Railway Related Impacts: the Turin-Lyon High-Speed Rail Case

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ABSTRACT

One of the best known cases of struggle for the commons in Italy, characterized by bitter controversies over the last 20 years, is the popular opposition to the construction of the High Speed Railway line (HSR, "TAV" in Italian) between Turin and Lyon, designed to cross the Susa Valley (at the Italian-French border) and the Alps. This HSR project still carries, in spite of twenty years of continuous updating and reworking, a great deal of unsolved environmental and economic issues. An issue of insufficient cost-benefit balance has recently come to clear evidence, especially in view of the non-negligible passenger and freight traffic decrease along the Turin-Lyon direction. The most important aspects dealing with economic costs and claimed benefits, energetic considerations, legal constraints, environmental impact, health impact potential, and the negative experience of other projects, are discussed.

1. Introduction

The Susa Valley situated between Maurienne, France and Turin, Italy, has been urbanized by the economic development of the region. The construction of infrastructures like the Frejus highway, an international railway, and a large number of dams, tunnels and industries, has generated significant environmental and social impacts. The proposed high-speed train line (Treno Alta Velocità in Italian, or TAV) between Turin and Lyon would pass cross the Susa Valley, via 2 main tunnels and several shorter ones across the Alps. The "No TAV" movement is a grass-roots movement of the Susa Valley population against the new line construction. The Turin-Lyon High Speed Railway (HSR) in the Susa Valley (Italy) has long been surrounded by bitter controversies about the most significant and technical aspects of the proposed project. The HSR project carries, after more than twenty years of strenuous and continuous redesigning, a large number of still unsolved environmental issues. Main pollution problems dealing with the railway construction have been put into evidence by several studies and official reports. For instance, the presence in the Susa Valley of geological formations with asbestos and uranium is of particular concern, also considering the final destination of the extracted inert [1]. Aspects related to local hydrogeology and its perturbations, and noise, are also of huge concern [2].

The insufficient cost-benefit balance, especially in view of the significant passenger and freight traffic decrease along the Turin-Lyon direction [3], has come to better evidence when the French Government (as of July 2012) announced a spending review that could stop the construction of the HSR Turin-Lyon and other ones on the French side [4].

Last but not least, the concept itself of this type of investment is under deep review, since the huge amount of public money invested or planned in support of such development does not appear to be justified by sufficient economic benefits associated to the investment [5]. In other words, not only a sequestration and degradation of the environment is going to take place, but also there is no advantage at all in economic terms, except probably for the companies involved in the construction business and, more likely, the banking system.

Getting back to the technical questions, we believe that the usual appeal to the Precautionary Principle [6,7] in the case of HSR project is not even necessary. Economic data, energetic considerations, legal questions, environmental impact, the health impact potential, the negative experience of other projects, and especially the common sense, suggest that the High-Speed Train Turin-Lyon is not an actual priority for Italy and Europe, and its construction should be immediately stopped.

2. Materials and Methods

2.1 The Susa Valley. Nature and history.

The Susa Valley is located in Northwest Italy at the border with France, from which it is separated by the Alps, 3600 meters high. It is the widest valley in the Western Alps; in fact, it is a natural corridor stretching from East to West. The two sides of the valley benefit from different sun exposure and this makes them quite different from one another. The left side is dry, while the right side is humid, shady and cold. The natural environment, and particularly the flora, are deeply affected by this peculiarity, resulting in a valley with extremely diverse and interesting sites and habitats. In particular, the Susa Valley is defined as a Site of Community Importance (SCI) according to the so-called European Commission “Habitats Directive” (92/43/EEC), within the Natura 2000 Network. The Dora Riparia River runs through the valley, and there are abundant springs and superficial aquifers. Large pastures are located in the high part of the valley,, while at lower heights (1300–1800 meters) it is possible to find steep crevasses. The Susa Valley is among the most developed alpine valleys from economic and infrastructural points of view. It is crossed by two main roads through the passes Monginevro and Moncenisio. Moreover, a motorway and an international railway reach France through the Fréjus tunnel. The Valley hosts three hydroelectric dams and is crossed by two electric lines. Many tourist and sport resorts make the valley a tourist attraction (it also was the base of the 2006 Winter Olympics). There are many industries, including mining, and many military roads built in previous centuries that are currently international tourist attractions for walkers and cyclists.

The valley has about 90,000 inhabitants, and it is divided into 39 Municipalities. There is a well-established tourist industry, as it is evident by the presence of “second homes”, hotels and motorway traffic. Notwithstanding the heavy human presence, the Susa Valley features wide semi-natural and wild areas, which host many examples of alpine fauna (deer, chamois, roe deer, wild boar, eagles, hawk, partridges and wolves) and a very rich diversity of flower species: there are four natural parks, two natural reserves and many areas of European interest. Livestock rearing, which was very intense until the end of World War II and subsequently declined, is now in a new phase of growth, albeit slow, and consists of about 8000 cattle, 12000 sheep and 800 goats.

2.2 *The new Turin-Lyon railway.*

In the year 2005 the Rome-Naples HSR line came into operation, the first one in Italy, followed by the Milano-Turin line in the year 2006, the Milan-Bologna line in 2008. the Bologna-Florence and a high-speed technological improvement of the Florence-Roma in 2009. Further line extensions (the Naples-Salerno and other minor lines) completed the first Italian high-speed network in the following years until 2011. The Salerno-Milan line is part of the North-South high speed European corridor, while the Milano-Turin-Lyon was designed to be part of a more ambitious project linking Kiev (Ukraine) to Lisboa (Portugal). The project, not included by European Union among its priority high-speed projects, has lost potential partners on the way (Spain, Portugal, Ukraine, Slovenia) due to the huge financial investments needed, low traffic forecasts, low economic return expected. As a consequence, it became a France-Italy bilateral project, still under debate and waiting for final approval and further funding. Its completion requires a new tunnel 57 km long and other rail works to link to the existing network. The entire Turin-Lyon line would be approximately 270 km long across the Susa Valley (Northern Italy) which originated heated debate and opposition by the local population over more than 20 years (and still pending). Supporters claim the new line to be able to transfer large fractions of freight traffic from road to rail, with consequent environmental advantages. The Governmental cost-benefits analysis [9], claims that by the year 2035 about 39.9 Mton/yr of freight will be traded through the new line across the Susa and Maurienne Valleys, accounting for about 55% of total freight traffic. Such amount translates into a ten times higher freight trade than in the year 2010, in contrast with the present trend of decreasing commercial traffic between Italy and France [8]. A residual 45% of traffic (1.6 times the 2010 traffic) would have to be transferred via road by trucks through the Mount Blanc tunnel, translating into about 2 million trucks, about 800,000 more than the 2010 circulating vehicles. Not a road traffic decrease, indeed, but a potential reduction of the planned increase [8].

2.3 *Economic Cost-Benefits Assessment*

Estimates about the needed investment and expected benefits have been very uncertain until recently (June 2012), when a Governmental cost-benefit analysis was finally presented [9] and published. The foreseen investment was so large that a plan B was put forward: instead of a 270 km line Turin-Lyon, a cheaper solution (only the 57 km base-tunnel and related links to the existing line) was designed, translating into a 60% cost abatement. Economic estimates have always been uncertain and subject to exponential increase due to real costs occurred and the consequences of organized crime and corruption, during the construction of the Salerno-Milan High Speed Rail, as clearly pointed out by the Italian Court of Auditors[1], by the results of a public audit performed by a special committee of the Italian Parlament [10] and other academic studies [11]. Some of these sources have strongly questioned the validity of the HSR investment and the possibility of a return on the invested capital.

2.4 *Environmental and energy costs*

A comparison between different transport modalities is presented, based on published literature [13-20] among others) and previous evaluations carried out by the Authors, referring to the Naples-Milan HSR as a case study [8,16]. In particular, the following Environmental Impact Categories are compared: Abiotic Resource Depletion, Cumulative Energy Demand, CO_2 emissions (Global Warming), SO_2 emissions (acidification).

Three passenger transport modalities (road car, intercity train and high speed train) and three freight transport modalities (heavy transport lorry, regular freight train, and an hypotetical use of high capacity/high speed freight train) are compared.

All calculated impacts refer to the functional units of 1 p-km and 1 t-km respectively for passengers and freight.

Other kinds of impacts (extraction of radioactive and asbestos materials and hydrological risk) are also assessed, based on Val Susa site-specific information.

3. Results

3.1 *Economic Costs-Benefits Assessment*

Concerning freight, the central problem is that rail freight transport in Italy occurs at an average speed of 19 km per hour [3], since trains are often diverted and parked in transit stations, to provide priority to passenger trains. This is the main bottleneck requiring improvement. It’s a nonsense for commodities to arrive from France at a speed of 150 kilometres per hour and have to stop and spend most of their time in a transit station when they arrive in Italy.

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[1] http://triskel182.wordpress.com/2012/03/06/tav-corte-dei-conti-costi-assurdi-paolo-m-ruggero /

Concerning passengers, it makes sense to talk of High Speed Rail when the journeys are longer than 250-300 km. In Italy, if we look closely at the rail transport statistics [3,7], we can see that 80% of the demand for passenger transport is for short journeys, less than 100 Km. It's true that Italian trains are overloaded with passengers on certain routes but only very few people go from one end of the country to the other, taking real advantage of the high speed (also in consideration of the growing offer for low-cost airfares, competing with high prices of HSR tickets).

Official costs estimates refer to the entire line (270 km), not just to the basic tunnel (57 km). Foreseen investments are around 22 billion euro, but previous experience shows that forecasts result much lower than final real costs. The Italian Milano-Salerno high speed train line, already implemented, costed three times more than the forecasts [12]; the benefits for long-distance passengers in terms of time saved cannot be disregarded, but they are offset by much higher tariffs, and, more than that, by the huge cost of the global investment. An ex-post cost-benefit assessment published by Beria and Grimaldi [11] in 2011 shows that even the high ticket prices on the Milan-Salerno HSR line do not pay back the long-term investment and daily operation costs. The implementation of the Turin-Lyon would probably be even worse, since the expected number of passengers is very low: the line should thus be essentially used for the transport of commodities, a modality that has been declining in the last 10 years [3] and that seems to have limited growth perspectives, due to the future competition by the new Gotthard tunnel through the Italy-Switzerland border, expected to attract the large majority of traffic in the North-South direction. Moreover the existing line, recently renewed and improved, can carry up to 20 million tons [3], a capacity that is much far from being saturated in the short-medium time (if ever).

Concerning construction and operating costs, at the beginning it was estimated that the whole Italian High-Speed network (and not just the Turin-Lyon HSR project) would pay back for 60% of its costs. Then this estimate decreased down to 40% and finally it was established that the 40% would not include the costs for the "nodes" near the cities, (really expensive). According to simulations in [7], the final estimate is around 20%. Concerning the Turin-Lyon HSR, even that 20% will probably not be achieved (no financial analysis is available yet), and the State is supposed to cover 100% of the costs. The Turin-Lyon is therefore a monument to dissipation: it will cost 2 or 3 times the estimated expenses for the (always postponed and now cancelled) bridge over the Strait of Messina (and would be equally useless).

As far as employment is concerned, nowadays, the massive projects have a modest multiplier effect: manual workers are not employed as they were in the 1800's. Moreover, the well known tourist value of Italian landscape (with expected increase of visitors from recently developed countries) should prevent from implementing further landscape degrading infrastructures, calling for much better ways to invest public and private money, for higher return in terms of revenues and jobs.

3.2 Environmental and Energy Assessment

Assessing the material and energy costs as well as emission flows for construction and operation of the Italian high-speed railway is not an easy task, due to the fog curtain and lack of transparent data that surrounds the entire process. It would be very useful (and would constitute a tribute to the rights of citizens to be properly informed according to the Aarhus convention, http://www.unece.org/env/pp/introduction.html) to implement a complete Life Cycle Assessment of the entire project (infrastructure construction and operation phase) by a third party team of experts. Environmental results are very sensitive to factors such as ridership (load factor), a country's electric mix, extent of use by passenger and by freight traffic (very uncertain at present), allocation of infrastructure costs to passenger and freight transport, site-specific aspects. As a consequence, all studies and estimates carried out up-to-date are rich with uncertainties and depend on sometimes arbitrary assumptions. We have personally identified very arbitrary assumptions in LCA and impact assessment studies performed within LCA commercial software as well as in official reports published in support of HSR. However, published peer-reviewed studies [11-16] allow at least a gross estimates of impacts (Tables 1 and 2).

Table 1. Average load factors and selected LCA impact categories for passenger road and rail transport modalities [16]

	Load factor (passengers per trip)	Abiotic material depletion (kg/p-km)	Cumulative Energy Demand (MJ/p-km)	CO_2 emissions (g CO_2/p-km)	SO_2 emissions (g SO_2/p-km)
Car	1.8	0.53	1.87	89.40	0.24
IC train	400	0.85	0.77	30.30	0.34
HS train	250	1.40	1.44	48.20	0.56

Table 2. Average load factors and selected LCA impact categories for freight road and rail transport modalities [16]

	Load factor (ton per trip)	Abiotic material depletion (kg/t-km)	Cumulative energy Demand (MJ/t-km)	CO_2 emissions (g CO_2/t-km)	SO_2 emissions (g SO_2/p-km)
Lorry (average)	8.8	0.60	1.25	72.10	0.21
Regular freight train	350	7.65	2.50	150.00	0.85
HS train	350	8.65	3.09	189.00	1.05

Tables reflect average values (based on estimates and published reports) of material and energy flows for the construction and operation of the Naples-Milan high speed rail [16,17]; results have been compared with internationally published literature, taking into proper account the variability of ridership and electric mix. The High Speed Rail transport always shows the worst performance compared to ordinary railway and car extraurban transport, except for the impact categories Cumulative Energy Demand and CO_2 emissions, where car transport performance is much worse.

Other CO2 emission forecasts have been made by international research Institutes. The German MVV Consulting [18] estimated about 31.5 g CO_2/p-km for Italian HSR in 2009, with projections of further decrease to 22.5 g CO_2/p-km in the year 2020, due to the expected increase of passenger traffic. While Federici et al [16] calculated 48 g CO_2/p-km, based on a loading factor around 60% of available seats, Chester e Horvath (2009; http://www.sustainable-transportation.com/) estimated 80 g CO_2/p-km for 90% seat occupancy and up to 700 g CO_2/p-km for a low 10% occupancy rate, in California. Finally, Preston [19] reviewed a number of private and public reports about High Speed Rail in Japan, France, Spain and Germany, and reported average values of 0.5 MJ/p-km for IC rail (load factor 44%), 1.08 MJ/p-km for HSR (load factor 49%) and 0.94 MJ/p-km for road car traffic (load factor 36%). Preston's values did not include the energy costs of infrastructures (unlike Tables 1 and 2), which Preston acknowledge in his work by referring to Chester and Horvath [13] estimates that allocate infrastructure energy costs and emissions to road, rail and air in percentages of respectively 63%, 155% and 31%.

4 Discussion

One of the main environmental justifications of HSR projects is the transfer of goods and passengers from road to rail modality, resulting in a reduction of the greenhouse gas and other pollutants released by the engines of trucks. Supporters of HSR put forward, as a main ecological justifications of projects, the energy savings and the expected decrease of pollutant emissions, associated to the shift of a fraction of freight and passenger traffic from road (fuel driven trucks and private cars) to electricity driven railway. This result, although valuable in principle, cannot be given for granted, and heavily depends not only on direct consumption of electricity and fuels, but also on the energy investment for the infrastructure construction, including the energy incorporated into the materials and their necessary management and maintenance. In the case of a big infrastructure project, such as HSR, this is a particularly important requirement for a careful analysis of the life cycle of the project. Rail transport, less versatile than road transport, may cause less pollution, but only if we use or improve on an existing network. If we build a new line with about 70 kilometers of tunnel, 10-20 years of construction work, tens of thousands of truck journeys, excavated material to dispose of, drills, thousands of tons of iron and concrete, heavy interference with underground and surface water, to mention only a few aspects, and the energy necessary to keep it working, then the consumption of raw materials and energy and the related emissions are so high as to entirely offset the claimed advantage of the hypothetical partial transfer of freight from road to rail [13,16,17]. The claimed virtuosity of the train is not always confirmed in real cases, and heavily depends on the energy investment for infrastructure, including the energy embodied in the materials and the necessary management and maintenance over the entire infrastructure life cycle. The ridership is also of paramount importance: in the presence of a small or decreasing traffic, the investment per unit of passenger and commodity transported would never be competitive with other transport modalities (or with a decreased transport demand driven by more local consumption, when such option exists). In the case of a big infrastructure project, such as the Lyon-Turin line between France and Italy, energy and environmental costs require a special attention and a careful analysis of the energy and material flows involved over the entire project life cycle.

The environmental impact of any new construction project is high; a project may be justified, however, if its usefulness compensates the environmental burden from construction and operation. Given the serious doubts about its usefulness under the perspective of declining freight traffic, the HSR project runs the risk that the shift in traffic from road to rail would not occur or be very low, and thus the benefits in the reduction of the environmental impact would also be very low. Planners forecast fourteen trains per day, while the capacity of the line is for 250 vehicles. Freight traffic on rail lines is in decline throughout Europe, with very few exceptions. Even in France, rail traffic is declining because in the last two centuries production has shifted away from raw materials traditionally carried by rail such as bricks, wood and coal. It would be much better from the environmental standpoint to invest in technologies that cost much less and can do a better job at dealing with any likely increases in demand.

4.1 Energy cost-benefit analysis

Energy intensity indicators for construction and operation listed in Table 1 for passenger traffic and Table 2 for freight traffic clearly show a much higher energy expenditure of HSR compared to Intercity rail as far as passenger traffic is concerned. The hypothetical use of HSR for freight transport is also very energy intensive compared to both regular freight trains and trucks. Only passenger transport by car is more energy expensive than any other modality. As already pointed out, results may depend on a variety of factors, including assumptions on vehicle load, on electric mix, on infrastructure allocation to transport modalities. Energy intensity values are affected to some extent by ridership: increased use may decrease the impact of infrastructure costs, in that this latter would be allocated to a much larger amount of freight transported. It would not, however, affect too much the operational energy costs, because of a proportional increase of electric use and commodities transported.

Calculations from [16,17] are based on present load factors from official statistics. A decreasing traffic would only have the effect of increasing the unit transportation costs and emissions. Claims of HSR proposers foresee increasing traffic in the next 30-50 years, which is not supported by present trend data and may rather be ascribed to fairy tales books. By the way, the present offer by the Italian railway companies (FS and NTV) is towards improving comfort for a limited category of users (business and executive class coaches), with about 40% decreased number of seats. Decreasing ridership inversely affects energy and environmental costs.

It should be noted from Tables 1 and 2 that cumulative energy demand for Intercity and HSR passenger transport are respectively 59% and 23% lower than for road vehicles, while the opposite is true for freight transport (respectively 2 and 2.4 time higher for IC and HSR than cars), due to higher loading factors for trucks compared to railway carriages.

Last but not least, Spiellman et al.[20], Zurich University, in their study about high speed transport in Switzerland, foresee increased energy demand and emissions due to rebound effect phenomena (and Jevons paradox): increased time use efficiency and longer distance run within the time fraction allocated to travel are estimated to increase the number of trips and trains on the same route, thus causing global higher energy consumption and CO_2 emissions. Similar results were confirmed for Italian freight transport by Ruzzenenti et al [21] and by Ruzzenenti and Basosi [22].

4.2 Carbon emissions

Train transportation modalities are claimed a priori to be carbon free or, at least, less carbon intensive. It is certainly true that a train does not directly release any CO_2 during its operation. However, the construction of the infrastructure (excavations, tracks, viaducts, concrete for tunnel walls reinforcement, electric lines) and vehicles, maintenance operations, and the provision of electric power all require huge amounts of energy that are in Italy mainly based on fossil fuels Considering the non linear increase of energy consumption of a running vehicle up to more than 3-4 times when speed increases from 100 to 300 km/yr [24], due to the kinetic energy loss while braking and aerodynamic resistance; considering also the need for strong, complex and much more sophisticated HSR infrastructures compared with regular IC trains, and finally considering the much lower occupancy per trip, CO_2 emissions per p-km and t-km come out to be more than 30% higher for HSR than for IC train (Tables 1 and 2) and likely to be even higher than highway track transport in times of increased decline of traffic along the Turin-Lyon corridor. Infrastructure-related energy costs and emissions account for about 40-45% of total life cycle [14,16], depending on the electric and energy mix of a country.

Calculations from the Italian Government's cost-benefit assessment [23] point out – for the entire, not yet existing, East-West EU Corridor 5 - an annual decrease of CO_2 emissions equal to 3 million ton/yr avoided by the year 2055 with a net release until 2038; in that year the foreseen (although not supported by any present real traffic data) increase of traffic and related savings on road transport should offset the emissions associated to the infrastructure and operation of HSR. Surprising it may appear, these calculations do not include the emissions related to infrastructure construction, which means that about 40% of total life cycle emissions are not accounted for, thus making the break-even point (if any) much beyond than the claimed year 2038.

The Frejus highway in the Susa Valley is presently used by approximately 3300 big transport trucks per day. The foreseen increase of freight traffic by ten times via railway and by 1.6 times via road by the year 2035 [23] must be combined to the almost certain decision to implement as a cheaper solution only the construction of the base tunnel (57 km) and links to the old line: this means that, considering the limited capacity of the latter (20 Mton/yr), additional 19.9 Mton/yr will have to flow through the Frejus highway instead of being transported via rail, thus totaling about 52.3 Mton/yr by truck. This translates into 3,300,000 truck trips per year, about 2.75 times the road traffic in the year 2010, a nightmare scenario for both energy consumption and CO_2 and other pollutants emissions. Actually, these results show that the traffic previsions used to support the HSR construction are unrealistic. It seems therefore very hard to support the claim that the construction of the HSR Turin-Lyon would be consistent with the requirements of the Kyoto Protocol and future similar low-carbon agreements.

The Italian Trenitalia SpA indicated up to the year 2008 non-negligible savings of CO_2 emissions by using railway instead of road and air carriers, based on ENEA (National Energy Agency) estimates, in turn based on the European Consulting ODYSSEE.[2] These data could not reliably include HSR, that was at its very beginning steps. In the last years, Trenitalia indicated on its railway tickets a new reference: www.ecopassenger.org, that in turn refers to, IFEU - Institut fur Energie und Umweltforschung, Heidelberg, Germany (IFEU, 2010). The IFEU study only includes emissions linked to direct electricity consumption, calculated with reference to average values of eight European countries, not including Italy. No evidence in the study of the inclusion of infrastructure construction.

Finally, the British Network Rail [24] estimates that the greenhouse gas emissions can in 2007 be attributed 80% to train operations, 18% to infrastructure and only 1% to train production, based on a Eurostar Class 373 (reflecting relatively long asset lives and intense utilisation; by calculating values in g CO2eq per seat-km instead of p-km, the report does not account for actual seat occupancy).

4.3 *Further site-specific impacts*

The Turin-Lyon HSR construction carries a number of additional environmental problems, that have been highlighted by several studies [1,3,16,25,26,27]. Particularly alarming is that the planned tunnel, which will be more than 100 kilometers long (a double tunnel, 57 km each one), will pass through zones with a high concentration of asbestos and uranium. For example, concerning uranium, it is planned that the resulting material from excavations will also be disposed of in two open-pit mines in the Susa Valley, Meana and Caprie. Thus, about 3.3 10^9 becquerels of radioactivity from uranium would be dispersed into the environment, with possible water and soil contamination. Due to weather conditions, resuspension of polluted dust is quite likely, and such a dispersion of pollutants would expose the local population to collective doses of several thousands of sieverts per person: this represents a hazard for public health in the zones surrounding the mines, where hundreds of persons are living.

Radioactive excavation materials

Concerning Uranium, it is foreseen that a fraction of the resulting material from excavations will be disposed of in two open-pit mines in the Valsusa, Meana and Caprie [27]. This would imply the dispersion into the environment of about 3.3 10^9 Bq of radioactivity, with likely water and soil contamination. Due to the action of meteorological agents, resuspension, and wind, such a dispersion of radioactive pollutants would expose the local population to collective doses of several thousands of Sv/person [27].

Concerning excavation of tunnels in uranium-bearing rocks, even with quite low concentration, the main source of radiation exposure is radon (^{222}Rn), a radioactive gas, and radon decay products. Radon is colorless, odorless, and chemically inert; it is formed by the radioactive decay of uranium in rock, soil, and water, and has a half-life of about four days. When radon undergoes radioactive decay, it emits ionizing radiation in the form of alpha particles. It also produces metallic short-lived decay products, like: ^{218}Po, ^{214}Pb, ^{214}Bi, ^{214}Po, ^{210}Bi, ^{210}Pb. Their chemical reactivity and electric properties make them stick to dust and other tiny particles in air. These dust particles can easily be inhaled into the lung and fixed to pulmonary

2 http://www.odyssee-indicators.org/

mucosae. The deposited atoms decay and eventually damage cells in the lung. A considerable amount of evidence has established that prolonged exposure to the α- emitting decay products of radon increases the risk of lung cancer [1] . Accurate measurements of concentration are mandatory by law in workplaces, and, in some cases, adequate countermeasures too. Compliance with dose constraints must be demonstrated by gas measurements and may be verified or predicted with dose assessments. The dose received by an individual working for the excavation of the HSR Tunnel is estimated, using the code RESRAD-BUILD [1].

Natural radionuclide concentrations in the Susa Valley can reach quite high concentrations in some selected locations, due to the presence of several uranium-rich geological formations and even some former sample uranium mines dating from the fifties. For instance, the Regional Agency for the Environment of Piedmont, Italy (ARPA) measure concentrations up to 100 Bq/g in samples of rock collected in Venaus (Susa Valley) [28]. We however refer to more moderate values, far from the above peak values. In particular, the world average concentration of U in rocks is estimated to be 0025 Bq/g, while worldwide mean values for other natural radioactive species are: 0.028 Bq/g (^{232}Th) and 0.37 Bq/g (^{40}K). We, therefore, assume a concentration equal to 0.0265 Bq/g, that is around 3800 times lower than the peak values above. This value is in agreement with measurements conducted by ARPA during the excavation of a service tunnel, carried out by the Italian Energy Authority AEM, not far from the village of Exilles in the Susa Valley [29].

According to these values, the absorbed dose for workers due to the permanence inside the tunnel exceeds the lowest threshold (1 mSv/h) imposed by the Italian law [30] in the absence of adequate ventilation: in particular, the dose equivalent value of about 197 mSv/yr without any ventilation can be reduced to 1 mSv/h with an air exchange rate of 0.87 (1/h), i.e, all the air content of the tunnel must be completely changed almost every hour. It is an amazing result, considering that we assumed a quite moderate concentration of uranium just slightly superior to the world average: in presence of real uranium-rich formations that can be found in many places in Valsusa [31]; these values would scale up to unsustainable levels.

Asbestos excavation materials

Concerning asbestos, HSR proposers claim that about 170,000 m^3 of asbestos-bearing rock with “relevant concentrations” [32] can be found 500 m from the base tunnel. This assumption can be proved to be a huge underestimate of the real case, by at least a factor 10. First of all, let’s note that “very low levels" are defined in [32] as "the ones under a 5% concentration of asbestos in rocks encountered during excavation”, while the legal limit is about 0.1% according to the Italian Law; the latter banned asbestos from any use since 1992 [33], since even a few fibers can cause serious health damages: if such more appropriate threshold concentration is assumed for asbestos then the estimated amount of asbestos-bearing rocks in excavation material would be much higher than 170,000 m^3. Moreover, in 1995-1998 the Turin University [34] performed evaluations in the Susa Valley showing the presence of chrysotile and tremolite, both asbestos minerals. It is important to point out that the study was commissioned by Alpetunnel, the first company responsible for the design of the Tunnel. The most recent surveys carried out by the HSR proponents [32] and claiming the absence of asbestos are instead questionable. The sampling activities were carried out in points where no asbestos presence was expected: the tectonics structure of the Western Alps in the Susa Valley zone is very complex, having been involved in various geological events; as a consequence, sumpling results would have been very different in the surrounding areas. Surveys of the University of Siena found asbestos fibers "with high tendency to defibrillation" [34] in 20 out of 39 rock samples tested in the Susa Valley. Further studies [35] concerning the presence of chrysotile veins identified non-negligible asbestos concentrations in many serpentinite rocks in Val Susa. Tremolite veins are common in small masses of serpentinite schists in the Piedmont area, especially in the upper Val Susa. Rocks are potentially asbestos-rich also in other lithological contexts, the serpentinized peridotites of the “Mount Musinè” in Susa Valley [36] and in the ultrabasic complex in Lanzo between Almese and Caselette in lower Susa Valley. The same rocks form the mountains above Chiusa San Michele, Sant'Ambrogio and Avigliana, municipalities included in the route of the international and domestic tracks of the HSR.

Hydrological risk

An assessment of hydrological risks connected with the HSR construction may be summarized as follows. In 2006, about 30 superficial water springs have been identified by the HSR proponents [36] along the old version of track of the national segment rail line, in many villages in the Susa Valley. Same situation appears in the Municipalities impacted by the international segment, where the number of water sources and creeks is quite high, with the complication that several of them are used as drinkable water supply. Therefore, two kinds of problems emerge:

- The excavation activities can drain or divert the springs leaving population without water
- The sources can be polluted, becoming undrinkable and unusable.

In the presence of very deep tunnel design, sampling surveys are not so easy because of the depth of some sites and because of the difficulty to reach the surface sampling sites located in mountain. Just to mention an example related to the Susa Valley, during the activities for the construction of the “Pont Ventoux” hydroelectric power plant, a large number of high pressure water jets have been found, together with an underground lake of hundreds of thousand cubic meters. Moreover, the artificial lake of the Mont Cenis, a 333 million cubic meters water reservoir at 2000 meters of altitude, supplying power plants in France and in Italy, is located in the area. Interception of very high-pressure jets cannot be excluded a priori during excavations.

4.4 *Economic cost-benefit*

Finally, Preston’s review at European level [19] points out that “the dominant benefits are time savings to HSR users and the net revenue to the rail industry. Other benefits, such as reduced overcrowding, the benefits of released capacity on the classic rail network and on parallel roads, and of reduced emissions of greenhouse gases are much smaller but are positive”.

This author underlines that benefits are estimated based on the claimed existence of increased strong demand for passenger rail services. Preston’s report warns that operating and maintenance costs might be covered by revenues from passenger traffic, but also states that the latter are unlikely to contribute to more than a small fraction of capital costs, thus requiring non-negligible public support. In conclusion, Preston states that “the limited reviews of high speed rail projects elsewhere in Europe indicate that they have been affected by appraisal optimism and that out-turn results suggest Benefit Cost Ratios much lower than those being forecast in Britain".

5 Conclusion

Recently, a down-sized project was presented by the Italian Government [37], costing one third of the original one, and limited to the base tunnel, i.e. without any improvement of the existing line outside it ("Low-Cost Solution"). In practice, this makes the overall time savings very modest, eliminating any possible relevance for the passenger traffic. No analysis has been presented yet, but for sure this downsizing is the consequence of the local opposition, the lack of public funds, and the widespread skepticism of the academic world. For sure, all the relevant impacts will also be proportionally reduced, although this "success" does not make the expenditure any more justified.

Can the opposition against HSR be defined as "against Progress"? Results suggest the opposite to be true. Progress and wellbeing must not be confused with infinite growth. The territory of Italy is small and over-populated. Natural resources (water, agricultural land, forests, minerals) are limited. Pollution and waste are increasing. Fossil energy supplies are coming to an end. Progress means understanding that physical limits exist to our mania to construct and transform the face of the planet. Progress means optimizing, increasing the efficiency and durability of already existing infrastructures and built environment, cutting out what is superfluous and investing in intellectual and cultural growth more than material one, using minds more than muscles. The HSR represents the exact opposite of this idea: wasting resources for no benefit.

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