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Renewable energy in China

Bringing renewable power 'by wire' from western China to its power-hungry Eastern cities could have benefits for both local air quality and global climate change, new research has found.

The study, published in the journal *Environmental Research Letters*, examined if ongoing power transmission capacity investment in China -- driven largely by concerns over air pollution -- could also reduce local adverse health impacts from air pollution, and greenhouse gas emissions.

China is the world's top carbon emitter, and suffers from severe air pollution. It recently committed to improve air quality and to peak its CO_2 emissions by 2030. The research team carried out a quantitative evaluation of the potential air quality, health and climate implications of long-distance energy by wire strategies.

Lead author Dr Wei Peng, from Harvard University, said: "We examined one possibility that could potentially address both problems: using long-distance electricity transmission to bring renewable power to the polluted eastern provinces."

"Using cutting edge atmospheric modelling and recent epidemiological data, we found that transmitting a hybrid of 60 per cent renewable power and 40 per cent coal -- known as hybrid-by-wire -- reduces 20 per cent more national air-pollution-associated deaths, and decreases three times more carbon emissions, than transmitting only coal-based electricity."

The study also found that, although transmitting coal power was slightly more effective at reducing air pollution impacts than simply replacing old coal power plants with newer, cleaner ones in the east, both coal scenarios had approximately the same carbon emissions.

Co-author Professor Denise Mauzerall, from Princeton University, said: "Our findings have several policy implications. First, it's critical that transmission planning is coordinated with renewable energy use to maximise the combined air quality and climate benefits from energy-by-wire plans. This sort of coordination can better exploit renewable resources in remote areas, and maximize climate, air quality and health co-benefits."

"As many countries also need to expand transmission to support greater use of renewable energy, grid planners should consider the air quality implications of investment in transmission capacity in order to increase the co-benefits for health and carbon mitigation.

The researchers also noted that long-distance transmission could lead to other local environmental impacts from power plants in the electricity exporting regions.

Professor Mauzerall said: "For example, relocating coal power generation to arid western regions could exacerbate water scarcity. Alternatively, extensive development of hydropower may have major impacts on local ecosystems. It is extremely important, therefore, that grid planners consider the overall impact of long-distance electricity transmission on the environment at regional, national and global scales."

Hotspots show that vegetation alters climate by up to 30 percent

Engineers find strong feedbacks between the atmosphere and vegetation that explain up to 30% of precipitation and surface radiation variance; study reveals large potential for improving seasonal weather predictions

A new Columbia Engineering study, led by Pierre Gentine, associate professor of earth and environmental engineering, analyzes global satellite observations and shows that vegetation alters climate and weather patterns by as much as 30 percent. Using a new approach, the researchers found that feedbacks between the atmosphere and vegetation (terrestrial biosphere) can be quite strong, explaining up to 30 percent of variability in precipitation and surface radiation. The paper (DOI 10.1038/ngeo2957), published May 29 in *Nature Geoscience*, is the first to look at biosphere-atmosphere interactions using purely observational data and could greatly improve weather and climate predictions critical to crop management, food security, water supplies, droughts, and heat waves.

"While we can currently make fairly reliable weather predictions, as, for example, five-day forecasts, we do not have good predictive power on sub-seasonal to seasonal time scale, which is essential for food security," Gentine says. "By more accurately observing and modeling the feedbacks between photosynthesis and the atmosphere, as we did in our paper, we should be able to improve climate forecasts on longer timescales."

Vegetation can affect climate and weather patterns due to the release of water vapor during photosynthesis. The release of vapor into the air alters the surface energy fluxes and leads to potential cloud formation. Clouds alter the amount of sunlight, or radiation,that can reach Earth, affecting Earth's energy balance, and in some areas can lead to precipitation. "But, until our study, researchers have not been able to exactly quantify in observations how much photosynthesis, and the biosphere more generally, can affect weather and climate," says Julia Green, Gentine's PhD student and the paper's lead author.

Recent advancements in satellite observations of solar-induced fluorescence, a proxy for photosynthesis, enabled the team to infer vegetation activity. They used remote sensing data for precipitation, radiation, and temperature to represent the atmosphere. They then applied a statistical technique to understand the cause and feedback loop between the biosphere and the atmosphere. Theirs is the first study investigating land-atmosphere interactions to determine both the strength of the predictive mechanism between variables and the time scale over which these links occur.

The researchers found that substantial vegetation-precipitation feedback loops often occur in semi-arid or monsoonal regions, in effect hotspots that are transitional between energy and water limitation. In addition, strong biosphere-radiation feedbacks are often present in several moderately wet regions, for instance in the Eastern U.S. and in the Mediterranean, where precipitation and radiation increase vegetation growth. Vegetation growth enhances heat transfer and increases the height of Earth's boundary layer, the lowest part of the atmosphere that is highly responsive to surface radiation. This increase in turn affects cloudiness and surface radiation.

"Current Earth system models underestimate these precipitation and radiation feedbacks mainly because they underestimate the biosphere response to radiation and water stress response," Green says. "We found that biosphere-atmosphere feedbacks cluster in hotspots, in specific climatic regions that also coincide with areas that are major continental CO2 sources and sinks. Our research demonstrates that those feedbacks are also essential for the global carbon cycle -- they help determine the net CO2 balance of the biosphere and have implications for improving critical management decisions in agriculture, security, climate change, and so much more."

Gentine and his team are now exploring ways to model how biosphere-atmosphere interactions may change with a shifting climate, as well as learning more about the drivers of photosynthesis, in order to better understand atmospheric variability.

Paul Dirmeyer, a professor in the department of atmospheric, oceanic and earth sciences at George Mason University who was not involved in the study, notes: "Green et al. put forward an intriguing and exciting new idea, expanding our measures of land-atmospheric feedbacks from mainly a phenomenon of the water and energy cycles to include the biosphere, both as a response to climate forcing and a forcing to climate response."

Journal Reference:

Julia K. Green, Alexandra G. Konings, Seyed Hamed Alemohammad, Joseph Berry, Dara Entekhabi, Jana Kolassa, Jung-Eun Lee, Pierre Gentine. **Regionally strong feedbacks between the atmosphere and terrestrial biosphere**. *Nature Geoscience*, 2017; DOI:

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