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Planning ground based utility scale solar energy as green infrastructure to enhance ecosystem services

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ABSTRACT

The agricultural sector is often characterized by monocultures and high company fragmentation that led to biodiversity loss and compromised important ecosystem functions, among these the pollination. Pollination is necessary for the health of ecological and agricultural systems, since they guarantee the fecundation of 80% of flower-flora species. This service is valuated among 235 and 577 billion dollars each year.

Land use change is among the potential cause of pollinator's reduction. In most southern Italian regions, as Apulia, there was a land use competition between agriculture and renewable energy production, in particular photovoltaic (PV) system, due to the European policy aiming to decarbonize the energy production.

Lot of agriculture companies moved toward the PV development to retrieve certain revenue, thanks to legislative and fiscal policies encouraging PV development.

Here we propose a methodology to harmonize energy production, agriculture and the enhancement of ecosystem services, looking for a synergy between different economic activities and stakeholders. Areas occupied by PV system can be used for other purposes, as grazing or cultivation or educational activities. Naturalization activities can give back these spaces to pollinator populations notwithstanding the presence of PV panels, enhancing the pollination ecosystem service without affecting other agricultural areas.

1. Introduction

Ecosystems, if adequately managed and used by human, can support directly and indirectly a wide range of human services fundamental for social and economic support of present and future generation, called ecosystem services. However, the increasing and unsustainable anthropogenic pressures are depleting biodiversity and compromising the provision of ecosystem services. In the past decades biodiversity loss has been so dramatic that it has been recognized as crucial in the context of global change (Walker and Steffen, 1996) and quality of human life. Recently, society has increased its awareness that natural resources are becoming greatly compromised by the overexploitation of biodiversity, and the factors that limit socio-economic development are not technological, but natural (Daily, 1997; Petrosillo et al., 2010).

Pollination by animals is a keystone process in both human managed and natural terrestrial ecosystems underpinning biodiversity and ecosystem services. The importance of pollination as an ecosystem service is widely recognized (MEA, 2005; Potts et al., 2010a), because it provides numerous benefits to society as food productions, farmers and beekeepers livelihoods and cultural values (Potts et al., 2016).

Animal pollination, guaranteeing the fertilisation of about 87% of flowering plant species (Ollerton et al., 2011), is indispensable for the health and function of both natural and agricultural systems, crop production and food security (Potts et al., 2010a; Ghazoul, 2005). Pollination is particularly important for agriculture productivity since more than 70% of the world crops depend on animal pollination and most of these crops are effectively pollinated by bees (Aizen et al., 2009; Klein et al., 2007), resulting the most important group of pollinators.

Many scholars have attempted to estimate the economic value of pollination (Hanley et al., 2015). Costanza et al. (1997) provided a global estimate at US$ 117·billion. More recently Gallai et al. (2009) have presented a methodologically improved estimation of the total economic value of pollination worldwide amounted to €153 billion, and specifically to €22 billion for Europe, highlighting that 10% of the total economic value of European food production is dependent upon insect

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pollination.

The economic benefits provided by pollinators are not equally distributed worldwide. The greatest benefits are placed in southern and eastern Asia and Mediterranean Europe because of greater production of highly pollinator-dependent crops and higher market prices (Potts et al., 2016).

In recent decades, however, pollinators have been exposed to growing pressures from climate change, loss and fragmentation of (semi-)natural habitats, increasing use of pesticides, spread of pathogens and introduction of invasive alien species (Potts et al., 2016; Vanbergen et al., 2013). These factors resulted in severe wild and domestic pollinators decline in many regions worldwide (Biesmeijer et al., 2006; Ghazoul, 2005; Potts et al., 2010a) with ecological and economic consequences. Specifically, both managed and wild bee pollinators have undergone marked declines mainly in the US (NRC, 2006; vanEngelsdorp et al., 2008; Bartomeus et al., 2013; Cameron et al., 2011) and some European countries (Biesmeijer et al., 2006; Bommarco et al., 2012; Potts et al., 2010b).

Given the importance of pollinators to crop production, food security, maintenance of wider biodiversity and ecosystem function and the evidence of their decline, several international and regional initiatives have been established to tackle the issues of pollinator declines and to monitor their status and promote their conservation. On a global scale, the Convention on Biological Diversity in 2000 has established the International initiative for the conservation and sustainable use of pollinators, also known as “IPI - International Pollinator Initiative” (http://www.cbd.int/decision/cop/?id=7147). But also at national and regional scales several programmes have promoted actions to protect the services provided by pollinators such as the Brazilian Pollinators Initiative (http://www.webbee.org.br/bpi/index.htm), the African Pollinators Initiative (http://www.arc.agric.za/arc-ppri/Pages/Biosystematics/African-Pollinator-Initiative-(API).aspx), the European Pollinator Initiative (http://www.europeanpollinatorinitiative.org/), and the North American Pollinator Protection Campaign (http://pollinator.org/nappc/), which includes Mexico, Canada and the USA.

1.1. The context of reference

South Italy traditionally has a large agricultural sector, representing the engine of Italian food production. The Apulia region (Fig. 1) tops the national table with 271,754 farms (16.8% of the total for Italy), 1,287,107.32 ha of farmland (10% of the national total) and a turnover of more than 2.3 billion euros in 2011.

The agricultural sector is often characterized by excessive recourse to monoculture and high fragmentation of farms, which have led to severe loss of biodiversity and associated ecosystemic functions such as pollination (Kremen et al., 2002; Winfree et al., 2009; Potts et al., 2010a).

Land-use change is one potential cause of the reduction in pollinator communities (Kremen et al. 2007), together with climate change, the use of pesticides and herbicides, fragmentation of habitats and invasion by alien species (Potts et al., 2016).

In addition, in southern Italy and in particular in Apulia region, a further problem that has emerged in the last few years is the full-scale competition for use of land between agriculture and renewable energy production, the result of specific European policies aimed to decarbonize the economy (Directive 2001/77/CE). For this reason, many crops have converted to photovoltaic electricity generation in return for certain earnings, helped by legislation (D.Lgs. 29/12/2003, n.387) and tax breaks (D.M. 19/02/2007) as well by intrinsic regional characteristics, such as topography and high solar irradiance: Apulia has more installed photovoltaic capacity than any other region in Italy and in 2015 it has detected the national record in terms of installed power with 2,600 (GSE, 2016).

This can be linked to two reasons: optimal environmental characteristics to guarantee high productivity of electrical energy from renewable sources and Regional laws that have favoured the installation of renewable energy production (L.R. n. 31 del 14.10.2008).

The generation of electricity through PV systems is acknowledged as a feasible solution against climate change that provides significant environmental benefits in comparison to the conventional (fossil) energy production (De Marco et al., 2014). The efforts toward a renewable energy system in low-economy areas and in developing nations, in substitution to conventional energy, are meant to reduce environmental impacts of fast growing populations and economies.

However, the realization of ground based photovoltaic systems requires suitable space and several environmental impacts on landscapes and biodiversity may result from site modifications, such as clearing of

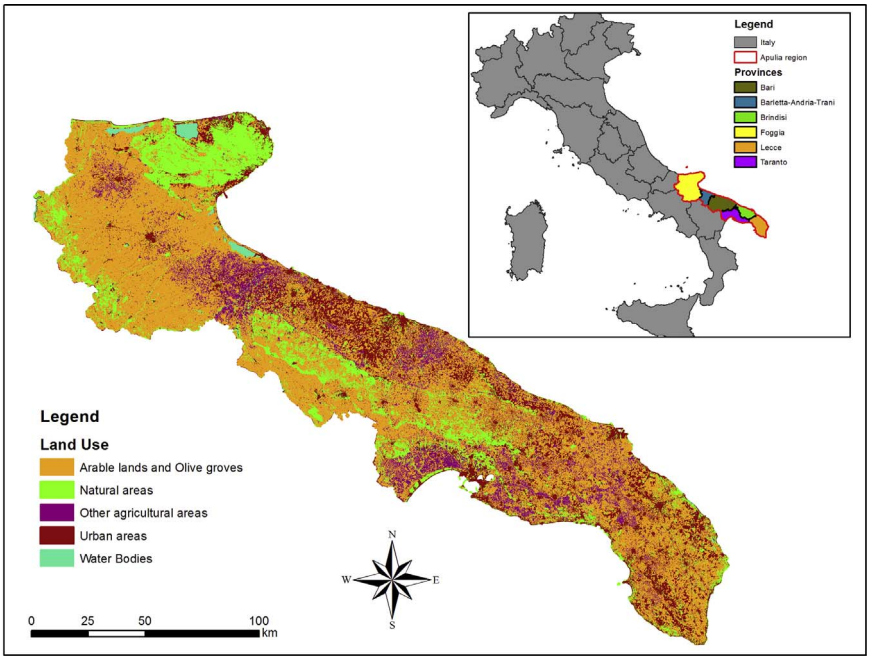

Fig. 1. Land use of Apulia region (map based on data from: www.sit.puglia.it).