Jim Shuttleworth's major research interests are in physical processes in hydrology, with emphasis on evaporation and hydrometerology as applied to environment change at local, regional. and gloal scales, the application of remote sensing methods within hydrology, improving weather and climate prediction, and the micrometerology of natural and agricultural vegetation, including improving estimates of irrigated crop water requirements. Dr.Shuttleworth, who is a Regents' Professor in both the Department of Hydrology and Water Resources and the Atmospheric Sciences Department at the University of Arizona, has served on numerous national and international scientific advisory committees, including the National Research Council, the International Council of Scientific Unions, the international Hydrology Programme, the International Geosphere-Biosphere Programme, and the World Climate Research Programme. He is a Fellow of American Geophysical Union, the American Meteorological Society, and Royal Meteorological Society and is a lifetime member of the British Hydrological Society and the European Geophysical Society. Dr. Shuttlleworth holds a Ph.D. in High Energy Nuclear Physics and a D.Sc. from Manchester University in the UK. In 2001 Dr. Shuttleworth was awared the AGU Hydrology Prize for "Outstanding contributions to the science of hydrology" and in 2006 IAHS, UNESCO and WMO jointly awarded Dr. Shuttleworth the prestigious International Hydrology Prize in recognition of his "innovative, international leadership over more than thirty years, contributing to the growth of hydrology into a major discipline of earth system science."

Back to Basics: On relating pan to reference crop evaporation rates

W. James Shuttleworth

A critical reappraisal is made of currently recommended methods for estimating the water requirements of irrigated crops in light of present-day knowledge of the evapotranspiration (ET) process for vegetation covered surfaces and for evaporation pans. There is a fundamental theoretical inconsistency between current understanding of the interaction between plant canopies and the atmosphere as represented by the Penman-Monteith (P-M) equation, and the procedures for estimating plant water requirements currently recommended by FAO. In the P-M equation stomatal and aerodynamic controls on the transfer processes are expressed in terms of resistances which are embedded among the meteorological controls with crop-to-crop differences expressed in terms of different values for these resistances. However, the current procedure recommended by FAO for estimating crop water represents crop-to-crop differences as simple multiplicative crop factor applied to an estimated evaporation rate calculated by the P-M Equation for a single reference crop with fixed surface resistance and aerodynamic characteristics. Recent theoretical developments that allow adoption of the more robust P-M equation description of ET for all irrigated crops are reviewed along with the example application of this new approach to estimate the water requirements in the major irrigation districts of Australia. Broader adoption into irrigation practice of this method which is known as the Matt Shuttleworth approach is recommended on the grounds that it is consistent with present day understanding of the evaporation process, is feasible and simple to apply, and will facilitate future adoption of realistic representations of the effect on evapotranspiration of plant stress and of crops with partial ground cover. However, when not all the weather variables needed to calculate crop evaporation rates are available, an estimate of reference crop evaporation may still have to be made by scaling down the measured evaporation loss from an evaporation pan by a “pan factor”. In the past the value of this pan factor has been defined empirically but recent research into the physics which controls evaporation from the Class A evaporation pan has resulted in a physically-based equation that describes pan evaporation in terms of ambient climate variables. This equation, which has been verified experimentally, allow a formal definition of the pan factor that is used to investigate theoretically how ancillary measurements (or estimates) of temperature and wind speed at an evaporation pan site might be used to improve the accuracy of a pan-based estimate of reference crop evaporation.