Reinforcing Landscape Rehabilitation using Visibility Analysis: A Case Study of Western Liguria, Italy

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Abstract  Italy is a major tourist attraction for Europeans and the rest of the world's population because of its natural and cultural beauty. The high influx of tourists after the 1950s provoked an uncontrollable urbanization in Italy, which primarily occurred in coastal areas. The region of Liguria, which is located in Northwest Italy, suffered heavily during this period, and the progressive degradation of the landscape has been a topic of discussion in Liguria and the European community for the past few decades. This study employed Geographical Information Systems (GIS) to identify the areas visible from roads that are frequently used by tourists. Visibility analysis has been proposed as a method to help focus rehabilitation processes on the most visible areas. The lack of conservation demonstrates the progressive abandonment of rural areas and suggests that forest fires are degrading the quality of the landscape. Historical and typical cultivation areas, however, have been suggested as targets for initiation of the rehabilitation process. A balance is required between the development of the tourist infrastructure and the preservation of the local identity to allow for economic development while maintaining the natural and historical heritage of the region.

Key words  Liguria, visibility analysis, tourism, landscape rehabilitation, cultural identity

Introduction

Italy is a country that is famous for natural beauty and artistic history with a diverse regional culture, which is reflected in the landscape. This environmental and cultural heterogeneity has allowed tourism to become one of the main economic resources of the country (Savelli 2004). Although the rapid tourist infrastructures expansion after the Second World War has gradually decreased, the number of visitors has continued to increase (WTO 1994). According to the United Nations World Tourism Organization (UNWTO), Italy is the fifth most frequently visited tourist destination (after France, Spain, the USA, and China), with 43.7 million tourists visiting the country in 2007 (UNWTO 2008). A large amount of capital was invested in the tourism sector during previous decades to satisfy the increasing number of travelers, which resulted in substantial construction and overexploitation close to the coastline. Since the beginning of the 21st century, tourism has received attention as a major sociocultural force that impacts the economy and potentially influences the local culture (Miller and Autong 1991). Although the Italian Ministry of Cultural Heritage has recognized and emphasized cultural heritage as an element of great importance, no effective strategies have been developed to conserve this heritage (Callegari 2003).

This study used visibility analysis to identify the most visible landscapes for tourists traveling on the roads and highlight locations with particular historical, cultural, and tourist interest. This analysis can be adapted to many different fields to investigate problems such as the natural impact of introducing new facilities in rural areas (Davidson et al. 1993) and landscape evaluation (Germino et al. 2001). Other studies have developed different approaches using visibility analysis techniques. These approaches have ranged from identifying scenic views in a specific environment (Chetri and Arrowsmith 2003), analyzing and visualizing visibility surfaces (Caldwell et al. 2003) and constructing multi-visibility maps (Coll et al. 2007). These studies highlighted the utility of visibility analysis as a tool to evaluate the landscape and the human impact on the natural environment, and visibility analysis was used in this study as a consolidated visualization method. Considering that the landscape is a key factor for sustained tourism, this method determined the highly visible areas that could be targeted for the rehabilitation process proposed by the Regional Council of Liguria (Bonini 1993). Furthermore, the natural landscape can also be considered as a marker of regional identity, which demonstrates the uniqueness of the territory (Kipar 2002).

Both natural and urban landscapes are critical factors
that influence tourist attraction (Paloscia 1994). After the adoption of the European Landscape Convention on October 20, 2000, attention has focused on regional projects and investments in Liguria, such as coastal rehabilitation and an enhancement of rural areas (Bonini 1993). Several action programs have been initiated in agreement with the European Landscape Convention, which was signed in Florence in 2002. Two examples are the “Piano Territoriale Regionale” (Regional Territorial Plan) for rural areas and green zone development and the “Piano Territoriale della Costa” (Coastal Territorial Plan) for coastal protection and determination of abandoned areas (Kipar 2002).

Study Area

Geographical characteristics

The Liguria region is located in Northwest Italy (Figure 1) and borders the southeastern coast of France (i.e., the “Riviera”), which is a historical destination for tourists (Segreto et al. 2009). Liguria is an area of approximately 5,400 km² (1.18% of the country), which is primarily hilly or mountainous terrain. The region is comprised of a narrow stretch of land between the sea and mountains with a maximum width of less than 30 km. The coast primarily consists of rocky cliffs with a flat coastline that eventually widens towards the western side of the region. The main elements that reinforce the tourism sector in Liguria are geographic location and climate, which is characterized by high insolation values and low amounts of precipitation (Touring Club Italiano 1982). Due to the lack of space on the western side of the region, the landscape has been deeply modified by the addition of terraces to allow for cultivation on hill slopes. Because terraces that are not maintained will eventually result in landslides and soil erosion (Shresta et al. 2004), the progressive abandonment of agricultural land in recent decades has been a major cause of land degradation. The complex topography of the region has not allowed for the development of roads, especially on the western side of Liguria. Therefore, the existing communication paths are very important to areas such as the Piemonte in the north and the Provence-Alpes-Cote d’Azur (in France) to the west.

The process of tourism development in Western Liguria

The tourism development process in Liguria was more consistent after the late 19th century when the Riviera became a preferred destination for elite tourism, primarily for tourists from Great Britain and Germany (Giuliani-Balestrino et al. 1991). The Mediterranean landscapes, mild climate, and cultural heritage were the main factors that attracted noble families from the colder regions of Europe. During this period, the territory was enhanced by international construction styles, such as villas and botanical gardens.

The first influx of mass tourism in the Italian Riviera occurred after the 1950s (Ugolini 1996), which negatively affected the territory because of the rapid, uncontrollable construction and mass urbanization. This new development created a nearly continuous urban belt, which extended along the coastline for over 300 km (Callegari 2003).

A second wave of tourism was observed during the late 1960s, which was primarily comprised of settlers from various European countries, such as Great Britain, Germany, and the Netherlands, who were interested in the Ligurian culture and tradition. Despite the presence of tourist infrastructures in coastal areas, these settlers moved to inland areas to purchase and refurbish old houses in rural villages and grounds, which reinforced the preservation of the landscape and allowed for easier integration of foreigners into the local communities (Segreto et al. 2009). During the 1970s and 1980s, Northern European tour operators switched to cheaper coastal areas in Italy and in other Mediterranean countries, but small investors continued to construct infrastructures in Liguria (Formica and Uysal 1996).

In recent decades, there has been a continuous decline in the influx of tourists. Figure 2 shows tourism statistics divided into arrival (number of tourists arriving) and presence (calculated based on check-in and check-out status of each tourist) number of days spent by each tourist stayed at destination). Figure 2a indicates the
arrivals of tourists and Figures 2b and 2c indicate the abundance of tourists in cities with artistic or historical interest and marine areas, respectively. According to ISTAT (the Istituto Nazionale di Statistica, National Institute of Statistics), the total number of tourists has constantly decreased from 15,469,184 in 2000 to 14,214,124 in 2008. This 1,255,060 decrease in tourists over the last eight years indicates the habitual change in tourism. Tourists still choose Liguria for a holiday destination, but visits are for shorter periods of time (shown by the decrease in presence). The total arrival of tourists, however, has only exhibited a slight decrease (3,501,160 tourists in 2000 vs. 3,487,924 in 2008). The number of tourists interested in history and art have increased from 1,154,116 in 2000 to 1,337,823 in 2008 (Figure 2b); however, this number is considerably smaller than the total shown in Figure 2a. This tendency confirms the progressive inland migration of tourism since the 1960s because tourists have been attracted to the traditional rural villages and natural landscapes. Despite the smaller number of tourists compared with the coastal areas, inland tourism provides significant economic income for the rural areas. Regardless of the relatively small increase in the number of tourists in artistic and historical areas, marine areas have experienced a higher loss in the presence of tourists with a decrease from 13,852,859 in 2000 to 12,325,474 in 2008 (Figure 2c).

The loss of 1,527,385 presences over the last decade was caused by changes in economic trends during the 1970s and 1980s, which decreased focus on the region as a main tourist attraction.

**Data and Methods**

In this paper, viewshed analysis was used to define and characterize the areas viewed by a hypothetical tourist in Western Liguria. Data for this research were provided by the laboratory UMR 6012 ESPACE of Nice, France and included the following components: a Digital Elevation Model (DEM), land use data vector files and roadwork network vector files.

With a resolution of 20 meters, the DEM raster file was used as the basis for the visibility analysis, which was the highest resolution available for this research. Due to the pixel size (20 m × 20 m), details below this limit, such as trees or buildings, were not considered for this analysis.

Land use data vector files were produced by the Ligurian Council. The land use categories were reclassified by the author to maximize the quality of results using the Corine Land Cover, which is an internationally recognized classification that was developed with the specific aim of monitoring regional use, managing sensitive areas, and improving local management in Europe (EEA 1994). The Corine Land Cover is a hierarchical classification,
which is divided into three levels of precision. Level 1 was used for the main maps in this study and is divided into five classes: artificial areas, agricultural lands, forests and semi-natural environments, wetlands, and water. A sixth class for the sea was added to differentiate marine waters from river waters. Each class was then divided into sub-levels (levels 2 and 3) to provide a higher resolution of description. For this study, two maps were created at different levels: level 1 functioned as a general overview and level 3 highlighted zones with specific characteristics, such as cultivation, which represented the typical features of the region.

Road network vector files containing all of the main communication roads in Western Liguria were also used in this analysis. Four main roads were selected because of their important role in connecting the littoral area, where the majority of Ligurian tourism occurs, to the Northern Italian region and Southeastern France (Scaltriti 2003). The poly-line data for each road was converted into poly-points using MapInfo with the Vertical Mapper plug-in. Several measurements were tested to determine the optimal space that should be inserted between each point in the conversion process. A spacing of 250 m was used for the visibility analysis, which allowed for 4 panoramic points per kilometer. This 250 m distance avoided overlapping of the visible area from each point and maintained the balance between accuracy and time required for data processing (Kim et al. 2004). Spacing below 250 m was not included in the results because the data would not provide any additional valuable information. Once all poly-line tracks were converted into poly-points at 250 m intervals, the visibility calculation was performed. This analysis was performed for each point on every road to represent a 360° view of the visible landscape at locations separated by a 250 m distance.

Four steps were developed to generate land use and visibility maps. The first raw results were produced from the visibility analysis and revealed the distinction between visible and non-visible locations. A further step was needed to calculate the number of times that each location was observed from the road and determine the regions typically viewed by tourists. A second map was produced to simulate the view of tourists throughout the route. Finally, the land-use data from the Corine Land Cover was clipped over the visibility map, which showed the land use types of the visible areas. In the end, two maps were produced: one for Corine Land Cover level 1 and a more detailed map representing Corine Land Cover level 3.

**Visibility Analysis**

**Main features viewed from the roads under study**

The visibility analysis method was used for four main roads in this study (shown in Figure 3), which are
important transportation paths connecting the coastal and inland areas. These roads, which lead to the Piemonte and Lombardia regions, are the main routes of travel for tourists in Western Liguria.

**Strada Statale No. 20 (SS20—Section Ventimiglia–French Border):** This road is located at the western end of the region near the border with France. Strada Statale No. 20 is the primary passage through the mountains to the Piemonte Region, and the route can be divided into two parts. The first part passes through the coastal town of Ventimiglia past historical sites, such as Roman ruins and a medieval city. A market area is also present in this area, which attracts tourists (particularly French tourists). The second section passes through the bottom of the valley and allows access to rural villages, such as Airole. The village of Airole exhibits a medieval urban structure featuring a concentric ellipsoid, which is typical of most rural villages in the hinterland of Liguria (Touring Club Italiano 2003).

**Strada Statale No. 28 (SS28—Section Imperia–Pornassio):** This road is not only important for tourism, but also for regional commerce as an alternative passage between Liguria and Piemonte (Azienda Nazionale Autonoma delle Strade 2009). Despite the presence of tunnels along the road, the morphology of the land allows for a broad view of the area and a visibility radius of over 5 km. The road starts in the city of Imperia, which is the main city of the province. The two main cities that comprise Imperia (Oneglia and Porto Maurizio) contain medieval areas, forts, and a port, which is important for fishing. The inland region contains many local villages of medieval origin, such as Chiusavecchia and Cesio, which have economies based on the cultivation of grapes and olives.

**Strada Provinciale No. 29 (SP29–Section Savona–Altare):** This road starts in the city of Savona, the second biggest port in Liguria. This city is important due to a variety of historical and tourist attractions. In addition, the harbor is frequently used for commerce within the Piemonte and Lombardia regions (Touring Club Italiano 2003). The SP29, which is a primary path between the coastal area and the inland territories, connects to the SS20 and continues towards the chief town of Piemonte. Rural villages along this road are also a component of the typical valley landscape.

**Highway A6:** This route, which is a two-way road everywhere except the coastal area, is the only highway between the Western Riviera and the northern Italian regions. The road was built in 1956 with a complex passage structure. Because this is a very dangerous highway, the construction of a second highway was initiated in 1973 to create two different paths, each with a two-way road (Autostrada Torino-Savona, 2010).

**Visibility index**

Figure 4 shows the visibility index, which is defined as “the number of occurrences of a particular entity within an unobstructed line-of-sight (LOS) from a given point (Kidner et al. 1997).” Therefore, a higher visibility index represents an area with a significant visual impact.

The SS20 passes through a narrow valley, and high mountains are situated very close to the road. Due to this particular topography, the area has a high visibility ratio from the road with a maximum range of 2 km. Three main sites are highlighted along the SS20: the historical and cultural tourist attraction cities of Ventimiglia and Airole have a high visibility index and the locality of Mt. Pozzo (569 m) exhibits the typical Ligurian terrace cultivation style. Although The SS28 has a similar topography as the SS20, it is only visible within a narrow range. The city of Imperia and the surrounding coastal area exhibit a uniform visible area over the first 4 km of the road. As a tourist destination, Imperia must be considered part of the distinctive landscape of the region. The inland part of the region is characterized by a number of small villages with economies that are primarily based on agriculture and local manufacturing. Among these villages, Chiusavecchia and Cesio have a high visibility index. The SP29 presents a different visibility pattern, and the analysis indicated a longer range of visibility, which was mainly due to the position of the road. After the first 5 km, the road ascends towards the valley and the view over the landscape is extended. There are multiple turns in the winding road, however, which reduce the visibility index to less than 20. These turns diminish the attraction of the road and fail to highlight tourist attractions and locations of cultural significance. Highway A6 is elevated from the ground and provides a nearly complete view of the coastal and marine zones. Indeed, this highway provides a general overview of the Savona area and the associated harbor to travelers from the northern Italian regions.

**Corine Land Cover land use classification**

The Corine Land Cover land use classes within the visible range are shown in Figure 5. The humid area class comprised 0.06% of the overall area and was too small to be representative; therefore, this class was deleted. Several differences were revealed when we compared the
classifications of these four roads. For SS20 and SS28, 19.87% and 41.22%, respectively, of the total visible area was devoted to agriculture, whereas for SP29 and A6, 14.70% and 8.74%, respectively, were dedicated to agriculture and most of the visible areas for SP29 and A6, 75.67% and 49.72% respectively, are natural environment. In the western part of the region, cultivation, which maintains the landscape, is a primary component of the economy. The cities of Savona and Vado Ligure are primarily seen from A6, and the main economic activities of these regions are related to the port. After the Second World War, the economic recovery of these areas primarily revolved around coal trading (Touring Club Italiano 2003), which explains the high percentage of forests and low agricultural development. The urban areas visible from the roads studied represent 3.92% of SS20 land use, 6.25% of SS28, 5.18% of SP29, and 9.21% of A6. The urban areas of the four roads are mainly distributed in the coastal areas because the majority of tourists in Liguria are attracted to the marine resorts and beaches.

Areas with a higher visibility index are primarily composed of agricultural fields, natural environments, and rural villages. Two different thematic areas could be established for the four roads according to the type of visible landscape. In the case of SS20 and SS28, agricultural activity is predominant in both valleys, whereas in the case of SP29 and A6 the natural forest and the coastal urban tissue are more relevant. Local areas producing fresh vegetables and historical rural sites are points of distinctive attraction in both areas.
**Local agriculture**

The typical cultivation of the region are olive trees, greenhouses, and vineyards (Figure 6), which are primarily found on the terraced fields. The panorama from SS28 is established by the cultivated olive terrace and offers a typical image to tourists passing through this route. A similar view is available from SS20, which also features olives and greenhouses. The SP29 and A6 roads exhibit differences in the economy of Savona, where agriculture is considered as a secondary development. The vineyards are very sparse and representative of the different valleys in Western Liguria. As agriculture is predominant in the SS20 and SS28 visible areas, preservation of the agricultural landscape is necessary to conserve the image of the region.

**Issues with the Landscape Rehabilitation Process in Western Liguria**

Landscape rehabilitation has been a topic of discussion at regional, national, and international scales (Vos and Meekes 1999). Successful preservation of the landscape allows for maintenance of the cultural and natural characteristics typical of a geographical location. The landscape of Liguria is one of the main factors attracting tourists. Therefore, the quality of the scenery visible from the roads directly impacts the tourism economy. In this study, visibility analysis was used to delineate the viewable characteristics of the landscape. A narrow range of visibility, which includes rural villages and terraces, are the main features that characterize the visible areas along SS20 and SS28. A larger range of visibility, natural...
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Forests, and a more prominent coastal development were observed along SP29 and A6. Despite the observed differences in land use characteristics by visibility analysis, this study detected three main issues affecting the Western Liguria landscape. The first issue derives from tourism and the constant pressure during the past 50 years to construct infrastructures that deeply modified the territory and damaged the natural environment, especially in the coastal areas where most of the tourist facilities are located (Callegari 2003). The second issue mainly occurs in the inland territories and concerns the abandonment of rural areas that are not considered economically productive, which has consequently resulted in migration towards cities. Therefore, the agricultural lands have not been cultivated and the forests were not preserved, which resulted in degradation of the typical terraces and natural forests (Conti and Fagarazzi 2004). This phenomenon has affected the whole region and is particularly visible in the areas surrounding SS20 and SS28, such as Mt. Pozzo and the area between Chiusavecchia and Cesio. The third issue derives from the lack of safeguards around rural areas, which has resulted in forest fires. The 2009 annual report for the Liguria region highlighted forest fires as one of the major threats to the territory. Indeed, there were 291 forest fires in 2008, which damaged 892 hectares. Interestingly, 68.4% of these fires were intentional arson (Regione Liguria 2009). Moreover, forest fires have frequently reoccurred in the same area, which has prevented the forest from recovering from the damages (Vazquez and Moreno 2001). Forest fires occur over a wide area, especially in the inland areas, which consequently affects the visible landscape from the

![Figure 6. Roads with relevant typical cultivation in Western Liguria.](image)
studied roads. For example, a recent devastating forest fire
in 2003 destroyed the forest and terraces of Monte Pozzo
and consequently damaged the landscape visible from
SS20.

The regional council started programs in the last two
decades to rehabilitate and preserve the landscape, which
emphasized the previously discussed landscape problems
(Bonini 1993). Region-wide plans for coastal and
inland rehabilitation were proposed after the European
Landscape Convention (Kipar 2002). Focused local
planning was also promoted to emphasize the necessity
of collaboration with local communities to accomplish
long-term rehabilitation and preservation programs
(Regione Liguria 2008). The efforts of the regional council
produced some positive results in enlarging the protected
areas of the region to 6,859 hectares, which comprises
7.8% of the whole region (Regione Liguria 2009).

Despite the projects planned during those years, there
were no concrete improvements in land abandonment,
forest fires, or coastal infrastructure construction. An
efficient landscape management program should invest
in preserving the landscape, protecting the natural
and historical environment, and rehabilitating the
areas damaged by forest fires or degraded after being
abandoned. Unfortunately, tourism is still declining,
and the landscape associated with roads has also been
affected, which demonstrates weaknesses in the execution
of the current planning in the territory. Part of the reason
for the failure of the rehabilitation process can likely be
attributed to the lack of collaboration between regional
and local governments. Another cause may be conflicts
between public and private interests. The private sector
often focuses solely on how to maximize profits without
considering the environmental impact. Furthermore,
unsuccessful economic strategies, which have invested
in new infrastructures rather than refurbishing existing
ones, and a lack of focused projects with prefixed terms
and specific rules are likely responsible for long delays
and slow advancement in the rehabilitation projects.

Concluding Remarks

This study used visibility analysis to visualize the
landscape from the main tourist roads and investigate
the cultural and natural attractiveness of the visible
areas. This method used three types of data (land use
cover, DEM, and four roads with tourism relevance)
to produce visibility index outputs and investigate the
land use types that existed within the visible areas. The
results demonstrated different types of landscapes for the
roads depending on the type of economic activity of the
area. Roads SS20 and SS28 represented all aspects of the
region and can be considered a better representation of
the regional identity. Typical agricultural produce, such as
olives and grapes, the richness of historical villages, and
the variety of coastal services enrich the landscape with
characteristics of the region. In contrast, SS29 and A6
are located in more commercial areas with more limited
agricultural activity and a larger proportion of natural
forests. Nevertheless, issues in the actual landscape were
still observed. Abandonment of rural areas, especially
agricultural activities on terraces, and the occurrence
of forest fires best explain the landscape degradation
occurring throughout the region. Furthermore, the
uncontrollable construction of infrastructures on coastal
areas has also damaged the natural environment and
affected the visibility. Therefore, previous plans have only
minimally fulfilled the landscape rehabilitation required
to preserve the local identity of historical and tourist
locations. Breton et al. (2000) suggested that achieving
a balance between coastal landscape preservation and
social/economic development is essential to preserve
the natural environment and reinforce landscape
rehabilitation. Liguria, however, still lacks this balance,
and more severe regional laws should be instated to
protect the coastal zone from new infrastructures. In
addition, more effective landscape management should
be employed to preserve the natural environment, such as
natural forest rehabilitation and protection, preservation
of historical sites, and safeguards against forest fires.
Successfully achieving these objectives would eventually
increase the attractiveness of the landscape highlighted in
this study (i.e., visible areas from the roads) and positively
impact the tourism economy.

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