Modeling Hydrodynamic Effects and Salinity Intrusion

Presented by Dr. Eric Swain, USGS Water Science Center, Fort Lauderdale Florida



Requirements Because coastal South Florida has unique features such as low gradients and high surfacewater/groundwater connectivity:

 Surface-water represented by hydrodynamic formulation to account for transient momentum changes
 Linkage to groundwater formulation to account for close interaction
 Salinity transport with density effects to account for coastal interactions





Surface Water Momentum Formulations



- Hydrodynamic
- friction slope depth gradient + temporal acceleration + spatial acceleration = bottom slope



Challenges

> Hydrodynamic formulation requires short timesteps and is computationally intensive > The combined sw/gw code with transport has a multitude of interrelated parameters Hydrodynamic formulation required when short-timescale transients occur, but often a simpler scheme suffices



Numerical Modeling Code

- FTLOADDS (Flow and Transport in a Linked Overland/Aquifer Density Dependent System) Combines:
 - SWIFT2D hydrodynamic surface water code
 - SEAWAT variable density ground-water flow and transport code
 - Satisfies requirements for modeling South Florida
 - Hydrodynamic representation of surface water in two-dimensions
 - Three dimensional representation of groundwater
 - Salinity transport is represented in each model and passed with leakage
 - Modifications
 - Heat Transport
 - Interfaces with other models





Computational Water, Energy, and Environmental Engineering, 2014, 3, 57-77 Published Online April 2014 in SciRes. <u>http://www.scirp.org/journal/cweee</u> http://dx.doi.org/10.4236/cweee.2014.32008

Scientific Research

Utilizing Dimensional Analysis with Observed Data to Determine the Significance of Hydrodynamic Solutions in Coastal Hydrology

Eric D. Swain¹, Jeremy D. Decker¹, Joseph D. Hughes²

¹US Geological Survey, Florida Water Science Center, Fort Lauderdale, USA
²US Geological Survey, Florida Water Science Center, Tampa, USA
Email: <u>edswain@uses.cov</u>

Received 3 December 2013; revised 6 April 2014; accepted 22 April 2014

Copyright © 2014 by authors and Scientific Research Publishing Inc. This work is licensed under the Creative Commons Attribution International License (CC BY) <u>http://creativecommons.org/licenses/by/4.0/</u> (0) UppmLacces

Abstract

In this paper, the authors present an analysis of the magnitude of the temporal and spatial acceleration (inertial) terms in the surface-water flow equations and determine the conditions under which these inertial terms have sufficient magnitude to be required in the computations. Data from two South Florida field sites are examined and the relative magnitudes of temporal acceleration, spatial acceleration, and the gravity and friction terms are compared. Parameters are derived by using dimensionless numbers and applied to quantify the significance of the hydrodynamic effects. The time series of the ratio of the inertial and gravity terms from field sites are pre sented and compared with both a simplified indicator parameter and a more complex parameter called the Hydrodynamic Significance Number (HSN). Two test-case models were developed by using the SWIFT2D hydrodynamic simulator to examine flow behavior with and without the inertial terms and compute the HSN. The first model represented one of the previously-mentioned field sites during gate operations of a structure-managed coastal canal. The second model was a synthetic test case illustrating the drainage of water down a sloped surface from an initial stage while under constant flow. The analyses indicate that the times of substantial hydrodynamic effects are sporadic but significant. The simplified indicator parameter correlates much better with the hydrodynamic effect magnitude for a constant width channel such as Miami Canal than at the non-uniform North River. Higher HSN values indicate flow situations where the inertial terms are large and need to be taken into account.

Keywords

Hydrodynamic, Dimensional Analysis, Coastal, Numerical Modeling

How to cite this paper: Swain, E.D., et al. (2014) Utilizing Dimensional Analysis with Observed Data to Determine the Significance of Hydrodynamic Solutions in Coastal Hydrology. Computational Water, Energy, and Environmental Engineering, 3 57-77. http://dx.doi.org/10.425/koreez.2013.2008



Recent publication surveys field conditions under which hydrodynamic terms are important



South Florida and Model Areas



When is a hydrodynamic simulation coupled with groundwater most useful?

 During major storm events, dynamic inundation brings water and salinity ashore
 Long-term simulation capabilities allow representation of salinity intrusion effects on surface water and groundwater

To simulate historic storms: Hindcast BISECT MODEL Representing historical period 1926-1932, 1926-1940

Boundary Data Tidal levels adjusted using Key West record Northern boundary flows synthesized based on Lake Okeechobee Rainfall from historic gages Hurricane events specified individually **Basic wind and** atmospheric data used from 1996-2002



Hindcast

- Simulate historical period with FTLOADDS model to determine water levels, salinity, and flows and compare with historic aerial photography
- Represent historic storms and effects on coastal regimes
- > Use results to develop insight into future



Salinity washed on shore important to Mangrove-Hammock Model



To Examine Future Conditions: Incorporating Sea-Level Rise

- Represent existing period with increased tidal levels
- Can be combined with estimated future conditions such as rainfall, water management
- Needed conditions for future storm effects



To Examine Future Conditions: Downscaled Climate Data

Rainfall data from Global Climate Models and reanalysis is downscaled for hydrology model input

Comparison is made between existing conditions and downscaled input

Effects of future rainfall scenarios can be examined





UTM Easting, in meters

UTM Easting, in meters



Swain, E., Stefanova, L., and Smith, T., 2014. Applying Downscaled Global Climate Model Data to a Hydrodynamic Surface-Water: American Journal of Climate Change, Vol. 3 No. 1, 2014, pp. 33-49.

-100 -80 -60 -40 -20 0 20 40 60 80 100 change in percent of time inundation

Differences in time inundated with future rainfall from global climate models



2038-2057 rainfall, 1 foot sea-level rise

Comparison of average salinity between late 20th century scenario and future rainfall and sea-level rise scenario.

Defining the salinity interface cumulative leakage from north to south





Location of transects through model domain







science for a changing with the result of th

tranaat



1997-1999 simulation shows changes only in top layer

Coastal Everglades salinity interface as indicated by model







East-west transect shows a saltwater interface representation Second Se

Publications – Codes and Models









FTLOADDS

SEAWAT





MDD/LOW-2008 the U.S. Geological Savey Modular General Water Model Desurementation of the SEAMUT 2000 Version with the Variable Desisty Fire Process (NDF) and the Imograph MT3DMS Transport Process (INIT)



USGS Presentation and advected in the

US DESIGNATION AND A CONTRACT OF DECIMPANTER SEA/VAT Version 4.

A Computer Program for Simulation of Nulti-Species Solute and Heat Transport

Bi-Chrokello Langers Classy Prices Allows of Decomerchance Classes, and

Opinitie Report Instances

With Department of the line in With the singlest Development



Publications – Additional USGS Reports

USGS

Two-Dimensional Hydrodynamic Simulation of Surface-Water Flow and Transport to Florida Bay Through the Southern Inland and Coastal Systems (SICS)

Water-Resources Investigations Report 03-4287





U.S. Department of the Interior U.S. Geological Survey Prepared in cooperation with the U.S. Geological Survey Priority

Ecosystem Science Program and the National Park Service Critical Ecosystem Studies Initiative Prepared as part of the US Geological Survey Priority Ecosy

National Park Service Critical Ecosystem Studies Inflative Assigning Boundary Conditions to the Southern Inland and Coastal Systems (SICS) Model Using Results from the South Florida Water Management Model (SFWMM)



Exclusion for a changing warth

Internet-based Modeling, Mapping, and Analysis for the Greater Everglades (IMMAGE; Version 1.0): Web-based Tools to Assess the Impact of Sea Level Rise in South Florida

By Paul Hearn, David Strong, Eric Swain, and Jeremy Decker



Prepared as part of the U.S. Geological Survey Priority Eccepations Science Initiative

Spatial and Stage-Structured Population Model of the American Crocodile for Comparison of Comprehensive Everglades Restoration Plan (CERP) Alternatives

By Timothy IN: Green, Daniel H. Sione, Bric D. Swein, Michael S. Cherken, Weinde Lohmann, Frank J. Mazzott, and Kanneth D. Pise

Open-File Report 2013-1185

U.S. Department of the Interior U.S. Geological Survey

Open-File Report 2010-1284

U.S. Department of the Interior U.S. Geological Survey

Publications – Additional Peer-reviewed

× whe

American Fournal of Clinate Change, 2013, *, ***, *** doi:10.4236/1.2013.***** Fublished Online ** 2013.0tm://www.adm.org/sound/fil

Scientific Research

Applying Downscaled Global Climate Model Data to a Hydrodynamic Surface-Water and Groundwater Model

Ex(c) dwarfs (2,4) as left-many², and Thuman Shellt²¹ 'U.S. Ghedgingh dwarfs, brinner, the NDW with dwarfs (2,4) as left (2,4) and the set of the Received \$1.4/2013

Abstrac

Advanced the start of the start of the discussion and have true downset with a surface a design to design the design the discussion of the start due to the respin to the start due to the st

ards: Hydrologic models, Climate change, Rainfall, Hydrody

1. Introduction

296

US Geological Survey, Florida Integ educatinghases.gov

INTRODUCTION

1. Introduction Interview of the strength of a solution of prefix the offset of attent of a distroyeen reasons on the distroy of annual and any solution with an offset of the strength of the solution of the OTLANDEO, simulate (12). In PILADEO, the solution of the solution of the solution of the OTLANDEO, simulate (12) is the TLANDEO the other solution of the solution of the solution of the other solution of the solution of the solution of the three-dimensional physical basing and with the solution of the the solution of the solution of the solution of the the solution of the solution of the solution of the basing and the solution of the solution of the basing a complex isolation of the basing and the solution of the solution of the basing a solution of the basing and the solution of the solution of the basing and the solution of the solution of the basing and the solution of the basing and the solution of the solution of the basing and the solution of the solution of the basing and the solution of the basing and the solution of the solution of the solution of the basing and the solution of the solution of the basing and the solution of the basing and the solution of the solution of the solution of the basing and the solution of the solution of the basing and the solution of the basing and the solution of the solution of the solution of the basing and the solution of the solution o

The Role of Hydrology in Water Resources Management (Proceedings of a symposium heli on the Island of Capri, Italy, October 2008). IAHS Publ. 327, 2009.

Internationalized Attraction Applications, of new and improved numerical models of proposed restancias neurons are ned user managers. Management of compatibility belowing in the towns is made reasons in communities the start of applications of new and improved numerical models. The start of a start of applications of new and improved numerical models in the start of applications of a start of applications of new and improved numerical models and the start of a start of applications of new and improved numerical models and the start of applications of the start of the start of applications of the start of the start of the start of applications of the start of the sta

Management of hydrological systems has become increasingly important in recent years, especially

considering the limited land and water resources available for the competing needs of an expanding considering the limited final and water resources available for the computing needs of an expanding population and algorize antimiter ecosymers. As a consequence, water managers mult increasingly tra's or profile to to understand the potential effects of decision-making processes. Experimental effects of the state of the state of the compensational broad state of the state comparison. As a state of a model water ecosystem restoration plans in the USA, and was initiated to restore the southern Florids. USA, and was initiated to restore the southern Florids. Desplay the state of the southern broad and of neurosing opplaudition demands (CAS Arrow Coays of the state) plans in the USA, and was initiated to restore the southern Florids. Desplay the state of neurosing opplaudition demands (CAS Arrow Coays of Taglastet) and a first device the of neurosing opplaudition demands (CAS Arrow Coays of Taglastet) and a first device the of neurosing opplaudition demands (CAS Arrow Coays of Taglastet) and a first device the of neurosing opplaudition demands (CAS Arrow Coays of Taglastet) and a first device the of neurosing opplaudition demands (CAS Arrow Coays of Taglastet) and and and the state of the state of the southern Florids. The state of the southern Florids Water and the state of the state of the state of the southern Florids and the state of the state of

Management District, 2003). Because of competing interests and conflicts between urban development, agricultural development and natural-area preservation, water managers require access to robust scientific information and interpretations that can be used to achieve accountable

access to robote scientific information and interpretations that can be used to achieve acceptible integritation of the effects of different water-management and restoration botions. The ability on noniter, model, and perfect the effects of different water-management and restoration accenter is an intuinated conditions inform different conducts a granter market of covers than interpretations based solvy on field data. When numerical models are used for predictive proposes, simulated based solvy on field data. When numerical models are used for predictive proposes, simulated maintainpret simulations. Without a data understanding of model construction details, water manager may intimitery the simulation classic construction. Construction, focare manager and statistications are also accessed on the simulation of t

Hydrological simulations of water-management scenarios in support of the Comprehensive Everglades Restoration Plan

ERIC D. SWAIN, MELINDA LOHMANN & JEREMY DECKER

Key words numerical modelline: restoration: water managers: Florida USA: Exceptions

Figure 1. Locations of TIME and BISCAYNE model areas i with Electric A number of Olobal Climate Models

ale, Florida 33315, USA

the Florida peninsula, and provide a useful tool to evaluate engoing restoration efforts to better regulate the quality, quantity, timing and distribution of water flows of the such Florida ecosystem and provide for water researce needs. The models can be used also to provide interpretive hydrologic information for ecologic models and water meangement decision met-ives.

dogy including precip-ted to simulate historic



Timothy W. Green - Daniel H. Sione - Eric D. Swain -Michael S. Cherkiss - Melinda Lohmann -Frank J. Mazzotti - Kenneth G. Rice

Received 31 July 2012 /Accepted 23 December 2012

Adversed The distribution and abundance of the American encodellic Coscolution and abundance of the Manura methods and the American and Hondrin and Statebase and American and American and American and American Restancian Phase (CRRP) is to create interact for theorem theory of the American and American and American passed for the passes on the according payment for the passed are the passes on the according payment for the passes of the American costellar payment for the theory of the American and the Interpartic for the American Physical payment and the Interpart of the Interpart payloas pay and stately deposite transmission. A disposi-tion to the American costellar payment and the condition were foreable. The model payloas the American condition were foreable. The model payloas the American American and angeingt inspars in American decrease approximately 3.% with the implementation of CERP compared to finant confidence without restoration, but local increases up to 20 % control in the loc Bay area near Taylor Slongla, and local decreases up to 20 % control in the vicinity of Battomwood Chand due to changes in selfinity and featurement. Keywords Spatial model - Population modeling based model - Crocodylase acutus - Mangroves -Introducts We have have models of a first "south? In pages recovery investories of the "in single prices in the South Findels products of the Comprehensive Doroglador Restorator Bray products of the Comprehensive Doroglador Restorator Bray products of the Comprehensive Doroglador Restorator Bray have a single and the single sector Bray have a single and the single sector Bray have a single and the single sector Bray have a single sector Bray and the single sector T. W. Green - D. H. Slone (E3) - K. G. Rice US Geological Survey, Souther 2201 NW 40th Terrace, Gainerville, FL 32605, USA e-mail: dalone@uags.gov E. D. Swein - M. Lohmann Rovey, Florida Water Science Center, 3110 SW 9th Avenue, Fort Lauderdale, FL 33315, USA M.S. Cherkin uvey, Southeast Ecological Science Center 3205 College Avenue, Davie, FL 33314, USA F. J. Muzzatti Department of Wildlife Ecology and Conservation, University of Florida, 3205 College Avenue, Davie, FL 33314, USA

4) Springer

U.S. Geological Survey

न्छ

Forida Integrated Science Center 3110 SW 9th Avenue Fort Landerdale, FL 33315, U.S.A. alsoratio@ecca.com

Wetlands (2010) 30:635-648 DOI 10.1007/s13157-010-005

ORIGINAL PAPER

Measurement-derived Heat-budget Approaches for Simulating Coastal Wetland Temperature with a Hydrodynamic Model

Eric Swain - Jeremy Decker

Received: 13 April 2009 / Accepted: 3 March 2010 / Published online: 4 May 2010 © Society of Webland Scientists 2010

Keywords Computational methods · Evapotranspiration · Heat transport · Surface water

Journal of Coastal Bosenech 24 6 1415-1429 West Palm Boach, Florida November 2018

Utilizing Spectral Analysis of Coastal Discharge Computed by

'Rosenstiel School of Marine and Atmospheric Science University of Miami

SWAIN, E.D.; LANGEVIN, C.D., and WANG, J.D., 2008. Utilizing spectral analysis of coastal discharge computed by a non-actival worked in determine houndary influence. *Journal of Cosstal Research*, 39(6), 1415–1409. West Pelm Bend

Product. 1997 OF 09 801. The propertical starts, propertical inductions are applied to field data and a summerical model of sumfantaments immediately for a call for propertical starts waters. From distances prove the properties, a comparing to the 18, 280, 204 Oral properties, manual entities waters from distances prove the properties of the 18, 200, 204 Oral properties, manual entities waters and the properties of the properties of the 18, 200, 204 Oral properties, manual entities waters and the properties of the properties of the 18, 200, 204 Oral properties, manual entities waters and the properties of the properties of the properties of the 18, 200, 204 Oral properties, manual entities waters and the properties of the properties of the properties of the 18, 200, 204 Oral properties, manual entities waters and the properties of the pro

dary, tidal forcing, frequency domain, gauge error

WRT, 2005). The properties of measured and simulated a were compared to ensure proper model development allocation

and combrations. A coupled surface-water-groundwater model was needed for the SUCS area because of significant interactions between the constal wetlands and the aquifir. The espability to rep-escent the density effects to constituent transpert is needed

reset the density effects of constituent transpect is needed because if the constituent at an other hydrogeneous terms is surface-state solution is required to accurately simulate the constait stage and fore transitiest. This messary com-pleting of this solvens also reasons that the radd readed much dynamics differ. In this constrained we hydrogeneous differ, and has more concern of surversitary. The place error bounds an one draw concer of surversitary. The place error bounds are drawn to be do to determine the survers of error in the extensive input data. The results of the numerical model can be compared with full measurements for calibration. In the SCI2 model area;

held measurements for calibration. In the SUCS model area, water levels, sulfnity, and discharge rates are measured at the coestal creeks where flow exits the wetlands into Fiorida Bay. A comparison of the magnitude and frequency of fluc-tuations in each data set can be useful, perviding insight as

University or Milana 4600 Rickenbacker Causeway Miami, FL 33149-1098, U.S.A.

a Numerical Model to Determine Boundary Influence

Eric D. Swain', Christian D. Langevin', and John D. Wang!

a numerical model to detern (Florida), ISSN 0749-0208.

DOTTIONAL INDEX WORDS: Fourier tra

INTRODUCTION

interest to water managers and others implementing a tem restoration initiatives. Surface water is represent the SICS model by SWIFT2D—a two-dimensional by

DOI: 19.2112/07-0848.1 received 9 March 2907; accepted in re 18 July 2007.

d and constal systems (SICS we model was developed for the coastal area of Everylades ational Park and Florida Bay in southern Florida (Figure 7). The flow volumes and patterns of flow through the coastal verke connacting the inland and offshere areas are of great

E. Swain (E2) · J. Decker Flends Weter Science Center, U.S. Geological Survey, 3120 SW 9th Avenue, Feet Landenhie, FL 33315, USA

Abstract Numerical modeling is needed to predict envi-ronmental temperatures, which affect a number of bioa in southern Florida, U.S.A., such as the Wost Indian manatere Representing : Representing heat transport in a hydrodynamic model ha (Trichechus manatus), which uses thermal basins for refiare provided useful information and statistics in regimes when frem lethal winter cold fronts. To numerically simulate heat-transport forough a dynamic coastal wetland region, an temperature is an important parameter (Bradley et al. 1998), Kim and Chapra (1997) developed a heat transport model for a shallow, transient stream accounting for the flux of heat energy between the water and sediments. A two-dimensional scheme was used by Cole (2000) for thermal algorithm was developed for the FTLOADDS coupled hydrodynamic surface-water/ground-water model that uses formulations and coefficients suited to the coastal wetland thermal environment. In this study, two field sites provided atmospheric data to develop coefficients for the heat flux modeling in a reservoir and Jin et al. (2000) used three dimensional heat transport for Lake Ochamorphicsic data to develop coefficients for the host flux terms representing this parcicular randy acors. Several method were examined to represent the host flux compo-nents used to correspond to the start best comparations, proceeding institute data/wavenge tempera-tures. Strandston of host-transport in the stordness Theory photon flux terms and temperature that the stordness the photon flux terms of the stordness the stordness Theory photon flux terms of the stordness the stordness the flux terms of the stordness terms of the stordness the flux terms of the stordness terms of the stordness the stordness possibly due to the lack of information on the statistic articless in heart terms terms stord acord terms. as did Jedrasik (1997) for the Galf of Gdansk in Poland These applications have focused on different surface wate

flow regimes. In both wetland and stream areas, heat transport in both wetaka and stream areas, new manper modeling has commonly focussed on the underlying ground water (Bravo et al. 2000; Lossy et al. 2006; McKenzie et al. 2007). Heat transport in ground-water modeling has often focused on estimating hydrailic conductivity frecupit the use of heat as a tracer (Anderson 2005). Heat transport in a wetland regime has not been investigated as much as has open-water environments.

recursors, possibly due to the BAG of intermation on the optical variations in hast transport parameters such as soil-hest capacity and surface albeds. These simulation results indicate that the new formation is satisfied for defining the existing thermohydrologic system and evaluating the ocological effect of prepared retension efforts in the southern Everglades of Florida. hat open-water environments. Methods dis comparing alvides has franc for open water have been developed by Welfer et al. (1995) busied on open-comes data and a seatilite data and have been used dis measuring solar radiation in modeling area-unitizet trangen-ture (Steager and Rithmenshill 1996). Falls masserements on has franc trans have been collected to compare exoptema-prisation rates in the worked environment (German 2002). Altiver 2005) and continue to provide an important excerc of information to commenteries above current reference along and contained to provide an important excerce From a solid has contain to provide in support in support of information to parameterize a heat transport formalisito. However, namerical isinalation of heat transport for large coartal wetlands has not been developed. The coastal wetland in the southern Everylades of Florida, U.S.A. has been the subject of numerous studies

D Springe

SWS

his article was describeded by: [USUS Librarian Program] 16 December 2003, 6t: 05:55

6 December 2003, Art 100100 Hent Taylor & Francis na Ltd Registered in England and Wake Registered Number: 1072994 Registered Montimer House, 37-41 Montimer Street, London WIT 3JH, UK



Critical Reviews in Environmental Science and Technology Publication details, including instructions for authors and aboutightion information http://www.tanefforline.com/fot/heat78

Use of Hydrologic and Hydrodynamic Modeling for Ecosystem Restoration Jayanta'a Obeysele a ⁴ , Jawa Kaeble r⁴ , Stabble Jhreed ⁶ , Max-II

Orang", Mc Ingel ", Orithtan Langevin", Eric Swain " 8. Vergohan ⁴Seath Renids Water Management District , West Palm Beach, PL, USA

^DU.S. Army Corps of Engineers , Jacksmille , FL, USA * Everglader National Tark , Hernertead, PL, USA ⁴ U.S. Geological Survey , Recton, M. USA * U.S. Declapical Servey , Port Leaderdale , PL, USA Published on Inc. 19 Peb 2011 .

seite this article. Javan the Operaelosts , Lasta Rabber , Stabber Ahmed , Wan-D Chang , Mc spill, Christian Langevin, Eric Swain B, Yongshan Wan (2011) Use of Hydrologic and Hydrologic amin obling for Economic Restoration, Critical Reviews in Environmental Science and Rectinology, 41:51 87-485 (010): 10.1088/10645389.2010.331228

blink to this article. http://ste.cb/.org/10.1050/10640509.2010.501226

LEASE SCROLL DOWN FOR ARTICLE

allor & Prancis makes every affort to ansure the accuracy of all the information (the Centerk) contained in the publications on our platform. However, Taylor & Prancis, ur agants, and our licensors make no representations or u ananties unlationary as to a accuracy, completeness, or quitability for any purpose of the Complet, kny carinous nd views expressed in this publication are the opinions and elevs of the exthors. nd are not the elevis of or endorsed by Taylor & Prends. The eccuracy of the Content. Indian to the field upon and should be independently verified with primary sources if information. Taylor and Trands shall not be liable for any losses, actions, daino, rocceshiga, domanda, coth, expenses, damages, and other liabilities in tabarear or ovapeuer caused arising directly or indirectly in connection vish... In relation to or arising ut of the use of the Conter

This article may be used for research, teaching, and prinate study purposes. Any substantial or systematic reproduction, real-influencing, loan, sub-framping, systematic supply, or distribution in any form to express is expressed forbidden. Terma B

The Role of Hydrology in Water Resources Management (Proceedings of a symposium held on the Island of Capit, Italy, October 2008). IAHS Publ. 327, 2009, 285-305.

Hydrological simulations of water-management scenarios in support of the Comprehensive Everglades Restoration Plan

ERIC D. SWAIN, MELINDA LOHMANN & JEREMY DECKER

Abstract Application of new and improved numerical models of proposed restoration in generation are presented and discussed in traves block by composed in accessibility in the straight of the hydrology in hydrole an angie concern in communities worldwide due to competition for limited water resources. Numerical models have been developed by the LS. Scological Stravey (ISS2) in softeen Heidel (SJA for the Comprehensive Foreglades, Restoration Plan Landow (SJA for the Straight Comparison) and the straight of the straight developed and applied to three locations to simulate the complex hydrology of solutions developed and applied to three locations to simulate the complex hydrology of southern Friedel. The Tables and Harbor in the Mangrossy of the Josephsel Tuber 1000 and 1000 are straight of the straight of the straight of the Straight of Harborghes to the straight of the Straight of Harborghes to the Straight of Harborghest to the Straight of Harborghest to the Straight of Harborghest to tharborghest to the Abstract Applications of new and improved numerical models of proposed restoration domain encompasses Everglades National Park, the Ten Thousand Island (TTI) domain contains the Ten-Thousand Islands and Picayune Strand Restoration Project area, and the Biscavne domain contains the coastal area of Miami-Dade county and Biscavne National Park. In a subarea of the TIME domain, the UCODE parameter estimation code was linked with FTLOADDS to design water-management restoration scenarios to maintain desired salinities within coastal estuaries.

The successful application of FTLOADD8 to evaluate CERP restoration scenarios required close communication and information transfer bytween water manager and hydrologists. The water manager defines the configuration of the proposed scenario and ensures that the hydrologist is presented with a realistic perspective of the system. The hydrologist clearly defines the assumption, limitations, and uncertainty of the model simulation and results. Application of a parameter-estimation code (UCODE) with FTLOADDS to design watermanagement scenarios displays the integration of water-management and hydrologic studies. Applications of FTLOADDS in southern Florida show how ecosystem restoration projects u sourced hydrologic modeling tools rely on continuous feedback between water sagers and hydrologists. that use advar

Key words numerical modelling; restoration; water manager

INTRODUCTION

Management of hydrologic systems has become increasingly important in recent years, especially considering limited land and water resources required by the competing needs of in expanding population and adjacent sensitive ecosystems. As a consequence, water managers must increasingly rely on predictive tools to understand the potential effects of decision-making proce

Numerical models are one of the most important and complex examples of scientific computations. A case study of models used for the Comprehensive Everglades Restoration



achieve restoration salinity performance measures

⁶ US Geological Survey, Florida Integrated Science Center, 3110 SW 9th Avenue, Fort Lauderdale, FL 33315, USA ⁹ MMH America: Inc., 400 Sourcest Connecte Derivery, East Landerdale, FL 33325, USA

Summary. The use of numerical medicing to evaluate regional used-management bearching house the sinulation of regional and the relative scenarios, with typically are desped intuitively rather than analytically. These scenario simulations are used to analyze the susceficit water analogement particles affect factors to an water levels. Rows, and salavites, In list of testing a voriety of scenario simulations in this and error management, an optimization bechnique may be used to more precisive and Everglades; Coastal hydrology; Optimization

An electric factor approaches to the contain regions of increases they are transposed to the contained of t

salinity values in the target area. The salinity variance in the primary zone of interest was reduced from an original value of 0.509 psu² to values 0.418 psu² and 0.342 psu² using

0022-1694/5 - see frant matter 10 2007 Elsevier B.V. All rights reserved. doi:10.1016/j.litevitrol.2007.12.017

E.C. Inverse modeling of surface-water discharge to

in Florida Bay, Florida

Eric D. Swain a,*, Dawn E. James b

Received 23 August 2007; received in revised form 1 December 2007; accepted 7 December 2007

Published online: 14 March 2013

A numerical model application in the coastal regions of Florida Bay and Everglader

Corresponding author. Tol.: +1 954 377 5925; fac: +1 954 377 5901. E-mail addresser: edomalograps.gov (E.D. Swain), Dawn E-Jamosou.mvMglobal.com (D.E. Jamos).

Other FTLOADDS Publications

- Cline, Jon C., Lorenz, Jerome J., and Swain, Eric D., 2004, Linking Hydrologic Modeling and Ecologic Modeling: An Application of Adaptive Ecosystem Management in the Everglades Mangrove Zone of Florida Bay: International Environmental Modelling and Software Society iEMSs 2004 International Conference, June 14-17 2004, University of Osnabrück, Germany.
- Swain, E.D., Langevin, C.D., and Wolfert, M.A. 2002. Cooperative linking of numerical models for coastal wetland planning: American Water Resources Association's Spring Specialty Conference on "Coastal Water Resources," May 13-15, 2002, New Orleans, Louisiana.
- Langevin, C.D., Swain, E.D., and Wolfert, M.A. 2002. Numerical simulation of integrated sur-facewater/ground-water flow and solute transport in the southern Everglades in Florida: Second Federal Interagency Hydrologic Modeling Conference, Las Vegas, Nevada, July 28 - August 1, 2002.
- Cline, Jon, and Swain, Eric, 2002, Coupling Ecological and Hydrologic Modeling: SICS and ATLSS: Second Federal Interagency Hydrologic Modeling Conference, Las Vegas, Nevada, July 28 - August 1, 2002.
- Swain, E.D., 2000, Dynamic numerical wetland modeling to determine destinations of surface water: AWRA 2000 Annual Water Resources Conference, Miami, Florida, November 6-9, 2000.
- Swain, E.D., 2000, Development of numerical tools for integrating wetland hydrologic processes: SICS and TIME: in U.S. Geological Survey Open-File report 00-449, p. 54-56.
- Swain, E.D., 1999, Two-dimensional simulation of flow and transport to Florida Bay through the Southern Inland and Coastal Systems (SICS): in U.S. Geological Survey Open-File Report 99-181, p. 108-109.
- Swain, E.D., 1999, Numerical Representation of Dynamic Flow and Transport at the Everglades/ Florida Bay Interface: Third International Symposium on Ecohydraulics, Salt Lake City, Utah, July 13-16, 1999.
- Swain, E.D., 1998, Using a Two-Dimensional Surface-Water Model to Integrate Coastal Wetland Data From Multiple Process Studies: Proceedings of the American Geophysical Union Spring Meeting, Boston Massachusetts, May 26-28 1998.

USGS Modeling Team and Collaborators

USGS Fort Lauderdale

- Eric Swain
- Melinda Lohmann
- Jeremy Decker
- Don DeAngelis

USGS Gainesville

- Brad Stith
- Catherine Langtimm
 USGS St. Petersburg
 - Dennis KrohnTom Smith



Collaborating Scientists

- Jon Cline, University of Tennessee
- Rafa Munez and Stuart Miller, University of Florida
- John Hamrick, Tetratech
- Glenn Landers, Russ Weeks, Jessica Files, USACE
- Jayantha Obeysekera, SFWMD
 - Kiren Bahm, Robert Fennema, Ed Kearns, Dewitt Smith, ENP
- Michael Swain, University of Miami