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Solar projects on water could come at a cost to the environment, alert experts

by Garima Prasher on 12 March 2021

- *To achieve the national goal of 100 GW solar capacity by 2022, various state governments have commissioned floating solar photovoltaics (floatovoltaics) projects in the recent past.*
- *While the cumulative capacity of in-operation floatovoltaic projects in India, as of 2019, was 2.7 MW, over 1.7 GW capacity projects were reported to be in various stages of development, according to a report by TERI.*
- *Ecologists and conservationists are concerned about the long-term impacts of largescale floatovoltaic projects on freshwater ecosystems. They caution that in absence of any reported data or studies available, these projects will lead to an irreparable loss of biodiversity.*
- *Floatovoltaics can trigger a chain of reactions in the water bodies, causing harm to aquatic life, leading to a shift in the ecology.*

As the ambitious national target of "100 GW solar energy by 2022" draws closer, solar panels seems to be popping up almost everywhere. After spanning agricultural lands, obscuring waste lands, and adorning a handful

of rooftops, the panels are now dropping anchors on water bodies. With delay in land acquisitions or other challenges associated with land availability for ground-mounted solar panels, governments have turned towards aquatic systems to ride the new wave of floatovoltaics (floating photovoltaics).

Earlier this year, the Madhya Pradesh government announced the world's largest floating solar project of 600 megawatt (MW) capacity in the backwaters of the Omkareshwar dam. The project is expected to cover approximately 2000 ha of water area and will begin operation in 2022-23. In December 2020, Maharashtra announced a floating solar plant of 80 MW capacity on middle Vaitarana dam, under national energy security programme. Karnataka, with a total installed capacity of 7,366 MW of solar energy as of December 2020, has recently rolled out its Draft Renewable Energy Policy (https://kredlinfo.in/solargrid/Letter%20for%20stake%20holder%20comments.pdf) 2021-2026, which includes floating solar projects on reservoirs and lakes. Even the country's public sector undertakings (PSUs) have issued large-scale floating solar tenders, heating up the floatovoltaic market.

According to a recent study (https://www.teriin.org/sites/default/files/2020-01/floating-solar-PV-report.pdf) done by The Energy and Resources Institute (TERI) in association with the Energy Transmission Commission India programme, as of 2019, while 2.7 MW capacity floatovoltaic projects were in operation, over 1.7 GW were in various stages of development.

This flurry of activities has researchers and freshwater ecologists worried. With multiple projects planned, experts fret over little attention being paid to the impacts of the floatovoltaics on water bodies and their ecosystems. Temperature variation, prolonged stratification, low Dissolved Oxygen (DO), anaerobic decomposition, impact on aquatic life, growth of shade-resistant cyanobacteria (blue-green algae) and impact on feeding habitat of migratory as well as resident birds are only some of the concerns.

Floating solar nightmares

According to experts, the solar panel array can block sunlight penetration into water bodies, disrupting the thermal gradient (both in lateral as well as in longitudinal direction).

"For an ecosystem to function, its structure should be left intact. Spatial extent of the solar panels can alter the amount of sunlight entering the system. This can interfere with various levels of food chain and biogeochemical cycles (water cycle, carbon cycle, nitrogen cycle) of the aquatic ecosystem. Floatovoltaics is an ad-hoc solution, which will prove to be unsustainable in the long run," says T. V. Ramachandra, coordinator, Energy & Wetlands Group, Centre for Ecological Sciences, Indian Institute of Science (IISc).

Researchers say that aquatic ecosystem proliferates under optimum temperature and presence of solar panels on the surface can alter the temperature profile. This can trigger a chain of reactions, leading to various adverse impacts on the ecosystem.

"With less sunlight available, photosynthetic activities inside the water decreases. Low rate of photosynthesis leads to loss of Phytoplankton (microscopic plants), macrophytes (aquatic plants that can be submerged or emergent) and less DO inside the water body. Dying plants further impact aquatic fauna that feed upon the plants and on the herbivorous (animals). While on one hand, lack of food leads to the loss of aquatic life, decomposition of this organic matter leads to increase in temperature, thereby depleting the DO. This rise in temperature and release of nutrients such as inorganic nitrates and phosphates can set off eutrophication process (excess nutrients inside a water body) giving rise to algal bloom (due to proliferation of cyanobacteria). Loss of aquatic fauna also impacts migratory as well as resident birds' feeding habitat," explains Vidyadhar Atkore, an aquatic ecologist working on the biodiversity of rivers and wetlands in India.

A farm using solar power. Photo by PWRDF/Flickr.

According to a recent study (https://iopscience.iop.org/article/10.1088/1748-9326/abbf7b) by researchers in the U.K. and U.S.A, floatovoltaics might also interfere with interaction between the water body and the atmosphere, causing the occurrence of deep-water anoxia (absence of oxygen), resulting in the release of phosphorus from bed sediments.

"Phosphorus is found in sediment bed naturally and is released in the water at a much slower rate. During deep water anoxia, which can get induced due to reduction in surface heating

and wind mixing, the sediment starts releasing phosphorus. Phosphorus is known as the most growth limiting nutrient for aquatic plants that can impact the food web, if it is made available in excess quantity. Too much phosphorus can lead to algal bloom and growth of large aquatic plants which can further bring down the DO level. High amount of algae growth can also release algal toxin which can be harmful to animal and human health," says Atkore.

As a result of the reduced sunlight, floating solar plants can also cause large areas of uneven surface heating, lowering reservoir turnover efficiencies, and impacting plant growth in the littoral zone (near shore area where sunlight penetrates all the way to the bottom of the water body, allowing aquatic plants to grow). Experts say that the effect of solar panels on a water body is highly uncertain and will differ depending on the water body form and floatovoltaic's architecture.

"In ponds as shallow as one-meter, diurnal stratification and destratification cycling events are normal and play an important role in oxygen and nutrient mixing. Stratification reduces water quality, which has consequences for phytoplankton, nutrient, and contaminant loads. Furthermore, these hydrological changes, when combined with the reduced amount of sunlight, can have significant ecological consequences," says Jai Asundi, executive director, Center for Study of Science, Technology, and Policy (CSTEP).

Floatovoltaic benefits: Overhyped or worth the sacrifice?

Some of the reported benefits of floatovoltaics include its land neutral characteristics, reduction in water evaporation, and less algal growth. However, according to some experts, these claims are shallow and not based on long-term scientific studies.

First, floatovoltaic proponents argue that the process of land acquisition is full of roadblocks, leading to slow progress (https://india.mongabay.com/2019/12/parliamentary-committee-concerned-whether-india-will-achieve-its-solar-power-target/) towards hitting the ambitious goal of 100 GW by 2022, making land-based solar plants non-feasible. Conservationists and researchers have a different standpoint. "If we must put PV cells, why are we not using building rooftops to full potential first? Urban rooftops are overheated, unused spaces and installing PV panels on rooftops will not only cool them down but will also bring down the land requirement. Yes, we cannot do mega solar projects on rooftops, but is there a big benefit to mega solar on a reservoir vs a small town's entire rooftop covered with solar

panels? Why take over natural places when we have massive institutions and building next to these water bodies? Why not first cover all the wastelands before we set our eyes on lakes and reservoirs?" asks Veena Srinivasan, Fellow, Ashoka Trust for Research in Ecology and the Environment (ATREE).

Secondly, since floatovoltaics are deployed on water surfaces, it is also thought to be beneficial in reducing evaporation by covering the surface and by limiting the interaction with wind. Here too, experts beg to differ.

"Evaporation has to take place to complete the evapotranspiration cycle in the aquatic systems for them to function in a healthy and efficient way. It forms a significant component of annual water budget too. Therefore 'reduction in evaporation' is not a benefit but can be detrimental not just to aquatic ecosystems, but to humans as well," says IISc's Ramachandra.

And finally, floatovoltaics advocates cite a reduction in algal growth due to shade that the panels provide to the water surface. However, various studies (https://link.springer.com/article/10.1007/s10452-016-9595-y) in past have highlighted that cyanobacteria vary widely in their characteristics, tolerance, and sensitivity and cannot be assumed as competitively inferior at lower temperatures. Moreover, some cyanobateria are shade tolerant by virtue of their efficiency in harvesting light and regulating buoyancy. According to a study (https://iopscience.iop.org/article/10.1088/1748-9326/abbf7b), a change in air-water interface due to the physical presence of the solar panels might impact surface meteorology and low temperature can amplify cyanobacterial biomass, triggering release of phosphorus from bed sediments.

Read more: India's growing solar power programme could leave behind a trail of waste (https://india.mongabay.com/2019/05/indias-growing-solar-power-programme-could-leave-behind-a-trail-of-waste/)

Some other reported benefits of floatovoltaics include ease of deployment, installation, and cleaning; higher energy production; flexibility to share existing electrical infrastructures; and easy integration with existing hydroelectric power plants. However, experts say that there is a need to carefully analyse the trade-off between the 'risk' and the 'return' of floatovoltaics before hopping on to the bandwagon.

Can we mitigate biodiversity impacts associated with floatovoltaics?

In its latest report (https://portals.iucn.org/library/node/49283), the International Union for Conservation of Nature (IUCN) clearly highlights the lack of sufficient study and data on the long-term effects of deploying large-scale floatovoltaics on waterbodies. Moreover, since waterbody characteristics vary widely, the scale of impact is site-specific in nature and hence it is vital to take all factors into consideration before deploying the panels.

Read more: [Analysis] Floating solar power along the dammed up Mekong River (https://news.mongabay.com/2019/12/analysis-floating-solar-power-along-the-dammed-up-mekong-delta/)

And while keeping the aquatic system free of PV cells should be the first choice, experts say that inevitable installations should be done only after analysing the depth profile and geomorphology of the water bodies.

"There exists a knowledge gap and we need to plug that as a priority. Moreover, in an aquatic system, each depth of water contributes to a different component of biodiversity. In case of an unavoidable installation, careful study of the water body becomes imperative. Decisions should be made on which part of the wetland should be taken away from biodiversity and from people who depend on these water bodies for livelihood. While big reservoirs are deep and their ability to host biodiversity is relatively limited, it is seldom absent," says Jagadish Krishnaswamy, senior fellow, Ashoka Trust for Research in Ecology and Environment (ATREE).

Use of non-toxic and low corrosive material for project components; design altercations to ensure minimal coverage of the water surface, development of novel material, and technological modifications while installing the panels are some alternative that presumably can mitigate the possible adverse impacts.

"Design the installation to provide the least amount of shade to the water body. Allow enough space between rows of panels for light to pass through wherever possible and keep row widths to a minimum by installing solar panels in a landscape orientation. Spacing can further mitigate the negative effects of the panels on water quality. Using horizontal directional drilling, anchors and floats, design the mooring and electrical system to prevent dragging on the bottom substrates," adds Asundi of CSTEP.

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