

SALT INTRUSIONS INTO A FRESHWATER SPRING IN A TROPICAL COASTAL LAGOON, YUCATAN, MEXICO

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INTRODUCTION

The study of salt intrusions into unconfined aquifers, besides the intrinsic scientific interest, is increasingly important because of its utility for the management and treatment of freshwater reservoirs. In the Yucatán peninsula, underground water is the only source of drinking water. The combined recent intensive freshwater exploitation and sea level rise make the salinity intrusion to the aquifer a serious problem (Vera et al. 2012, Parra et al. 2016).

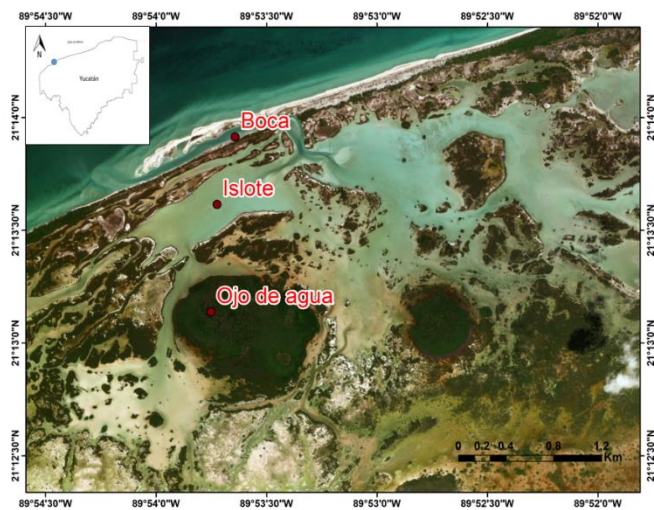


Figure 1. Location of the study area

La Carbonera lagoon (LC) is located in the Yucatán peninsula, where the geology is karst and relevant freshwater flows are conducted through fractures and caverns in the underground. At LC, one intense freshwater spring (Ojo de Agua) is located in the southern region (Figure 1). LC can be classified as a restricted coastal lagoon Kjerfve, 1986), shallow, with tidal and wind driven circulation and brackish to hypersaline water, except near Ojo de agua, where freshwater dominates.

This investigation presents salinity intrusions observed within one year of in situ measurements at the freshwater spring and their relations with atmospheric and marine variables.

METODOLOGY

Temperature, salinity and water level were registered three sites: Boca, Islote and Ojo de Agua from September 5 of 2014 to August 20 of 2015, by mooring CTD Divers at each point (Figure 1). During the same period, wind data was collected from a weather station located 15 km to the west from LC. Despite the efforts, a gap in the data exists from February to June of 2015.

RESULTS

Salinity and temperature at the freshwater spring were nearly constant along the entire sampling period, except during ten events where “peaks” in each variable occurred (Figure 2). The duration of the events varied from 1 to 10 hours. In all cases, salinity was higher (2 to 20 units) than the base level. On the other hand, as salinity increased, in summer, temperature increased, because lagoon water was hotter than groundwater. During the winter time, as salinity increased the temperature decreased, because lagoon water was cooler than groundwater. Examples of both winter and summer events are show in Figure 2 b and c.

All salinity increments occur at low local water level (at Ojo de Agua), exclusively during spring tides with a tidal range of at least 58 cm. A delay between the lowest water level and the salinity maximum at Ojo de Agua was observed, varying from 0.5 to 3.6 hours. The delay can be explained by the morphology of the elongated channel that connects the spring with the lagoon where previously discharged groundwater intrudes before saline water is registered at the spring mouth.

The pressure sensors revealed that the tide slows from the mouth into the lagoon, while the water level fluctuations are transmitted almost simultaneously through the subterranean porous media. In consequence, the lowest water level at Ojo de Agua is reached when the tidal wave is still propagating by the surface. The low water level in Ojo de Agua leads a surface flow inversion and later on, salt intrusion. The water level records at Boca, Islote and Ojo de Agua effectively show this.

Preliminary results show that northerly winds had the most dramatic influence enhancing salt intrusion during longer periods (e.g. third intrusion event occurred with strong wind from the north (~29 m/s)), the in situ measured salinity varied from 1.58 to 17.8 and the inflow was observed for about 10.1 hours.

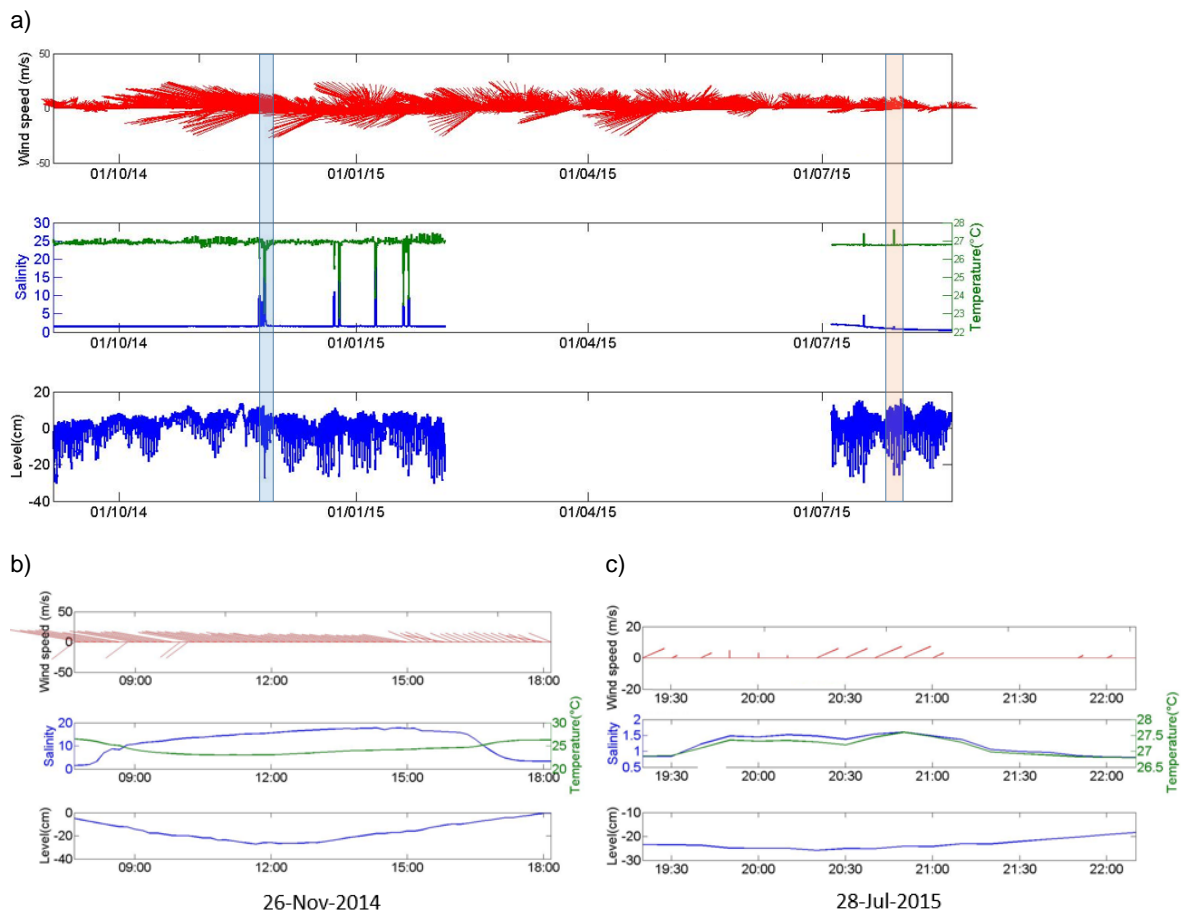


Figure 2. a) Wind and water level variations during salt intrusion events revealed through temperature and salinity peaks; b) and c) are detailed sections of the two events highlighted in a)

REFERENCES

- Kjerfve (1986): Comparative oceanography of coastal lagoons. Estuarine Variability (Wolfe, ed). Academic Press, New York, pp. 63-81
- Parra, Valle-Levinson, Mariño-Tapia, Enríquez (2015): Salt Intrusion at a submarine spring in a fringing reef lagoon. Journal of Geophysical Research: Oceans, vol.120, pp. 2736-2750.
- Vera, Mariño-Tapia, Enríquez (2012): Effects of drought and subtidal sea-level variability on salt intrusion in a coastal karst aquifer. Marine and Freshwater Research, vol 63, pp. 485-493.

EXCEED - SWINDON Conference 2019

THE FUTURE OF WATER RESOURCES

October 13th - 16th, Mérida, Mexico



Programme and Book of Abstracts

PROGRAMME

Sunday, 13 th		Arrival	
19:00	-	21:00	Welcome cocktail

Monday, 14 th		Conference Day 1	
08:30	-	09:00	Registration
09:00	-	09:30	Opening Ceremony <ul style="list-style-type: none"> • Norbert Dichtl • Andreas Haarstrick • Rodolfo Silva • Local authority
09:30	-	10:00	Keynote speech <ul style="list-style-type: none"> • Norbert Dichtl
10:00	-	10:10	Break
Session 1: The impact/performance/role of SDGs Chairman: Valeria Chávez			
10:10	-	10:30	Exploring some ocean energy possibilities in Latin America (Jassiel Hernández)
10:30	-	10:50	Water energy nexus in the MENA region (Abbas Al-Omari)
10:50	-	11:10	Ocean energy and marine biodiversity affectations: a life cycle assessment review (Dora Ruiz-Méndez)
11:10	-	11:40	Coffee Break
Session 2: Water-Energy-Nexus (I) Chairman: Dwi Andreas Santosa			
11:40	-	12:00	Wastewater/waste to energy in MENA region: A review for opportunities (Zeinab Abou Elnaga)
12:00	-	12:20	Water-energy nexus in a wastewater treatment plant: Energy efficiency and recovery (Wang Hongtao)
12:20	-	12:40	From wastewater treatment plants to a resources recovery facility (Marcelo Nolasco)
12:40	-	13:00	Seasonal assessment of the energetic potential associated with salinity gradient: Champoton River, Mexico (Gregorio Posada Vanegas)
13:00	-	14:30	Lunch
Session 3: Water, ecosystem and socio-economic integrating aspects (I) Chairman: Germán Rivillas			
14:30	-	14:50	Decolourization and mineralization of acid green 25 dye through single and catalytic ozonation (Liliana Amaral Féris)

14:50	-	15:10	Adsorption of naphtholate-as dye in wastewater of batik industry using green synthesized zn layered hydroxyl salts (Sri Juari Santosa)
15:10	-	15:30	Adsorption of hexavalent chromium in coal beneficiation tailing in fixed bed column (Liliana Amaral Féris)
15:30	-	15:50	Kinetics of the adsorption of anionic and cationic dyes in aqueous solution by low-cost activated carbons prepared from sea cake and cotton cake (Ibrahim Tchakala)
15:50	-	16:10	Distribution of microplastics in water and sediment in a Biosphere Reserve (Cecilia Enriquez)
16:10	-	16:30	Evaluation of microplastics contamination in the margins of the Patos Lagoon in south of Brazil (Eduardo Saldanha Vogelmann)
16:30	-	17:00	Coffee Break
Session 4: Water, ecosystem and socio-economic integrating aspects (II) Chairman: Rodolfo Silva			
17:00	-	17:20	Hydrodynamic modelling of the Huave Lagoon System, Oaxaca (María Fernanda González Amador)
17:20	-	17:40	Impact effects of hard infrastructure in Salamanca Natural Park (Juan Carlos Caez-Perez)
17:40	-	18:00	The decision-making in face to coastal squeeze, analysis between social and economic impacts: Case study of Campeche, Mexico (Debora L. Ramírez-Vargas)
18:00	-	18:30	Keynote speech • Elvis Carissimi
20:00			Dinner

Tuesday, 15th		Conference Day 2	
Session 5: Water, ecosystem and socio-economic integrating aspects (III) Chairman: Arwa Naser Damen Hamaideh			
09:00	-	09:20	Dispersion of submarine groundwater discharges in reef lagoons and associated environmental effects (Arlett Rosado Torres)
09:20	-	09:40	Salt intrusions into a freshwater spring in a tropical coastal lagoon, Yucatán, Mexico (Xaní Malagón)
09:40	-	10:00	Variability of the saline gradient in a hypersaline coastal lagoon (Brenda Natalia Fitch Geymonat)
10:00	-	10:20	Sedimentation and water quality status of lake Tana, the headwaters of the Blue Nile, Ethiopia (Seifu A Tilahun)
10:20	-	10:40	An innovative approach to mitigate risks on the existing iron tailings dams in Brazil (Jose Araruna)

10:40	-	11:00	Urban sustainable water management and water efficiency improvement for buildings – a case study for Istanbul (Ahmet Baban)
11:00	-	11:30	Coffee Break
Session 6: Water-Energy-Nexus (II) Chairman: Eduardo Saldanha Vogelmann			
11:30	-	11:50	Reverse electrodialysis for energy and water: coupled systems based in salinity gradients (Mateo Roldan-Carvajal)
11:50	-	12:10	Development of graphene oxide membranes for its use in reverse electrodialysis systems (Eddie López Honorato)
12:10	-	12:30	Development of graphene oxide based materials for water treatment (Ana Cecilia Reynosa Martinez)
12:30	-	12:50	Laboratory experiences on marine energy conversion devices for supplying electricity demand of remote coastal communities (Jassiel Hernández)
12:50	-	13:10	Plate type obstacles used for coastal protection and power generation (Luis Eduardo Pérez Paez)
13:10	-	14:40	Lunch
Session 7: Water, ecosystem and socio-economic integrating aspects (IV) Chairman: Thi Thanh Van Ngo			
14:40	-	15:00	Evaluating combinatorial water treatment by locally available materials (Chrispin Kowenje)
15:00	-	15:20	Desalination by capacitive deionization as a tool to provide drinkable water to small communities in the Brazilian semiarid (Luis Augusto Martins Ruotolo)
15:20	-	15:40	Fluoride ions removal from groundwater by alumina adsorption (Elvis Carissimi)
15:40	-	16:00	Bio-refineries: A new concept towards green energy production from agroindustrial wastewater (Víctor Alcaraz)
16:00	-	16:20	The importance of water and nutrients management in paddy fields as an effort to increase crop yields and producing an electrical energy through microbial fuel cells (Dwi Andreas Santosa)
16:20	-	16:50	Coffee Break
16:50	-	17:20	Keynote speech • Klaus Fricke
16:50	-	18:00	Panel discussion Moderators: Edmilson Santos de Lima and Norbert Dichtl
20:00			Gala dinner