Baroclinic dynamics at the downstream junction of the Bassac River, Mekong Delta, Vietnam

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Introduction

The rapidly urbanizing and low-lying Mekong Delta (Figure 1, left panel) is suffering from salt intrusion. Excessive ground water extraction and land use change (urban development) are perhaps leading to subsidence rates exceeding sea level rise (Minderhoud et al. 2015 and Erban et al. 2014). In the context of the Rise and Fall project, we study the effect of subsidence on saltwater intrusion in the Mekong delta. To characterize the salinity patterns and estuarine dynamics near the junction, field data were collected near the most downstream junction of the Bassac River (Figure 1). The main question addressed at this poster is:

What are the estuarine dynamics of the two downstream branches of the Bassac and how do they interact?

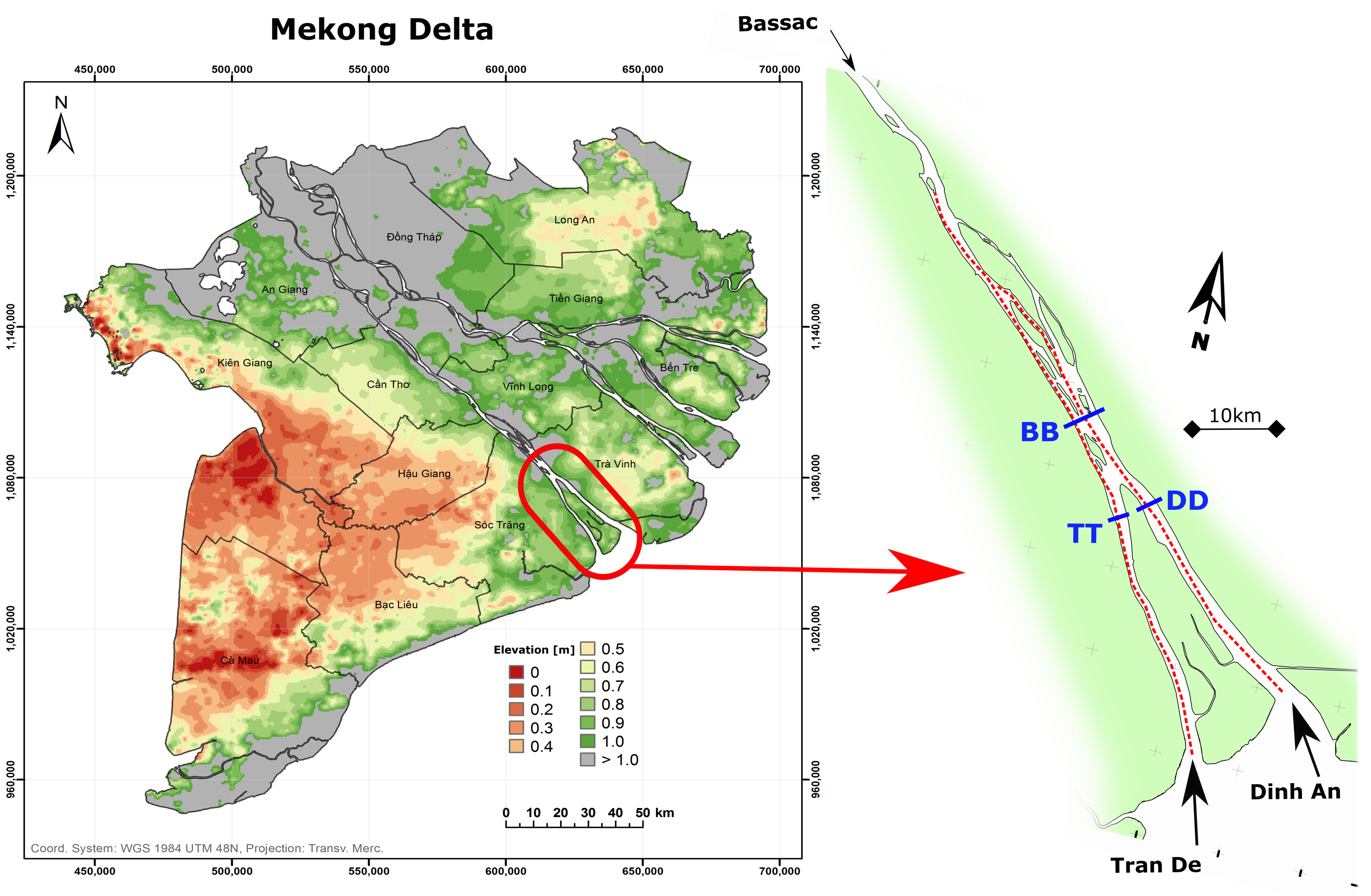


Figure 1. Left panel: elevation map of the Mekong Delta, Vietnam, with warmer colors emphasizing vulnerability to sea level rise or land subsidence (from Coumou & Minderhoud 2016) and the field campaign location encircled in red. Right panel: The Bassac River and the two downstream branches (Dinh An and Tran De) with the moving boat measurement tracks in dashed red line and the cross-channel ADCP measurements in solid blue line.

Set-up of the field campaign

The field campaign took place during the transition from neap to spring tide, in April 2016.

- Salinity structure along the estuary at High Water Slack (HWS) was measured at the beginning (neap tide) and at the end (spring tide) of the measurement campaign (see the sailing tracks in Figure 1, right panel) following the moving boat technique of Savenije (1989). Salinity was converted from conductivity and temperature measured by Tetracon 700IQ sensors, read from a WTW logger onboard.

- Water levels were measured at 7 stations along the two-channel system.

- Flow velocities were measured for 13 hours at the three cross-sections using a 600 kHz Teledyne-RDI ADCP, mounted to a wooden boat.

- At three pre-defined points per cross-section (CTD stations), salinity was measured over depth (See Figure 2).

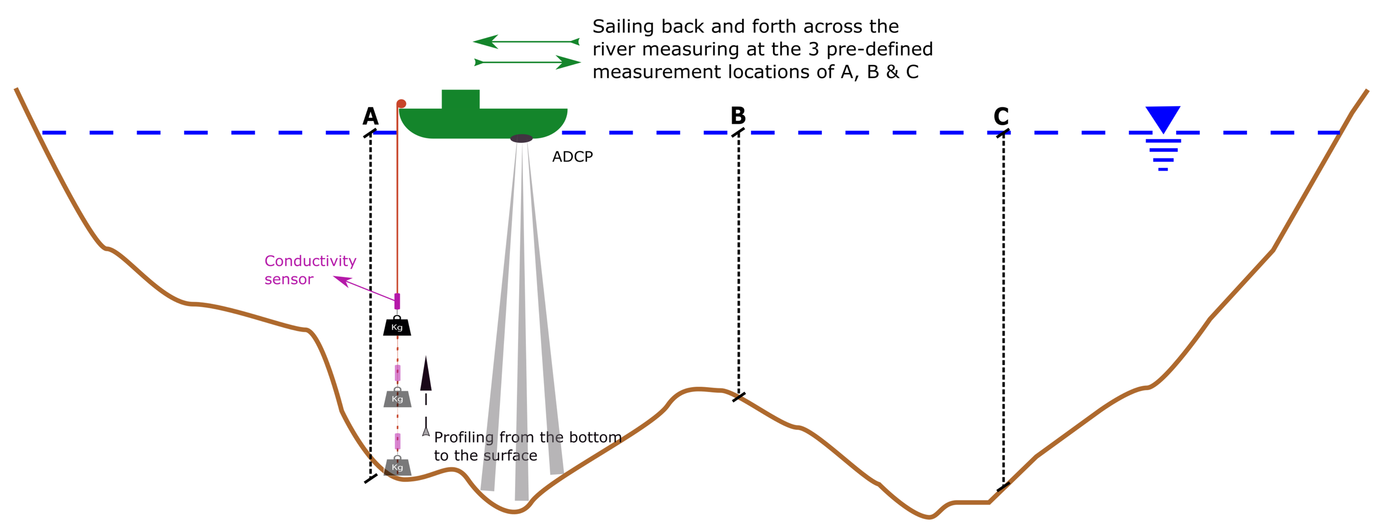


Figure 2. A diagram showing the measurement set-up

Post-processing

The ADCP data were projected on a fixed grid over the cross-section. The data with low correlation or high error was filtered and spatial averages were interpolated over the projection grid. The resulting flow velocities were harmonically analyzed, resulting in amplitude and phase of the semi-diurnal tide and higher harmonics (M_2, M_4 & M_6) and the tidal mean were determined (see Figure 4b, c &d). Note that due to 13-hour measurements, and the mixed tide in the Mekong Delta (diurnal and semi-diurnal), it is difficult to discriminate between the diurnal tide and the calculated mean flow.

To derive the salt flux at the CTD stations (Figure 4a & 4e), the salinity profiles were then multiplied by local velocities (per grid point) and integrated over depth.

Preliminary observations

- There can be significant difference in salinity between the two downstream branches (Figure 3). During neap tide, salinity in the deeper and wider ´Dinh An´ channel was higher than in the ´Tran De´ channel. During spring tide the two channels show a more similar salinity structure. Furthermore, during spring tide the estuary is more mixed while during neap tide it can be relatively stratified.

- The measured along–channel M2 velocities show clear phase differences between the three channels, and within the cross-sections. For example the tidal wave arrives to the junction from 'Dinh An' earlier than Tran De, and across DD (Dinh An), the phase difference reach up to 1 hour.

- The residual flow in the main river (Bassac) shows strong spatial variation across the cross-section (upstream near the left bank and downstream near the right bank, see Figure 4b).

- From the local salt flux diagram (Figure 4a) and the demonstrated salt flux assymetry across different cross-sections, it is conceivable that there is a salt flux from the wider and deeper ´Dinh An´ to the shallower and narrower ´Tran De´.

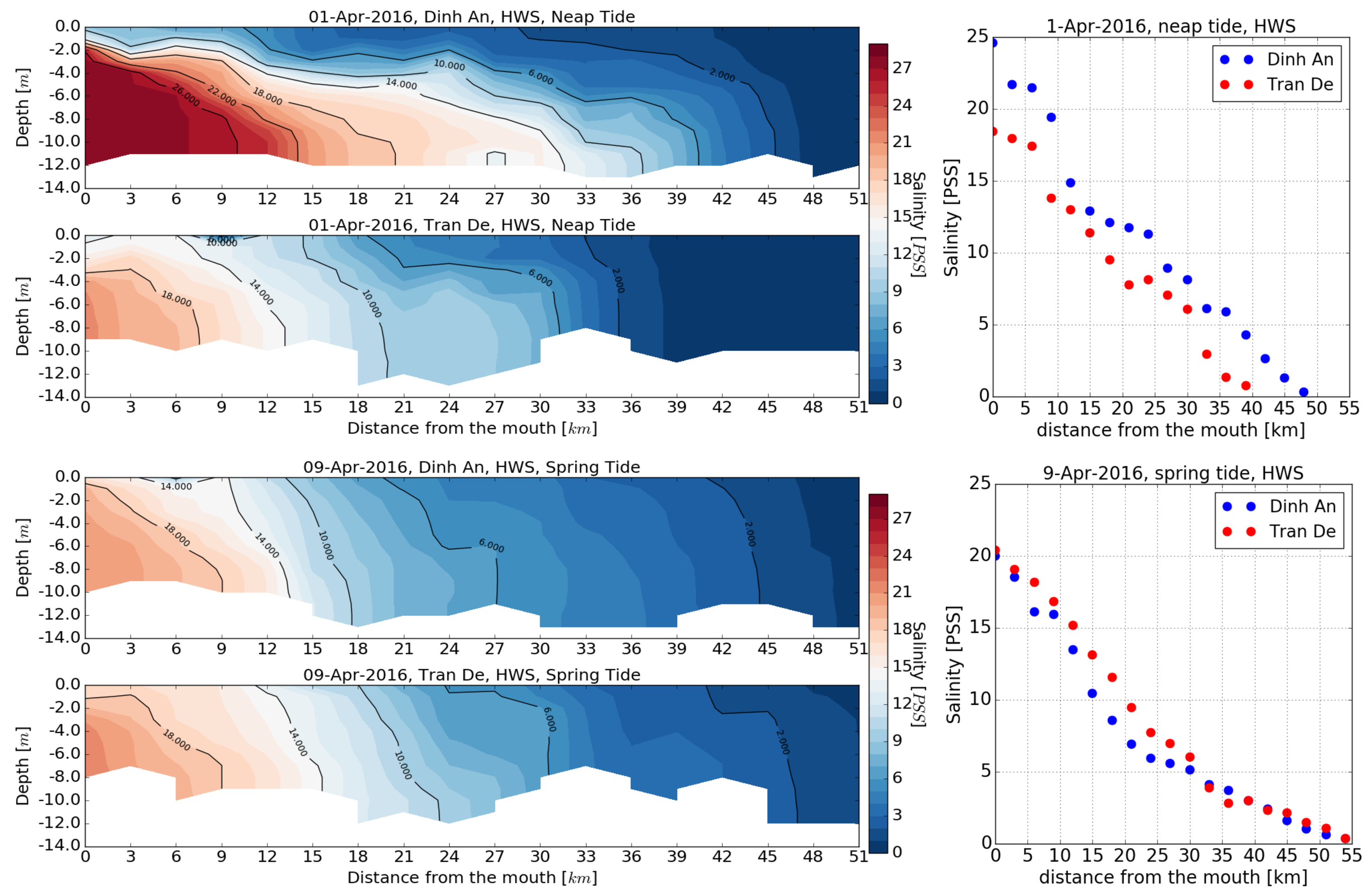
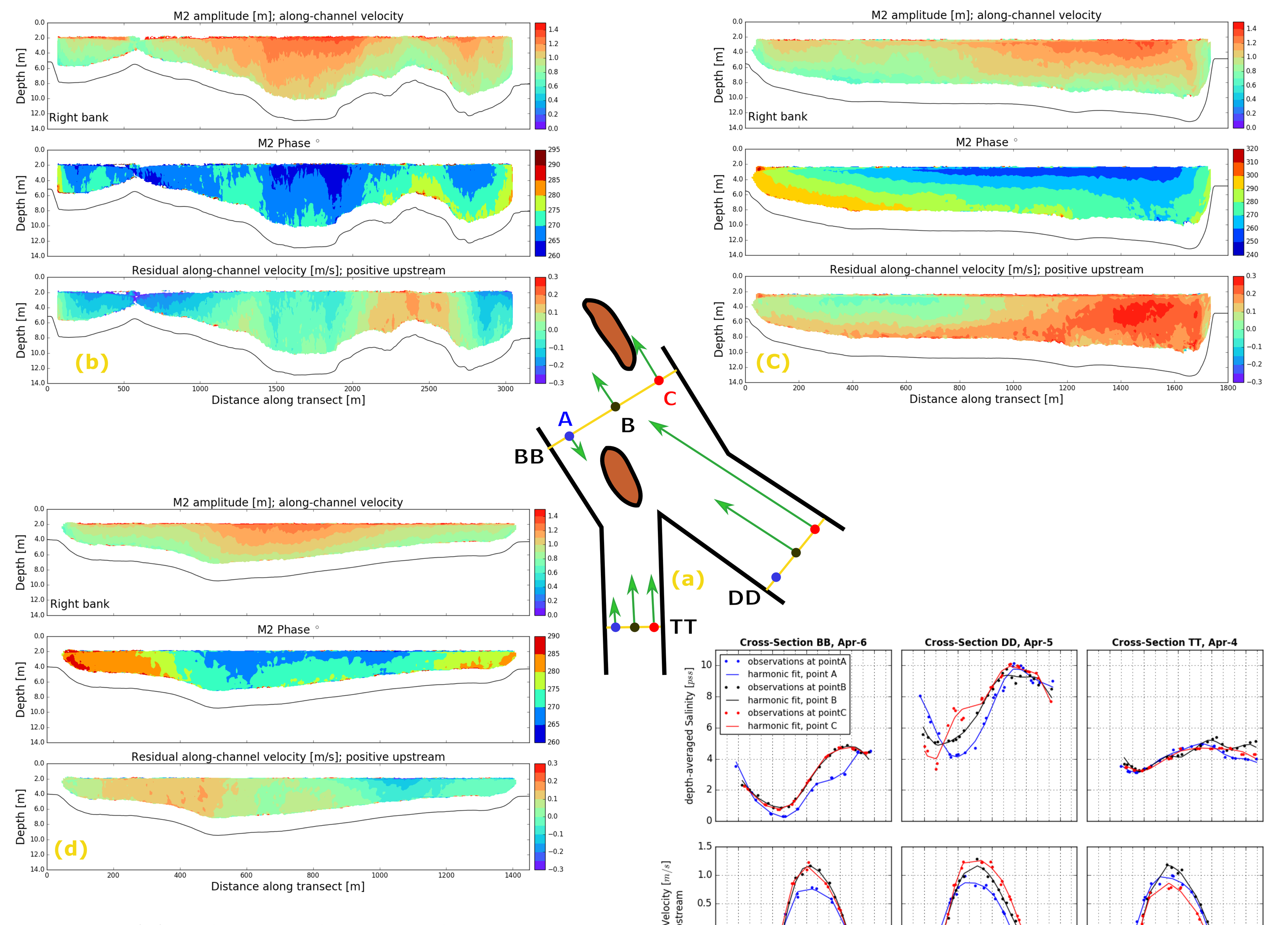


Figure 3. Salinity Structure along the two estuary channels at the beginning and at the end of the field campaign



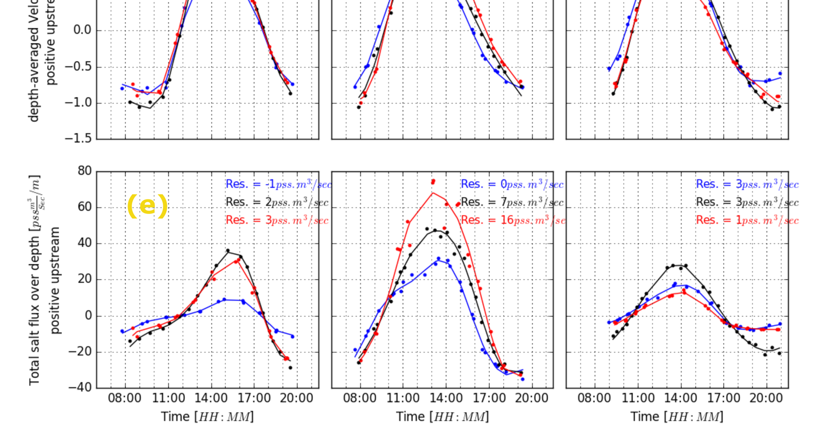


Figure 4. (a) A diagram depicting the Bassac River and its two branches near the junction with the measured salt fluxes (shown by scaled arrows). (b),(c) & (d) show the harmonically analyzed ADCP data of DD and TT respectively. (e) Time series of local depth-averaged salinity (top panels), depth-averaged velocity (middle panels) and total salt flux (lower panels) at points A, B and C (per panel) per cross-section (BB, DD & TT in columns). In each panel, the dots show observations and the solid line is the harmonic fit.

Future steps

By calibrating a 3D numerical model, the salt and fresh water fluxes at the junction and between the two channels will be studied in detail to explain the physics of salinity intrusion in this multi-channel estuarine system.

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