

DEVELOPMENTS IN WATER SCIENCE

1

G. BUGLIARELLO AND F.J. GUNTHER

COMPUTER SYSTEMS AND WATER RESOURCES

ELSEVIER

COMPUTER SYSTEMS AND WATER RESOURCES

DEVELOPMENTS IN WATER SCIENCE

advisory editor

VEN TE CHOW

Professor of Civil Engineering

Hydrosystems Laboratory

Civil Engineering Building

University of Illinois

Urbana, Ill., U.S.A.

This book is produced by a photographic off-set process directly from the manuscript submitted by the authors. Thus, the authors themselves are responsible for any errors appearing in the book.

DEVELOPMENTS IN WATER SCIENCE

1

COMPUTER SYSTEMS and WATER RESOURCES

by

GEORGE BUGLIARELLO

President, Polytechnic Institute of New York

and

FRED GUNTHER

Research Assistant, University of Illinois at Chicago Circle



ELSEVIER SCIENTIFIC PUBLISHING COMPANY

AMSTERDAM — OXFORD — NEW YORK — 1974

ELSEVIER SCIENTIFIC PUBLISHING COMPANY

335 Jan van Galenstraat

P.O. Box 211, Amsterdam, The Netherlands

AMERICAN ELSEVIER PUBLISHING COMPANY, INC.

52 Vanderbilt Avenue

New York, New York 10017

Library of Congress Card Number: 74-83312

ISBN: 0-444-41259-X

Copyright © 1974 by Elsevier Scientific Publishing Company, Amsterdam

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted in any form or by any means, electronic, mechanical, photocopying, recording, or otherwise, without the prior written permission of the publisher,
Elsevier Scientific Publishing Company, Jan van Galenstraat 335, Amsterdam

Printed in The Netherlands

PREFACE

We should like to state from the outset what this book is not. It is not a study of water resource systems or of methodologies for the planning, design, and operation of such systems—topics that are treated in a vast body of excellent books, papers, and reports which have appeared in recent years. Rather, the book addresses itself to an area in water resources technology that has received practically no attention in the literature: the description and assessment of the pervasive role that computer systems have come to exert in this field, and are likely to exert in the future. While there are few practitioners or researchers in water resources today who have not used a computer in their work, and derived opinions, preferences, and a feeling for the possible directions of future evolution concerning computer systems, it is fair to say that a systematic and comprehensive discussion of the subject has been lacking. Though this book does not provide such a comprehensive discussion, it does offer a state of the art overview of some of the principal considerations concerning computer systems that the decision-maker and practitioner in water resources can no longer afford to neglect. Since we believe that an historical perspective is important, in several sections of the book we have provided brief sketches of the early use of computers in a number of water resource areas.

The germ of the book was a study carried out for the U.S. Office of Water Resources Research¹, which was subsequently expanded, modified, and brought up to date. The study could not have been accomplished without the expertise of numerous persons. In addition to Robert Cheever who was a participant in the original study, numerous persons have contributed their expertise and advice. Personal communications with M. Abbott, E. Altouney, P. Caruso, P. Combs, A. Cosper, N.H. Crawford, B. Doyle, A.J. Frederick, C. Furgeson, S. Lang, H.L. Longford, L. Manning, R. Myrick, J. Orlob, R.V. Thomann, and D.W. Webber, to name only a few, provided valuable direction and insight into the important, but often subtle problems encountered in the establishment of computer and programming policy. Contributions by Sheri Gunther and Brandy Rommel (Editing), Vivian

¹Bugliarello, G. and Gunther, F.J., *Computers and Water Resources*, U.S. Office of Water Resources Research, 1973.

Cardwell (Administration), Myra Martin (Typing), and Edward Daniels (Drafting), in dealing with the practical aspects of generating this document cannot be fully acknowledged.

LIST OF ABBREVIATIONS

A-D	Analog to Digital
ADP	Automatic Data Processing
ADTS	Automated Data and Telecommunications Service
AEC	Atomic Energy Commission
Agriculture	Department of Agriculture
ARIS	Automatic Radio Interrogation System
ARS	Agricultural Research Service
ASCE	American Society of Civil Engineers
ASP	Automatic Synthesis Program
BDC	Bureau of Domestic Commerce
BIA	Bureau of Indian Affairs
BLM	Bureau of Land Management
BM	Bureau of Mines
BOD	Biochemical Oxygen Demand
BOR	Bureau of Outdoor Recreation
BPA	Bonneville Power Administration
BR	Bureau of Reclamation
BRECS	Bureau of Reclamation Engineering Computer Systems
BSYS	Bridge System
Calif	California Department of Water Resources
CDA	Command Data Acquisition
CDC	Control Data Corporation
CE	Corps of Engineers
Census	Bureau of the Census
CG	Coast Guard
Commerce	Department of Commerce
CPU	Central Processing Unit
CRT	Cathode Ray Tube
CSC	Computer Sciences Corporation
D-A	Digital to Analog
DEC	Digital Equipment Corporation
DECUS	Digital Equipment Computer Users Society
Defense	Department of Defense
DO	Dissolved Oxygen
DOT	Department of Transportation

EAI	Electronic Associates, Inc.
ECM	Extended Core Memory
EDP	Electronic Data Processing
EDS	Environmental Data Service
EPA	Environmental Protection Agency
ERL	Environmental Research Laboratories
EROS	Earth Resources Observation Satellite
ERTS	Earth Resources Technology Satellite
FHWA	Federal Highway Administration
FPC	Federal Power Commission
FS	Forest Service
FWPCA	Federal Water Pollution Control Admin.
GE	General Electric
GS	Geological Survey
GSA	General Services Administration
HEC	Hydrologic Engineering Center
HEW	Department of Health, Education and Welfare
HR	Hour
HSP	Hydrocomp Simulation Program
HYDC	Hydrocomp, Inc.
HYDS	Hydrosience, Inc.
HUD	Department of Housing and Urban Development
IAHR	International Association of Hydraulic Research
IBM	International Business Machines
IBWC	International Boundry and Water Commission
ICES	Integrated Civil Engineering System
IJC	International Joint Commission
Ind. Agencies	Independent Agencies
INSIGHT	Interactive System for Investigation by Graphics of Hydrological Trends
Interior	Department of the Interior
I/O	Input/Output
ISD	Information System Design
K	Kilo (1000)
kw	Kilowatt
LCS	Large Capacity Storage
MCAUTO	McDonald Automation
Mega	Mega (10^6)
Min	Minute
Mini	Minicomputer
MIT	Massachusetts Institute of Technology

MS	Master of Science
MSPS	Multi-Spectral Point Scanner
MTBF	Mean Time Between Failures
NASA	National Aeronautics and Space Admin.
NAWDEX	National Water Data Exchange
NCC	National Climatic Center
NFEC	Naval Facilities Engineering Command
NMFS	National Marine Fisheries Service
NOAA	National Oceanographic and Atmospheric Adm.
NODC	National Oceanographic Data Center
Non-Federal	Non-Federal Agencies
NOS	National Ocean Survey
NPS	National Park Service
NWS	National Weather Service
N.Y.	New York Department of Environmental Conservation
ORD	Ohio River Division
OSI	Optimum Systems, Inc.
OSW	Office of Saline Water
OWRR	Office of Water Resources Research
Penn	Pennsylvania Department of Health
PhD	Doctor of Philosophy
PHS	Public Health Service
PL/I	Programming Language 1
POL	Problem-Oriented Language
PROGS	Progress of Ground Settlement
PROM	Programmable Read Only Memory
QLM	Quirk, Lawler & Matusky, Inc.
RAM	Random Access Memory
R&D	Research and Development
RJE	Remote Job Entry
ROM	Read Only Memory
SCS	Soil Conservation Service
Sec	Second
SF&W	Bureau of Sport Fisheries and Wildlife
STAR	String Array
State	Department of State
STORET	Storage and Retrieval
TV	Television
TVA	Tennessee Valley Authority
UNIV	Universities, Colleges, etc.
UNMES	Utah New Mexico Earthwork System

USGS	United States Geological Survey
Va	Virginia
Wash	Washington (D.C.)
WPO	Water Programs Office
WRC	Water Resources Council
WRD	Water Resources Division
WRE	Water Resources Engineers, Inc.
μ	Micro (10^{-6})