

ANDREW J DRAPER

Nationality	Joint British/American
Year of Birth	1957
Profession	Civil Engineer
Specialization	Water Resources

KEY QUALIFICATIONS

Dr Draper has over 25 years experience in water resources engineering, and reservoir operations modeling. He has a background in irrigated agricultural development and has undertaken feasibility studies, detailed design, construction supervision and management of irrigation projects in both the Middle East and Africa. Dr Draper has specialized in the use of simulation and optimization models for the planning, operation, and management of water resources systems. He was one of the principal authors of the CALVIN model, an economic-driven optimization model of California's statewide inter-linked water system that was developed at University of California, Davis for California's Resources Agency. Working for the California Department of Water Resources, Dr Draper worked on the development and application of the CalSim modeling software, which simulates operation of over 20 reservoirs statewide, and allocates over 20 million acre-feet of water to meet urban, agricultural and environmental demands. Dr Draper has lectured at University of California, Davis, on engineering optimization and operations research.

EDUCATION AND PROFESSIONAL STATUS

BA (Hnrs), General Engineering, University of Cambridge, UK, 1978
MSc, Irrigation Engineering, University of Southampton, UK, 1985
PhD, Water Resources, University of California, Davis, 2001

Professional Engineer, California, 2002
Member of the Institution of Civil Engineers, UK, 1983

EMPLOYMENT RECORD

2003 - to date	MONTGOMERY WATSON HARZA, USA
2001 - 2003	CALIFORNIA DEPARTMENT OF WATER RESOURCES, USA
1995 - 2000	UNIVERSITY OF CALIFORNIA AT DAVIS, USA
1996 - 1999	RESOURCE MANAGEMENT INTERNATIONAL, USA
1986 - 1995	MOTT MACDONALD GROUP, formerly Sir M. MacDonald & Partners , UK
1984 - 1986	HR, WALLINGFORD, formerly Hydraulics Research, UK
1981 - 1983	BINNIE BLACK AND VETCH, formerly Binnie & Partners, UK
1978 - 1980	TAYLOR WOODROW INTERNATIONAL, UK

EXPERIENCE RECORD

2003 to date **MONTGOMERY WATSON HARZA**
 Principal Engineer, Water Resources, USA

Technical support to various water projects in California, relating to water resources evaluation, construction of new storage, management of existing storage, licensing of hydropower facilities, and environmental compliance. Supervised project related hydrologic, hydrodynamic, water quality and water temperature analysis.

2006 **CalSim III Hydrology Development**

Development of hydrologic model for California's Sacramento Valley to simulate agricultural water use, rainfall-runoff, stream-aquifer interaction, and groundwater response to pumping and recharge.

2006 **Los Vaqueros Expansion Studies**

Yield analysis and engineering feasibility design of 500,000 acre-feet off-stream reservoir.

2006 **Lower Yuba River Accord**

Analysis of reservoir operations and conjunctive use of groundwater to support instream flows and water transfer program.

2005 **Oroville Facilities Relicensing Project**

Modified the CalSim II model to improve the representation of the Feather River below Oroville dam. Modifications included adjustments to contract demands along the Feather River, and development of water demands for rice straw decomposition.

2005 **Sacramento River Water Reliability Study**

Dr Draper provided review and quality control for modeling associated with the Sacramento River Water Reliability Study. The goal of the study is to develop a water supply plan that is consistent with the Sacramento Area Water Forum vision of a sustainable water supply to meet planned development in the Sacramento Region while promoting the Lower American River ecosystem.

2005 **City of Stockton Delta Water Supply Project**

Analysis of reservoir water supplies and urban water demands for the City of Stockton. Analysis included hydrologic modeling, hydrodynamic modeling of Sacramento-San Joaquin Delta, and water quality modeling.

2004 **San Luis Low-Point Improvement Project**

Reservoir operation analysis for 2.2 million acre-feet off-stream reservoir for agricultural and urban water supply.

2004 **CALSIM II Development Plan**

Developed strategic plan for development of water resources planning tools for the California Department of Water Resources

2001 to 2003 **CALIFORNIA DEPARTMENT OF WATER RESOURCES, SACRAMENTO**
Senior Engineer, Water Resources, USA

The California Department of Water Resources and the US Bureau of Reclamation jointly developed a generalized water resources simulation model (CalSim) for evaluating operational alternatives of large, complex river basins. Responsible for development of the CalSim model and its application in planning studies for the State Water Project and Central Valley Project – a system with a combined storage capacity of 18 Gm³ delivering over 16 Gm³/yr. Also responsible for development of projections of future water supplies, stream flows, and agricultural and urban demands for California's Central Valley.

1995 to date **UNIVERSITY OF CALIFORNIA at DAVIS**
Post Graduate Researcher, USA

Doctorate in water resources and natural resource economics. Ph.D. thesis on multi-reservoir operation using optimization (linear programming).

1998-2000 **Analysis of Finance Options for California's Water Supply,**
funded by the State of California Resources Agency

Study to investigate the economic impact of introducing a regulated water market in the State of California. Developed a state-wide optimization model for California's interconnected water supply system. The model represented 49 major surface water reservoirs and 26 groundwater basins. Based on a 72-year historical record, the model determined water allocations to maximize economic return to water. The economic value (shadow price) of proposed water storage and conveyance facilities was calculated. As part of the study, determined the economic benefits of new storage facilities, and conjunctive use of groundwater.

1996-1997 **Environmental and Agricultural Economic Tradeoffs in the Upper Klamath Basin,**
funded by US Department of Agriculture

Water management study in the Upper Klamath Basin in the states of California and Oregon. The study aimed to quantify economic impacts to agriculture and impacts to wildlife refuges of reduced water allocations in order to satisfy in-stream environmental demands. Developed a Geographic Information System (GIS) for data collection, storage and analysis, and developed a canal operations model for water supply analysis.

1996-1999 **RESOURCE MANAGEMENT INTERNATIONAL**
Irrigation Management Specialist

1996, '97, '99 **Tadla Irrigation Project, Morocco**
funded by USAID

Reviewed operation and management of canal system for a major irrigation project supplying water to 30,000 farmers. Undertook assessment of surface water resources. Recommended changes in canal operation and water scheduling practices. Designed database software and graphical user interface to help plan annual water allocations and subsequent scheduling and monitoring of irrigation deliveries. Undertook non-steady state analysis of canal operations.

1986 - 1995 **MOTT MACDONALD GROUP (formerly Sir M. MacDonald & Partners)**
Project Engineer/Senior Irrigation Engineer

1994 - 1995 **Kpong Irrigation Project, Ghana, Phase III- Construction,
funded by African Development Bank**

ed-out hydraulic and structural analysis for the inlet works and spillway for a 30 m high earthfill dam in seismic zone. Supervised hydraulic model studies of the proposed design.

1981 - 1983 **Greater Mussayib Project, Iraq
Phase I Feasibility, Phase II - Detailed Design
funded by Iraqi Government**

Feasibility study for the rehabilitation of a 90,000 ha (215,000 acre) irrigation scheme. Undertook review Head of on-site design office responsible for production of construction drawings, including general layout drawings for canal network, night storage reservoirs, hydraulic structures, reinforcement drawings and mechanical gate details.

1990 - 1994 **Bas Cheliff Irrigation Rehabilitation Project,Algeria
Phase I: Field Surveys, Phase II: Feasibility, Phase III: Detailed Design
funded by the World Bank**

The Bas Cheliff study, comprised the rehabilitation of an existing irrigation and drainage system serving 4,000 ha (9,600 acres) and the development of extensions covering 10,000 ha (24,000 acres). Responsible for all engineering studies. Undertook assessment of the existing irrigation infrastructure and completed a review of its operation by the local irrigation authority. Collected and analyzed meteorological data and calculated crop and project water requirements.

Reviewed water master plan for the Cheliff Valley. Constructed a multi-reservoir simulation model for the project and used non-linear programming techniques to determine optimal levels of agricultural development for different levels of reliability and operating rules for three independent surface water resources. Carried-out economic and financial analysis of water supply options from a recently constructed dam. Compared pumping costs with the value of hydro-electric power generation and capital, annual, and recurrent costs. As a result of economic analysis, current construction of a hydro-electric facility was abandoned.

Undertook feasibility-level engineering design for different development alternatives followed by a full economic analysis for project funding.

Head of design team responsible for the design and preparation of tender documents for irrigation and drainage works covering 9,000 ha. The design comprised major flood control works, open canal and low-pressure pipe distribution systems, irrigation pumping stations, surface drainage and ground water drainage for salinity control.

1989 **Goulmina-Errachidia-Boudenib and Fez-Meknes Groundwater Project, Morocco
funded by the World Bank**

Developed data for a groundwater management model to assist in the development and optimum use of groundwater in two different regions in Morocco. Work included the assessment of existing and future crop water requirements and the likely impact of surface water shortages.

1987 - 1989 **Kpong Irrigation Project, Ghana
Phase I: Feasibility, Phase II: Detailed Design
funded by the African Development Bank**

Team member for feasibility study of 3,000 ha (7,200 acre) irrigated rice development comprising a mixture of rehabilitation and new works. Undertook all field investigations. Carried-out hydrologic

analysis required for flood protection works and calculated irrigation water demands. Produced preliminary engineering designs and cost estimates.

Team leader for the detailed design and preparation of tender documents for all irrigation and drainage works, associated buildings and infrastructure and procurement contracts. Wrote project preparation report for project funding.

1987 **Dara Salaam Busley Agricultural Development Project,
funded by the European Community**

Rural development study including the improvement of 3,500 ha (8,400 acre) of flood irrigation on the left bank of the Shebelle River. By means of village interviews and land surveys, identified areas that were most suitable for capital investment and recommended improvement measures. Produced designs and tender documents for hydraulic structures, surfaced roads and open wells for water supply.

1986 **Metahara Sugar Estate Extension, Ethiopia
funded by Ethiopian Government**

Led team in Ethiopia responsible for the design of a 1,250 ha (3,000 acre) extension to sugar estate in the Awash Valley. Work included review of river basin master plan, assessment of surface water resources, flood control and water quality issues associated with drainage return flows. Tender drawings, documents and cost estimates were produced for canal network and associated hydraulic structures.

1984 - 1986 **HR, WALLINGFORD (formerly Hydraulics Research)
Research Scientist**

1984 - 1986 **Mushandike Irrigation Scheme, Zimbabwe
funded by UK Overseas Development Aid**

Devised and implemented a research project for the control of schistosomiasis on small-scale irrigation schemes. Designed conversion of 600 ha (1,500 acre) of commercial farms into smallholdings (0.5 ha plots). Working with local counterpart engineers produced designs for the rehabilitation of the canal system, night storage reservoirs, watercourses, hydraulic structures, field drains and access roads. Supervised the construction of the initial 100 ha using direct labor.

1983 - 1984 **INSTITUTE OF IRRIGATION STUDIES
UNIVERSITY OF SOUTHAMPTON, UK**

Completed a Master's degree in irrigation engineering. Developed a finite-difference groundwater model to investigate the influence of groundwater pumping on adjacent stream flow.

1981 - 1983 **BINNIE, BLACK & VETCH (formerly Binnie & Partners)**
Design Engineer

1983 **Mantaro Water Transfer Scheme, Peru**

Carriof canal and drainage infrastructure. Produced engineering designs for new distribution canals, hydraulic structures and drainage works and estimated remodeling costs. Supervised land surveys and geotechnical investigations. Produced detailed designs and drawings for 19,000 ha center-pivot irrigation scheme, including civil and mechanical design of 1.7 m³/s high-pressure pumping station and hydraulic design of pipe network.

1978 - 1980 **TAYLOR WOODROW INTERNATIONAL**
Civil Engineer, Ghana, Bahrain, UK

Managed construction work for various large civil engineering projects.

RECENT PUBLICATIONS

Draper, A. J., A. Munévar, S. Arora, E. Reyes, N. Parker, F. Chung, and L. Peterson (2004). "CalSim: A generalized model for reservoir system analysis." *Journal of Water Resources Planning and Management*, ASCE, Vol. 130, No. 6, pp. 480-489.

Draper, A. J., M. W. Jenkins, K. W. Kirby, J. R. Lund, and R. E. Howitt (2003). "Economic-engineering optimization for California Water Management." *Journal of Water Resources Planning and Management*, ASCE, Vol. 129, No. 3, pp. 155-164.

Draper, A. J. and J. R. Lund (2004). "Optimal Hedging and Carryover Storage Value." *Journal of Water Resources Planning and Management*, ASCE, Vol. 130, No. 1, pp. 83-87.

Jenkins, M. W., J. R. Lund, R. E. Howitt, A. J. Draper, S. M. Msangi, S. K. Tanaka, R. S. Ritzema, and G. F. Marques (2004). "Optimization of California's water Supply system: Results and Insights." *Journal of Water Resources Planning and Management*, ASCE, Vol. 130, No. 4, pp. 271-280.