Boskalis

# HOW TO REALIZE BENEFICIAL FINE SEDIMENT PROJECTS?

## ENABLERS AND PRACTICAL LESSONS LEARNED

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KIMA CONGRESS

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KIMA

# BEFORE WE START:

We will use Mentimeter during this session:

Go to www.menti.com and use the code:

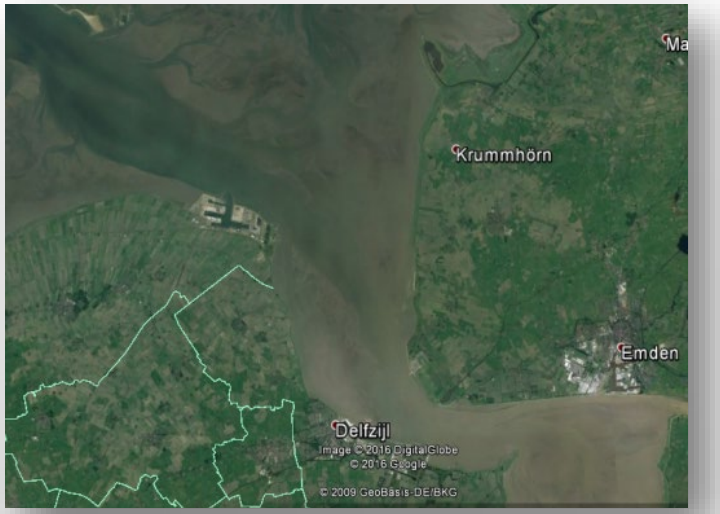
3152 2493

Please answer the first question:
*Which words come into mind when you think about Beneficial Use of Sediment?*

# SEDIMENT



# SEDIMENT




**Too much …**

Coastal erosion

Need for land

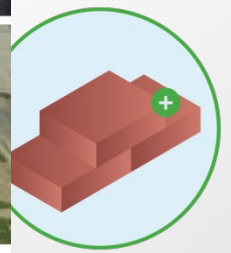
**Too little …**

# BENEFICIAL [illegible] T - DEFINITION

CEDA (201[illegible]
"the use of [illegible] nent in
applications[illegible] in harmony to
(human and[illegible]


Flood risk management

Na[illegible]



Building material

Local economy

CEDA Central Dredging Association

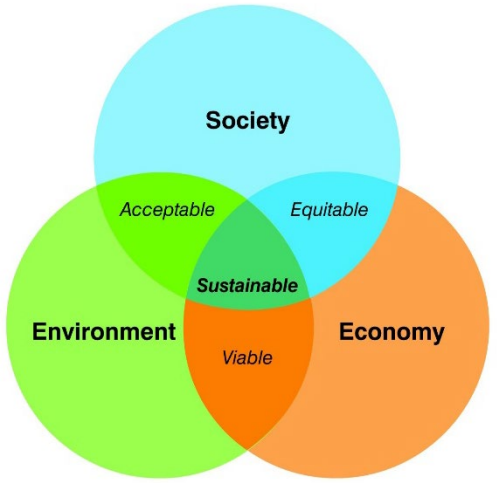
# BENEFICIAL USE OF SEDIMENT

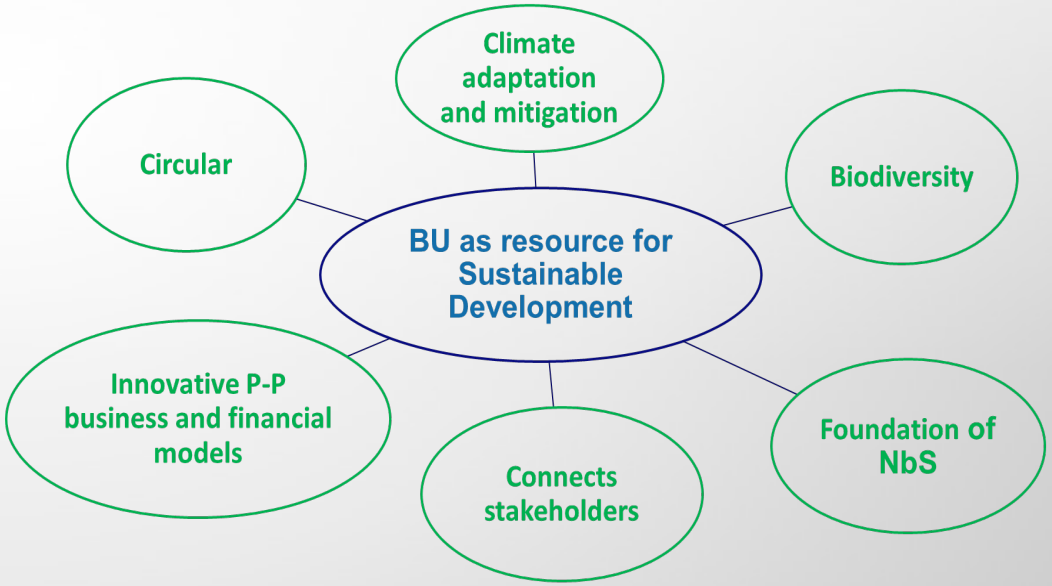
## IN RELATION TO SUSTAINABILITY

Sustainability often is described through three pillars:

- Environmental
- Social
- Economic

BU linked to recognized features of sustainability, achievable through the three pillars, especially those related to natural resources



# BUILDING WITH “UNSUITABLE” MATERIAL



increasing strength requirements and complexity

CEDA and PIANC working groups on Beneficial Use of Sediment

Marker Wadden: a clear example project!

https://dredging.org/content/content.asp?menu=1000_203

# ENABLERS AND KEY STAKEHOLDERS

## LET'S HAVE YOUR OPINION!

POLL #1: What do you consider the most urgent barrier to enable Beneficial Use?

a) Cos

b) Tim

c) Log

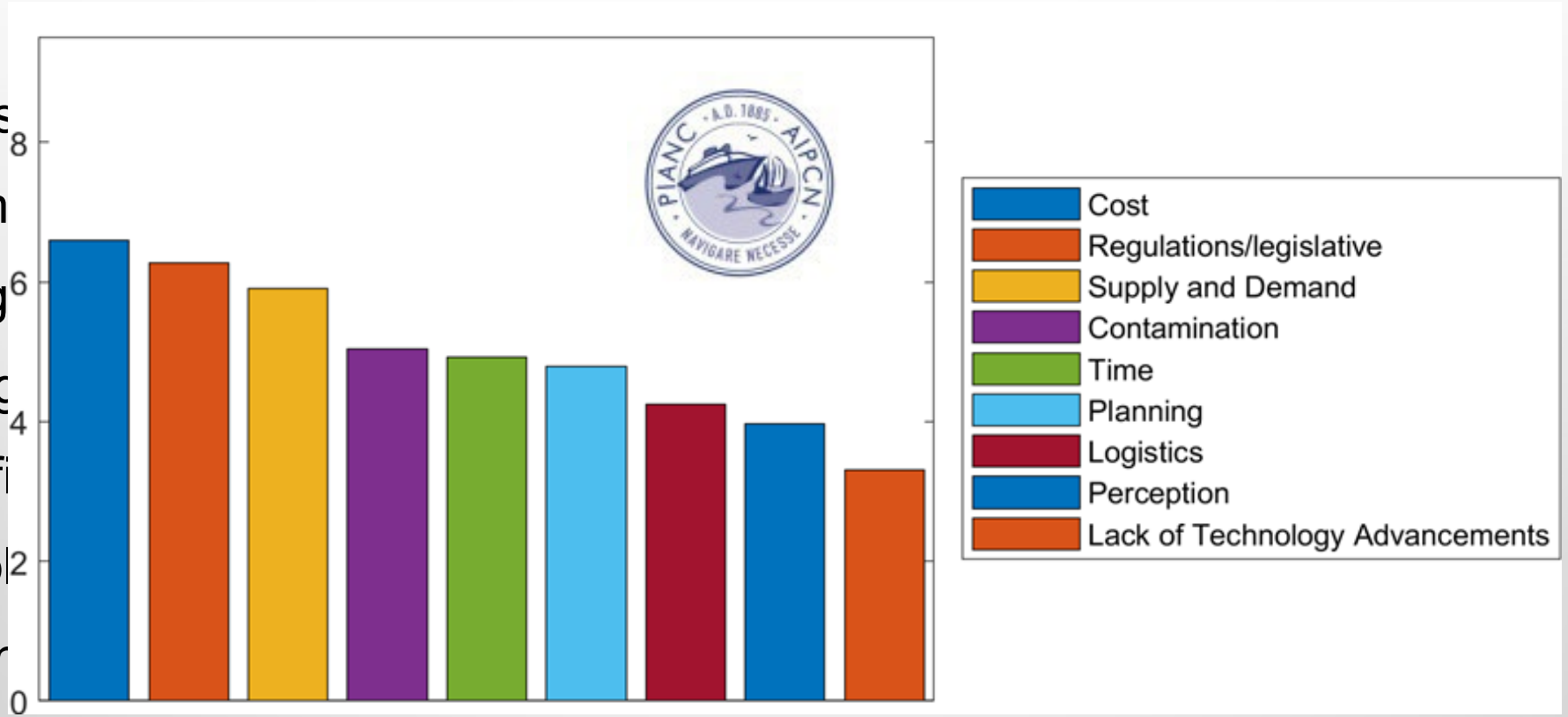
d) Reg

e) Diff

f) Pub

g) Cor

h) Lack of technology



# ENABLERS AND KEY STAKEHOLDERS

## LET'S HAVE YOUR OPINION!

POLL #2: Who are the key stakeholders that you believe are critical to incr

a) F

b) I

c) D

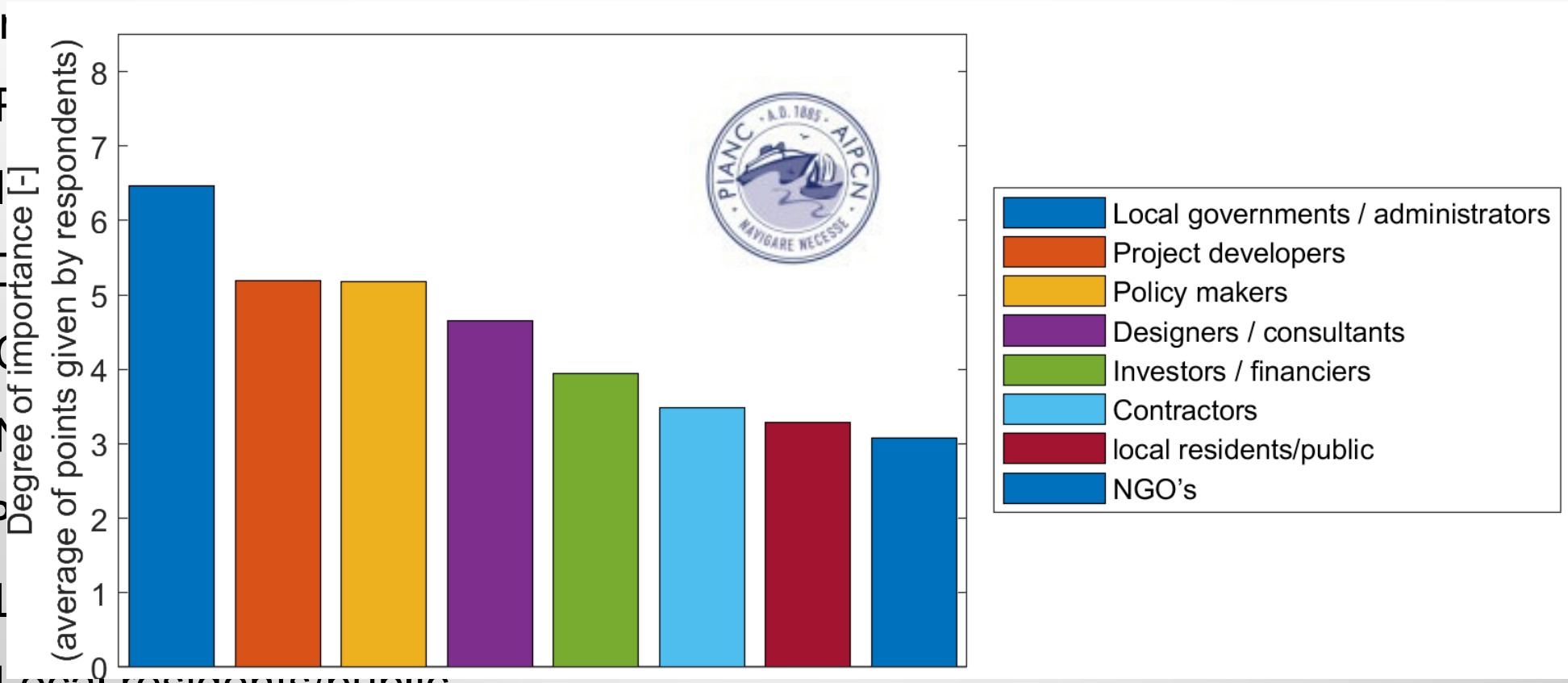
d) C

e) N

f) P

g) L

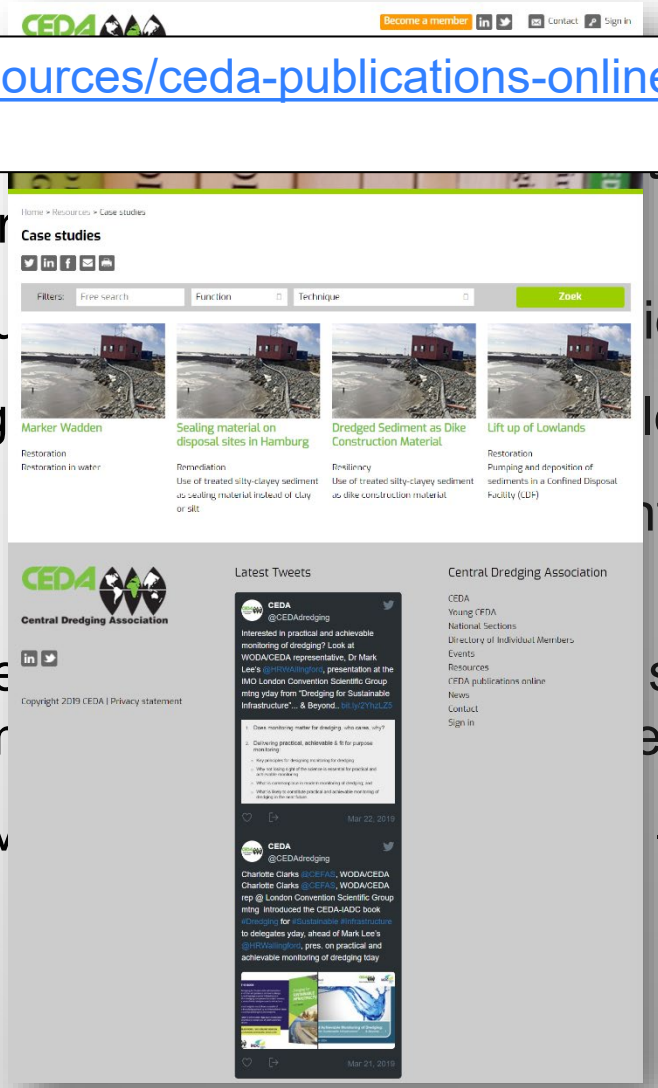
h) Local residents/public



# MAJOR FINDINGS CEDA WG

https://dredging.org/resources/ceda-publications-online/beneficial-use-of-sediments-case-studies

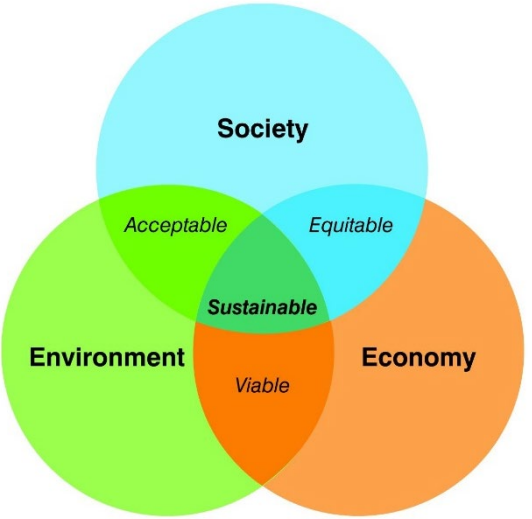
- Nature-based solu … year;
- Attention focusing … ilding material;
- Legislation varies … beneficial and sustainable use;
- Clear and sound e … osite CEDA!). Many still at pilot implem …
- Focus also on gov … dition to technique;



# BARRIES DEFINED BY PIANC WG

Sediment BU hindered by economic, social, and environmental barriers that constrain implementation:

- Economic barriers involve the cost of BU, if perceived as unacceptable or not fairly distributed
- Social barriers involve public perception, limited stakeholder support and suboptimal governance
- Environmental barriers involve categorizing sediment as ‘waste’ and legislation limitations to BU, often linked to contamination or concerns about negative impacts to ecosystems




# MESSAGE FROM PIANC WG

Prioritize BU

- Focus on value creation, multi-functionality, & ecosystem services
- Connect supply & demand; distribute costs & benefits appropriately
- Improve perception, engagement, and governance
- From waste to resource, adaptive risk management and monitoring
- Create vision toward sustainable BU: triple-win bottom line outcomes: environmental, social, & economic benefits

# KEY FACTORS TO ENABLE BENEFICIAL USE IN RELATION TO MARKER WADDEN

| Enablers (Book: *Dredging for Sustainable Infrastructure*) | Marker Wadden |
|---|---|
| Matching of supply and demand of dredged volume streams | Multiple locations to collect external volume streams, which also generates income |
| Engagement of stakeholders and partnering | Funding for project was split over many different parties |
| Commitments for further knowledge development and innovation | Knowledge and Innovation program Marker Wadden: focus on building with sand/mud, ecological improvement and governance |
| Knowledge exchange of lessons learned in projects | Extensive LL sessions during project execution between Client and Contractor to promote adaptive management |
| Communication on benefits | Active media attention to explain results of the project |
| | |

# MORE INFORMATION?

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# CONTENTS

# MARKER WADDEN (MW)

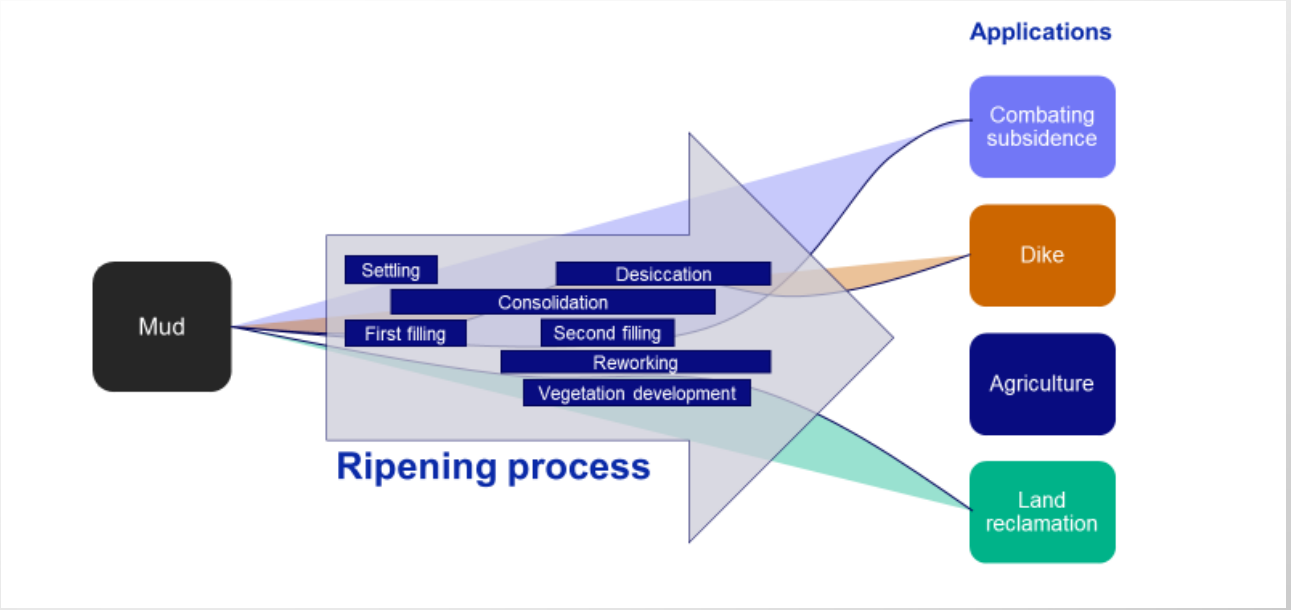

# KLEIRIJPERIJ (CR)





# EXPERIENCES

- VARIABILITY OF MATERIAL PROPERTIES (MW)
- CONSOLIDATION EASY TO HINDCAST BUT HARD TO FORECAST (MW)
- LARGE INITIAL LAYER THICKNESS CHALLENGING (CR)
- SALT AND OM CONTENT ONLY DECREASE TOWARDS THE END (CR)



# CONTROLS: FILL DESIGN AND PROJECT PLANNING

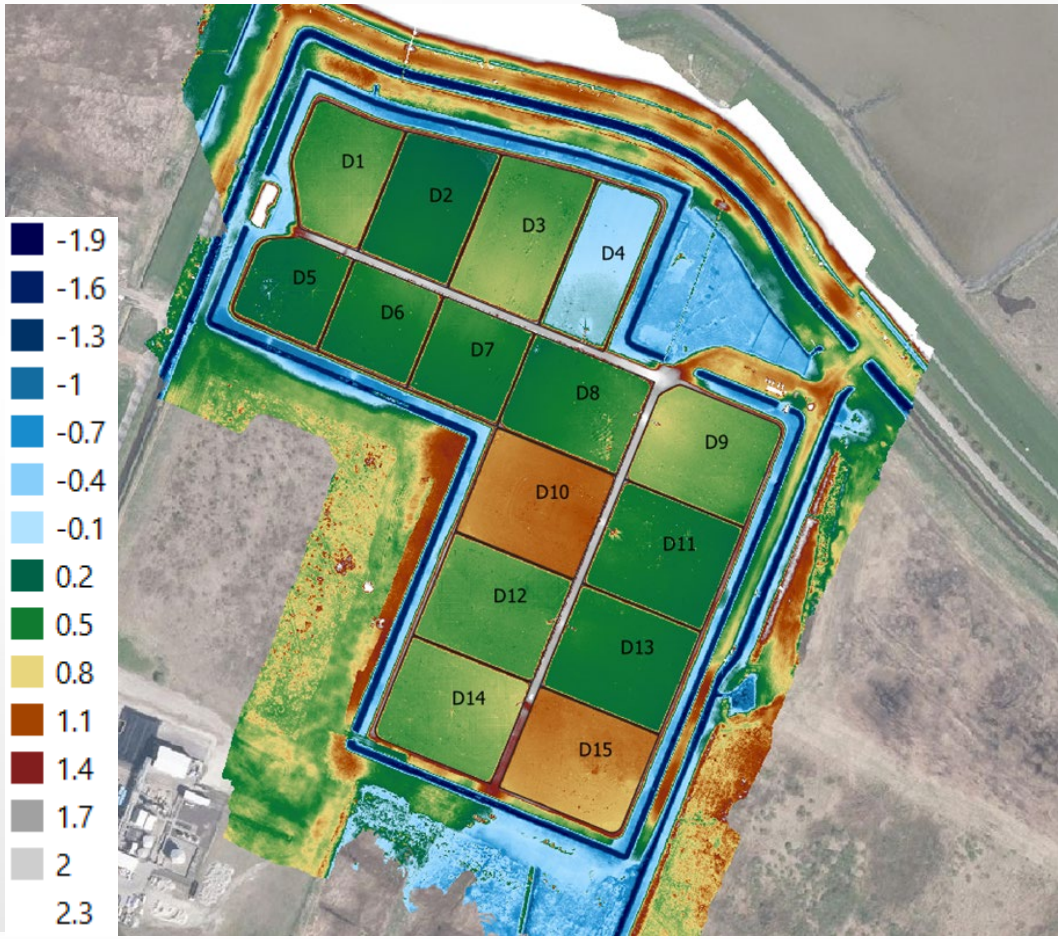
LAYOUT OF COMPARTMENT

FILLING VOLUME, THICKNESS, FREQUENCY

DRAINAGE

PROPERTIES AND CONDITIONS SUBSOIL

PLANNING OF RIPENING PHASE IN SEASON



# CONTROLS: FILLING PROCESS

DENSITY AND COMPOSITION OF FILLING MATERIAL

PRODUCTION AND FILLING SPEED

MIXING WITH FRESH WATER (CR)

CLAY BALL FORMATION (MW)

# PRACTICAL GUIDELINES (1)

## THE BEST STRATEGY FOR A FILL DEPENDS ON THE FINAL REQUIREMENTS

### GENERAL RECOMMENDATIONS:

- Minimize reworking as much as possible. Let gravity and evaporation do the work
- Horizontal transport expensive. Ripening and application sites should be nearby

### DESIGN OF FILL LAYOUT:

- Location of inflow and outflow point determine discharge patterns, segregation and run-off
- Using one fill basin may lead to a large outflow of fine sediment
- Coupling multiple fill basins better keep fine sediments in
- Even in smaller basins, strong heterogeneity in density and sediment composition may occur
- Bigger basins/compartments sensitive to wave generation

# PRACTICAL GUIDELINES (2)

## FILL LAYER THICKNESS, FREQUENCY OF FILLING AND WAITING TIME BETWEEN FILL LAYERS:

- Layer thickness is critical, choice depends on mud properties, climate, available time, and space
- Consolidation time increases quadratically with layer thickness
- With multiple fill layers more control
- Previously formed crusts may disappear after refilling
- Staged filling can lead to sandwich layering

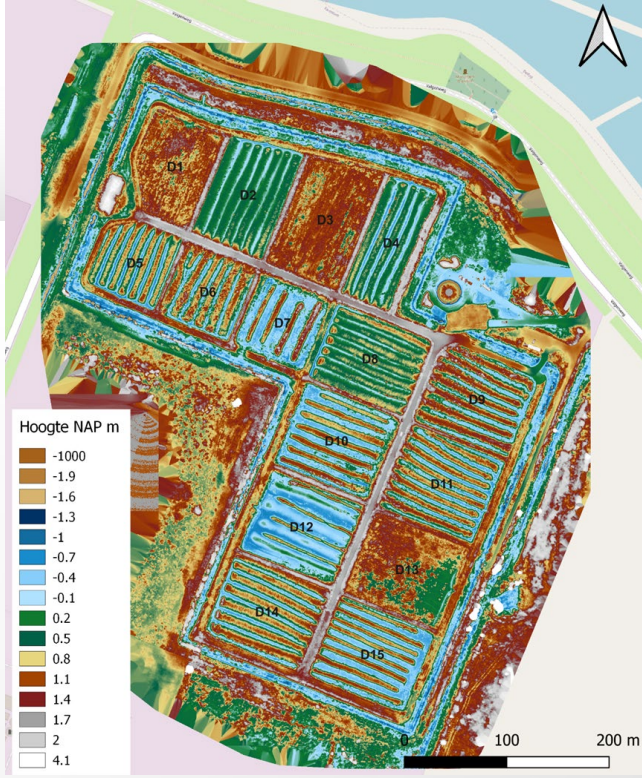
## DRAINAGE:

- Sand drainage with drainage pipes improves drainage, notably for clayey subsoil
- Sand may have adverse effect on ripening, as it limits the depth of cracks

## FILLING SPEED / DISCHARGE / PRODUCTION RATES:

- Lower speeds and rates more favorable for consolidation and stability

# PRACTICAL GUIDELINES (3)




## PLANNING OF RIPENING WITH RESPECT TO CLIMATE CONDITIONS:

- Climate and seasonal variations are crucial in planning a clay ripening project
- Think in seasons
- If density and water content are the only parameters of interest, reduce exposure of mud to the atmosphere in winter and increase exposure in summer

## FILLING MATERIAL DENSITY:

- Lower pumping densities increases segregation during the filling process
- Density in a basin decreases with distance from the filling point, which may create level differences
- A flat surface requires more homogeneous high-density profiles over the fill
- A higher water content leads to a thicker crust with deeper cracks. This causes more consolidation and desiccation. Underneath a crust not much happens

# PRACTICAL GUIDELINES (4)

## COMPOSITION OF FILLING MATERIAL

- PSD impacts sedimentation. Sand deposits close to the inlet and hampers crack formation
- Fines percentage increases with distance from the inlet
- Assess Atterberg limits and relation to the mud/clay water content. Assess volumes always in relation to volume fractions of solids, water and air
- Sand generally increases drainage capacity and causes less cracks in dried top layer

## SUBSOIL CONDITIONS UNDERNEATH FILL AREA:

- Subsoil settlement due to increased loading by the mud deposit is an important factor. Subsoil settlement may be of the same order of magnitude as settlement of the mud deposit itself
- A clayey subsoil causes a slower ripening process

# PRACTICAL GUIDELINES (5)

## DESALINATION OF SEDIMENT

- Desalination can be achieved by adding fresh water and mixing this with the sediment
- Adding fresh water during pumping process works better than adding fresh water after deposition

## WATER LEVEL CONTROL

- Water level control is complex, but one of the most effective control
- Water level control is more suitable/practical in smaller basins/compartments
- Possible water outflow through weir boxes

# PRACTICAL GUIDELINES

## VEGETATION DEVELOPMENT

- The roots of crops enhance the dewatering process of the deposit by evapotranspiration.
- The root development brings oxygen into the deposit.
- Initially, the ripening process goes as deep as the roots. Eventually, desiccation may progress deeper into the deposit, depending on water table level.
- The water level in a basin determines the conditions for development of vegetation.

## REWORKING OF MATERIAL

- Mixing of top layer of dried clay with unripened soft clay layer underneath should be prevented. Harvesting the ripened top layer is preferred.
- In case no drainage: unripened soil to be set up on ridges.
- In case of drainage: remove the ripened top layer, expose layer underneath

# DISCUSSION AND Q&A

- ADAPTIVE CONSTRUCTION WITH 2-3 LAYERS REDUCES UNCERTAINTY
- FACILITATE EASY ON-SITE TESTING;
- INCLUDE MONITORING DEMANDS AS EARLY AS POSSIBLE IN THE DESIGN PHASE OF PROJECTS;
- BE FLEXIBLE IN MONITORING;
- APPLY SIMPLE AND AUTOMATED MEASURING TECHNIQUES AT THE DEPOSIT SITE;
- WHEN APPROPRIATE, USE REMOTE SENSING TECHNIQUES (SATELLITE, UAV'S).