MONITORING INLET MORPHODYNAMICS VIA TIDAL RESPONSE, SEEN THROUGH A NOVEL 24.5HOUR MOVING WINDOW

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INTRODUCTION

The understanding of inlet morphodynamics remains an important and fascinating challenge for coastal engineers. This understanding is improved through more data of which, measured morphological data is perhaps the most obvious option. It is however expensive and hence scarce. Another option is to use more abundant tide gauge data and infer the underlying morphodynamics as in: reduced tidal response in a coastal lagoon indicates that the inlet has become more restrictive to tidal flow.

This line of thought is not new, but we present a novel approach to tidal analysis. Traditional approaches have looked for the change to the astronomically defined M_2, S_2, O_1, K_1, etc However, in order to resolve the most important 4 or 5 say astronomical components a window of two weeks or more is necessary and this is too long for capturing morphological changes through storm events, which usually last only 2 to 5 days.

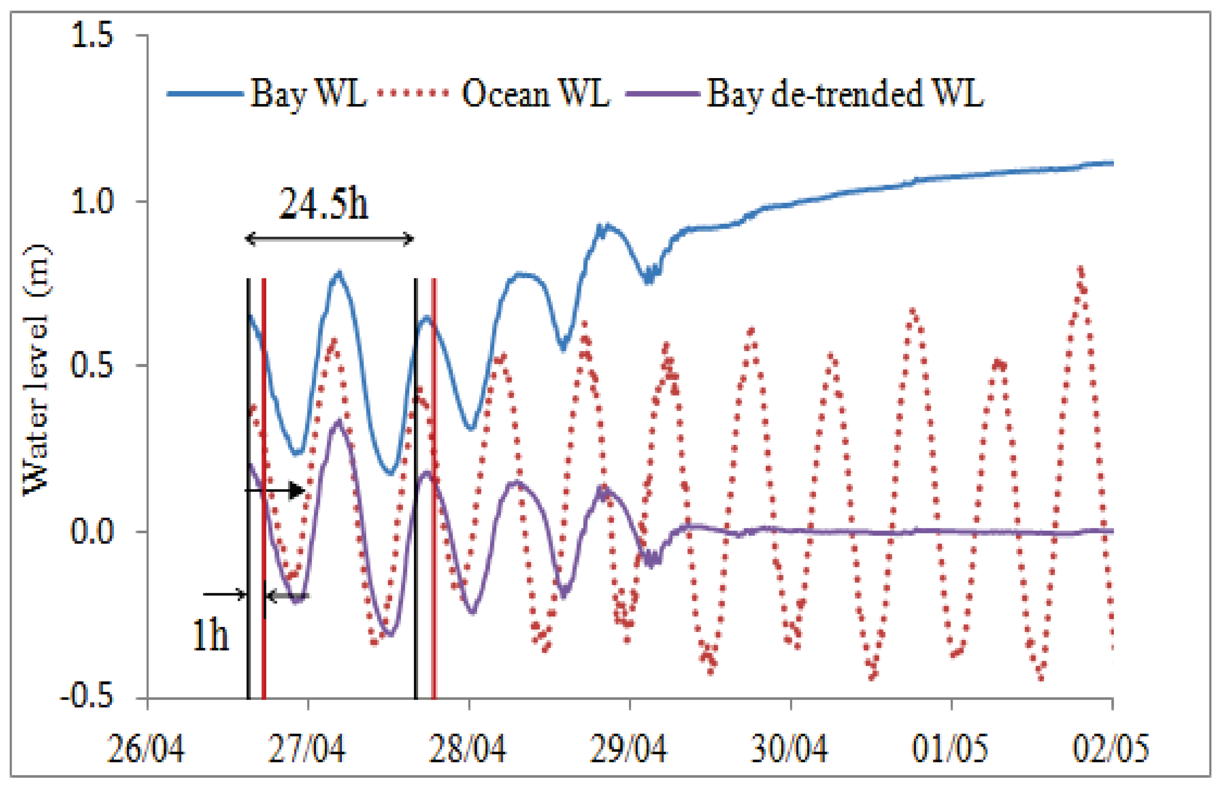

Figure 1: Illustration of the 24.5h moving window concept during Closure Event at Avoca inlet April, 2011

METHODOLOGY

The promising testing of a different approach, which works with a moving 24.5hour top-hat window. Within each window a diurnal 24.5hour component $\eta_{\text{diurnal}} = a_{\text{diurnal}}(t)\cos\left[\frac{2\pi}{24.5\text{hours}}t' - \varphi_{\text{diurnal}}(t)\right]$ and an analogous 12.25hour semi-diurnal component $\eta_{\text{semi-diurnal}}$ are determined. By comparing amplitudes and phases from tide gauges outside and inside the inlet time series of the gains [$G_{\text{diurnal}}(t)$, $G_{\text{semi-diurnal}}(t)$] and phase lags [$\varphi_{\text{diurnal}}(t)$, $\varphi_{\text{semi-diurnal}}(t)$] of the lagoon tide are obtained. Figure 1 sketch the 24.5h moving window concept.

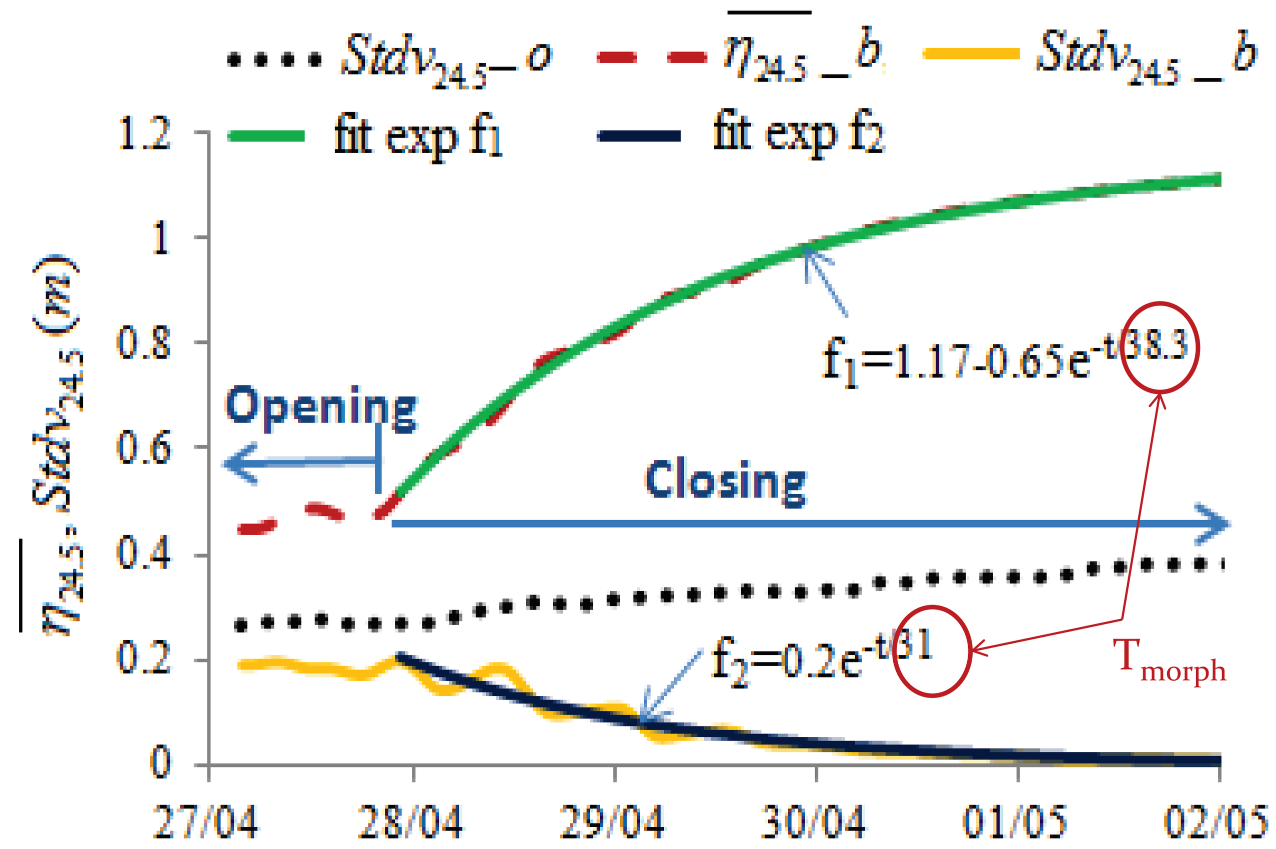

Figure 2: $\overline{\eta_{24.5}(t)}$ of bay tides, $Stdv_{24.5}(t)$ of ocean and bay, T_{morph} computed by fitting exponential curves of $\overline{\eta_{24.5}(t)}$ & $Stdv_{24.5}(t)$ for the bay during Closure Event April , 2011 at Avoca. Notation "o" for ocean and "b" for bay.

APPLICATION & RESULTS

The application of the 24.5h moving window method in monitoring inlet morphodynamics is presented in three categories of events, viz.,

1) closure events with determining T_{morph} for small tidal inlets of NSW (Figure 2) from $Stdv_{24.5}(t)$ & $\overline{\eta_{24.5}(t)}$ Response function $F_{\text{semi-diurnal}}$ for dominant component in Figure 3 moving 'monotonically' towards the origin corresponding to inlet restriction during closure, along a curve which resembles the half-circle

2) flood event in a medium sized system (Brunswick River, NSW- Figure 4) with no clear evidence of enlarged entrance, due to scouring, by the large flow Q_f leading to more hydraulic efficiency.

3) surge events in a large system (Thyborøen Inlet, Denmark- Figure 5). During surge events 1, 2, 3 following the flushing event $\overline{\eta_{24.5}(t)}$ drops sharply, G_2 increases and φ_2 reduces. This indicates that the inlet scours out due to the significant outflow resulting in increased hydraulic efficiency.

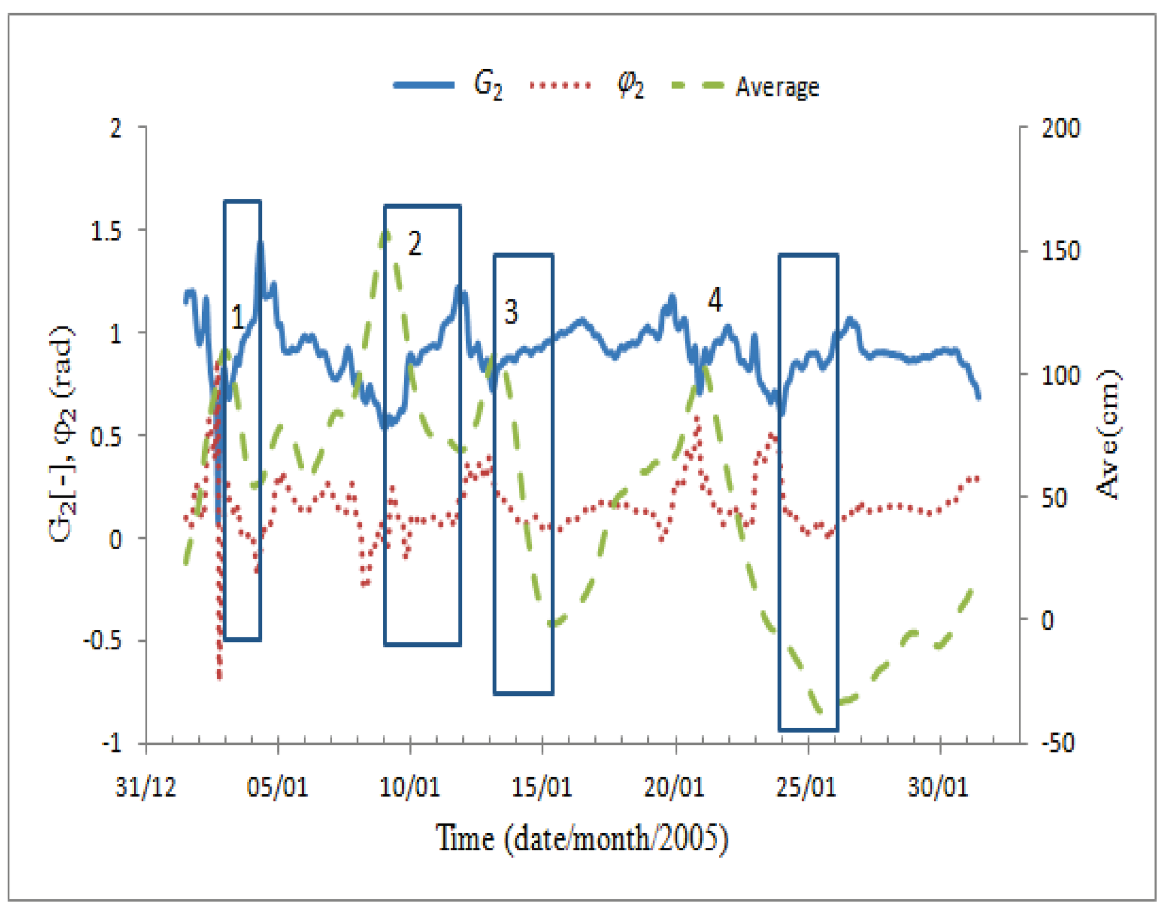

Figure 5: Gain, G_2, increases and phase lag, φ_2, reduces of primary component with $\overline{\eta_{24.5}(t)}$ drops sharply indicate that the inlet scours out due to the significant outflow by surge events at Thyborøen inlet, Denmark

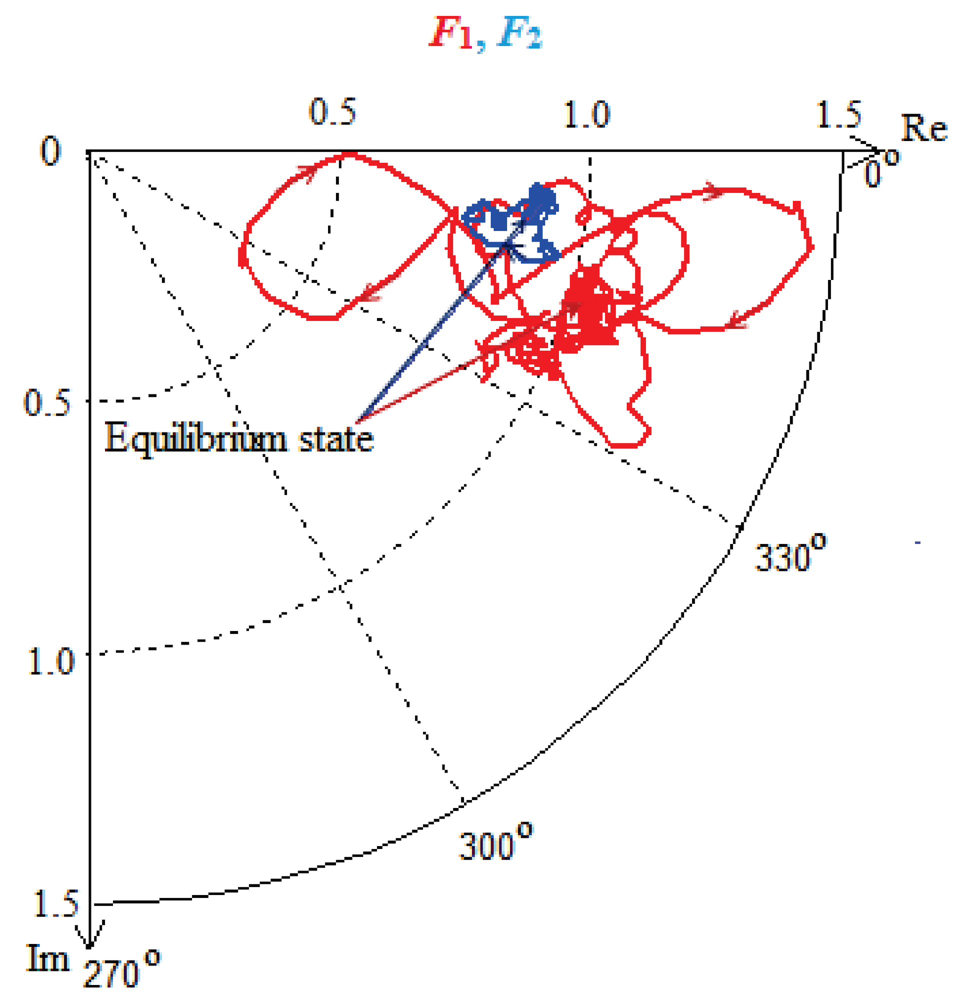

Figure 4: The track of diurnal constituent F_1 (red) and dominant constituent F_2 (blue) running out of equilibrium during flood event in May 2009 and then returning to the equilibrium point in complex plane at Brunswick River

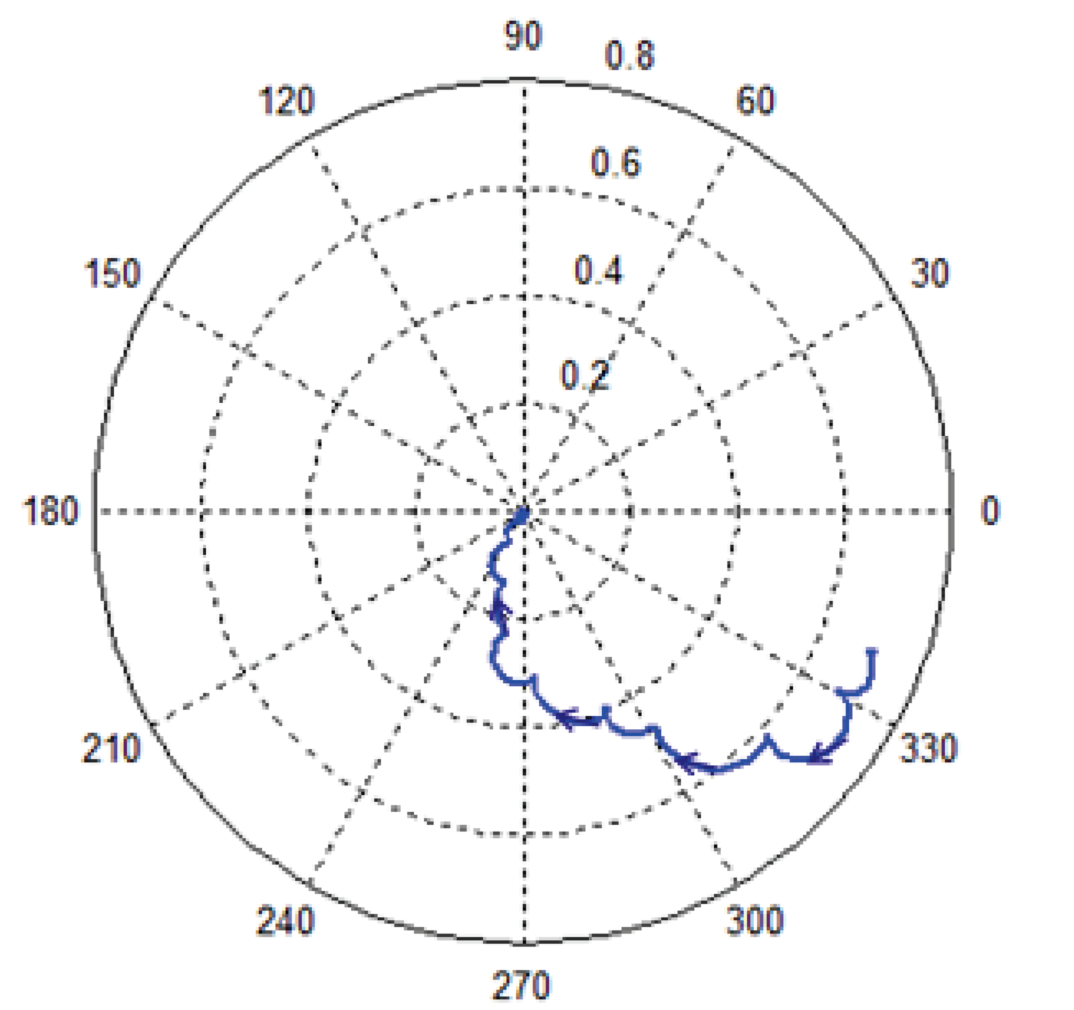

Figure 3: Response function $F_{\text{semi-diurnal}}$ for dominant component moving 'monotonically' towards the origin during closure, along a curve which resembles the half-circle

CONCLUSIONS

- The new method is effective way to determine morphology time scale T_{morph} for closure events at small inlet systems
- Relation between T_{morph} ~ external forces of waves and tides can be made to estimate T_{close} then help researchers and local authorities better in management coastal inlets.
- It is a good approach to investigate the occurrence of change in hydraulic efficiency due to surge or flood events for large systems