STUDY AND CONTROL OF THE MORPHODYNAMIC OF CUAUTLA CHANNEL, NAYARIT, MEXICO

Cuauhtémoc Franco Ochoa
Edgar Gerardo Mendoza Baldwin
Amaia Ruiz de Alegría Arzaburu
Ismael de Jesús Mariño Tapia
Adán Mejía Trejo
Rodolfo Silva Casarín

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GRUPO DE INGENIERÍA DE COSTAS Y PUERTOS

DESCRIPTION OF THE STUDY AREA

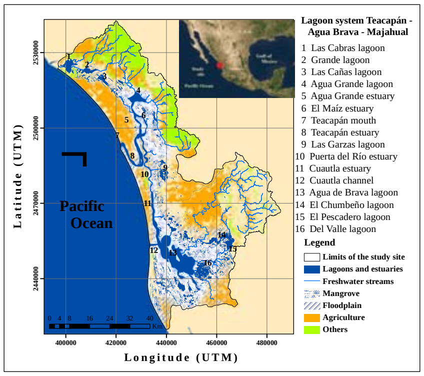


Figure 1.- Location of the study area

The study site is located in the west of Mexico, on the coastal plain of northern Nayarit and southern Sinaloa. It is a huge area that includes rivers flowing Into the Pacific Ocean, coastal lagoons and the vast area known as Marismas Nacionales which is a valuable, protected region of salt marshes (**Figure 1**).

HISTORICAL EVOLUTION OF THE CHANNEL

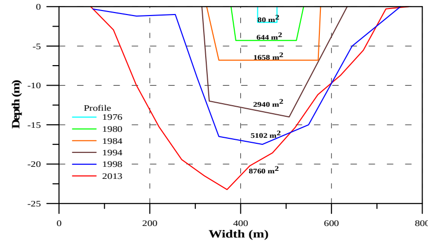


Figure 2.- Evolution of the channel

In the 1970's a 3 km long artificial channel was opened close to the coastal town of Cuautla, with the objective of facilitating fishing activities. Its original cross section was 40 m wide and 2 m deep but its poor design and the large volumes of water that pass through the channel during storms, have eroded the channel to 800 m width and 25 m depth.

The stability of the cross-section of the Cuautla channel was analyzed following Stive and Rakhorst, 2008 procedure to get an equation for estimating the cross-section of the mouth of a lagoon as a function of the tidal prism. The results show that the channel has not yet reached a condition of stability, meaning that if no action is taken, it will continue to grow in width and depth.

$$A_c = 7.6699 \times 10^{-5} P = 9{,}104\ m^2$$

FIELD WORK

The main goal of the work presented here is to understand the hydraulic distribution (flows and water quality) and the morphological evolution of the channel, which has never been thoroughly done before. This will enable us to see how the system is currently working in order to propose an engineering solution focused on stabilizing the channel and recovering the natural areas that have been degraded. Two field trips have been carried out in which bathymetry, sand properties, currents, tides and water quality parameters (salinity) were recorded.

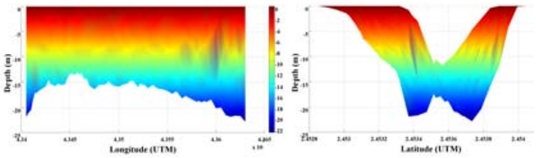
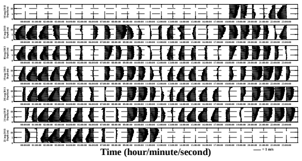


Figure 3.- Bathymetry of the channel

To the authors' knowledge, this is the first time that a detailed bathymetry has been measured; **Figure 3** shows longitudinal (left) and cross (right) views of the channel morphology. It can be seen that the deepest part is at the lagoon end, revealing that the erosion depends on land processes more than on sea processes.



During the second field work, on August 2013 a velocity profiler, AWAC, was installed in the Cuautla channel; **Figure 4** shows a small sample of the velocities recorded for the water column. Tidal phases can be clearly seen.

Figure 4.- Velocities registered at the channel

In the first field work, sand samples were taken along the channel, at the points shown in **Figure 5**. The results of their analysis are shown in the **Table 1**.

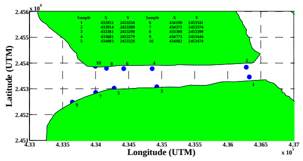


Figure 5.- Location of the sand samples

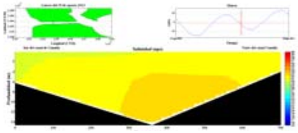


Figure 6.- Salinity in the channel

Table 1.- Sand Properties

N°	ρ (kg/m³)	W_f (cm/s)	D_{50} (mm)	Classification: Standard deviation	Classification: Skewness	Classification: Kurtosis	Type of sediments: Wentworth	Type of sediments: ASTM
1	2,580	0.86	0.119	Moderately sorted	Near symmetrical	Mesokurtic	Very fine sand	Fine sand
2	2,650	2.16	0.144	Moderately sorted	Coarse skewed	Mesokurtic	Fine sand	Fine sand
3	2,550	1.85	0.212	Moderately well sorted	Coarse skewed	Mesokurtic	Fine sand	Fine sand
4	2,600	1.05	0.140	Moderately sorted	Near symmetrical	Mesokurtic	Fine sand	Fine sand
5	2,520	0.96	0.144	Moderately sorted	Near symmetrical	Mesokurtic	Fine sand	Fine sand
6	2,400	1.54	0.185	Well sorted	Near symmetrical	Mesokurtic	Fine sand	Fine sand
7	2,500	1.16	0.156	Moderately sorted	Very fine skewed	Leptokurtic	Fine sand	Fine sand
8	2,410	1.37	0.168	Moderately sorted	Very fine skewed	Platykurtic	Fine sand	Fine sand
9	2,550	2.46	0.262	Moderately well sorted	Very fine skewed	Platykurtic	Medium sand	Fine sand
10	2,460	0.97	0.134	Poorly sorted	Very fine skewed	Leptokurtic	Fine sand	Fine sand

In both field works, salinity samples were taken along the channel (**Figure 6)**. It is possible to identify a body of brackish water on the south of the channel, during the ebb tidal.

Using on site observation nad sediment size distribution, a conceptual model of the flow along the channel has been derived, **Figure 7**, which sets the basis for the design of the engineering solution.

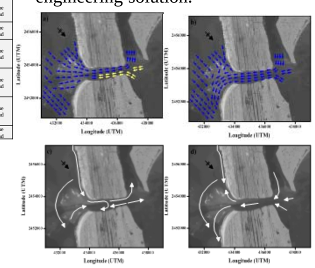


Figure 7.- Conceptual model of the flow and sediment dynamics

HYDRODYNAMIC MODEL

The calibration of a depth integrated NLSWE model was made with data from the first field work and validation was performed with data from the second one.

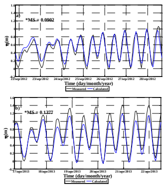


Figure 8.- Comparison between measured and computed free surface levels a) first field work, b) second field work.

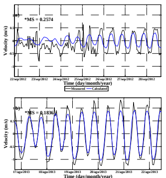


Figure 9.- Comparison of measured and computed currents, only with tidal forcing: a) first field work, b) second field work

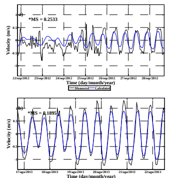
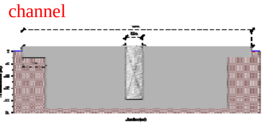


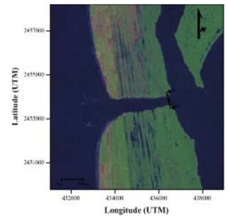
Figure 10.- Comparison of measured and computed currents, tidal forcing and rivers discharge: a) first field work, b) second field work

PERFORMANCE OF THE SOLUTION ALTERNATIVES

In order to send back water to the northern part of the system and to control the erosion of the channel, the following solutions are proposed:

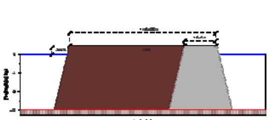
The construction of a rigid structure on the lagoon side channel

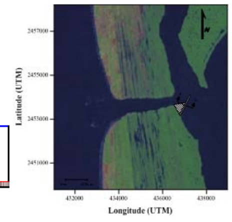




- ✓ Represents an appropriate solution for the erosion control of the channel it also has a desirable impact in the volume of water derived to the northern part of the system.
- ✓ The actual coastal activities and dynamics will be affected.
- ✓ It is technically and economically feasible, but the operation of the gate requires strict control and monitoring of the changes in the system.

Building a rigid structure within the Agua Brava Lagoon





- ✓ Is a suitable solution for erosion control without major alteration of the actual coastal activities and dynamics.
- ✓ It has null maintenance and operation costs.
- ✓ It has little impact in the volume of water given to the northern part of the system.
- ✓ Biological type analysis to determine how much would be appropriate to alter channel morphology is necessary.

Circuito Escolar, Edificio 5, Cub. 408
Ciudad Universitaria, Coyoacán
04510, México, DF, México

www.ii.unam.mx

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