Green beaches for a green future?

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The Paris climate agreement aims to limit global warming through a collective and ambitious effort. Scenario analyses however reveal that "traditional mitigation" (avoiding CO2 emissions) alone is not enough. To reach the Paris targets, we also need to actively take up CO2 from the atmosphere (i.e. negative emissions). This is done with so-called "negative emissions technologies", which are currently in an early stage of research and development.

Enhanced silicate weathering (ESW) is a negative emission technology based on the natural weathering of silicate rocks, which is known to take CO2 from the atmosphere. But natural weathering is slow, and so the idea is to speed up this process by:
[1] using fast-weathering silicate rocks, like the green-colored olivine,
[2] finely grinding these rocks (exposing more surface area to weathering), and
[3] spreading silicate rocks into the dynamic coastal zone.

This concept has been succinctly described as "green beaches neutralizing CO2". The deployment of ESW within coastal systems can be done with currently existing infrastructure and technology (mining, transport, marine engineering), making coastal ESW readily deployable, scalable, and cost-effective. This provides ESW with a considerable advantage over other negative emission technologies. Yet, there are uncertainties regarding the efficiency of CO2-uptake and the impact of the released weathering products on marine ecosystems.

The overall goal of my PhD-project is to investigate the global potential of coastal ESW. By constructing detailed biogeochemical models of coastal ecosystems, we aim to quantify the CO2 uptake, trace metal release, and other impacts of a local ESW application. These results are subsequently used as input into an Integrated Assessment Model (IAM) FeLiX, which links the effects of coastal ESW to the global socio-economic system (accounting for energy use and other societal responses). This allows the assessment of the global application potential, CO2 sequestration potential, and full-scale effect of ESW. By running varying societal responses (i.e. scenarios) in FeLiX, we can infer a range of potential outcomes for ESW. In the "coal phase-out scenario", where we link the decrease of coal mining activities to an increase in silicate mining, thereby keeping global mining activity constant. In the "ambitious mitigation scenario", we explore the maximum potential for ESW provided that society is accepting of large mining activity. Finally, in the "global panic scenario", society remains hesitant about the deployment of ESW, but when climate warming consequences strike hard, society chooses an "all-we-can approach" to sequester CO2 from the atmosphere. In my presentation, I discuss these scenarios, which offer a glimpse of the future role ESW can play in drawing down CO2 from the atmosphere and associated societal responses.

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