Climate Engineering: Potential Pathways, Consequences and Risks

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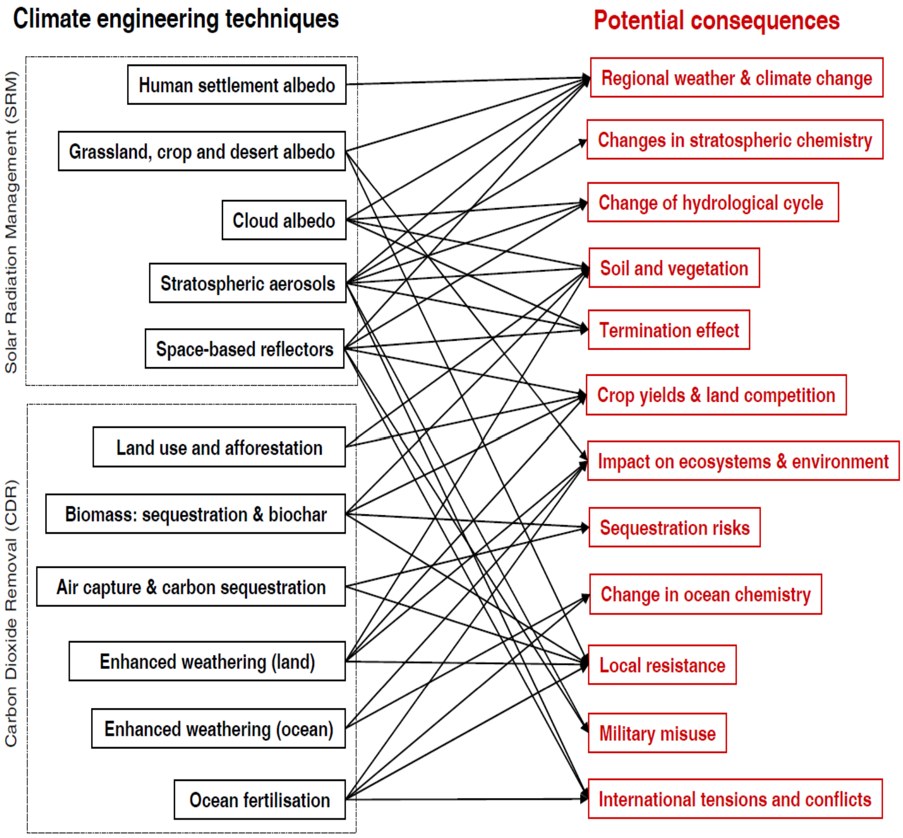


Possible consequences and risks

Little experience with climate engineering (CE) and large-scale tests: Study of consequences and risks quite hypothetical yet

Systematic approach to restrain possibilities looks at impact chains and action pathways in certain environments.

Risks: expected loss and probability of events

Consequences: events or sequences induced by CE:

- Plausibility based on experiences and logical reasoning
- Relevance of events for the actors

1. **Direct impacts on local environments** to which CE measures are applied (atmosphere, ocean, water cycle, biodiversity, forests, agriculture, cities).
2. **Implications from intended impact on climate system**: expected and foreseeable impacts, side-effects, externalities (e.g. cooling or changing rainfall patterns from aerosol emissions, ecosystem change, demographic patterns).
3. **Unintended impacts on the climate system**: unexpected and unforeseeable side-effects and externalities due to uncertainties and complexities that exceed prediction.
4. **Consequences from CE implementation process:**
   - CE requires infrastructure and considerable efforts and activities which change natural and social systems
   - Opportunity costs compared to alternative investments
   - Resource competition: need for energy, land, other resources
   - Additional pollution from CE in conflict with environmental law
   - CE implications for climate policy (e.g. blocking mitigation & adaptation strategies)
   - Protests and conflicts at each stage of implementation (anticipation, research, development, testing, deployment)
5. **Responses and interactions in the international system**:
   - World regions affected differently by climate change and CE
   - Asymmetric distribution of benefits, costs and risks
   - Resistance of States feeling threatened or at disadvantage
   - Security dilemmas, tensions, disruption of cooperation

Plausibility and relevance depend on the stakeholders

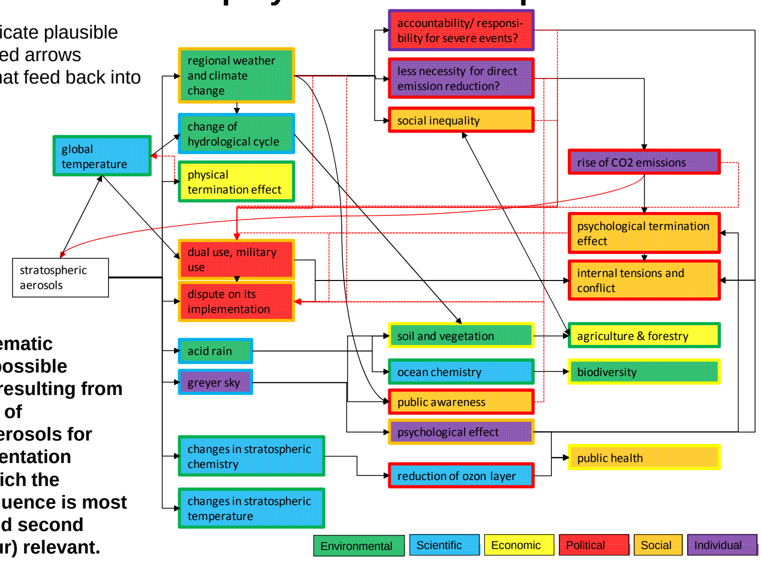
The CE discourse occurs in multi-dimensional argumentation spheres (scientific, environmental, economic, political, social, individual), each of which follows its own logic and reasoning (Scheffran & Cannaday 2012). Most convincing are arguments that are plausible and relevant to a significant number of stakeholders who participate in the discourse (Corner et al. 2012, Betz & Cacean 2012). Pre-deployment discussions depend on which groups of stakeholders might be affected by which consequences of the deployment of a specific CE technology, shaping the social and political dynamics triggered by a deployment.

E.g., the deployment of stratospheric aerosols could lead to a rise of CO_2 emissions, which would necessitate an increased deployment in stratospheric aerosols in a feedback loop. To manage and reduce the risk of potential consequences all spheres would need to be taken into account: Scientific theories and simulations can describe the physical or chemical efficiency. Environmental effects can have direct implications on precipitation patterns and the water quality as well as indirect implications on biodiversity and harvesting; Policies would need to deal with social inequality and public health issues as well as termination effects, potential misuse or conflicting dynamics.

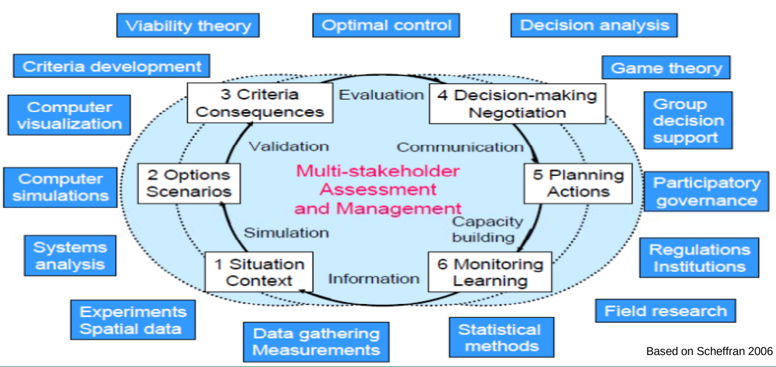
Consequences of the deployment of stratospheric aerosols

Black arrows indicate plausible consequences, red arrows consequences that feed back into preceding ones.

Exemplary schematic overview over possible consequences resulting from the deployment of stratospheric aerosols for different argumentation spheres, for which the specific consequence is most (field colour) and second most (line colour) relevant.



Framework of multi-stakeholder assessment & management



Based on Scheffran 2006

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