

DISPERSION OF SUBMARINE GROUNDWATER DISCHARGES IN REEF LAGOONS AND ASSOCIATED ENVIRONMENTAL EFFECTS

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INTRODUCTION

In some regions of the world, such as the Yucatan Peninsula, most of the continental water contribution to the ocean comes from Submarine Groundwater Discharges (SGD); a mixture of freshwater from the continental aquifer with recirculated seawater (Li et al. 1999; Taniguchi et al. 2002). SGDs are recognized as an important pathway to the transport of materials and properties to the marine environment (Burnett et al. 2006), and occur diffusely, or punctually as groundwater springs (Stieglitz 2005). Currently, there is little quantitative information regarding submarine groundwater discharges into the sea because the measurements are difficult to achieve given the temporal and spatial variability of the flows, and the inconspicuous nature of the phenomenon (Stieglitz 2005; Burnett et al. 2006). However, the importance of nutrient fluxes associated with groundwater reaching coastal environments has been widely recognized (Burnett et al 2007; Santos et al. 2008; Hernández-Terrones et al. 2011). The discharge of groundwater can play a significant ecological role because its nutrient concentrations are usually greater than those of surface seawater (Stieglitz 2005), and therefore, even a small flow of groundwater can raise coastal nutrient concentrations (Li et al. 1999; Stieglitz 2005; Burnett et al. 2006). SGD also act as a source of organic and inorganic carbon, and other dissolved species that may be contaminants (e.g. caffeine, cotinine, cocaine) (Metcalfe et al. 2011) to coastal waters and ecosystems (Burnett et al. 2007). Worldwide, the discharge of nutrients from SGD can be 3 to 4 times greater than that associated with rivers and provide important flows of nutrients such as N, P and Fe (Johannes 1980; Santos et al. 2008).

In addition to the continental contribution, there are extreme events capable of increasing the nutrient concentration in the coastal zone (e.g. upwelling (van Tussenbroek 2011) or massive macroalgal blooms (Hillard 2015)), which can generate important transformations in the ecosystem and must be taken into account.

The site of study, Puerto Morelos reef lagoon (PMRL) is located on the north-eastern coast of the Yucatan Peninsula, ~25 km south of Cancun. The coast off Puerto Morelos is fringed by a reef that stretches about 4 km in length alongshore, creating a reef lagoon whose width varies between 550 and 1,500 m (Coronado et al. 2007) (Figure 1).

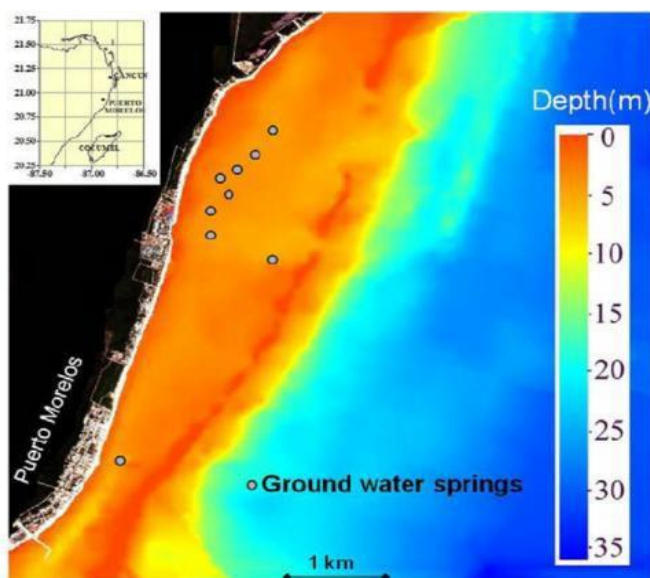


Figure 1. Location of Puerto Morelos, Q. Roo, México and groundwater springs in the reef lagoon (Mariño et al. 2010).

SGD INFLUENCE AND DISPERSION PLUMES

Previous studies of point source SGDs in the PMRL have shown that these systems are strongly modulated by sea level (tides and wave set up; Parra et al. 2015) and the salinities can decrease up to 26 psu. Nevertheless, during the present study, we have found clear evidence of SGD influence with salinity values as low as 10 PSU (measured with CTD) on the reef crest (Figure 2) which seems to be of a diffusive nature as there is no spring. Furthermore, the concentration of nitrates and silicates in water samples would confirm the presence of a diffuse SGD in the forereef. This is relevant because this discharge could have important implications for the surrounding ecosystem, including excessive growth of macroalgae and reduction in reef roughness (Rosado-Torres et al., 2019). The mechanisms that disperse the SGD waters on the ocean and the respective regions of influence have not been studied, therefore the aim of this work is to investigate the dispersal of SGD waters under the influence of several oceanographic mechanisms.

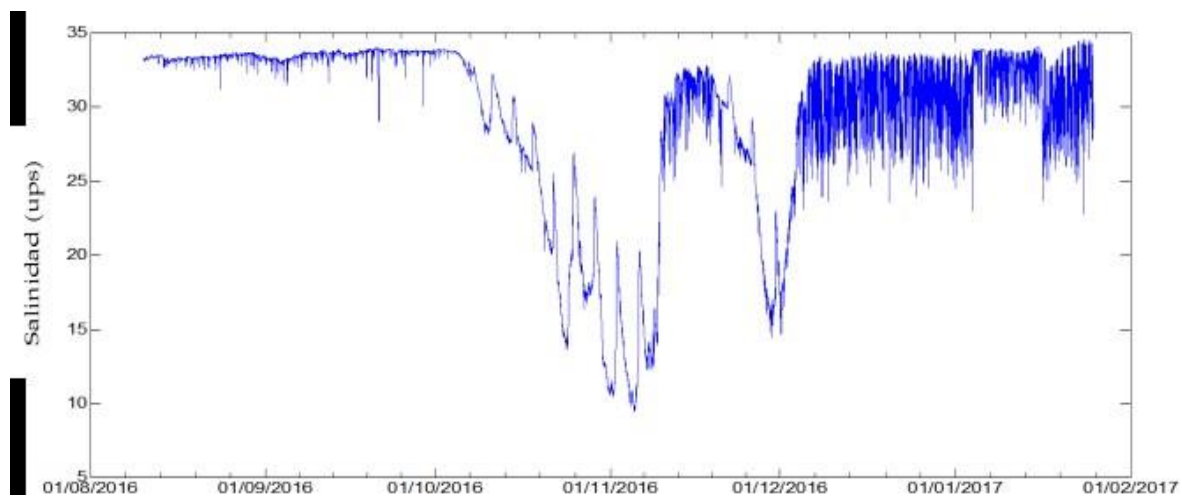


Figure 2. Salinity measures at the fore-reef from a CTD Diver.

Numerical modelling using the Delft 3D hydrodynamic model (FLOW and WAVE modules) has been implemented at the site, in order to determine the regions of SGD influence at the reef lagoon. The model was validated with measurements of oceanographic instruments installed in the lagoon and forereef. Wave, wind, sea level and the effects of different SGD discharges and their magnitudes were included in the model. Different combinations of environmental conditions are tested to create dispersion scenarios and determine the consistency of their patterns. This seem to explain the observed effects of ecosystem change and reef degradation at the site. Further results will be presented of the 3D circulation established on the site and the relative importance of different processes on the modelled dispersion patterns, including the residence time of different regions of the reef lagoon.

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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)
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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