# Solar and wind power could mitigate conflict in northeast Africa

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The dam is located in Ethiopia, near the border with Sudan. Credit: Google

A new study shows that several disagreements between Ethiopia, Sudan and Egypt around Africa's largest hydropower plant, the new Grand Ethiopian Renaissance Dam (GERD), could be alleviated by massively

expanding solar and wind power across the region. Adapting GERD operation to support grid integration of solar and wind power would provide tangible energy and water benefits to all involved countries, creating regional win-win situations. "Our results call for integrated hydro-solar-wind planning to be taken up in the GERD negotiations," says Sebastian Sterl, energy planning expert at Vrije Universiteit Brussel (VUB) and KU Leuven in Belgium and lead author of the study, published in *Nature Energy*.

For several years, political tensions between Egypt, Sudan and Ethiopia have been escalating in a conflict surrounding Africa's largest hydropower plant: the nearly complete Grand Ethiopian Renaissance Dam (GERD) on the Blue Nile. Ethiopia, which started filling GERD's massive reservoir in 2020, says it needs GERD's electricity to lift millions of its citizens out of poverty.

But Egypt is deeply concerned by the mega-dam's consequences for the Nile river, since its agriculture depends completely on Nile water—Egypt raised this issue to the UN Security Council earlier in 2020. Sudan, meanwhile, appears caught between both sides. Ongoing African Union-led mediation talks to agree on long-term operation of the dam have so far yielded little fruit. Certain tongues have even invoked the looming threat of a "water war" between Cairo and Addis Ababa.

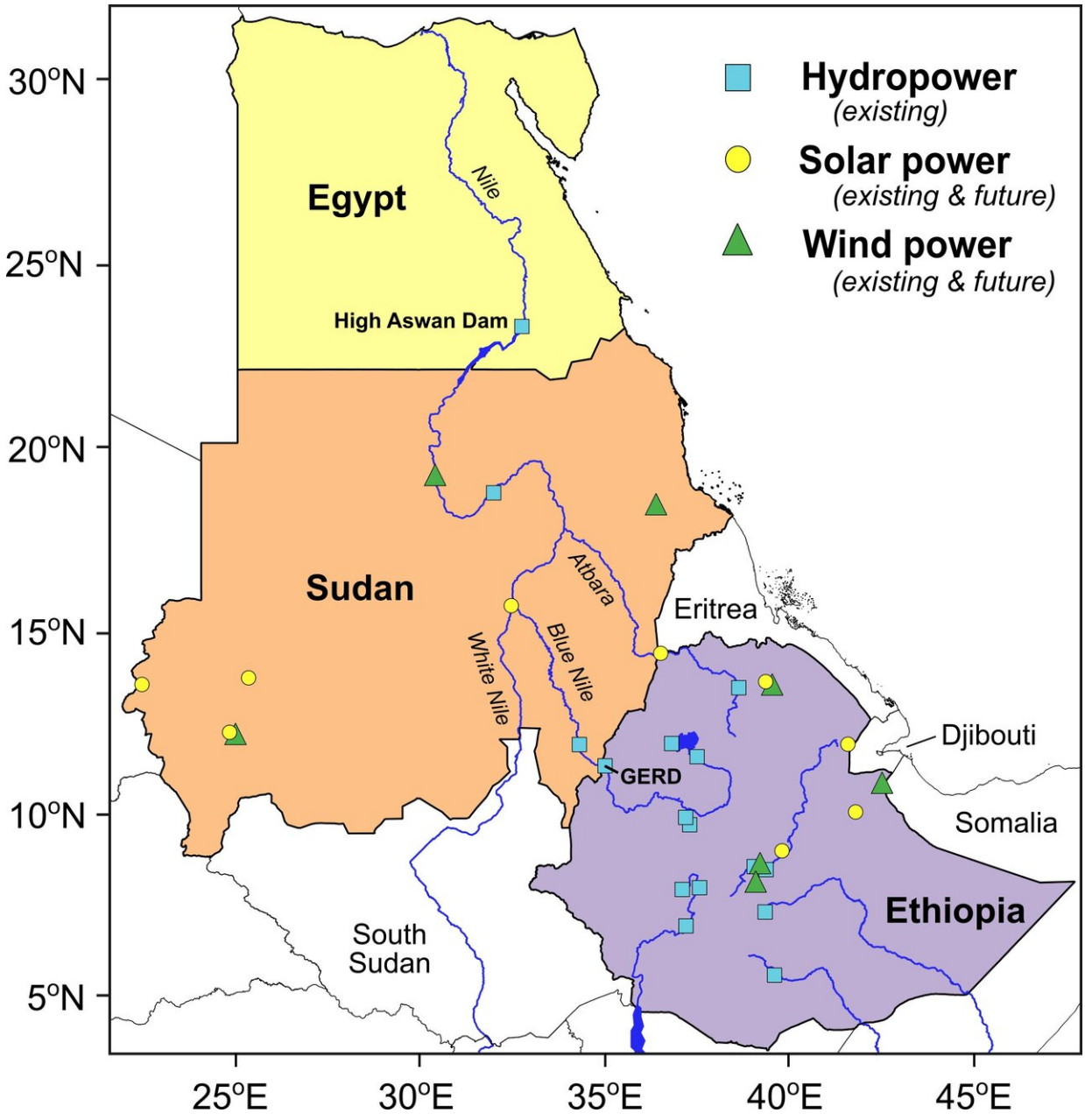
## Seasonal profiles

Sebastian Sterl, energy planning expert at VUB and KU Leuven and lead author of the study, explains: "The Blue Nile is a highly seasonal river. The GERD's reservoir is so large that it can store the river's full peak flow and deliver hydropower at a stable rate throughout the year, removing the flow seasonality. This makes a lot of sense from the Ethiopian perspective, but it overhauls the natural timing of the water

reaching Sudan and Egypt. Behind many disagreements around GERD lies the question of who, if anyone, should be allowed to exert such control over the Nile river."

A group of researchers based in Belgium and Germany, led by Sterl, have now identified a surprising method that could solve multiple disagreements around the dam at once and benefit all three countries. The idea boils down to massively deploying modern, clean solar and wind power to serve as a complement to GERD's hydropower. More concretely: the researchers propose that Ethiopia and its neighbors deploy large-scale solar and wind farms, work towards a regionally integrated power grid, and then agree on Ethiopia operating GERD in synergy with solar and wind power. This would mean turbining less water on sunny and windy days, and more water during cloudy, windless spells and at nighttime, to "firm up" the always-fluctuating solar and wind power.

The researchers realized that sunshine and wind in many regions of Ethiopia, Sudan and their eastern African neighbors have opposite seasonal profiles to the Blue Nile flow. In these places, the sun shines brightest and the winds blow strongest during the dry season. This "seasonal synergy" between water, sun and wind lies at the heart of the researchers' findings.




Energy map of the area near the dam. Credit: VUB/KU Leuven

The study found that, if GERD were operated to back up solar and wind power throughout the year—both hourly and seasonally—this would automatically mean producing less hydropower during the dry season,

and more during the wet season, without negatively affecting GERD's yearly average power output. The water flowing out of the dam would then have a seasonality somewhat resembling the natural river flow, with a clear peak in the wet season.

According to Sterl, if GERD were operated in this way, "Essentially, Ethiopia would have all the expected benefits of a big dam—but for Sudan and Egypt, it would look as if the Ethiopians only built a modest, relatively small reservoir. There are many such reservoirs already on the Nile, so no country downstream of Ethiopia could really object to this."

## Regional cooperation

By reconciling parties around common energy and water objectives, the researchers identified at least five concrete benefits of such integrated hydro-solar-wind planning. First, Ethiopia could become Africa's largest power exporter while reducing its dependence on hydropower and lowering its electricity generation costs on the long term. Second, consumption of polluting fossil fuels in Sudan and other eastern African countries could be displaced by solar and wind power, backed up by GERD.

Third, thanks to the proposed operation scheme of GERD, Egypt could receive more water during dry years than before and would not need to change the operation of its own High Aswan Dam. Fourth, Ethiopia would make more efficient use of its mega-dam's more than a dozen turbines by frequently producing at peak power whenever solar and wind would be unavailable. And fifth, Nile river ecology across Sudan would be less affected by the new dam, as flow seasonality is an important component of rivers' ecological sustainability.

According to the authors, the entire eastern African region stands to contribute. "Ethiopia could theoretically go alone, using GERD to back

up its own solar and wind power," says Sterl. "But it would work much better if, say, Sudan were to join in—it has better solar and wind resources than Ethiopia, allowing for better hydro-solar-wind synergies and reducing the overall costs of renewable power generation. Egypt has great solar and wind resources too, as do Djibouti, South Sudan and other eastern African countries. Regional cooperation in a common, Eastern African Power Pool could be key."

The results of the study suggest that integrated hydro-solar-wind planning could be a highly interesting option to discuss in the ongoing GERD negotations between Ethiopia, Sudan and Egypt. "You could call it a win-win situation," says prof. Wim Thiery, climate researcher at VUB and co-author of the study. "The entire region would benefit."

The researchers obtained their results by using a dedicated, highly detailed computer model (REVUB) conceived to simulate the operation of hydropower dams alongside other renewables, like solar and wind power. The model was originally created by the same VUB-researchers in 2019 to study renewable electricity scenarios for West Africa. Later, as the GERD negotiations became more and more present in the media, the researchers realized they could directly apply the same tool to study solar and wind power as potential solutions to the GERD conflict.

**More information:** Sebastian Sterl et al, Linking solar and wind power in eastern Africa with operation of the Grand Ethiopian Renaissance Dam, *Nature Energy* (2021). DOI: 10.1038/s41560-021-00799-5

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