Memorial to Waite R. Osterkamp 1939–2020

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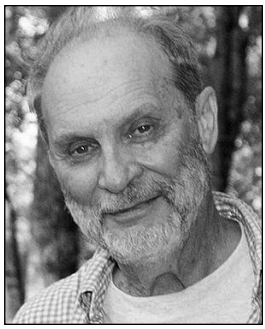

Waite R. Osterkamp, age eighty, of Tucson, Arizona, passed away on 8 March 2020. He and his wife, Linda Kautz, who passed away in 2017, are survived by Waite's son Jeffrey and wife Erica; daughter Laurel and husband Rich; Linda's son Andy and wife Lori; and Linda's daughter Becky and husband Adam. Waite and Linda's grandchildren are Jonathan, Elliot, Eli, Pauline, Theo, Kinzie, Hunter, and Aaron. Waite adored his dogs Pepper and Sophie; they were by his side when he died unexpectedly.

Waite was raised in Kirkwood, Missouri. Growing up, he and his family vacationed frequently in Colorado and the Rockies became his second home. Waite obtained two B.S. degrees, one in geology (1961) and the other in chemistry (1963), from the University of Colorado. As an undergraduate Waite began working for the U.S. Geological Survey (USGS) Water Resources Division (WRD) in Denver (1961–1966). After he graduated from the University of Colorado, he worked on water-quality studies in the USGS Montana District Office (1966–1968). He went on to earn his M.S. and Ph.D. degrees in geology and hydrology at the University of Arizona in 1970 and 1976, respectively. While in Tucson, he worked for the USGS Arizona District Office in WRD (1971–1974) and later moved to Lawrence, where he worked in the USGS Kansas District Office (1974–1980).

Waite joined the National Research Program (NRP) in USGS-WRD and served as project chief for sediment impacts from disturbed lands from 1980 until his retirement in 2010. His NRP duty stations spanned the eastern (Reston, Virginia), central (Lakewood, Colorado), and western (Tucson, Arizona) regions, and his USGS career spanned 44 and a half years. In 1991–1992 and 2002–2004, Waite served as research advisor for the geomorphology and sediment transport discipline in WRD. He held adjunct faculty appointments at the University of Denver, George Mason University, and the University of Arizona; he also served as visiting scientist at the U.S. Department of Agriculture Agricultural Research Service research facility in Tucson. In recognition of his many contributions, Waite was elected a Geological Society of America (GSA) Fellow in 1993; he was a member of GSA since 1967.

From 1968 to 1977, Waite's efforts were devoted mostly to groundwater studies in Montana and Arizona (Osterkamp, 1968, 1974). With his move to Kansas in the mid-1970s, his studies turned to evaluating sedimentation trends at stream gauge stations in the Arkansas River Basin. Waite's Ph.D. dissertation at the University of Arizona, supervised by Bill Bull, was entitled, "The Role of Sediment in Determining the Geometry of Alluvial Stream Channels." Waite used measurements of channel width at established streamflow gauging stations to develop a power-

function relation between width and mean annual discharge, indicating static allometric growth, for high-gradient perennial streams in the American West and Midwest. Used in a multiple-regression equation, this power function enabled estimation of discharge from ungauged basins. It also permitted prediction of short-term changes in channel morphology resulting from altered supplies of water or sediment. Waite's results were in close agreement with an earlier (1953) pioneering study by Luna Leopold and Thomas J. Maddock Jr. (U.S. Geological Survey Professional Paper 252). In 1977, Waite published these results with his USGS Kansas District colleague, Bob Hedman (Osterkamp and Hedman, 1977). For the next five years, Waite and his colleagues continued investigations of channel geometry, basin characteristics, mean annual discharge, and particle-size sediment data in both perennial and intermittent streams, mostly published in the USGS Publication Series.

By the early 1980s, Waite had become a card-carrying geomorphologist and began turning his attention to new frontiers, including the close intertwining of vegetation dynamics and geomorphic processes. In his first papers on this topic, Waite and his close NRP colleague Cliff Hupp collected geometry, sediment, and woody-vegetation data from bottomland geomorphic surfaces at valley sections along three gauged streams in northern Virginia, within an hour's drive from their offices at USGS National Headquarters in Reston (Osterkamp and Hupp, 1984; Hupp and Osterkamp, 1985). Each fluvial geomorphic landform (depositional bar, active-channel shelf and terrace) supported characteristic plant species, some nearly unique to a surface. Plant distributions on these fluvial landforms largely are controlled by flow frequency and intensity, Waite and Cliff argued, and could be used to identify different terraces and potential for flood damage.

Waite and Cliff next turned their attention to evidence of debris flows common along the glacially fed streams of the Mount Shasta volcano in northern California. These debris flows occurred frequently during the late Holocene in response to rapid runoff from melting snow and ice. Debris flows since ~1580 could be documented by studying trees damaged by or growing on debris flows. Waite and Cliff used tree-ring dating in conjunction with geomorphic evidence to estimate magnitude and frequency relations for debris flows that occurred during the last four centuries, an early application of 'dendrogeomorphology' (Osterkamp et al., 1986, 1987). For the following two decades, Waite published multiple papers on the interactions of vegetation and geomorphic processes (Hupp et al., 1996; Friedman et al., 1996a, 1996b, 1998; Osterkamp et al., 2006, 2012; Lenart et al., 2010; Osterkamp and Hupp, 2010). Over three decades, Waite and his colleagues had helped pioneer the field of 'biogeomorphology' (Hupp et al., 1996).

In the late 1980s, Waite forged a close collaboration with another NRP colleague in Reston, Warren Wood. Together they published two classic papers in *GSA Bulletin* about the formation of playas on the Southern High Plains of Texas and New Mexico (Osterkamp and Wood, 1987; Wood and Osterkamp, 1987). There have been various theories proposed to account for the origin and growth of these playa basins. Prior to Waite and Warren's work, the most popular theory involved deflation or wind erosion. They proposed a different mechanism, however, whereby water collecting in eolian and other depressions infiltrates and moves organic material into the unsaturated zone. Oxidation of the organic matter produces carbonic acid, forming carbonates and increasing permeability. Descending groundwater results in subsidence of near-surface beds, deepening and expanding basins radially. Despite the clay-rich soils of playa floors, Waite and Warren concluded that playas are a major source of focused recharge to the High Plains aquifer.

Waite's coauthored papers with Luna Leopold and Bill Emmett on the Vigil Network, illustrate his lifelong commitment to the long-term measurements of landscapes and the archiving of geomorphic data for future generations (Osterkamp et al., 1991). The Vigil Network is a system of small sites and drainage basins where geomorphic, hydrologic, and biological data are periodically collected (https://archive.usgs.gov/archive/sites/wwwpaztcn.wr.usgs.gov/vigil/). Waite

frequently promoted the concept of the Vigil Network, and it was he who changed the preservation of data from files in a dusty box maintained by the USGS library to an open-access digital database (Orr and Osterkamp, 1999).

In the latter stages of his career, Waite increasingly turned to the challenges of accelerated land use and erosion, diminishing water availability, increased urbanization, mining, and the potential threats posed by nuclear waste. With his University of Denver colleague Terry Toy, he published important studies on application of the Revised Universal Soil Loss Equation (RUSLE) and other erosion-prediction methods at hillslope to drainage-basin scales in the United States (Osterkamp and Toy, 1994, 1997; Toy and Osterkamp, 1999; Gonzales-Bonorino and Osterkamp, 2004). And for the San Juan Metropolitan Area in Puerto Rico, Waite assessed the environmental impacts of urbanization and mining, advocating that urban planners embrace a long-term, cause-and-effect perspective to avoid resource shortages and deficiencies in urban infrastructure (Osterkamp and Morton, 1996). As part of an overall site characterization for possible storage of high-level radioactive wastes at Yucca Mountain and the Nevada Test Site, Waite used a water-balance approach to calculate transmission losses of ephemeral streamflow and upland recharge resulting from extreme precipitation events in the Upper Amargosa Basin (Osterkamp et al., 1994).

In his activities abroad, Waite applied a similar water-balance approach to estimating groundwater recharge for ungauged basins of Oman and Abu Dhabi, United Arab Emirates, an area of groundwater overdraft (Osterkamp et al., 1995). In 2002, Waite and his USGS colleague John Gray visited what was then known as the Northwest Sci-Tech University for Agriculture and Forestry (NWSUAF) in Yangling, Shaanxi Province, China to establish the Sino-U.S. Centers for Soil and Water Conservation and Environmental Protection. Establishing the Sino-U.S. Centers culminated a two-year effort initiated by the NWSUAF, USDA-ARS, USGS, and University of Arizona. During their visit to China, Waite and John compared sediment aggradation problems along the Yellow River, where bed levels are rising a meter per decade, to two river basins in the United States experiencing similar aggradation problems.

Over his career, Waite served capably on a variety of advisory committees and panels. For example, he served as consultant for the Department of Justice and U.S. Fish and Wildlife Service in litigation for the adjudication of water along the Snake River, Idaho, where he had carefully studied the evolution of islands in the river channel (Osterkamp, 1998). And he served on the board of directors, and as vice president, for the Research Ranch Foundation of the Appleton-Whittell Research Ranch, a National Audubon Society facility in southern Arizona.

Our friend and colleague, Waite Osterkamp, was an excellent scientist and geomorphologist. He was also a gentleman in every sense of the word, gentle in disposition and a true gentleman in demeanor. Waite was an effective teacher; along with Bill Emmett and others, he was one of the instigators and instructors of the annual USGS fluvial training class at the Denver Federal Center through 2006. He was honest, straightforward, forgiving, and quick to laugh and smile. Waite was, above all, an exceptional collaborator, a man who loved nature and society, and a most wonderful friend.

SELECTED BIBLIOGRAPHY OF WAITE R. OSTERKAMP

**denotes Osterkamp was first author on a multi-authored paper*

1968 Occurrence of Ground Water in the Judith River Formation, North-Central Montana: U.S. Geological Survey Hydrologic Investigations Atlas HA-308.

1974 Map Showing Ground-Water Velocities in the Uppermost Saturated Alluvial Deposits of the Tucson Area, Arizona: U.S. Geological Survey Miscellaneous Geologic Investigations Map I-844-K.

1977* (with Hedman, E.R.) Variation of width and discharge for natural high-gradient stream channels: Water Resources Research, v. 13, p. 256–258, https://doi.org/10.1029/WR013i002p00256.
1984* (with Hupp, C.R.) Geomorphic and vegetative characteristics along three northern Virginia streams: Geological Society of America Bulletin, v. 95, p. 1093–1101, https://doi.org/10.1130/0016-7606(1984)95<1093:GAVCAT>2.0.CO;2.
1985 (with Hupp, C.R.) Bottomland vegetation distribution along Passage Creek, Virginia, in relation to fluvial landforms: Ecology, v. 66, p. 670–681, https://doi.org/10.2307/1940528.
1986* (with Hupp, C.R., and Blodgett, J.C.) Magnitude and Frequency of Debris Flows, and Areas of Hazard on Mount Shasta, Northern California: U.S. Geological Survey Professional Paper 1396-C, 21 p., 1 pl.
1987* (with Wood, W.W.) Playa-lake basins on the Southern High Plains of Texas and New Mexico: Part I. Hydrologic, geomorphic, and geologic evidence for their development: Geological Society of America Bulletin, v. 99, p. 215–223, https://doi.org/10.1130/0016-7606(1987)99<215:PBOTSH>2.0.CO;2.
1987 (with Wood, W.W.) Playa-lake basins on the Southern High Plains of Texas and New Mexico: Part II. A hydrologic model and mass-balance arguments for their development: Geological Society of America Bulletin, v. 99, p. 224–230, https://doi.org/10.1130/0016-7606(1987)99<224:PBOTSH>2.0.CO;2.
1987 (with Hupp, C.R., and Thornton, J.L.) Dendrogeomorphic Evidence and Dating of Debris Flows on Mount Shasta, Northern California: U.S. Geological Survey Professional Paper 1396-B, 39 p.
1987* (with Fenton, M.M., Gustavson, T.C., Hadley, R.F., Holliday, V.T., Morrison, R.B., and Toy, T.J.) Great Plains, *in* Graf, W.L., ed., Geomorphic Systems of North America: Boulder, Colorado, Geological Society of America, Centennial Special Volume 2, p. 163–210.
1991* (with Emmett, W.W., and Leopold, L.B.) The Vigil Network: A means of observing landscape change in drainage basins: International Association of Hydrological Sciences Journal, v. 36, p. 281–294.
1993 (with Toy, T.J., and Renard, K.G.) Prediction by regression and intra-range data scatter in surface-process studies: Environmental Geology, v. 22, p. 121–128, https://doi.org/10.1007/BF00789324.
1994* (with Toy, T.J.) The healing of disturbed hillslopes by gully gravure: Geological Society of America Bulletin, v. 106, p. 1233–1241, https://doi.org/10.1130/0016-7606(1994)106<1233:THODHB>2.3.CO;2.
1994* (with Lane, L.J., and Savard, C.S.) Recharge estimates using a geomorphic/distributed-parameter simulation approach, Amargosa River Basin: Water Resources Bulletin, v. 30, no. 3, p. 493–507, https://doi.org/10.1111/j.1752-1688.1994.tb03308.x.
1995 (with Toy, T.J.) The applicability of RUSLE to geomorphic studies: Journal of Soil and Water Conservation, v. 50, p. 498–503.
1995* (with Lane, L.J., and Menges, C.M.) Techniques of ground-water recharge estimates in arid/semiarid areas, with examples from Abu Dhabi: Journal of Arid Environments, v. 31, p. 349–369, https://doi.org/10.1016/S0140-1963(05)80038-2.
1996 (with Hupp, C.R.) Riparian vegetation and fluvial geomorphic processes: Geomorphology, v. 14, p. 277–295, https://doi.org/10.1016/0169-555X(95)00042-4.
1996 (editors) (with Hupp, C.R., and Howard, A.D.) Biogeomorphology, Terrestrial and Freshwater Systems: Amsterdam, Elsevier, 347 p.
1996* (with Morton, R.A.) Environmental impacts of urbanization and mining: An international project on global change: GSA Today, v. 6, p. 14–15, 26.

1996a (with Friedman, J.M., and Lewis, W.M., Jr.) The role of vegetation and bed-level fluctuations in the process of channel narrowing: Geomorphology, v. 14, p. 341–351.
1996b (with Friedman, J.M., and Lewis, W.M., Jr.) Channel narrowing and vegetation development following a Great Plains flood: Ecology, v. 77, p. 2167–2181.
1997* (with Morton, R.A.) Global impacts of mining and urbanization on fluvial and coastal systems—The San Juan case study: GSA Today, v. 7, p. 13–15.
1997* (with Toy, T.J.) Geomorphic considerations for erosion prediction: Environmental Geology, v. 29, p. 152–157, https://doi.org/10.1007/s002540050113.
1998 Processes of fluvial-island formation, with examples from Plum Creek, Colorado, and Snake River, Idaho: Wetlands, v. 18, p. 530–545, https://doi.org/10.1007/BF03161670.
1998 (with Friedman, J.M., Scott, M.L., and Auble, G.T.) Downstream effects of dams: Regional patterns in the Great Plains: Wetlands, v. 18, p. 619–633, https://doi.org/10.1007/BF03161677.
1999 (with Orr, T.) Vigil Network data now online: Eos (Transactions, American Geophysical Union), v. 80, p. 346, https://doi.org/10.1029/EO080i031p00346-01.
1999 (with Toy, T.J.) The stability of rock-veneered hillslopes: International Journal of Sediment Research, v. 14, p. 63–73.
2000* (with Friedman, J.M.) The disparity between extreme rainfall events and rare floods—With emphasis on the semiarid American West: Hydrological Processes, v. 14, p. 2817–2829, https://doi.org/10.1002/1099-1085(200011/12)14:16/17<2817::AID-HYP121>3.0.CO;2-B.
2003 (with Gray, J.R., Christiansen, S., and Sprigg, W.A.) Formation of the Sino-U.S. Centers for Soil and Water Conservation and Environmental Protection: International Journal of Sediment Research Special Issue on Sediment Transport and Environmental Studies, v. 18, p. 248–252.
2004 (with Gonzales-Bonorino, G.) Applying RUSLE 2.0 on burned forest lands—An appraisal: Journal of Soil and Water Conservation, v. 59, p. 36–42.
2006* (with Toy, T.J., and Lenart, M.T.) Development of partial rock veneers by root throw in a subalpine setting: Earth Surface Processes and Landforms, v. 31, p. 1–14, https://doi.org/10.1002/esp.1222.
2010* (with Hupp, C.R.) Fluvial processes and vegetation—Glimpses of the past, the present, and perhaps the future: Geomorphology, v. 116, p. 274–285, https://doi.org/10.1016/j.geomorph.2009.11.018.
2010 (with Lenart, M.T., Falk, D.A., and Scatena, F.N.) Estimating soil turnover rate from tree uprooting during hurricanes in Puerto Rico: Forest Ecology and Management, v. 259, p. 1076–1084, https://doi.org/10.1016/j.foreco.2009.12.014.
2012* (Hupp, C.R., and Stoffel, M.) The interactions between vegetation and erosion: New directions for research at the interface of ecology and geomorphology: Earth Surface Processes and Landforms, v. 37, p. 23–36, https://doi.org/10.1002/esp.2173.