



BALANCING WATTS AND WATER: TOWARD SCIENCE-INFORMED DEPLOYMENT OF FLOATING PHOTOVOLTAICS IN DRYLAND FRESHWATERS

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Drylands are characterized by a growing imbalance between water supply and societal demand. They host nearly 40% of the global population while supporting water provision for drinking, food production, and energy generation, however, drylands are experiencing more frequent and intense droughts due to global climate change, rising evapotranspiration rates, and anthropogenic pressures such as eutrophication, threatening water availability, and quality. Within the water–energy–food–Ecosystem (WEFE) nexus framework, floating photovoltaics (FPVs), solar panels deployed on the surface of water bodies, have emerged as a promising technology to address these interconnected challenges. Rather than presenting new empirical results, this study offers a perspective on FPV deployment, focusing on its potential to reshape freshwater ecosystem services in dryland regions. By acting as physical barriers at the air–water interface, FPVs can reduce evaporation and variability in water levels, as well as surface temperatures. This could potentially limit eutrophication and enhance regulating and provisioning services. In degraded dryland lakes, these effects can extend beyond ecosystem services maintenance and potentially contribute to ecosystem restoration. Combined with renewable energy generation and integration with food production systems (e.g., aquaculture), FPVs hold win-win potential in drylands. However, reduced light penetration and wind-driven mixing can constrain primary production, alter nutrient cycling, and disrupt oxygen dynamics, potentially shifting communities toward low-light-adapted species, impairing biodiversity and ecosystem functioning. At high FPV coverage, these changes may push lake metabolism toward heterotrophy, turning systems into net CO₂ and CH₄ sources. FPVs may also restrict access to water bodies and modify landscape aesthetics, affecting cultural services. Optimizing the trade-offs of FPV deployment in dryland lakes will depend critically on the relationship between panel coverage and lake morphometry as smaller, shallower systems,



are expected to be more sensitive, while larger systems may buffer FPV impacts more effectively. Advancing evidence-based and environmentally sustainable use of FPVs will therefore require targeted investment in research integrating limnological, social and engineering perspectives across contrasting dryland lake systems.

Palavras-chave: *Renewable energy; freshwater services; water-energy-food nexus; ecosystem functioning; global change*