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Program assessment and the EU's agrienvironmental Measure 214: An investigation of the spatial dynamics of agrienvironmental policies in Sardinia, Italy

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A B S T R A C T

This paper examines the observed impact of Measure 214, an EU agrienvironmental policy initiative, on the economic landscape of Sardinia. Using both geographically weighted regression (GWR) and ordinary least squares (OLS) regression, the paper observes the relationship between participation in Measure 214 programs and the region's socioeconomic structure through the examination of agriculturally related factors. In our analysis, GWR demonstrates the spatial dynamics and impact of Measure 214 on the region's economy. The GWR model illustrates regions with vibrant spatial patterns, as evaluated by parameter estimates and clarified through explanatory variables. Moreover, the GWR model performs better than the OLS model, as calculated by lower Akaike index AICc and higher adjusted *R* Squared (adjusted R^2) values, reduced spatial autocorrelation of residuals, and higher *F* values from Analysis of Variance (ANOVA). The results also suggest that non-participating communities, although influenced by the wave of industrial development, show a different pattern of economic development. The paper concludes that future funding of agrienvironmental and climate change initiatives under EU Measures will expand the observed pattern of organic production, agricultural employment, and integrated husbandry systems and provide further opportunities for sustainable development.

Introduction: background and motivation

Government-funded agricultural initiatives have a definitive aim and outcome for the future development of organic farming and sustainable agriculture. These initiatives include maintaining the existing cultivated land, increasing the number of organic farms, expanding product territory, improving product quality by processing support, and educating the public through marketing initiatives. Furthermore, these initiatives support society's growing demand for ecosystem services and for those agrienvironmental subsidies that play a strategic role in a region by promoting sustainable development in rural areas. This support occurs through the introduction and maintenance of the agricultural production methods that are compatible with the protection of natural resources (water, air and soil), together with the landscape and its associated biodiversity.

To better understand the evolution and dynamics of Measure 214 in Sardinia's diverse geographical environment, several parameters were considered and applied. From 2008 to 2010, three actions were examined to evaluate the impact of this measure. These actions include 214.1 (organic farming), 214.2 (soil preservation), and 214.42 (raising animal breeds of local importance at risk for abandonment or extinction). Organic farming activities emphasize the importance of the social role played by the farmer, including his or her contributions to the community and to sustaining "public goods," and the protection of the environment and rural areas. All of these goals are expected to be achieved without remuneration from the market. The agrienvironmental measure is thus an example of sustainable development as interpreted by the EU because it ensures the protection of the environment while also contributing to increased innovation and competitiveness in the agriculture sector.

In 2010, Measure 214 was updated to include actions 214.6 (integrated production) and 214.7 (protection of the bustard, *Tetrax tetrax*, L.); however, these actions are not included in the present analysis. In 2010, 336 of 377 municipalities were covered by the measure.

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The results shown in Fig. 1 convey a positive assessment of the development of sustained organic agricultural practices in Sardinia. The increase in the organic farming area is the best indication of the success of Measure 214 during this three-year timeframe. Fig. 1 shows sustained growth of organic farming from 2008 to 2010.

The potential for Measure 214 to spread throughout the island suggests the benefits of a geographical approach to the study of organic farming. To analyze these agrienvironmental measures, we use geographically weighted regression (GWR) and begin with a review of the GWR and associated regression analysis literature.

Regression analysis

Land use and geomorphologic, orographic, social and economic variations on the island greatly influence the geospatial pattern of Measure 214. The social perspective is especially fundamental to understanding the spatial pattern. Farmers moving from traditional to organic agriculture under the agrienvironmental measure create a “revolution” in the management of their farms.

These considerations motivate us to examine the spatial relationship variations between organic agriculture areas and several determining factors of change, such as economic dimension of the farms, number of workers in agriculture, organic conditions, etc. An analysis of the various implications on the Sardinian agriculture planning system provided the capabilities for understanding the impact of the agrienvironmental measure. Statistical regression analysis was necessary to investigate and determine the appropriate variables.

Global and local regression models

There are two forms of regression analysis: global and local models. In a global model, the assumption is that the variation in the dependent variable can be accounted for by a single set of regression coefficients that describe the contributions of the independent variables. However, using such a global model does not accurately represent the variation in the dependent variable at any individual location (Lloyd, 2011 , chap. 5). Global models that make use of all available data are rarely adequate descriptors of local conditions. For example, estimated regression parameters often need to be estimated locally to produce explanatory models with high goodness-of-fit statistics.

Local models are estimated using a localized subset of the data (Lloyd, 2011 , chap. 5). Local regression analysis, also called geographically weighted regression (GWR) analysis, uses the information for each known point to derive application based studies for localized analysis (Fotheringham, Brunsdon, & Charlton, 2002). In Sardinia, estimations of the agrienvironmental measures were based on localized datasets and this approach increased the explanatory power of the developed models. Use of a global model would have been inappropriate and would not have permitted an understanding of the influence of local variables across the island of Sardinia.

GWR

The GWR model assumes that there is a geographically weighted function that can be estimated to determine the influence of the set of independent variables in characterizing the variation in the dependent variable. It is assumed that the model parameter estimates will vary across the study area and thus differ from ordinary regression models that produce one single estimating equation (Foody, 2003; Fotheringham et al., 2002; Platt, 2004; Zhang, Bi, Cheng, & Davis, 2004). The parameters use a weighting function to reflect the influence of distance. The model's parameters may vary in space, and this provides a basis to explore spatial non-stationarity, as opposed to the stationarity assumed in a global regression model (Brunsdon, Fotheringham, & Charlton, 1996; Fotheringham et al. 2002). The inference is that points closer to the point being estimated have greater influence on the weight (Fotheringham et al., 2002).

Thus, GWR allows for the modeling of social processes that vary geographically. This model uses a set of local parameter estimates for each relationship to produce a mapped surface across the study region (Lloyd, 2011 , chap. 5). A “continuous surface of parameters values” allows mapping for visual inspection (Fotheringham et al.,

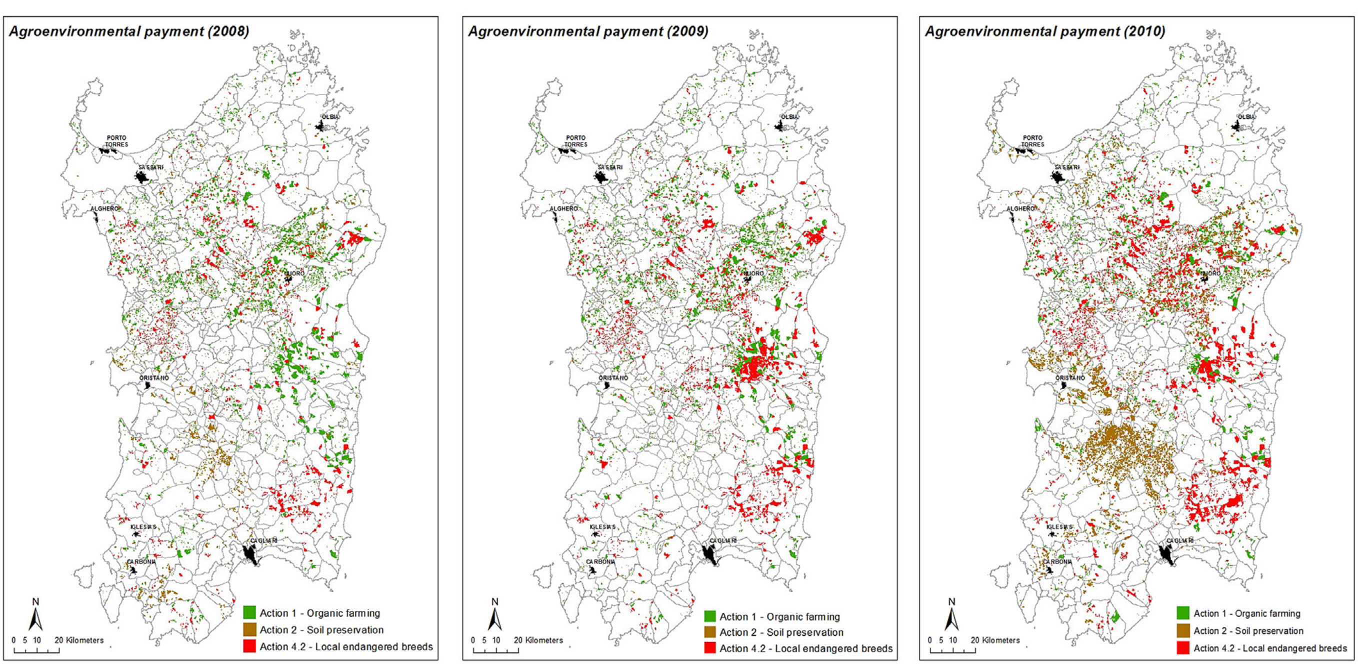

Fig. 1. Three years of agrienvironmental measures.