Cycling Mobility for a Green Micro-Economic Development of the Apennines Inlands

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Abstract. This paper refers to a research project on the cycling mobility micro-economic effects in the highland of Navelli located in the Apennines Inland of Abruzzo (Italy), one of the greenest Region in Europe (30% of its territory consists of parks and protected areas). The study proposes a green economic development model based on cycling tourism, territorial/architecture enhancement, built heritage recovery and micro entrepreneurial activities in the receptive field. To this purpose, a main cycling path is mostly realized through an ancient sheep track and associated with complementary cycle trail is designed. The study results are illustrated and discussed in terms of economic (costs, revenues income) social and environmental benefits.

1. Introduction

The 1987 Brundtland Report, drafted by the World Commission for Environment and Development, stated: “Sustainable development is development that meets the needs of the present without compromising the ability of future generations to satisfy their own” [1].

Several authors studied cycling mobility effects in particular on the urban context [2] [3] [4] [5] [6]. In the current paper, we approaches the cycling theme in rural and inland context from touristic development point of view. Therefore, the cycling tourism represents a mode of sustainable tourism. It is a form of active and highly engaging tourism, not only from the physical but also emotional point of view.

The effects that cycling activities generate on the territory regard the following benefits [7]:
- Economic: the European Cyclists Federation (ECF) carried out a report that illustrates how cycling as a mode of transport is a factor of economic growth and provides social benefits [8] [9].
- Environmental: cycling generates a green economy and creates an induced through the cultural, landscape and environmental heritage. The bike is an eco-sustainable mean of transport [10].
- Social: cycling tourism increases bike use, as to transfer its values even in everyday life [8] [9].

There are many European countries that in recent years have focused on cycling tourism for an economic development, promoting the construction of bicycle lanes and services dedicated to them. Cycling tourism, however, is not widespread in a homogeneous way; the northern countries have developed a network of bicycle lanes not only used by tourists but also by the residents themselves. We cite some...
main examples: i) research and studies carried out in Germany indicate that among the population, the use of bicycles is not just a way to enjoy a slow holiday, but it is also a widespread mean of transport [11]; ii) in the theme of cycle tourism, Austria is characterized by being one of the largest organized countries and it is therefore an interesting case (https://www.danube-cycle-path.com/); iii) the VENTO cycling path is under construction in the North of Italy [12] (http://www.project.vento.polimi.it/).

This article illustrates a research study, elaborated by the University of L’Aquila, and concerns the design of a cycling framework (lanes and services) necessary to promote tourism and micro-economic development in one of the inland areas of Abruzzo Region (Italy).

2. Context and territorial analyses

The analysed territorial context is located in Abruzzo, a region of central Italy, exactly in the province of L’Aquila (Figure 1 left). Abruzzo is the greenest region in Europe – 30% of its territory consists of parks and protected areas – in which over 30 naturalistic reserves, rare animal and species plant are protected.

This area concides with the highland of Navelli (800 m a.s.l.) that is internationally known for the highest quality of the saffron production. The landscape is surrounded by two natural reserves: the “Gran Sasso and Monti della Laga National Park” at North and the “Sirente-Velino Regional Nature Park” at South.

In this context there is a varied landscape (Figure 1 central) which includes mountain areas, hills and coastal areas. This territorial system has constituted natural barriers that are difficult to overcome and influenced the development of the territory.

The area includes seven small historical centres [13]: Barisciano, Caporciano, Collepietro, Navelli, Prata d’Ansidonia, San Benedetto in Perillis, S. Pio delle Camere - (Figure 1 right), which are all independents from an administrative point of view, and meaningful religious-architectural, landscape heritage and archaeological sites.

![Figure 1. From left to right: Abruzzo region in Italian context; the landscapes of the Abruzzo region [14]; the seven municipalities of the study area.](image)

It is an area rich in architectural, historical and religious elements (Table 1), but despite of the potentiality of the territory, there is no a development asset and an adequate tourism development. The considered area has a large number of mountainous historical centres, scarcely occupied, in the process of abandonment, despite of the good possibilities for development, especially in terms of tourism.

The area was hit by the earthquake (April 2009) that mostly destroyed architectural, historical and monumental heritage. This study considers the post-earthquake reconstruction [15] as an opportunity for starting a “green” and economic development model based on:
i. Cycling tourism;
ii. Local development;
iii. Recovery and use of heritage buildings;
iv. Micro business activities in the tourism field.

Table 1. Historical heritage

| Municipalities          | Churches | Castles | Archaeological Areas |
|------------------------|----------|---------|---------------------|
| Barisciano             | 2        | 1       | -                   |
| Caporciano             | 7        | 2       | 2                   |
| Collepietro            | 2        | -       | -                   |
| Navelli                | 9        | 1       | -                   |
| Prata d’ Ansidonia     | 3        | 1       | 1                   |
| S. Benedetto in Perillis | 2     | -       | -                   |
| S. Pio delle Camere    | 3        | 1       | -                   |
| **Total**              | **28**   | **6**   | **3**               |

The study has been elaborated starting from the territorial, socio-economic analysis and from the territorial cognitive framework of the planning. This framework includes a series of territorial analysis necessary to assess the resources of the territory, the legal constraints and the elements of possible conflict for the design.

2.1. Historical Framework

The Navelli highland is crossed by an historical sheep track – the ancient routes of transhumance of sheeps, that is a wide grassy path, stony or clay, which has naturally been created from the passage of sheeps and shepherds. This sheep track is called “King’s sheep track”, because it is the most important and the most extensive of the ancient five sheep tracks (244 km length) in Italy (Figure 2) [13] [16] [17] [18]. The part of the sheep track that crosses the study area is highlighted in yellow (Figure 2).

It connected the mountain of Gran Sasso in Abruzzo with the lowlands of the Region of Puglia since the Roman Age. The “King’s sheep track” was a pole of attraction for the settlements and a means of communication between men; a path through which transmit the principles of human cohesion, ideas, knowledge and models, but also allows war attacks, destruction and submission of people.

![Figure 2. Map of the ancient sheep tracks (the “King’s sheep track” is in red)](image_url)
In the past, these paths were used by shepherds to carry out the transhumance, or to transfer seasonal flocks from one pasture to another one. Transhumant pastoral civilization and agricultural sedentary civilization intersected each other and left their testimony in a long drift of artefacts, stories, villages, migrations and abandonments, characters and architectures.

This highland is rich in historical heritage from pre-italic to renaissance ages passing through the roman and medieval ages [13] [17] [18].

Currently, the “King’s sheep track” is fragmented, and in some parts it is not possible to follow the ancient path, so it was made a reconstruction by the analysed maps.

2.2. Territorial Analysis
The territorial analysis was carried out by performing several thematic maps that represent the basis for the construction of the cognitive framework landscape; these maps classify the soils constituting the natural and settlement systems and recognize, as follows:
- Risk areas, parts of territory characterized by the presence of instability factors, fragility and loss of recognized qualities, which compromise one or more constitutive features;
- Constraint areas, parts of the territory for which protection actions are already in force deriving from the application of laws;
- Degradation and abandonment areas, parts of territory characterized by a phenomenon abandonment (of anthropic uses) and the consequent degradation of the constitutive factors;
- Value areas, parts of the territory characterized by details and specifications naturalistic-environmental, landscape, historical-artistic, archaeological and naturalistic qualities agronomists that individually or together contribute to the definition regional identities;
- Conflict areas, parts of territory characterized by situations of conflict between recognized qualities and risk factors and/or Degradation and Abandonment, including transformation processes (in progress or completed) not compatible.

These maps highlight the presence of a landscape constraint on the “King’s sheep track” and of the archaeological areas of Peluinium and Cinturelli (Figure 3) and that will be used for compatibility assessment in a context of high landscape, environmental and historical value.

![Figure 3. Map of landscape values](image-url)
2.3. Socio-Economic Analyses

The Navelli highland is classified as an inland area. Currently, the total population of the municipalities of this highland is estimated in 4,132 inhabitants. This highland had a significant decrease of the population (65.6%) over the years (data of the National Institute of Statistics – ISTAT, 2011). Figure 4 illustrates the demographic trend between the years 1861-2011. The phenomenon of emigration with the departure of young people has led to the impoverishment of the area in terms of services, abandonment of the primary activities. The demographic loss also involved a process of weakening personal services. However, these territories are also the site of a large unused territorial, natural and human capital, considered strategic for the country's growth.

![Figure 4. Population trend between 1861-2011](image)

The area is characterized by an intense depopulation phenomenon and by a high presence of the elderly population (32.5%).

The analysis results show that this highland is affected by the main following socio-economic issues: i) negative demographic trends and lack of development which also depend on the insufficient supply of basic services / goods (school, health and mobility); ii) the degeneration of natural and cultural capital, the alteration of the eco-systemic balances and the instability of soils in these areas put risk on the citizens' security and generate hardly reversible changes; iii) the unused territorial capital is huge. In the analysis of the socio-economic framework data social aspects, the trend of the population of the district, the economic-tourism data, and the agricultural activities were collected.

In order to promote the inland areas development, the “National Strategy” [19] considers three interconnected general objectives:

- protect the territory and the safety of the inhabitants by entrusting their care;
- promote natural, cultural, landscape diversity and polycentrism by opening up to the outside;
- re-launch development and work through the use of potential resources badly used.

For each municipality of the selected highland, Figure 5 illustrates the per capita income referred to ones of Abruzzo region and Trentino region (data from the Italian Ministry for Economy and Finance, 2015). This is the Italian region that has a mountain tourism networks well developed.

The Navelli highland average per capita income (14,290 €/person/year) is lower of 14.7% and 31.8% than the Abruzzo and Trentino regional ones, respectively.
Figure 5. Per capita income of each centre of the area

For each municipality, Figure 6 shows the Touristic index defined as the ratio between the total presence of tourists with the population. The municipalities taken into consideration by this study have an index ranging from 4.4 for Barisciano to 14.1 for Prata D'Ansidonia, very low values compared to L'Aquila, with 45.2, or Roccaraso (a mountain place with ski facilities), with 70.2 [20].

Figure 6. Map of the Touristic index of the area

3. Cycle Lane Plan
The research proposed the design of cycling network consisting of a main cycling path (25.1 km) crossing the ancient sheep track, associated to a series of complementary routs (in promiscuous traffic), in order to reach all the residential centres and the religious and architectural values of the highland (Figure 7).

In this context the green cycle paths unfolds, with the aim to retrace as much as possible the historical path of the “King’s sheep track”, enhancing it and helping to discover the great heritage of the highland of Navelli.

According to the existing landscape and the archaeological constraints illustrated in section 2.2, and for an environmental sustainable policy, mostly (85%) of the cycle path crossing the sheep track is realized by tamped earth, while the remaining part is made in ecological asphalt. The considered elements for the project are different: the location, the intersection, the comfortable road paving, the signage, length and slope. The main cycle path has a maximum incline of 8%, according to the limit imposed by the legislation (Italian Legislative Decree n. 42/04) has an equal difference of 203 metres. Along the 25.1 km of the cycle path, there are three typological sections [21]:

A. Bike path on King’s sheep track (a dirt road) and on protected areas, realized with stabilized earth flooring.
B. Bike path on dirt road, realized with stabilized earth flooring with a special signage.
C. Bike path on asphalt road, realized with ecological asphalt with a special signage.

The Figure 7 shows the cycle path. The path typological sections are differentiated with the colours (outlined scheme on the left in the Figure 7). For 45% the cycle path passes through the “King’s sheep track”, and through the archaeological areas of Peltinium and Cinturelli, which constitute two important points for the definition of the project (type A). For 40% the cycle path passes on the route of existing country roads (type B). For 15% the project involves the construction of the cycle path on the adjacent strip of the existing asphalted road (type C). It is expected the installation of vertical signs and the painting for signage horizontal (stripes, writings, symbols).

![Figure 7](image)

Figure 7. Map of the cycle path and complementary routes in promiscuous path

The adopted design solution meets the durability, structural stability, water flow permeability requirements, and context integration. Technical solutions respond to environmental sustainability and ecology requirements illustrated in section 2.2.

For each cycle typological sections, the table 2 shows the length, the percentage value, and the costs that have been evaluated by means of an estimative metric calculation.

| Typological Section | km  | %   | €/km | k€  |
|---------------------|-----|-----|------|-----|
| A                   | 11.40 | 45  | 96.62 | 1.101 |
| B                   | 9.90  | 40  | 99.12 | 981  |
| C                   | 3.80  | 15  | 200.90 | 963  |
| **Total**           | **25.1** | **100** | **200.90** | **2.846** |

The results of analysis shows that the cycle path construction cost is estimated in about 2.85 M€.
4. Economic analyses and discussions

The economic analysis was oriented to sizing and to compute the potential economic revenues of the proposed cycling infrastructure.

Italian experiences made were taken into account as reference: in particular, the data concerning the VENTO cycle [12] were taken in consideration due to its similar conditions as the territory is littered with cultural heritage, artefacts of historical, artistic and cultural values.

Direct investigation on Navelli highland site had allowed to estimate the daily average expenditure in 64€/day of which 30% for food, 40% accommodation and 30% services.

The Figure 8 illustrates the main assumptions adopted in order to estimate the amount of cycling tourist per year and economic revenues related to the use of the proposed cycle network. Due to the environmental/weather conditions of the highland a yearly cycling touristic summer season of 90 days has been taken into consideration.

![Figure 8. Calculation assumptions and flow chart](image)

The results show that the proposed green cycle network could potentially generate a number of users/tourists equal to 14,000 per year with an induced revenues of about 842,400 € per year.

Concerning to the services, a sleeping accommodation increase of 156 beds/day has been evaluated.

Figure 9 illustrates the cumulative yearly revenues related to the cycling touristic induced compared to the cycling infrastructure costs in correspondence of an estimated demand curve. It can be noted that the investment back time is evaluated in 5.5 years.

The cycling touristic green path generates an annual income of about 203.9 €/inhabitant/year with an increasing of 1.4% of the per capita income.

The construction cost of the cycle path could be covered by public funding for post-earthquake recovery of the damaged heritage, that is some previously initiated. Private contribution is required to develop and handle the accommodation activities.

In addition to the health, social, sportive, ecological benefits related to the proposed green development model, the results of the analysis highlighted that the proposed cycling network could potentially generate benefits that spread to the surrounding area: both economic and landscape. It is also
able to generate a green economy, which is the engine of development for many locations, and new jobs in the area of tourist services (hotels, restaurants, assistance, etc.).

![Figure 9. Demand curve and cumulative revenues](image)

5. Conclusions
A research study on a micro-economic development of the Apennines inlands (Navelli highland with 7 municipalities, about 4.100 inhabitants and rich in architectural, historical and religious elements) based on cyclist tourism was illustrated in this paper.

A design and construction of cycling network consisting of a main cycling path (25.1 km) crossing the ancient sheep track, associated to a series of complementary routs (in promiscuous traffic) was proposed.

Territorial and socio-economic analyses were carried out in order to carried out the cognitive framework landscape.

The results show that the proposed green cycling infrastructure (2.8 M€ of costs) is potentially able to generate:

- A number of users/tourists equal to 14,000 per year;
- A revenues of about 842,400 €/year;
- An investment payback time of about 5.2 years;
- An increasing of 1.4% of the per capita income.

This study demonstrates that in the inland areas that present greater processes of abandonment and economic regression it is possible to introduce development projects able to use many resources effectively.

The proposed green cycle development model is able to bring different benefits as follows:

i. Directly monetizable benefits generated by cycling activities and related services;
ii. Non-monetizable benefits generated by improved health and social aspects;

A part of the research of the University of L’Aquila is oriented precisely towards objectives that is to the recovery of the production capacity of the inland areas and their connection with the European and
World context. The resources for tourism certainly represent, in specific cases such as the one described in this article, fundamental and unfortunately unused elements for a real socio-economic impact.

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