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Could concrete be a suitable material for reef restauration and related applications?

Structure of this presentation

- Motivation
- What is concrete? And how does it relate to nature?
- Why is concrete a suitable material for settlement of organisms?
- Are there indications for its functionality?
- How does our work eventually benefit society?

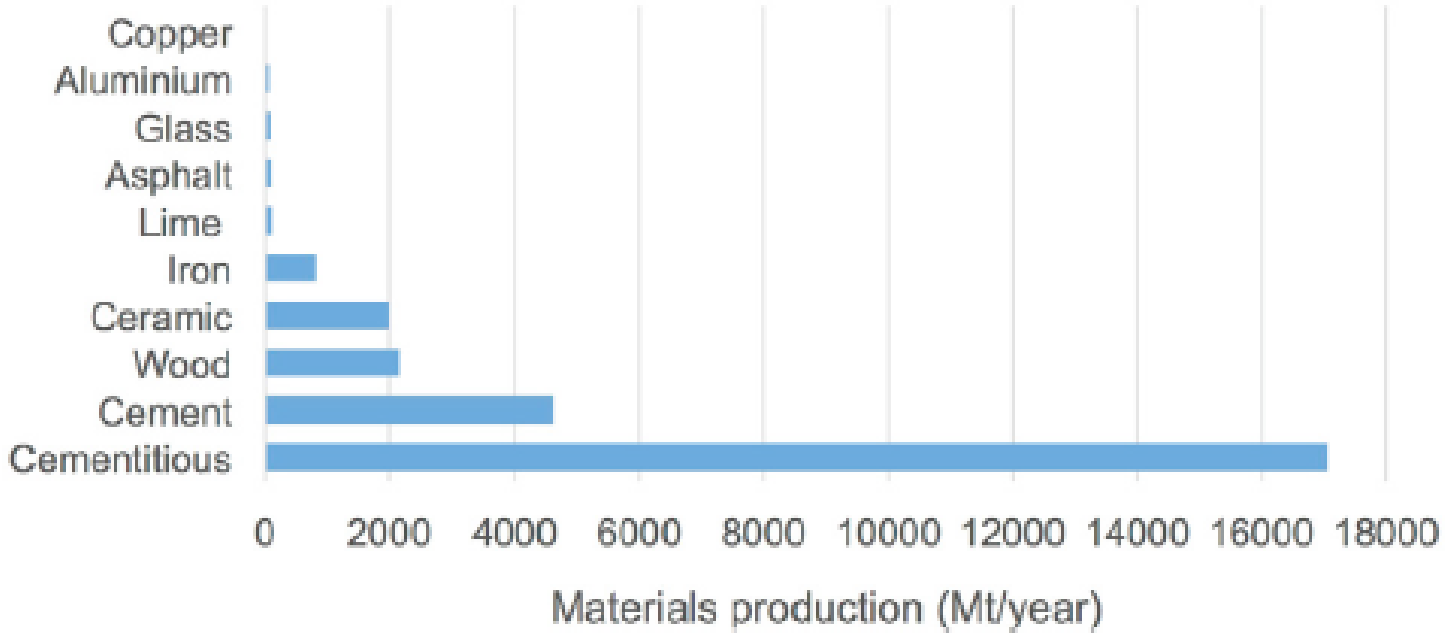
  = *“til gavn for samfund”*

Engineering and biodiversity?

- A question of perspectives in a highly specialised professional / academic world?
- Need for interdisciplinary collaboration!

DTU Aqua	DTU Byg
ecosystems	design parameter
Design for **faster** colonization (**biology**) + improved performance (**engineering**)	

Why engineers and society make concrete successful & problematic material



CCR 114 (2018) pp 2-26

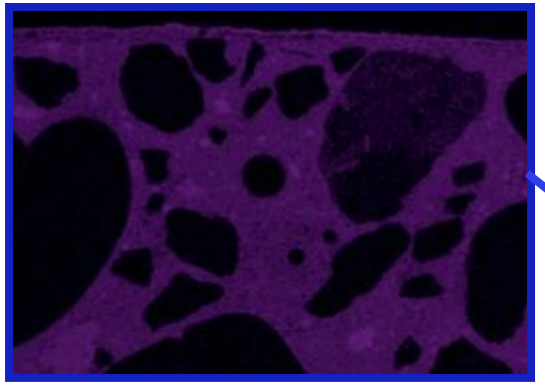
- Low price
- High availability
- Formability
- High durability

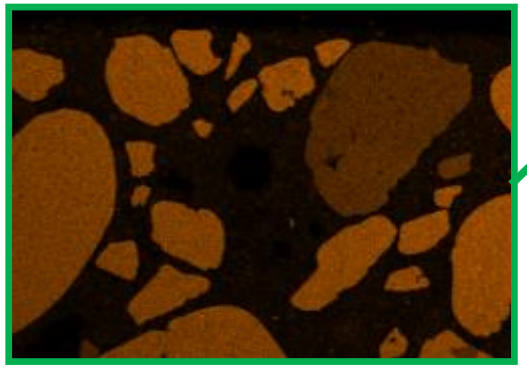
What is concrete:

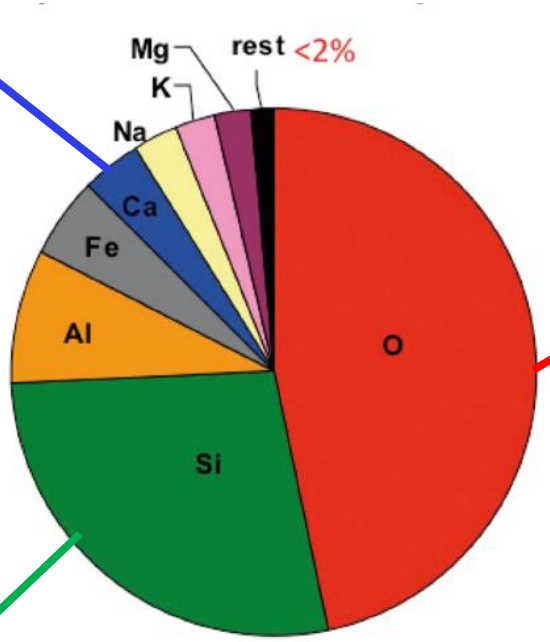
Typical compositions: *without reinforcement steel!*

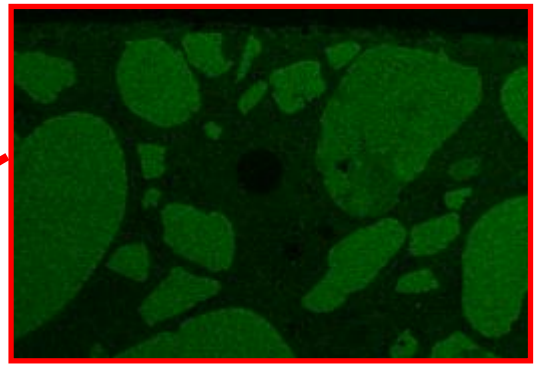
Cement (10-20 vol.%) = O, Ca, Si, Fe, Al, *Mg, S, Na, K*

Water (15-25 vol.%) = O, H







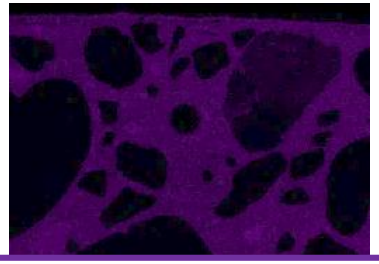


Earths crusts composition

Source: Wikipedia

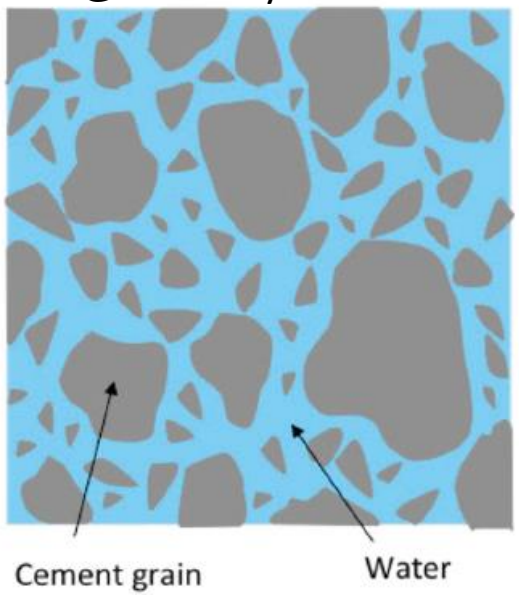
Sand and gravel (60-80 vol.%) = O, Si *(recycling?)*

The hardening process of cement paste (hydration)



cement + water

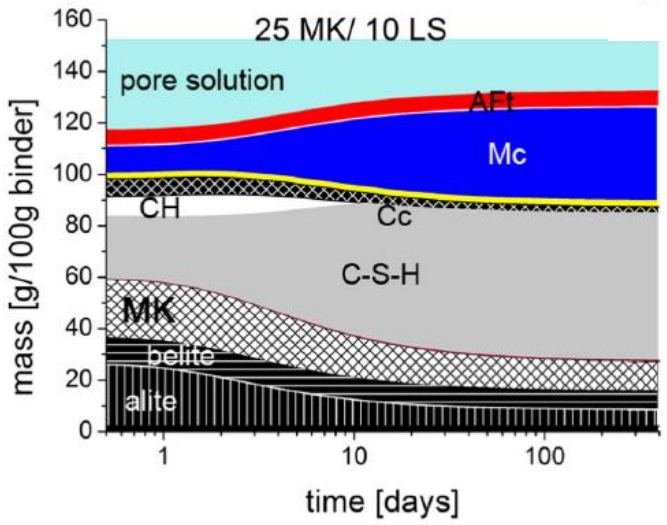
@ t ≈ 0 days



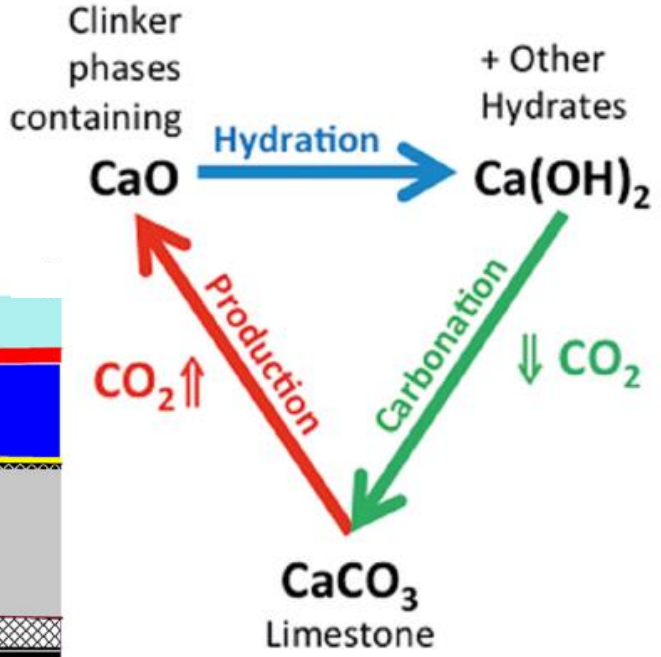
cement + water

@ t ≈ weeks to months

CCR 114 (2018) pp. 2-26



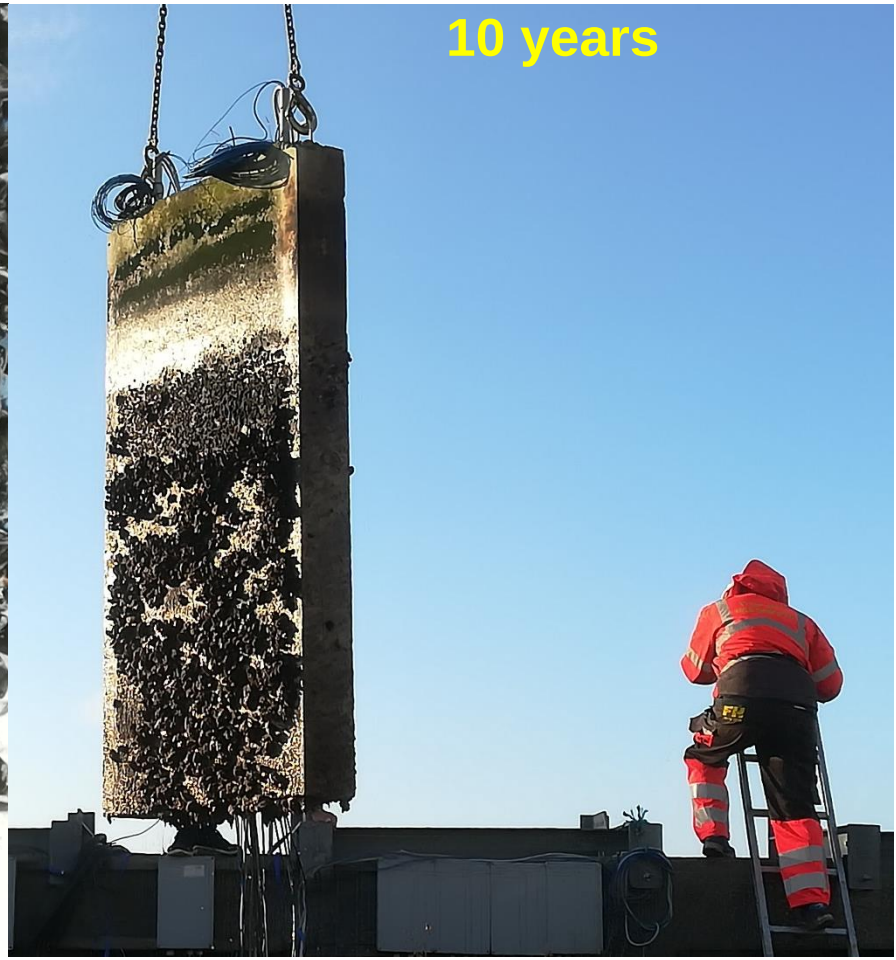
CCR 86 (2016) pp. 29–41



from bio-mineralization

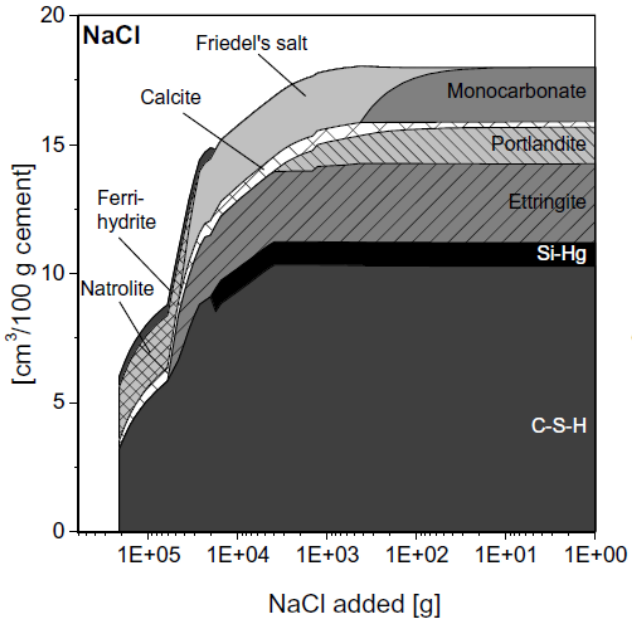
such as coral reefs and mussels etc.!

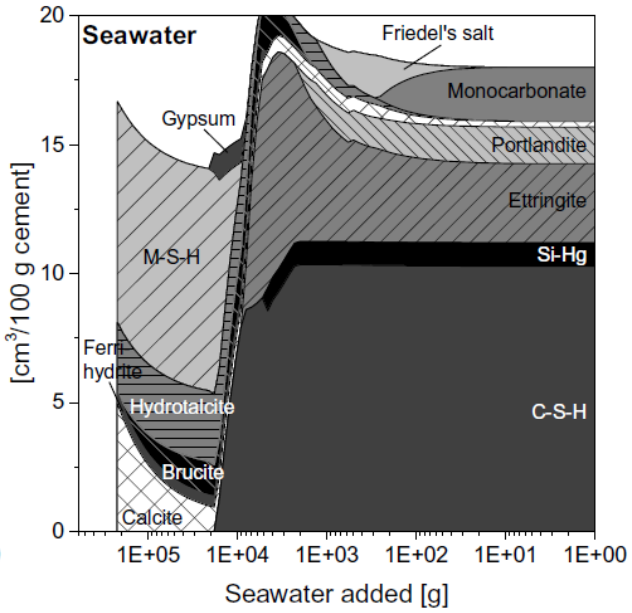
Does it work unplanned?



Simplifying interactions for slow processes:
the example of seawater interaction

- Acceleration vs. natural conditions
  - Ionic transport
  - Chemical reactions (thermodynamics and kinetics)
  - Mineralogical characterization

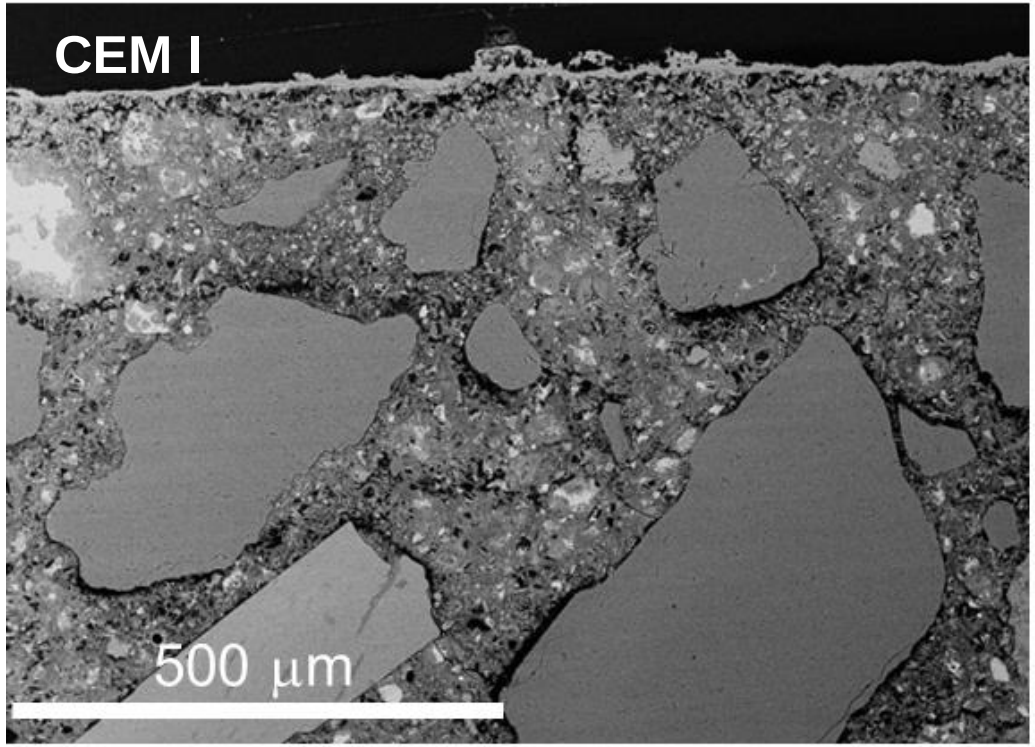


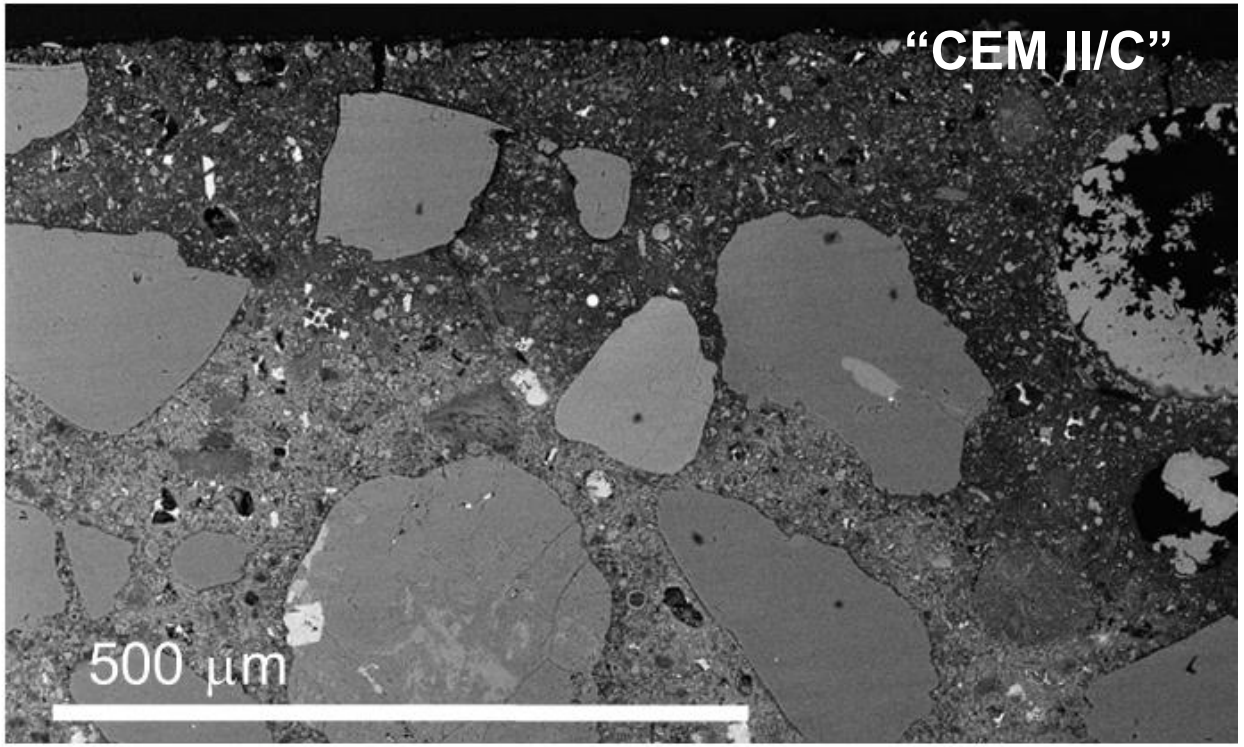


CCR 115 (2019) pp. 80–89

Material converts to $CaCO_3$ and other minerals

but different **cements** react differently

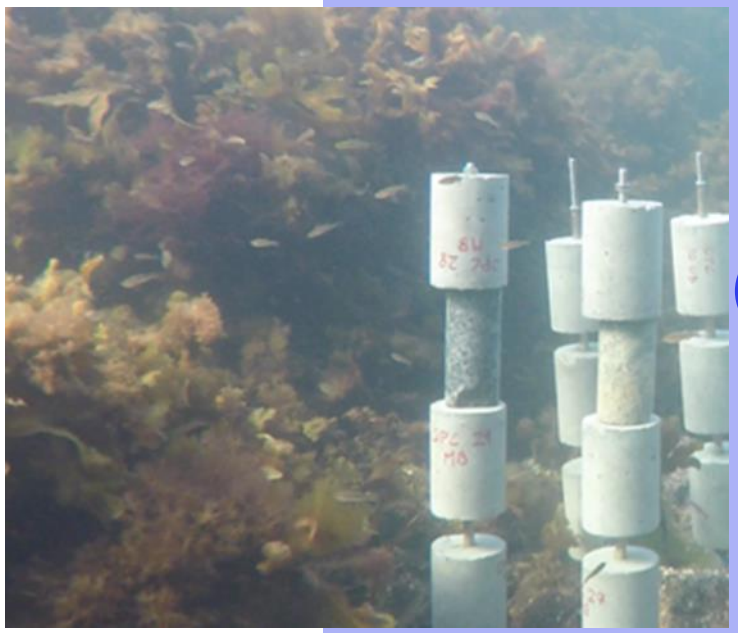




What do we try to achieve:

conservationist groups

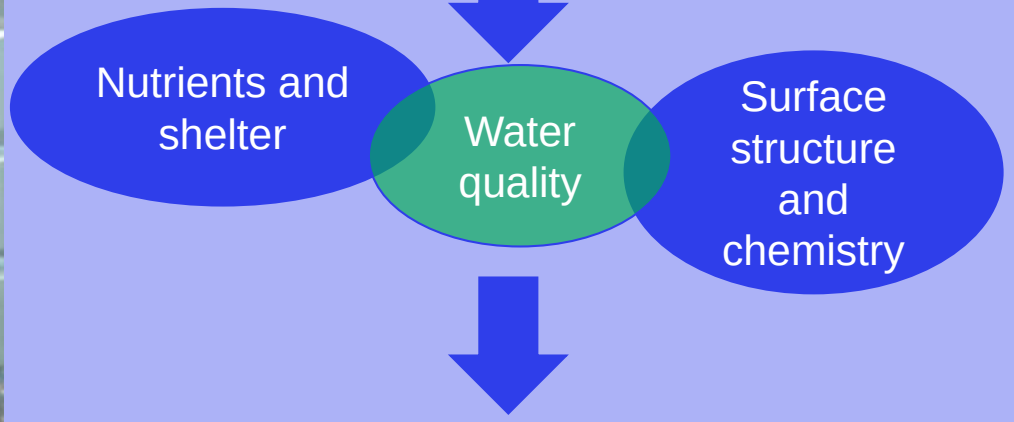
public stakeholders



DTU Aqua — ecosystems

DTU Byg — design parameter

Design for **faster** colonization (**biology**) + improved performance (**engineering**)



Nature inclusive design for:
restoration of reefs,
harbour infrastructure,
costal protection? etc.

commercial stakeholders

private stakeholders

…afterwards?

Take home messages:

concrete is an **artificial rock** of **natural origin**

it´s **cheap (local), formable and durable** - *CO_2 emissions are an "issue of scale"*

processes are slow and should be evaluated in **meaningful time periods**

Spørgsmål?