Concrete solutions that lower both emissions and air pollution

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Workers apply cement at the University of California, Davis. Credit: Karin Higgins/UC Davis

Sometimes, fixing one problem can create another.

Concrete production contributes 8 percent of global greenhouse gases, and demand continues to rise as populations and incomes grow. Yet some commonly discussed strategies to reduce the sector's global GHG emissions could, under some scenarios, increase local air pollution and related health damages, according to a study from the University of California, Davis.

For the study, published today in the journal *Nature Climate Change*, scientists quantified the costs of climate change impacts and of death and illness from air pollution. They found that concrete production causes about $335 billion per year in damages, a large fraction of the industry value.

The scientists also compared several GHG-reduction strategies to determine which are most likely to lower both global emissions and local air pollution related to concrete production. They found that a variety of available methods could, together, reduce climate and health damage costs by 44 percent.

"There is a high emissions burden associated with the production of concrete because there is so much demand for it," said lead author Sabbie Miller, an assistant professor in the UC Davis Department of Civil and Environmental Engineering. "We clearly care a great deal about greenhouse gas emissions. But we haven't paid as much attention to health burdens, which are also are driven in large part by this demand."

Assessing the damages

Among the most effective strategies include using cleaner-burning kiln fuel, more renewable energy and replacing a portion of the cement used in production with lower-carbon alternative materials.

While carbon capture and storage technologies could reduce GHG emissions from concrete production by up to 28 percent, the study found it could actually increase human health impacts from air pollutants unless the technology itself is powered by clean energy. It's also not currently widely implementable.

"Air pollution and climate change problems are really intertwined when we talk about solutions," said co-author Frances Moore, an assistant professor with the UC Davis Department of Environmental Science and Policy. "This paper takes these two problems and their joint nature seriously. It shows how different solutions have different effects for global climate change and local air pollution, which may matter a lot for policymakers."

Cement production is responsible for about half of the total climate (32 percent) and health (18 percent) damages of making concrete. That is followed by aggregate production, which is responsible for 34 percent of health damages and 4 percent in climate damages.

As populations and incomes grow, so does the demand for buildings, roads and concrete. Credit: Karin Higgins/UC Davis

Mixing concrete, or batching, contributes little to climate damages but represents 11 percent of health damages.

To reduce these impacts, the authors evaluated eight GHG reduction strategies and presented the options in ways policymakers can consider for feasibility.

Reducing GHGs

Methods that can be readily implemented to reduce climate damages include:

- Cleaner combusting kiln fuel
- Increase use of limestone filler or other low-impact mineral additions to partially replace cement
- Clean energy, such as wind power

Amine scrubbing and calcium looping, which are forms of carbon capture storage, could reduce climate damage costs over 50 percent and 65 percent, respectively. They are not yet readily implementable but may become so in the future.

Reducing air pollution

Cleaner combusting kiln fuel shows the greatest co-benefit, with a 14 percent reduction in health damages—four times as large as any other mitigation strategy for air quality benefits.

The authors note that additional strategies and policies that reduce particulate matter emissions may reduce air pollution impacts more directly.

Major concrete-producing communities include parts of the U.S., China, Brazil, India, Russia and other regions. While effectiveness of strategies varies by region, the study says that overall, a mixture of the strategies could reduce climate and health damages by 85 percent and 19 percent, respectively.

"As the cement and concrete industries make large efforts to reduce greenhouse gas emissions, it is critical that they remain mindful of the impacts decisions have on other environmental burdens to avoid undesired side effects," Miller said.

More information: Climate and health damages from global concrete production, *Nature Climate Change* (2020). DOI:

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