

## **Earth system studies and geo-engineering: Challenges and opportunities for Pakistan**

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The past 10,000 years have witnessed the growth of homo-sapien population from about a million to a staggering 7 billion at present. This exponential increase in number has also been accompanied by unidirectional and largely irreversible changes on the earth's surface in the realms of farming, mining and excavation, industrialization and urbanization. So far the earth's natural regulatory system has been able to keep everything from the climate to the supply of water and other resources inside narrow comfortable zones. The demands of these 7 billion souls for fresh air, clean water, healthy food, restful shelter, cheap energy and other material and aesthetic pleasures have now stretched the capacity and the capability of the earth system to a certain breaking point – a stage where the humanity's own survival and that of other species which co-habit this planet has become a big question mark.

On a global scale, the recognition of these human-induced fatalities and the initiation of remedial actions to partially offset, if not totally reverse these changes has begun belatedly, half-heartedly and to some extent without adequate studies and enough political will. The victim is none else but the Earth System with its major constituting components of atmosphere, lithosphere, hydrosphere and biosphere. The remedy being suggested recently is called geoengineering. It is a newly emerging field but is controversial from its very outset. It aims to fix the climate regionally, if not in the beginning globally.

Can a country like Pakistan, small in area, large in population and home to a multitude of natural and man-made hazards, derive enough developmental space to envision a better, prosperous, and more equitable future for its people? This paper looks into these possibilities in the overall context of the interconnectedness of earth system, geoengineering, and development economics that could result in evolving sustainable growth strategies ensuring water, energy, mineral, and food security for Pakistan. In the backdrop of this holistic, but hitherto neglected, approach, it offers some practical and cost-effective suggestions to make policies and programmes which should be knowledge-based, people-centric and environment-friendly. Proper understanding of the earth system operating within and on the lithospheric crust of Pakistan is the surest and safest way to turn calamities into opportunities and potential into assets. However, to benefit from all that nature has endowed Pakistan in abundance, the pre-requisite is to overcome the institutional inertias reflective of a non-progressive political mindset and outdated organizational structures and procedures.