European Commission

Science for Environment Policy

Solar park impacts on microclimate, plants and greenhouse gas emissions

15 December 2016
Issue 479

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Source: Armstrong, A., Ostle, N.J. & Whitaker, J. (2016). Solar park microclimate and vegetation management effects on grassland carbon cycling. *Environmental Research Letters*, 11 (7): 074016. DOI:10.1088/1748-9326/11/7/074016. This study is free to view at: http://iopscience.iop.org/article/10.1088/1748-9326/11/7/074016.

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To cite this article/service: "Science for Environment Policy": European Commission DG Environment News Alert Service, edited by SCU, The University of the West of England, Bristol.

A UK solar park has been found to change the local microclimate, reports recently published research. Moreover, the microclimate coupled with management activities had an impact on greenhouse gas emissions and plant-community diversity and productivity under the solar panels. The study's authors say their research provides a starting point for considering how to improve solar-park design in order to deliver co-benefits for biodiversity and farming, and minimise any negative environmental effects.

There has been a large increase in solar parks around the world, which has led to significant land-use change. In Europe, they are mostly placed on farmland and grassland and, in 2013, an estimated 204–1019 km^2 of European land was converted for ground-mounted solar photovoltaic (PV) panels. Solar PV panels have the greatest potential for generating power among all sources of renewable energy and the growth in solar parks is expected to continue.

However, the ecological implications of the land-use change caused by solar parks are poorly understood. To help fill this gap in knowledge, this study explored the effects of a typical solar park on microclimate and plant–soil processes. The park, in the south of the UK, on former cropland, has a 5 megawatt (MW) capacity and 36 rows of PV panels covering 12.1 hectares in total (including gaps between panels). It produces 4.8 gigawatt hours per year (GWhr/year), which is approximately equivalent to the annual electricity consumption of 1 400 homes.

Two to three years after the panels were first installed, the researchers monitored the microclimate, soil properties, vegetation and greenhouse gases (GHG) released and taken up by the grassland at the site over the course of one year. They measured these at 12 different 1.5 m^2 plots; four were underneath panels, four were in gaps (11.2 m wide) between the panel rows and four were control plots for comparison, over 7 m away from any panels.

Results showed that the panels had a number of impacts on microclimate. From spring to autumn, for example, soil under the panels was up to 5.2 ^{0}C cooler, on average, than soil in the gap and control plots. Lower soil temperatures are likely to affect many important plant–soil processes, including productivity and decomposition, the researchers suggest.

Other microclimate impacts included less moisture in the air below panels, which could indicate that there was less transpiration (evaporation of water from plants) due to lower photosynthesis rates and fewer plants.

Smaller microclimate effects were also noted in the gap plots, when compared with the controls. For instance, soil in the gaps was 1.7 ^{0}C cooler during autumn and winter than in control plots, and air temperature was 2.5 ^{0}C cooler during the day.

These microclimatic effects are attributable to the reduction in solar radiation reaching the land surface, the insulating effect of the panels reducing heat loss from the land surface and the impact of the panels on wind speed and turbulence, altering the transfer of heat and water vapour, say the researchers. The differences in trend throughout the year are due to the changing position of the sun.

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Results also showed clear differences in vegetation. Total above-ground plant biomass was four times greater in gap and control areas than in areas under panels. There were also significantly fewer species of plants under panels; daisies and clover, for example, were completely absent under panels but present elsewhere. Although the researchers note that the gap and control areas had been sown with seeds of meadow plants, they suggest that the panels' effects on microclimate may also have contributed to differences in vegetation. No differences in soil properties (carbon, nitrogen, density, particle-size distribution) were found between areas under panels, in the gaps between and in control areas.

Another key finding was that control and gap areas tended to be a sink of carbon dioxide (CO_2), although the differences were not always statistically different, whereas areas under panels were more likely to be a source of CO_2. This may have been the result of both the re-seeding in gaps and control plots as well as the differing microclimates, and emphasises the importance of managing vegetation at solar parks, the researchers comment.

Solar parks will have different impacts depending on their location. Less solar radiation (which can stress plants) under panels in sunny regions, such as the European Mediterranean, could actually boost plant growth, for instance. These sorts of impacts could be exploited for co-benefits for biodiversity or crop production.

The study's authors conclude that solar parks contribute to the fight against climate change by displacing fossil fuels. However, increased understanding of other environmental costs and benefits will enable any negative impacts to be minimised whilst ecosystem benefits are maximised. Another study exploring solar park impacts on ecosystem services, SPIES, is currently underway.

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