Anthropocene under dark skies

The compounding effects of nuclear winter and overstepped planetary boundaries

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Key Findings

- Simplified analysis of catastrophic events ignores interacting risks. COVID-19 shows the need to consider cascading risks.
- Investigating nuclear winter and planetary boundaries reveals complex risk interactions.
- Preserving some boundaries, like biosphere integrity, increasing the chance of human survival before and after nuclear war.
- Nitrogen emissions can alleviate need for fertilizer in nuclear winter. Mitigating climate change could worsen it.
- Balancing planetary boundary preservation with nuclear war risks is crucial for survival.
- Understanding risk interactions is key to developing effective catastrophic event strategies.

Interactions between planetary boundaries and nuclear winter

Land System Change

- Agricultural expansion and deforestation harm biodiversity and climate, while nuclear winter will accelerate land system change and require a shift in food production to warmer regions.
- Converting currently unused land to agriculture and clearing more areas now can ease the transition during nuclear winter.

Biogeochemical Flows

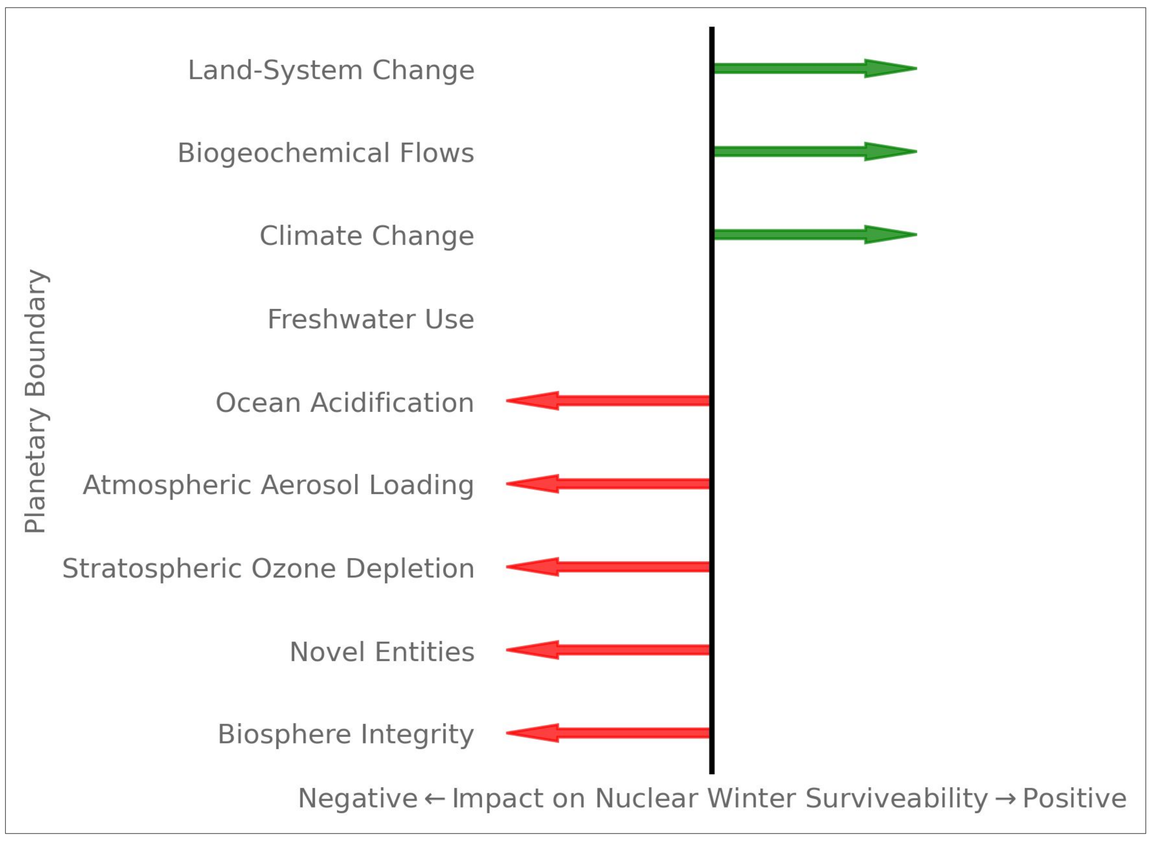
- Biochemical flows of nitrogen and phosphorus are mainly emitted through fertilizers, and nuclear winter will disrupt global agriculture and reduce fertilizer availability.
- Overstepping the biogeochemical boundary now may increase nutrient availability and could make humanity more resilient to nuclear winter.

Climate Change

- Climate change and nuclear winter are human-driven climatic changes with different temperature effects, estimated to cause warming and cooling by 2.1-3.9°C and 9°C, respectively.
- Global warming could mitigate some effects of a nuclear winter, but the restoration process may be harder in a world facing strong global warming pressures.

Ocean Acidification

- Oceans absorb carbon dioxide, lowering pH and harming marine species, leading to declining fish populations.
- Nuclear winter is predicted to increase global pH, which may further harm marine life that must adapt to rapid pH changes. Slowing ocean acidification is important for ecosystem adaptation and increasing food availability during a nuclear winter.



Atmospheric Aerosol Loading

- Aerosols impact human health, solar radiation, and hydrological cycles, while nuclear winter is mainly driven by soot emissions that contribute to atmospheric aerosol loading.
- Removing aerosols now to respect the planetary boundary may result in a warmer planet that cools less during nuclear winter, presenting similar issues to the interaction between climate change and nuclear winter.

Stratospheric Ozone Depletion

- The ozone layer is currently safe, but a nuclear war could cause significant damage, with losses of up to 75% and recovery taking 12-15 years.
- It is crucial to maintain the ozone layer intact as a buffer for the devastating effects of a nuclear war.

Novel Entities

- Man-made chemicals known as novel entities cause harm to humans and the environment, and the planetary boundary for them is currently overstepped.
- Nuclear war introduces more novel entities, pushing concentrations further beyond the safe operating space and potentially causing more harm.

Biosphere Integrity

- Biosphere integrity is crucial in helping ecosystems cope with nuclear winter and increasing biodiversity likely makes ecosystems more resilient to climate extremes.
- Nuclear winter would have an outsized impact on the global biosphere, and the higher the biosphere integrity, the easier it will be to restore Earth.

Freshwater Use

- Nuclear winter may decrease water availability, but the effect of current freshwater use on nuclear winter is likely small.
- Having full water storages now would be beneficial during nuclear winter.

ALLFED

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