HYDRODYNAMIC MODELLING OF CIÉNAGA GRANDE DE SANTA MARTA COASTAL LAGOON (COLOMBIAN CARIBBEAN) USING MOHID WATER MODELLING SYSTEM

Marcos Carvajalino-Fernández [1,2], Oliver Lojek [2], Luis Fernandes [3] & Janet Vivas-Aguas [4]

[1] Forschungs- und Technologiezentrum Westküste, Christian-Albrechts-Universität zu Kiel. Kiel, Germany. E-mail: mcarvajalino@corelab.uni-kiel.de
[2]Franzius-Institut für Wasserbau, Ästuar- und Küsteningenieurwesen, Leibniz Universität Hannover. Hannover, Germany. E-mail: lojek@fi.uni-hannover.de (O.L.)
[3]Action Modulers Consulting & Technology. Mafra, Portugal
[4] Instituto de Investigaciones Marinas y Costeras "José Benito Vives de Andreis" - INVEMAR. Santa Marta, Colombia

INTRODUCTION:

Located in northern Colombia, Ciénaga Grande de Santa Marta (CGSM) is the largest coastal lagoon complex in the country with an extension of 4280 Km^2. It comprises more than 730 Km^2 of water bodies and has been declared both RAMSAR site and UNESCO biosphere reserve.

Traditionally an area of very high primary productivity (990 gCm^{-2}yr^{-1}), research has focused mostly on the biotic aspects of the region. Studies regarding hydrodynamics and transport regimes are very scarce and mostly limited to the analysis of short-term phenomena in certain parts of the system. To date, no official hydrodynamic model for the whole area seems to have been developed by the authorities.

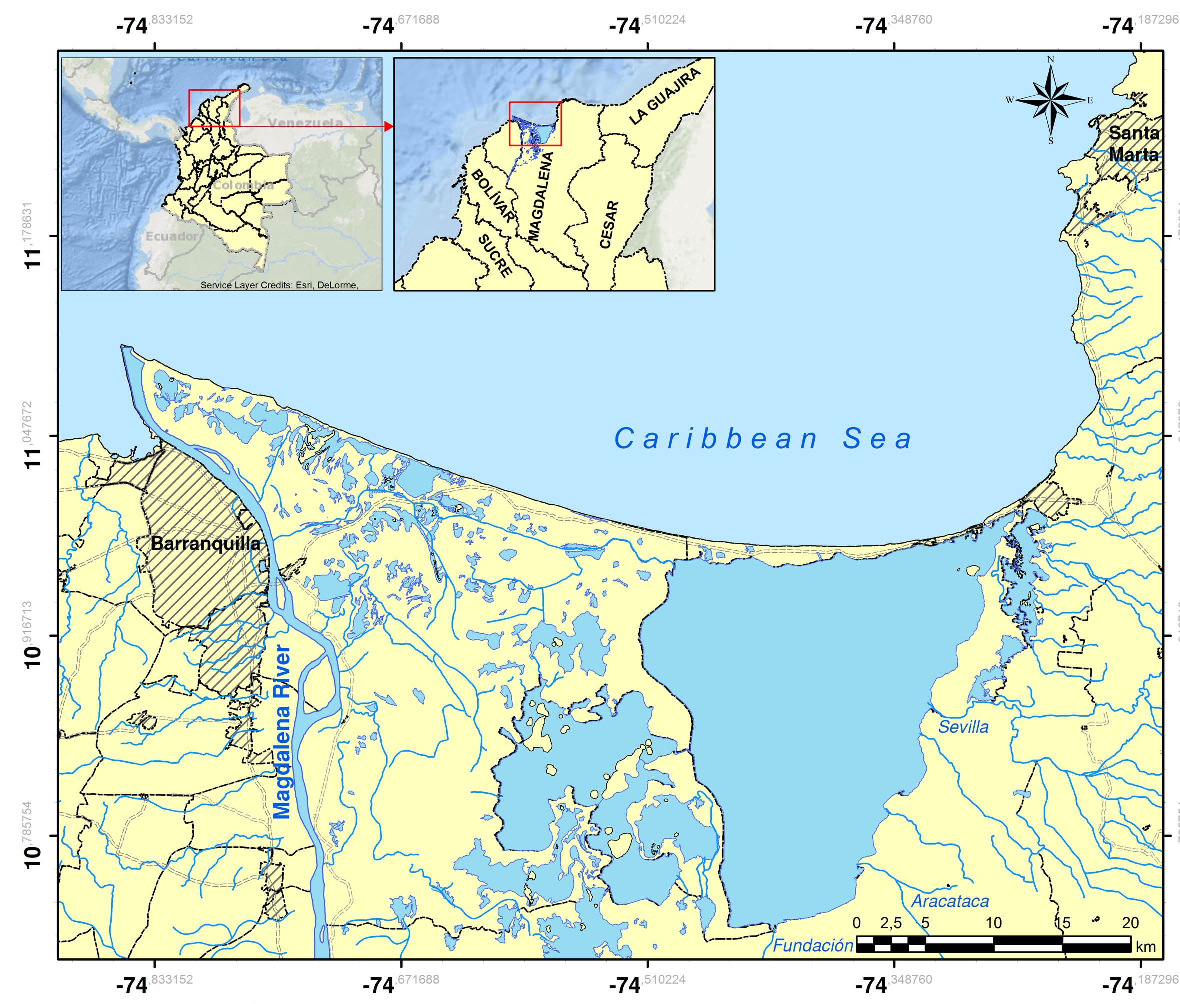


Fig. 1: Ciénaga Grande de Santa Marta lagoon complex and its location in northern Colombia

PURPOSE:

Developing a hydrodynamic model for CGSM can be used as a foundation stone for diverse studies at Instituto de Investigaciones Marinas y Costeras "José Benito Vives de Andréis" - INVEMAR, the major advisor on marine related topics for the Colombian government.

INPUTS AND MODEL CONFIGURATION:

The model domain comprises the two largest lagoons inside the system (i.e. CGSM and Pajarales) and extends 36 Km offshore. Simulations were carried out using MOHID Water modelling system (University of Lisbon) with the following configuration:

- 2DH model with terrain following vertical layer (σ - layer)
- Structured variable width mesh:
  - Base element size: 500m
  - Gradual refinement to 50m in the sole seaward inlet (La Barra)
  - Gradual refinement to 200m in the connection between the 2 major lagoons
- Variable time step ranging from 2-5 seconds
- Open boundary forcing by major tide harmonics from FES 2004, identified using T_Tide MATLAB's routine.
- Monthly averaged freshwater inflows from 3 rivers and 2 creeks
- Monthly averaged meteorological input for winds, precipitation and evaporation

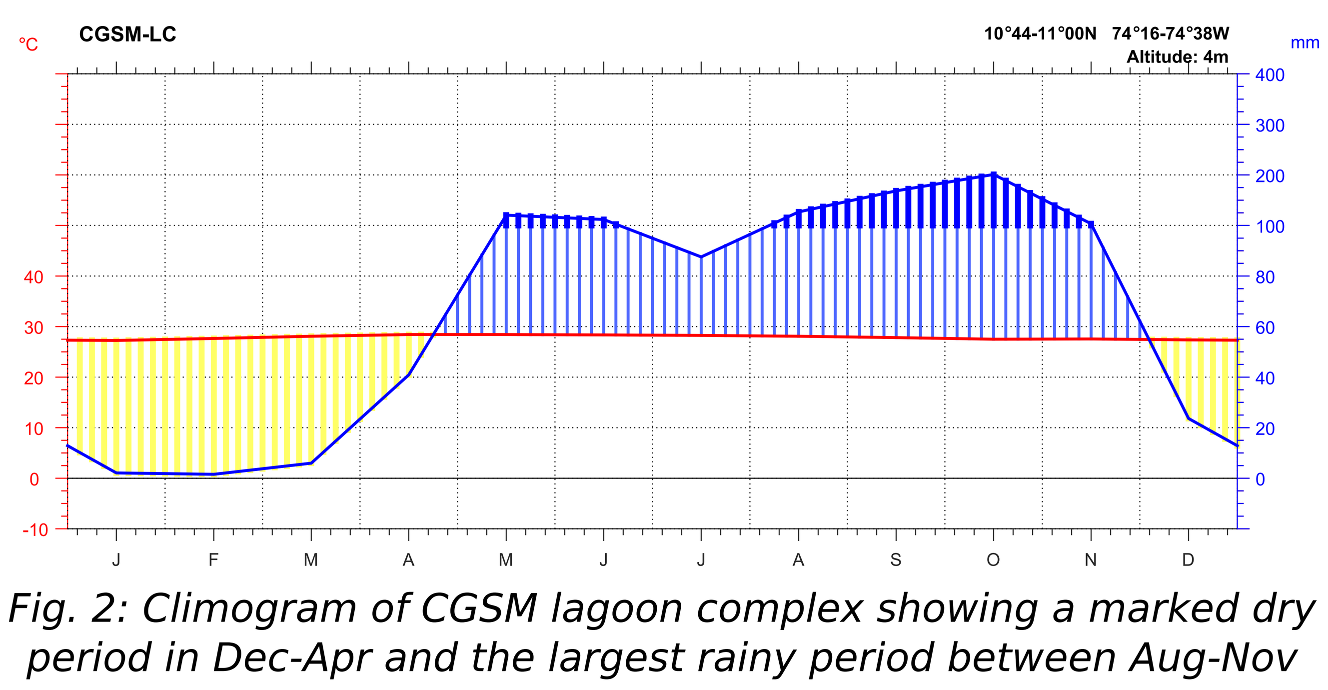


Fig. 2: Climogram of CGSM lagoon complex showing a marked dry period in Dec-Apr and the largest rainy period between Aug-Nov

RESULTS AND DISCUSSION:

The model was able to reproduce year-long patterns of water level, flow velocity and salinity inside the system, with a fairly good agreement to the mixed-semidiurnal tide signal and the strongly seasonal meteorological patterns in the study area.

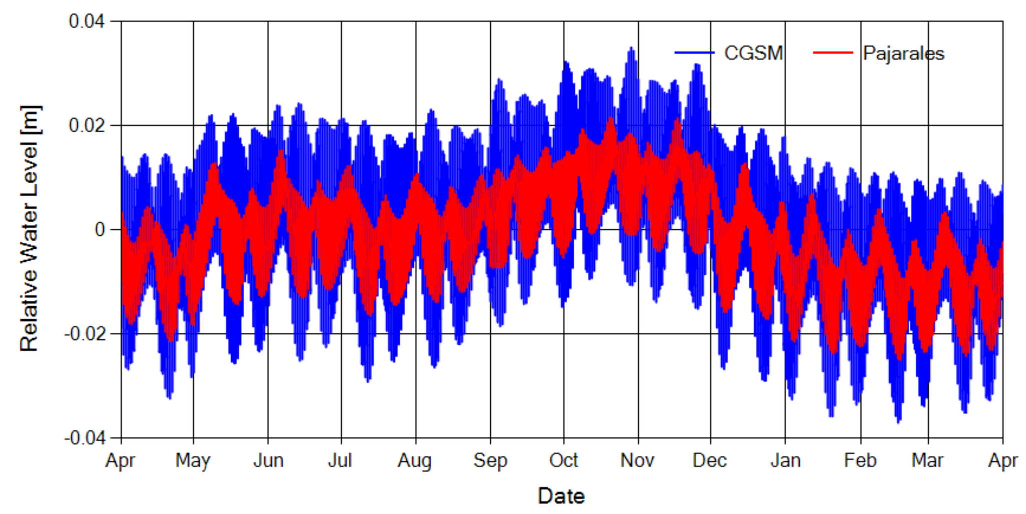
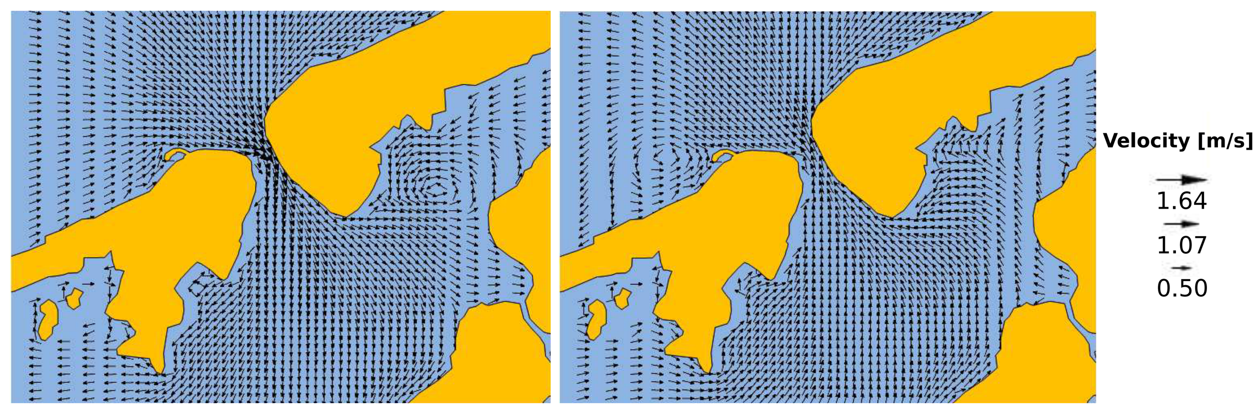


Fig.3: Water level variations in the two main lagoons of CGSM. Due to large surface area, level fluctuations do not exceed 5 cm during the 15-d tidal cycle.

Fig. 4: Largest velocities in the system were observed in the sea inlet due to strong flow constriction.



As a systematic monitoring of water level and velocities inside the lagoons is not being implemented, comparison of modelled salinity patterns against bimonthly monitoring data from INVEMAR was used as the main source of verification.

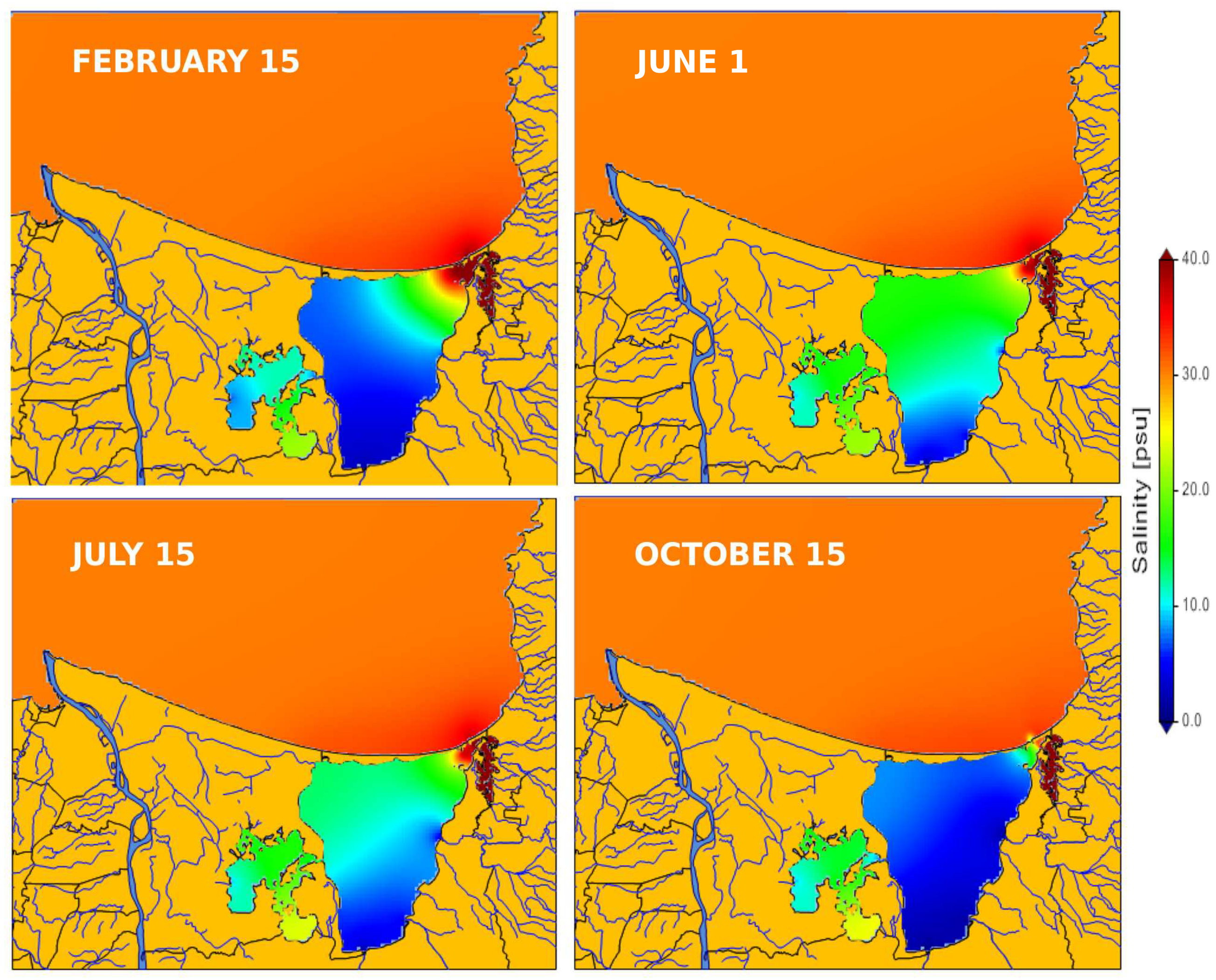


Fig. 5: Salinity patterns inside the model domain. Maximum salinity levels in the estuary occur around June with a strong turnover to freshwater conditions during the rainy season

The year-long salinity patterns showed very good agreement with the observed values for the main lagoon of the system, which is highly influenced by the tidal input from open seas. However, simulations for Pajarales lagoon revealed a very poor fit to observed data, indicating the need to further research hydrological forcings in this area of the complex, especially the inflows from Magdalena river through existing creeks.

CONCLUSIONS:

- Model results obtained with MOHID Water agreed well with reported values for tides, water level, currents and salinity in the system for long term simualtions.
- Lack of field data for many physical processes in the system is the major drawback for the model. Modification of the monitoring programs to include field data gathering for inflows, detailed bathymetries and velocities is mandatory.
- Further calibration of the model parameters, specially eddy viscosity are required before the model can be used as a management tool.

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