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Stop emitting CO2 or geoengineering could be our only hope

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The future of the Earth could rest on potentially dangerous and unproven geoengineering technologies unless emissions of carbon dioxide can be greatly reduced, the latest Royal Society report has found.

Geoengineering the climate: Science, governance and uncertainty (published today, 1st September, by the Royal Society) found that unless future efforts to reduce greenhouse gas emissions are much more successful than they have been so far, additional action in the form of geoengineering will be necessary if we are to cool the planet. Geoengineering technologies were found to be very likely to be technically possible and some were considered to be potentially useful to augment the continuing efforts to mitigate climate change by reducing emissions. However, the report identified major uncertainties regarding their effectiveness, costs and environmental impacts.

Professor John Shepherd, who chaired the Royal Society's geoengineering study(2), said, "It is an unpalatable truth that unless we can succeed in greatly reducing CO2 emissions we are headed for a very uncomfortable and challenging climate future, and geoengineering will be the only option left to limit further temperature increases. Our research found that some geoengineering techniques could have serious unintended and detrimental effects on many people and ecosystems - yet we are still failing to take the only action that will prevent us from having to rely on them. Geoengineering and its consequences are the price we may have to pay for failure to act on climate change."

The report assesses the two main kinds of geoengineering techniques Carbon Dioxide Removal (CDR) and Solar Radiation Management (SRM). CDR techniques address the root of the problem rising CO2 and so have fewer uncertainties and risks, as they work to return the Earth to a more normal state. They are therefore considered preferable to SRM techniques, but none has yet been demonstrated to

be effective at an affordable cost, with acceptable environmental impacts, and they only work to reduce temperatures over very long timescales.

SRM techniques act by reflecting the sun's energy away from Earth, meaning they lower temperatures rapidly, but do not affect CO2 levels. They therefore fail to address the wider effects of rising CO2, such as ocean acidification, and would need to be deployed for a very long time. Although they are relatively cheap to deploy, there are considerable uncertainties about their regional consequences, and they only reduce some, but not all, of the effects of climate change, while possibly creating other problems. The report concludes that SRM techniques could be useful if a threshold is reached where action to reduce temperatures must be taken rapidly, but that they are not an alternative to emissions reductions or CDR techniques.

Professor Shepherd added, "None of the geoengineering technologies so far suggested is a magic bullet, and all have risks and uncertainties associated with them. It is essential that we strive to cut emissions now, but we must also face the very real possibility that we will fail. If "Plan B" is to be an option in the future, considerable research and development of the different methods, their environmental impacts and governance issues must be undertaken now. Used irresponsibly or without regard for possible side effects, geoengineering could have catastrophic consequences similar to those of climate change itself. We must ensure that a governance framework is in place to prevent this."

Of the CDR techniques assessed, the following were considered to have most useful potential:

- CO2 capture from ambient air this would be the preferred method of geoengineering, as it effectively reverses the cause of climate change. At this stage no cost-effective methods have yet been demonstrated and much more research and development is needed.
- Enhanced weathering this technique, which utilises naturally occurring reactions of CO2 from the air with rocks and minerals, was identified as a prospective longer-term option. However more research is needed to find cost-effective methods and to understand the wider environmental implications.
- Land use and afforestation the report found that land use management could and should play a small but significant role in reducing the growth of atmospheric CO2 concentrations. However the scope for applying this technique would be limited by land use conflicts, and all the competing demands for land must be considered when assessing the potential for afforestation and reforestation.

Should temperatures rise to such a level where more rapid action needs to be taken, the following SRM techniques were considered to have most potential:

- Stratospheric aerosols these were found to be feasible, and previous volcanic eruptions have effectively provided short-term preliminary case studies of the potential effectiveness of this method. The cost was assessed as likely to be relatively low and the timescale of action short. However, there are some serious questions over adverse effects, particularly depletion of stratospheric ozone.
- Space-based methods these were considered to be a potential SRM technique for long-term use, if the major problems of implementation and maintenance could be solved. At present the techniques remain prohibitively expensive, complex and would be slow to implement.
- Cloud albedo approaches (eg. cloud ships) the effects would be localised and the impacts on regional weather patterns and ocean currents are of considerable concern but are not well understood. The feasibility and effectiveness of the technique is uncertain. A great deal more research would be needed before this technique could be seriously considered.

The following techniques were considered to have lower potential:

- Biochar (CDR technique) the report identified significant doubts relating to the potential scope, effectiveness and safety of this technique and recommended that substantial research would be required before it could be considered for eligibility for UN carbon credits.
- Ocean fertilisation (CDR technique) the report found that this technique had not been proved to be effective and had high potential for unintended and undesirable ecological side effects.
- Surface albedo approaches (SRM technique, including white roof methods, reflective crops and desert reflectors) these were found to be ineffective, expensive and, in some cases, likely to have serious impacts on local and regional weather patterns.