express pleasure at the thought of the basin becoming a world-class research area, envisioning the boost to the economy that visiting scientists would bring.

Professional and technical staff with local government agencies felt the field experience was helpful to them: they were able to get out of the office and work with the resource they manage, learn new research skills, exchange information about the local environment, and network with staff from other agencies and the research community. Private citizens, who may be more suspicious of government research, were involved as equal participants in the data collection process and could satisfy themselves with the objectivity and intent of the program. Student volunteers attained valuable field research experience and were exposed to real-world problems. People with differing ideologies worked together, literally on "common ground," which may form the basis for future cooperation.

7. CONCLUSIONS

Both the SALSA global change research program and the local community have benefited by "thinking globally" while "acting locally" to address a common research objective. Although the results of the 1997 Riparian Campaign will answer only a few of the questions concerning water and habitat management in the Upper San Pedro Basin, the experience sets the path for future research campaigns. Subsequent SALSA research will likely focus on topics such as natural recharge processes, mountain hydrology, integration of US and Mexican basin studies, and landscape-level habitat change.

Based on suggestions by community participants, it is recommended that SALSA:

- obtain additional funding for educational outreach and local involvement in order to better integrate the community into the research effort;
- deposit copies of research reports at public libraries and government offices, and publish

summaries in the popular press and the Internet; and,

- keep the public informed about SALSA research with interpretive signs at study sites and through public speaking engagements with local service groups.

8. ACKNOWLEDGMENTS

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9. REFERENCES

- ADWR. 1991. Hydrographic survey report for the San Pedro River watershed. Volume 1: general assessment, in re the general adjudication of the Gila River system and source. Arizona Department of Water Resources, Phoenix, AZ. Filed with the Court, November 20, 1991.
- Bahre, C.J. 1991. A legacy of change: historic human impact on vegetation in the Arizona borderlands. The University of Arizona Press, Tucson, AZ.
- BLM. 1989. San Pedro River riparian management plan and environmental impact statement. Final. Safford, AZ: US Department of the Interior, Bureau of Land Management.
- City of Sierra Vista. 1997. A walk along the San Pedro River. Pamphlet. City of Sierra Vista, AZ.
- Corell, S.W., F. Corkhill, D. Lovvik, and F. Putnam. 1996. A groundwater flow model of the Sierra Vista subwatershed of the Upper San Pedro Basin - Southeastern Arizona. Modeling Report No. 10. Arizona Department of Water Resources, Hydrology Division, Phoenix, AZ.
- Davis, T. 1995. The Southwest's last real river: will it flow on? High Country News, June 12, 1995 (Vol. 27, No. 11). Paonia, CO.
- Earthlaw. 1997. Earthlaw wins first U.S. NAFTA petition: international commission to investigate harm to Southwest's last real river. Newsletter, May 26, 1997. Earthlaw, Denver, CO. Internet document <http://www.envirolink.org/orgs/elaw/Feature/river.htm>.
- Goodrich, D.C., and J.R. Simanton. 1995. Water research and management in semiarid environments. *J. Soil and Water Conserv.* 50(5): 416-419.
- Goodrich, D.C., A. Chehbouni, B. Goff, B. MacNish, T. Maddock, S. Moran, W.J. Shuttleworth, D.G. Williams, J.J. Toth, C. Watts, L.H. Hipps, D.I. Cooper, J. Schieldge, Y.H. Kerr, H. Arias, M. Kirkland, R. Carlos, W. Kepner, B. Jones, R. Avissar, A. Begue, G. Boulet, B. Branat, I. Braud, J.P. Brunel, L.C. Chen, T. Clarke, M.R. Davis, J. Dauzat, H. DeBruin, G. Dedieu, W.E. Eichinger, E. Elguero, J. Everitt, J. Garatuzza-Payan, A. Garibay, V.L. Gempko, H. Gupta, C. Harlow, O. Hartogensis, M. Helfert, C. Holifield, D. Hymer, A. Kahle, T. Keefer, S. Krishnamoorthy, J-P. Lhomme, D. Lo Seen, D. Luquet, R. Marsett, B. Monteny, W. Ni, Y. Nouvellon, R. Pinker, C. Peters, D. Pool, J. Qi, S. Rambal, H. Rey, J. Rodriguez, E. Sano, S.M. Schaeffer, M. Schulte, R. Scott, X. Shao, K.A. Snyder, S. Sorooshian, C.L. Unkrich, M.P.L. Whitaker, I. Yucel. 1997. An overview of the 1997 activities of the semi-arid land-surface-atmosphere (SALSA) program. (This issue).
- Jackson, W., T. Martinez, P. Cuplin, W.L. Minkley, B. Shelby, P. Summers, D. McGlothlin, and B. Van Haveren. 1987. Assessment of water conditions and management opportunities in support of riparian values: BLM San Pedro River properties, Arizona, project completion report. Report No. BLM/YA/PT-88/004+7200. US Department of the Interior, Bureau of Land Management Service Center, Denver, CO.
- Kepner, W.G., K.H. Riitters, and J.D. Wickham. 1995. A landscape approach to monitoring and assessing ecological condition of rangelands -San Pedro River case study. Proc. Symp. EMAP Science, Chapel Hill, NC, March 7-9, 1995. U.S. Environmental Protection Agency, Environmental Monitoring and Assessment Program, Research Triangle Park, NC.

Silver, R. 1994. Efforts to save the San Pedro River intensify. News Release: November 18, 1994. Southwest Center for Biological Diversity, Phoenix, AZ. Internet document <http://www.metla.fi/archive/forest/1994/11/msg00107.html>.

Stromberg, J.C. 1993. Fremont cottonwood-Goodding willow forests: a review of their ecology, threats, and recovery potential. *J. Arizona-Nevada Academy of Science* 26:97-110.

USAG. 1997. Environmental assessment, 1995 Base Realignment and Closure, Fort Huachuca, Arizona. Appendix A: synopsis of hydrogeological studies. US Army Garrison,

Directorate of Engineering and Housing, Fort Huachuca, AZ.

Wallace, J. 1995. Multidisciplinary program studies land-atmosphere interactions in semi-arid regions. A "meeting report" on the SALSA workshop held in Tucson, Arizona, August 1995. *EOS, Trans., American Geophysical Union*, 76(46), 465, 469.

World Rivers Review. 1997. Biodiversity, North America. *World Rivers Review, News Briefs*, Volume 12, Number 1, February 1997. International Rivers Network. Internet document

<http://www.irm.org/pubs/wrr/9701/briefs.html>.