Deltares
Enabling Delta Life

Kickoff MSc Thesis O.C.P. Bots

Resuspension of fine sediments near a coral reef (Ras Ghanada), Case Khalifa Port - Abu Dhabi UAE

Royal
Boskalis Westminster nv

Khalifa Port Project
Boskalis / (Hydronamic) / Deltares

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Khalifa Project, where?

<u>98% of time:</u> Hs < 2m

And windspeed < 6 Bft

Pred. wind and (highest) waves direction: N-E

Tm0.1 < 5 sec

<u>Shamal conditions:</u>

Hs_max: 4.43m

Windspeed: 17.45 m/s

Period: October 2007 – January 2012

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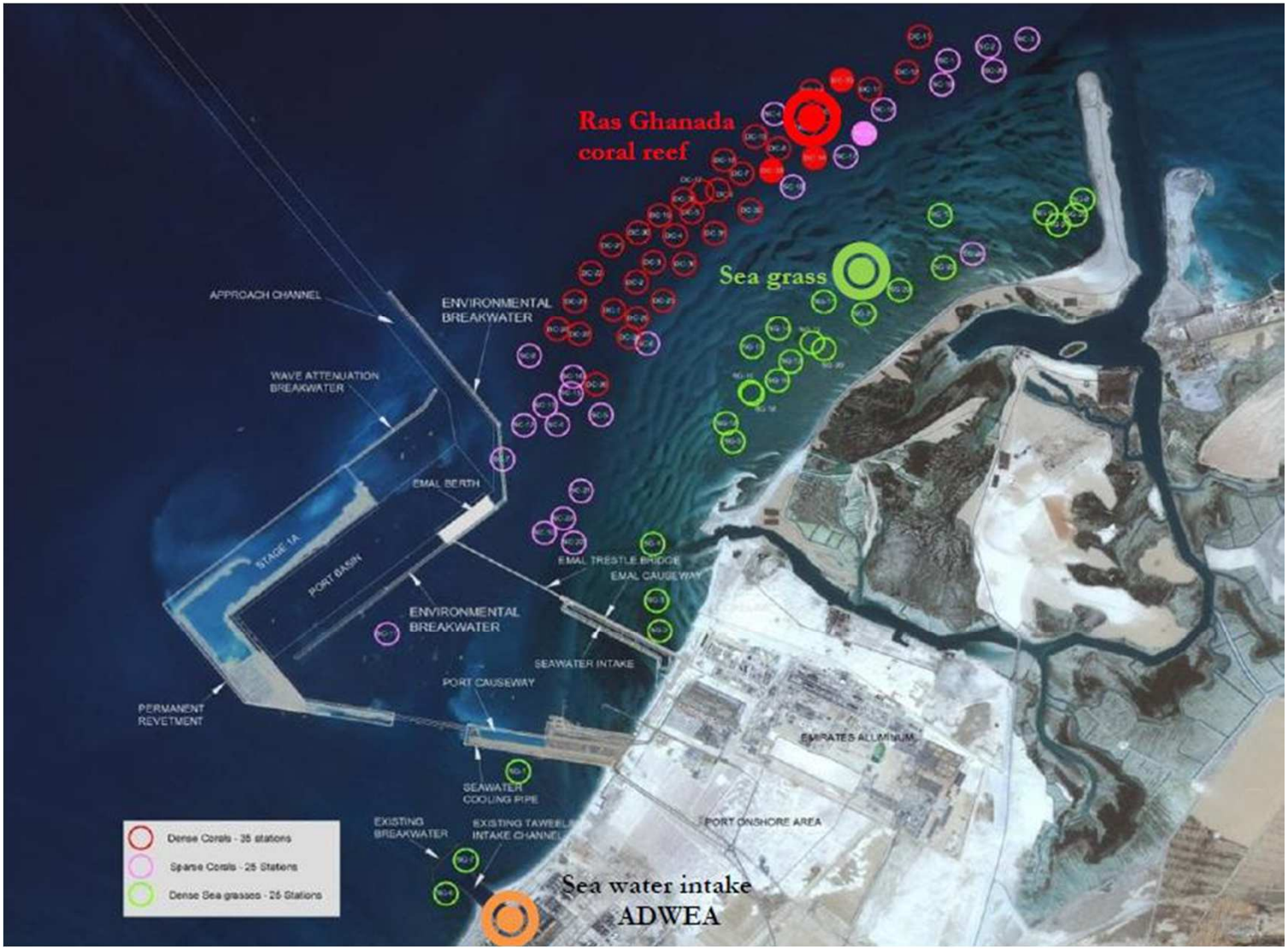
Khalifa Project = Unique project



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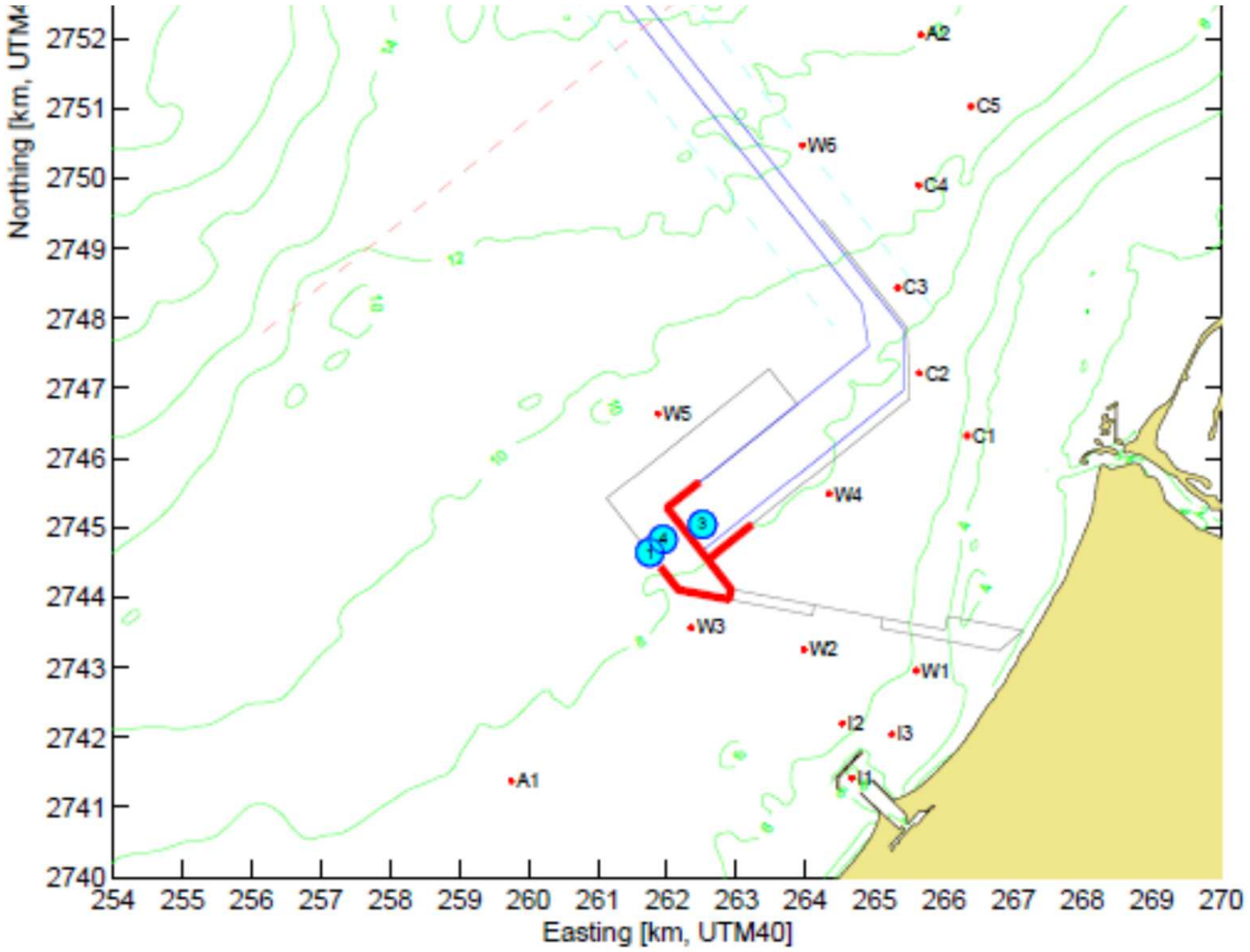
Measurements at site, 14 fixed stations



Stations A1-A2
Turb limit: [-]
water levels, waves, currents, temp.

Stations C1-C5
Turb limit: 10 NTU
Coral reef

Station I1 – I3
Turb limit 10 NTU
Intake sea water

Stations W1 – W6
Turb limit 29 NTU
Work area

NTU = Nephelometric turbidity units = corelated to concentration

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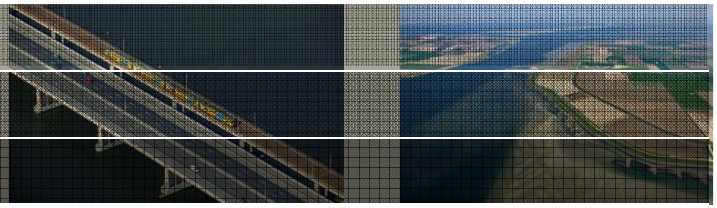
Measuring characteristics



- Measuring frequency: 2 Hz, 24/7, during whole operation
- Monitoring of Pressure, Turbidity, Currents, Waves, Water temp.
- Data send to shore: averaged value of 1200 NTU measurements
- Result of exceeding NTU limits: stop execution at whole project
- Most of the time: cause of exceedance was outside KPMC's influence (KPMC = building consortium for Khalifa Port)
- Unique dataset!!!!

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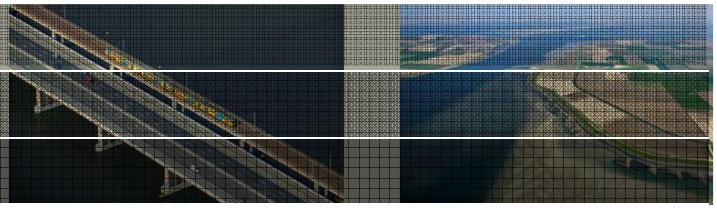
Problem definition



BoKa is in a Tender Phase: Most often; Quick desitions have to be made.

⇩

Detailed modelling information & time & money are hardly available

⇩

Client has imposed strict rules (implies Risks for BoKa)

⇩

Tender phase is about lots of millions of euro's and try to estimate project risks.

⇩

In this phase: BoKa wants to have an idea about the processes which are will play a roll and affect the execution

⇩

→ Thesis related Example!!! ←

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Problem definition → Thesis related Example

Fine Dredged material gets in suspension (e.g. Overflow) → settles on the sea bed; possibly in vicinity of fragile areas

Question 1: will arise: what to do with fine sediment on the sea bed?

Question 2: will arise: take measures or not?

Conclusion: Already in a tender phase you want to have insight in the behaviour of fine fractions.

2 possiblities!!! (remember: limited data, time and money)

1. USE project related Experience

2. USE Theory

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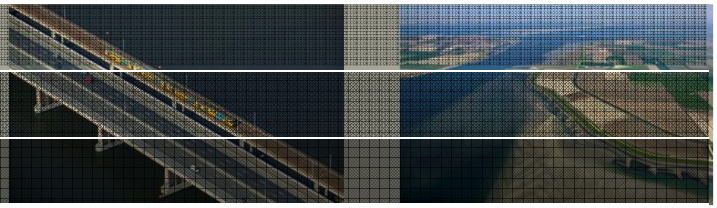
Goals for Thesis



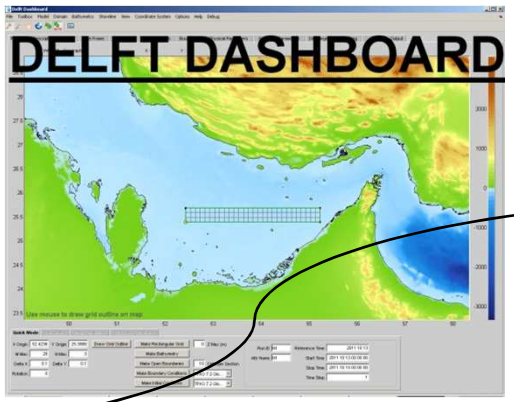
Goals:

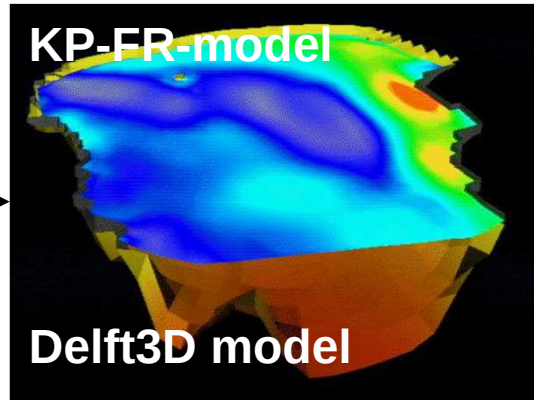
1. Study behaviour of fine sediment under the influence of natural circumstances and dredging activities.

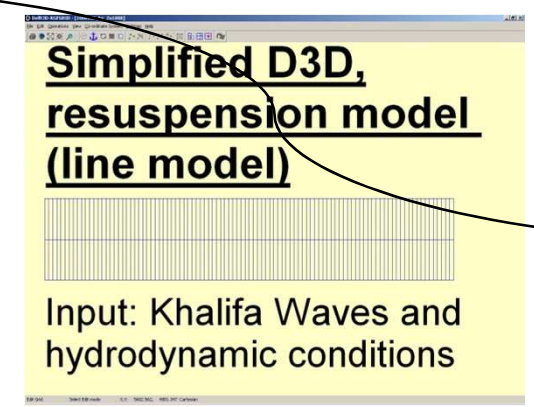
2. Develop: BOKA-TOOL.
    a. Develop Quasi2DV tool → Name: BoKa Tool
    b. Validate Khalifa Port Delft3D; modified for resuspension of fine bed material
    c. Test tool for different cases to test functionality and restrictions

Research questions 1 – Part of goal 2 (BoKa tool)

1. Is it possible to use a Q2DV tool assessment tool in the tender phase to get a better feeling for the resuspension behaviour of fine sediment during different conditions?







Duration: 3 months

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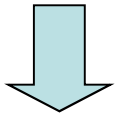
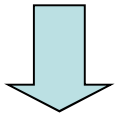
Research question 2 – Part of goal 2 (BoKa Tool)

2. What are the driving forces that cause seabed material to resuspend?



Literature study /



Implement forcing if necessary into tool

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Research question 3 – part of goal 2 (BoKa tool)

3. What's the dynamic behaviour of a silt blanket on the bed?

Think of: When does deposition takes place? What is the influence of the initial concentration in suspension? Cohesive behaviour? Compaction/consolidation? Bed strength? Differential settling? Flocculation and deflocculation?

(Split up in 2 periods, total duration 1.5 - 2 months)

Research question 4 – 6. Part of Goal 1

4. How does a bed covered/build-up with a fine sediment fraction behave on a short time scale? With the effect on a short time scale is intended: what is the influence of a single representative storm condition on fine sediment deposited on the bottom? (flush system clean): Planned duration: 1 month

5. Does the build-up of the silt blanket during execution affect the resuspension behaviour of fine sediment? What silt-blanket-thicknesses deposited at the bed can be expected at different construction phases. What is the range of a silt blanket when being transported? Planned duration: 1 month

6. What is the dynamic behaviour of the fine sediment; a few years (so long term) after dredging activities have been completed? Can you still observe the impact of dredging activities from the presence of fine sediment on the bed after a few years after execution? Planned duration: 1 month

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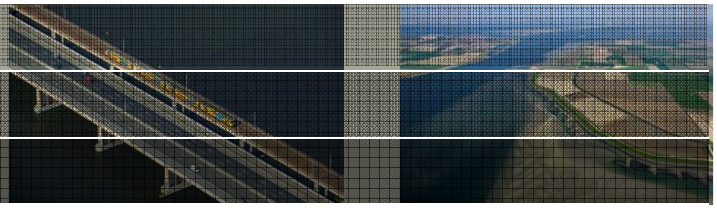
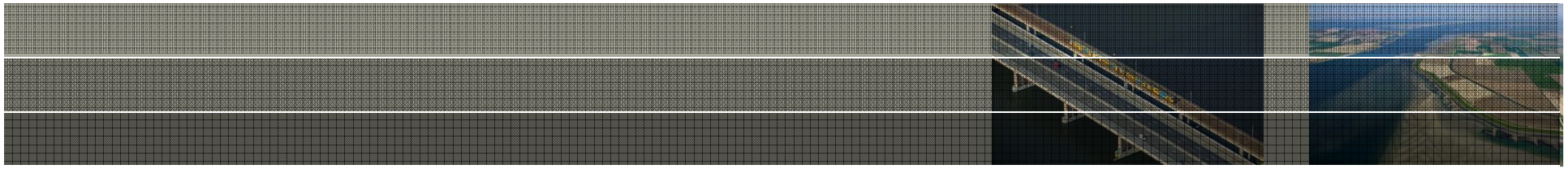
Proposal



- Develop Q2DV tool
  - Research questions 1, 2, 3 (research question 3 has been split up in two parts, see planning)
- Do research on question 5
- If there is time: Do research on question 4
- Leave question 6 for another graduation study, perhaps combine with ecological landscaping (EcoShape)



END

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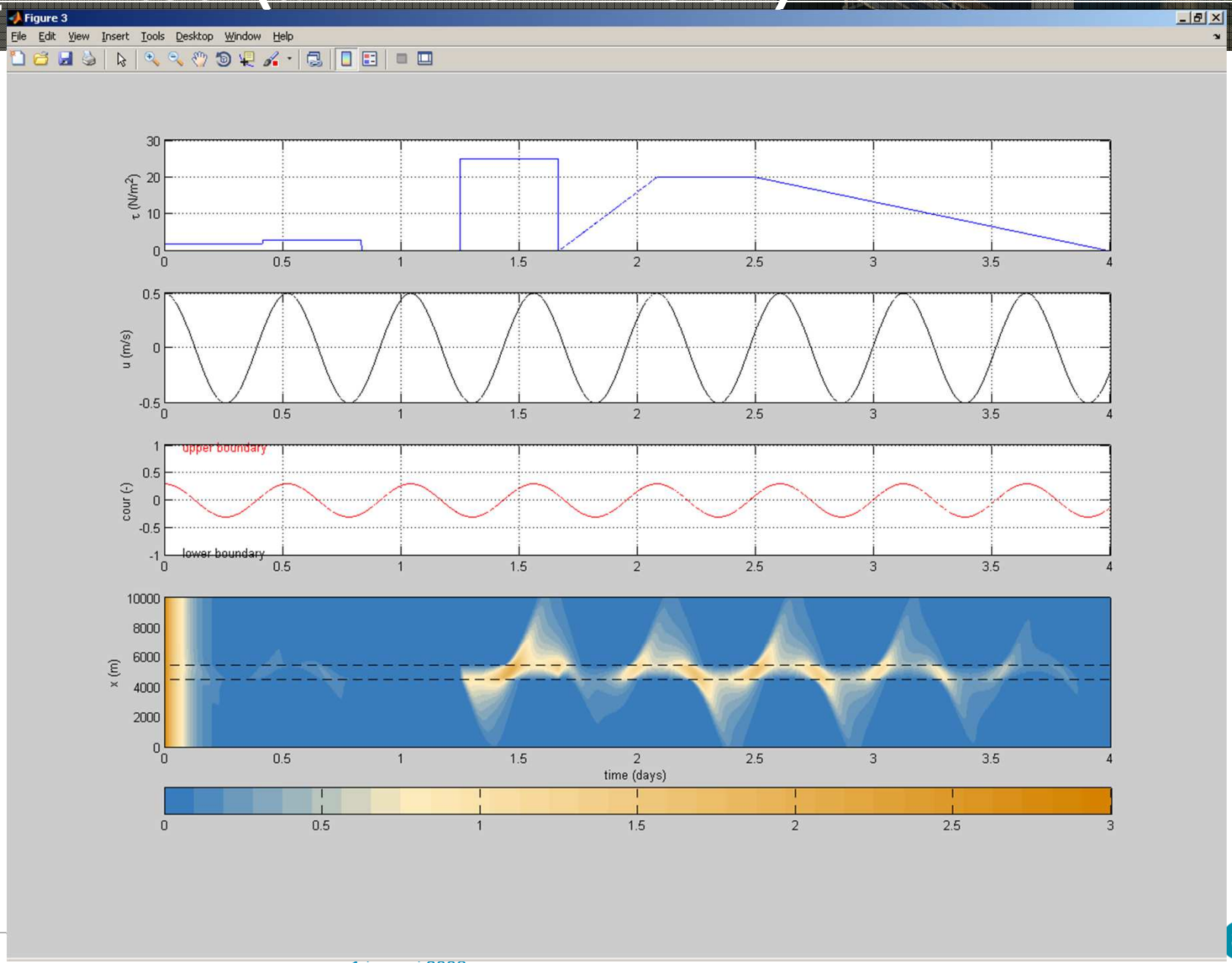
Project phase vs. Models/tools

Overview project phase vs. tools	Q2DV tool – model along a single trajectory, depth averaged information	U,V (2DH) – (Spatial model)	Stripped Delft3D (short run, simple input). For example Delft-Dash-Board.	Full Delft3D model or equivalent like Mike21 from DHI
Project development phase	--	-	+/-	++
Tender	++	+	+/-	--
Project preparation phase (tendering stage won)	+/-	+	+	++
Execution phase (to solve semi-short term problems)				
Operational phase (long term)				++
++ (very well applicable), + (well applicable), +/- (applicable in some occasions), - (not recommended), -- (not applicable at all)				
Decision may depend on factors like: available time and money, available data for input, accuracy of obtained results,				

Q2DV tool (a.k.a. BOKA-TOOL)



Simplified Delft3D model – forced with KP_data

Why use a simplified D3D model?

- To check output of tool in ‘tool development phase’ assuming simple model is correct.

Full KP-Delft3D model vs. Simplified D3D line-model

- Simple check for a ‘simple’ tool, instead of complex check for a simple tool.

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DELFT DASHBOARD (Based on Delft3D)

Can be used in two ways:

1. To check output of tool in ‘tool development phase’ → DDB has same purpose as self created simplified D3D tool.
2. Once tool is finished: To have better input for tool, think of.....

- Bathymetry
- Bed Shear stress
- Tidal variation

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Full Delft3D model: name: KP-FR-model
Task: adjust for resuspension

Khalifa model already used for:

- Wave modelling
- Hydrodynamic modelling
- Suspended sediment studies
- Sediment transport and coastline evolution
- Water quality assessment
- Assessments on site

---------- and can be used for...

- Checking tool accuraccy
- Answering research question on resuspension topics

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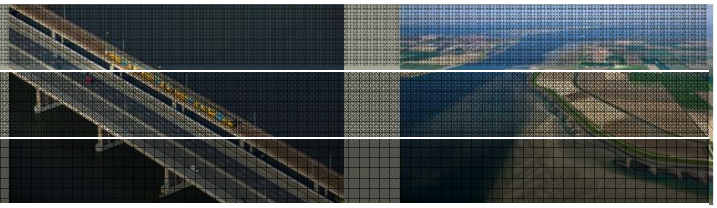
Possible Test Cases:



a. Transport of sediment deposition along approach channel Khalifa Port (real life problem).
b. Case to prove hypothesis that current is not the main driver behind resuspension.
c. Case at different trajectories offshore to prove the behaviour at different depth.
d. A run near a complex geometry to test the functionality and get insight into the tool's restrictions.