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CHIARA CERTOMÀ[1], FEDERICO MARTELLOZZO[2]

THE SPATIAL DISTRIBUTION OF URBAN GARDENING AND SPATIAL INJUSTICE. IN BETWEEN SOCIAL-ECONOMIC AND ENVIRONMENTAL DETERMINANTS

1. *Introduction*

There is now a growing body of literature exploring the different forms and aims of political gardening (ranging from food policy contestation, to gentrification, to informal planning etc. Eizenberg, 2013; McKay, 2011; Purcell, Tyman, 2014); however little attention has been devoted to the analysis of the relationship between justice theory and socially-committed urban gardening initiatives (henceforth PG), particularly in its quali-quantitive aspects. This work aims at investigating whether PG can be actually explained as a tentative answer to socio-environmental disparities.

The case study grounds on the analysis of relevant data about urban gardening initiatives in Rome, and it features a GIS-based application aiming at exploring the relationship between the geographical distributions of critical gardening activities and spatial justice indicators which jeopardise urban space in social and environmental terms.

The unequal spatial distribution of environmental degradation, economic deprivation and social marginality conditions in Rome, resulting from the analysis of a number of selected indicators chosen on the base of relevant literature linking these to spatial injustice (EPA, 2010; Faburel, 2010; Fredericks, 2011) makes evident how these burdens disproportionately affect diverse areas of the city. We apply simple statistical regression method (OLS) to spatially explicit data in order to compare the performance of several permutations of different explanatory variables linked to spatial injustice in explaining the distribution of PG initiatives.

The results will offer new insights to understand whether the wide spreading practice of cultivating the city can be actually understood as a grassroots-based form of collective agency addressing the environmental, economic and cultural conditions determining injustices.

2. *Spatial&Environmental Injustice theory and Political gardening*

Since the early '70s the debate on spatial justice attracted a broad scholarly interest in showing how the living conditions of different social groups play a major role in determining their wealth, opportunity, health outcomes, educational attainment and virtually influence all aspects of life's quality (Harvey, 1973; 1996; Lefebvre, 1991; Soja, 1989). A vast array of researches proved that opportunities, material and non-material benefits, services and resources are not equally distributed through space (Soja, 2010); this unequal distribution overlaps the unequal economic and social power distribution occurring through the social body (Young, 1990; Haughton, 1999). More recently, social research established that, amongst other burdens, environmental problems are not randomly distributed in

[1] Ghent University.
[2] University of Florence.

space and they do affect some people more than others (EPA). Subsequently, environmental injustice occurs when unaccountable social agents externalize the environmental costs of their decisions and practices to third parties in circumstances when the affected parties have no knowledge of, or input in, the ecological risk-generating decisions and practices. The link between spatial justice and environmental issues (Homer Dixon, 1994; Agyeman, 2005; Dryzek, 1987) engaged scholars' debate and fueled the disputes regarding its etiology, consequences and controversies.

As Julian Agyeman points out, environmental justice has not only to be interpreted from a negative perspective but should also be seen as a proactive tool for accessing and distributing the environmental benefits necessary for sustainable societies with a high quality of life (Agyeman, 2005). In order for this to happen, activists, research bodies and the academia shall attempt at providing an accurate, detailed and punctual representation of *spatial&environmental injustice* (see for instance the ENTITLE project) and the related conflicts (see for instance EJOLT project).

Nevertheless the fuzziness of theoretical definition, together with its breadth (spamming across a vast number of disciplinary fields, including geography, IR, law, international business studies, political theory…) made it difficult to fully appreciate the multilayered and cross-scalar consequences of spatial injustice, most notably the socio-environmental conflicts. The narrative and the representation of *spatial&environmental injustices* and subsequent conflicts through geographic, qualitative and quantitative data (which can prove to be reliable, scientifically accurate and complete) is of capital importance for a full consideration in both academic debate, and in decision support system and policy-making processes.

This research features an empirical case study dealing with the distribution of urban gardening/agriculture activities in Rome. The starting hypothesis is that urban gardening agency, as seen in literature, can be indicative and hence adequately be used as a proxy for spatial injustice phenomena. This is because urban gardening activities are often proposed by grassroots movements as a mean to counter fight the emergence of injustice. Therefore, through a quantitative investigation of the correlation of the spatial distribution of urban gardening agency in Rome and multiple variables often associated with spatial injustice, we aim at describing which of these variables show higher significance in predicting the pattern of urban gardening agency.

In this work we define urban gardening as the set of collective processes aimed at designing, organising, realising and cultivating flowers and vegetables in (semi-)public spaces, including caring of existing gardens or establishment of new ones through a broad array of spontaneous or loosely-formalised (Hou, 2010) up to sophisticated and professional practices. As a consequence, "urban gardening" is here adopted as an inclusive label, encompassing community gardens (McKay, 2011), guerrilla gardening spots (Tracey, 2007), urban allotments (Crouch, Ward, 1988, Ferris *et al*., 2001), vertical gardens and some initiatives in urban agriculture or food growing activities in the city. While the socio-political character of urban gardening has been variously pointed out in time, only recently it has been openly recognised as a distinctive feature of gardening initiatives (Certomà, Tornaghi, 2015), when a more extended interpretation of the political, focusing on the substantive micropolitics of life (Dean, 1999; Foucault, 2007). This acknowledged that, aside from the mere purpose of "greening" the city, urban gardening initiatives contribute at a wide number of purposes e.g. social cohesion and community-building (Purcell, 2002; Beckie, Bogdan, 2010; Hinchliffe, Whatmore, 2006; Bin, Voicu, 2006); help social disadvantages (Emmet, 2011); provision of marginalised social groups with dedicated spaces for self-improvement and rights protection (Flachs, 2010). While the city of Rome is presented in the official declarations as the greenest city in Europe, with its green space encompassing approximately 68% of the total urban surface, the living conditions are severely downgraded by the unequal distribution of green areas (Cioli, D'Eusebio, 2011). This is combined with a minimal care for the existing public green spaces in the city that become unpleasant and desolated.

Critical gardening developed in Rome in reaction to the lack of available and enjoyable green spaces in large and densely populated areas of the city. Since 2006, a large number of associations and informal citizens groups have started to engage in collective gardening. The movement is rapidly growing, both in the form of flash actions put forward by Guerrilla Gardening groups and in the long-lasting community gardens projects run by local associations. Today, more than 150 community gardens, vegetable gardens and permanent Guerrilla Gardening spots exist in Rome. Environmental care and social integration are generally left to private initiatives and historically are very poorly supported by public administrations; this condition makes the critical gardening initiatives particularly relevant especially in some forgotten urban areas.

3. *Methods and Data*

The analysis of the spatial distribution of social phenomena is extremely relevant for policy makers (Goodchild, 1992). There are multiple reasons why developing accurate prediction of such spatial patterns is often a difficult task, the main relevant ones can be summarized as follow: 1) the elusive nature of some of the variables related to social phenomena, for example very often the emergence of social agency deals with the collective subjective perception of a particular economic-environmental aspect of the people living a certain place, therefore intelligibly measuring that perception can be an extremely demanding task when not possible at all (Goodchild *et al*., 1992); 2) data availability. Some data may be unavailable due to incompleteness of the data, inappropriateness of the scale at which the data was collected is, or because access to the data is not possible for political reasons; 3) Redundancy and significance; even if all variables where to be at hand, the discernment of which variables to choose in order to maximize their significance and minimize their redundancy is not always straightforward (Fotheringham *et al*., 2000).

One of the aims of this study is to systematically explore the variables that influence spatial injustice so to better understand which are the most important and how significantly these relate to spatial injustice. Since we want also to map the spatial distribution of injustice, we decided to use a spatial regression method. The method consists in investigating the degree of correlation of many variables with the phenomenon object of interest building upon data that are spatially explicit.

We first conducted a literature review of all the variables considered relevant to spatial and environmental injustice. Then, in respect to the first two main limitations presented above, we eliminated those whose nature is too elusive to be adequately captured in a systematic and intelligible way, or for which no data were available. Consequently, we obtained a subset of 16 usable variables (tab. 1). We consider this subset to be substantially representative of the main variables reported to shape spatial/environmental injustice, in fact it is well balanced between socio-economic variables and environmental variables.

Variable's name	Variable's description	Variable's tye
Occurrence of social urban gardening agency	Distribution of urban gardening activities in Rome. Dataset from the Ass. Zappataromana.	dependent variable
Cultural diversity index	A cultural diversity index was composed to indetify the level of cultural mix in each cell. The dataset used is the open data of the municipality of Rome regarding school population.	social-economic
Landuse suitability for gardening	A degree of suitability for gardening purposes based on landuse composition of each cell. Landuse information is taken from the Corine 2012 dataset.	environmental
public transport accessibility	A public trasnport accessibility index was computed from the opne data of public transport of the Municipality of Rome.	social-economic
urban growth (Δ '00-'12 %)	Urban growth occurred between 2000 and 2012 (in %). Data from Corine Land Cover 2000 and 2012	environmental
urban cover (%)	Proportion of urban cover in each cell. Data from Corine Land Cover 2012.	environmental
environm. reported conflicts	Density of documented environmental conflicts as reported by population. (multiple sources)	social-economic
population density	Density of population in each cell. Open dataof the Municipality of Rome.	social-economic
access cultural services	Accessibility index developed considering the offer of libraries, cinemas, theatres, museums, archeologic sites. Open data Municipality fo Rome.	social-economic
green land cover (%)	Proportion of green cover in each cell. Data from Corine Land Cover 2012.	environmental
households revenues	Average level of wealth of households living in each cell. Data from the National Institute of Statistics.	social-economic
hydrogeological risk	Spatial distribution of the hydrogeological risk. Data from the National GeoPortal.	environmental
real estate value	Distribution of real estate values. Elaboratin on sample data from the Agency for the Territory 2017.	social-economic
accessibility to usable green areas	Accessibility to usable green areas. Open data of the Municipality of Rome	environmental
air pollution (PM10)	Air pollution concentration. Data from ARPA Lazio.	environmental
access social facilities (mainstream)	Density of mainstream social facilities including education and service points for elderly people and neighbour community (multiple sources).	social-economic
access social facilitites (alternative)	Density of alternative social facilities including solidarity purchasing groups, social squats, community byke workshops (multiple sources).	social-economic

Table 1. List of the variables used in the spatial regression modeling framework. Own elaboration.

The method chosen to investigate the degree of correlation of our explanatory variables with the dependent variable (i.e. the spatial distribution of urban garden activities in Rome) is the ordinary least squares method (OLS). This statistical procedure consists in a linear regression model in which the unknown parameters (e.g. constant, coefficients and standard errors) are estimated by finding the function that can minimize the sum of the squares of the differences between the observed responses (values of the variable being predicted) in the given dataset and those predicted by a linear function of a set of explanatory variables (Equation 1).

$$Y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_n x_n + \varepsilon \qquad \text{[eq. 1]}$$

Where:
Y is the dependent variable;
B_0 is the intercept (constant);
B_1, B_2, B_n are the coefficients corresponding respectively to the variable x_1, x_2 and x_n;
ε is the standard residual (error).

In other words, this method aims at finding the function that can best predict the behavior of our dependent variable according to the values of the corresponding explanatory variables. OLS is a very flexible yet simple model, and therefore has been proficiently applied in a plethora of different fields. OLS can be implemented in different ways all resulting in producing the same formulas and same sort of results (Fotheringham *et al*., 2000). The main assumption behind this modeling effort is that the emergence of social urban gardening agency can be used as a proxy for spatial injustice, so to detect and map where spatial injustice may be (felt) stronger

This application focuses particularly on the spatial dimension of urban gardening agency, therefore, we need to first design and establish a representation/conceptualization of the space that can adequately support the OLS modeling effort. We used an orthogonal grid with a spatial resolution of 1km (fig. 1). For each of the cell belonging to the area of interest, the spatial distribution of all the 16 variables listed in table 1 as well as the distribution of the dependent variable (fig. 1) was calculated, so to have a sample population of over 1500 homogenous elements.

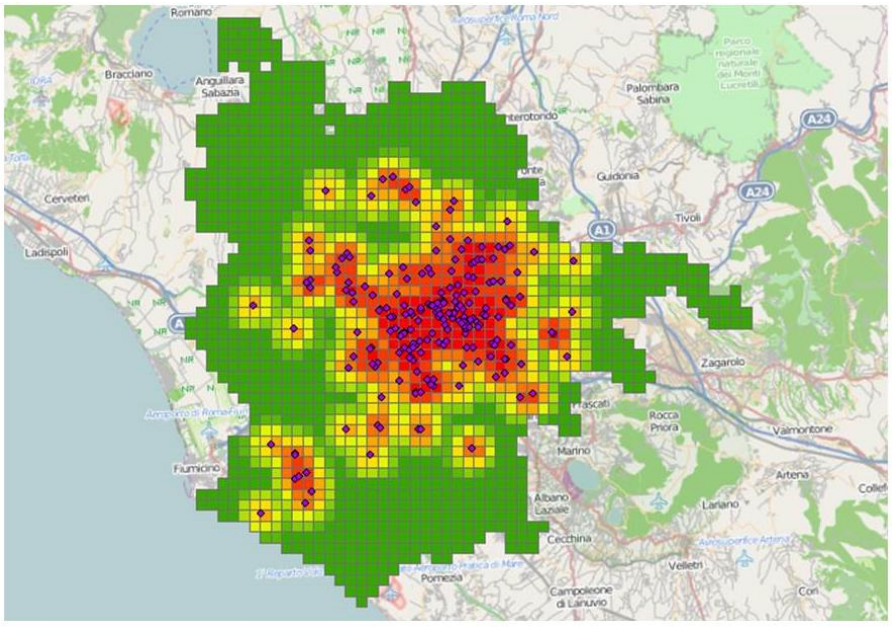

Figure 1. Area of interest, spatial distribution of the dependent variable, 1km spatial grid used.

The first aim of using a linear regression model is to explore how several variables perform in describing/predicting the distribution of urban gardening activities in Rome so to select only those correlating best with the dependent variables. To do so, we ran a single OLS regression for each of the possible combinations of our 16 explanatory variables, allowing the model to feature from 2 to 16 variables. This adds up to over 65,000 possible permutations. The software used is Esri ArcGis 10.2. For each run (possible combination of variables) the model computes also several statistical tests that are then used to identify which model, or models, can best predict the independent variable's distribution through a comparative analysis.

4. *Results and discussion*

As a first preliminary result, it is worth to observe the importance of each single variable *per se* by calculating the aggregate degree of significance of each variable taken individually (equation 2):

$$Var_i\_S = \overline{(\sum(sc\_Var_iMod_j)} \qquad \text{[eq. 2]}$$

Where:

Var_i_S is the aggregate variable significance of the *i*-th variable through all the models where it appears;

$sc\_Var_iMod_j$ is the significance of the correlation between the *i*-th explanatory variable and the dependent variable for the *j*-th model.

When looking at the best ~ 50 models the variables that show the highest degree of significance are: access to social facilities (both mainstream and alternative), real estate value, accessibility to green areas, and household revenues (upper right quadrant in fig. 2).

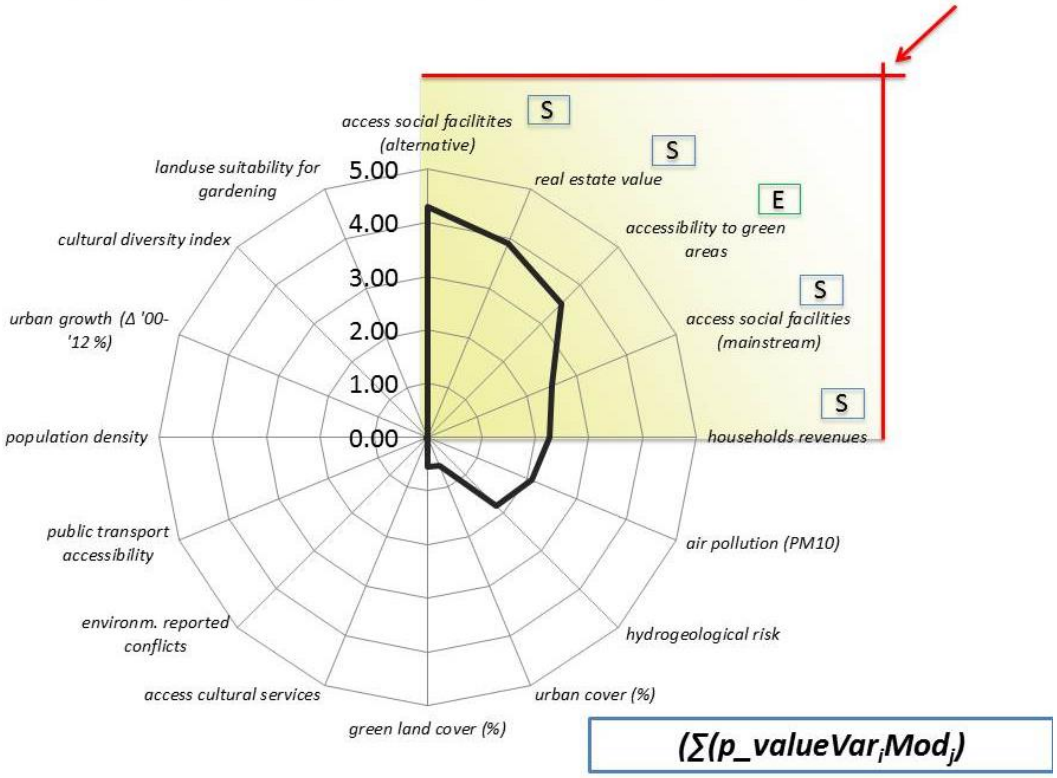

Figure 2. Aggregate average explanatory variables' significance over the best 50 variables' permutations considered.

It is worth to note that among the most significant variables only one is an environmental variable while all the others belong to the social-economic dimension. This could support the speculation that social-economic variables may have a greater influence in predicting (higher degree of correlation) the spatial distribution of urban gardening activities in Rome. Furthermore

The model's run featuring (all and exclusively) the 5 variables highlighted in figure 2 (upper right quadrant) is also the one that in our opinion (and according to our statistical model's test) can more proficiently predict/mimic the behavior of the dependent variable. These are: the accessibility to social facilities (both mainstream and alternative), which correlates positively, hence identifying that the probability of the emergence of urban gardening agency is higher where this accessibility is also higher; the level of wealth which through its negative correlation suggests that spatial/environmental injustice is felt more where people with lower wages live; not surprisingly this phenomenon shows a negative correlation also with the real estate values, therefore suggesting that the emergence of urban gardening agency identifying spatial/environmental injustice occurrences is higher where real estate are lower. Last but not least the accessibility to green areas, which is the only environmental variables featured by the model we chose, suggests that having access to green usable areas is a more relevant driver for the emergence of urban gardening agency, than having higher proportion of green areas with lower accessibility. However, in order to provide a fully spatial regression analysis, this investigation should also explore whether standard residuals of the model tend to form clusters of similar values. In fact, when investigating the degree of clustering of residuals through the Moran's statistical test, results show that although the model chosen is capable of explaining 80% of the variance of the dependent variable, probably there still is an unidentified spatial effect, that can be due to either to unknown variables or to not-linear relationships, or to location specific dynamics, as for example the strong centripetal effect that a monocentric core as the city of Rome exerts on any phenomena occurring in it.

Conclusion

This empirical exercise does not aim at being exhaustive, but propose some findings that can be reasonably indicative of certain dynamics. In this regard, results suggest that, counterintuitively and although being important, environmental variables are not as relevant as socio-economic. Therefore, policy makers wishing to understand the distribution of the emergence of spatial injustice may proficiently focus more on the socio-economic dimension rather than on the environmental dimension, as often suggested in literature. Among these variables we identified a few that seem to be better predictors of the phenomenon object of this study. Nevertheless, the statistical tests developed to determine if the spatial variability is fully explained by the model chosen show that there is still a spatial influence that is not fully understood. In conclusion, although being confident that this research has already identified interesting, more research is needed to further explore dynamics and variables that have not been considered.

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