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The Effects of the Saint Gotthard Base Tunnel System on the Transformation of Cross-Border Land and Its Contribution to a More Circular Economy

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ABSTRACT

The Saint Gotthard railway base tunnel, located in Switzerland, has an extension of 57 km, is considered the largest in the world, was inaugurated in June 2016, its construction has generated an integral system, with the purpose of achieving efficient operation. This type of project generates transformations in urban environments and in the landscape in a definitive way. Without long-term articulated policies, directed only at economic competitiveness or national development, leaving aside policies to protect the environment, to enhance existing infrastructures and intermodal transport, run the risk of being political instruments that devastate the territories where they are implanted. The purpose of this study is to develop an approach that shows the experience in Switzerland in contributing to a more circular economy, by executing an adequate management policy for excavated material, by the construction of the Gotthard base tunnel and analyzing its effects on the transformation of the territory by the creation of complementary works, environmental compensation and works that enhance it. Three levels of study were identified; in addition, a brief comparative analysis is carried out with the future Lyon-Turin base tunnel, in order to identify the effects produced in the transformation of the border territory between Switzerland and northern Italy by the construction of the Saint Gotthard railway base tunnel.

Keywords: Transport infrastructure, Intermodal transport, Rail transport, Infrastructure and territory

INTRODUCTION

The Gotthard Base Tunnel (SG) runs between the Swiss cities of Erstfeld (north) and Bodio (south), it is part of the European Rhine-Alps rail freight traffic corridor, which runs from the cities of Rotterdam and Zeebrugge in the Netherlands, to the Italian city of Genoa, is also part of the New Transalpine Railway approved by popular vote in 1992. The Swiss Confederation opted for a long-term transport policy, together with accompanying policies, which seek to protect alpine environment, transferring freight traffic from road to rail, they have even influenced Italian rail and intermodal transport policies. Switzerland has an exemplary system of financing, public debate and referendum for decision-making, which would be difficult to find another case study with similar conditions worldwide.

The cost of the work was 15,000 million euros approx. and for the enhance of the Gotthard System it was approximately 624 million euros, financed by the Railway Infrastructure Fund (FIF), which was extended until the year 2035, obtained mainly from heavy vehicles tax according to its performance (TTPCP), VAT, income from federal personal income tax and annual cantonal contributions (UFT, 2020).

To identify the impact of this infrastructure on the cross-border territory between Switzerland and Italy, it is proposed to carry out a comparative analysis with the Lyon-Turin base tunnel (axis 1), which will link the French city of Saint-Jean-de-Maurienne with the Italian Susa (under construction) and will have an extension of 57.5 km (TELT, 2022). France and Italy opted for other supporting policies that were not born of a referendum like the Swiss ones.

To carry out this study, 3 levels of analysis are proposed: at the Milan-Zurich metropolitan level (axis 2), Mendrisio-Stabio-Arcisate-Varese-Gallarate cross-border level, and at the local level, the Swiss cantons of Ticino, Uri and Grigioni. The research hypothesis corresponds to: the complementary projects, of compensation and that potentiate axis 2 contribute to a more circular economy and will be significantly superior with respect to axis 1, influenced by the Swiss policies applied in the long term in the construction of the Saint Gotthard base tunnel.

CONTRIBUTION TO THE CIRCULAR ECONOMY IN THE TRANSFORMATION OF THE LAND THROUGH PROJECTS THAT POTENTIALIZE THE "GOTTHARD SYSTEM"

Thanks to sustainable circular economy measures, which minimize the generation of excavation material produced by the construction of the SG tunnel, of the 28 million tons extracted, 66.3% was used for filling railway tracks, compensation projects detailed bellow, 33% of this material was destined for the production of concrete, which was used inside the tunnel and only 0.7% ended up in urban dumps. It was an efficient management for the reuse of excavation material, thanks to special machinery and constant controls that made it possible to obtain suitable aggregates for the production of concrete (AlpTransit San Gottardo, 2012).

At the metropolitan level (ML), as a direct consequence of the construction of the SG base tunnel, there is the positioning of the Swiss intermodal company Hupac SpA in Italian territory with the Busto Arsizio/Gallarate terminal (245,000 m2) and the *Centro Intermodale Merci Novara*, CIM Spa (600,000 m2), located on axis 2 Milan-Zurich (see Figure 2), in Italian territory, are strategic terminals for transalpine traffic, this is how Hupac in 2019 consolidates its position in Italy, buying 44% of the shares of the Novara Interport that controls the intermodal rail transport hubs in the north-western area (Trasporto Europa, 2019). Subsequently, since September 2021, the CIM Novara interport is managed by the Combiconnect company, which is also controlled by Hupac (Trasporto Europa, 2021). Hupac is one of the main beneficiaries of Swiss economic subsidies that support intermodal transport

Table 1. List of works that enhance the base tunnels of axis 1 and axis 2. Cross-border regional level. Personal elaboration with information obtained from: (OTI nord, 2022) and (TRENORD, 2018).

Axis 1 Lyon – Turin	Axis 2 Milan – Zurich (Gotthard Base Tunnel)
Strengthening of the Turin interport S.I.T.O. Spa in rail, logistics and intermodality services. Cost 500 million euros.	**T1.** Railway connection Seregno-Bergamo 32 km, cost 1,000 million euros. **T2.** Terminal intermodal center "*Milano Smistamento*". 400,000 m2. Cost 80 million euros. **T3.** Brescia Terminal "*La Piccola Velocita*". Cost 60 million euros. **T4.** Piacenza Terminal "*Le Mose*". Cost 60 million euros. **T5.** Strengthening of the Rho-Gallarate railway line, 25km and a fourth platform between the stations of the cities of Rho and Parabiago. Cost 723 million euros. **T6.** Strengthening of the Novara-Malpensa-Seregno 14km railway line. Cost 393 million euros. **T7.** Public park and the biotope-phytopurification project. Tregarezzo, 8,264 m2. **T8.** New Arcisate-Stabio railway line and the Como-Mendrisio-Varese-Malpensa Airport connection. Cost 261 million euros (see figure 1)

and seeks to enhance the "Gotthard System" until 2030 (Trasporto Europa, 2019).

The works that enhance the Gotthard System consist of increasing the parking capacity in the stations, with platforms for trains of 740 meters in length (European Court of Accounts, 2020) and the importance of the gauge of the trains, with the possibility of loading semi-trailers (to be transported by road) 4 meters high (Ferrovie Federali Svizzere FFS, 2015) and allow the transit of intermodal freight trains without limitations. The so-called "4 m Corridor" (C4m) consists of the expansion of tunnels, adaptation of train shelters, signaling systems, and electric railway traction between Basel and the Italian border at a cost of 947 million euros (Ferrovie Federali Svizzere-FFS, 2016). Also as part of the corridor, the quadrupling of the Chiasso-Monza railway line in Italian territory is considered, with a cost of 1,410 million euros (OTI nord, 2022).

At the cross-border regional level (CRL) in Italian territory, a greater concentration of projects is observed (see Figure 2) in axis 2 compared to axis 1, new infrastructures, expansion and modernization works are identified; On the other hand, in axis 1 this type of project is a minority (see Table 1).

At the local level (LL) in Swiss territory of axis 2, ecological and hydraulic compensation works are identified (see Figure 2) as:

> L1. Three artificial lakes for cooling drainage water from the mountain where the tunnel passes before directing it to the Ticino River. 7,100 m2, construction period 2014–2015, located in Pollegio, Ticino canton.

Figure 1: T8 new Arcisate-Stabio railway line and the Como-Mendrisio-Varese-Malpensa airport connection. (Personal elaboration with information obtained from: OTI Nord 2022 and TRENORD 2018).

L2. The artificial green hill in Biasca, as a deposit for excavation material, was approximately 7 million tons, it was built from 1999 to 2019 (Alpitransit, 2019).
L3. Afforestation of the abandoned areas of Santa Petronilla in Biasca, Ticino canton. Year 2005.
L4. Lac de Claus artificial lake in Sedrun, 2.9 million tons of excavation material was used, located in Tujetsch, canton Grigioni. (SWIswissinfo.ch, 2011).
L5. Six artificial Lorelei Islands, made up of 2.6 million tons of excavated material, were built in the period 2000-2005, the cost was 23 million euros, located in Seedorf, canton Uri (SWI swissinfo.ch, 2011).
L7. Faido portal square, made with crushed material from the excavation of the tunnel located in Faido, Grigioni canton (Espazium, 2016).

As complementary projects (see Figure 2):

L6. El Portal Building, made up of the central ventilation and railway technical area, was built in the period 2012-2014, located in Faido, Grigioni canton. (Space, 2016).
L8. Justice Node, made up of the 7 km tunnel on the south side of the SG base tunnel, the bridge with two High Speed railway binaries over the Froda River, a retention chamber (5,500 m3), the embankment of the modified cantonal highway and the new emergency access to the Justicia highway. Built in the periods 2000-2002 and 2011-2015, the approximate cost was 30.8 million euros. (Space, 2016).

At the local level of axis 1, in the Saint Jean de Maurienne-Susa section, the complementary projects where the tunnel is built are limited with respect to axis 2. As in the Gotthard, the residual material from the excavation of the tunnel of base creates a circular economy, which reuses 60% of the material used to make structural concrete elements. Projects are mainly proposed:

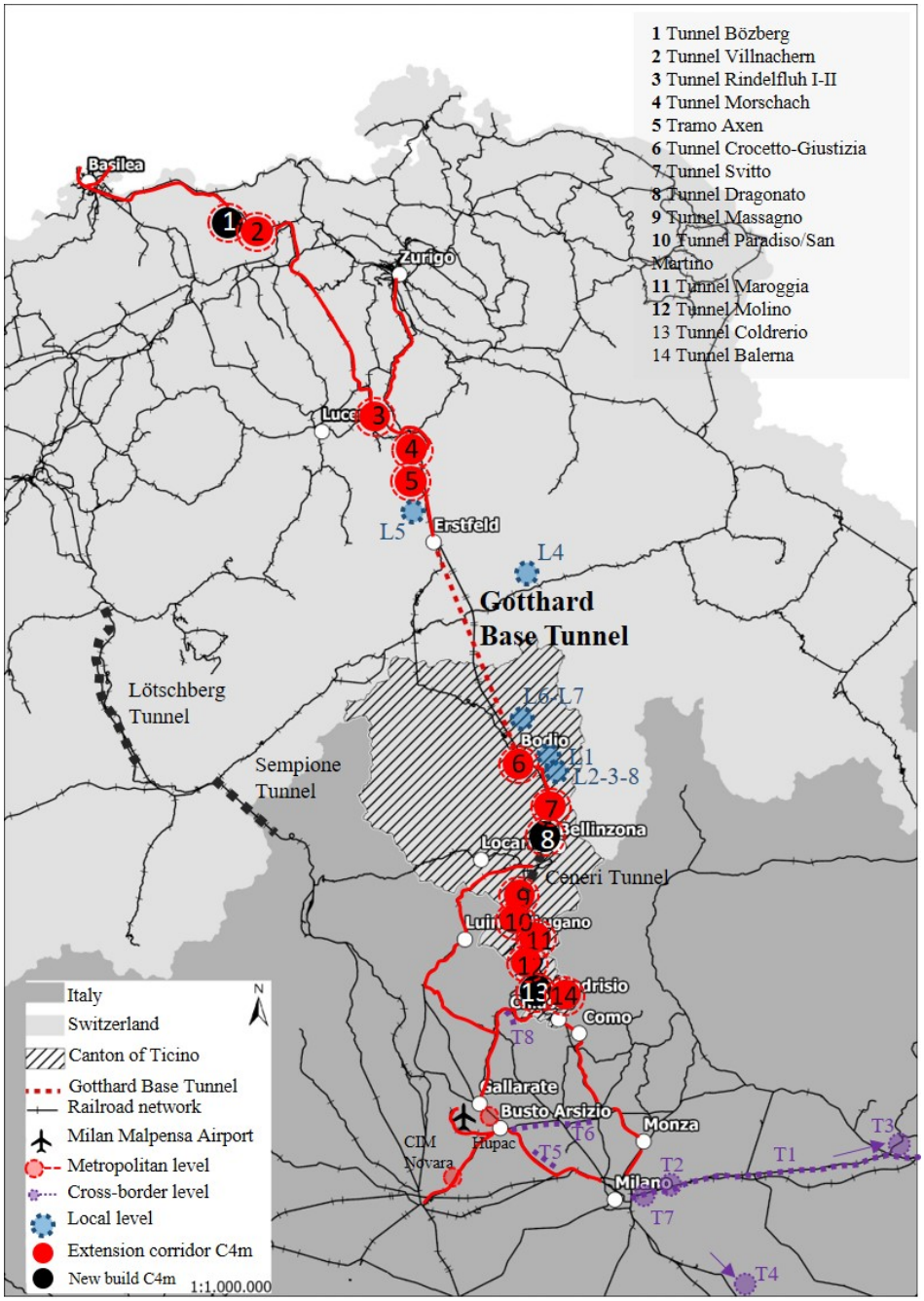

Figure 2: Main complementary works, of compensation and that potentiate the Gotthard system according to the three levels of analysis. (Personal elaboration with information obtained from: OTI Nord 2022 and FFS 2015).

urban regeneration in the Maurienne Valley area (France), a 14-hectare tunnel excavation material deposit, and a concrete ring factory (*concio*) in the Saint-Martin-La-Porte area, Salbertrand, Turin, the estimated construction period is 2019-2028. Storage tanks for the waste material from the tunnel

excavation located in Caprie and Torrazza Piemonte, (Italy). External groundwater cooling tanks for the excavation of the tunnel, in Chiomonte, Italy (Tunnel Euralpin Lyon Turin - TELT, 2020).

CONCLUSION

The accompanying instruments and policies have favored potentiating the "Gotthard System" to bring it up to European standards, but as the research shows, they have had an impact on the transformation of the land at the three levels of analysis, due to the construction of complementary and ecological works, agricultural and hydraulic compensation, the physical and biological cover have been altered. These measures have undoubtedly contributed to the protection of the alpine environment, but the transformation of the soil has been displaced to transboundary regional levels in northern Italy.

Formally, two types of works are detected, type 1 Metropolitan Level (ML) - Cross-Border Regional Level (CRL) and type 2 Local Level (LL), among the compensation works and complementary projects analysed, the first one has formally linear characteristics of railway connection and intermodal logistics infrastructure, while the second type , formally they are punctual projects, located in the areas adjoining the two tunnels and a few kilometers away, which function as complementary and compensation support buildings. Due to its proximity to the SG base tunnel, the local level (LL) was the one with the greatest contribution to the circular economy compared to the other two levels (ML-CRL), the specific contribution in the reuse of excavation material was 27.8 million tons. The research hypothesis is confirmed, the transformation of the soil by complementary, compensation and potentializing projects of the Gotthard base tunnel of axis 2 is significantly higher than axis 1 of the Lyon-Turin base tunnel.

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