



Measuring the Existence of a Link between Crime and Social Deprivation within a Metropolitan Area

Medición de la Relación Existente entre Delito y Privación Social dentro de un Área Metropolitana

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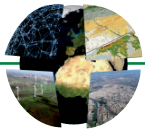
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ABSTRACT

The purpose of the investigation, carried out in the municipality of Genoa (Italy), is to verify the existence of a relationship between crime, observed at the place where the criminal act is committed, and social deprivation. In other words, it aims to investigate the relation between crime and social deprivation from a spatial perspective. Crime, which manifests itself in various forms, is identified in the scientific literature from the concept of a "deviant act" that can be analysed with spatially, temporally and psychologically based approaches. Social deprivation, on the other hand, is a complex phenomenon, defined by Townsend, whose analysis is based primarily on the relational aspect of marginalised and vulnerable groups. The main contribution of this work is the high territorial consistency of the data, referring to the local districts of Genoa. The methodology consists in the realisation of two aggregative quantitative analyses for the construction of the indices. On the one hand, crime is measured using a method based on the sum of standardised variables, while social deprivation is studied by DP2 method. The analysis shows a trend of high levels of crime in districts closest to the centre of the city of Genoa, a trend that decreases as it moves toward the periphery. The city centre areas are the most crowded and the most difficult to control continuously due to the intense traffic of people, especially during rush hours. A similar result can be observed in terms of social deprivation: the districts closer to the centre tend to be more socially critical, while the more distant districts have a stronger social fabric, also due to less traffic by residents. The work can be a useful tool to help policymakers define timely and localised measures to combat crime.

RESUMEN

El propósito de la investigación, realizada en el municipio de Génova (Italia), es verificar la existencia de una relación entre delito, observado en el lugar donde se comete el acto delictivo, y privación social. En otras palabras, se pretende investigar la relación existente entre delito y privación social desde una perspectiva espacial. El delito, que se manifiesta en varias formas, se identifica en la literatura científica a partir del concepto de un "acto desviado" que puede analizarse con enfoques de base espacial, temporal y psicológica. Por su parte, la privación social es un fenómeno complejo, definido por Townsend, cuyo análisis se basa fundamentalmente en el aspecto relacional de grupos marginados y vulnerables. La principal aportación de este trabajo estriba en la alta consistencia territorial de los datos, referidos a distrito local de Génova. La metodología consiste en la realización de dos análisis cuantitativos agregados para la construcción de los índices. Por un lado, el delito se mide con la aplicación



de un método de suma de variables estandarizadas, mientras que la privación social se estudia a través del método DP2. Los análisis muestran una tendencia de altos niveles de delincuencia en los distritos más cercanos al centro de la ciudad de Génova, tendencia que disminuye al desplazarse hacia la periferia. Las zonas del centro de la ciudad son las más concurridas y las más difíciles de controlar continuamente debido al intenso tránsito de personas, especialmente en las horas punta. Un resultado similar se observa en lo que respecta a la privación social: los distritos más cercanos al centro tienden a ser más críticos desde el punto de vista social, mientras que los distritos más alejados tienen un tejido social más sólido, debido también a una menor tránsito de los residentes. El trabajo puede ser un instrumento útil para ayudar a los responsables de la formulación de políticas a definir medidas oportunas y localizadas para luchar contra la delincuencia.

1. INTRODUCTION

Conducting scientific research on the topic of crime means having to face a vast area of analysis: the cause of this should be sought in the relativity of the definition of “deviance”, that is an act that “violates the norms of a community and is punished with a penalty” (Bagnasco, Barbagli & Cavalli, 2012). An act is not deviant for an intrinsic property, but becomes one according to the social context and its current rules. Therefore, it is very important for a correct analysis to highlight the links between the act committed and the socio-economic aspect.

The literature in the study of crime privileged the analysis from an objective point of view (Gartner, 1990), concerning the number of reported crimes. This approach allows the analysis of crime according to criteria of time, space and seriousness. The subjective approach (Hannon, 2002), on the other hand, is inherent to the characteristics of the accused and convicted - such as sex, age, citizenship, marital status, education and employment -, as well as the study of recidivism. The subjective analysis, however, tends to overlook the victim's point of view. In order to avoid this distorting effect, it is useful to focus the investigation on the area where the criminal act takes place (Moffitt, Miech & Silva, P., 1999), including, in a broad sense, the analysis in the so-called “victimization investigations”, which place greater emphasis on the perception of safety as an essential element that contributes to the quality of life (Muratore, 2015).

Several studies reveal that there is a relationship between crime and deprivation (Hsieh & Pugh, 1993; Tumin, 1953). In particular, a growing relative deprivation, as an element capable of increasing resentment and sense of inequality of people that live in the most difficult social conditions, would have a greater impact on the increase in crime (LaFree, 1998).

To define social deprivation, we adopt the definition that Townsend, P. (1987, 1993) provides, in two works of primary importance in this field of analysis. Townsend was the first to write that “social deprivation implies a non-participation in the roles, relationships, customs, functions, rights and responsibilities involved in being an active member of society or group” (Townsend, 1993). In his definition, Townsend places emphasis on the relational and anagraphic aspects of the deprivation.

The use of deprivation indicators can be a useful tool to evaluate situations of poor economic or social well-being and the significant differences that are found between the different areas of the Ligurian capital. Their analysis could lead to the creation of specific policies to be adopted in order to make these disparities less evident. In fact, using geographically aggregated indices presupposes that they are a good approximation of individual risk and that there is, therefore, a certain “contextual effect”, i.e. a specific environmental factor that similarly influences people (Macintyre, Ellaway & Cummins, 2002).

The purpose of the investigation is to analyse the crimes registered in the various districts of the municipality of Genoa by all law enforcement agencies, and to relate these crimes to an element of analysis of social disadvantage, that is a deprivation index on a geographical basis divided into the same district. The aim is to identify a possible relationship of correlation between crimes committed in certain areas and the presence of elements of social exclusion.

The paper is organized as follows: in the paragraph 2 we deal with the motivation, the aim and the theoretical perspective of our study; in paragraph 3 research method is developed; the main research findings and contribution paper outline are examined in paragraph 4 and 5 respectively.



2. THEORY

2.1. Crime

The concept of crime refers to the definition of deviance, that is an act that “violates the norms of a community and is punished with a sanction” (Bagnasco, H., et al., 2012). A deviant act is not such because of intrinsic properties, but based on the social context in which it is committed and on its current rules; in fact, the act considered “deviated” within one community could be considered differently in another.

Crimes are created by the interactions of potential offenders with potential targets in settings that make committing the crime easy, safe and profitable (Brantingham & Brantingham, 1993; Felson, 1994).

People tend to commit offences close to the central places (nodes) in their lives (Brantingham & Brantingham, 1991), as homes, working places, schools, favourite recreation sites, shopping centres. People are also victimized near their central nodes (ibidem).

Paths determine where people go and what they learn about the city (Braçe, 2016). Because of their critical importance in shaping routine activities, paths trace where people search for criminal targets and where people are victimized (Brantingham, Brantingham & Seagrave, 1995). Nodal crime sites such as a city centre bar district, a shopping mall, or a secondary school tend to attract offenders from many different directions (Costanzo, Halperin & Gale, 1986). This pattern is very similar to the more general pattern of movement in relation to more mundane activities such as shopping. Criminal events cluster near major traffic arteries and near major intersections between arteries (Wilcox, 1973; Alston, 1994).

Criminality can be analysed taking into account “edges”, i.e. places where there is enough distinctiveness from one bit to another that the change is noticeable (Cromwell, Olson & Avary, 1991). An edge can be represented by the land bordering on a river, the houses behind a commercial strip development and the businesses; also parks, residential areas and commercial areas have edges. In the literature, edges are considered as limits of perceptual comfort felt by outsiders entering unknown areas (Wright & Decker, 1994). At the opposite, the areas around edges often experience high crime rates (Walsh, 1986).

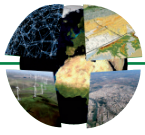
In the society, there has always been a group of people who deliberately put themselves outside the whole society, sometimes outside the will of the majority in it and sometimes only outside the will of the ruling minority (Ferenc, 2007). Some of them led forward while others led astray those who became their followers. They and their followers have a strong faith (in other words: unshakable conviction) that only they walk on the right path and all those who do not share their views are the victims of deception or error. Because of their deep faith and distort “sense of majority”, there is no threat of punishment that can make them change their minds: whether they observe the law or not is not influenced by the threat of (even the most severe) punishment (ibidem).

In order to secure compliance to the basic rules necessary for the existence and development of society and to prevent crimes that pose a serious threat to society, it is necessary to establish some key points for the fight against crime. A first aspect refers to the legal framework, i.e. the limits of state control and of the system of punishments. The second element can be associated to the harmonization of public and private interests and to strengthening control; the aim is to replace social threats with behaviour useful to the communities. Then, it is necessary to consider the theme of crime prevention in a wider sense, with all its priorities (Hetzer, 2006).

The theme of crime-fighting has attracted wide coverage in the media, especially in the past one or two decades. The opinion that relations in society can be changed to an extent that may have a positive impact on crime, gained dominance (Ferenc, 2007). A popular way of thinking is centred on the assumption that it is the government and not the different non-governmental professional organizations (NGOs) that should prepare programmes on a mass scale to prevent people from becoming criminals.

The possibility of formal and actual control over people has undergone extensive changes in the past decade (ibidem).

The key to reduce the crime rate would seem to be prevention rather than punishment (Hope, 2009). Crime prevention refers to actions intended to change the social conditions that are believed to sustain



crime in residential communities. It concentrates usually on the ability of local social institutions to reduce crime in residential neighbourhoods (ibidem).

A strand of theories on crime prevention is part of the “accountability strategy”. It consists not in direct action through state agencies (police, courts, prisons, social work, etc.) but instead in indirect action, seeking to activate action on the part of non-state agencies and organisations. Its keywords are terms such as “partnership”, “inter-agency cooperation”, “the multi-agency approach”, “activating communities”, creating “active citizens”, “help for self-help” (Garland, 1996, 2001).

Other models of prevention are based on a “social” or “developmental” approach. The former incorporates interventions aimed at both reducing individual motivations to offend via their social influences and institutions of socialisation, and altering social relationships and/or the social environment, through a collective focus on communities, neighbourhoods or social networks (Crawford & Traynor, 2012). The latter involves various kinds of theories, which entail intervention early in personal pathways that may result in criminal behaviours and other social problems to prevent the development of criminal potential in individuals. More in general, developmental crime prevention is based on the idea that offending is determined by behavioural and attitudinal patterns learned and produced throughout the course of an individual’s life. It proceeds from the basis that risk factors exist at different ages and that life events affect the course of development. It focuses largely on childhood development and the opportunities present at critical junctures during the life-course, to prevent the onset of offending in the early years (McAra & McVie, 2012a,b; Farrington, 2007).

The difficulty that affects crime prevention is that futures prevented remain unknown and hard to measure or account for. Prevention fits well with the prevailing concern for “governing the future”, averting potential harms, through foresight, anticipation and pre-emption (Zedner, 2009).

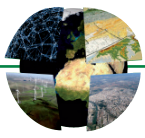
New technologies offer analysis systems that can facilitate the creation of new prevention models. The volume, variety and velocity of new forms of data enable interventions in the present that shape the future in diverse and unimaginable ways that escape the search for causality (Mayer-Schönberger & Cukier, 2013), with clear implications for security.

The constant use of big data in the field of public security is one of the solutions offered by technological innovation. As Amazon and Google seek to predict your tastes, so too the algorithms of future services, providers and utilities may seek to prevent “bad risks” (Harcourt, 2015).

2.2. Social Deprivation

Studies concerning the analysis of the diversity of the socio-economic context and its influence on the state of health are part of the line of research relating to the theme of deprivation, inaugurated in the 1980s in Britain by multiple works (Jarman, 1983; Townsend, 1987; Townsend, Phillimore, & Battie, 1988), that is the analysis of the state of disadvantage in which individuals find themselves, compared to the living conditions of the community to which they belong (Townsend, 1987). In our paper we adopt the theoretical perspective launched by the English author to define the social deprivation.

Deprivation indices are fairly simple and inexpensive instruments to measure the socio-economic conditions of areas of residence because they are generally made up of census indicators which are easily available, thus combining different types of statistical data (Bartley & Blane, 1994). As stated by P. Townsend (1987), it should be noted that the lack of availability of goods, services, resources, conveniences normally enjoyed or at least widely accepted as primary goods, can be identified with the concept of “material deprivation”, while “social deprivation” implies a non-participation in the roles, relationships, uses, functions, rights and responsibilities involved in belonging to a community or a group of its members (Testi & Ivaldi, 2008). A measure of social deprivation, therefore, refers to those characteristics which in themselves do not necessarily entail negative effects, but which can indirectly determine conditions of disadvantage based on the social context, as they could make it difficult to participate in roles, relationships, rights and responsibilities which are typical of a member of that context. The influence of the latter is more difficult to quantify due to their non-objective nature and the difficulty to detect them (Macintyre et al., 2002). The social dimension



is mainly expressed by social cohesion, disaggregation, and social capital of the population group (Bellani & D'Ambrosio, 2011; Mabughi & Selim, 2006). Social cohesion refers to the intensity of social relations and the consensus of a social group, classically understood as the existence of bonds between social actors, allowing them to have a coordinated and harmonious action. On the other hand, the concept of social capital describes the meaning and coherence of social relations and the way in which they are structured in relation to a social actor (Oxoby, 2009).

In literature, contributors trace the busiest areas as potential critical point from a social perspective. A high degree of fluidity as well as an intense predisposition to residential turnover can compromise the balance of the social fabric (Bruzzi, Ivaldi & Landi, 2020). As a consequence, different forms of marginalization can derive: social exclusion, lack of social networks and family support, isolation, racism (Townsend, 1987).

Studies of social marginalization identify groups that are particularly vulnerable to social exclusion (Townsend, 1987). Unemployed people, especially low-skilled workers or of a certain age (the younger or those older than 50) along with the disabled, single-parent or multi-child families, families struggling with alcohol problems, drug addiction or violence, as well as refugees are exposed to difficult social situations (Swigost, 2017). More in general, social deprivation refers to an individual's ability to fully participate in community life (Townsend, 1987). Research evidence shows that a consistent number of criminals leave school before the age of 16. Very few attend a third level institution. In addition, a large percentage of criminals had been unemployed prior to their criminal act (O'Mahony, 1997).

In general, deprivation generates crime and distrust. Failure to achieve a socially desirable goal can increase an individual's social intolerance. The roots of this sentiment can degenerate into growing social isolation and violent acts (de Courson, & Nettle, 2020).

The role of the social class in generating criminality is, internationally, an important topic of research, analysis, and public debate. International research has confirmed the strong links between various forms of socio-economic deprivation and serious involvement in crime (West & Farrington, 1973). Many researchers and analysts have taken the view that this relationship between socio-economic marginalisation and involvement in crime is undeniable (Kolvin, Miller, Fleeting & Kolvin, 1988).

However, in the literature there are researchers of different orientation. The sociologist C. McCullagh (1996) has forcefully challenged the notion that the bulk of crime is committed by working-class offenders on the credible grounds that an immense amount of white collar crime goes unnoticed and unpunished, at least by the conventional apparatus of the criminal justice system. He argues that crimes of financial dishonesty have a pervasive presence in society, but that this is not reflected in official statistical reports on crime.

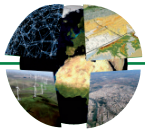
Some works show that social deprivation is not sufficient in itself to cause criminality and that a socially deprived background does not inevitably lead to a life of crime (O'Mahony, 1986). They underline the need to acknowledge the importance of individual-based factors such as temperament, unique aspects of personal experience, and intellectual, psychological and physical resources, all of which are likely to interact with adverse aspects of a person's social background to make crime more or less likely (West & Farrington, 1992).

In this paper, we assume that there may be a spatial relationship between crime and deprivation. Consequently, our perspective aims to highlight, if any, correlations between socio-economic aspects and deprivation, putting these aspects before the individualistic considerations presented by other authors in different analytical contexts.

3. METHODOLOGY

In this study we apply the additive aggregative method to obtain a crime index that contributes to and detects the constituencies of Genoa where crime episodes occur most frequently (Carstairs & Morris, 1991; Ivaldi, 2006). We start from the formative conceptual framework (Maggino, 2017a, b).

The social deprivation index has been developed consistently with what has been done in Bruzzi, Soliani & Ivaldi (2017). The variables are identified starting from the definition of social deprivation advanced by Townsend, 1987; 1993) and from the recent literature about social deprivation (Bruzzi et al., 2020).



The hypothesis we started from is that crime, if it depends on deprivation, must show a positive spatial correlation with social deprivation itself. We want to identify their relation by using two index and to describe with what spatial scheme crime and social deprivation proliferate in Genoa.

3.1. Data and sources

The area under investigation is represented by the administrative districts of the municipality of Genoa; crime data was provided by the Genoa Police Headquarters¹.

The current metropolitan city of Genoa was born following a series of annexations of small neighbouring municipalities incorporated in the Greater Genoa starting from 1926. Today these realities can be considered neighbourhoods, areas with their own traditional, cultural and geographical identity that makes them distinguishable in the overall metropolitan context. These 71 urban units, defined in 1969 with the birth of the "neighbourhood and delegation councils", with an average population of 8549 inhabitants, are aggregated into 25 administrative districts and used by the law enforcement agency for the purpose of geo-referencing data. Therefore, with the aim of comparing the data relating to crime, it was decided to identify these areas as small areas of reference, as they represent a subdivision suitable to grasp differences and tendencies regarding trends in the field of crime and deprivation.

The source of the data relating to crime are the Genoa Police Headquarters. The data refer to the three-year period 2015-2017. A preliminary average was calculated for each type of crime, so that any anomalous data would not have a distorting effect.

3.2. Formative approach to building the index

The analysis is based on a formative (or causal) approach, according to which the indicators taken into consideration affect the phenomenon under study, determining changes in value (Blalock, 1964). The formative approach refers to the bottom-up explanatory approach. According to this approach, a concept is assumed to be defined by a group of indicators, identified in order to define it.

The formative approach is characterised by the following properties (Diamantopoulos, & Winklhofer, 2001):

- indicators are not interchangeable (omitting an indicator is omitting part of the construct);
- eventual correlations between indicators are not explained by the measurement model;
- internal consistency is of minimal importance: two uncorrelated indicators can both serve as meaningful indicators of the same construct;
- indicators do not have error terms; error variance is represented only as disturbance terms (ζ).

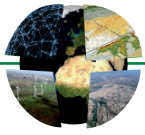
In this case, the latent variable is defined by a linear combination of indicators (Maggino, 2017a, b):

$$\eta = \gamma_1 x_1 + \gamma_2 x_2 + \dots + \gamma_n x_n + \zeta$$

where:

- η is the latent variable
- x_i is the indicator i
- γ is the expected effect of x_i on η
- ζ is the disturbance term with $\text{COV}(x_i, \zeta) = 0$ and $E(\zeta) = 0$

1. Following a request forwarded to the Genoa Police Headquarters, it was possible to view sensitive data in aggregate form, geo-referenced by district, in order to develop this project. The data collection system is called "FASTSDI". The data within it is subject to the protection provided for by art. 9 L.121 / 81.



3.3. Construction of the crime index

The analysis concerned the number of crimes committed, according to the data collected by all police forces on the Genoese territory through the Investigation System (SDI), a detection system which allows to record multiple information about the crime such as the day, the hour, the place, up to the street and the house number. In addition, the recorded data can be implemented with specific notes in which to specify each relevant detail. Since 2012 this system has been called Georeferencing.

In order to analyse crime in every district in more detail, the crimes have been grouped into seven groups according to their scope² (table 1):

Table 1. Subdivision of the groups of crimes.

N° GROUP	TYPE OF CRIME
Group 1	Thefts and robberies
Group 2	Threats, insults, extortions, beatings, injuries, damages
Group 3	Counterfeiting of industrial brands and products
Group 4	Scams, fraud and cybercrime
Group 5	Receiving stolen goods and money laundering
Group 6	Sexual violence

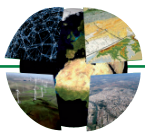
Certain types of crime were excluded from the analysis since, due to their low number, they would not have been useful for the purpose of drafting the statistical analysis. Among the excluded crimes there are murders (voluntary, attempted, unpremeditated, involuntary), sexual acts with minors, corruption of a minor, usury, kidnappings, criminal and mafia associations, exploitation of prostitution, child pornography, infringement of intellectual property. These variables are small in number, which is why they would affect the overall index value more significantly, distorting the analysis. Furthermore, it is useful to remember that crimes related to drugs have not been taken into consideration since, according to the records provided by the Police Headquarters, they do not represent the crimes reported and committed, but refer to the prevention activity that the police forces operate; for the same reason, such crimes are difficult to control. Drug crimes are difficult to identify and may not be exhaustive. The choice not to consider the data relative to drugs is also due to the very nature of the substance, the portability, which often prevails over group consumption. Moreover, possessing drugs for personal use is not a crime itself, if it is not intended for distribution to other types of distribution on a small or large scale. This regulatory aspect sometimes makes it more difficult to prove that a drug crime has been committed.

In order to identify the riskier situations within the various Genoese districts, a crime indicator was calculated for each group of crimes, applying the additive method (Carstairs & Morris, 1991; Ivaldi, 2006), adding up the values of the variables examined.

The crime rate is calculated as the unweighted sum of each indicator taken in its standardized form:

$$Z_1 = \frac{x_1 - \mu x_1}{\sigma x_1}; Z_2 = \frac{x_2 - \mu x_2}{\sigma x_2} \dots Z_i = \frac{x_i - \mu x_i}{\sigma x_i} \dots Z_n = \frac{x_n - \mu x_n}{\sigma x_n}$$

2. Whose legislative reference is the “Criminal Code and transitional provisions” updated by the Gazzetta Ufficiale no. 206 of 4 September 2017.



since μx_i and σx_i ($i = 6$) are respectively the means and the mean square deviations of the variables taken into consideration, the index is:

$$\text{Crime Index (IC)} = \sum_1^6 Z_i$$

Wanting to obtain a geographical representation of the phenomenon, it is possible to resort to a “homogeneous grouping of crime”, providing a predetermined number of classes that identify increasing levels of crime to which to assign each unit of reference for which the index has been calculated. The classes were identified by using population quintiles (Jarman, 1983; Townsend, Phillimore & Battie, 1988; Carstairs, 2000; Ivaldi, 2006; Bruzzi et al., 2020). This method allows to preserve the dimensional homogeneity of the classes, as each class contains about 25% of the Genoese population.

3.4. Construction of the social deprivation index (ids)

The variables used to quantify social deprivation, provided in table 2, were chosen taking as reference the work proposed by C. Bruzzi et al. (2020), related to the analysis of deprivation in the city of Genoa. The variables are identified starting from those that are used in the literature to represent the socio-economic nature of the context to which individuals belong. In the case under analysis, the data comes from re-elaborations of the Statistics Office of the Municipality of Genoa on the census surveys of 2011.

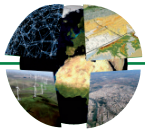
Table 2. Description of the social deprivation variables.

VARIABLE	DESCRIPTION
Index of old age	Ratio between population aged 65 and over and population under the age of 15;
Lone elders	Number of people aged 65 and over who live alone out of the total population;
Resident foreigners	Number of people born abroad out of total population;
Foreigners in schools	Number of people born abroad aged between 5 and 14 out of the resident population aged between 5 and 14
Single-parent families	Number of families composed of one parent and dependent children out of total families;
Single-member families	Number of people living alone out of total families;

The social deprivation variables were aggregated in the social deprivation index (IDS), according to the DP2 method (Sommariba & Pena, 2009; Bruzzi et al., 2017). The DP2 measures distance in relation to an object of each analysis unit.

Originally conceived as a measure of the Quality of Life (Peña, 1977), the DP2 index received international recognition in 2009, with the publication of the article “Synthetic Indicators of Quality of Life in Europe” (Sommariba & Pena, 2009), which compares three calculation methods: PCA, DEA and DP2 (Montero, Chasco & Larraz, 2010).

The DP2 index enjoys some desirable properties: non-negativity, commutativity, triangular inequality, monotony, exhaustiveness, existence, determination, transitivity, invariance to change of scale or origin, invariance with respect to a change in general conditions. The DP2 index also allows to solve some problems frequently encountered in the construction of statistical measures, since it is a partially non-compensatory methodology. Assuming that the aggregate elements in the construction of a synthetic measure of a multidimensional phenomenon are not replaceable, the non-compensatory models allow to preserve the



information contained in all the variables. Unlike in the case of crime, in the case of social deprivation some variables are not replaceable. A compensatory aggregation could offset the surplus or deficit in one component, thus reducing the relevant information (Mazziotta & Pareto, 2016).

The index is processed in the following steps:

first we proceed to the standardization of the original matrix $X = \{x_{ij}\}$ with $i=1, \dots, n$ where n is the number of analysis units and $j=1, \dots, m$ where m is the number of variables:

$$Z_{ij} = \frac{x_{ij} - \mu_j}{\sigma_{x_j}}$$

Where $\mu_j = \frac{\sum_{i=1}^n x_{ij}}{n}$ is the arithmetic mean of the j^{th} variable

and $\sigma_{x_j} = \sqrt{\frac{\sum_{i=1}^n (x_{ij} - \mu_j)^2}{n}}$ is the mean square deviation of the j^{th} variable.

For each value of the variable, the distance from the minimum value of the same is identified:

$$d_{ij} = |z_{ij} - \min\{z_{ij}\}|$$

The new matrix obtained represents the distance of each analysis unit from the reference value. Not applying specific weights to the single variables, it is valid for each unit of analysis:

$$DF = \sum_{j=1}^m d_{ij}$$

which additively summarizes all the variables detected on each analysis unit. This value is compared individually with each variable through the quantification of the Pearson's coefficient.

The degree of correlation of the Pearson index between each variable and the DF value determines the descending order in which to determine the weight $(1 - R_j^2)$, as in the Montero variant (Montero et al. 2010), which will be attributed to each variable at the time of aggregation of the DP2, with R_j^2 determined as the coefficient of determination in the regression of z_{ij} on $z_{j-1}, z_{j-2}, \dots, z_1, z_{j-1}$, given for the variable with greater r_j , $R_2 = 1$.

Based on the construction of the index, higher scores correspond to situations of greater deprivation.)

$$DP2_i = \sum_{j=1}^m d_{ij} (1 - R_{j,j-1, \dots, 1}^2)$$

4. RESULTS

4.1. Crime index

The analysis takes into account six incidence rates, divided by "crime group" in each of the twenty-five districts, obtained from the ratio between the absolute values of the crime under analysis in a district and the resident population multiplied by one thousand. Table 3 shows the results obtained by each district within the metropolitan area of Genoa for each crime group.

Table 4 presents the subdivision of the districts into five classes, obtained through the population quintiles, based on the value of their crime rate; lower classes correspond to higher values of the index and, therefore, greater crime.

**Table 3.** Incidence rate for crimes (% per 1000 inhabitants).

NN	Districts	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6
2	Pra' (Ponente)	22,08	21,19	0,05	0,84	0,35	0,15
1	Voltri (Ponente)	40,35	23,39	0,24	1,06	0,57	0,33
3	Pegli (Ponente)	15,09	15,62	0,00	0,57	0,11	0,08
4	Sestri Ponente (Medio Ponente)	26,97	20,13	0,22	0,76	0,63	0,00
8	Cornigliano (Medio Ponente)	35,16	30,66	0,13	0,34	0,94	0,34
9	Sampierdarena (Centro Ovest)	59,49	24,90	0,02	2,50	1,40	0,39
10	San Teodoro (Centro Ovest)	43,26	23,47	2,10	1,38	1,57	0,33
5	Rivarolo (Valpolcevera)	22,83	24,32	0,00	0,33	0,60	0,15
7	Pontedecimo (Valpolcevera)	34,17	23,24	0,16	0,99	0,41	0,08
6	Bolzaneto (Valpolcevera)	20,05	17,56	0,07	1,08	0,20	0,00
19	Molassana (Media Val Bisagno)	16,13	17,89	0,00	0,48	0,08	0,04
18	Staglieno (Media Val Bisagno)	26,58	23,23	0,10	0,73	0,29	0,15
20	Struppa (Media Val Bisagno)	14,38	16,18	0,10	1,00	2,60	0,40
17	Marassi (Bassa Val Bisagno)	20,49	15,96	0,00	0,83	0,13	0,10
16	San Fruttuoso (Bassa Val Bisagno)	30,60	21,02	0,12	1,10	0,29	0,09
12	Centro Storico (Centro Est)	100,95	21,95	4,11	1,04	4,83	0,52
13	Castelletto (Centro Est)	25,54	13,61	0,04	1,04	0,11	0,00
11	Oregina Lagaccio (Centro Est)	16,20	11,44	0,08	0,41	0,33	0,04
14	Portoria (Centro Est)	186,98	37,38	0,16	2,80	2,08	0,00
22	San Martino (Medio Levante)	31,13	17,98	0,07	0,93	0,40	0,00
15	Foce (Medio Levante)	90,32	41,60	0,57	2,67	1,53	0,19
23	Albaro (Medio Levante)	45,52	26,09	0,07	2,01	0,25	0,11
21	Valle Sturla (Levante)	11,23	9,78	0,00	0,28	0,07	0,00
24	Quarto (Levante)	36,39	20,99	0,03	0,72	0,24	0,07
25	Nervi (Levante)	18,06	12,01	0,00	0,16	0,16	0,00

Source: SDI and Municipality of Genoa.

The Centro Est municipality shows the highest crime rates among all the districts. Within it, it is possible to identify clear divisions, which reflect the different nature of the different areas that make up the municipality; on the one hand Oregina Lagaccio (-0.79, the second lowest value of the crime index) and Castelletto (-0.52), two mostly residential neighbourhoods with a low crime rate, on the other Portoria (3.77) and Centro Storico (1.59), the districts with the first and third crime rates respectively, located closer to the city centre. Furthermore, Centro Storico and Portoria have the highest values in different specific crime groups. Centro Storico is first in receiving stolen goods and money laundering (4.83) and counterfeiting (4.11), while Porto-



ria is the first district by thefts and robberies (186.98), and threats, insults, beatings, injuries, extortion and damage (37.38).

The situation in the Centro Ovest municipality presents homogeneity as regards the crime incidence rate, showing rather high values, but unevenness regarding the type of crimes.

Overall, San Teodoro and Sampierdarena show similar crime profiles for how it concerns threats, insults, extortions, beatings, injuries, damages (23.47 vs 24.9), receiving stolen goods and money laundering (1.57 vs 1.4) and sexual violence (0.33 vs 0.39). In contrast, the most conflicting values between San Teodoro and Sampierdarena emerge in counterfeiting of industrial brands and products (2.1 vs 0.02) and scams, fraud and cybercrime (1.38 vs 2.5). Sampierdarena and San Teodoro are respectively in fourth and sixth place in the crime ranking.

In the Bassa Val Bisagno, an area bordering the Centro Est municipality, San Fruttuoso (-0.23) has a higher crime incidence rate than Marassi (-0.58); however, the crime rates of the two districts included in the Bassa Val Bisagno are not particularly high for any of the crime groups considered, assuming in almost all cases values that are within the average or low.

A marked lack of homogeneity in crime rates emerges within the Media Val Bisagno municipality, where the data show high crime rates in Struppa, despite the latter being the most distant area from the centre. Struppa has high values in the crime groups related to sexual violence (0.4, second worst performance in the crime group 6), and receiving stolen goods and money laundering (2.6, second worst performance in the group 5). By contrast, Molassana shows a low crime rate (-0.65), falling back into the class with the lowest aggregate crime rates; Staglieno, however, ranks in the middle of the standings, with a crime index value of -0.28.

Of the districts within the Val Polcevera municipality, Rivarolo (-0.34) ranks in the third class, Bolzaneto (-0.55) in the fourth class and Pontedecimo (-0.09) in the second class. These results reveal an uneven distribution of the three districts, although not particularly negative as a whole.

Within the Medio Ponente municipality, the crime incidence rate is distributed unevenly between the two districts of Cornigliano (0.1) and Sestri Ponente (-0.33). Cornigliano has crime values far superior to those that characterize Sestri Ponente. This polarization can be traced back to the proximity between Cornigliano and the Centro Ovest and Centro Est municipalities, or the municipalities with the highest crime rates. Particularly negative is the crime detected in the district of Cornigliano in reference to threats, injuries, beatings, extortion, injuries, damages and fires (30.66), the third highest value of the entire distribution.

The Ponente municipality is characterized by a situation of great inhomogeneity. Voltri, despite being the most peripheral district, falls into the second class by value of the crime index (0.06); Prà ranks in the fourth class, presenting a low index value (-0.42); finally, proceeding in descending order of class, there is Pegli, with one of the lowest crime rates (-0.72).

Considering the Medio Levante municipality, it can be noted that the Foce district, together with the Centro Storico and Portoria (Centro Est municipality), has the highest crime rate in the entire municipal area (1.67). Two of the three districts within the Medio Levante are positioned in first class by value of the crime index. Again, a clear trend can be identified on a territorial basis: as you get closer to the city centre, the incidence rate increases progressively. The Foce presents the most critical issues in the crime group 2 (41.6, worst district of the entire distribution) and in group 4 (with a value of 2.67, it is the worst district after Portoria). Albaro (0.25) presents a rather uneven distribution of the amount of crimes between the different groups; the critical points, attributable to the crime groups 1, 2 and 4, relegate Albaro to first class. San Martino (-0.29), with greater homogeneity, ranks third.

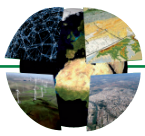
The Levante municipality has low crime index values; Valle Sturla, with a score of -0.95, occupies the fifth class and is the district in which the lowest crime rate is found. Nervi also shows low values (-0.74) of the index, thus falling in the fifth class. On the other hand, Quarto has a high crime index value, collecting a score of -0.11. Valle Sturla and Nervi jointly present the lowest crime values in crime groups 3, 4, 6.

Figure 1 shows the geographical distribution, for each district, of the index values over five classes, which represent increasing levels of crime: with the intensification of the blue colour, the incidence rate of crime by district increases.

**Table 4.** The five classes of growing crime by population quintiles.

N° of district	Districts	Crime Index	Class
14	Portoria (Centro Est)	3,77	1
15	Foce (Medio Levante)	1,67	1
12	Centro Storico (Centro Est)	1,59	1
9	Sampierdarena (Centro Ovest)	0,58	1
23	Albaro (Medio Levante)	0,25	1
10	San Teodoro (Centro Ovest)	0,20	2
8	Cornigliano (Medio Ponente)	0,10	2
1	Voltri (Ponente)	0,06	2
7	Pontedecimo (Valpolcevera)	-0,09	2
24	Quarto (Levante)	-0,11	2
16	San Fruttuoso (Bassa Val Bisagno)	-0,23	2
18	Staglieno (Media Val Bisagno)	-0,28	3
22	San Martino (Medio Levante)	-0,29	3
4	Sestri Ponente (Medio Ponente)	-0,33	3
5	Rivarolo (Valpolcevera)	-0,34	3
2	Pra (Ponente)	-0,42	4
13	Castelletto (Centro Est)	-0,52	4
6	Bolzaneto (Valpolcevera)	-0,55	4
17	Marassi (Bassa Val Bisagno)	-0,58	4
20	Struppa (Media Val Bisagno)	-0,65	5
19	Molassana (Media Val Bisagno)	-0,65	5
3	Pegli (Ponente)	-0,72	5
25	Nervi (Levante)	-0,74	5
11	Oregina Lagaccio (Centro Est)	-0,79	5
21	Valle Sturla (Levante)	-0,95	5

The results indicate that crime is differently distributed in the Genoese areas. The districts Centro Storico, Portoria and Foce occupy the first three positions. Portoria and Centro Storico represent the historical part of the city, characterized at the same time both by very busy roads with public and private transport, and by the alleys, that is, narrow streets with pedestrian traffic. Both areas, forming a neighbouring extension together with the Foce, constitute the nerve centre of the city or the areas of greatest passage of the population, where the main railway stations, tourist attractions and the centre of urban night life are located. Also not to be overlooked is the proximity of these three districts, together with that of San Teodoro, to the port, in particular to the ferry terminal, where there is a high transit of passengers every day.



More specifically, a clear trend emerges: the crime incidence rate is high in the districts located near the centre of the city of Genoa; the rate gradually decreases in areas close to the periphery, with the exception of the rate that characterizes particular urban areas, such as the districts that present public housing structures. The rate is mainly low in the residential districts, while it increases in the districts which house a large number of workers on a daily basis, or, in general, which are busier.

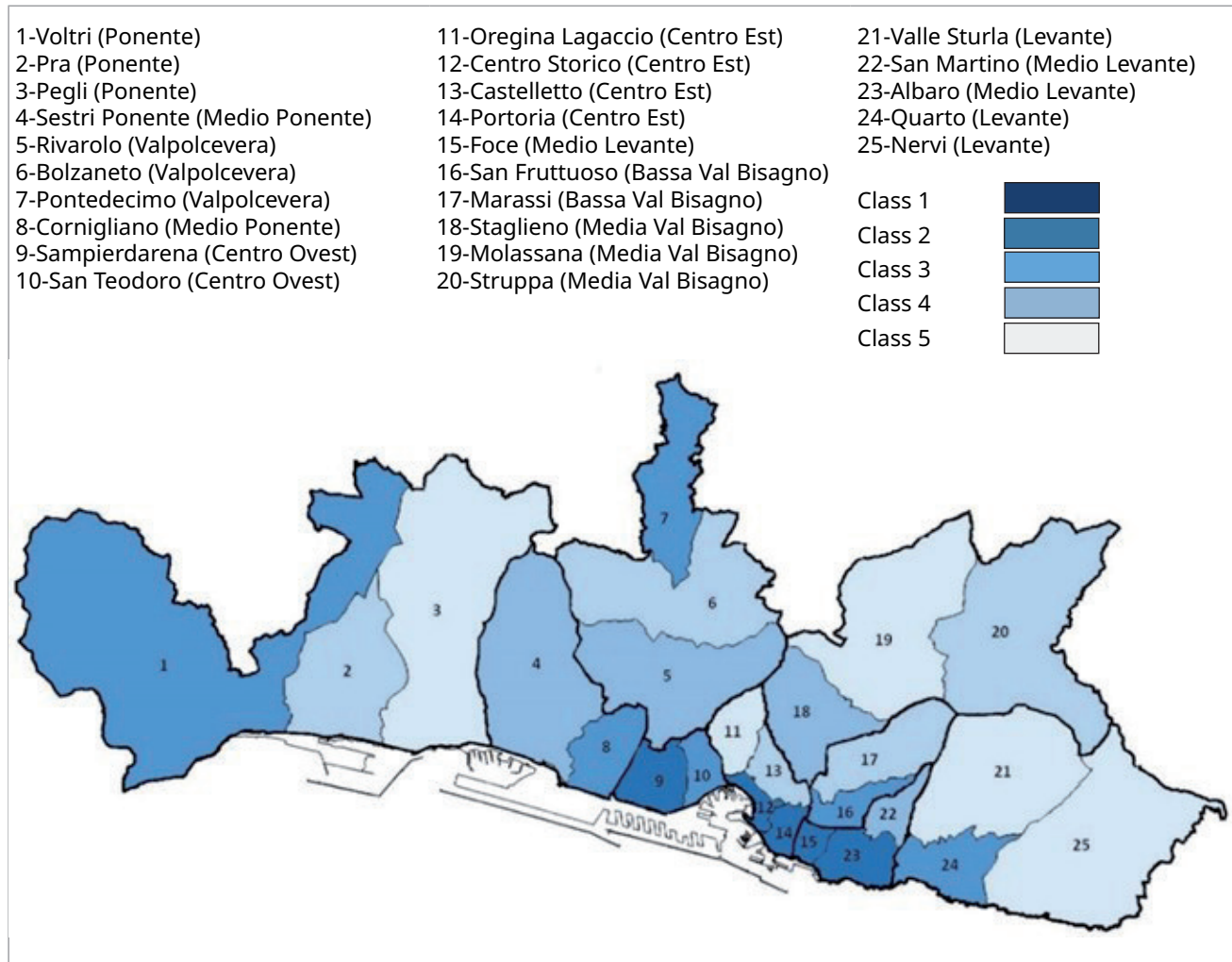


Figure 1. Visual representation of the five classes of growing crime (from dark blue to light blue).

4.2. Social deprivation index

Table 5 shows the results obtained by the various districts in terms of social deprivation. The highest deprivation scores emerge in the areas included between Centro Est and Centro Ovest: Centro Storico (14.07 the value of the social deprivation index), Sampierdarena (13.4) and San Teodoro (12.04) are the areas in which the most marked social deprivation is found. By contrast, the districts Struppa (5.57) and Molassana (6.54) in the municipal area of Media Val Bisagno, and Pegli (6.93) and Voltri (7.04) in the municipal area of Ponente, are the districts with the lowest social deprivation. Thus, a rather marked territorial polarization can be found.

Figure 2 shows the distribution of social deprivation in the various urban territorial areas. A more marked shade of colour corresponds to a higher deprivation value.

The least deprived areas from a social point of view are located in the hinterland or, in any case, they are the ones with a territorial extension from the coast to the interior of the region. At the same time, the districts that are closest to the city centre confirm greater social deprivation.



Table 5. Social deprivation by district.

N° of district	Districts	Social Deprivation	Classes
12	Centro Storico (Centro Est)	14,07	1
9	Sampierdarena (Centro Ovest)	13,40	1
10	San Teodoro (Centro Ovest)	12,04	2
15	Foce (Medio Levante)	12,00	2
8	Cornigliano (Medio Ponente)	11,84	2
16	San Fruttuoso (Bassa Val Bisagno)	11,31	2
6	Bolzaneto (Valpolcevera)	11,20	2
18	Staglieno (Media Val Bisagno)	11,12	2
11	Oregina Lagaccio (Centro Est)	10,61	3
14	Portoria (Centro Est)	10,59	3
5	Rivarolo (Valpolcevera)	10,35	3
22	San Martino (Medio Levante)	10,29	3
17	Marassi (Bassa Val Bisagno)	10,07	3
23	Albaro (Medio Levante)	9,86	3
24	Quarto (Levante)	9,57	3
2	Pra (Ponente)	9,26	3
25	Nervi (Levante)	9,21	3
21	Valle Sturla (Levante)	8,88	3
4	Sestri Ponente (Medio Ponente)	8,58	3
13	Castelletto (Centro Est)	8,29	3
1	Voltri (Ponente)	7,04	4
3	Pegli (Ponente)	6,93	4
19	Molassana (Media Val Bisagno)	6,54	4
20	Struppa (Media Val Bisagno)	5,57	5
7	Pontedecimo (Valpolcevera)	5,47	5

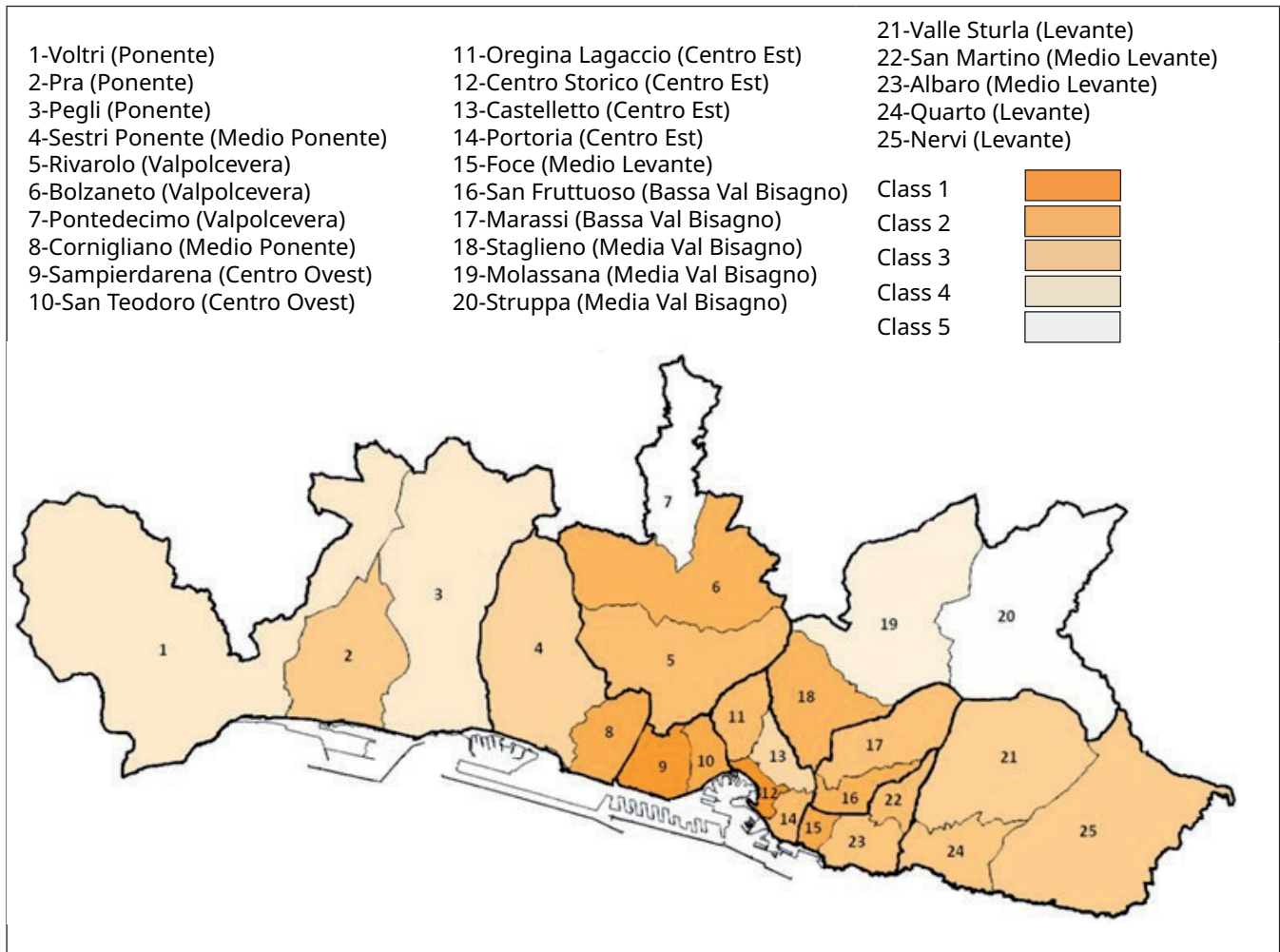
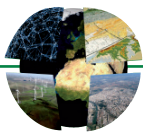


Figure 2. Social deprivation on the territory of Genoa.

4.3. Crime-deprivation relationship

In order to verify the possible link between the observed crime for the different crime groups and social deprivation, the Spearman rho index was calculated, the results of which are collected in table 6.

From the correlation analysis it is clear that the areas with the lowest incidence of crime are also those characterized by the least social deprivation. The correlation is significant between social deprivation and the crime rate (0.532). The crime group with respect to which the highest correlation with social deprivation is established is the group thefts and robberies (0.540); a relationship is also identified between deprivation and the group that includes threats, insults, beatings, extortion, injury, damage, fire (0.462).

5. DISCUSSION AND CONCLUSIONS

The purpose of the analysis was to verify the existence of a relationship between the crime observed in the place of the criminal act and the phenomenon of social deprivation. The use of data characterized by a high degree of territorial pervasiveness was aimed at the acquisition of quantitative information such as to increase the accuracy of the analysis at a district level.

As noted by this work and by the previous literature, deprivation is attributable to the potential factors that determine the demand for services, therefore its measurement can become a useful tool for analysis



Table 6. Correlation between crimes and deprivation.

Correlations	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	Crime Index (IC)	Social Deprivation (IDS)
Group 1	1	0,823**	0,633 **	0,668**	0,618**	0,364	0,975**	0,540**
Group 2	0,823**	1	0,530 **	0,537**	0,655**	0,537**	0,900**	0,462*
Group 3	0,633**	0,530**	1	0,549 **	0,732**	0,382	0,666**	0,331
Group 4	0,668**	0,537**	0,549 **	1	0,452*	0,25	0,701**	0,345
Group 5	0,618**	0,655**	0,732 **	0,452 *	1	0,614**	0,677**	0,433*
Group 6	0,364	0,537**	0,382	0,25	0,614**	1	0,470**	0,367
Crime Index (IC)	0,975**	0,900**	0,666**	0,701**	0,677**	0,470**	1	0,532**
Social Deprivation (IDS)	0,540**	0,462*	0,331	0,345	0,433*	0,367	0,532**	1

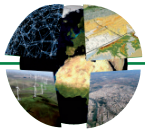
** Correlation is significant at the 0.01 level (2-tailed). * Correlation is significant at the 0.05 level (2-tailed).

and evaluation (Landi, Ivaldi & Testi, 2017). On the one hand, it is useful for the preparation of *ad hoc* policies aimed at countering it, as well as to prevent conditions of socio-economic inequality and the costs that these would potentially produce. In addition, a careful analysis of the level of deprivation can be used to distribute and allocate public resources fairly.

For measuring criminality, the additive method has been used, since the different types of crimes are measured on the same scale (Carstairs, 2000; Ivaldi, 2006), and it was not intended to make a qualitative distinction between the different criminal acts in this analysis.

From the analysis of the results, clear trends emerge regarding the distribution of crimes at the district level. The crime rate is high in the districts near the centre of the city of Genoa, as in the case of Centro Storico, Sampierdarena and San Teodoro; the only exceptions are the district of Oregina Lagaccio, that with a crime index equal to -0.79 is placed in the last class for crime intensity, and Castelletto (-0.52) in class 4. The rate gradually decreases in the areas closest to the periphery, with the exception of the rate that characterizes particular urban areas, such as the districts in which public housing structures are located. The proximity of the city centre to the main jobs is a factor that makes the crime rate in the districts of Centro Storico, Foce and Portoria higher (Brantingbam & Brantingbam, 1991, 1993a & 1993b). It demonstrates that the daily routine traces edges along which crime episodes can be observed more frequently (Cromwell et al., 1991; Wright & Decker, 1994; Seagrave, 1995). Regarding crime prevention systems, in the most frequented areas difficulties in managing dense micro-criminal networks is observed (Zedner, 2009). The rate increases in the districts that show the passage of many workers. As written by P.L. Brantingbam and P.J. Brantingbam (1991), the daily movement of large flows of people in the central areas of the city makes monitoring more difficult and increases the probability that the criminal act will be carried out. On the other side, the rate is mostly low in the residential districts, as is the case of Valle Sturla, Oregina Lagaccio and Nervi for example. In the minds of criminals and victims, they are perceived as safe zone of the city (Wright & Decker, 1994).

Social deprivation follows a trend similar to that of crime. The areas least deprived from a social point of view are located inland or develop territorially from the coast towards the interior of the region, where the social cohesion is stronger (for example Pontedecimo in Valpocevera and the district in Media Val Bisagno and Ponente areas) (Bellaini & D'Ambrosio, 2011; Oxoby, 2009). Similarly, the districts located near the city centre have a high social deprivation. We can notice this tendency looking at Centro Storico, Sampierdarena and San Teodoro, that are respectively first, second and third in the ranking of the social deprivation.



From the correlation analysis it is clear that the areas with the highest crime rate are, at the same time, those characterized by the highest level of social deprivation. It confirms the relationship existing between socio-economic marginalisation and involvement in crime (West & Farrington, 1973; Kolvin et al., 1988).

What has just been said provides for some exceptions, since it refers to a general trend which leaves space for specific cases of a different nature, as the case of Pontedecimo in Valpocevera and Voltri in Ponente. The Genoese territorial context is characterized by territorial specificities that have contributed to create very different contexts even in small areas. This phenomenon is the result of the historical origin of Genoa previous the unification of the city, when many autonomous towns existed around the ancient city before Grande Genova was formed by law in 1926. As a consequence, historically, different identities are detected even within the same neighbourhood or, as in this case, urban planning units. For example, the hill villages of Pontedecimo, located on the Polcevera torrent and originally a mostly agricultural area, now is a residential place with large families, assisted elderly people at home and not left alone, few foreigners and therefore little social deprivation. The social fabric is more cohesive and less critical issues emerge.

A similar development has distinguished Voltri, a seaside resort located in the most inland sector of the Gulf of Genoa. Demographic variations have been limited, households have remained relatively stable, the influx of migrants has been contained; these are the reasons of its low levels of social deprivation.

The understanding of the interrelationship of these phenomena can help develop the ability to contrast the criminal and social degradation characterizing the different districts. Promoting studies on deprivation could be a valuable approach to joint crime analysis. Such studies should, however, take into account additional variables, such as socio-cultural background, that characterize people in their complex sphere. Correct integration and interpretation of these factors can result in the ability of the researcher to provide incisive insights.

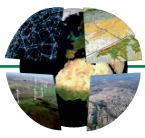
The main critical points of the work can be associated with the fact that the data provided by the police forces do not provide an exhaustive picture of crime in the city. The collection of such data, coming from reports to law enforcement agencies, is largely influenced by the "victim"s willingness to report the incident or not. New technologies offer innovative solutions for data collection. The pursuit of greater interoperability and transparency in databases collecting crime data is a goal of the current era. The availability of data to tackle crime is a need to be reconciled with the protection of privacy (Mayer-Schönberger & Cukier, 2013; Zhang, 2018).

On the other hand, as regards the analysis of deprivation, it can be observed that there is always a possible risk linked to the interpretation of the so-called ecological fallacy, that is, the fact that a characteristic of a group cannot be attributed with certainty to each individual, because "not all deprived people live in deprived areas" (Carr-Hill, Jamison & O'Reilly, 2002). Thoughts about spatial socio-economic analysis should always not underestimate the differences that emerges into each geographical clusters (O'Mahony, 1986).

The picture that emerges from this analysis can be conceived as a useful tool to highlight the criminal problems afflicting the various districts, in order to contain these problems through the consequent adoption of appropriate counter-measures.

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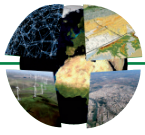
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