

Periurban Hiking Trails Evaluation as Part of the Sustainable Tourism Infrastructure in Nemi (Italy)

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Hiking trails are one of the most important amenities that attract visitors into any area which has natural potential for tourism development. This paper assesses two periurban hiking trails in the town of Nemi, 30 km south of Rome in Italy. There are two popular hiking trails; Trail A loops around Nemi and Trail B leads from Nemi to Genzano. Herein we evaluated the trails' attractiveness in detail. This commenced with monitoring the surface conditions and their degree of destruction, followed by the identification of risks (e.g. falling rocks, erosion) and scope of available amenities. The major 60.7% of Trail A is covered by stone pavement and this leads through a further 57.4% of steep slopes above 25°. Thus, although the trail is more vulnerable to water erosion, the vegetation growing on adjacent slopes greatly reduces the erosion. Trail B runs along the contour line and the major issue we faced here was the width of the trail. The width is less than 30 cm on 22.4 % of the trail and this presents safety problems from both surface stability and the threat of falling rocks. The Decision Checklist for trail assessment and subsequent proposal of measures was then applied. This method provides information and help for land managers, agencies, protected area administration and also private individuals. The method can also be applied to acquire detailed information on the condition of trails used for leisure activities and for proposal of further measures necessary to increase the tourism potential of subject areas.

Key words: hiking trails, decision checklist for trail assessment, sustainable tourism, Nemi

Tourism over past decades has become one of the fastest-growing industries in the world and it is closely linked to the development of new destinations. According to the ranking of the world's top international tourism destinations (while considering both international tourist arrivals and international tourism receipts), Italy is ranked No. 5 for international tourists' arrivals (58.3 million visitors per year) and No. 6 as for international tourism receipts (44.2 US\$ billion). Italy and Spain reported an increase of six million arrivals each in 2017, compared to 2016. It is also worth mentioning that 4 out of 5 tourists travel within their region (UNWTO Tourism Highlights, 2018).

We are presenting results of our field survey which was carried out in Nemi municipality as a deliverable report for the project titled "Characterisation of a green microenvironment and to study its impact upon health and well-being in the elderly as a way forward for health tourism". Technical University in Zvolen is a member of the consortium responsible for the characterization of Nemi's ecosystem and in particular, its infrastructure with special regards to community health issues, air and water quality, and land-use. Nemi can be considered as a less-known tourist destination from the knowledge of international tourists' point of view, although the area is rich in history and has the potential to attract visitors.

State of the art

Nemi vicinity offers a natural area with a good network of walking trails as well as benefits of views. Besides, the whole cadastre of the town lies with the Parco

Regionale Castelli dei Romani region. The significance of natural areas vicinity to towns or large urban centres is well described by several authors, especially its benefits upon well-being and health (Jiricka-Pürerer et al., 2017; Hartig et al., 2014). Hansmann et al. (2007) or Maas et al. (2009). They investigated whether the presence of green space (1 and 3 km radius around the resident's address postal code) can attenuate negative health impacts of stressful life events and also how it influences social contacts. Results show that less green in people's living environment coincided with a feeling of loneliness and with a perceived shortage of social contacts. A similar study was carried out by Kardan et al. (2015) in Toronto, Canada where people who live in neighborhoods with a higher density of trees on their streets report significantly higher health perception.

Work by Kulczyk et al. (2018) on the integrated model of recreational ecosystem services – based on landscape, amenities (facilities), and visitors – suggests that it is not landscape potential, but recreational facilities that correlates with recreational use and that the responsible management of an area can significantly influence its recreational use. Reynolds et al. (2007) suggest that trails designed with the issues of visibility and safety in mind and with trailside services and amenities will be used more heavily. Positive associations with trail use should be encouraged, such as views, good trail conditions, presence of amenities and negative associations should be minimized (e.g. litter, noise, higher vegetation density).

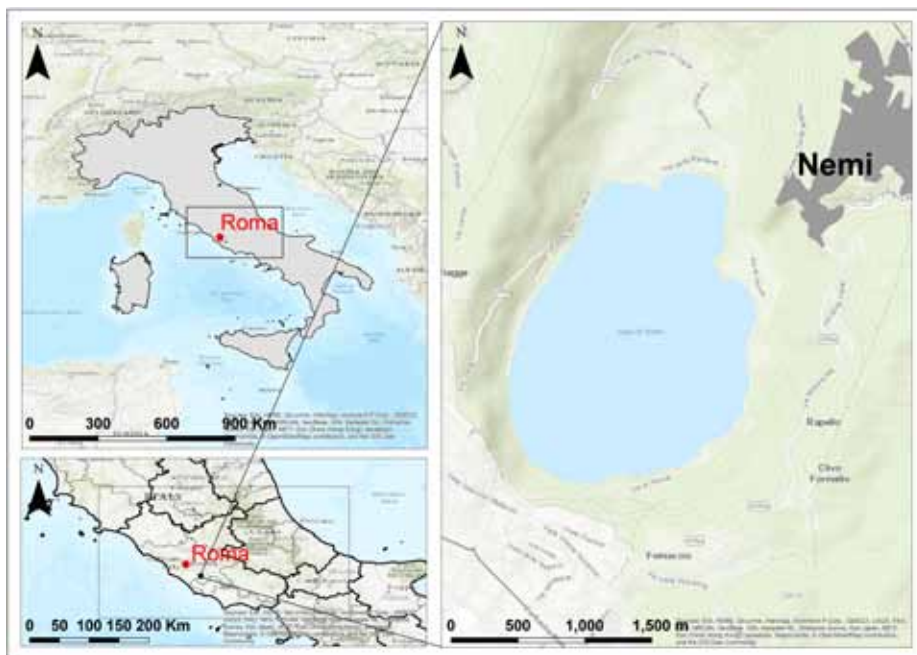


Fig. 1. Location of Nemi (source: World Topographic Map – the Map service by ESRI)

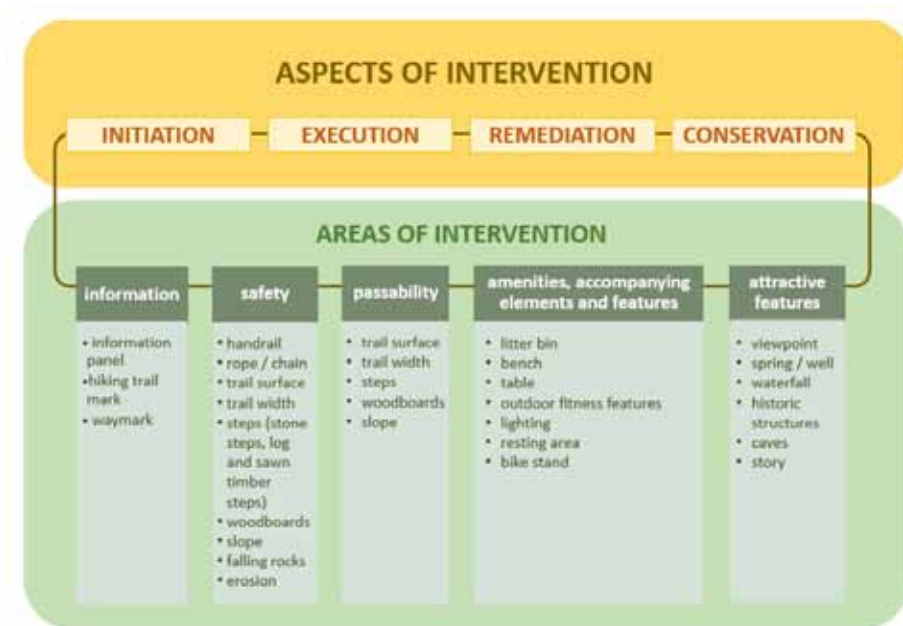


Fig. 2. Decision Checklist for trail assessment and proposal of measures (Vavrinová, 2020)

Li et al. (2005) examined hiking trails and tourism activities' impact in the protected area in Jiuzhaigou Biosphere Reserve in China. They identified trampling to be the main problem on the trails (especially trails widening, multiple trails creation, and root exposure). Similar research was carried out by Svajda et al. (2016) regarding the impact of an increased number of visitors leading to human trampling of vegetation and soil along hiking trails in Rocky Mountains National Park, USA. The research

found out that trail widening and soil loss are the most visible effects of trail degradation.

Once having natural conditions allowing the existence of infrastructure development for tourism activities it is important to remember the minimal impact upon nature. To meet the expectations of visitors to the best and at the same time preserve the natural environment it is inevitable to have a good knowledge of the area. To balance those two requirements good planning is important. Then, depending on healthy nature potential, new services can be introduced to visitors (e.g. guided tours, mindfulness techniques presentations, yoga classes, hiking with viewpoints). A good field survey can further help to eliminate any potential threats (e.g. trail destruction by erosion) and increase safety (knowledge of trail features, surface, width, slope, etc.).

Study area

Nemi commune is located 30 km southeast of Rome (Fig. 1). Nemi is a small town with an area of 7.36 km², altitude of 521 m a.s.l. (above sea level) and population of 1930 inhabitants (ISTAT, 2020). It belongs to the Parco Regionale Castelli dei Romani region established in 1984 and covering a total area of approx. 120 km² within the territories of 16 communes of the province of Rome. The area with

its crater lake of the same name (Lago di Nemi, Nemi lake) belongs to the Colli Albani volcanic complex with its highest peak Monte Cavo (949 m a.s.l.). Nemi lake level lies at 319 m a.s.l. with an area of 1.72 km² and a circuit length of 5.4 km. Nemi crater rim ranges from 426 m a.s.l. at southwest to 650 m a.s.l. at east where it reaches the slope of 83° near the Nemi village (Riguzzi et al., 2008; Margaritora et al., 2003). Main soils are derived from volcanic materials – Cambisols, Andosols; soils with clay and iron oxides

accumulation – Luvisols; alluvial soils – Fluvisols; soils of anthropic terraces – Anthropogenic Regosols. Climate is Mediterranean oceanic to suboceanic, mean annual air temperature is 13 – 17°C, and mean annual precipitation is 750 – 1,000 mm (Costantini et al., 2013). Vegetation cover depends mainly on soil thickness, exposure, and water availability, the main vegetation type in the area is mixed mesophilous forest (Abbate et al., 2009). Based on our preliminary investigations of the Nemi lake caldera the mixed forest stands are formed mainly by broad-leaved trees such as oaks, hornbeam, chestnut, common hazel, and maples.

Methods used

Looking at the trails network in surrounding Nemi we found that all trails are relatively interconnected providing great opportunities for walks, runs, and cycling. Considering the intensity of use based on the STRAVA Global Heatmap (2019) and after the field examination in summer 2019, we focused our attention on two trails, that were assessed with measures proposed to improve their usability and safety. Each segment of the trail was measured using GPS GeoExplorer 600 (Trimble) and data were processed using ArcView 10.0.

The assessment of trails was carried out according to the following categories:

- (a) the type of trail surface;
- (b) the trail surface condition;
- (c) trail amenities and accompanying elements;
- (d) attractive features;
- (e) negative phenomena/trail sections under threat.

Maps were produced using the satellite images purchased from the GISAT company working in the field of Earth remote sensing. All input data for slope and profile calculations were first modified to a uniform format, with a raster of a single cell size of 25 m. The slope layer was modeled in ArcGIS 10 (ESRI) from Digital Elevation

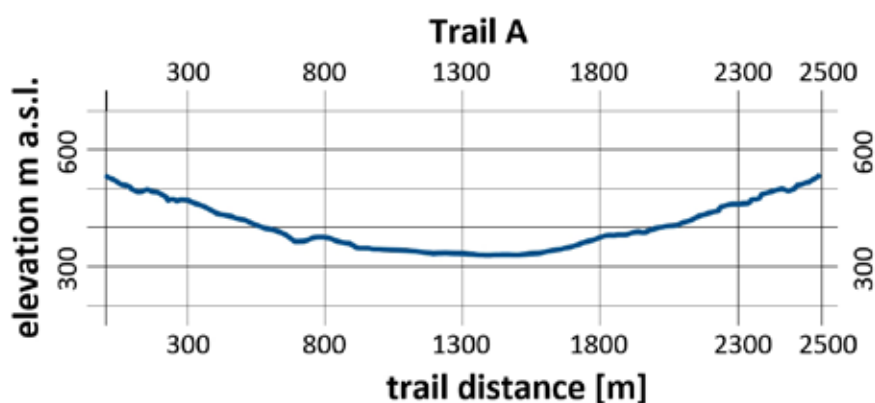


Fig. 3. Elevation profile of the Trail A (Source: EU-DEM v1.1, edited by authors)

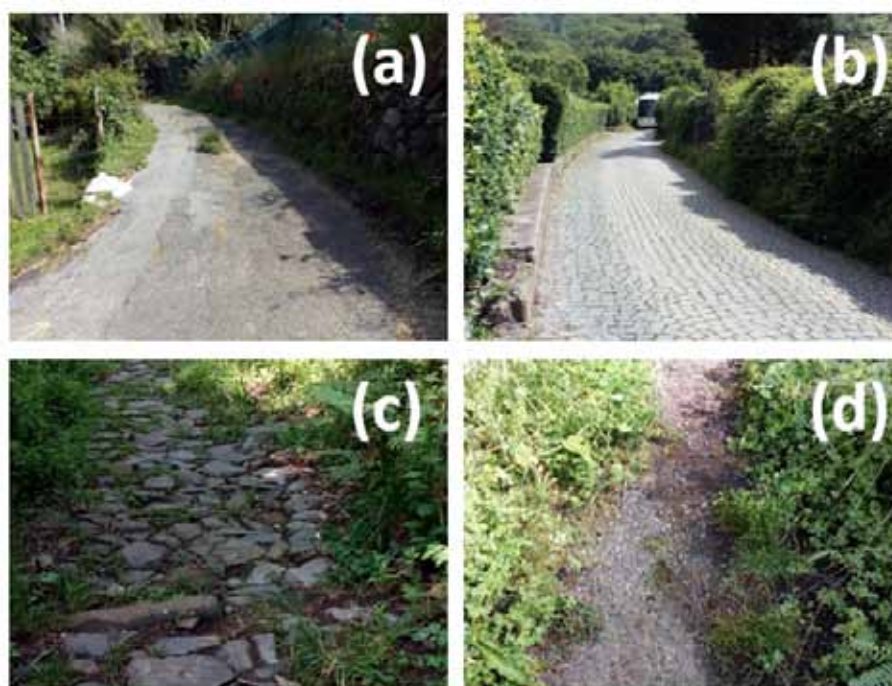


Fig. 4. Surface types of the Trail A: (a) asphalt, (b) stone cubes, (c) stone pavement, (d) gravel (June 2019). Photo: Zuzana Gallayová

Model over Europe (EU-DEM v1.1) in a cell size of 25 m.

Further, the *Decision Checklist for trail assessment* (Vavrinová et al., in press) was applied with the proposal of measures to secure the safety of trails and increase their attractiveness. This checklist suggests four main aspects of the intervention (Initiation, Execution, Remediation, and Conservation) with five main areas regarding (a) Information, (b) Safety, (c) Passability, (d) Amenities, and (e) Attractive features of the trail. Subsequently, measures are proposed (Fig. 2) to increase safety and passability of trails, to highlight any attractive features, to offer information to trail users (about the trail itself or the surrounding landscape as the educative and interpretative component

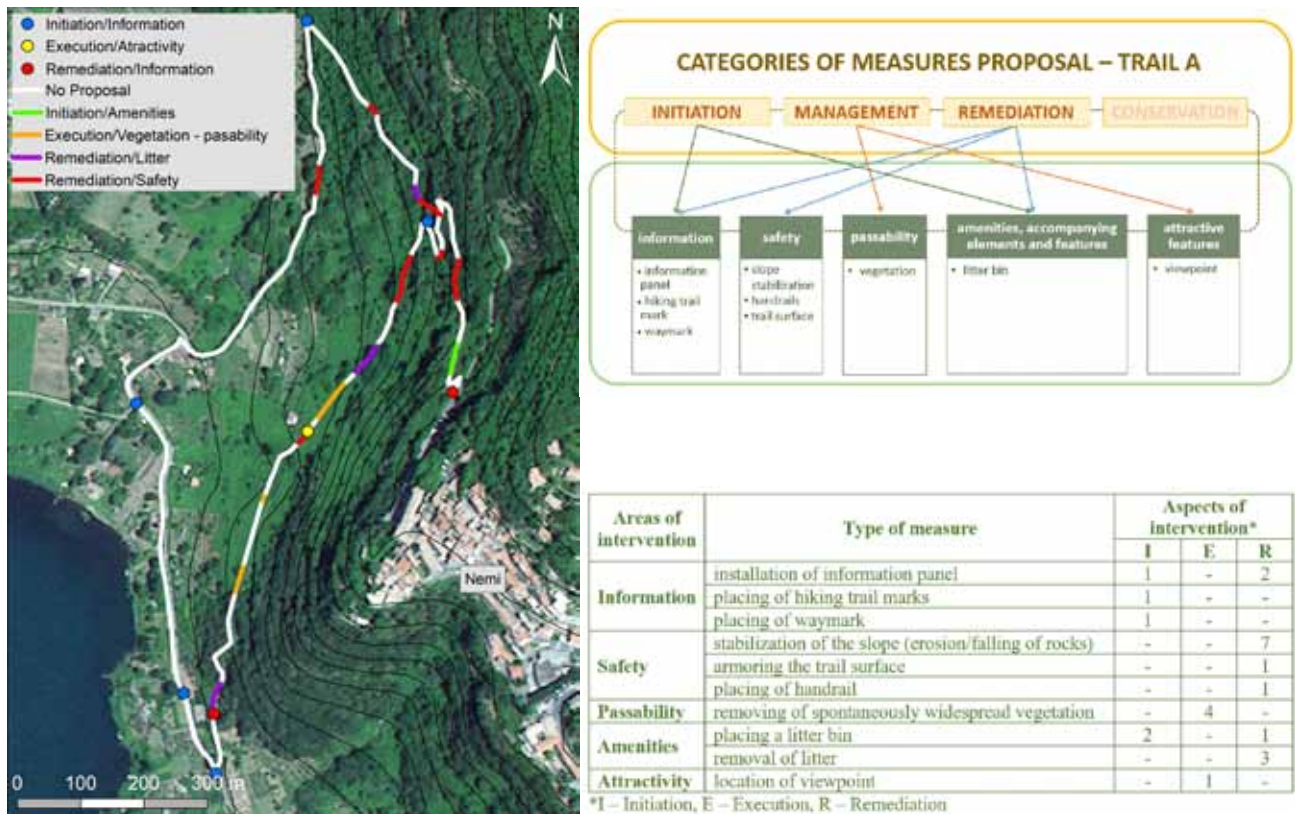


Fig. 5. Proposed measures for the Trail A – loop trail (Source: GISAT 2018, edited by authors)

represents a significant added value to visitors), to be aware of any positive or negative features and to identify the placement of necessary amenities.

Report results

The network of trails that is appropriately constructed and maintained represents an important component of sustainable tourism development in any area. Properly secured infrastructure can encourage the arrival of tourists to any region resulting also in the increase of the local economy, respecting the ecological and social sustainability of the area.

Our assessed trails, as for the natural conditions and history, have the same background. However, they differ in some features, e.g. the Trail A leads from the rim of the crater to its bottom (grade is 201 m), crossing steep slopes and the majority of its surface is paved, whereas the Trail B follows mostly the contour line (grade is 83 m) and its surface is covered mostly by natural dirt.

Trail A – loop trail

The starting and the ending point of this loop trail is in Nemi. The length is 2.5 km, the elevation ranges from 328 m a.s.l. to 529 m a.s.l. and it is used both by hikers and cyclists (Fig. 3).

This loop trail is suitable mainly for short-term visitors to Nemi. The assessed area is located within the satellite crater of a volcano. As most of the trail is paved, the trail surface vulnerability to water erosion (linear or planar) or landslides is minimal. Although, these processes can endanger the trail surface, especially at places with adjacent slopes that are very steep (upper parts of the crater with slopes often over 40°). It is also necessary to be aware of the falling rocks or collapsing of rock walls, especially at the top of the crater, where the rocky surface often emerges to the surface.

The trail leads through the dissected area. More than half of it runs through parts with an inclination over 25° (57.4 %). Only 20 % of the trail leads through a territory with an inclination of adjacent slopes between 5 and 10°.

The surface of the Trail A (Fig. 4) is maintained. Almost its full length is reinforced by various materials. The most represented is stone pavement on the 60.7 % of the total trail length, followed by asphalt (27.9 %), stone cubes (10.3 %), stone steps (0.9 %) and gravel (0.2 %).

After assessing the surface condition of the trail, we found that almost half of the trail surface was without any signs of damage (48.4 %), partially damaged was 23.3 %, and damaged 28.3 %. The trail with no sign of damage passed mainly through slope ranging from 5 to 15° (52.9 % of its total length). Partially damaged (73.4 %) and damaged (80 %) trail surface of the trail was leading through

slopes above 25°, however, these slopes are stabilized by forest. Nevertheless, in case of a heavy rainfall even here the soil and the skeleton can be washed to the trail.

Proposal of measures for Trail A – loop trail

Based on the field survey and assessment results, certain measures are proposed according to the *Decision Checklist for trail assessment* (Fig. 5):

In the *Initiation* aspect of the intervention, measures proposed are connected with *Information* and *Amenities*: information panels absence, both in Italian and English, was recognized; present information panels are damaged, destroyed with unreadable letters; natural construction material is recommended to be used (wood, stone); other language mutations (depending on the country of origin of visitors to Nemi) can be available at the web site of Nemi commune and linked via QR codes.

Information panels do not just provide information on the visited area but have educational or interpretative significance. Looping of the trail, its reasonable length, low difficulty level, and passing through various environments (forests, open areas, views, proximity to the lake, the presence of farms, etc.) opens the potential to explore nature directly outdoors. It can be made even more attractive for young generations by letting them use the mobile technology outdoors (e.g. Pl@ntNet, application for the identification of plants or GPS for Geocaching).

Installation of a new information panel is recommended by the spring with basic information on the water quality, the importance of water, water cycle, and its protection. For the easier orientation of visitors, it is necessary to restore the hiking trails signs and add waymarks.

As for the *Remediation* intervention aspect, most suggestions concern the *Safety*:

- in several parts of the trail there are fallen rocks (danger and risk to users, both tourists and cyclists) and in some parts, the soil is flooded on the trail; the stabilization of the slope in these indicated parts is suggested;
- almost a quarter of the trail (23.3 %) is protected by handrails, mostly wooden (85 %), which of 55.2 % is damaged and 24.3 % partly damaged and part of the handrail accompanying the trail does not need to be repaired or replaced as vegetation and trees already created a natural barrier;
- the passability of the trail in several sections is difficult due to succession vegetation, removal of such vegetation is suggested.

The attractiveness of the trail (e.g. viewpoints) can be

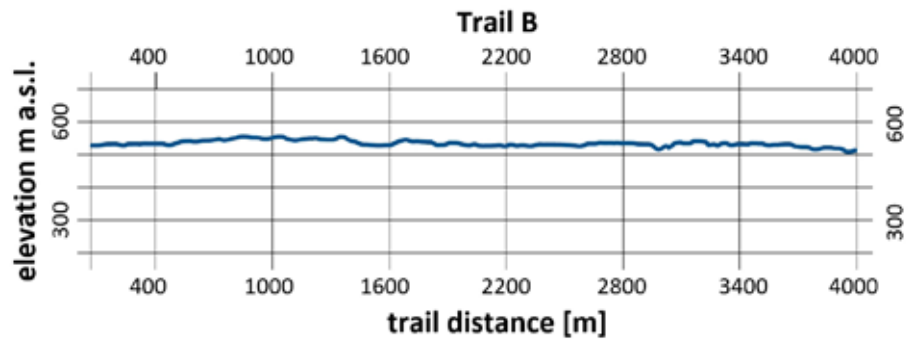


Fig. 6. Elevation profile of the Trail B (source: EU-DEM v1.1, edited by authors)

increased through the implementation of vegetation management, so the visitors' comfort and safety are secured.

In terms of *Amenities* litter bins and benches are well located. These contribute to the attractiveness of the trail as well as ensure its sustainable use. As for negative features, missing trail marks and waymarks in some parts of the trail were noted. Present fly tipping (mostly construction material and electronics) should be removed; bigger litter bins installation is not considered as a solution. From the prevention point of view, it is advised to cooperate with the local government.

Trail B – trail from Nemi to Genzano

The Trail B leads from Nemi to Genzano (Fig. 6), it is 4 km long, the elevation ranges from 481 m a.s.l. to 564 m a.s.l. and is used solely by hikers.

As for the Trail B, natural dirt surface prevails (90 %). Most of the trail leads through the head of terraces used for agriculture in the past. The trail mostly follows the contour line and it is used by hikers/walkers only as in several places the trail leads through rock tunnels that narrow down to ca 1 m in width in some places (might result in limited passability of this trail). The trail follows an old aqueduct path connecting Genzano and Nemi that was renewed in 2013 through a citizens' initiative "Via Verde dei Latini" (www.castelliromanigreentour.it). It is a parallel trail among other official trails – trails No. 511 and No. 512 connecting Nemi and Genzano at the top of the rim and trail No. 515 along Nemi lakeshore. As the trail follows the contour line and some of its parts lead through terraces, the surface is not endangered by soil erosion (linear or planar) and furrows or grooves are not developed. The majority of the trail (96 %) intersect slopes above 25° but surrounding slopes are stabilized by vegetation (forest).

The trail has sufficient width comfortable for hikers. Reduced passability was recorded on the 22.4 % of the total length of the trail (width only up to 30 cm). These parts are suggested to be stabilized for the higher safety of visitors. Parts of this trail under adjacent steep slope can be endangered by the deposition of eroded soil, by falling rocks, or by other slope processes. However, surrounding

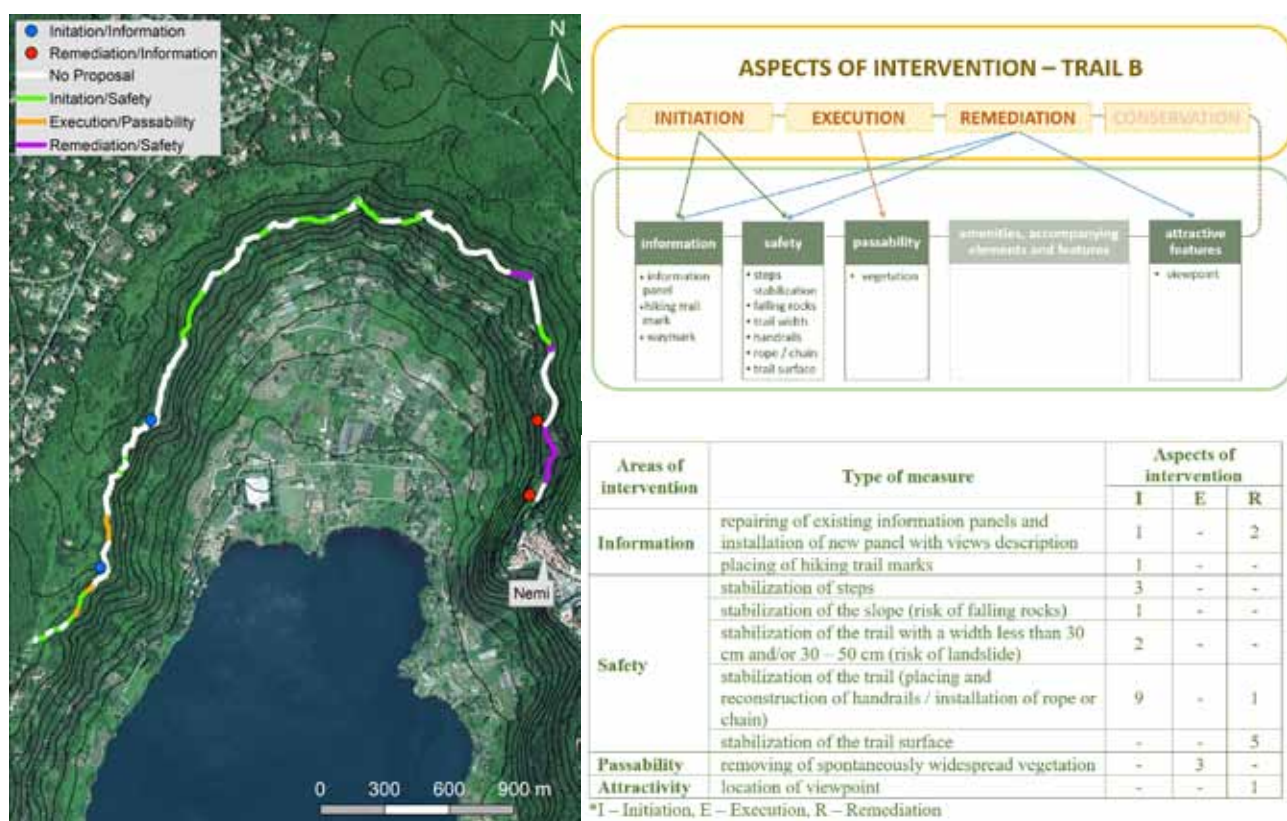


Fig. 7. Proposed measures for the Trail B from Nemi to Genzano (source: GISAT 2018, edited by authors)

slopes are well protected by vegetation. In overall, this trail can be considered more attractive thanks to the aqueduct, little waterfalls or number of natural rock tunnels that visitors have to pass.

Proposal of measures for Trail B – Nemi to Genzano

Based on the results of the field survey several measures are proposed (Fig. 7):

The *Initiation* aspect of intervention regarding *Safety* applies to the stabilization proposals and concerns 24 % (956.5 m) of the total trail length. Proposed measures are:

- stabilization of steps (currently cut into the soil surface); steps can help prevent erosion and at the same time aid hikers; wood logs or larger stones can help to stabilize these steps;
- stabilization of the trail with the width less than 30 cm as the priority measure, considering also parts of the trail with the width 30 - 50 cm; stabilization is necessary due to the risk of a landslide; at present, erosion traces are visible – this can result in rerouting the trail by tourists and acceleration of problems;
- handrails can be installed in places where the trail is narrow, serving as passage aid; in addition, chain or rope can help in sections where the narrow trail leads along rocks (here the trail surface stabilization is recommended to decrease the risk of accidents, e.g. slipping).

Along this trail, there is an attractive, almost 270° viewpoint. The *Information* area of intervention suggests the installation of a horizontal information panel and the trailhead sign with a photo and description of the visible landscape from the viewer’s point of view. Such panels provide essential information about the trail and help visitors with better orientation.

As for the *Remediation* aspect of intervention regarding *Safety* following measures are suggested:

- handrail repair in the total length of 76 m;
- trail surface stabilization as prevention from erosion, representing 251 m (6 %) of the total trail length.

As for the *Execution* aspect of intervention regarding *Passability*, it is necessary to clean the trail from spontaneously expanded vegetation in a total of 167.6 m of the trail length (4 %).

* * *

This report presents measures that can be applied to existing trails through the use of a *Decision Checklist for trail assessment* applied after field surveys. This checklist can be even helpful while designing new trails as it summarizes various aspects and areas of intervention resulting in measures proposal.

In our subject area, we evaluated two hiking trails (Trail A – loop trail from Nemi to lake Nemi and back and

Trail B connecting Nemi and Genzano). Attention was paid to increasing the security of visitors using both trails, also enhancing the educational and interpretive component of a given territory, and at the same time keeping in mind the protection of natural values.

Trails surface types and trails condition according to the degree of destruction were assessed. Necessary measures to ensure trails accessibility were proposed. Further, the attention was paid to the presence or absence of trails amenities (e.g. benches, litter bins, picnic spots), and trails attractiveness (e.g. views).

The trail A leads through a dissected area and more than half of it runs through parts with inclination over 25° (57.4 %, grade of the trail is 201 m). Here, the stone-paved surface prevails (60.7 % of its total length), whereas the Trail B leads mostly along the contour line (grade 83 m) with a dirt surface (90 %).

As for the Trail A, approximately half of the trail surface is preserved (48.3 %), damaged is 28.3 % and 23.3 % is partially damaged. Nearly a quarter of the sidewalk is secured by handrails (23.3 %). The Trail B was not assessed as for its surface damage as here the main problem identified was the safety (need for stabilization measures, concerning 24 % of the total trail length). In several places, this trail leads through attractive rock tunnels.

At present, it is important to think about minimizing any threats to the natural environment while using it for leisure activities. For the local population, the level of financial benefits from incoming visitors is significant. Thus, it is necessary to interconnect the sustainable development of the area, including tourism and its economic growth. Planning is essential to minimize any impact of human activities and to support the functioning of natural processes on one hand and use the landscape potential for the development of different forms of tourism on the other. The hiking trails net, supporting and contributing to the potential of tourism centers, should be designed and maintained in a sustainable way.

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References

- Abbate, G., Bonacquisti, S., Giovi, E., Iamónico, D., Iberite, M., Lorenzetti, R.: Contribution to the vascular flora of the Castelli Romani Regional Park (Rome, Central Italy) with recent observations and early herbarium surveys. *Webbia*, 2009, 64, 1, p. 47 – 74.
- Costantini, E.A.C., Barbetti, R., Fantappie, M., L'abate, G., Lorenzetti, R., Magini, S.: Pedodiversity. In Costantini, E.A.C., Dazzi, C. (eds.): *The Soils of Italy*, World Soils Book Series, 2013, p. 105 – 178.
- EU-DEM v1.1: Digital Elevation Model, 2019. (<https://land.copernicus.eu/imagery-in-situ/eu-dem/eu-dem-v1.1>)
- Hansmann, R., Hug, S. M., Seeland, K.: Restoration and Stress Relief through Physical Activities in Forests and Parks. *Urban Forestry & Urban Greening*, 2007, 6, 4, p. 213 – 225.
- Hartig, T., Mitchell, R., De Vries, S., Frumkin, H.: *Nature and Health*. Annual Review Public Health, 2014, 35, p. 207 – 28.
- ISTAT – Istituto Nazionale di Statistica: Demographic Balance for the year 2020, province: Roma, Nemi, 2020 (http://demo.istat.it/bilmen-s2020gen/index02_e.html)
- Jiricka-Pürrier, A., Tadini, V., Tucki, A., Salak, B., Senes, G.: Exploring the Well-Being Effect of Protected Areas – An Intercultural Comparison. Austrian Research and Training Centre for Forests, Natural Hazards and Landscape & Institute of Landscape Development, Recreation and Conservation Planning, University of Natural Resources and Life Sciences, Vienna (eds.): *Proceedings of the 3rd International Conference on Landscape and Human Health: Forests, Parks and Green Care*. Vienna: BFW, 2017, p. 66.
- Kardan, O., Gozdya, P., Misić, B., Moola, F., Palmer, L.J., Paus, T., Berman, M.G.: *Neighborhood greenspace and health in a large urban center*. Scientific Reports, 2015, 5, 13 p.
- Kulczyk, S., Woźniak, E., Derek, M.: *Landscape, facilities and visitors: An integrated model of recreational ecosystem services*. *Ecosystem Services*, 2018, 31, p. 491 – 501.
- Li, W., Ge, X., Liu, C.: Hiking Trails and Tourism Impact Assessment in Protected Area: Jiuzhaigou Biosphere Reserve, China. *Environmental Monitoring and Assessment*, 2005, 108, p. 279 – 293.
- Maas, J., van Dillen, S., Verheij, R., Groenewegen, P.: Social Contacts as a Possible Mechanism behind the Relation between Green Space and Health. *Health & Place*, 2009, 15, 2, p. 586 – 595.
- Margaritora, F.G., Bazzanti, M., Ferrara, O., Mastrantuono, L., Seminara, M., Vagaggini, D.: Classification of the ecological status of volcanic lakes in Central Italy. *Journal of Limnology*, 2003, 62, 1, p. 49 – 59.
- Reynolds, K., Wolch, J., Byrne, J., Chou, C., Feng, G., Weaver, S., Jerrrett, M.: Trail Characteristics as Correlates of Urban Trail Use. *American Journal of Health Promotion*, 2007, 21, 4, p. 335 – 345.
- Riguzzi, F., Pietrantonio, G., Baiocchi, V., Mazzoni, A.: Water level and volume estimations of the Albano and Nemi lakes (central Italy). *Annals of Geophysics*, 2008, 51, p. 563 – 573.
- STRAVA: Strava Global Heatmap, 2020. (<https://www.strava.com/heatmap>)
- Svajda, J., Korony, S., Brighton, I., Esser, S., Ciapala, S.: Trail Monitoring in Rocky Mountain National Park, USA. *Solid Earth*, 2016, 7, 1, p. 115 – 128.
- UNWTO Tourism Highlights: 2018 Edition. Published: August 2018 (<https://www.e-unwto.org/doi/book/10.18111/9789284419876>)
- Vavrincová, K., Pichlerová, M., Wieková, A., Fassnacht, R.: Opportunities for Tourism near Nemi and Proposal of Measures to Increase the Usability of Hiking Trails (in Slovak). *Acta Facultatis Ecologiae, Zvolen*, 2020, in press, 15 p.

Ing. Igor Gallay, PhD., igor.gallay@tuzvo.sk
Ing. Zuzana Gallayová, PhD., zgallayova@gmail.com
Katedra aplikovanej ekológie Fakulty ekológie a environmentalistiky Technickej univerzity vo Zvolene, Ul. T. G. Masaryka 24, 960 01 Zvolen

Ing. Magdaléna Pichlerová, PhD.,
magdalena.pichlerova@tuzvo.sk
Katedra plánovania a tvorby krajiny Fakulty ekológie a environmentalistiky Technickej univerzity vo Zvolene, Ul. T. G. Masaryka 24, 960 01 Zvolen

Dr. Ronny Fassnacht, ronny.fassnacht1964@gmail.com
Nemi Territorio e Turismo, Corso Vittorio Emanuele 29, 00040 Nemi, Taliansko