ANNOTATED BIBLIOGRAPY OF SELECTED PUBLICATIONS RELATED TO HYDROLOGIC EFFECTS OF WET MEADOW RESTORATION IN THE SIERRA NEVADA

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A. Meadow restoration effects on groundwater storage and streamflow in the western United States

1. **Cornwell, Kevin, and Brown, Kamala, 2008, Physical and hydrological characterization of Clark's Meadow in the Last Chance Watershed of Plumas County: Report to the Natural Heritage Institute, Mountain Meadows IRWMP, California State University Sacramento, Department of Geology, 38 pp.**

http://ceic.resources.ca.gov/catalog/SacramentoRiverWatershedData/PhysicalAndHydrologicalCharacterizationOfClarksMeadow.html

Plug and pond meadow restoration increased the volume of groundwater available to supply summer baseflow, but effects on streamflow were not evaluated. Unrestored meadow channels were dry by mid-summer.

2. **Elmore, Wayne, and Beschta, R.L., 1987, Riparian areas: perceptions in management: Rangelands 9(6):260-265.**

http://www.rmrs.nau.edu/awa/ripthreatbib/elmore_beschta_riperianareas.pdf

Provides a general discussion of adverse impacts of stream incision on summer baseflows in eastern Oregon rangelands and provides photographic and anecdotal information on improved baseflow volumes and duration for streams restored to aggrading conditions using grazing strategies and vegetative manipulation.

3. **Hammersmark, C., Rains, M., and Mount, J., 2008, Quantifying the hydrological effects of stream restoration in a montane meadow, northern California, USA: River Research and Applications 24(6): 735-753.**

http://onlinelibrary.wiley.com/doi/10.1002/rra.1077/abstract

Plug and pond meadow restoration in Lassen County resulted in higher water table elevations, increased groundwater storage, a non-detectable decrease in total annual streamflow, and a decreased duration of base flow at the midpoint of the restored meadow reach. Baseflow downstream of the restored reach was reported to have increased after restoration, but was not quantified. The decreased mid-meadow baseflow was attributed to increased evapotranspiration and increased downstream groundwater discharge that was not included as streamflow.

4. **Heede, B.H., 1979, Deteriorated watersheds can be restored: a case study: Environmental Management 3(3):271-281**

http://www.springerlink.com/content/g4rg7745761vgu56/

Restoration of a watershed in western Colorado using range management and check-dam construction in gullies eroded in alluvial valley floors restored perennial flow to streams within 7 years after restoration.

5. **Klein, L.R., Clayton, S.R., Alldredge, J.R., and Goodwin, Peter, 2007, Long-term monitoring and evaluation of the Lower Red River meadow restoration project, Idaho, USA: Restoration Ecology 15(2):223-239.**

http://onlinelibrary.wiley.com/doi/10.1111/j.1526-100X.2007.00206.x/pdf

Evaluation of restoration of a large meadow in Idaho showed that restoration resulted in increased duration, extent, and volume of overbank flooding.

6. **Liang, L., Kavvas, M.L., Chen, Z.Q., Anderson, M., Ohara, N., Wilcox, J., and Mink, L., 2007, Modeling river restoration impact on flow and sediment in a California watershed: Proceedings of ASCE World Environmental and Water Resources Congress, ed. by. Karen C. Kabbes, Conf. in Tampa, Florida, May, 2007.**

Not available via internet.

Plug and pond restoration in Last Chance Meadow along a tributary of the Feather River in Plumas County was shown with a modeling approach to increase summer baseflows.

7. **Loheide, S.P. II, and Gorelick, S.M., 2006, Quantifying stream-aquifer interactions through the analysis of remotely sensed thermographic profiles and in situ temperature histories: Enivonmental Science and Technology 40(10):3336-3341.**

http://www.clas.ufl.edu/users/jbmartin/website/Classes/Surface_Groundwater/Class%203/Loheide%20and%20Gorelick%20Environ%20Sci%20Tech%202006%20Hypor%20and%20T.pdf

Water temperature data were used to infer increased baseflow in restored meadow reaches relative to unrestored reaches in the upper Feather River watershed (Plumas NF).

8. **Loheide, S.P. II, and Gorelick, S.M., 2007, Riparian hydroecology: a coupled model of the observed interactions between groundwater flow and meadow vegetation patterning: Water Resources Research, vol. 43, W07414**

http://www.agu.org/journals/ABS/2007/2006WR005233.shtml

Meadow restoration along tributaries to the Feather River increases groundwater residence time and may contribute to late summer streamflow duration owing to longer groundwater flow paths relative to incised meadows.

9. **Loheide, S.P., and Booth, E.G., 2010, Effects of changing channel morphology on vegetation, groundwater, and soil moisture regimes in groundwater-dependent ecosystems: Geomorphology (article in press).**

http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6V93-50106MJ-2&_user=4250274&_coverDate=05%2F05%2F2010&_rdoc=1&_fmt=high&_orig=search&_origin=search&_sort=d&_docanchor=&view=c&_searchStrId=1551700173&_rerunOrigin=google&_acct=C000052423&_version=1&_urlVersion=0&_userid=4250274&md5=5847b8885034e26e3f9376a1e9293daf&searchtype=a

Effects of channel incision and widening on vegetation and groundwater in alluvial aquifers such as meadows were evaluated. Effects on streamflow were not analyzed.

10. **Ponce, V.M., and Lindquist, D.S., 1990, Management strategies for baseflow augmentation: Proceedings, ASCE Irrigation and Drainage Division, Watershed Management Symposium, Durango, Colorado, July 9-11, 1990.**

http://saltonsea.sdsu.edu/watershedplanbaseflowaug313.html

Provides examples of several western mountain meadows where restoration, primarily with check dams, converted ephemeral channels to perennial flow.

11. **Swanson, Sherman, Franzen, Dave, and Manning, Mary, 1987, Rodero Creek: rising water on the high desert: Journal of Soil and Water Conservation 42(6):405-407.**

www.jswconline.org/content/42/6/405.extract

Meadow restoration with check dams in northwestern Nevada transformed about a mile of intermittent channel to perennial flow.

12. **Tague, Christina, Valentine, Scott, and Kotchen, Matthew, 2008, Effect of geomorphic channel restoration on streamflow and groundwater in a snowmelt-dominated watershed: Water Resources Research 44, W10415, 10 pp.**

http://environment.yale.edu/kotchen/pubs/stream.pdf

Plug and pond restoration of Trout Creek near Lake Tahoe resulted in higher water-table elevations and increased mid-summer streamflow. Post-restoration streamflow in late summer was about the same as pre-restoration flow.

B. Erosion and restoration effects on meadow vegetation in the western United States

1. **Allen-Diaz, B.H., 1991, Water table and plant species relationships in Sierra Nevada meadows: American Midland Naturalist 126:30-43.**

http://www.jstor.org/stable/2426147

Plant species composition on meadows at Sagehen Creek (Tahoe NF) were largely controlled by depth to the water table.

2. **Cottam, W.P., 1929, Man as a biotic factor illustrated by recent floristic and physiographic changes at the Mountain Meadows, Washington County, Utah: Ecology 10(4):361-363**

http://www.esajournals.org/doi/abs/10.2307/1931143

Historical observations were used to illustrate relations between human land disturbance, meadow erosion, and subsequent shifts to xeric vegetation in a meadow in Utah.

3. **Cottam, W.P., and Stewart, George, 1940, Plant succession as a result of grazing and of meadow dessication by erosion since settlement in 1862: Journal of Forestry 38:613-626.**

http://www.ingentaconnect.com/content/saf/jof/1940/00000038/00000008/art00004

A shift from meadow grasses to junipers was documented and related to gully erosion in a meadow in Utah.

4. **Darroutzet-Nardi, Anthony, D'Antonio, C.M., and Dawson, T.E., 2006, Depth of water acquisition by invading shrubs and resident herbs in a Sierra Nevada meadow: Plant and Soil 285:31-43**

http://anthony.darrouzet-nardi.net/works/Darrouzet-Nardi2006b.pdf

Sagebrush in meadows of the Kern Plateau expanded its range owing to gully erosion and lower water-table elevations.

5. **Debinski, D.M., Wickham, Hadley, Kindscher, Kelly, Caruthers, J.C., and Germino, Matthew, 2010, Montane meadow change during drought varies with background hydrologic regime and plant functional group: Ecology 91(6):1672-1681.**

http://www.esajournals.org/doi/abs/10.1890/09-0567.1

Vegetation changes during drought in meadows in Yellowstone National Park were documented and related to hydrologic conditions.

6. **Hammersmark, C.T., Rains, M.C., Wickland, A.C., and Mount, J.F., 2009, Vegetation and water-table relationships in a hydrologically restored riparian meadow: Wetlands 29(3):785-797.**

http://www.bioone.org/doi/abs/10.1672/08-15.1

Plant communities following plug-and-pond restoration of Bear Meadow in Lassen County followed hydrologic gradients.

7. **Hammersmark, C.T., Dobrowski, S.Z., Rains, M.C., and Mount, J.F., 2010, Simulated effects of stream restoration on the distribution of wet-meadow vegetation: Restoration Ecology 18(6):882-893.**

http://onlinelibrary.wiley.com/doi/10.1111/j.1526-100X.2009.00519.x/pdf

A model was used to show an expansion of suitable habitat for mesic vegetation and a decrease in suitable habitat for xeric vegetation following restoration of a wet meadow on Bear Creek in Lassen County.

C. Meadow evapotranspiration in the western United States

1. **Borrelli, John, and Burman, R.D., 1982, Evapotranspiration from heterogeneous mountain meadows: Water Resources Series No. 86, Wyoming Water Research Center, University of Wyoming, Laramie, WY, 31 pp.**

http://library.wrds.uwyo.edu/wrs/wrs-86/abstract.html

Monthly ET rates in wet meadows ranged from 2.8 to 25.0 cm during growing season.

2. **Loheide, S.P. II, and Gorelick, S.M., 2005, A local-scale, high-resolution evapotranpiration mapping algorithm (ETMA) with hydroecological applications at riparian meadow restoration sites: Remote sensing of Environment 98: 182-200.**

http://www.feather-river-crm.org/project-files/ETPaper.pdf

ET in eroded meadows in the Feather River watershed ranged from 1.5 to 4 mm/day. ET in restored meadows ranged from 5 to 6.5 mm/day.

3. **Lowry, C.S., and Loheide, S.P. II, 2010, Groundwater-dependent vegetation: quantifying the groundwater subsidy: Water Resources Research 46, W06202, 8 pp.**

http://www.agu.org/pubs/crossref/2010/2009WR008874.shtml

ET from groundwater comprised a large proportion of total wet-meadow ET, and reached rates of roughly 3 mm/day.

4. **Sanderson, J.S., and Cooper, D.J., 2008, Ground water discharge by evapotranspiration in wetlands of an arid intermountain basin: Journal of Hydrology 351: 344-359.**

http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6V6C-4RGM0V9-3&_user=4250274&_coverDate=04%2F15%2F2008&_rdoc=1&_fmt=high&_orig=search&_origin=search&_sort=d&_docanchor=&view=c&_searchStrId=1551778614&_rerunOrigin=google&_acct=C000052423&_version=1&_urlVersion=0&_userid=4250274&md5=215d32ef4b2418a74f0259b74b1010a4&searchtype=a

Wet-meadow ET from groundwater was distinguished from total ET, and was found to be related to depth to the water table. Results from a variety of models were compared and assessed. Daily actual ET ranged from roughly 1 to 9 mm/day for wet meadows.

5. **Steinwand, A.L., Harrington, R.F., and Or, D., 2006, Water balance for Great Basin phreatophytes derived from eddy covariance, soil water, and water table measurements: Journal of Hydrology 329(3-4):595-605.**

http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6V6C-4K0FK06-2&_user=4250274&_coverDate=10%2F15%2F2006&_rdoc=1&_fmt=high&_orig=search&_origin=search&_sort=d&_docanchor=&view=c&_searchStrId=1551786995&_rerunOrigin=google&_acct=C000052423&_version=1&_urlVersion=0&_userid=4250274&md5=241899b90510761cee444c14b943dd7a&searchtype=a

ET of meadows in the Owens Valley near the Inyo NF was evaluated throughout annual cycles. Total growing season ET ranged from 53 to 646 mm. In wet alkali meadows with shallow water tables, groundwater supplied 60 to 81% of total ET. Use of groundwater by plants was correlated with water-table depth and leaf-area index.

D. Meadow stratigraphy

The following publications provide information on meadow alluvium, including information useful for inferring hydraulic properties such as specific yield and permeability.

1. **Anderson, R.S., and Smith, S.J., 1994, Paleoclimatic interpretations of meadow sediment and pollen stratigraphies from California: Geology, vol. 22, p. 723-726.**

http://geology.geoscienceworld.org/cgi/content/abstract/22/8/723

Nine meadows in the central and southern Sierra Nevada were examined for this study. All had surficial peat deposits of roughly 0.5 to 2 m thickness, and most had subsurface strata composed of fine-grained organic silts with thickness of 1 to 2 m.

2. **Koehler, P.A., and Anderson, R.S., 1994, The paleoecology and stratigraphy of Nichols Meadow, Sierra National Forest, California, USA: Palaeogeography, Palaeoclimatology, Palaeoecology 112: 1-17.**

http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6V6R-4894VG2-S&_user=4250274&_coverDate=11%2F30%2F1994&_rdoc=1&_fmt=high&_orig=search&_origin=search&_sort=d&_docanchor=&view=c&_searchStrId=1553447910&_rerunOrigin=google&_acct=C000052423&_version=1&_urlVersion=0&_userid=4250274&md5=4a11b509278ecdc4c64d2dfcbf2c2b06&searchtype=a

The stratigraphy of a meadow on the Sierra NF was composed mostly of silty sand, sand, and gravel, with minor amounts of clay and silty clay and no peat or other highly organic strata.

3. **Wood, S.H., 1975, Holocene stratigraphy and chronology of mountain meadows, Sierra Nevada, California: USDA-Forest Service Earth Surface Monograph 4, Pacific Southwest Region.**

http://thesis.library.caltech.edu/5570/

This monograph includes a wealth of information on meadow stratigraphy, origins, stability, erosion, groundwater dynamics, evapotranspiration, plant ecology, and chronology.

E. Hydraulics of flow between bedrock and meadow aquifers in the western United States

The articles listed under this topic concern the hydrologic relations between meadow aquifers and their surrounding bedrock aquifers and watersheds. The hydrologic and hydraulic connections between meadows and their watersheds are now widely recognized.

1. **Atekwana, E.A., and Richardson, D.S., 2004, Geochemical and isotopic evidence of a groundwater source in the Corral Canyon meadow complex, central Nevada, USA: Hydrological Processes 18:2801-2815.**

http://onlinelibrary.wiley.com/doi/10.1002/hyp.1495/abstract

The source of meadow groundwater was found to be groundwater discharged from the surrounding watershed through bedrock.

2. **Hill, B.R., 1990, Groundwater discharge to a headwater valley, northwestern Nevada, USA: Journal of Hydrology 113: 265-283.**

http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6V6C-4876D4N-4M&_user=4250274&_coverDate=02%2F28%2F1990&_rdoc=1&_fmt=high&_orig=search&_origin=search&_sort=d&_docanchor=&view=c&_searchStrId=1554647423&_rerunOrigin=google&_acct=C000052423&_version=1&_urlVersion=0&_userid=4250274&md5=502b6c0172dbaad5b05795caeee929eb&searchtype=a

An eroded meadow in Nevada allowed direct discharge of groundwater from fractured bedrock to an incised gully. Meadow alluvium had lower permeability than surrounding bedrock, and may have restricted groundwater discharge prior to erosion of the gully.

3. **Hill, B.R., and Mitchell-Bruker, Sherry, 2010, Comment on "A framework for understanding the hydroecology of impacted wet meadows in the Sierra Nevada and Cascade Ranges, California, USA": paper published in *Hydrogeology Journal* (2009) 17:229–246, by Steven P. Loheide II, Richard S. Deitchman, David J. Cooper, Evan C. Wolf, Christopher T. Hammersmark, Jessica D. Lundquist: Hydrogeology Journal 18(7):1741-1743.**

http://www.springerlink.com/content/5077179318n71301/

This comment and accompanying reply (see Loheide and others, 2009, below) address the issue of the relative permeability of meadow alluvium and surrounding bedrock, and implications for streamflow regimen.

4. **Jewett, D.G., Lord, M.L., Miller, J.R., and Chambers, J.C., 2004, Geomorphic and hydrologic controls on surface and subsurface flow regimes in riparian meadow ecosystems, Chapter 5, p. 124-161, <u>in</u>: Great Basin Riparian Ecosystems, Chambers,**

J.C., and Miller, J.R. (eds.), Society for Ecological Restoration International, Island Press, Covelo, CA.

http://books.google.com/books?id=irAQvednci4C&pg=PA124&lpg=PA124&dq=jewett+chambers+great+basin+riparian+ecosystems+2004&source=bl&ots=qve4wBC7DK&sig=y8tm15LfWmr9mbewrWyUz5YaTfk&hl=en&ei=0U_tTNKOL4T0swPDzcCqBw&sa=X&oi=book_result&ct=result&resnum=1&ved=0CBkQ6AEwAA#v=onepage&q&f=false

Upward vertical hydraulic gradients of meadows in central Nevada were the result of heterogeneities in meadow alluvium that caused variations in permeability.

5. **Loheide, S.P. II, Deitchman, R.S., Cooper, D.J., Wolf, E.C., Hammersmark, C.T., and Lundquist, J.D., 2009, A framework for understanding the hydroecology of impacted wet meadows in the Sierra Nevada and Cascade Ranges, California, USA: Hydrogeology Journal 17:229-246.**

http://www.ingentaconnect.com/content/klu/10040/2009/00000017/00000001/00000380

Lower permeability of meadow alluvium, higher rates of groundwater inflow, and a high ratio of lateral to basal groundwater inflow all tend to result in higher meadow water-table elevations.

6. **Lowry, C.S., Deems, J.S., Loheide, S.P. II, and Lundquist, J.D., 2010, Linking snowmelt-derived fluxes and groundwater flow in a high elevation meadow system, Sierra Nevada Mountains, California: Hydrological Processes 24(20):2821-2833.**

http://onlinelibrary.wiley.com/doi/10.1002/hyp.7714/abstract

Groundwater levels in Tuolumne Meadows in Yosemite NP were found to be controlled by hillslope sources of snowmelt runoff, snowmelt on the meadow surface, and stream recharge.

F. Alluvial channel incision (gully erosion) effects on streamflow in other geographic areas

1. **Costa, F.M., and de Almeida Prado Bacellar, Luis, 2007, Analysis of the influence of gully erosion in the flow pattern of catchment streams, Southeastern Brazil: Catena 69: 230-238.**

http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6VCG-4KDBM9F-1&_user=4250274&_coverDate=04%2F15%2F2007&_rdoc=1&_fmt=high&_orig=search&_origin=search&_sort=d&_docanchor=&view=c&_acct=C000052423&_version=1&_urlVersion=0&_userid=4250274&md5=ed821e963953200e805e3ad171db9be0&searchtype=a

Gully erosion of alluvial and colluvial valleys resulted in higher peak flows and lower base flows. See reference number 4. below for additional analyses of the effects of gully erosion on confined groundwater flows.

2. **De A.P. Bacellar, Coehlo Netto, A.L., and Lacerda, W.A., 2005, Controlling factors of gullying in the Maracuja Catchment, Southeastern Brazil: Earth Surface Processes and Landforms 30:1369-1385.**

http://onlinelibrary.wiley.com/doi/10.1002/esp.1193/pdf

Gully erosion was related to breaching of a confining clay layer overlying a more permeable saprolite aquifer by roads and ditches.

3. **Larkin, R.G., and Sharp, J.M., Jr., 1992, On the relationship between river-basin geomorphology, aquifer hydraulics, and ground-water flow direction in alluvial aquifers: Geological Society of America Bulletin 104(12): 1608-1620.**

http://bulletin.geoscienceworld.org/cgi/content/abstract/104/12/1608

Alluvial aquifers in various locations throughout the United States were classified either as baseflow (groundwater flow perpendicular to the stream channel) or underflow (groundwater flow parallel to the stream). Factors important in determining the relative proportions of groundwater flowing toward the channel or down the axis of the valley included channel gradient, channel depth, and sinuosity.

4. **Nogueras, Pascual, Burjachs, Francesc, Gallart, Francesc, and Puigdefabregas, Joan, 2000, Recent gully erosion in the El Cautivo badlands (Tabernas, SE Spain): Catena 40:203-215.**

http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6VCG-40GJDN8-6&_user=4250274&_coverDate=06%2F15%2F2000&_rdoc=1&_fmt=high&_orig=search&_origin=search&_sort=d&_docanchor=&view=c&_searchStrId=1606478070&_rerunOrigin=google&_acct=C000052423&_version=1&_urlVersion=0&_userid=4250274&md5=9d689683506fd8a80fc5a68242a7b4d2&searchtype=a

This study infers a natural groundwater storage function for valley fills that remain uneroded by gullies. However, no data on this topic are presented.

5. **Rutherfurd, Ian, Hoang, Tam, Prosser, Ian, Abernethy, Bruce, and Jayasuriya, Nira, 1996, The impacts of gully networks on the time-to-peak and size of flood hydrographs, in: Hydrology and Water Resources Symposium 1996: Water and the Environment, Preprints of papers, p. 397-402.**

http://search.informit.com.au/documentSummary;dn=364553489879848;res=IELENG>ISBN:0858256495

Gully erosion of alluvial headwater valleys in Australia increased flood peaks by 12 to 20% and decreased time to peak by 20 to 24% for the 100-year and 1-year floods, respectively.

6. **Schilling, K.E., Zhang, Y.K., and Drobney, P., 2004, Water table fluctuations near an incised stream, Walnut Creek, Iowa: Journal of Hydrology 286(1-4), p. 236-248.**

http://www.sciencedirect.com

Stream incision of 3 m into an alluvial valley floor increased flood peaks and reduced the time between peak rainfall and streamflow. Groundwater storage was reduced. Hydraulic gradients toward the stream were increased.

7. **Shields, R.D., Jr., Knight, S.S., and Cooper, C.M., 1994, Effects of channel incision on baseflow stream habitats and fishes: Environmental Management 18(1):43-57.**

http://www.springerlink.com/content/l8ph1q731j370186/fulltext.pdf

An unincised reference stream had higher autumn baseflow than 3 incised streams in Mississippi.

G. Hydrologic functions of unincised headwater wetlands in other geographic areas

1. **Bullock, Andrew, 1992, Dambo hydrology in southern Africa—review and assessment: Journal of Hydrology 134(1-4):373-396.**

http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6V6C-48C7D50-5X&_user=4250274&_coverDate=06%2F30%2F1992&_rdoc=1&_fmt=high&_orig=search&_origin=search&_sort=d&_docanchor=&view=c&_searchStrId=1554706096&_rerunOrigin=google&_acct=C000052423&_version=1&_urlVersion=0&_userid=4250274&md5=dcf5d0f9a6c5ef3c757a37140c0055c9&searchtype=a

This article reviews published research on the hydrologic functions of dambos (small alluvial headwater wetlands in Africa), notes a lack of consensus of the effects of dambos on low flows, and proposes that dambos may reduce baseflows.

2. **Bullock, Andy, and Acreman, Mike, 2003, The role of wetlands in the hydrological cycle: Hydrology and Earth Systems Sciences 7(3):358-389.**

http://www.hydrol-earth-syst-sci.net/7/358/2003/hess-7-358-2003.html

This article reviews published information on the subject and classifies results based on types of wetlands worldwide. Most studies of wetland effects on baseflows showed decreases.

3. **Prosser, I.P., Chappell, John, and Gillespie, Richard, 1994, Holocene valley aggradation and gully erosion in headwater catchments, South-Eastern highlands of Australia: Earth Surface Processes and Landforms 19: 465-480.**

http://onlinelibrary.wiley.com/doi/10.1002/esp.3290190507/pdf

Swampy meadows were inferred to increase peak flows owing to greater proportions of saturated overland flow relative to valleys eroded by gullies. Effects of meadows or erosion on baseflows were not assessed.

4. **Smakhtin, V.U., and Batchelor, A.L., 2005, Evaluating wetland flow regulating functions using discharge time-series: Hydrological Processes 19:1293-1305.**

http://onlinelibrary.wiley.com/doi/10.1002/hyp.5555/pdf

Regional flow-duration curves and paired (upstream/downstream) streamgages were used to evaluate streamflow regulation in a large flood-plain wetland similar in South

Africa. The wetland had many similarities to alluvial meadows in the western U.S. The wetland was found to attenuate flood peaks and increase baseflows.

5. **Von der Heyden, C.J., 2004, The hydrology and hydrogeology of dambos: a review: Progress in Physical Geography 28(4):544-564.**

http://ppg.sagepub.com/content/28/4/544.abstract

This paper reviews available information on hydrology of dambos (small alluvial headwater wetlands in Africa) and describes the current lack of consensus on their hydrological functions, including maintenance of low flows.