Análisis de Sistemas de Recursos Hídricos: Herramientas para la toma de decisiones en torno al agua

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Desafíos de gestión del agua

FALTA DE AGUA (ESCASEZ)

EXCESO DE AGUA (INUNDACIONES)

MALA CALIDAD (CONTAMINACIÓN)

DAÑO A ECOSISTEMAS

Múltiples usos del agua

EXTRACTIVOS

- Agua potable
- Riego
- Generación hidroeléctrica
- Industria
- Minería

IN SITU

- Navegación
- Recreación
- Preservación escénica
- Preservación flora y fauna
- Evacuación y dilución de aguas residuales

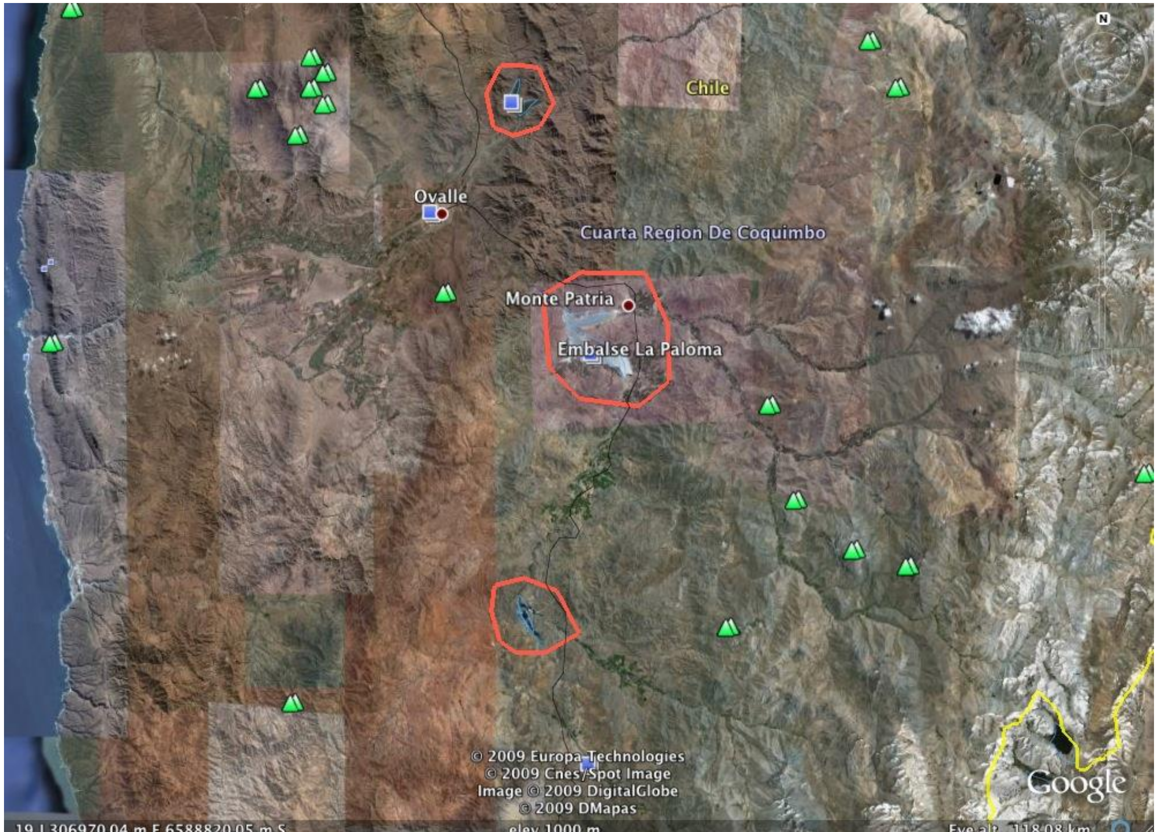
¿Qué es Análisis de Sistemas de Recursos Hídricos?

Estudio de los sistemas de recursos hídricos usando ***representaciones matemáticas*** *de los procesos e interacciones del sistema para mejorar el entendimiento o* ***apoyar la toma de decisiones*** *(Loucks et al., 1981, Loucks & van Beek, 2005)*

Conjunto de técnicas matemáticas para la ***planificación y diseño*** *de sistemas de recursos hídricos, que involucran algún tipo de* ***optimización****. (Rogers & Fiering, 1986)*

Sistemas de Recursos Hídricos

- Físico (natural y construido)
- Socioeconómico (Actividades productivas, etc)
- Administrativo e Institucional (Derechos de agua, organizaciones de usuarios)



Orígenes del ASRH (Harvard Water Program)

WATER RESOURCES RESEARCH, VOL. 22, NO. 9, PAGES 146S–158S, AUGUST 1986

Use of Systems Analysis in Water Management

PETER P. ROGERS AND MYRON B FIERING

Harvard University, Cambridge, Massachusetts

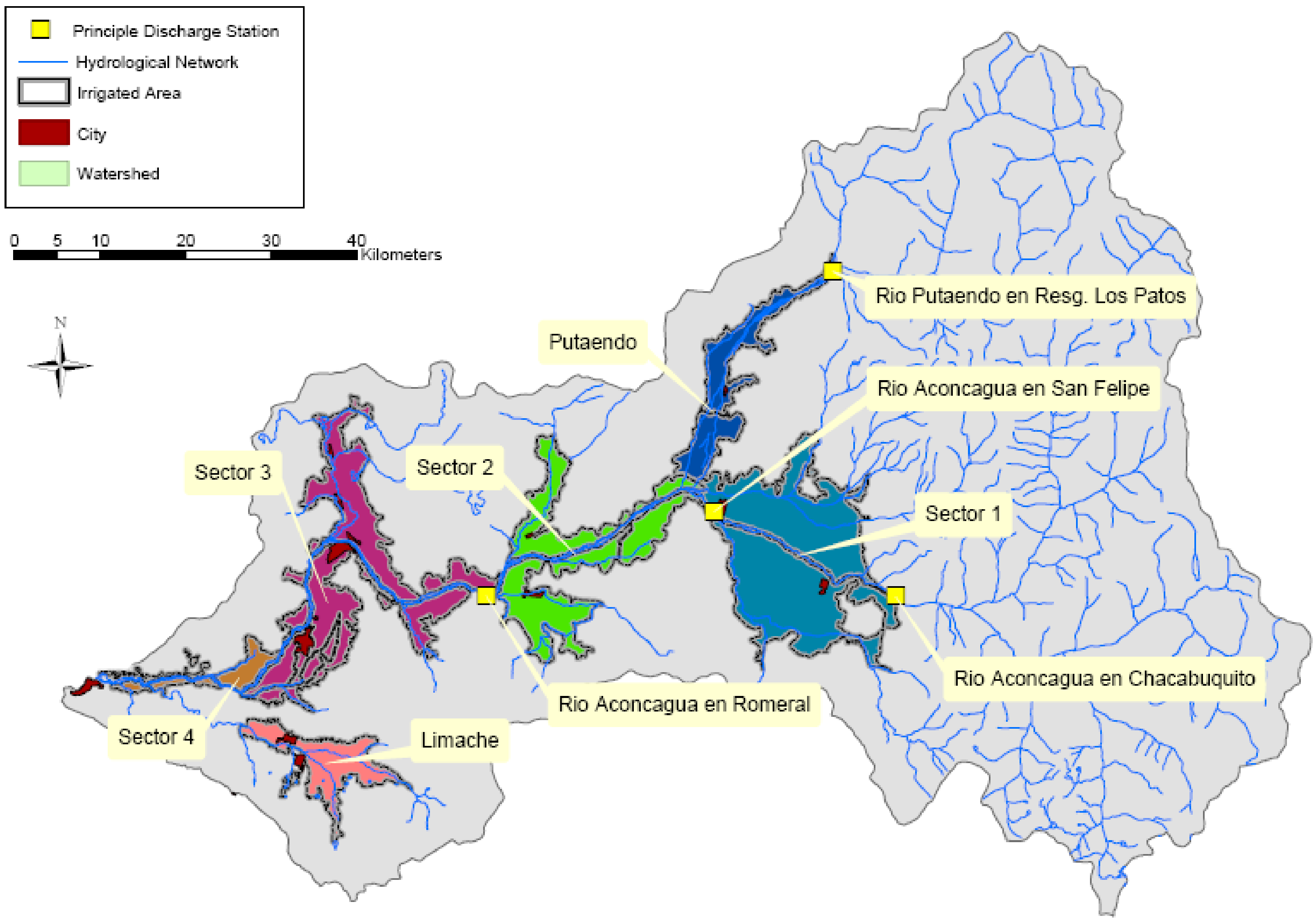
Over the past 30 years systems analysis applied to the planning and operation of water resource systems has grown from a mathematical curiosity to a major specialty. We define systems analysis as that set of mathematical planning and design techniques which includes at least some formal optimization procedure. Based on the increasingly large number of systems-oriented papers which appear in the civil engineering literature, it is not unreasonable to expect that the use of one or another optimization technique would have been undertaken in a significant number of completed projects and described in the literature; this turns out not to be the case. Moreover, U.S. federal agencies and major consultants do not appear to use these techniques in any but a handful of projects. We offer several explanations for this, including institutional resistance to use of the techniques, deficiencies in data bases, inadequacies in modeling, and the fundamental insensitivity of many systems (not merely the models thereof) to wide variations in design choices. We explore the differences between application in developed and developing countries.

Enfoque de sistemas requiere:

- **Objetivos** razonablemente bien definidos (Económico, social, ambiental)
- **Tomadores de decisión** bien identificados
- Varias **decisiones alternativas**. (Estructurales y no estructurales). Mejor decisión no obvia.
- E**valuar efecto** de decisiones sobre objetivos (uso de modelos)

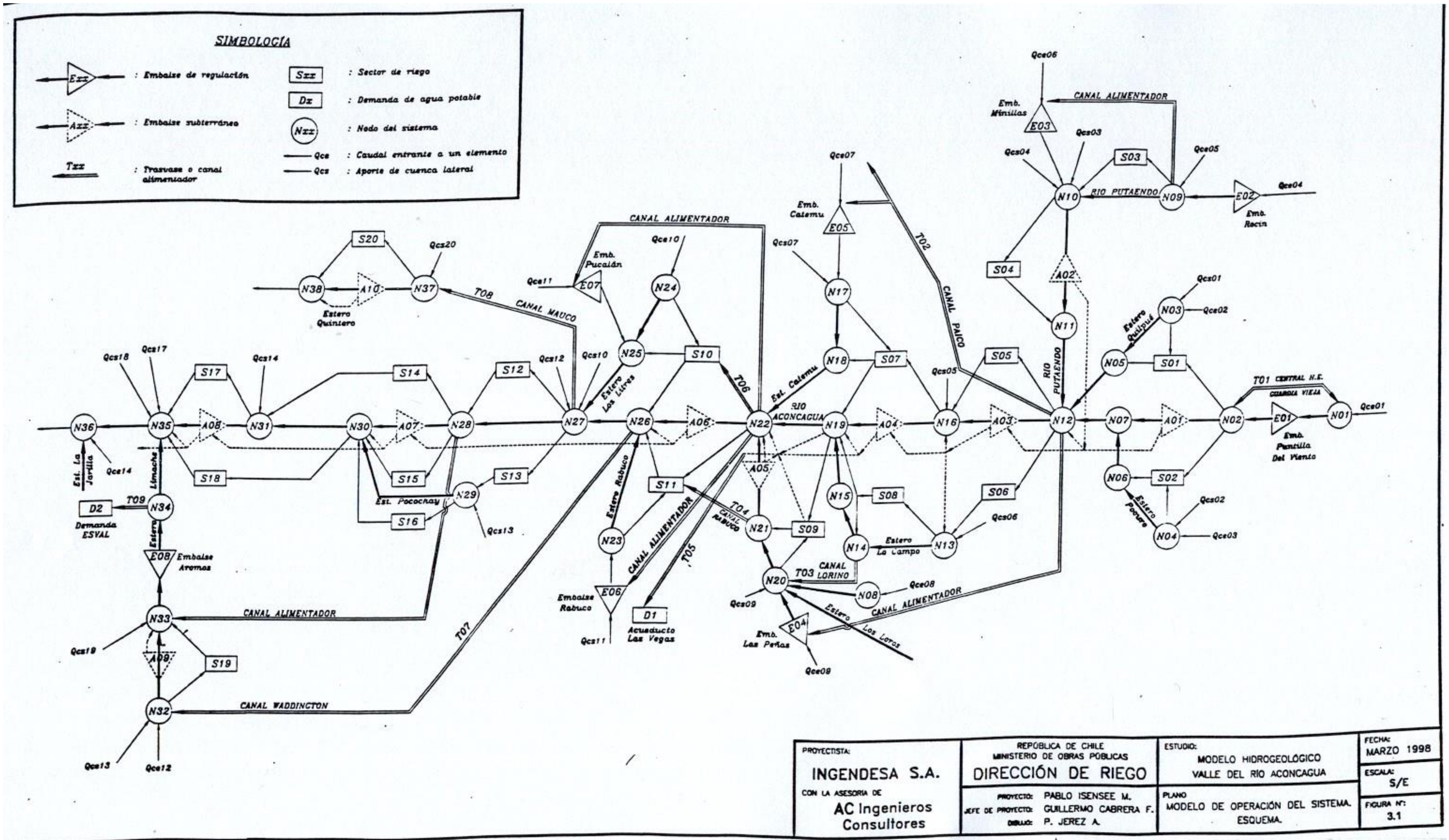
Modelo de un SRH

Cuenca rio Aconcagua



Modelo de un SRH

Cuenca rio Aconcagua



Modelos matemáticos como herramienta de gestión del agua

Representación simplificada y seleccionada de un sistema real a través de **variables** y **ecuaciones.**

"Essentially, all models are wrong, but some are useful."

(Box, George E. P.; Norman R. Draper (1987). Empirical Model-Building and Response Surfaces. Wiley. pp. p. 424.)

Modelos matemáticos como herramienta de gestión del agua

- Modelos de **simulación** (¿Qué pasa si…?)

*¿Cómo aumenta la seguridad de riego si se contruye un nuevo embalse **de cierta capacidad** y se opera con una **regla de operación dada**?*

- Modelo de **optimización** (¿Cuál es la mejor opción?)

*¿Cuál es la **capacidad y operación óptima** de un nuevo embalse para **maximizar la seguridad de riego**?*

Modelos hidroeconómicos incluyen:

- Representación desagregada de sistemas de recursos hídricos
- Infraestructura
- Alternativas de gestión
- Valoración económica

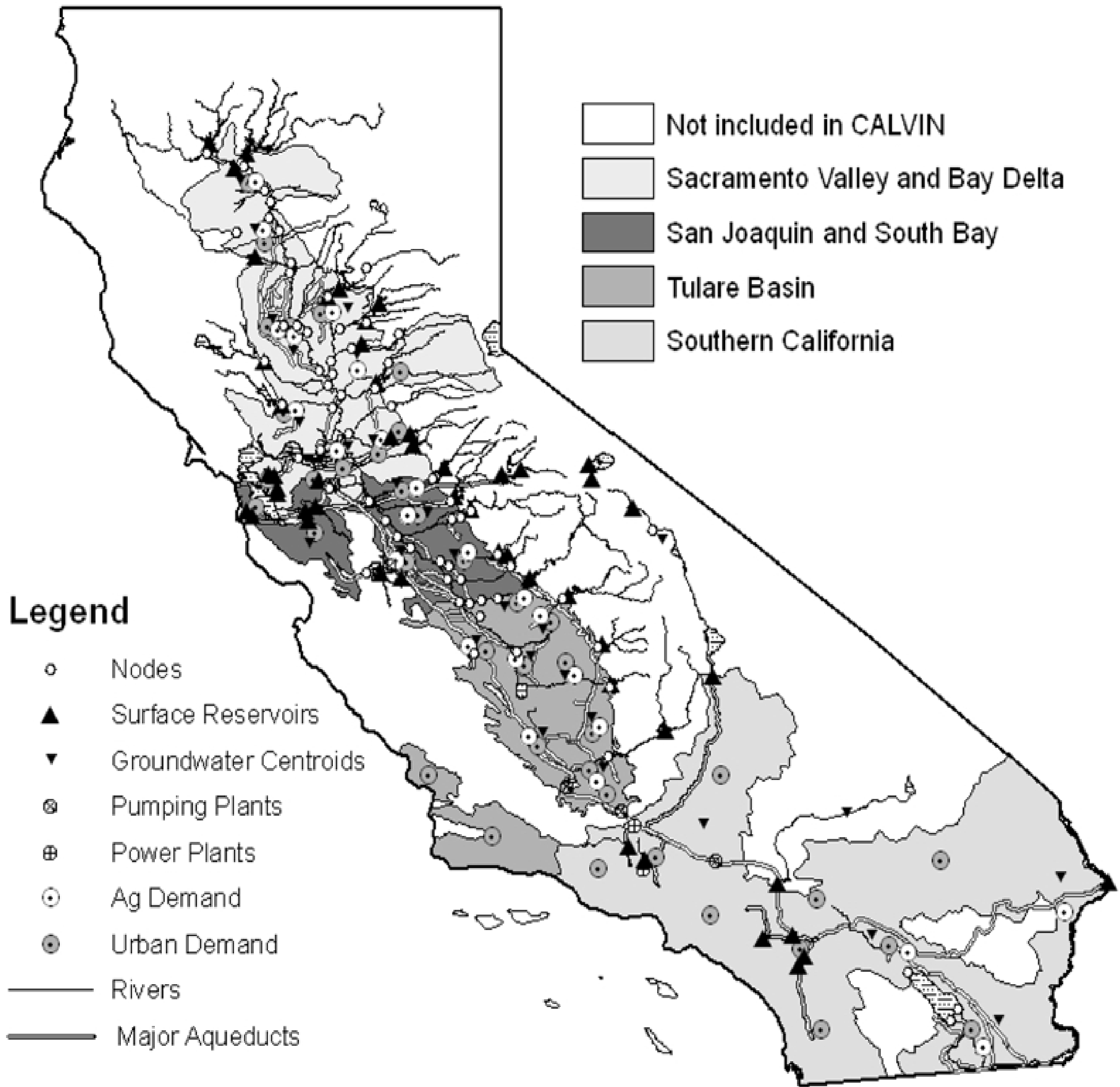
"*Los modelos hidroeconómicos representan los aspectos hidrológicos, ingenieriles, ambientales y económicos de sistemas de recursos hídricos de gran escala*" (Harou et al. 2009)

ASRH en California (U. of California Davis)

Modelo de optimización hidroeconómico

CALVIN

(California Value Integrated Network)



ASRH en California (UC Davis)

COMPARING FUTURES
FOR THE SACRAMENTO–SAN JOAQUIN DELTA

JAY LUND | ELLEN HANAK | WILLIAM FLEENOR
WILLIAM BENNETT | RICHARD HOWITT
JEFFREY MOUNT | PETER MOYLE

2008

Supported with funding from
Stephen D. Bechtel Jr. and the David and Lucile Packard Foundation

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Managing California's Water
From Conflict to Reconciliation

Ellen Hanak · Jay Lund · Ariel Dinar
Brian Gray · Richard Howitt · Jeffrey Mount
Peter Moyle · Barton "Buzz" Thompson

ASRH en California (UC Davis)

WATER RESOURCES RESEARCH, VOL. 46, W05522, doi:10.1029/2008WR007681, 2010

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Economic consequences of optimized water management for a prolonged, severe drought in California

Julien J. Harou,[1] Josué Medellín-Azuara,[2] Tingju Zhu,[3] Stacy K. Tanaka,[4] Ja
Scott Stine,[5] Marcelo A. Olivares,[6] and Marion W. Jenkins[2]

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DOI 10.1007/s10584-007-9355-z

Adaptability and adaptations of California's water supply system to dry climate warming

Josué Medellín-Azuara · Julien J. Harou · Marcelo A. Olivares · Kaveh Madani · Jay R. Lund · Richard E. Howitt · Stacy K. Tanaka · Marion W. Jenkins · Tingju Zhu

Journal of Environmental Management 136 (2014) 121–13

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ELSEVIER

Optimizing the dammed: Water supply losses and fish habitat gains from dam removal in California

CrossMark

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Ejemplo uso de modelos de optimización en Chile: Operación del SIC

- **Objetivo**: Satisfacer la demanda a costo mínimo
- **Decisiones**: Generación horaria de cada central (hidro, térmica, ERNC) del sistema.

Futuro del ASRH

Water Resources Research

RESEARCH ARTICLE

10.1002/2015WR017114

Special Section:
The 50th Anniversary of Water Resources Research

The future of water resources systems analysis: Toward a scientific framework for sustainable water management

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Key Points:
- WRSA evolved from a prescriptive science to science of water resources systems
- WRSA has long focused on the water-related variables that are important to society
- WRSA should adopt a scientific initiative based on the prediction of water resources variables

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Abstract This paper presents a short history of water resources systems analysis from its beginnings in the Harvard Water Program, through its continuing evolution toward a general field of water resources systems science. Current systems analysis practice is widespread and addresses the most challenging water issues of our times, including water scarcity and drought, climate change, providing water for food and energy production, decision making amid competing objectives, and bringing economic incentives to bear on water use. The emergence of public recognition and concern for the state of water resources provides an opportune moment for the field to reorient to meet the complex, interdependent, interdisciplinary, and global nature of today's water challenges. At present, water resources systems analysis is limited by low scientific and academic visibility relative to its influence in practice and bridled by localized findings that are difficult to generalize. The evident success of water resource systems analysis in practice (which is set out in this paper) needs in future to be strengthened by substantiating the field as the science of water resources that seeks to predict the water resources variables and outcomes that are important to governments, industries, and the public the world over. Doing so promotes the scientific credibility of the field, provides understanding of the state of water resources and furnishes the basis for predicting the impacts of our water choices.

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