

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



Thuy T. T. Vu, Water Resources University, Vietnam, vuthuyau@gmail.com, The University of Queensland, Australia,
Peter Nielsen, The University of Queensland, Australia, p.nielsen@uq.edu.au,
David P Callaghan, The University of Queensland, dave.callaghan@uq.edu.au



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.

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 $\eta_{\text{diurnal}} = a_{\text{diurnal}}(t) \cos \left[\frac{2\pi}{24.5\text{hours}} t' - \phi_{\text{diurnal}}(t) \right]$ 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 $[\phi_{\text{diurnal}}(t), \phi_{\text{semi-diurnal}}(t)]$ of the lagoon tide are obtained. Figure 1 sketch the 24.5h moving window concept.

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.

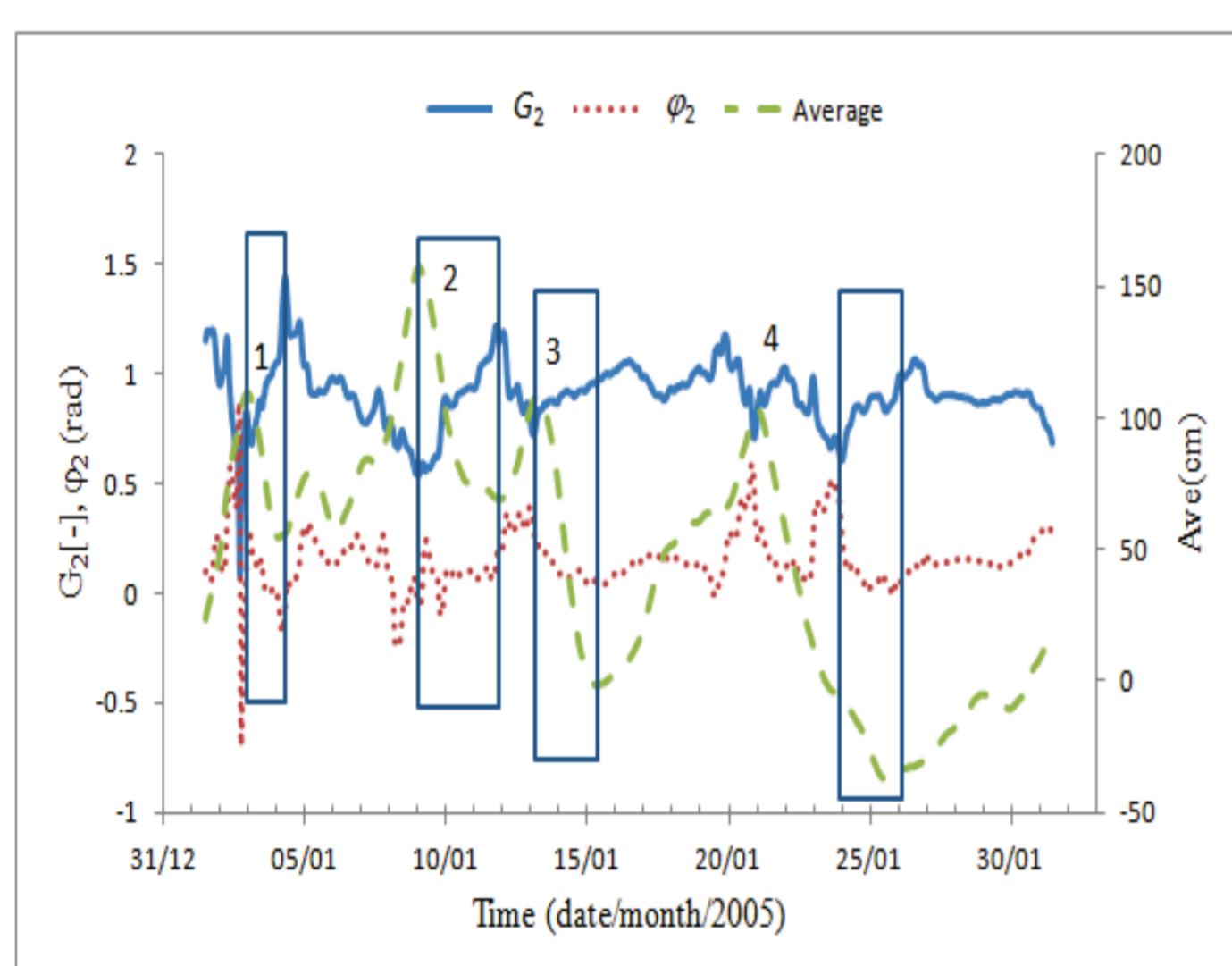


Figure 5: Gain, G_2 , increases and phase lag, ϕ_2 , reduces of primary component with $\overline{\eta_{24.5}}(t)$ drops sharply indicate that the inlet scours out due to the significant outflow by **surge events** at Thyborøen inlet, Denmark

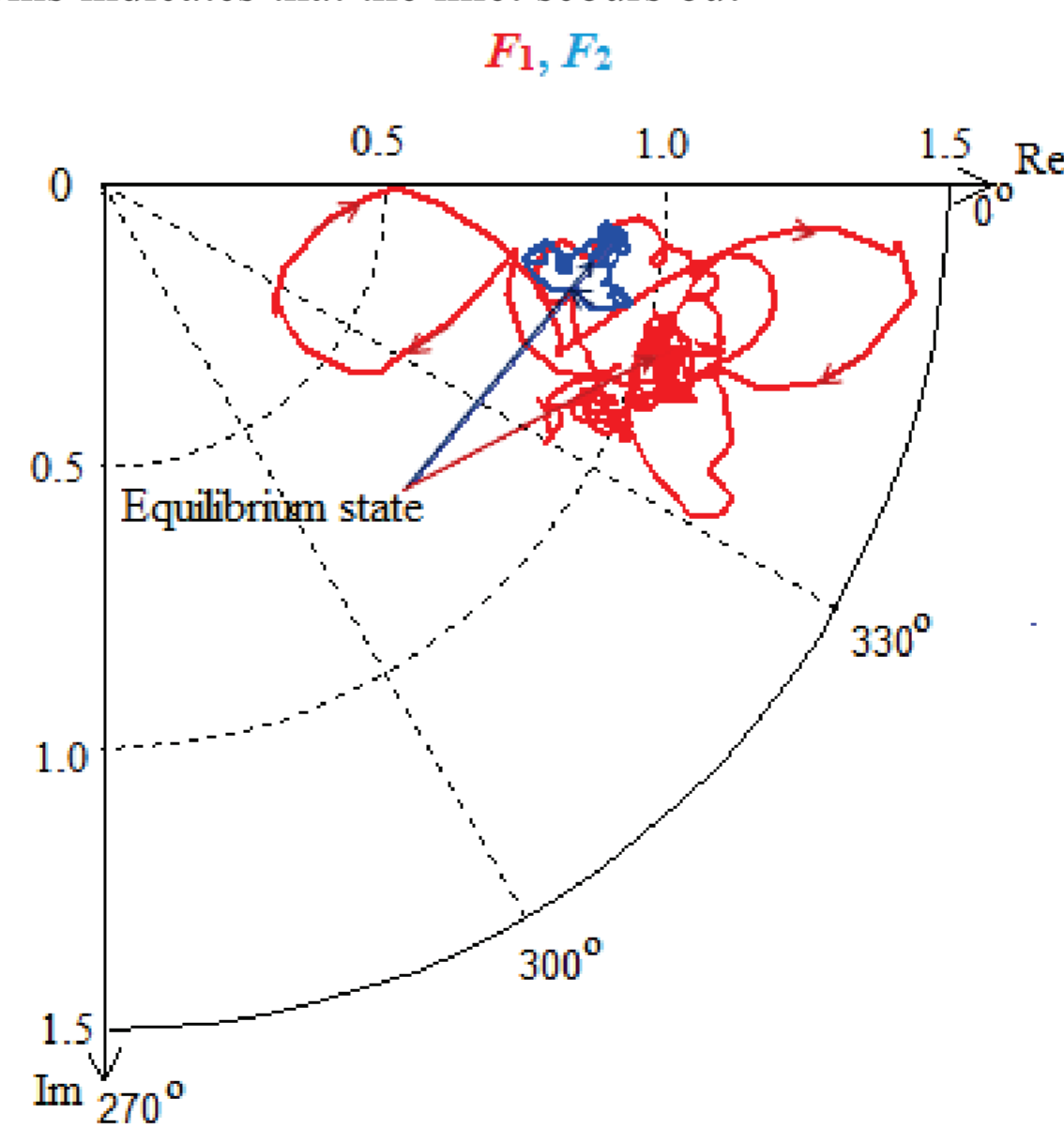


Figure 4: The track of diurnal constituent F_1 (red) and dominant constituent F_2 (blue) running out of equilibrium during **flood event** in May 2009 and then returning to the equilibrium point in complex plane at Brunswick River

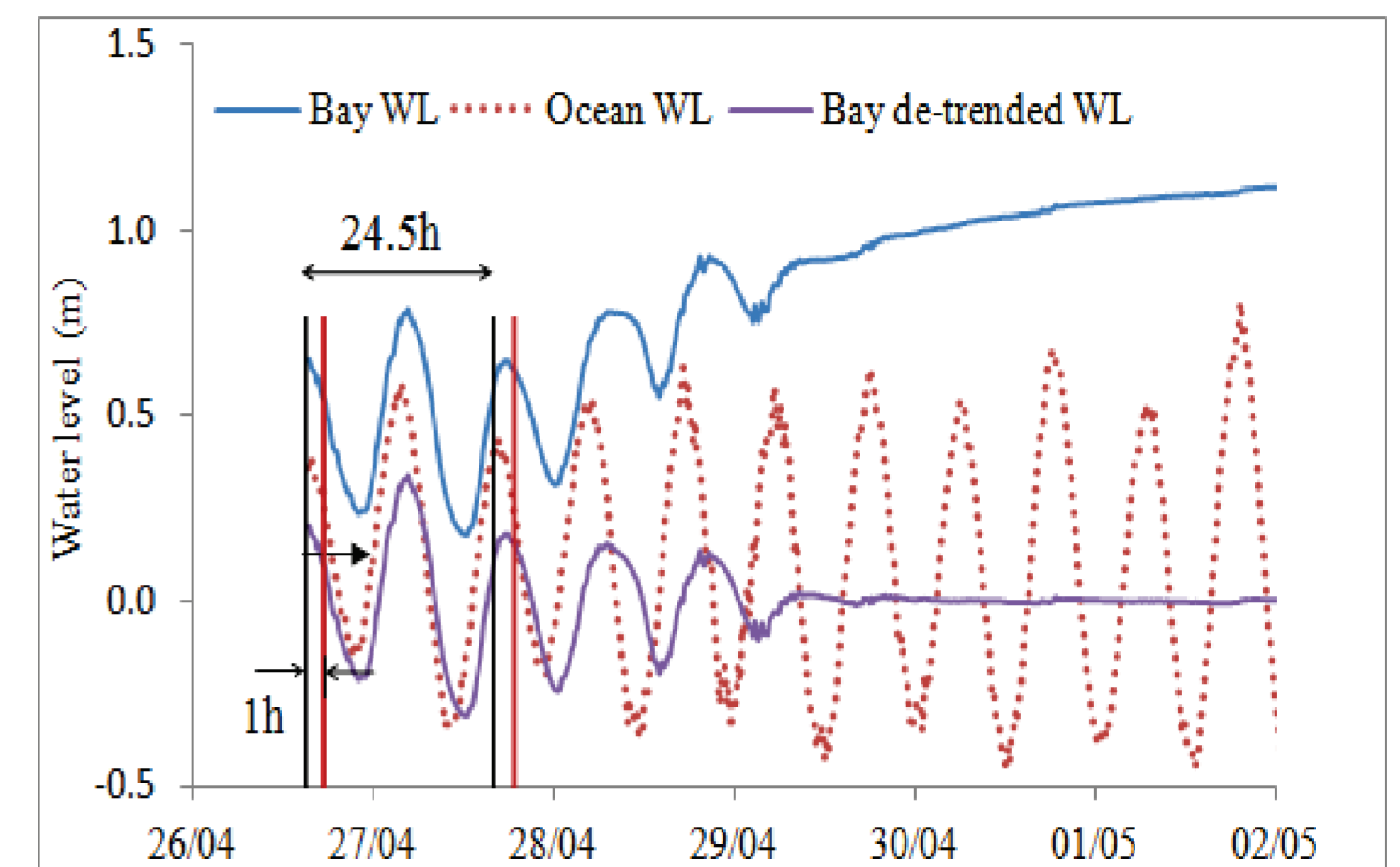


Figure 1: Illustration of the 24.5h moving window concept during **Closure Event** at Avoca inlet April, 2011

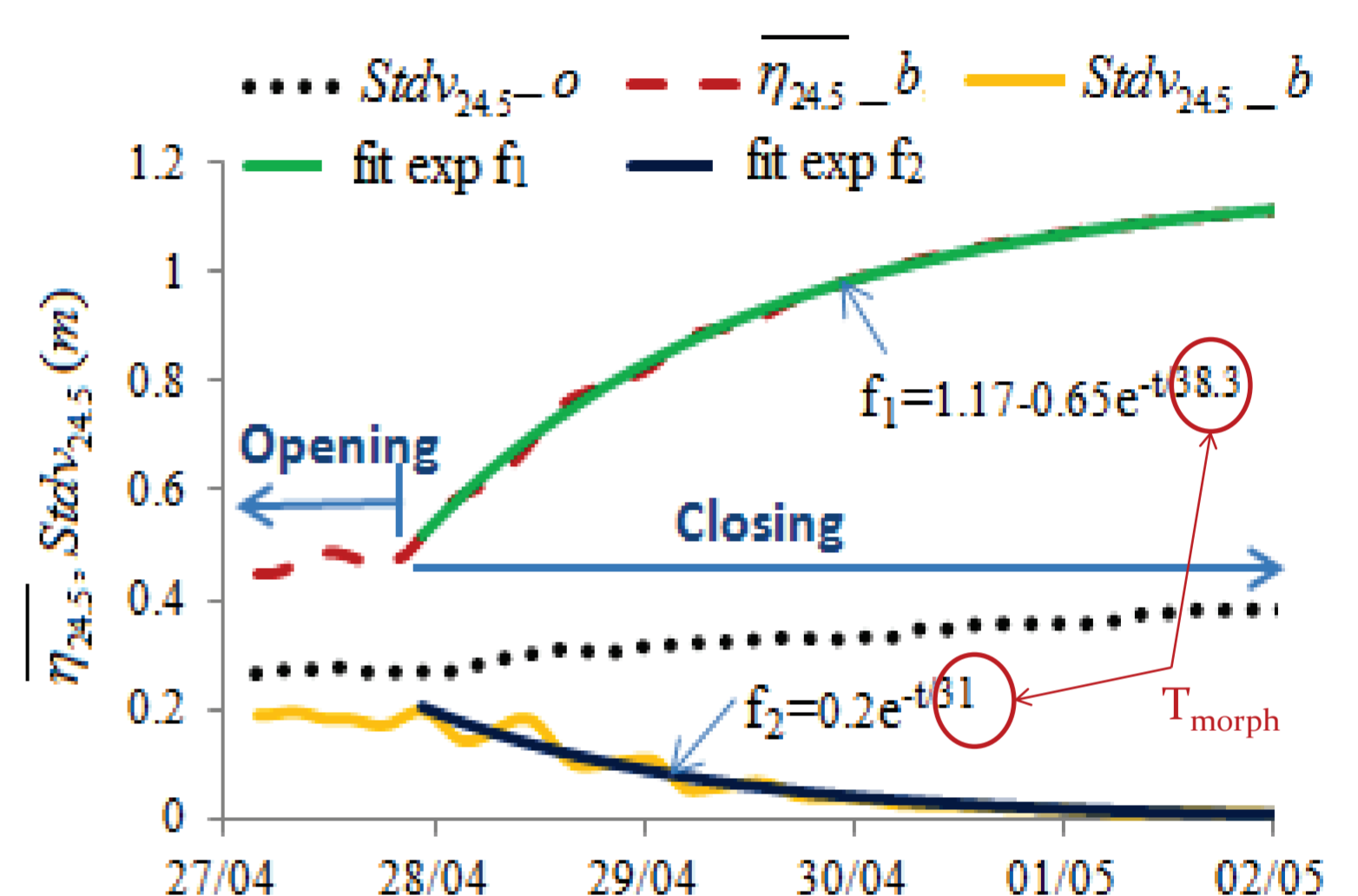


Figure 2: $\overline{\eta_{24.5}}(t)$ of bay tides, $Stdv_{24.5}(t)$ of ocean and bay, T_{morph} computed by fitting exponential curves of $\overline{\eta_{24.5}}(t)$ & $Stdv_{24.5}(t)$ for the bay during **Closure Event** April, 2011 at Avoca. Notation "o" for ocean and "b" for bay.

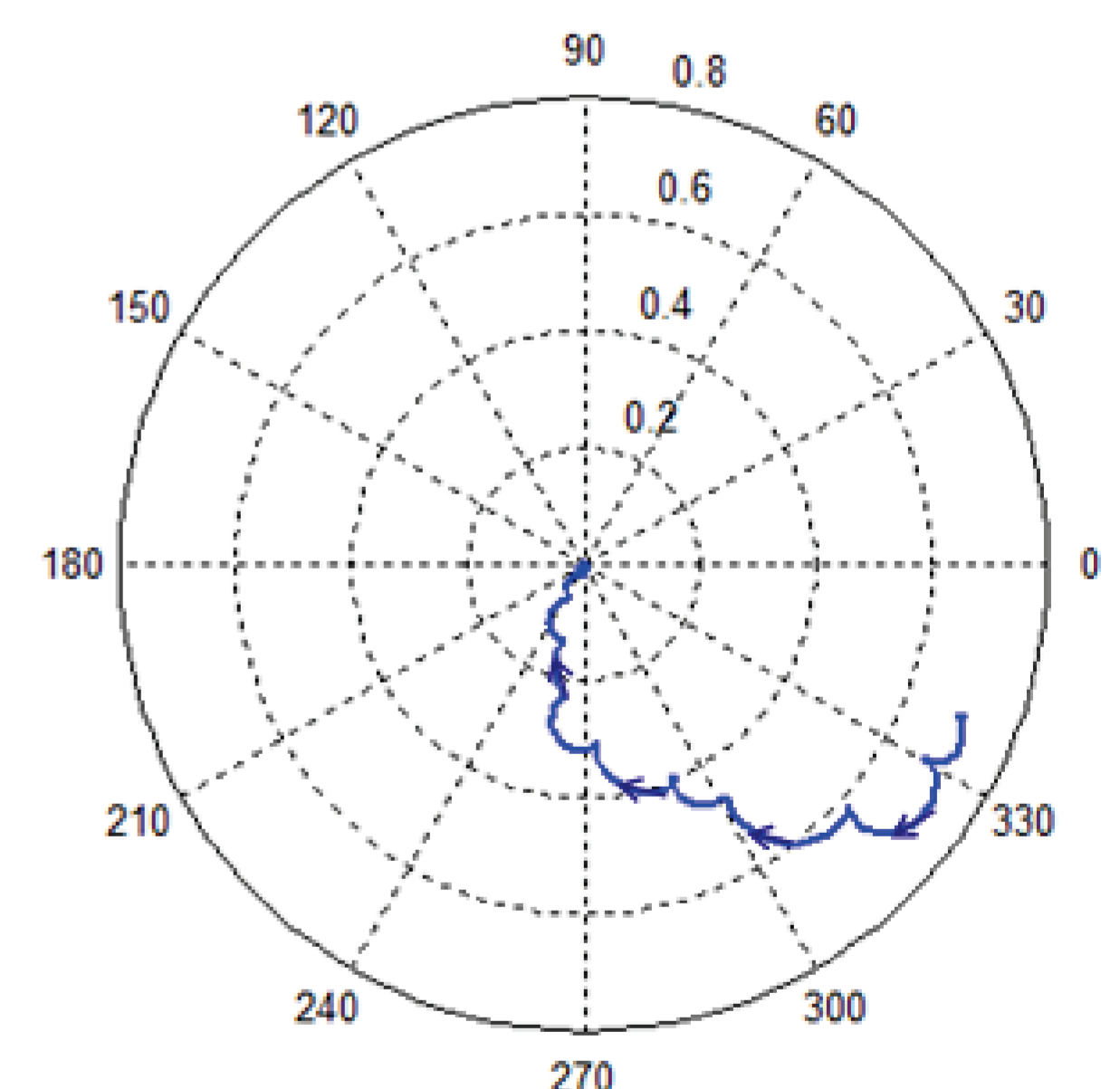


Figure 3: Response function $F_{\text{semi-diurnal}}$ for dominant component moving 'monotonically' towards the origin during **closure**, along a curve which resembles the half-circle

CONCLUSIONS

- The new method is effective way to determine morphology time scale T_{morph} for closure events at small inlet systems
- Relation between $T_{\text{morph}} \sim$ 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