Network analysis approach to map tourism mobility

Rosario D'Agata, Simona Gozzo & Venera Tomaselli

Quality & Quantity
International Journal of Methodology

ISSN 0033-5177
Volume 47
Number 6

Qual Quant (2013) 47:3167-3184
DOI 10.1007/s11135-012-9710-7

Springer

Qual Quant (2013) 47:3167–3184
DOI 10.1007/s11135-012-9710-7

Network analysis approach to map tourism mobility

Rosario D'Agata · Simona Gozzo · Venera Tomaselli

Published online: 1 May 2012

Abstract The spatial distribution of tourists is uneven and it can include some areas at regional and/or sub-regional level. The social–economic and environmental impacts of tourism, are concentrated in different areas. Some recent contributions show the usefulness and the effectiveness of network analysis (NA) approach in revising the organization of tourist facilities and services. This paper proposes to apply methods borrowed from NA to map the spatial distribution of tourism mobility in Sicily. So, we analyze the network features of tourism in a multi-destinations net. By means of traditional measures of NA, we propose to measure the links among destinations. The study aims to connect destinations, represented as nodes, to define a territorial network of tourism demand. In the specific instance, the degree centrality, closeness centrality, betweenness centrality are used to localize central areas and the main routes. We test survey data collected on a sample of tourists leaving from airports and ports of the main Sicilian cities, who visited two destinations at least. Then, we study tourism mobility on those areas selected by tourists. Finally, employing measures derived from NA, the work attempts to set out territorial networks. This approach could be useful to plane tourism development policies.

Keywords Network analysis · Tourism mobility · Destination clustering · Tourism development

1 Network analysis and tourism

In the study of tourism mobility, the spatial distribution of tourists affects some areas at regional and/or sub-regional level where the economic and environmental impact of tourism is more concentrated.

R. D'Agata · S. Gozzo · V. Tomaselli (✉)
Department of Analisi dei Processi Politici, Sociali ed Istituzionali, Faculty of Political Sciences, University of Catania, Catania, Italy
e-mail: tomavene@unict.it

Since the tourism sector, more than any other economic sector, involves interconnected partnerships, where the structure is found to be strongly correlated to function of delivering its product (Bickerdyke 1996), some studies examine tourism destinations as a complex dynamic system of interrelated components in order to identify critical junctures in destinations that cross functional, hierarchical or geographic boundaries (Carlsen 1999; Cross et al. 2002).

A tourism destination is a system composed of both a large amount of natural, cultural, artistic resources and economic, non-economic and institutional actors, who provide tourism services.[1] Such a destination is characterized by a complementarity of development opportunities and available resources but also by constraints which derive from its own structural features and of other destinations located in the regional area (Baggio et al. 2008). Most destinations consist of networks of tourism suppliers (Buhalis 2000) and the benefits of such networks are more profitable tourism destinations (Morrison et al. 2004).

Some recent contributions in literature show the usefulness and the effectiveness of the *Network Analysis* (NA) approach as a standard diagnostic tool and a set of available integrated techniques to draw the relational content of tourism destinations (Shih 2006; Baggio 2008) and organization of facilities and services as a set of linkages among nodes (Scott et al. 2008a,b; Baggio and Cooper 2010).

We chose NA methodological tools to study the structure of destination networks in order to investigate whether the tourism destination pattern shares certain formal, informal and structural properties as a whole: local and long-distance connections as geographical, content, social or economic distances. This methodology is useful for investigating the network features of multiple destinations and thereby, to specify both the relevant and the marginal destinations by their centrality within the routes.

Our research focused on links among tourism destinations, represented as nodes, to define a territorial network of tourism demand by mapping the spatial distribution of tourism mobility (Lew and McKercher 2006). So, we analyzed the network topological features of tourism destinations to specify main or marginal areas identified by routes among tourism destinations. By means of the NA approach and according to graph theory, we investigated the structure of relations such as tourism routes (displayed by links) among destinations (termed by nodes) both visualizing and providing metrics for cohesion as relevant indicators of destination network effectiveness. In this specific instance, after collecting relational data and organizing it into a matrix, we computed *density*, *in-degree* and*out-degree centrality, betweenness centrality, closeness centrality*. Other parameters were computed to assess the network properties within localized territorial areas. We then examined relevant routes for a comparative analysis of each tourism destination as a network node.

2 Measuring the tourism destination network

Employing NA, we aimed to explore the structured pattern of ties as a restricted sort of net in which one destination/node was connected to another one by tourism routes or links. In many research fields, NA has been used both to explore how networks are formed in the interaction among different *nodes* of network and to analyze economic phenomena that are constrained by the structure (Wasserman and Faust 1994). Few studies applied these techniques to the

[1] In lack of resources, a network of interested stakeholders is involved in many of the main resources of a tourism destination such as beaches, lakes, scenic outlooks and national parks; built resources such as museums, art galleries and heritage buildings; or intangible resources such as destination brands or the reputation for friendliness of local people (Scott et al. 2008a,b).

study of the tourism sector. Some scholars showed the usefulness and the effectiveness of this approach in research on tourism phenomena by analyzing relationships among tourist organizations (Scott et al. 2008a,b). An interesting paper showed the use of these methods to revise the organization of tourist facilities and services in each destination by measuring the structural characteristics of routes taken by tourists in multi-destination trips (Shih 2006).

In our analysis, we decided to study the network structure of tourism destinations by the means of some main measures of NA. In order to determine the effectiveness of the typology of the linkages, NA methodological tools allowed us to measure some structural properties of each destination network. We used NA techniques to classify destinations by a set of metrics able to measure relationships among tourism destinations and to describe their network features.

Therefore, if we take into account tourism routes as links among destinations or nodes, a basic indicator of interest is the *network size*. This measures the number of direct ties involving nodes as degrees of integration in a network.

Afterwards, we used *density* and, its opposite measure, *cohesion* degree. In our study, density was used to count the actual number of links as tourism routes among destinations as a ratio of the maximum number of potential connections in the Sicilian area. So, we used density as a property of the whole network. Density, in fact, describes the general level of linkage among the points in a graph. The more points are connected to one another, the more dense the graph will be. The *density* of a graph is defined as the number of lines incident with each node in a graph, expressed as the ratio of the number of relationships that exist compared with the total number of possible ties $g\,(g-1)/2$, if each member were tied to every other member (Wasserman and Faust 1994, p. 101). *Density* measure is computed as:

$$\Delta = \frac{L}{\frac{g(g-1)}{2}} \tag{1}$$

where L is the number of lines present. This measure can vary from 0 to 1. So, the *density* of a complete graph[2] is 1, because all possible ties exist (Rowley 1997).

Cohesion takes into account the node connection process according to strong common relationships with each other.

Secondly, we computed other relevant measures of centrality used in network analysis: *degree centrality*, *betweenness* and *closeness centrality*.

In our study, we used centrality as a basic measure to identify the most important nodes of the tourism destination network. We can thereby, recognize some central or main tourism destinations within the network, comparing the different centrality measures.

Degree centrality is defined as the number of links incident upon a node (Opsahl et al. 2010). The degree of a vertex is the number of edges that connects it to other vertexes.

Since the network is directed, we specify the two separate measures of degree centrality, namely *in-degree* and *out-degree*: for a node, the first is the number of head endpoints adjacent to a node and *out-degree* is the number of tail endpoints that the node directs to others.

The *in-degree* is denoted $deg^-(v)$ and the *out-degree* as $deg^+(v)$. A vertex with $deg^-(v) = 0$ is called a source, as it is the origin of each of its incident edges. Similarly, a vertex with $deg^+(v) = 0$ is called a sink. For a directed graph, the degree sum formula states that:

[2] A complete graph is one in which all the points are adjacent to one another (Wasserman and Faust 1994, p. 102) and each point is connected directly to every other point.

$$\sum_{v \in V} \deg^+(v) = \sum_{v \in V} \deg^-(v) = |A|. \tag{2}$$

In our research, in order to analyze the tourism destination network, we measured the *betweenness* as an indicator of the importance or influence of a single destination in a pattern. *Betweenness centrality* is a measure of node centrality in a network. Basically, it is the fraction of shortest paths between node pairs, from all vertices to all others, that pass through that node of interest. It is a most useful measure of the node importance in the network. We can define it as a centrality measure of a vertex within a graph. Vertices that occur on many shortest paths between other vertices have higher *betweenness* than those that do not. Therefore, the *betweenness* centrality of a node v is given by the formula:

$$g(v) = \sum_{s \neq v \neq t} \frac{\sigma_{st}(v)}{\sigma_{st}} \tag{3}$$

where σ_{st} is the total number of shortest paths from node s to node t and $\sigma_{st}(v)$ is the number of shortest paths from s to t that pass through a vertex v.

Another important measure of centrality is*closeness*. In our study, we computed the *in-closeness* centrality to reveal the extent to which each tourism destination as node of the network is reachable from every other destination. Closeness is defined as the mean geodesic distance (i.e., the shortest path) between a vertex v or node and all other vertices reachable from it:

$$\frac{\sum_{t \in V \setminus v} d_G(v, t)}{n - 1} \tag{4}$$

The closeness $C_C(v)$ for a vertex v is the reciprocal of the sum of geodesic distances to all other vertices of V. We use the reciprocal in order to count as 0 the vertices that are not reachable, because we want higher values to be taken by the most central vertices:

$$C_C(v) = \frac{1}{\sum_{t \in V \setminus v} d_G(v, t)} \tag{5}$$

Finally, since *betweennees and centrality* measures provide information only about the location of each destination within the network, we use *sub-group* analysis, by the means of components and *cliques*, to specify the main paths among destinations.[3]

Components notice disconnected or partially connected nodes and/or overlapped groups. The *clique* analysis, instead, allows us to identify cohesive groups or sub-groups, such as nodes connected through dense, direct and mutual links. So,*cliques* are totally connected components and these sub-groups represent densely connected destinations of the network (Wasserman and Faust 1994). The formal definition of a *clique,* as used in NA is much more narrow and precise than the general notion of a high local density: a *clique* is the maximum number of nodes which have all potential ties present among themselves.

In graph theory, a *clique* in an undirected graph $G = (V, E)$ is a subset of the vertex set $C \subseteq V$, such that, for every two vertices in C, there exists an edge connecting the two. This is equivalent to saying that the sub-graph induced by C is complete. The opposite of a *clique* is an independent set.

In our aim, *cliques* are a tool to look for sub-structure within the net. We know that some regions of a graph may be less connected to the whole than others, but its nodes

[3] Many of the approaches to understanding the structure of a network emphasize how dense connections are built-up from simpler dyads and triads to more extended dense clusters such as *cliques*.

can be strongly connected to each other. A map of the whole network can be built-up by examining the sizes of the various *clique*s and noting their size and overlaps. *Clique* structure also allows us to answer the main questions about a graph, in terms of its sub-structures, such as: how separate are the sub-graphs? Do they overlap and share members or do they divide the network? How large are the connected sub-graphs? Are there a few big groups or a larger number of small groups? Are there particular nodes—destinations, in our study—that appear to connect the graph or which are isolated from groups?

3 Empirical analysis

3.1 Destinations as network

This study analyzed individual nets of tourist destinations in Sicily[4] and pointed out the most selected routes. The aim was to identify the main tourism routes by incorporating several destinations rather than just one. Different reasons supported this choice (Shih 2006). Firstly, tourists have many interests and their trips subtend this multidimensional dimension; they prefer to engage more than only one activity during their journey. The planning of multiple destinations reduces the risk of the tourist not enjoying the journey (Bansal and Eiselt 2004). If some facilities prove to be disappointing, he/she can move on and have a more positive experience at the next destination. Besides, multiple decision-makers are typically involved in the planning and execution of the journey. Finally, the multi-destination journey optimizes cost and time (Hall 2008). Nevertheless, the most important reason concerned geographical and structural resources of Sicily. Recent studies (Hwang and Fesenmaier 2003; Jeng and Fesenmaier 1998; Tideswell and Faulkner 1999) have shown that multi-destination travel is influenced not only by the motivations of the tourist but also by the geographic characteristics, such as distance and opportunity configuration. Sicilian municipalities are deeply different, considering both geographical and structural resources. Sicily has various and specialized tourism offers, but structural resources are often insufficient in respect to the tourism demand, so central areas could be simply the best organized municipalities, able to guarantee connection with other Sicilian destinations and tourism services thanks to structural resources. A tourism route can also be defined by the way in which it incorporates several destinations rather than just one: a central area is connected to different areas and a peripheral area is probably more disconnected than other municipalities.

This study used the Sicilian municipalities as destinations, i.e., as nodes to investigate the network characteristics of tourism routes. We selected the answers of 3,182 interviewees who described their tourism itinerary in Sicilian municipalities, obtaining five matrixes representing the move through six Sicilian destinations. Then we overlapped these matrixes extracting a weighted matrix, representative of multiple displacements. At last, we selected only those areas visited at least twice (median) and we removed 'isolated' nodes,[5] obtaining

[4] The results are on the survey: PRIN 2007–2009 "Socio–economic effects of behavior and motivations of real tourism in Sicily. Internal mobility and its economic effects", University of Palermo, Catania, Sassari, Bologna. Selected data consist in face-to-face interviews submitted to tourists during their departures from Sicily. Interviews were carried out in Sicilian ports and aeroports.

[5] Isolated nodes are municipalities without connection. For the purpose of this study, subjects that only visited one destination (isolated nodes) were also eliminated.

the most relevant areas and routes. So we distinguished between two weighted matrixes: the original-one and the cut-one.

Although the choice of the cut-point was arbitrary, two steps could be implemented for preliminary sensitivity testing to identify the most appropriate value (Chang and Shih 2005). First, the difference in the structural patterns of a network system is reasonably stable since the cut-off value changes from very low to very high, so that it can choose just one cut-off value for carrying out the purposes of this study. Second, the appropriate cut-off value must be selected based on the heuristic criteria that the distinguishing characteristic in the structure of a network system can be detected, rather than the very low or very high values that characterize almost completely connected or nearly totally unconnected networks. We were interested in focusing our attention on the most relevant connections among touristic destinations, removing both redundancy and irrelevant paths, i.e., ties among municipalities without tourism relevance. Some useful information came from density and cohesion measurements. The original matrix had a density of 0.07 (matrix average) with a standard deviation of 0.77, whereas the cut-one density was 0.32 with a standard deviation of 0.54.

In this study, data showed that our network was not strongly connected and this was an expected outcome. In fact, Sicily is the biggest region of Italy, with distant places which are scarcely connected. These structural elements encourage the choice of routes spread out in different municipalities, with lots of disconnected paths that lead to few central municipalities displaced through the whole island. Further important information concerning the whole matrix cohesion is the average distance between reachable pairs (2.8 against 2.1 for the cut-matrix); the distance-based cohesion or "compactness"[6] (0.3 against 0.5), and the distance-weighted fragmentation (0.7 versus 0.4). By comparing all these measurements, we concluded that the cut-matrix permitted a better representation of tourism routes than the original-one, defining a more compact network with a good representation of Sicilian paths, revolving around a limited number of central places: 12 % ($n = 645$) of these routes involved only two nodes (single routes between two municipalities); 57 % ($n = 2,988$) referred to ties among three nodes; 28 % ($n = 1,473$) involved four destinations and only the remaining quota ($n = 78$) included five destinations.

The subsequent step concerned the identification of central nodes within the network, identified thanks to centrality measures. In particular, we compared *degree*, *closeness* and *betweenness* measures, focusing on different concepts of centrality.

The indicator of *degree* centrality showed that a given destination is either dependent or conductive. The whole network *in-degree* centralization is 41 % and this measure showed node dependence; the network *out-degree* centralization was 42.5 % and it measured node conductivity. Palermo, Catania, Agrigento, Siracusa and Taormina had the highest *out-degree* centrality, whereas Agrigento, Catania and Siracusa had the highest *in-degree* centrality (Table 1).

These measures applied to the nets of destinations showed that central municipalities are far from random. The most relevant areas are the same, both considering in and out-degree measures, such as the other centrality indices. This is a confirmation of our consideration concerning the structure of Sicilian tourism: the whole network of routes revolves around few, strongly attractive areas. Generally speaking, the identified key-nodes are big towns with structural resources such as tourist facilities and public/private transport systems (by road, by rail, by sea, by air, etc.), or little towns with landscape resources. The former, derive their income from a number of market sectors (such as airports or large hotels), and are involved

[6] This measure ranges from 0 to 1, with larger values indicating greater cohesiveness.

Table 1 Sicilian tourism routes (*degree centrality measure*)

	OutDegree	InDegree	NrmOutDeg	NrmInDeg
Palermo	39.000	32.000	54.167	44.444
Agrigento	30.000	38.000	41.667	52.778
Catania	30.000	37.000	41.667	51.389
Siracusa	30.000	37.000	41.667	51.389
Taormina	30.000	31.000	41.667	43.056
Cefalù	25.000	26.000	34.722	36.111
Noto	23.000	16.000	31.944	22.222
Castellammare del Golfo	19.000	17.000	26.389	23.611
San Vito Lo Capo	18.000	22.000	25.000	30.556
Sciacca	18.000	13.000	25.000	18.056
Trapani	17.000	14.000	23.611	19.444
Ragusa	17.000	25.000	23.611	34.722
Erice	15.000	19.000	20.833	26.389
Marsala	15.000	10.000	20.833	13.889
Lipari	15.000	13.000	20.833	18.056
Giardinello	14.000	11.000	19.444	15.278
Messina	14.000	16.000	19.444	22.222
Milazzo	13.000	6.000	18.056	8.333
Favignana	11.000	9.000	15.278	12.500
Castelvetrano	11.000	15.000	15.278	20.833
Modica	11.000	13.000	15.278	18.056
Acireale	11.000	13.000	15.278	18.056
Piazza Armerina	10.000	15.000	13.889	20.833

in more than one, and often many, communities of interest at the destination level. The latter are characterized by a sectorial/seasonal tourism.

Furthermore, comparing the *in-degree* and *out-degree* of each destination we revealed destinations as beginning, core or terminal nodes of tourist routes (Shih 2006). The most relevant beginning destinations are Palermo and Noto. Palermo is the Sicilian capital and is the main Sicilian transport gateway; Noto is a little town and is a particularly famous locality for its ancient baroque buildings and its beautiful landscape. The most attractive areas (*in-degree* is higher than *out-degree*) are Agrigento, Catania and Siracusa, followed by Taormina, Cafalù, Ragusa and San Vito lo Capo. The former are metropolitan areas and they offer a large number of services and transport opportunities (the two Sicilian airports are in Catania and Palermo). The latter areas are little seaside or mountain cities with a strong potential for tourism attraction (Fig. 1).

Although these areas constitute the most relevant municipalities within the network, apart from the specific centrality index, their rank changes according to centrality measurement. *Closeness* centrality is defined as the mean geodesic distance between a node and all other reachable nodes, so that, *in-closeness* centrality reveals the extent to which a particular destination is reachable from other destinations. Siracuse, Catania and Agrigento have the highest *incloseness* centrality, which means that they can be reached by the majority of other destinations by various tourism routes. These areas are so accessible and popular that many organized

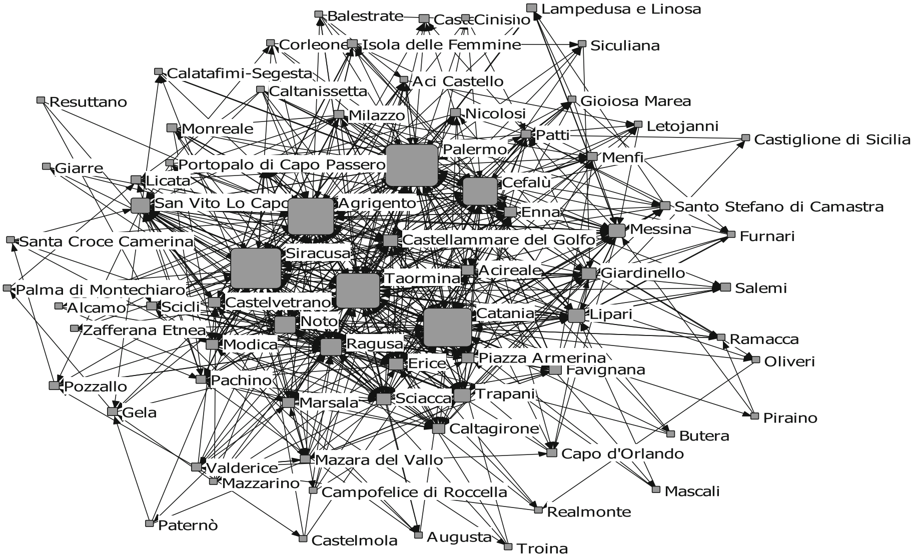

Fig. 1 The net graph of most attractive areas concerning Sicilian tourism routes

trips include these destinations on touring routes. Finally, *betweenneess* centrality is particularly important because it discloses the extent to which, tourists stop at a destination during their routes between pairs of other destinations. It indicates the importance of destinations as 'bridges' linking other areas. Palermo and Siracusa, due to their high *betweenness* centrality, act as highly critical intermediates between pairs of other destinations. These municipalities are followed by Agrigento, Taormina and Cefalù with very small differences in index values.

Concerning the destinations whose degree, closeness and *betweenness* centralities are low, four peripheral destinations were identified within the network, namely Castiglione di Sicilia, Giarre, Butera and Piraino. They have few connections with adjacent destinations, and are relatively inaccessible, and less active as intermediates between other destinations due to their location on the outskirts of main Sicilian tourism destinations. Specifically, Castiglione di Sicilia and Giarre are in the North-East of the island, near Catania; Butera is a little town in the South-West, near Ragusa and Piraino is a town in Northern Sicily, next to Messina. Although these areas could attract tourists, because of their position, they are almost inaccessible owing to the lack of structural resources and tourism facilities.

3.2 Groups and sub-structures of municipalities: components and cliques

In order to describe the relevance of specific paths, we analyzed sub-groups by means of components and *cliques*. Since cliques are totally connected components, they are sub-groups representing densely connected regions of the network. This tool was applied, to identify those regions of the graph that are weakly connected to the whole network but strongly connected inside. These sub-graphs were composed to strongly linked nodes. The structural effect was particularly important in identifying the most attractive tourism routes.

The first step was to identify the main components within the net, i.e., the main routes among destinations. We located two main paths (Cefalù-Palermo and Taormina-Agrigento), four frequent paths with different node numerousness (Calatafimi Segesta-Castellammare

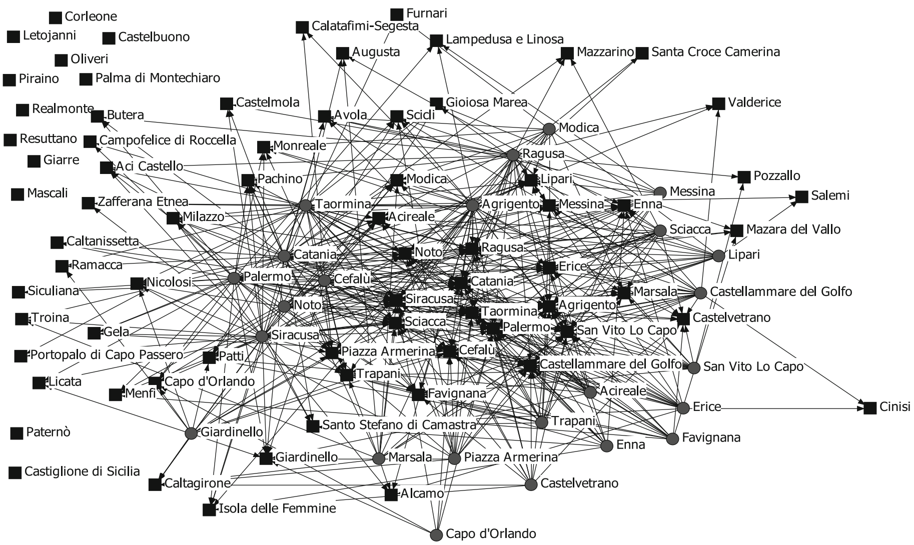

Fig. 2 *Clique* co-membership (two mode network). Circles represent the main destinations, whereas *squares* represent co-membership destinations

del Golfo-Castelvetrano-Erice-Favignana-Marsala; S.Vito lo Capo-Trapani; Lipari-Messina; Avola-Noto) and two other less relevant routes (Enna-P.zza Armerina-Aci Castello-Acireale-Caltagirone-Pachino-Siracusa-Portopalo di Capopassero; Valderice-Balestrate). These paths can be split into two categories: the routes between two far off main areas, spread within the whole Sicilian territory but easy to reach; and the routes among many smaller—but closer—areas located in the West or Centre of Sicily. These typologies are probably the expression of two different kinds of tourism: the business tourism, characterized by international movements and the niche tourism characterized by national movements.

Afterward, once *cliques* had been identified, we obtained a list of 149 overlapping subgroups. We wanted to reduce this number of *cliques* assessing the importance of each node for overlapped groups. There are two main techniques for describing and reducing the amount of overlap: hierarchical clustering of overlap matrix and Actor-by-Actor *Clique* Co-Membership Matrix. Selecting the last one, we distinguished between destinations belonging to the majority of *cliques* (main destinations), other nodes belonging to the same *cliques* of main destinations (co-membership destinations) and nodes excluded in the main destinations co-membership (Fig. 2).

Referring to the amount of overlapped *clique*s (Fig. 3), we can identify as the most important municipalities Palermo, Catania, Agrigento and Siracusa.

The analysis of each node's co-membership shows that every single municipality is characterized to a 'gravitational' area, with specific links spread all over Sicily. We mapped the gravitational areas of the most relevant municipalities, that is those areas with a great number of overlapped cliques (Fig. 4).

Mapping the cliques co-membership of these areas, we notice that the most cited cliques are on the Southern and North-Western Sicilian coasts. A specific typology of co-membership is referred to Palermo and Catania's overlapped *cliques*, including a group of municipalities located in the inner island.

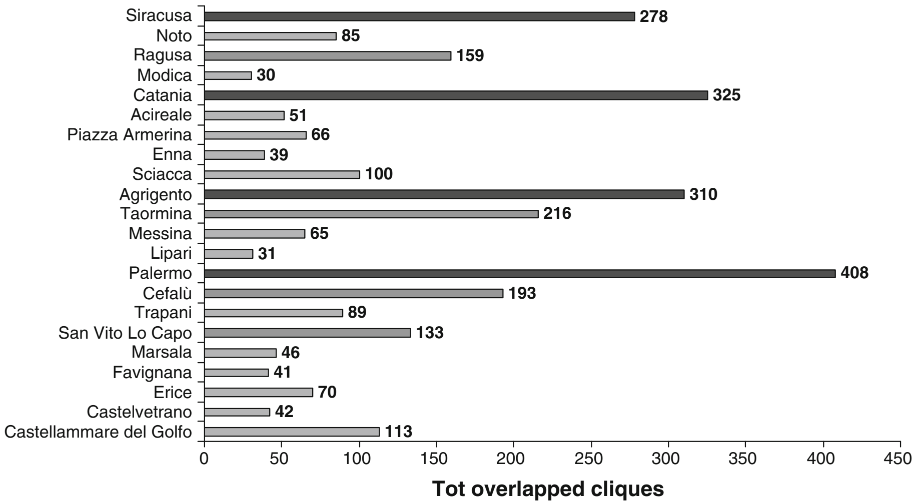

Fig. 3 *Clique* co-memberships of the most cited Sicilian destinations

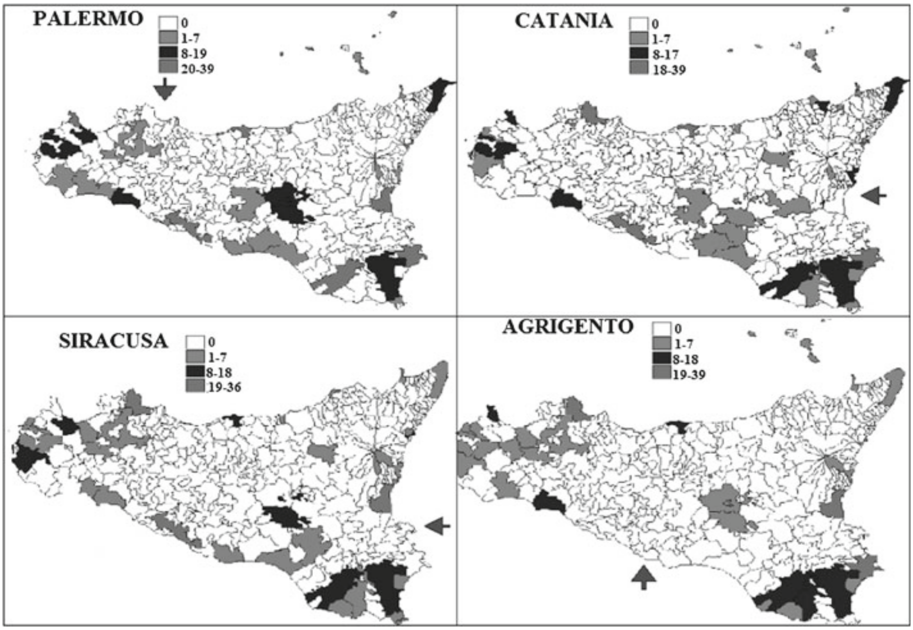

Fig. 4 *Clique* co-memberships of the main destinations

4 Classifying tourism destinations

By means of network measures shown previously, in this section we propose some classifying techniques in order to group observed tourism destinations. First of all, we aim to point out destinations departing from identical places and moving toward identical places. From a heuristic point of view, knowing these destinations could be useful in analyzing tourist routes and allows detection of clusters of places 'playing' the identical role inside the network. In order to identify these clusters, we employed the concept of *structural equivalence* (Borgatti and Everett 1992) considering the positions of the destinations in the network. "Two actors are structurally equivalent if and only if they have identical ties to and from identical other actors" (Wasserman and Faust 1994, p. 468)". In our application, actors are the destinations representing network nodes. In the traditional field of network analysis, *Structural Equivalence* is considered a strongly limited method because of its severe assumptions and often other concepts of equivalence are preferred (e.g. *Automorphic Equivalence* or *Regular Equivalence*). In tourism studies, however, what is usually seen as a limit, could represent an important knowledge element and a useful tourism planning tool. Clustering the groups of structurally equivalent destinations, in fact, allows us to identify alternative routes, replacing a destination with an equivalent other one, helping tourism firms to differ territorial tourism supply.

Among the techniques proposed in literature to investigate the pattern of similarities regarding node tie-profiles and to group the nodes in equivalence classes, we employed the procedure of *CONvergence of iterated CORrelation* (CONCOR). Formalized by Breiger et al. (1975), the CONCOR algorithm is the most common *blockmodelling* method. Not entering in mathematical details (Nunkesser and Sawitzki 2005; Schwartz 1977), CONCOR procedure starts by a correlation matrix where each pair of nodes is correlated with the other ones. Each row of this matrix is extracted and is correlated with other rows aiming to obtain similarity profiles of nodes. By means of these similarity profiles correlations, CONCOR detects two clusters. Then, the procedure is repeated inside of each cluster until a satisfactory subsets partition is obtained.

In our study on tourism in Sicily, the analysis of *Structural Equivalence* by means of CONCOR procedure, implemented in UCINET, allowed us to group the 73 observed destinations in four clusters (Fig. 5).

From a descriptive point of view, we note that the first cluster includes mainly Southern Sicilian destinations (Fig. 6); the second one appears localized in the Eastern areas, the third one and the fourth one, finally, characterize the Western part of the Island.

Actually, geographic proximity plays an important role in determining *Structural Equivalence*. Therefore, it is probable that neighboring destinations are structurally equivalent but, focusing on the destinations inside each cluster, we observe that it is not always like this. In the first cluster, for example, we find destinations such as Aci Castello, a seaside village in the Eastside of the Island and Resuttano, a small hilly village in the Westside and also in the other clusters we observe similar cases. It is important to remember that inside each cluster, every destination shares with each other the in- and the out-flow. In other words, tourists arrive in those destinations leaving from the identical destination and leave them toward identical places. Understanding the reason for this *Structural Equivalence* could provide important information in order to develop the tourism industry in Sicily.

Another important feature in tourism studies concerns the 'bridge' role played by some destinations. Unlike structurally equivalent destinations, in this case, it is relevant to detect those destinations linking two, not necessary identical, places. Such bridging destinations represent an intermediate point along the route and investigating them could help tourism route planners to 're-draw' tourism paths.

In order to analyze the bridging destinations, let us switch our attention from the nodes to the links and introduce the *lambda sets* (Borgatti et al. 1990). Quoting Wasserman and Faust (1994, 270) we can say that considering "pairs of nodes in the sub-graph G_s with node set N_s, the set N_s, is a lambda set if any pair of node in a lambda set has larger

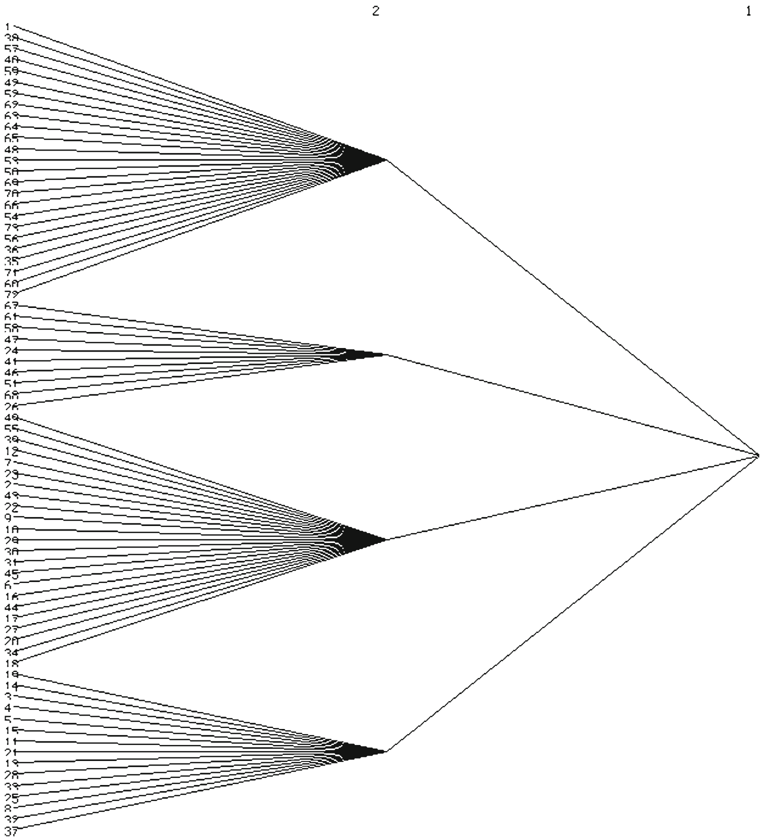

Fig. 5 The 4 structurally equivalent clusters

line connectivity than any pair of nodes consisting of one node from within the lambda set and a second node outside the lambda set". Thus, by comparing connectivity lines, it is possible to rank network links from the most important ones to the less important. The most important links represent the bridges without which the network might lose its cohesion.

Considering tourism destination in Sicily, we analyzed the lambda sets of the node ties aiming to point out the bridging destinations which most tourism routes follow. Figure 7, at the bottom of the dendrogram, shows the most important nodes. These node ties, in other words, maintain the network structure cohesive and allow to detect central destinations, i.e., the destinations playing a 'bridge' role inside the network.

Actually, it is likely that an often selected destination is also a bridge destination. Figure 8 shows the map of lambda sets in Sicily, where in dark gray, we find both core and bridge destinations, while in light gray just the bridge destinations. Except for two destinations localized in the central area of the Island (Enna and Piazza Armerina), all the other bridge destinations are situated on the seaside, thereby confirming the exclusively bathing vocation of tourism in Sicily.

After obtaining two types of classification by means of *Structural Equivalence* and lambda sets, in this final section we try to cluster destinations on the basis of their similar features concerning observed tourist routes. Starting from a similarity matrix, by means of *multidi-*

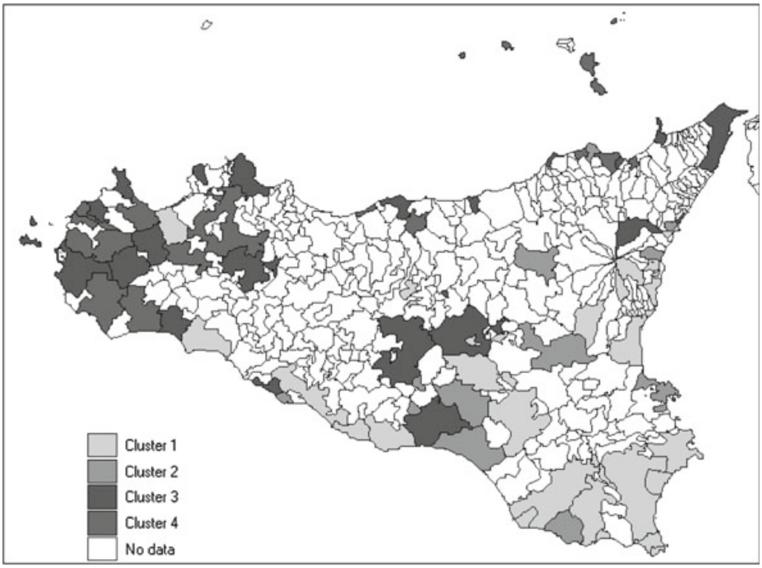

Fig. 6 The territorial distribution of clusters in Sicily

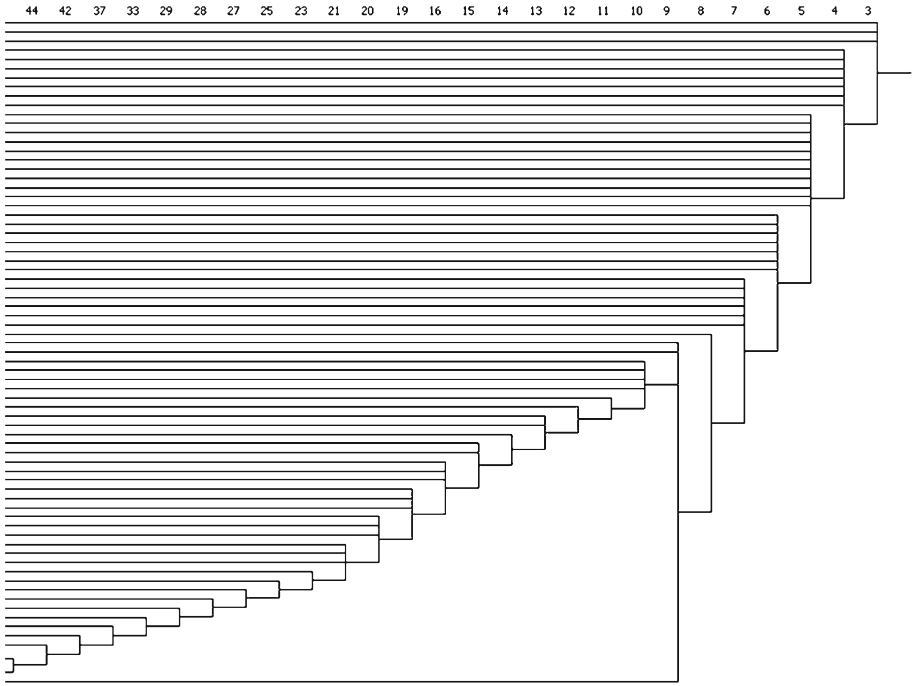

Fig. 7 Dendrogram of lambda sets (each line identifies a destination)

mensional scaling (MDS), we reduced all the information extracting two dimensions, two Cartesian coordinates upon which we plotted the destinations as shown in Fig. 9.

In each quadrant of MDS configuration we find destinations sharing some common features (Breiger et al. 1975). It is important to underline that for each quadrant, destination

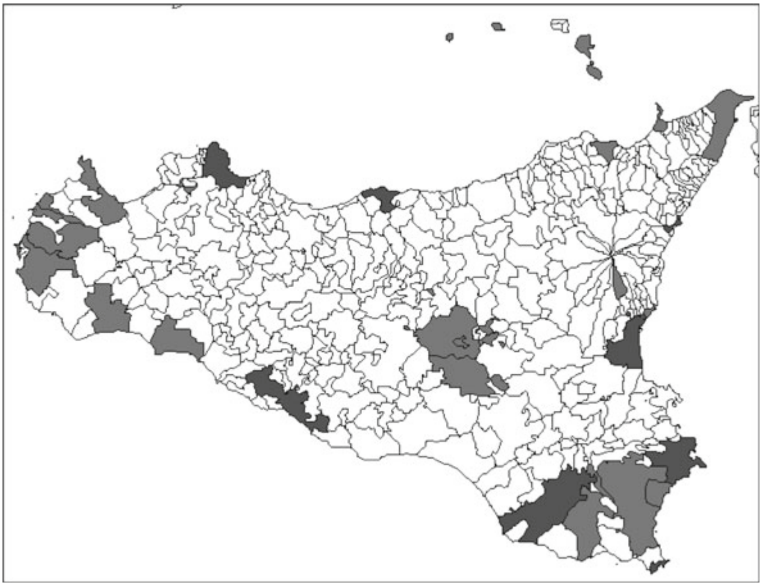

Fig. 8 The geographic distribution of *lambda sets*

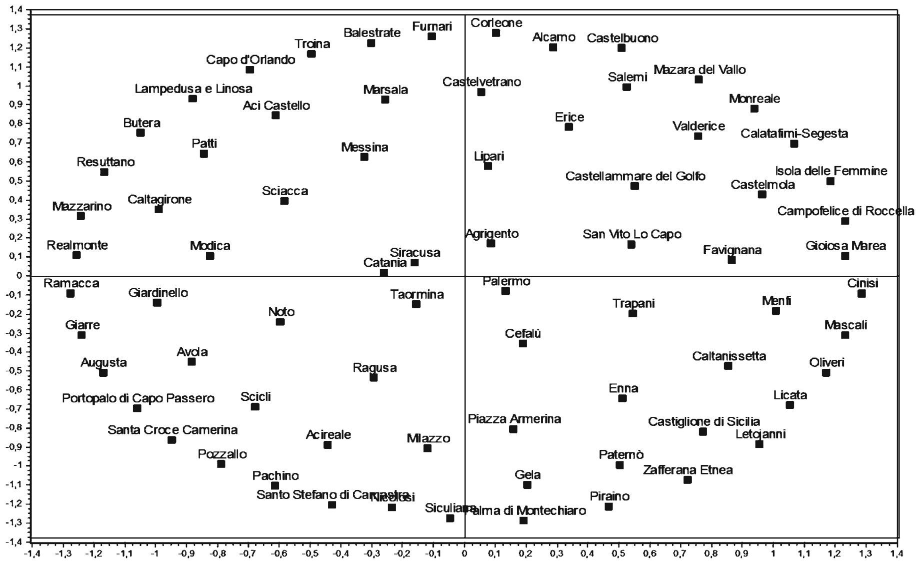

Fig. 9 MDS plot of destinations similarity matrix

proximity does not depend on territorial closeness. Although below we will define the quadrants as 'areas', it does not mean territorial areas but a sort of 'typological' areas. In other words, destinations in each area share some features related to the tourism flows and their proximity is just a geodesic proximity, not necessarily spatial closeness.

Each area shows a representative destination located, graphically, close to axis origin. For each area, therefore, we can detect a destination strictly linked to the other ones belonging to the same area. We can imagine these places as 'attractive centers' and all destinations are located within their orbit. The attractive destinations are the most famous tourism towns in Sicily and it could be interesting to observe where the tourists move after (or before) visiting them.

Furthermore, the destination role inside of each area could provide information about tourism mobility in Sicily. It is important, in fact, to know the destination through which tourists come into the area. At the same time, knowing the place the tourists leave the area from, extends the analysis of tourism mobility. Inside of each area, destinations play different roles in featuring tourism flows.

In order to investigate destination role inside the network areas, we employed the *brokerage* analysis (Gould and Fernandez 1989). Also in this case, we focused on links, that in our study represent the routes, rather than nodes. After detecting the areas, by means of MDS, we aimed to control possible brokerage effects inside them and, specifically, we tried to investigate the typologies of such brokerage effects.

According to Gould and Fernandez' ties classification, we can distinguish 5 relation types. That is, in our studies, destinations played 5 different broker roles inside each attractive area. Since the broker is a node linking two other nodes and defining A, B, C three different attractive areas where destinations are in, we could have the following roles:

Coordinator A → A → A. In this case all the nodes belong to the same group and the broker links two destinations located in the same attraction area. Looking at the first quadrant of *MDS* plot, for example, in a possible route 'Sciacca → Messina → Marsala', Messina could play the coordinator role.

Gatekeeper B → A → A. The broker destination represents a sort of bridge between a destination located in a different attractive area and a destination whom it shares attractive area with. In our application, hence, in a path like 'Lipari → Siracusa → Catania', Siracusa plays the role of gatekeeper because Lipari is in the second quadrant while Catania is in the first one, as well as Siracusa.

Representative A → A → B. The broker constitutes a junction between a destination of its own attraction area and a destination of another attraction area. Considering the route 'Siracusa → Catania → Agrigento', Catania is the representative node because it receives tourists from a place situated in its own area and from Catania, tourists move to another area.

Consultant B → A → B. The broker links two destinations belonging to the same area. In our study if we observe a path such as 'Agrigento → Marsala → Lipari', the intermediate destination (Marsala) plays the role of consultant because it belongs to the first attractive area and Agrigento and Lipari are included in the second one.

Liaison B → A → C. In this case all destinations belong to different attractive areas. Looking at the *MDS* plot, in the route 'Catania → Palermo → Agrigento, Palermo (in the third area) acts a liaison between Catania (in the first area) and Agrigento (in the second area).

After exposing the types of *brokerage* adapted to our aims, by means of suitable routine[7] implemented in UCINET 6 (Borgatti et al. 2002) we identified the roles played by observed destinations. Table 2 shows the brokerage scores of destinations included in the two most important areas, the first and the third quadrant of the previous plot. Looking at the scores of the first area, Catania and Siracusa, we note the central role of Catania showing a total brokerage score equal to 148. Catania, of course, is the most *representative* node in the attractive area and it confirms what we exposed previously analyzing Catania proximity to axis origin. Nevertheless, the destination with the highest total brokerage score was Siracusa

[7] In short, the routine computes the frequency which a node plays a role in the network with, reporting so the frequency for each role (*brokerage score*).

(172). Again, except for *representative* role score, in all the others roles, Siracusa showed the highest scores. It should be noted, in fact, that Siracusa plays, more than other destinations in the area, the role of *liaison*. In other words, Siracusa acts as connector between destinations of different attractive areas. Furthermore, Siracusa plays the role of *consultant* 34 times, that is, it represents a strategic node for intra-area mobility. Siracusa acts as *gatekeeper* (25 times) too, although in this case, the role of Marsala should be noted showing a score equal to 22.

The second half of Table 2 shows the *brokerage* scores of the Palermo attraction area. Recalling that Palermo is the Sicilian capital, we can make remarks similar to those made before regarding Catania and Siracusa. In this case, a role similar to Siracusa is played by Cefalù. Although the highest value of total brokerage scores is observed in Palermo (127), which is also the *representative* node in the area, Cefalù plays all the other roles more frequently than any other destination. So, Cefalù, a seaside village in the North of the Island, acts as a *liaison* (30) connecting destinations belonging to two different areas. Furthermore, considering the role of *liaison*, relevant is the score of Piazza Armerina whose *brokerage* score could be the consequence of its geographical position. It is located, in fact, in the center of Sicily. Finally, Cefalù, more than other destinations in the area, plays the role of *consultant*, *gatekeeper* and *coordinator*, as well.

5 Conclusions

The paper proposes an application of *Network Analysis* to study tourism mobility from individual routes, examining effects both on the single destinations and the whole tourism system. By means of *Network Analysis* measures, we take into account the structure of links among the tourism destinations and their position in the network, in order to obtain a classification of destinations. Usually, *Network Analysis* methodology is applied to study the relational structure among actors, defined as nodes. In our proposal, instead, we suggest using this approach which aims to analyse tourism destinations as nodes. So, employing traditional tools of *Network Analysis* allows us to identify main tourism areas in Sicily. Data shows the presence of a low dense network with few effectively important destinations.

Through *components* and *cliques*, moreover, we map the most selected routes as closed paths. The main Sicilian routes are made up of strongly connected far away places. The paths pass through few central destinations throughout the whole Island. Among these destinations, by means of *lambda sets*, we identify the most important sites playing a 'bridge' role between two areas. On these 'bridge' destinations, network structure maintains its cohesion.

In order to classify tourism sites we apply two procedures. The first one, *structural equivalence*, allows us to cluster destinations featured by identical paths. In other words, tourists arrive at those destinations leaving from identical destinations and leave them toward identical places. The second classification procedure, *brokerage,* is applied on the four 'attractive centers' identified through *MDS* analysis. These centers are referred to few attractive destinations, the most famous tourism towns in Sicily, where the tourists move after (or before) visiting them. After detecting these areas, we focus on links instead on nodes. So, we examine brokerage effects inside them, pointing out brokerage roles: *Gatekeeper*, *Representative*, *Consultant, Coordinator and Liaison*.

Our proposal could be used to evaluate patterns of tourism flows and tourism mobility, even in order to examine the territorial features of tourism market.

Table 2 The *brokerage* score for the two most important attraction area

MDS	Municipalities	*Coordinator*	*Gatekeeper*	*Representative*	*Consultant*	*Liaison*	Total
Catania and Siracusa attraction areas	Lampedusa e Linosa	0	1	0	0	0	1
	Catania	**6**	9	59	19	55	**148**
	Resuttano	0	0	0	0	0	0
	Balestrate	0	1	0	0	1	2
	Realmonte	0	0	0	1	4	5
	Sciacca	1	5	8	9	21	44
	Marsala	1	**22**	3	11	13	50
	Butera	0	0	0	0	0	0
	Modica	0	12	3	9	12	36
	Patti	1	9	4	6	18	38
	Mazzarino	0	0	2	0	0	2
	Aci Castello	2	0	4	0	1	7
	Furnari	0	0	2	1	2	5
	Caltagirone	1	7	2	3	10	23
	Troina	0	0	1	0	0	1
	Messina	5	16	10	7	20	58
	Capo d'Orlando	0	1	1	1	1	4
	Siracusa	8	**25**	35	**34**	70	**172**
Palermo attraction area	Palma di Monte-chiaro	0	1	0	0	0	1
	Palermo	3	16	21	27	60	**127**
	Licata	0	0	4	4	0	8
	Enna	1	2	6	5	12	26
	Mascali	0	1	0	0	1	2
	Castelbuono	0	0	0	0	0	0
	Paterno	0	1	0	0	0	1
	Menfi	0	1	2	3	6	12
	Zafferana Etnea	0	0	0	1	1	2
	Caltanissetta	1	0	2	0	0	3
	Gela	0	0	0	1	0	1
	Trapani	1	3	5	7	11	27
	Valderice	0	0	0	6	8	14
	Oliveri	0	0	1	1	0	2
	Piazza Armerina	3	4	14	9	**13**	**43**
	Piraino	0	0	0	0	0	0
	Cefalù	**15**	**26**	33	**19**	**30**	123
	Cinisi	0	1	0	1	2	4
	Letojanni	0	3	0	2	4	9
	Castiglione di Sicilia	0	0	0	0	1	1

References

Baggio, R.: Symptoms of complexity in a tourism system. Tour. Anal. **13**(1), 1–20 (2008)

Baggio, R., Cooper, C.: Knowledge transfer in a tourism destination: the effects of a network structure. Serv. Indus. J. (Special issue on: advances in service network analysis, edited by Scott N., Laws E.) **30**(8), 1–15 (2010)

Baggio, R., Scott, N., Cooper, C.: Network science and socio-economic systems. A review focused on a tourism destination (Dondena Working Paper No. 7): "Carlo F. Dondena" Centre for Research on Social Dynamics, Bocconi University. Retrieved October, 2008. http://www.dondena.unibocconi.it/wp7 (2008)

Bansal, H., Eiselt, H.A.: Exploratory research of tourist motivations and planning. Tour. Manage. **25**, 387–396 (2004)

Bickerdyke, I.: Australia: The evolving structure and strategies of business networks. In: OECD (ed.) Networks of Enterprises and Local Development: Competing and Co-operating in Local productive Systems, Paris: Organisation for Economic Co-operation and Development, 203–216 (1996)

Borgatti, S.P., Everett, M.G.: Notions of positions in social network analysis. Sociol. Methodol. **22**, 1–35 (1992)

Borgatti, S.P., Everett, M.G., Shirey, P.: LS sets, lambda sets and other cohesive subsets. Soc. Netw. **12**, 337–357 (1990)

Borgatti, S.P., Everett, M.G., Freeman, L.C.: UCINET 6 For Windows: Software for Social Network Analysis. Analytic Technologies, Harvard, MA (2002)

Breiger, R.L., Boorman, S.A., Arabie, P.: Algorithm for clustering relational data with applications to social network analysis and comparison with multidimensional-scaling. J. Math. Psychol. **12**, 328–383 (1975)

Buhalis, D.: Marketing the competitive destinations of the future. Tour. Manage. **29**, 1131–1140 (2000)

Carlsen, J.: A systems approach to island tourism destination management. Syst. Res. Behav. Sci. **16**(4), 321–327 (1999)

Chang, P.L., Shih, H.Y.: Comparing patterns of intersectoral innovation diffusion in Taiwan and China: a network analysis. Technovation. **25**, 155–169 (2005)

Cross, R.L., Borgatti, S.P., Parker, A.: Making invisible work visible: using social network analysis to support human networks. Calif. Manage. Rev. **44**(2), 25–46 (2002)

Gould, R., Fernandez, R.: Structures of mediation: a formal approach to brokerage in transaction networks. Sociol. Methodol. **19**, 89–126 (1989)

Hall, C.M.: Tourism Planning. Policies, Processes and Relationship. Prentice Hall, Pearson (2008)

Hwang, Y.H., Fesenmaier, D.R.: Multidestination pleasure travel patterns: empirical evidence from the American travel survey. J. Trav. Res. **42**, 166–171 (2003)

Jeng, J.M., Fesenmaier, D.: Destination compatibility in multidestination pleasure travel. Tour. Anal. **3**(3), 77–87 (1998)

Lew, A., McKercher, B.: Modeling tourist movements: a local destination analysis. Annal. Tour. Res. **33**(2), 403–423 (2006)

Morrison, A., Lynch, P., Johns, N.: International tourism networks. Int. J. Contemp. Hosp. Manage. **16**(3), 197–202 (2004)

Nunkesser, M., Sawitzki, D.: Blockmodels. In: Brandes, U., Erlebach, T. (eds.) Network analysis: methodological foundations, pp. 253–292. Springer-Verlag, Hidelberg (2005)

Opsahl, T., Agneessens, F., Skvoretz, J.: Node centrality in weighted networks: Generalizing degree and shortest paths. Soc. Netw. **32**, 245–251 (2010)

Rowley, T.J.: Moving beyond dyadic ties: a network theory of stakeholder influences. Acad. Manag. Rev. **22**(4), 887–910 (1997)

Schwartz, J.E.: An examination of CONCOR and related methods for blocking sociometric data. Sociol. Methodol. **7**, 255–282 (1977)

Scott, N., Baggio, R., Cooper, C.: Network Analysis and Tourism: From Theory to Practice. Channel View Publications, Clevedon (2008a)

Scott, N., Cooper, C., Baggio, R.: Destination networks. Four Australian cases. Annal. Tour. Res. **35**(1), 169–188 (2008b)

Shih, H.: Network characteristics of drive tourism destinations: an application of network analysis in tourism. Tour. Manag. **27**, 1029–1039 (2006)

Tideswell, C., Faulkner, B.: Multi-destination travel patterns of International Visitors to Queensland. Australia. J. Trav. Res. **37**, 364–374 (1999)

Wasserman, S., Faust, K.: Social Network Analysis: Methods and Applications. Cambridge University Press, Cambridge (1994)

DICHIARAZIONE SOSTITUTIVA DI ATTO DI NOTORIETA'
(sull'attribuzione della responsabilità dei singoli autori di lavori congiunti)
(Artt. 19 e 47 del D.P.R. 28.12.2000, n. 445)

La sottoscritta TOMASELLI Venera nata a Catania l'1/9/1961, residente a Pedara (provincia di CT) Corso Ara di Giove n. 12, C.A.P 95030, consapevole che, ai sensi dell'art. 76 del D.P.R. 445/2000, dichiarazioni mendaci, formazione o uso di atti falsi sono puniti ai sensi del codice penale e delle leggi speciali in materia,

DICHIARA

che nel lavoro a firma congiunta:

> D'Agata R., Gozzo S., TOMASELLI V. (2013). Network analysis approach to map tourism mobility. QUALITY & QUANTITY, vol. 47, n. 6, p. 3167-3184, ISSN: 0033-5177, doi: 10.1007/s11135-012-9710-7.
> *Fascia A lista A.N.V.U.R., area 13, SSD 13/D3, Peer-review, IF=0.867. 5 years 2015, IF=0,929.*

il contributo degli autori è da considerarsi paritetico sotto ogni aspetto *e l'ordine degli autori è esclusivamente alfabetico.*

L'attribuzione della redazione dei paragrafi, tuttavia, è da intendersi nel seguente modo:

D'Agata R.: paragrafo 1.
Gozzo S.: paragrafo 3.
TOMASELLI V.: paragrafi 2, 4, 5.

La sottoscritta dichiara di essere informata, ai sensi dell'art. 10 della legge 675/96, che i dati sopra riportati saranno utilizzati nell'ambito del procedimento per il quale la presente dichiarazione viene resa.

Catania, 21/11/2016

La sottoscritta
Venera Tomaselli

Venera Tomaselli