

An aerial photograph of the city of Patras, Greece, with a blue line representing a proposed rail route. The route starts from the top left, follows the coast, and then curves inland. Seven white circular markers with blue outlines indicate station locations along the route. The background is a detailed street map of the city.

CODE Patras

RAIL & CITY

A Synopsis of the Project
and Final Recommendations

Zurich, July 2018

Imprint

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Fig.1: The former building of Agios Dionyssios railway station (source: T.Papamichail, 2014, edited by T.Furrer).

Preface

After the completion of “CODE Patras” project and the ongoing discussion in the city of Patras about the railway and city development, it has been considered indispensable to proceed with an overview and assessment of the whole process to pinpoint considerable issues about the future decision-making on railway integration towards sustainable spatial and city development.

The current synopsis attempts to present briefly and comprehensively the whole process of the railway upgrade in the city, including the official plans and intentions, the contribution of Code Patras project and especially of the Test Planning Process. The respective results of the last two initiatives will outline some final recommendations and critical questions. In particular, the aim is to illustrate a holistic overview of the discussed possible scenarios – the bypass, the tunnel and the ground-level solution – about the integration of the railway line on city level, the costs, the benefits and the time framework and reconsider some significant preconditions and facts for the final solution in Patras.

The documentation is structured as follows. The introduction refers to the current and provisioned conditions of railway development and funding between Athens-Patras as well as the role and importance of the city of Patras in the decision-making process, the current problem and the initiative of “CODE Patras” project. The next section focuses on those three discussed scenarios clarifying the alignment and providing a rough cost estimation, the benefits and the risks. The third section introduces the solution of “CODE Patras” project compared with the other solutions assessed on city level and in three different sections, which also indicate a step-wise development. Ultimately, the final recommendations delineate considerable synergies between spatial planning, time and decision-making.

Therefore, the core of this synopsis is once again the railway and urban development. At this point, I would like to thank cordially the University of Patras and the NTU Athens, as well as all those interdisciplinary experts and scholars, for their continuous collaboration and support. Without them the project of “CODE Patras” would have been impossible.

I wish this synopsis will contribute further important foundations for the following discussions and projects on the future railway and city development in Patras.

Zurich, July 2018

Dr. Bernd Scholl
Professor of Spatial Development, ETH Zurich

1 Introduction

1.1. Railway development as an objective of European and National importance

After a prolonged socioeconomic crisis, Greece is still facing major challenges. The financial shock wave of international financial markets of late 2009 crippled the country: not only it had too much private debt ended up in speculative private real estate investment, but national (and regional/local) governments had borrowed to fund infrastructure that encouraged such inefficient development – for instance, building roads for unsustainable sprawling development rather than trains for compact sustainable development (Papamichail, Perić 2018). This combined with a complex spatial planning reality set a challenging scene of seminal investments on railway as part of an integral transport infrastructure system along with spatial development. To rehabilitate such socioeconomic conditions, reliable and efficient railway connections can become a strategic backbone for the nation’s spatial and transportation development. With an environmentally friendly transport system, a network of cities and sites can emerge that will create better prerequisites for the future challenges of economic development, contribute to the desired decentralised development of the country, and open new and interesting markets for tourism. (Scholl et al. 2015).

Concerning railway infrastructure in Greece, the connection between Athens-Patras is a component of the European core network and particularly of the Orient/East-Med Corridor (see Fig.1), which is the main axis toward the extension of the TEN-Ts and transport connectivity between Western Balkans, Middle East and Europe. The strategic role of the corridor, and especially of Greece, is also illustrated by Chinese investments on railway and major ports, such as Piraeus and Thessaloniki. However, this corridor is still missing numerous links of multi-modal connections to be constructed or upgraded. One of these links is the connection between Athens – Patras, which is also part of the national strategic transport corridor PATHE (Patras-Athens-Thessaloniki-Eidomeni) (see Fig.2) and more specifically the rail integration in Patras city.

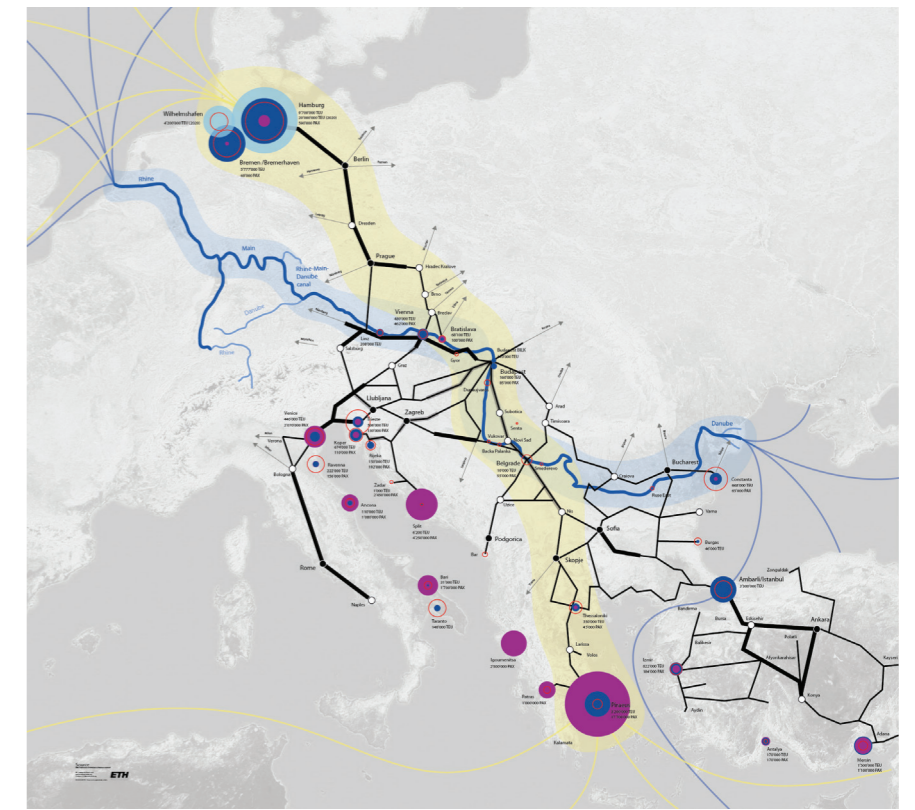
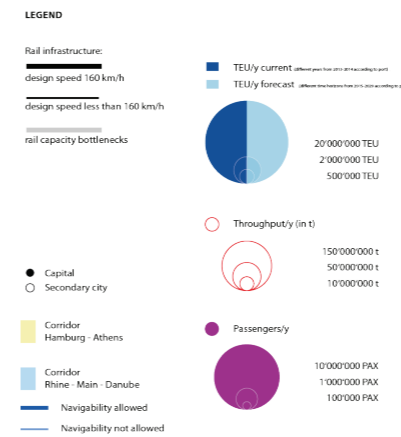


Fig.1: TEN-Ts, Orient/East Med Corridor, (source: ETH, IRL).

Regarding the future tensions on railway development, on national level (see Fig.2) a perspective for future railway development focuses on the construction of “Egnatia” Railway Corridor. Parallel to Egnatia Highway, a railway corridor is considered to connect Igoumenitsa Port with the Port of Thessaloniki and ports of smaller capacity, e.g. Kavala and Alexandroupoli, improving the accessibility for passengers and freight towards the East, the further connection to Europe and consequently the northern part of Greece. Concerning the simultaneous private investment on Thessaloniki Port, which follows the example of Piraeus Port¹, the spatial conditions of the relevant cities and regions regarding railway and urban development will change rapidly. Moreover, another future connection, which is not described on this map, is the one between Patras-Pyrgos-Kalamata (see Fig.2).

Reflecting to all future-mentioned tensions of railway development, the costs of new investments and infrastructure needs between the connected urban nodes should be carefully reconsidered.

1. The privatisation of Thessaloniki Port led to the acquisition of 67% of port’s shares by the Deutsche Invest Equity Partners. This is a German private-equity, Terminal Link is a subsidiary of French CMA CGM – a container transportation and shipping company owned by a French-Lebanese businessman - Belterra Investments belongs to Russian-Greek investor Ivan Savvidis. (ource: <http://www.keptalkinggreece.com/2017/04/24/german-led-consortium-wins-67-stake-thessaloniki-port-for-e231-million/>)

For instance, the railway alignment between Patras-Kalamata already exists and consists a future potential toward the reactivation of Peloponnese railway network for tourism and other economic sectors, while the new sections of “Egnatia” Railway Corridor require a completely new railway alignment (tunnels, land expropriation etc.), crossing the harsh landscape of mountainous northern Greece. At the same time, the freight capacity between Igoumenitsa-Thessaloniki is serviced by the new highway.

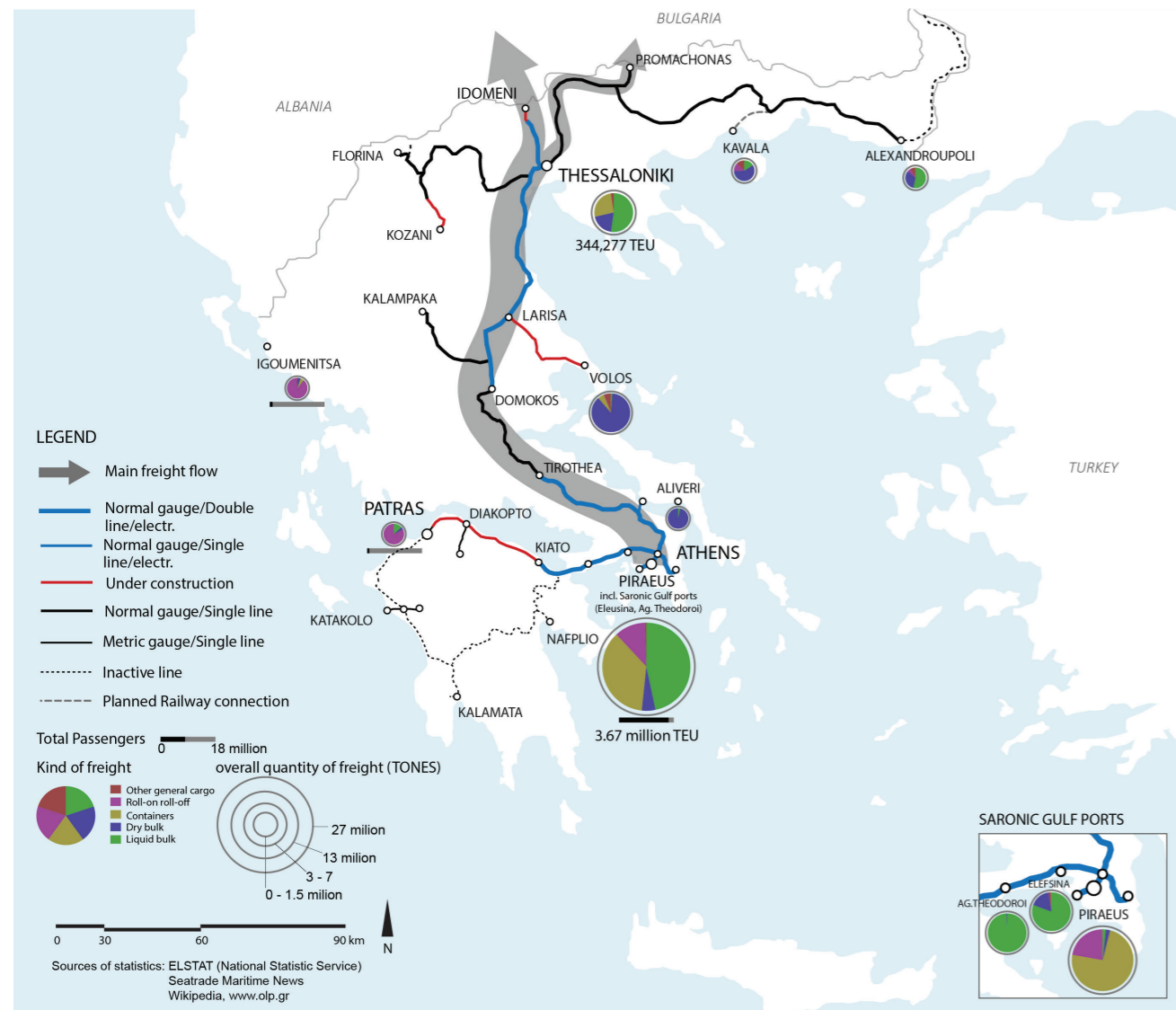


Fig.2: Current and provisioned conditions of the railway network in Greece, (source: ETH, IRL, TP, IT).

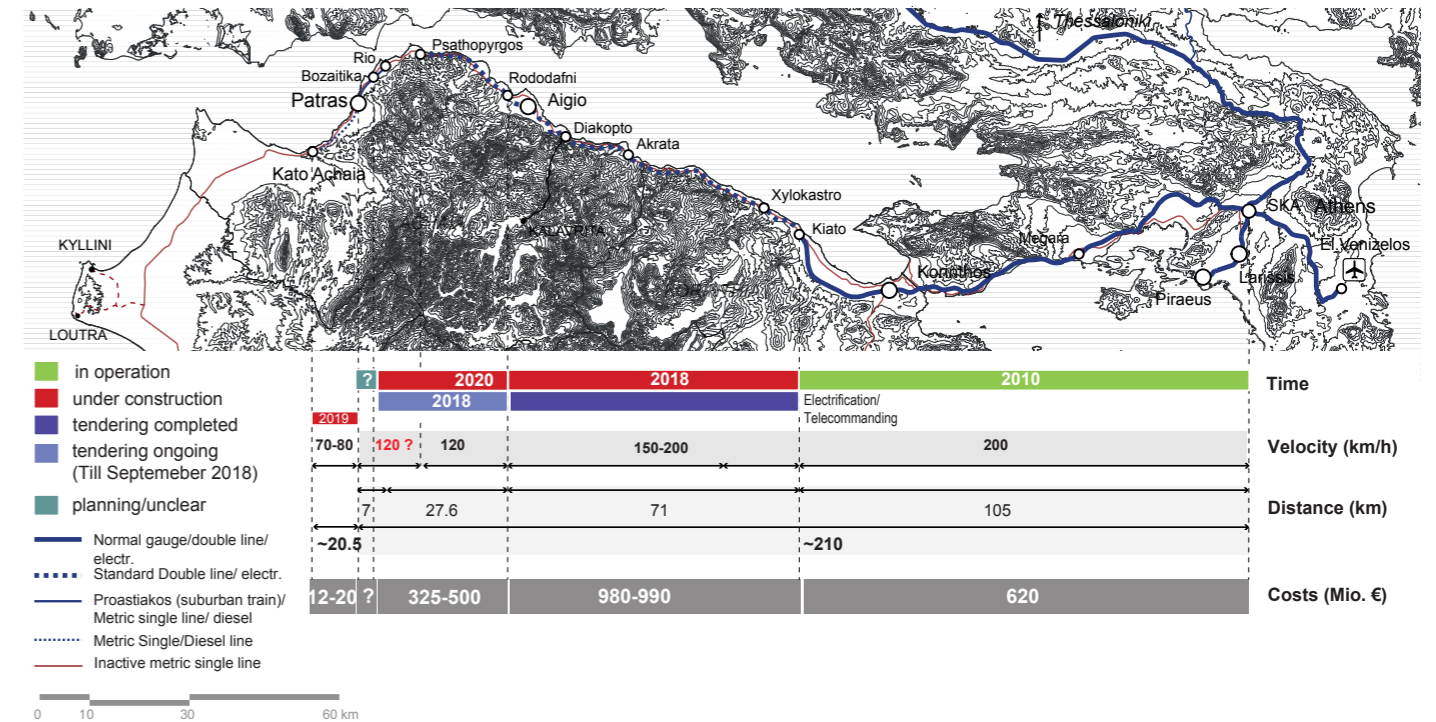


Fig.3: The current conditions and provisioned time framework and projects between Athens-Patras, (source: ETH, IRL, TP, IT).

Thus, a question emerges regarding a step-wise and sustainable railway and urban development. In the case of Peloponnese, the challenge for Patras city to redefine its role as an urban node and establish itself as a multi-modal transport hub, toward the further development and rehabilitation of Peloponnese Peninsula is a circumstance.

1.2. Current situation on the railway corridor Athens-Patras

On regional level according to the current estimations, the connection Athens-Patras is going to be completed in the next five years (see Fig.3). More specifically, the section between Athens-Kiato is in operation since 2010, while the sections between Kiato - Rododafni (Psathopyrgos) and Psathopyrgos - Rio (Bozaitika) are tendered and under construction, instead of the electrification project for the section Rododafni-Bozaitika that is going to be tendered till September 2018. The study for the final section Rio (Bozaitika) - Patras (New Port) has not been completed and submitted yet, since the discussion towards three scenarios - the bypass, the tunnel and the ground-level solution - is underway.

Beyond the last officially announced time framework, funding and tendering procedures as well as some important institutional changes may still influence the completion time of scheduled and upcoming infrastructural projects regarding funding and decision-making. The first one is the end of the present EU funding programme and the beginning of

the next one 2021-2027, for which any future projects should be submitted in order to be included. Moreover, the European Parliament Elections in 2019, as well as the parliamentary along with municipal and regional elections in Greece the same year should be considered as a transition period with its respective challenges.

1.3. The importance of Patras as a multi-modal transport and urban node

Instead of the above-mentioned importance of Athens-Patras railway connection as a component of the Orient/East Med Corridor and the national transport corridor PATHE, the city of Patras has also a key role in regional and local development. Concerning port facilities, Patras' new port is recognized as the only core maritime port in Peloponnese region (as a geographic entity), for which a railway connection is foreseen (EU Regulation No 1315/2013). Moreover, Patras Port is part of the MoS EU Programme and particularly the MoS Venice-Igoumenitsa/Patras initiative, which aims at upgrading the existing maritime link connecting the TEN-T core ports of Venice and Patras. It foresees port investments that will enable to concentrate freight flows in viable, regular and reliable MoS link and enhance its integration in the Core Network Corridors (Baltic-Adriatic and Mediterranean Corridors in Venice and Orient-East Med corridor in Patras), by expanding ports capacity and optimizing the management of cargo flows. Instead of the importance of Patras Port, given the freight and passenger flow circumstances in Greece (see Fig.2), the kind and investment of railway connection between the city center and the new port is questioned concerning its feasibility. This means an in-depth view and reconsideration of the strategy towards current and future capacity and kind of freight flows should be the core of attention of Patras Port Authorities.

Given a broader view of the population and economic activities of Patras, Of the 310'000 residents who live in Achaia Prefecture, 214'000 persons live in Patras (2011). In Ileia, in contrast, 75% of the population live in rural areas. The national population of Greece is mainly concentrated in the coastal regions. The economy of Patras is based mainly on small businesses, which

are based on commercial, education, tourism and agriculture. Regarding tourism, 60.4% of all employees work in this sector, while 90% of the companies operate in the coastal regions. Looking at the number of hotel beds, 3'874 in Achaia and 4'039 in Ileia are available (data from 2010) which decreased by 61% and 66% respectively since 2008. Despite the fact that businesses started to shrink, agricultural production still represents a basic activity with citrus fruit, tomatoes, olive oil, and potatoes for Achaia Regional Unit (Prefecture). In 2008, Achaia generated a scant 3% and Ileia just 1% of the Greek GNP (gross national product) (MAS Task Mission 2017).

Another important economic factor concerns Patras as an educational center. A significant number of almost 28'000 students in University and TEI (Technical Institute) support city's economy. Finally, Patras harbour still keeps a great position of all passenger's transportation in Greece. However, the unemployment rates remain relatively high for Achaia Regional Unit (Prefecture) reaching approximately 48.64% of Region of Western Greece and an increased burden rate of unemployment of 10,91%. Nevertheless, according to a study carried out by the University of Patras, Achaia region and the city of Patras, is still perceived as the optimal location concentrating the main bulk of infrastructure, services and access to nature, delineating a direction for the future spatial development (MAS Task Mission 2017).

Tourism may be considered as another future potential. Patras city could be transformed into a node of conference, cultural, religion and urban tourism. Take for instance, the University and Science Park that gather several conferences and research activities supported by sufficient accommodation and other facilities. In addition to this, several cultural sites, such as the castle, the roman agora, the new archaeological museum etc., the combination of sea and mountainous areas, the ski centre in Kalavryta and the broader region are attractions for a long weekend destination. Last but no least, the cathedral church of Agios Andreas attracts a great number of orthodox visitors from Russia or other Balkan areas. Another question is the capacity of port infrastructure concerning cruise ships and hydroplanes since the port and the geomorphology have a potential.

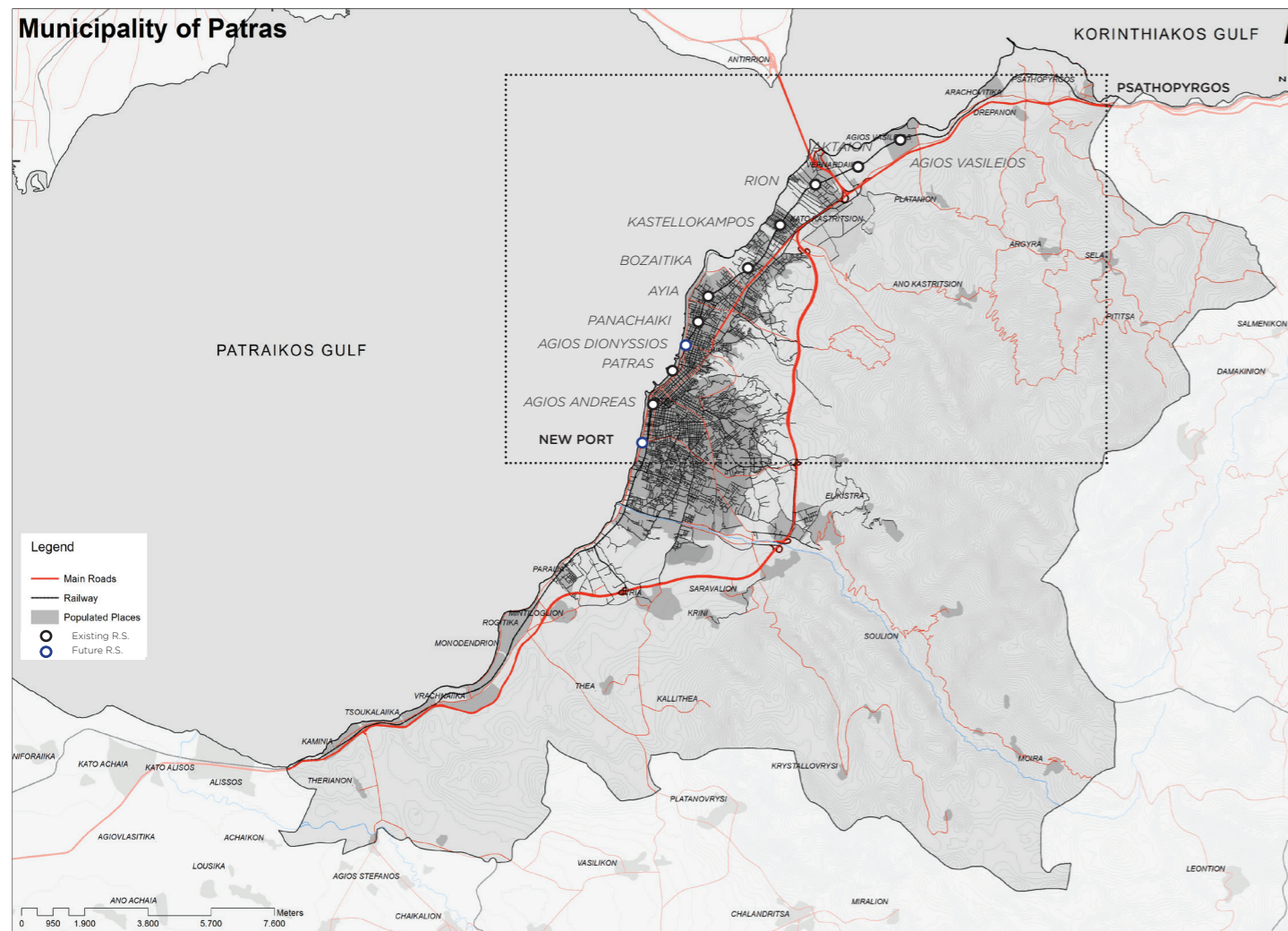


Fig.4: Map of the Municipality of Patras, (source: V.Pappas, 2017, names and symbols of railway stations, and the perimeter framework are added).

Considering global tourism trends and ideas, Patras could develop new strategies on city tourism based on shared local experience and co-creation of places capturing the interest of various travelers, since more people, who travel either for leisure or business, are attracted by the authenticity and knowledge for local places and habits (Strategy 2020, DMO). Hence, tourism development can be an urban catalyst and enhance multiple synergies between different economic sectors for Patras and Peloponnese Region. To support such accessibility and cooperation on different levels, Patras role as a multi-modal hub is still under question.

1.4. The problem of railway and city development

Originally, and after decades of discussions, it was planned that Patras would build an urban tunnel and an underground station using the normal track gauge railway for the connection to Athens, as it is provided by the official General Urban Plan of the city (see Annex A.2). This means the meter gauge system would have to be replaced. The high cost of over 700 Mio € blocked this solution. Another scenario in public discussion was the bypass solution, which was included at the official plan of 1980's before the underground proposal, exceeding the amount of 700 Mio €. Other alternatives did not exist. It should also be mentioned that before both scenarios being integrated into the official urban plan, they were never tested for costs, time efficiency and their contribution to an integral plan of sustainable transport using a preliminary feasibility study or other planning instruments. As a result, both of these solutions were rejected from EU funding programmes in the past mainly due to high costs and time efficiency.

This is related to shortcomings of the formal planning system, the efforts of which, plagued by administrative disagreements and political contests have produced competing unilateral project plans undermining hopes for coordination and failing to make the necessary adjustments to yield practical railway integration feasible and affordable.

Considering railway development as a catalyst for urban and economic rehabilitation, neither the bypass or the tunnel solution provided a simultaneous urban and landscape development approach, nor considered the administrative fragmentation of land-use of the areas crossed by the existing railway line creating a conflict of interest among numerous stakeholders. However, an integral and simultaneous railway and city development is indispensable due to:

- The specific landscape features, such as the green areas the streams and the city's waterfront
- The changing elevation of the railway alignment
- The vicinity and identity of adjacent neighborhoods (suburban, dense or non-dense populated areas)

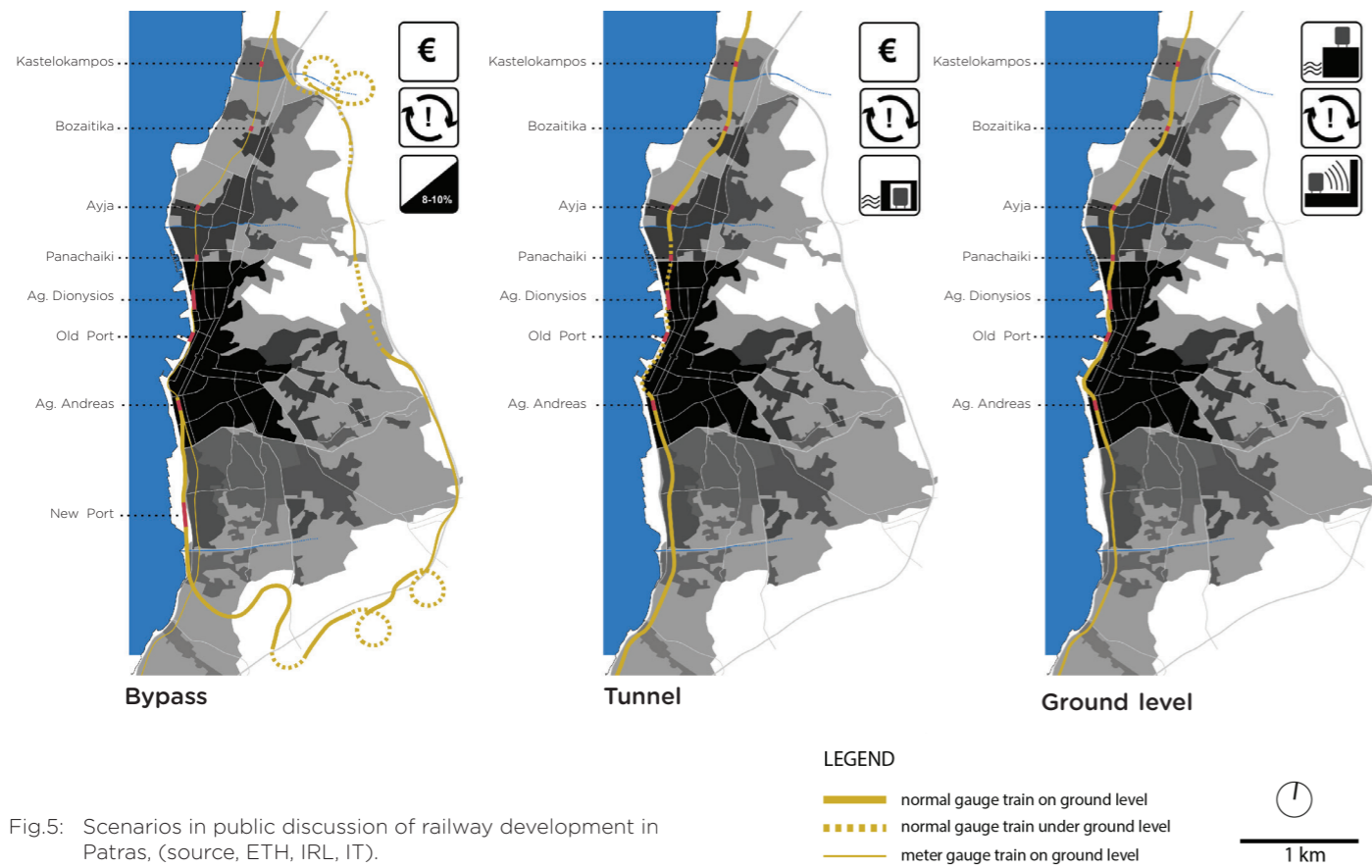


Fig.5: Scenarios in public discussion of railway development in Patras, (source, ETH, IRL, IT).

- The combination of other public transport and planned infrastructural projects
- The urban and cultural locations and networks of interest and daily transport

Comprehensive and integral plans can only be produced and implemented based on consensus including all these groups of interest influenced by them. To do so, new synergies among all interested groups using shared market risk and reward versus commands using hierarchical mandates and bureaucratic entitlement are necessary.

1.5. The initiative of Code Patras project and the Test Planning Process

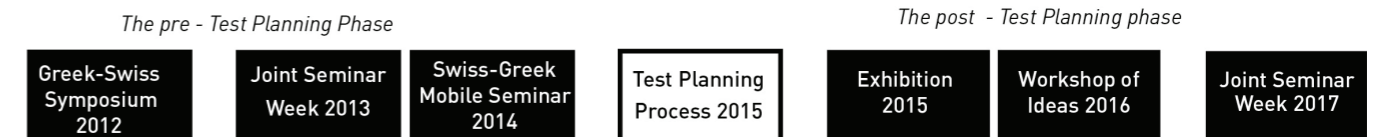
Upon considering the fore mentioned situation, the University of Patras, the National Technical University of Athens and ETH Zurich decided to initiate a project, called Code Patras, to explore alternative scenarios of simultaneous rail and city development in consecutive steps. The whole project started since November 2012 and was completed in June 2017 (see Fig.6), while each step was complementary to another oriented in problem exploring and solving and in trust-building.

The core of the whole project was the Test Planning Process (TPP), which took place between December 2014 and July 2015. The Test Planning Process is an informal planning method for creating concrete and feasible proposals and solving the challenging tasks in spatial planning, while it is a broadly used method in different contexts. Many cities were pioneers in implementing the TPP, such as: Vienna's need for the Danube River flood protection (Vienna Model); Frankfurt's regeneration of the urban area along the Main River waterfront (Stadtraum Main); or Swiss cases of Solothurn's revitalization of one of the largest brownfields and the

Communication with the Public

Continuing communication: press release/publication, invitation and information of the stakeholders

Steps of the whole process in Patras



Steps of the Test Planning Process in Patras

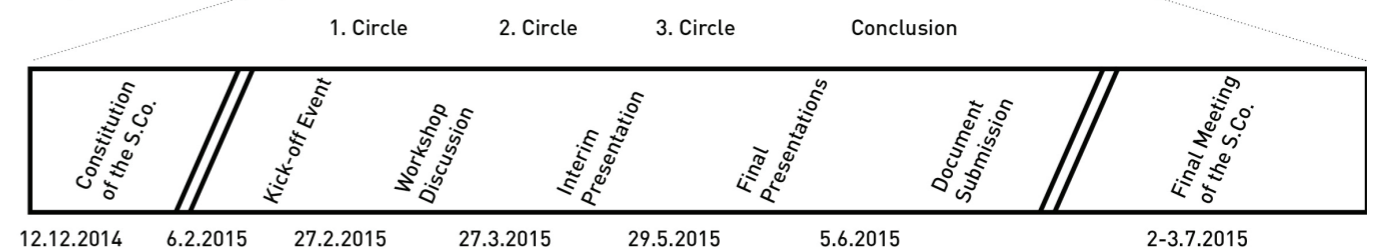


Fig.6: Time framework and steps of the Code Patras project and the Test Planning Process, (source: ETH, IRL, TP).

transformation of the abandoned military airport Dübendorf (Scholl 2017). In the case of Patras, the Test Planning Process lasted six months and was realized in consecutive steps (see Fig. 6). Beyond any formal plans and political announcements, Test Planning Process as an informal planning method contributed, as a pioneer process for Greece, in the following issues (Papamichail, Perić 2018):

- It opened and established an intensive public discussion about the rail and city development.
- It provided a modest form of networking as it encouraged different stakeholders, i.e. the OSE and the ERGOSE to join the process. Representatives from these organizations who held opposing positions at the beginning had found they could converge towards a common solution at the end.
- It built assessment and feed-back into the cycles of plan making linking expert and political judgment in the rhythm of working together.
- It broke formal bureaucratic plan making into a series of small group conversations focused on problem setting and solving efforts.
- The diversity and interdependence among the planning teams and the Steering Committee members assured diverse approaches to composing scenarios and tracking risks or benefits across multiple stakeholder interests.
- The TPP participation structure insulated participants from conventional roles as they engaged in dialogue as members of the Steering Committee or planning teams using discourse to compose and assess scenarios in terms of diverse interests.

Proastiakos and Urban Transport System in Patras:

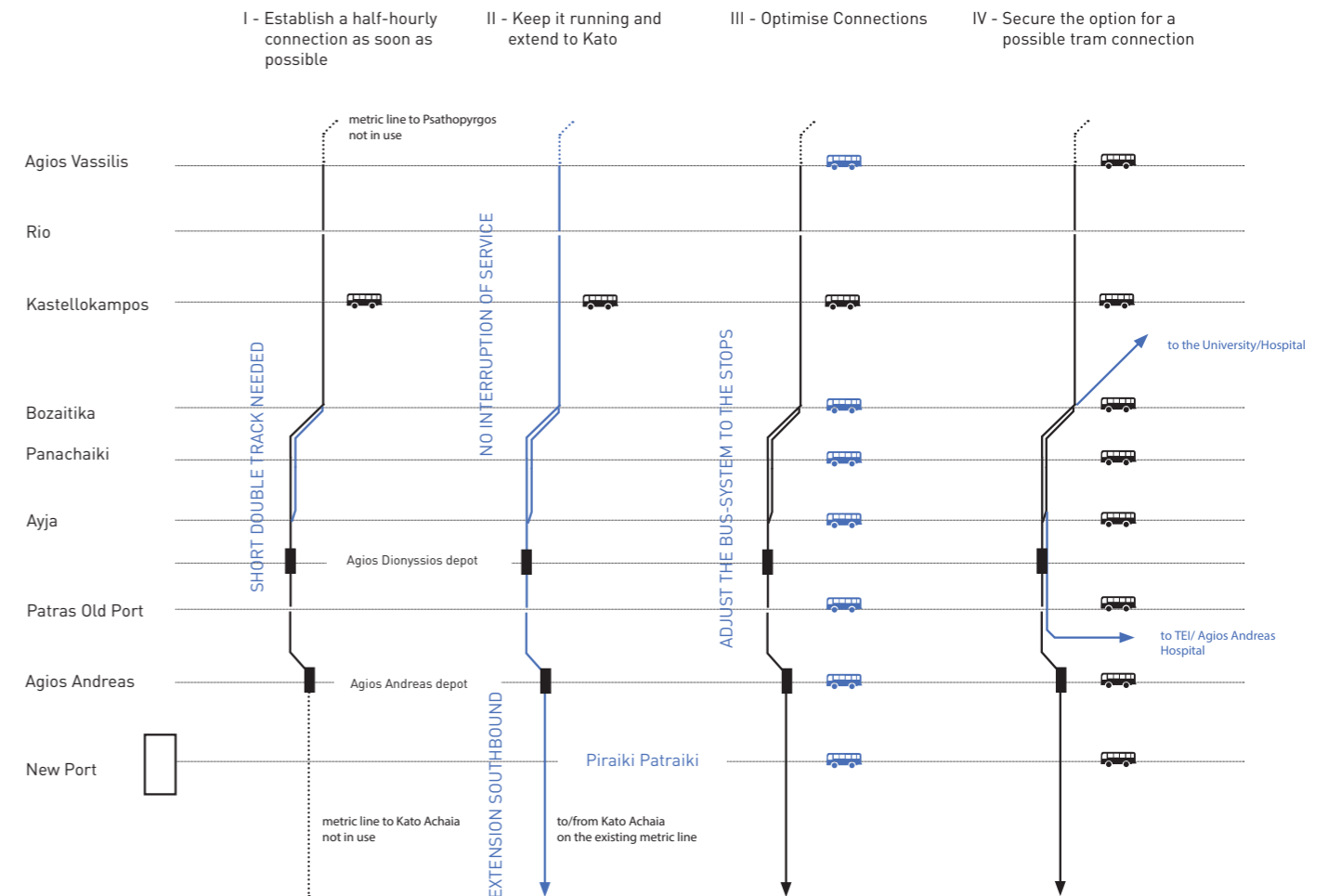


Fig.7: Recommendations of the Test Planning Process on Proastiakos and urban transport system in Patras, (source: ETH, IRL, TPP 2015).

Development of the Railway infrastructure in Patras

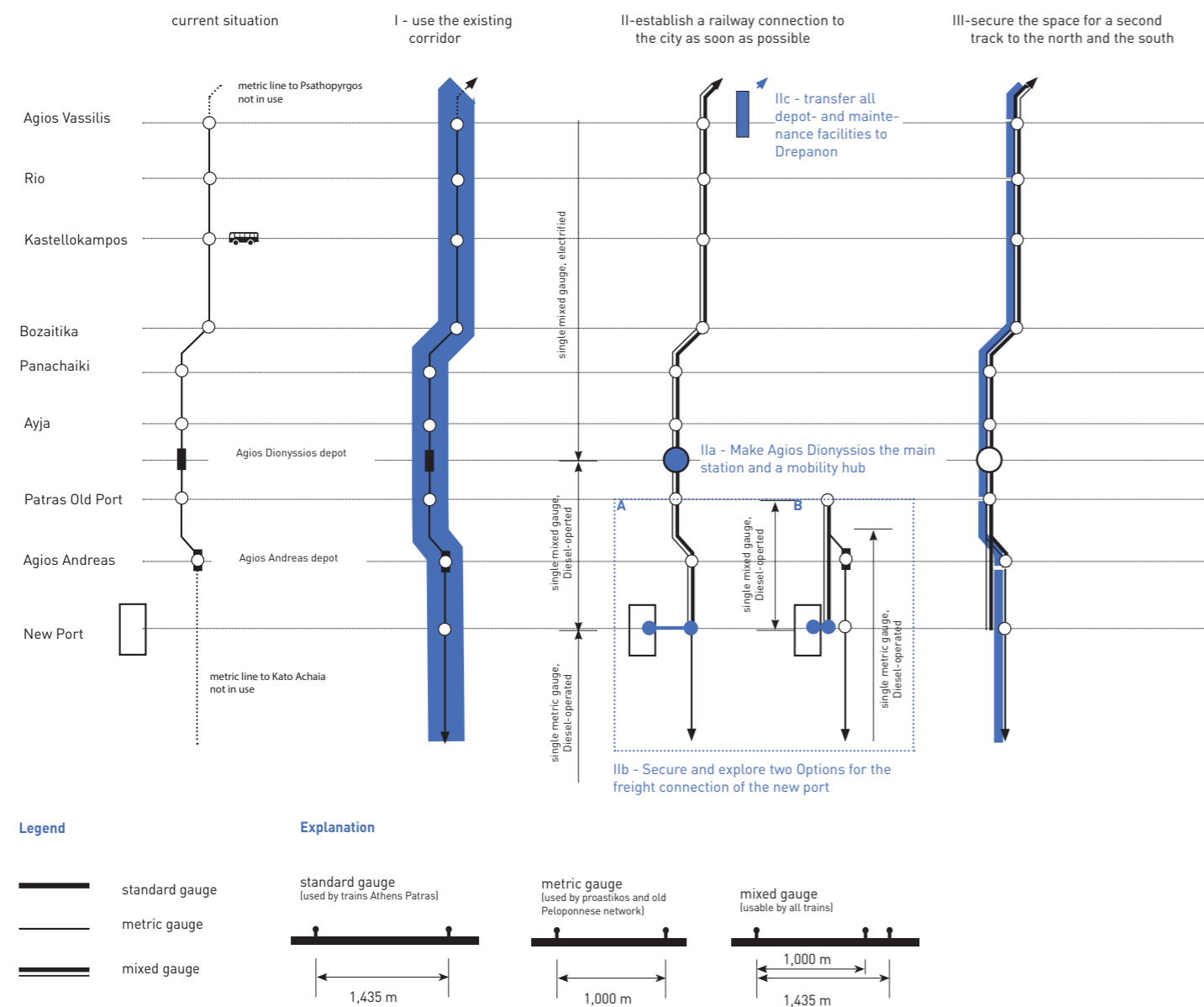


Fig.8: Recommendations of the Test Planning Process about the railway infrastructure in Patras (source: TPP 2015).

Concerning the recommendations about rail and city development, the Test Planning Process led to the following conclusions:

- The recommendations of the Test-Planning Process formulate a feasible solution for the integration of the new railway line into the city of Patras and the new port with simultaneous urban and landscape development. This solution is based on the premises of minimal use of financial resources as well as the possibility of stepwise development.
- In addition, it allows maintaining Proastiakos (suburban train) in service during the construction phase.
- One main finding of the process was that Agios Dionysios' location as the main station is crucial for the success of the railway line and further city development.
- However, the discussion of this solution showed, that different options of the proposed alignment should be discussed in order to improve the integration of the railway into the partially densely populated urban areas.
- These options should not contradict the aim of reaching the city center of Patras and the port at the earliest possible moment to use the full potential of the line as passenger and freight-connection.

1.6. Conclusions

Given the fore mentioned overview of railway and city development in Patras, some concluding remarks are following:

- The stepwise development of the railway line between Kiato-Patras (component of the PATHE corridor), is underway and at least tendered until the borders of the city of Patras (Bozaitika).
- This does not include the rail connection with Patras port - which consists a fundamental condition for financing the railway corridor, neither the rail connection with the city center - a precondition for an attractive conventional and touristic passenger service between Athens and Patras.

- The official (and unofficial) concepts for integrating the railway into the city centre of Patras concentrate on avoiding freight traffic in the city through bypass- or tunnel-solutions.
- The high costs and technical requirements of these solutions can neither be financed, nor realized within a reasonable time frame.

To prevent a project bottleneck and manifest an enduring provisory solution of a terminal station in the outskirts of Patras, in Bozaitika, (which might cause severe problems of traffic and settlement development), new approaches and solutions have to be found.

2 Assessment of recently discussed options for the railway integration into the city of Patras

Despite the recommendations of the Test Planning Process, the discussion of options about the railway integration into the city of Patras is still underway. In this light, a more detailed assessment of the remaining options was conducted. The assessment builds up on the assumption, that the currently tendered section between Rio and Bozaitika might be the status quo for a long time, if there is no decision for the ongoing alignment. This scenario contains the risk, that a temporary main station in Patras would be located in the suburban outskirts of the city. This might cause severe consequences for the surrounding areas, both spatially and traffic-wise, while it could also lead to a reduction of passengers due to the distance of the station to the city centre.

Therefore the examined options are not only assessed on their technical and financial feasibility, but also on the possibility of short-term realisation and stepwise development.

2.1. The long tunnel, the short tunnel and the ground-level alignment

The assessment consists of a detailed test of possible alignments along with the needed gradients. Furthermore, the cost estimation, modes of operation and possible steps of realisation are provided.

The three assessed options are:

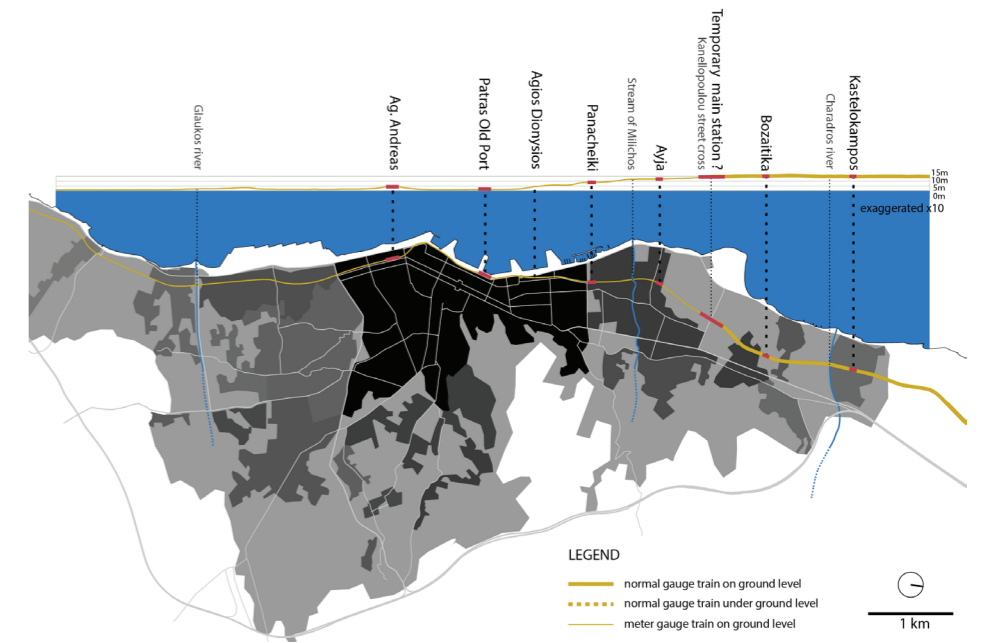


Fig.9: Situation in Patras after completion of the now tendered projects, (source, ETH, IRL, IT, MN, TP).

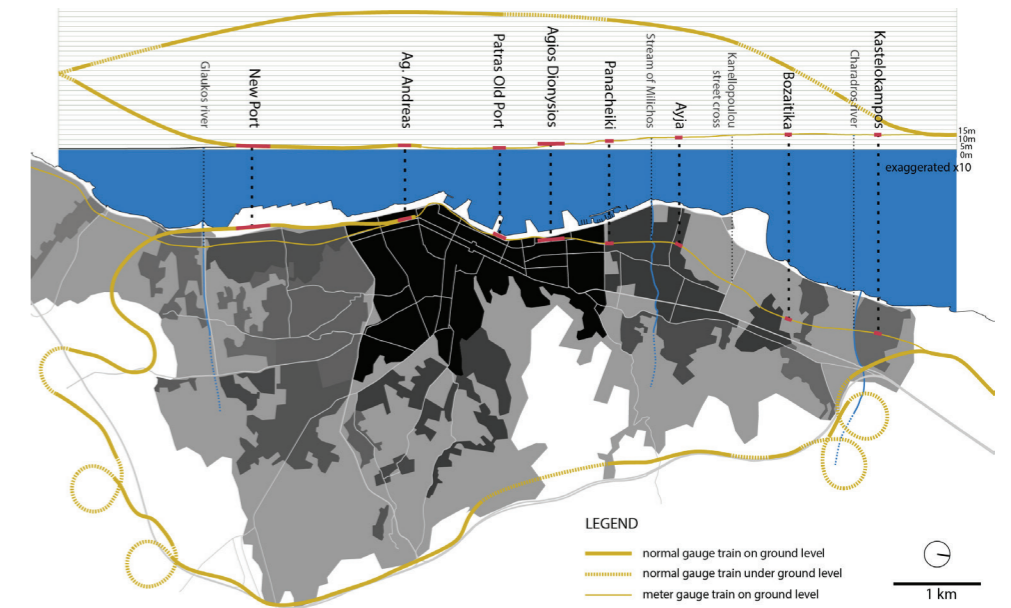
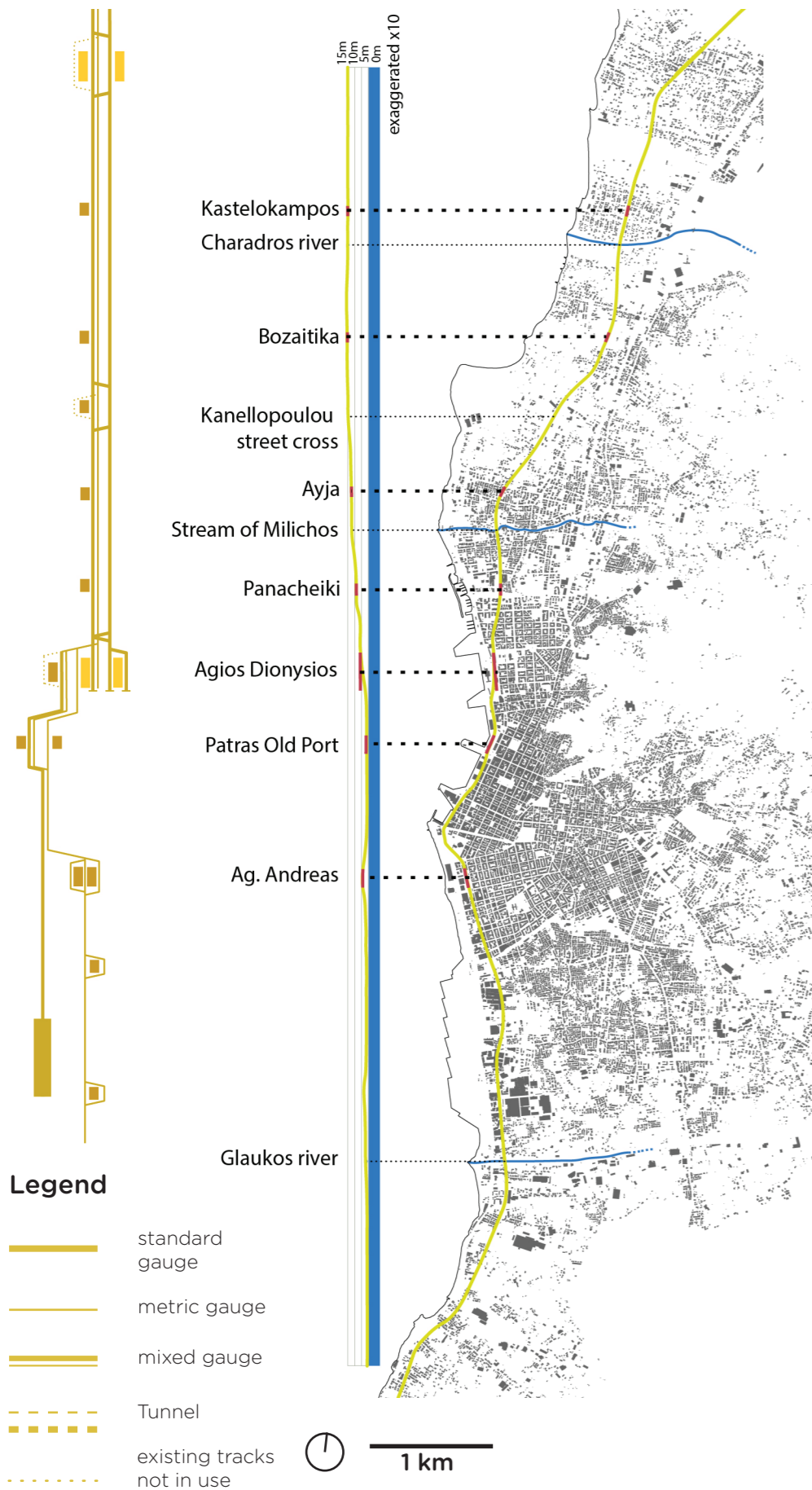


Fig.10: Interpretation of the discussed bypass-solution. Alignment alongside the Motorway source, (ETH, IRL, IT, MN, TP).

- The ground-level solution (as recommended in the Test Planning Process)
- The long tunnel solution (official GUP Patras)
- The short tunnel solution (former proposal of ERGOSE)

The bypass solution is not introduced into detailed assessment, since, besides the costs, this option does not serve the dense populated areas in the city and it is not feasible for train operation due to the high gradients. Especially for freight trains, this would mean adding additional or more powerful locomotives only for the bypass in the periphery of Patras.



Description

- Connection Athens-Patras with IC-Service (normal line)
- Proastiakos (suburban, metric line) every half an hour
- Services further south optional metric/normal
- Freight traffic through the city (pedestrian velocity)

Year of the study

2015 (TPP)

Estimated costs

Approx. 250 Mio € (incl. the central Railway station in AD)

Unclear

- Future of the metric line system further south
- Operation of Proastiakos during construction phase

2.2. The ground level solution

The ground level solution was elaborated and recommended during the Test Planning Process in Patras. It offers an early introduction of the railway line into the city centre, which is considered as crucial for the success of the train connection.

The major disadvantage of this option is the fact, that the southbound traffic (including possible freight trains) runs between the city and the waterfront. This can be handled with operational and constructional measures, such as a slab track and a massive reduction of velocity (especially for freight trains). Examples in other cities show, that up to a certain number of trains this system works without safety problems and it is easily integrated into city life.

Benefits

- Stepwise development possible
- Short-term building time
- Flexibility of infrastructure development in Agios Dionysios
- Decision about next steps can be taken later

Risks

- Railway through the city (also freight trains)
- Noise emission
- Proastiakos (suburban train) could be interrupted during construction phase

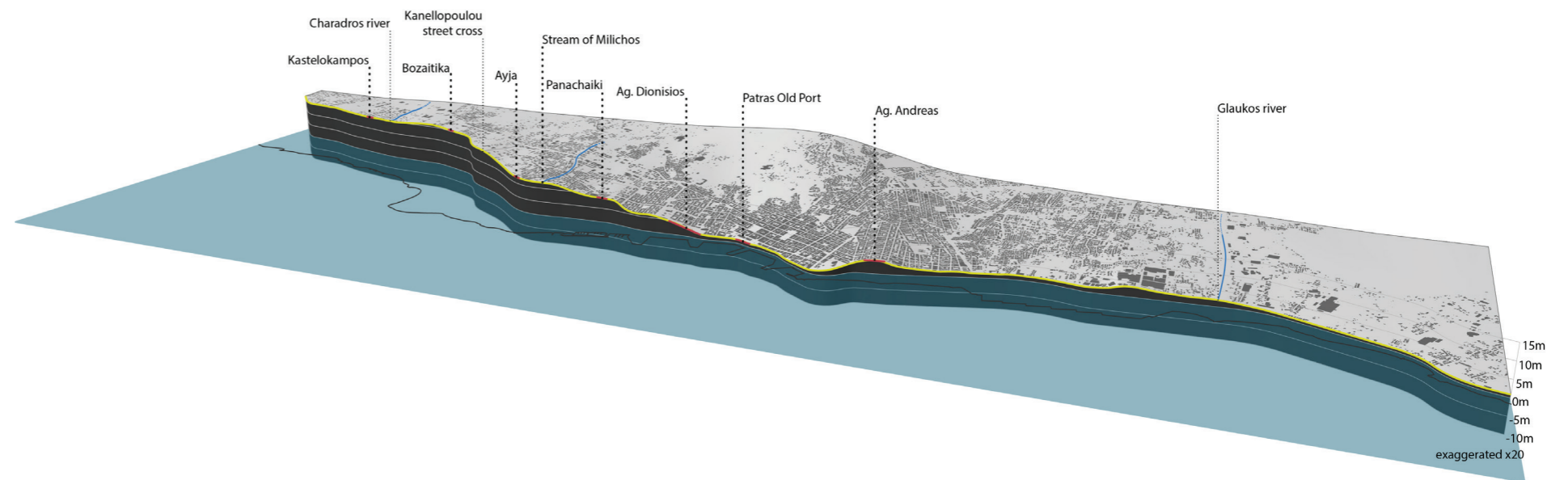
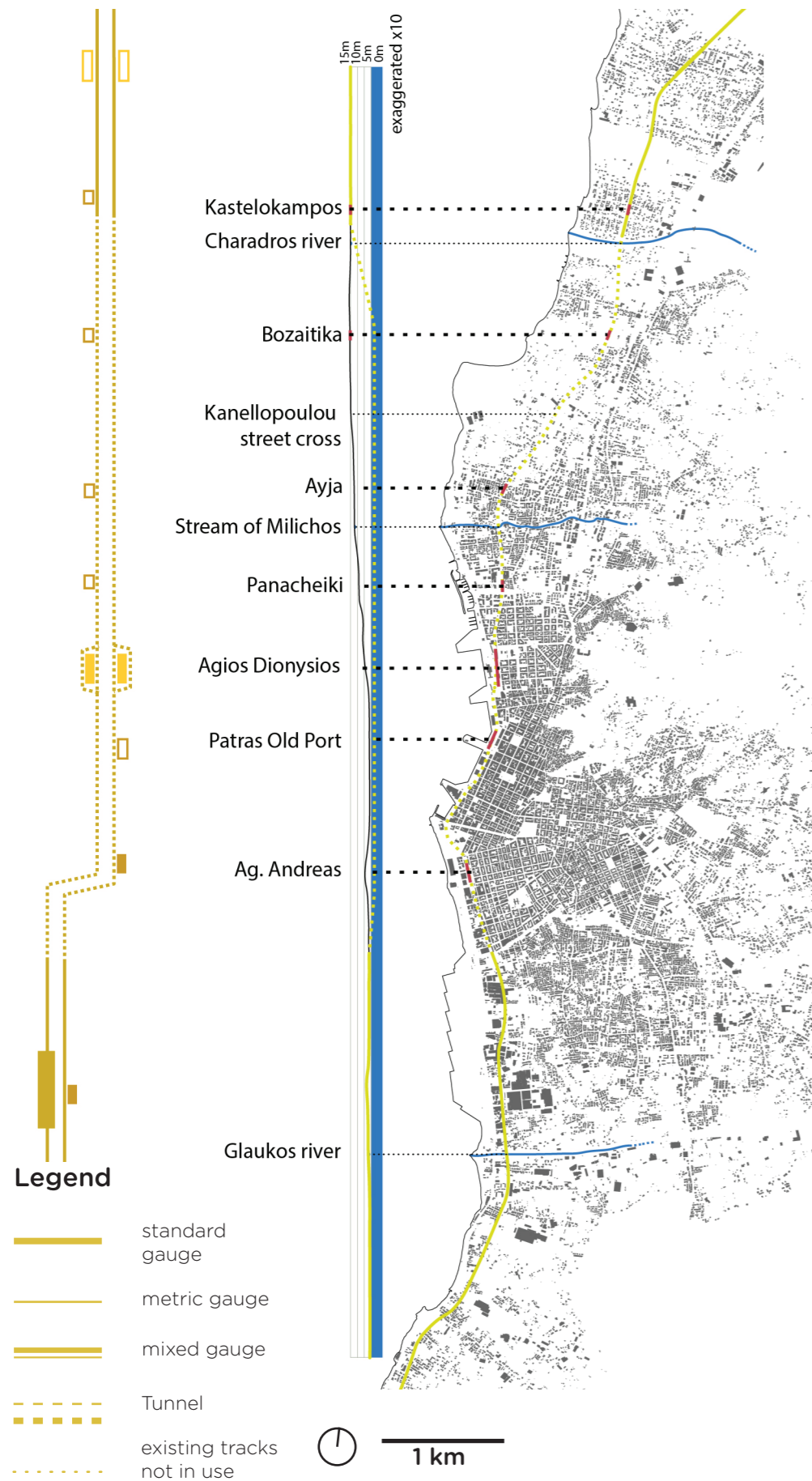


Fig.11: Master plan of the railway development of the ground solution, (source ETH, IRL, IT, MN).

Fig.12: The ground level option in bird's eye view (Cut of the ground along the alignment in order to display better the trajectory options), (source ETH, IRL, IT).



Description

- Connection Athens-Patras with IC-Service (normal line)
- Proastiakos (suburban, metric line) every half an hour
- Services further south possible but unclear
- Freight traffic in the tunnel

Year of the study

2009
(General Urban Plan)

Estimated costs

aprox. 700 Mio €
(No cost estimation before integrated into the General Urban Plan)

Unclear

- The ramps of the tunnel (15m of height difference)
- The system further south
- The operation of Proastiakos (suburban train) (how many underground stations?)
- Maintenance facilities

2.3. The long tunnel

The General Urban Plan still shows the option of a long tunnel between the station of Kastelokampos and Agios Andreas with additional underground stations in Agios Dionysios and Patras city centre. It relieves the city completely from train traffic.

However, the long tunnel is the most cost intensive option and might exceed estimated costs - not only during the construction phase, but also in maintenance, since the main tunnel section has to be located under the sea level.

Besides the problem, that the built tunnel infrastructure cannot be transformed or extended afterwards, an open question is how many intermediate stations will be possible. The risk is therefore, that the line cannot serve as suburban service, which is the current situation.

Benefits

- No noise emissions and infrastructure in the city
- Enough capacity
- Higher speeds possible
- Proastiakos (suburban train) can partly stay in service during construction phase

Risks

- Long-term realisation phase
- High costs of construction and maintenance
- No flexibility for future changes (further south)
- No extension possible

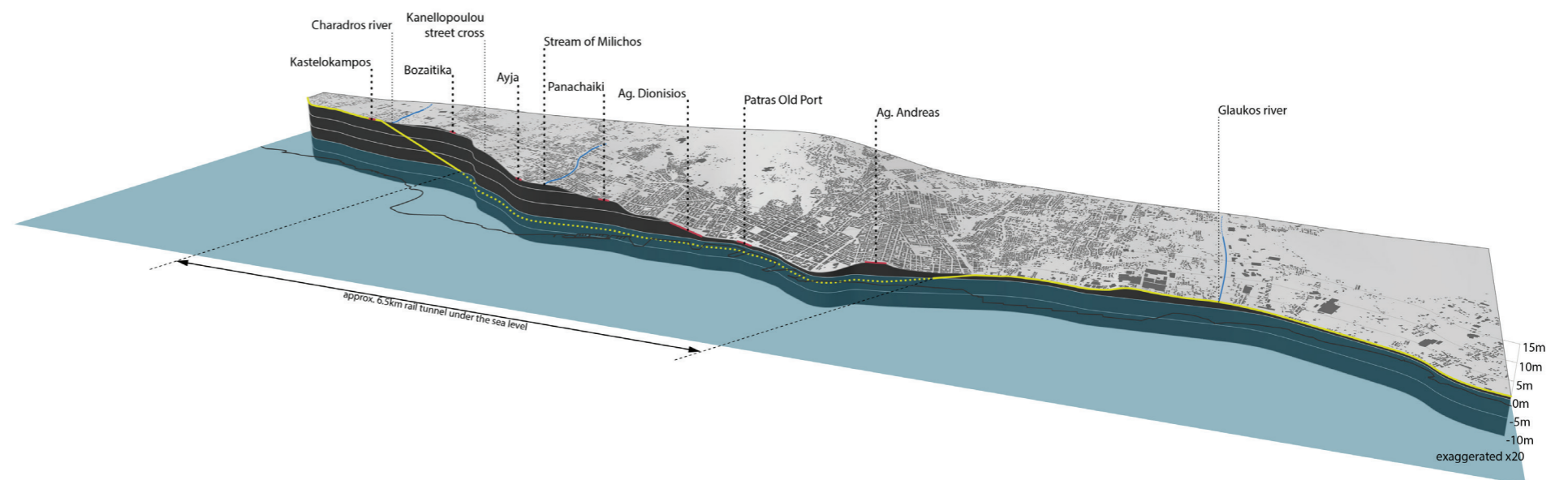


Fig.13: Master plan of the railway development of the long tunnel solution, (source ETH, IRL, IT, MN).

Fig.14: The long tunnel in Bird's eye view (Cut of the ground along the alignment in order to display better the trajectory options), (source ETH, IRL, IT).

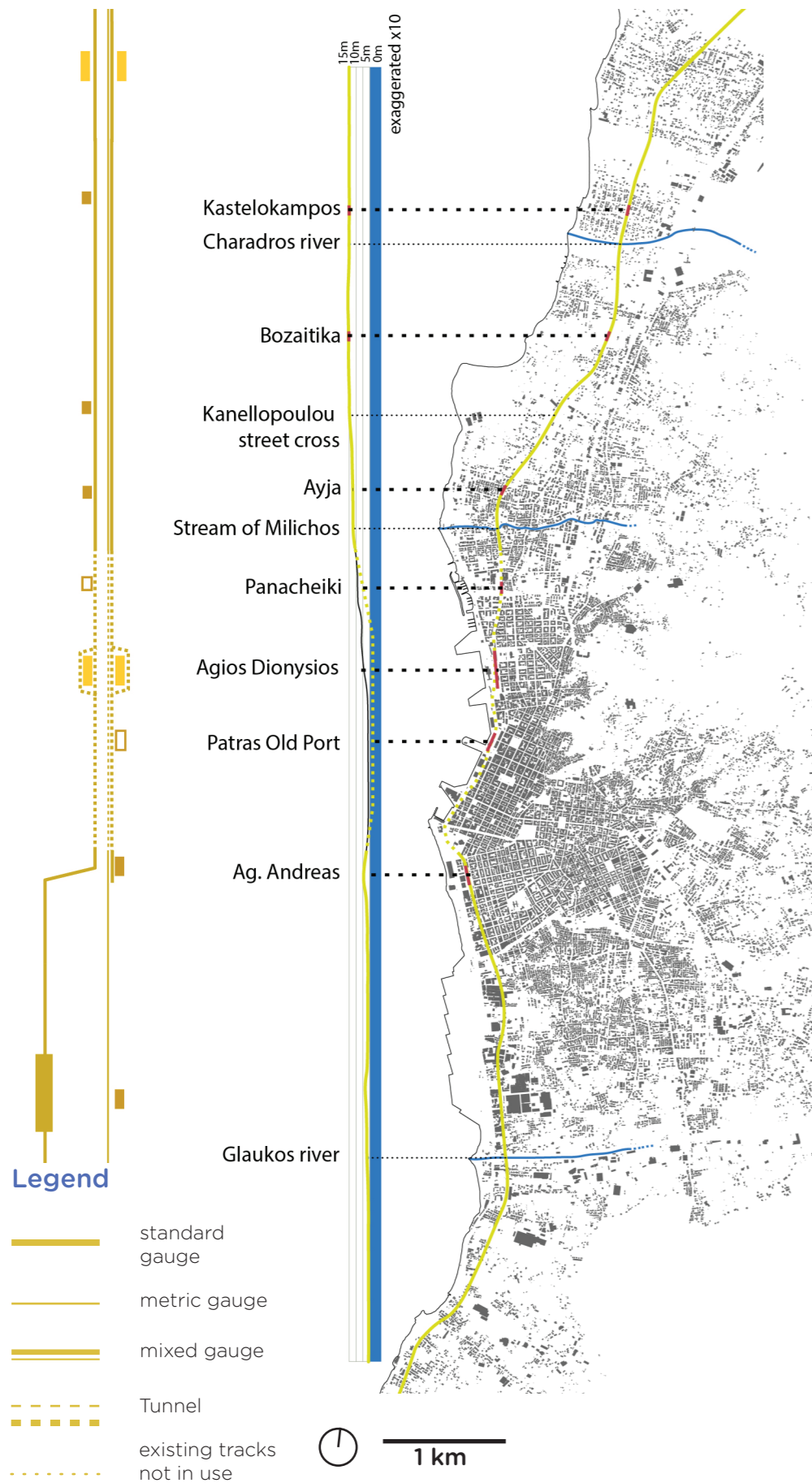


Fig.15: Master plan of the railway development of the short tunnel solution, (source ETH, IRL, IT, MN).

Description

- Connection Athens-Patras with IC-Service (normal line)
- Proastiakos (suburban, metric line) every half an hour
- Services further south possible but unclear
- Freight traffic in the tunnel

Year of the study

2007/2017
(similar proposal)

Estimated costs

Approx. 350 Mio € (without incl. the central station)

Unclear

- Ramps of the tunnel (15m of height difference)
- System further south
- Operation of Proastiakos (how many underground stations?)
- Maintenance facilities

2.4. The short tunnel

The short tunnel is a proposal of the Greek railway infrastructure organisation ERGOSE proposed in 2007 and again in 2017. It shares the same advantages and disadvantages with the long tunnel option - just on shorter length. Therefore, more stations could be reached by a possible future commuter service.

Similar to the long tunnel option, one of the main risks of such infrastructure is the given uncertainties of funding and the final costs, which might exceed the estimation of 350 Mio €. One additional disadvantage is, that the northern areas of Patras will be nevertheless affected by rail traffic, as with the ground level option.

Benefits

- No noise emissions and infrastructure in the city
- Enough capacity
- Higher speeds possible
- Proastiakos (suburban train) can partly stay in service during construction phase

Risks

- Long-term realisation phase
- High costs of construction and maintenance
- No flexibility for future changes (further south)
- No extension possible

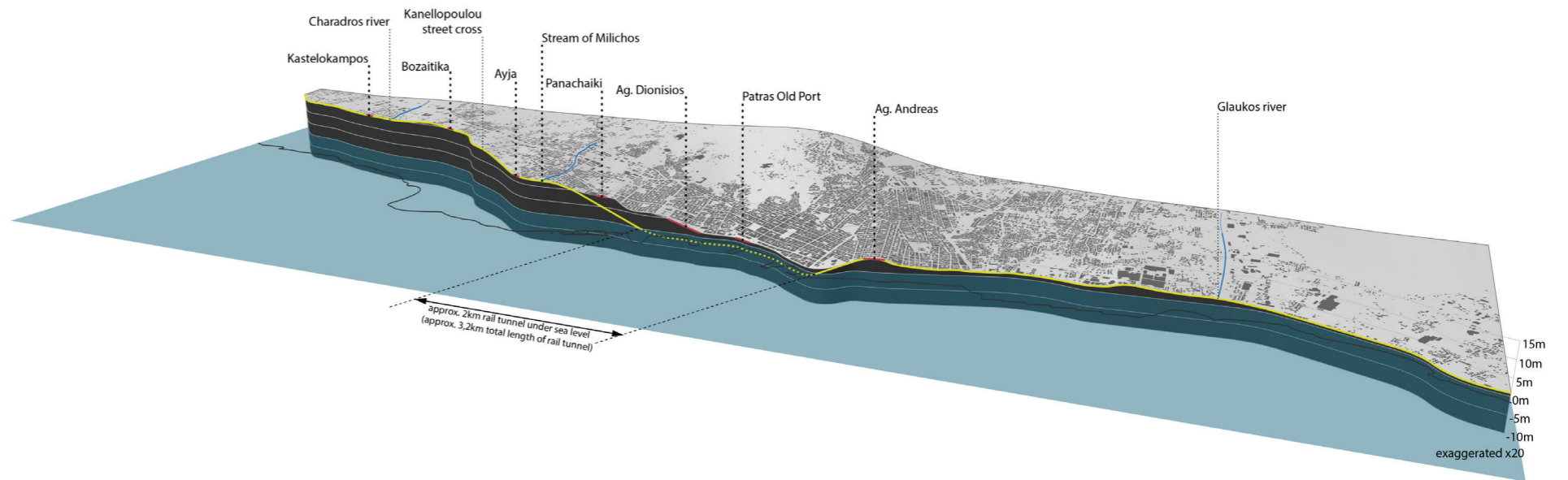


Fig.16: The short tunnel in Bird's eye view (Cut of the ground along the alignment in order to display better the trajectory options), (source ETH, IRL, IT).

2.5. Conclusions

Common examples of such situations illustrate that different options lead to a dilemma between those solutions, which either solve technically spatial problems or offer a certain reliability of costs and short-term realisation, both along with some disadvantages. Taking a closer look to the assessment, it can clearly favour the ground level option out of several reasons:

- The aim to reach Patras city centre by the railway as soon as possible is crucial both for the city development and the railway operator. The advantage of the rail connection to Athens is obviously the direct connection between both centres without losing time in the outskirts of both cities. If this advantage is not considered, the risk is eminent, that the new connection won't be used despite the completed and planned huge investments. Due to the current conditions, the tunnel options risk to delay by years the connection to Patras centre, till they are financed and constructed.
- The ground level solution is the only option which can be realised stepwise and therefore offers the possibility to reach the centre of Patras also with reduced infrastructure investments.
- It is still unclear, how and in which operational mode the railway will continue further south. Due to the fact that Peloponnese Peninsula still possesses a more or less functioning metric line railway system, Patras could be the inter-modal hub between the national and regional system. Only with the ground level solution, this decision may stay open until further notice and be implemented afterwards without high costs.

Nevertheless the recommended ground level solution has some open questions, which should be clarified further:

- Within the given perimeter, the railway line crosses one of the most densely populated areas within the Peloponnese region. The recommended proposal is optimised in terms of limited financial means and therefore offers no flanking measures to ease the negative effects of this intervention.
- The integration of Agios Dionysios Station into the urban fabric has to be tested further regarding also possible enhancements.
- The connection to the new port of Patras shows still different possibilities, which should also be clarified.

3 Assessment of the ground level solution - clarification of open questions

As it is already discussed, the recommended ground level option still sets open questions to be clarified in order to proceed with further steps. This clarification should be conducted at a deeper technical level than the current state of knowledge. Nevertheless, a preliminary study can provide valuable insights into future discussions. The preliminary studies may focus on three sections of the line:

- The station of Agios Dionysios
- The section between Bozaitika and Agios Dionysios
- The connection to the New Port

3.1. The station of Agios Dionysios

Regardless the assessed option, the former depot of Agios Dionysios has prevailed as the optimal site for the main station in Patras. The recommended solution of the Test Planning Process is the so called "split-level solution", which aims to reach the requirements of the national railway services to Athens, the regional and suburban services (Proastiakos) as well as the freight traffic with the minimum financial resources.

The possible layout and requirements of this solution were to be tested as well as its comparison with another option - the so called "harbour-level option". These two options were tested with the following station layout:

- Four (dead end) normal gauge tracks with a platform length of 300 m to host trains from Athens.
- One metric gauge track with a platform length of 200 m to serve the Proastiakos and possible regional trains further south.
- One track of mixed gauge for Proastiakos and possible regional trains further south as well as freight trains from and to the new port.

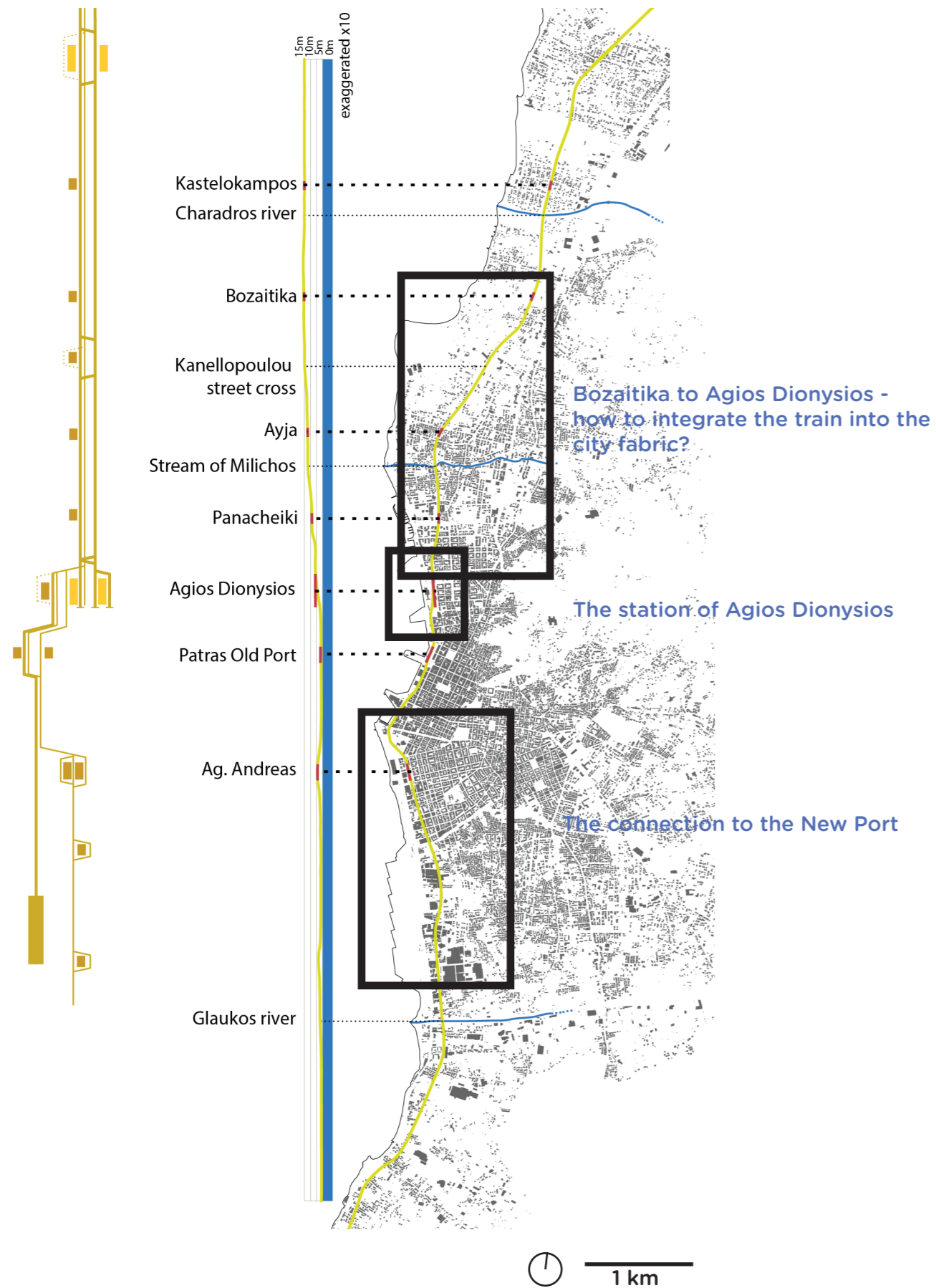


Fig.17: Master plan of the railway development focusing on areas of special interest, (source ETH, IRL, IT, MN).

The “split-level” solution

The “split-level” solution (see p.32-33) was recommended by the Test Planning Process and can be seen as the minimal invasive option.

It uses the height difference of 4m on the plot to divide the station into two levels: the upper level for the trains from Athens (normal gauge) and the lower level for regional trains further south, the Proastiakos and possible freight trains. Due to the design, it offers the possibility of a stepwise and comparably inexpensive realisation.

However, due to its layout, this option would cross the densely populated neighbourhood of Agios Alexios at street level, forming a considerable barrier and leading to noise emissions.

The “harbour level” solution

The “harbour-level solution” (see p.34-35) uses the same station layout as the “split-level” solution with the exception that the whole station is located on the lower level. This solution requires a greater transformation of the terrain, but offers the possibility to form a ‘balcony’ towards the sea for passenger distribution and accessibility to the waterfront. Furthermore, it crosses the neighbourhood of Agios Alexios in a open cut of 4-6 m allowing to cross the line on bridges and reducing noise emissions.

Further Options

Alongside the tunnel-option, which should also be assessed further regarding the technical feasibility and the costs, another option arose in the assessment, which might be worth being taken into the following discussions.

If the new port of Patras will need a connection of high freight (or passenger) capacity, the tracks near the city could be lowered by two meters in order to prolong it with a tunnel under the city (over the water level). This option could be combined with the harbour-level solution and it should be tested, how it could be implemented at a later phase.

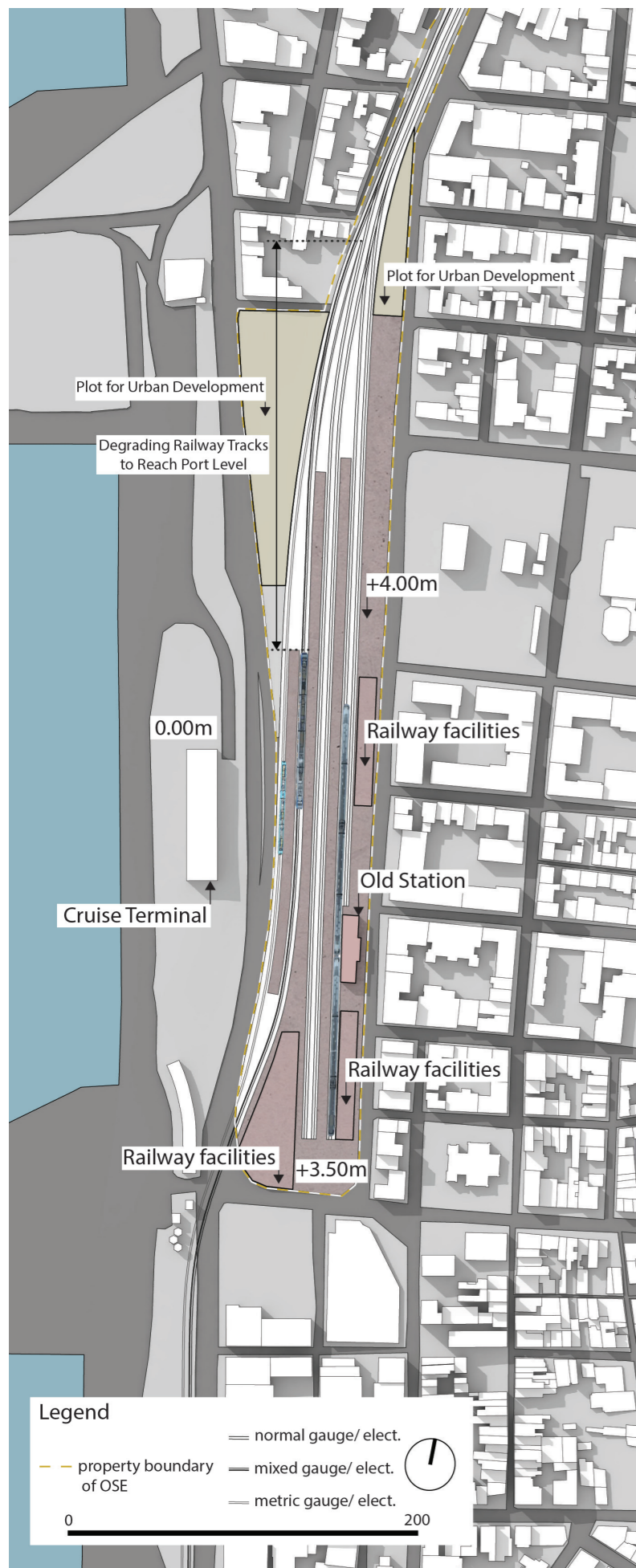


Fig.18: Plan of Ag. Dionysios plot, (source, ETH, IRL, IT).

The “split-level” solution

Benefits

- Flexible layout, extensions possible
- Enough capacity
- Stepwise development possible
- Comparably inexpensive

Risks

- Passenger management between the two levels inconvenient
- Noise emissions in two neighbourhoods
- Blocks the internal mobility inside the neighbourhood of Agios Alexios

Unclear

- Crossing of the Politechniou street (planned on the same level)
- Relocation of maintenance facilities

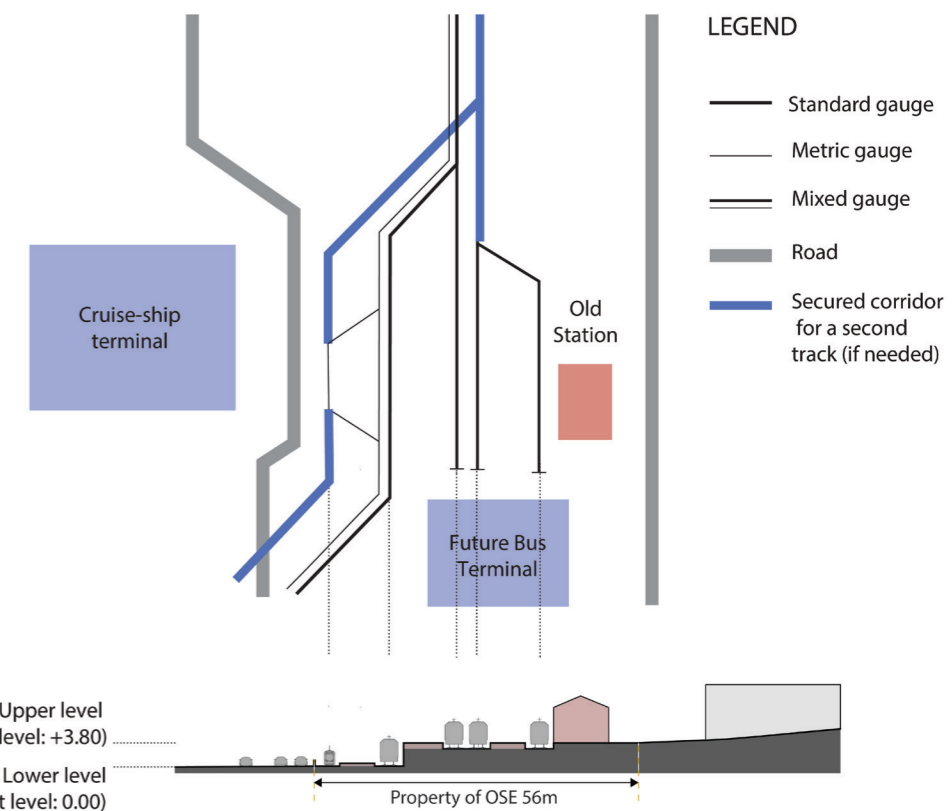


Fig.20: Schematic diagram and section of Ag. Dionysios station, (source ETH, IRL, IT based on TPP in 2015).

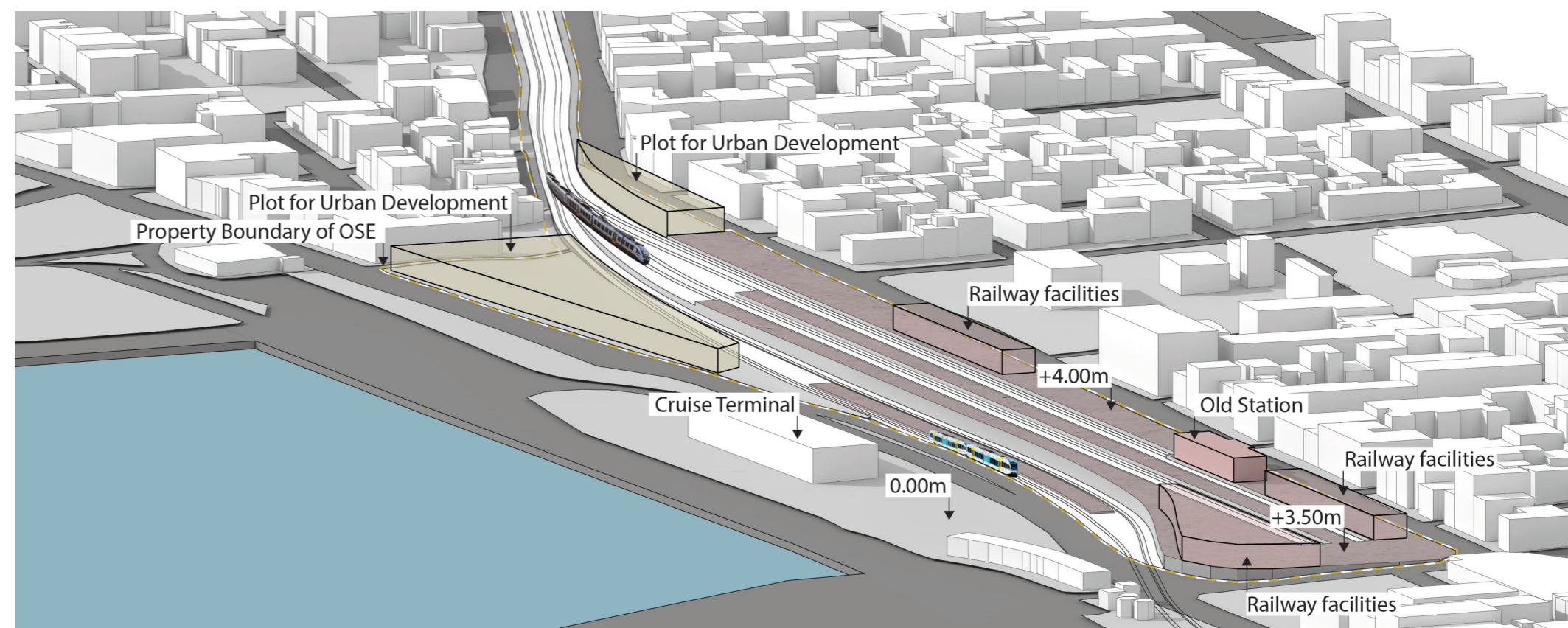


Fig.19: Bird's eye view of Ag. Dionysios station, (source ETH, IRL, IT, MN).

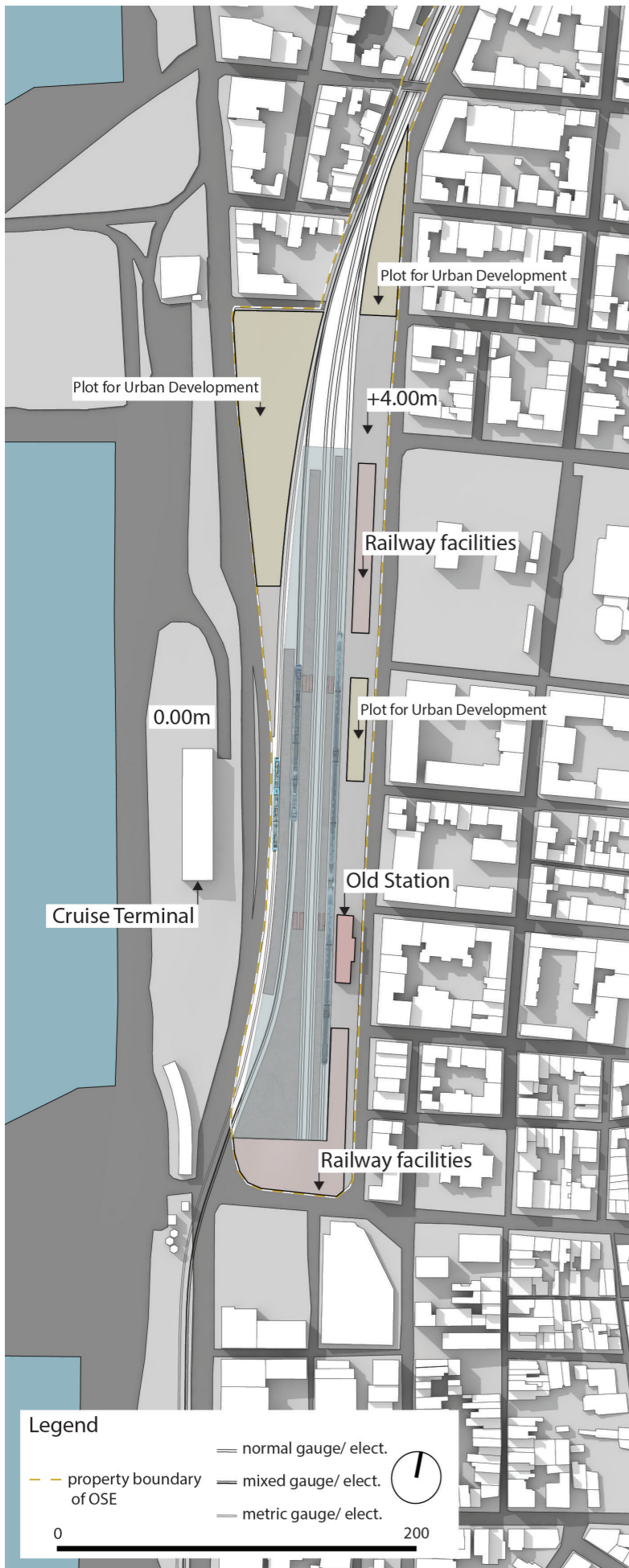


Fig.21: Plan of Ag. Dionysios plot, (source, ETH, IRL, IT).

The “harbour-level” solution

Benefits

- Flexible layout, extensions possible partly possible
- Enough capacity
- Easy passenger management above the line
- Stepwise development possible
- Much less expensive than a tunnel-solution

Risks

- It needs considerable earthwork in the first phase

Unclear

- Crossing of Politechniou street (planned on the same level)
- Relocation of maintenance facilities

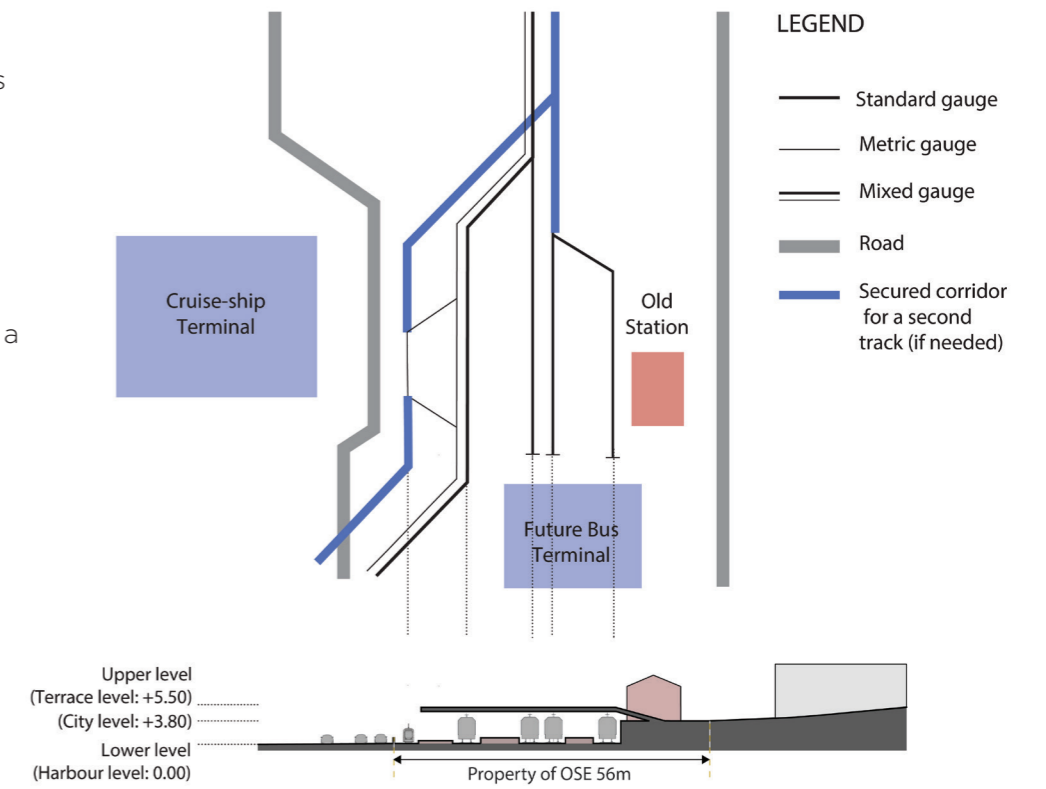


Fig.23: Schematic diagram and section of Ag. Dionysios station, (source ETH, IRL, IT).

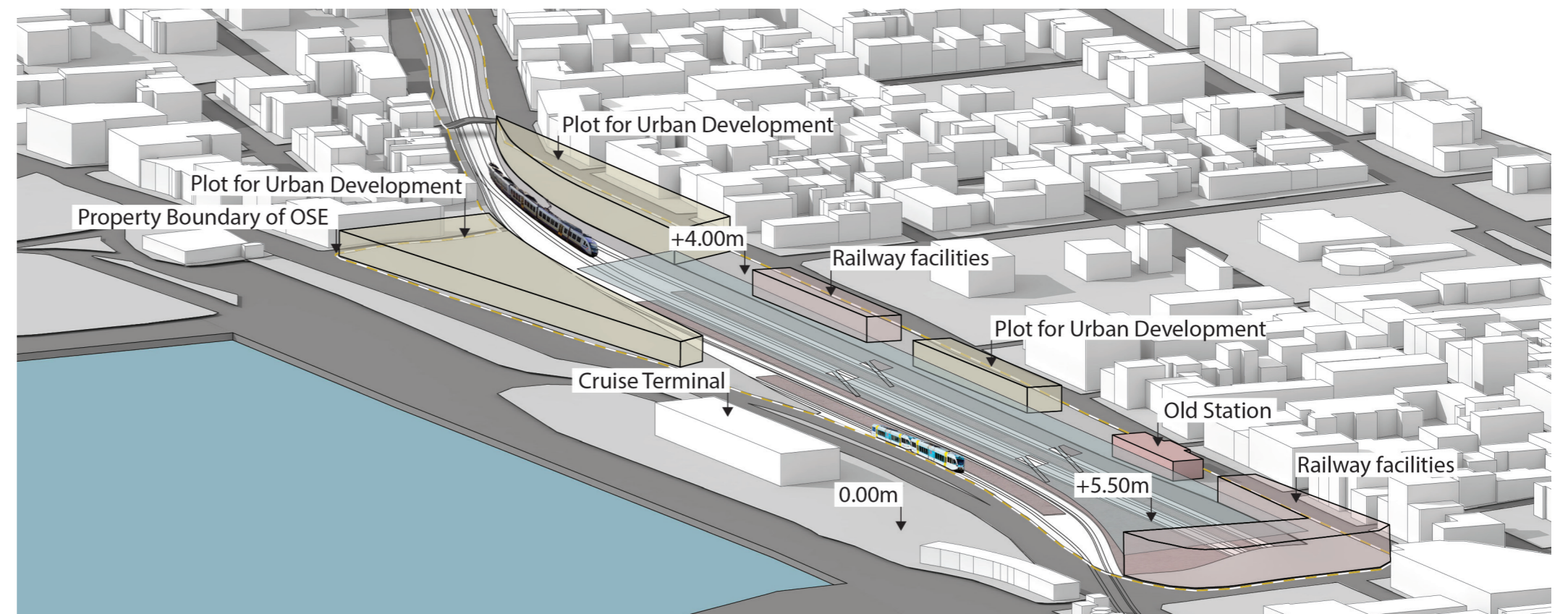


Fig.22: Bird's eye view of Ag. Dionysios station, (source ETH, IRL, IT, MN).

Also the crossing of the railway line and Polytechniou street should be a matter of further transport studies, since the crossing of the railway on the same level of the street might result in traffic issues. To solve this, a number of options are considerable including a massive reduction of the streets' function and traffic load (which is currently blocking the whole city centre from the waterfront).

Conclusions and further steps

The preliminary assessment of the station area shows that there are feasible and recommendable alternatives for the new main railway station in Agios Dionysios. Instead of the complete tunnel solution, these options can be developed stepwise. Furthermore, some conclusions are following:

- The different scenarios show also the possibilities of using the existing height differences to connect the station with the city and the port area - which might be transformed into a ferry and cruise ship terminal and an attractive waterfront. Moreover, if the former station building cannot be used, other possible space for the station building facilities is indicated (see Fig.19, 22).
- Although the financial means and realisation costs are of great importance, the options show that, especially in the city centre, some additional measures of a more efficient railway integration into the urban fabric might be worth taken into consideration. The open cut of the harbour-level solution could be an option, that offers both and therefore should be taken into consideration.
- To choose the right option is not only a matter of technical assessment, but a discussion orientated in the light of the time framework and the available financial means.
- To save space for urban development in Agios Dionysios, maintenance facilities can be possibly located in Agios Andreas (for Proastiakos service) and in the outskirts of Patras, in Drepanon area (for normal gauge trains, OSE's property) (see Annex, Fig. A.3-4).

Hence, it is recommended to perform a joint feasibility study of the fore mentioned solutions, including the tunnel, in order to select this one, which responds better to the city's needs for sustainable urban development and to the financial conditions.

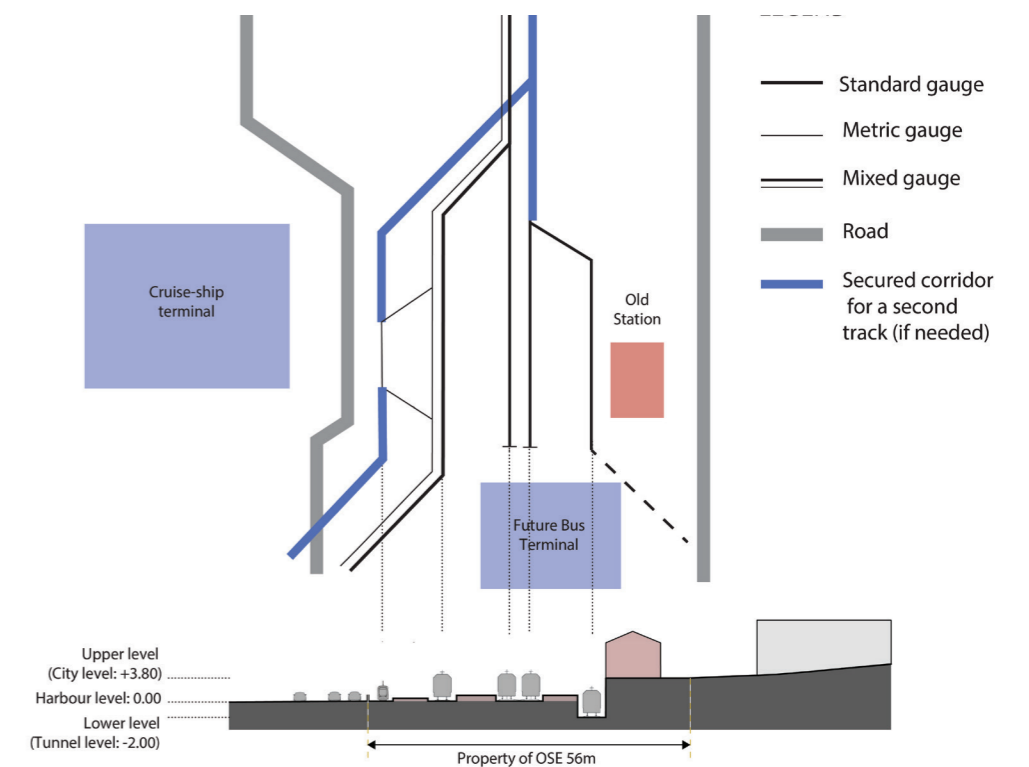


Fig.24: Possible option of a tunnel under the city, (source: ETH, IRL, IT).

3.2. From Bozaitika to Agios Dionysios - how to integrate the train into the urban fabric?

The location of the station in Agios Dionysios defines, which options exist concerning the railway line integration into the urban fabric.

The overview shows the consequences and possibilities of different options from Bozaitika (the section Pspathopyrgos-Bozaitika is already funded) to Agios Dionysios (see p.38-39).

Beginning with the crossing section in Bozaitika (which is taken for granted) the 3.5 km of railway line mark also different spots, where ramps and gradients are not possible. These are the stations of Panachaiki and Ayja as well as Milichos river. In particular:

- For the harbour-level option, i.e. this means to construct the ramp either before the station of Ayja or after Milichos river.
- For the tunnel-solution (1c) the line has to be integrated in a tunnel north of Milichos river, otherwise the distance is not long enough to degrade approximately 15m.

These circumstances mark the framework, into which the optimal solution for Patras should be developed. Moreover, this section has vice versa an impact on the choice of the option for Agios Dionysios station.

The section between Bozaitika - Agios Dionysios

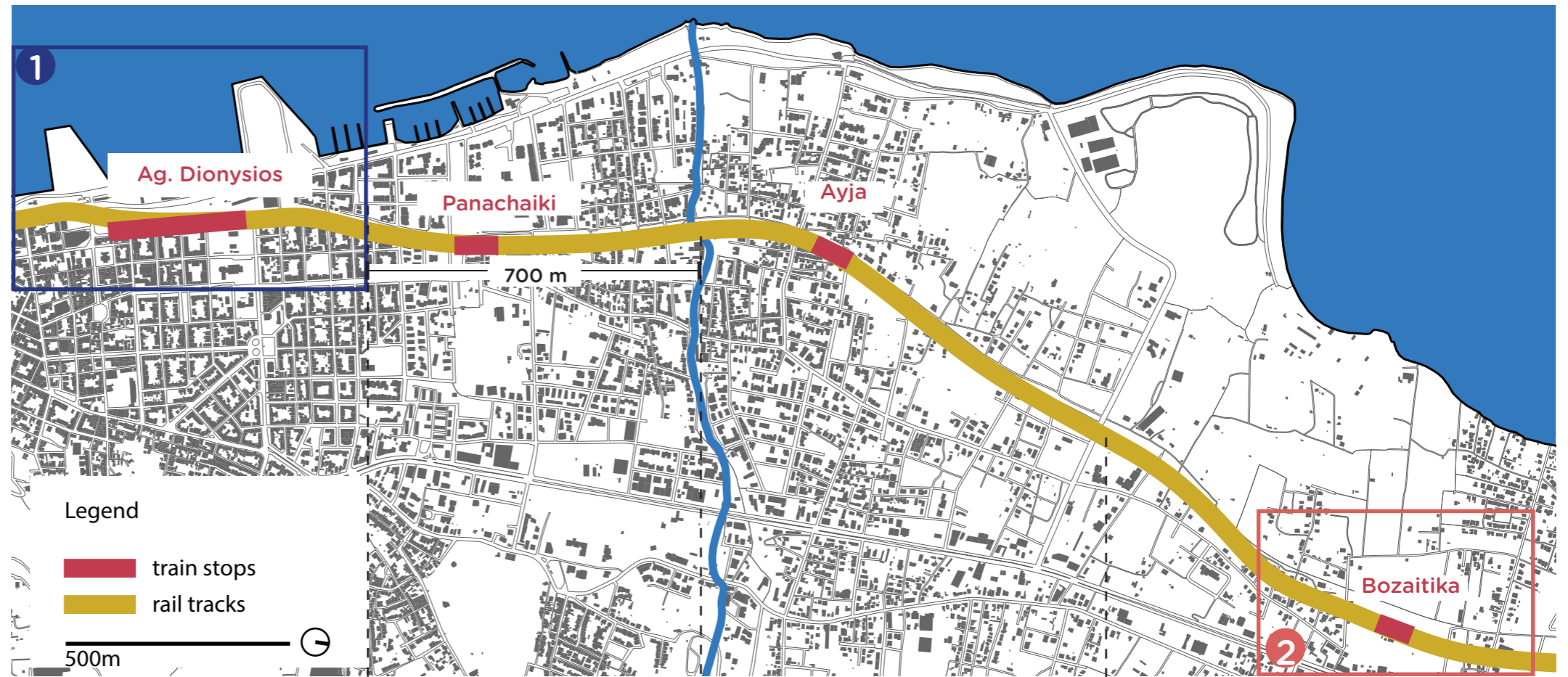


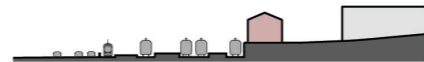
Fig.25: Overview 1: Bozaitika - Agios Dionysios (approx. 3.5 km), (source: ETH, IRL, IT, TP).

OPTIONS IN AGIOS DIONYSIOS

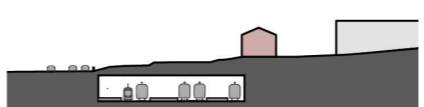
1a. Split-level



1b. Harbour-level



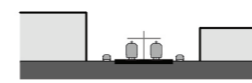
1c. Tunnel Solution



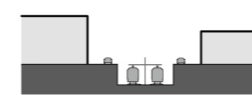
1d. City tunnel



IN-BETWEEN OPTIONS



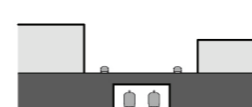
800 m



300 m

500 m

-1500 m



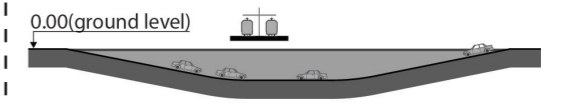
800 m



800 m

OPTION IN BOZAITIKA

2a. (+) Rail and (-) Street Elevation



Degrading before the station of Ayja

500 m

Degrading latest before Milichos river

500 m

1a, 1b 1d (Tunnel towards the city)

1c

15
10
5
0
exaggerated x10

The section between Agios Dionysios - New Port

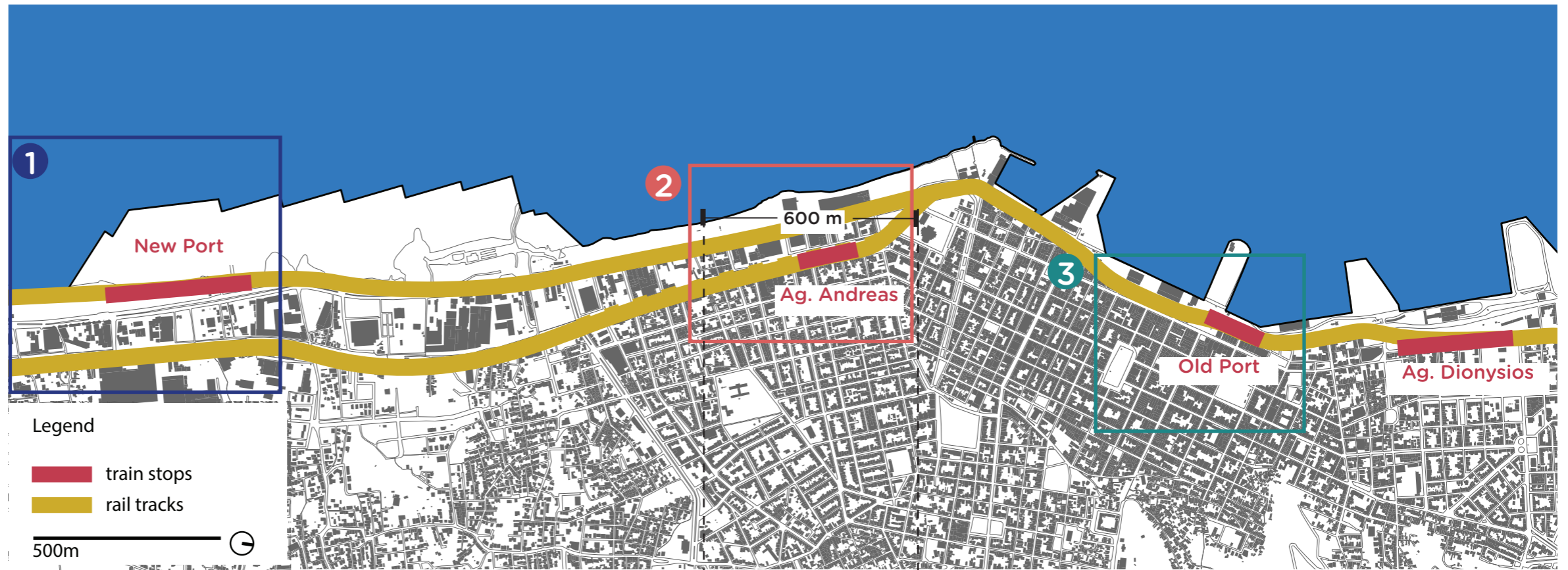
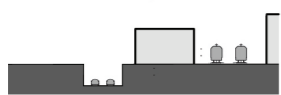


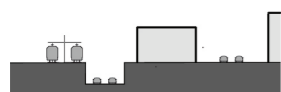
Fig.26: Overview 2: Agios Dionysios - New Port (approx. 4 km), (source: ETH, IRL, IT, TP).

1 Ground-level (degrade the street)

PASSENGER SERVICE (Existing alignment)



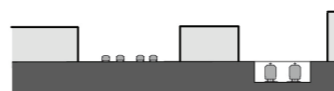
FREIGHT SERVICE (New alignment)



2a. Ground-level



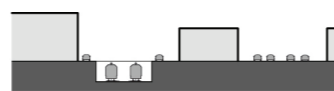
b. Cut&Cover



a. Ground-level



b. Cut&Cover

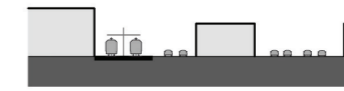


600 m

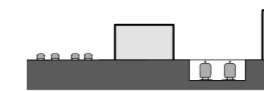
Non-access to the waterfront

600 m

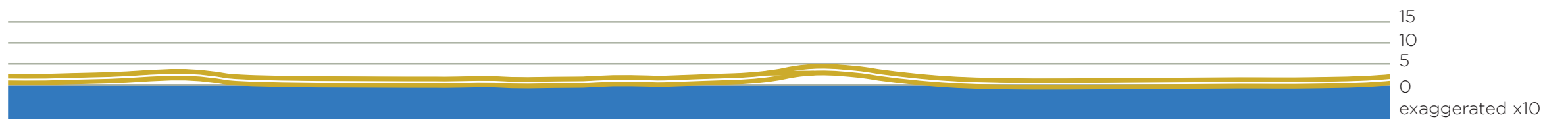
3a. Ground level



b. Cut & Cover



option a
option b



3.3. The connection to the new port

Regarding the connection to the new port, different options are possible (see p. 40-41). It has to be distinguished between the original alignment of the metric line and an alternative one alongside the waterfront.

The alternative alignment can be considered in case of freight service. The existing alignment is currently extended southern as a single metric diesel line. Its upgrade into a normal gauge electrified line should be considered carefully along with the adjacent neighbourhoods.

Up to a certain load of freight trains, the alignment through the city is considered to be bearable (i.e. in Zurich, four freight trains per day cross a high densely populated area) as long as they run with additional security measures and walking speed.

3.4. General conclusions and recommendations for further steps

The illustrated steps and synergies define a framework in which the following discussion about the railway development should begin on regional, national and international level. Decision-making for some sections can be immediate, while the framework should be flexible enough to postpone certain decisions to a later phase:

- Depending on the available financial means, the section between Bozaitika and Agios Dionysios should be projected and constructed as soon as possible including a station in Agios Dionysios.
- This first step does not have to include the full scope of the infrastructure, but the decision-making should make clear which strategy/alignment is followed.
- Taking into account the densely populated areas, the financial aspect should not be the only guideline for the decision. Smart ways of using height differences and punctual technical solutions, such as 'cuts' or 'cut and cover' could be an adding value for the urban life.

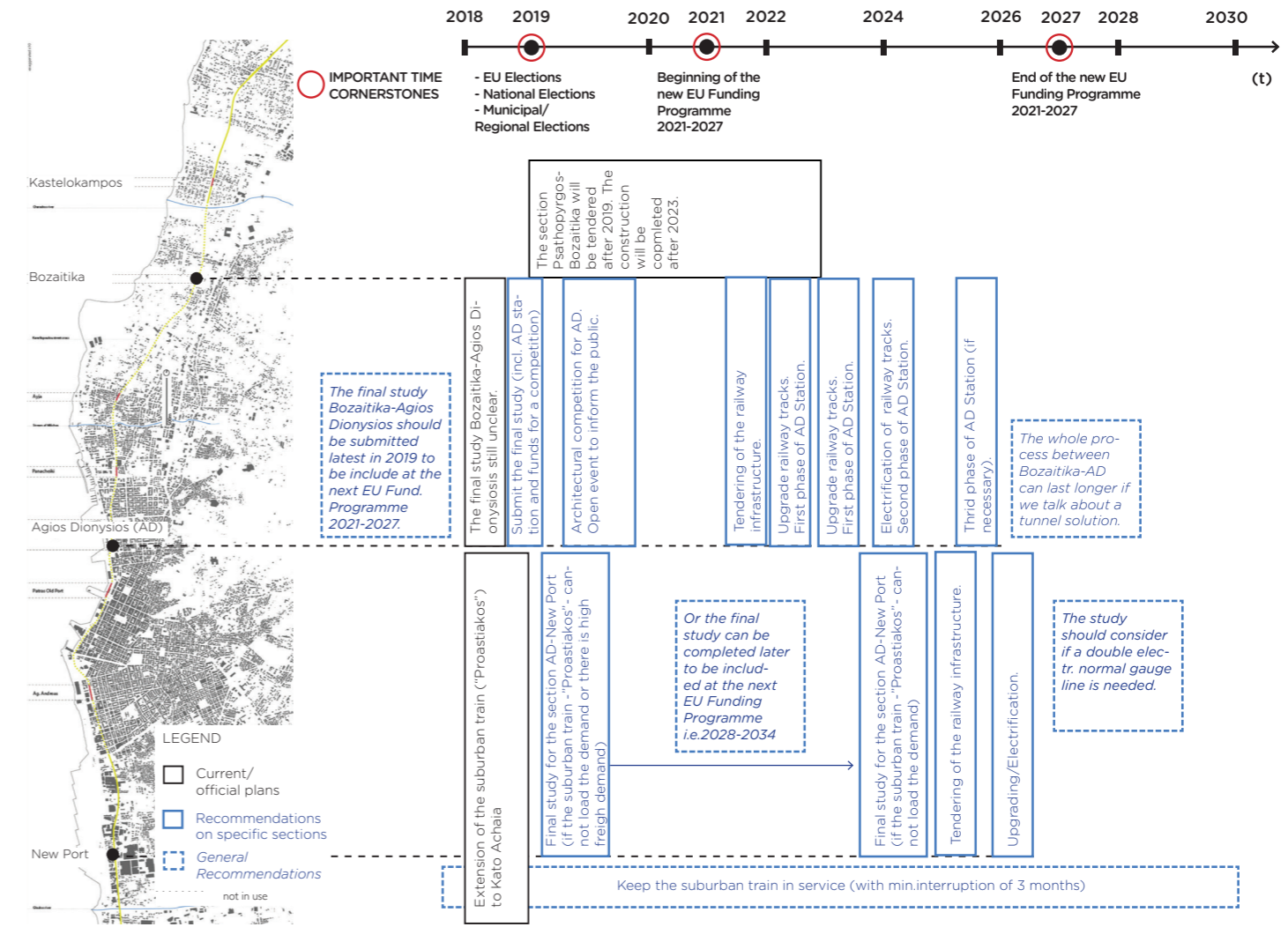


Fig.27: Time framework of the current plans/ announcements and recommended actions, (source: ETH, IRL TP).

Hence, it is strongly recommended to assess all various options simultaneously in order to attain comparable basis for a common discussion. In addition, the future steps of the railway extension to the south should also be clarified. The decision, whether this extension is a normal gauge line or a metric one, defines the further steps for planning and decision-making.

Further steps

In order to achieve the goal of reaching the city centre of Patras as soon as possible, it is highly recommended to restart planning actions immediately. The reason for this recommendation does not only concern the spatial consequences of the railway line, but also the time restrictions of the EU Funding programme. The time-framework (see fig. 27) shows important steps and options for further development.

In order to be able to participate in the next EU-Funding programme 2021-2027, the relevant projects should be submitted latest in 2019. This means, that further discussions and feasibility studies should start if possible in 2018.

An important condition is that the decision of the principal layout of the railway solution within Patras should be delimited soon. With this decision in hand, suitable steps of development can be discussed.

Furthermore, it is highly recommended to design a planning and negotiation process, to discuss all required aspects and create a common ground for decision-making. During this process, representatives of the municipality, the region, the ministry of transport, the railway and preferably also the EU should participate. Hence, a joint decision can be prepared.

Since the decision for the railway upgrade and integration in Patras faces a strict time-framework along with funding and institutional changes on EU and national level (see. Fig.27), the following steps are recommended:

- To complete the study till Agios Dionysios and conduct an international architectural competition for the main railway station in Agios Dionysios.
- To conduct a study for the section between Agios Dionysios-New Port, including the connection of the asset of Piraiki Patraiki along with a respective feasibility study of the asset too (See Annex Fig. A.3-3,4).

4 Final recommendations: Synergies and new perspectives between space, time and decisions

The cooperative planning and discussion process in Patras did not only reveal new feasible options for an innovative and synergetic integration of the railway in the city, but also new questions emerged, which should also be discussed on the EU-level:

I The planning process showed, that the port of Patras has nowadays very few potential of transferring freight from ship to railway or vice versa. Taking this into account, the rail connection of the port was a precondition for funding the port infrastructure. Thus, it should be considered, that:

- The region of Patras should be allowed to integrate the rail connection of the new port into a stepwise development (which means, to secure the connection technically and by law, but not to build it before ensuring its feasibility).
- Or the Port of Patras should redefine its strategy and role considering the possibility to be transformed into a trimodal transport hub.

II According to the EU Regulation No 1315/2013, the main objectives for funding transport infrastructure are: "cohesion, efficiency, sustainability, increasing its benefits for its users and contributing to further economic growth and competitiveness in a global perspective". Moreover, under the same law, the technical provisions required for funding railway infrastructure are referring to the next table (see Fig. 28).

However, in several cases the complete upgrade of metric railway lines to electrified normal gauge lines is not feasible, which means that the possibility of exceptions as it is referred to the EU Regulation should be considered more extensively. This would be helpful in cases, such as the regional railway corridor in Peloponnese, Greece, which do not belong to the EU core network, but they still have a potential for alternative

economic sectors, such in tourism. In addition, a stepwise approach in planning could set the scene for common investment priorities between EU and Greece or other country members along with the respective funding and financial mechanisms. In order to allow more-tailor made solutions:

- The EU should clarify under which conditions a metric line is also funded by EU infrastructure funds, such as the Regulation (EU) No 1315/2013.
- Possible synergies of railway and regional tourism development should be explored further in different regions of the EU.
- Different funding and financing instruments and settings as well as possible combinations of them should be explored to leverage financial resources, especially for those sections of the railway network that do not fulfil the current requirements of EU infrastructure funds.

III Beyond any railway infrastructure development, urban and landscape planning should play a distinctive role of the future solution, including the specific features of the city of Patras. A “prescriptive one-size-fits-all” approach has been proved in many cases inefficient. The specific identity, features and needs of the adjacent neighbourhoods along the existing rail alignment should be examined more thoroughly, if an integral solution is the final aim.

Traction	Full electrification
ERTMS (Telecommunication + Signaling Full deployment)	GSM-R +ETCS
Track gauge	1.435 mm (exceptions possible)
Max. line speed (freight lines)	≥ 100 km/h
Max. axle load (freight lines)	≥ 22.5 t
Max. train length (freight lines)	Min. 740 m

Fig.28: Provisions of EU Funding for railway infrastructure, (ETH, IRL MN based on EU Regulation No 1315/2013).

IV To avoid contradictory development of funded infrastructure - like the possible one in Patras - the EU should consider to integrate collaborative planning processes, such as the Test Planning Process (TPP) for Patras, in the existing decision-making processes for infrastructure funding. In doing so, the EU can:

- Define clearly investment priorities, increasing time and resources effectiveness.
- Oversee in cooperation with the local and regional authorities, if the funds are invested in a reasonable and sustainable way, thus streamlining and optimizing the procedures.
- Foster its goal of integral and sustainable infrastructure development as well as the cohesion between its member states.

Taken into consideration the above-mentioned recommendations, creating and supporting synergies between spatial planning, time frameworks and decision-making can lead in feasible railway connections and a broader multi-modal transport development. However, these synergies can only be based on common strategic priorities of spatial development and planning processes that achieve maximum consensus. Hence, to ensure a strategic approach for complex problems respecting the different planning cultures, further research and commitment on new tools and processes -between EU member states as well as on national level- can pave the way towards the desired social cohesion and efficiency in the domain of multi-speed Europe.



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ANNEX

A.1 The structure of responsible organisations for the Greek Railway system

A.2 Official documents of relevant authorities

A.3 Additional maps and diagrams

A.1 The structure of responsible organisations for the Greek Railway system

1. OSE (Hellenic Railway Organisation) is the Greek national railway company, which owns, maintains and operates the railway infrastructure. It was founded in 1971, taking over from the Hellenic State Railways, founded in 1920. Since 1970s, the network of Greek railways has been extensively modernized and parts of it have been electrified, notably between the cities of Thessaloniki and Larissa, as well as between Athens' International Airport and Kiato (Hellenic Railway Organisation, 2010). However, since the beginning of new millennium, the OSE has been operating at a loss of about \$3.8 million per day, having accumulated a total debt of 13 billion \$, or about 5% of Greek GDP (2010). The bulk of this debt matures in 2014. In 2008, the company reported a loss of more than \$1 billion, on sales of about \$253 million. Between 2000 and 2009, the cost of the company's payroll soared by 50 percent even as 11 overall personnel decreased by 30 percent (Code Athens, 2015; Railways of Greece, n.d.).

2. ERGOSE is a subsidiary of the OSE (Hellenic Railways Organisation), established in 1996 to undertake the management of OSE's Investment Programme projects and in particular those co-funded by EU Programmes. According to the Law 3891/2010 "Restructuring, reorganization and development of OSE group and TRAINOSE" (Article 4), ERGOSE's tasks include planning, development, support, management, design, supervision and construction of all types of projects for third parties in Greece and abroad, as well as land acquisition for the state or other public bodies (<http://ergose.gr>). Projects implemented by ERGOSE are funded from the following sources: 1) the Greek state, which secures national public expenditure for co-financed programmes; 2) the European Union, through several funds (European Regional Development Fund - ERDF, Cohesion Fund - CF, and Trans-European Transport Networks). Figure 2.7 shows the network of primary, secondary, as well as the routes under construction in Greece.

3. TrainOSE, formerly subsidiary of the OSE, has been an independent state-owned company since 2008. It manages the rail (passengers and freight train) services throughout the Greek railway network. An outlook into the trains service development in the past years can be seen in Table 2.2. TrainOSE also operates the suburban and commuter rail services of Greece on a modernized network around the cities of Athens, Thessaloniki and Patras. TrainOSE employs all train crews, operators and manages the rail services throughout the Greek railway network, but does not own any rolling stock, leasing it from the OSE instead (TrainOSE, n.d.). TrainOSE operates three types of rail passenger services, including regular-, express- and Intercity (IC) trains. The regular rail service is the cheapest and slowest, with trains making frequent stops. Express trains are faster, making fewer stops in sections served by regular trains. Intercity (IC) trains are the fastest and the most expensive (CODE ATHENS 2015, TrainOSE, n.d.). However, since 2016, TrainOSE is not the only operator at the railway market, because the Regulatory Authority of Railways (RAS) gave the permission to another private company (RAS, Report 2016, n.d.)

4. GAIAOSE is also a subsidiary of the group OSE (Hellenic Railways Organisation), founded in 2002. It became a key player in the real estate market. The recent reorganisation of the group OSE substantially upgraded the role of the company and equipped it with appropriate institutional tools for faster and more efficient use of property. The portfolio managed by GAIAOSE consists of about 4600 buildings and land plots of about 100,000 acres. The main axes of GAIAOSE's business plan is the development - refurbishment of the large railway stations in urban centres (Athens, Piraeus, Thessaloniki, Patras, Larissa, Volos), the 12 development of intermodal freight centres, outstanding the role of Thriasio Pedio, as well as active and dynamic management of the rental property across the country (<http://gaiaose.com>).

A.2 Official documents of relevant authorities

For years the tunnel solution for the railway line in Patras was claimed as the desired solution with no plan for integral urban development, which is the reason for the initiative of Code Patras project. The below picture illustrates a former proposal of ERGOSE, from Ayia area until Agios Andreas railway station. Nowadays, the solution for a shorter tunnel for a double railway line from Agios Dionysios R. Station until approx. Agios Andreas railway station is proposed with the main railway station in Agios Dionysios and an underground stop at the end of Agiou Nikolaou street, at the old port area. Estimated cost of the new proposal is 250 Mio Euros. The pre-study for the section Bozaitika- Patras (New Port) has been elaborated by OSE, but it is not yet published. Moreover, an estimation for the Bypass alignment by ERGOSE overcomes the amount of 750 Mio Euros.

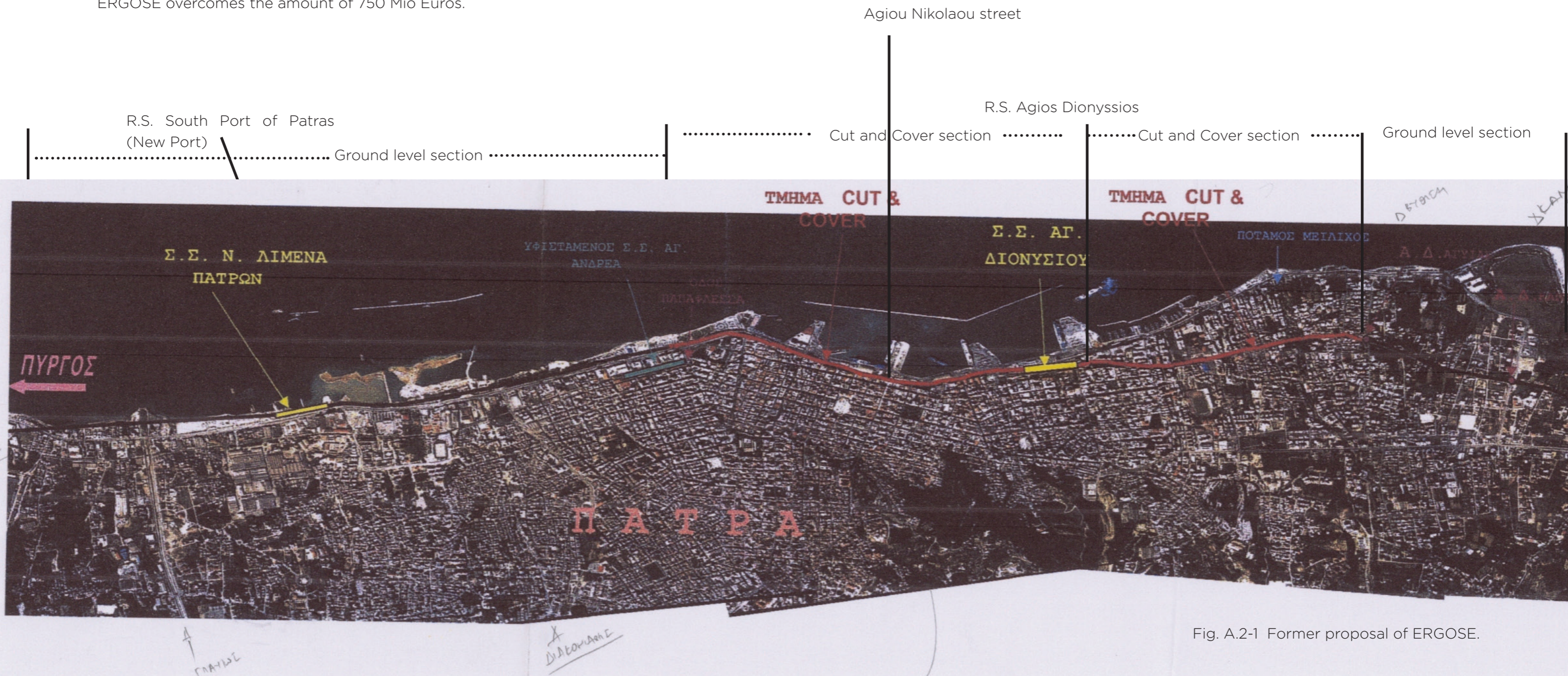


Fig. A.2-1 Former proposal of ERGOSE.

A.3 Additional maps and diagrams

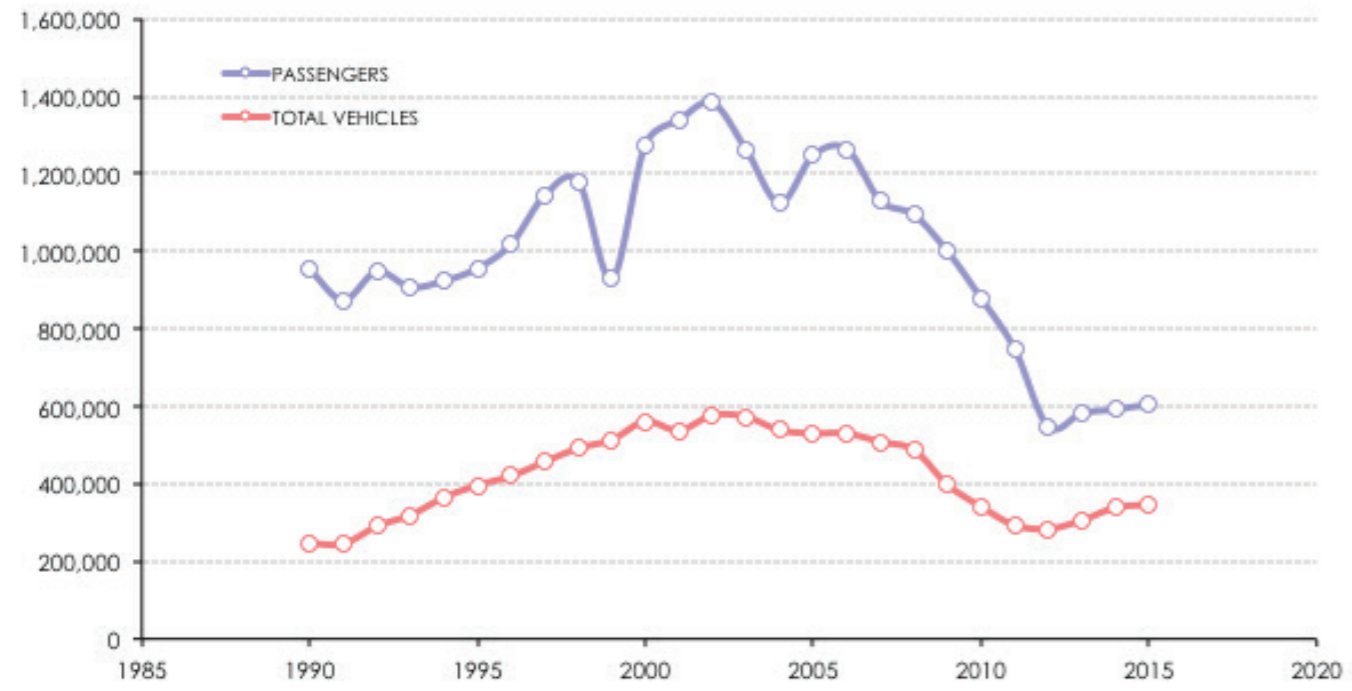


Fig. A.2-3 Passenger and vehicle statistics for Patras' port, source: V.Pappas, 2017



Fig.A.2-4 Aerial photo of the new port, source: V.Pappas, 2017.

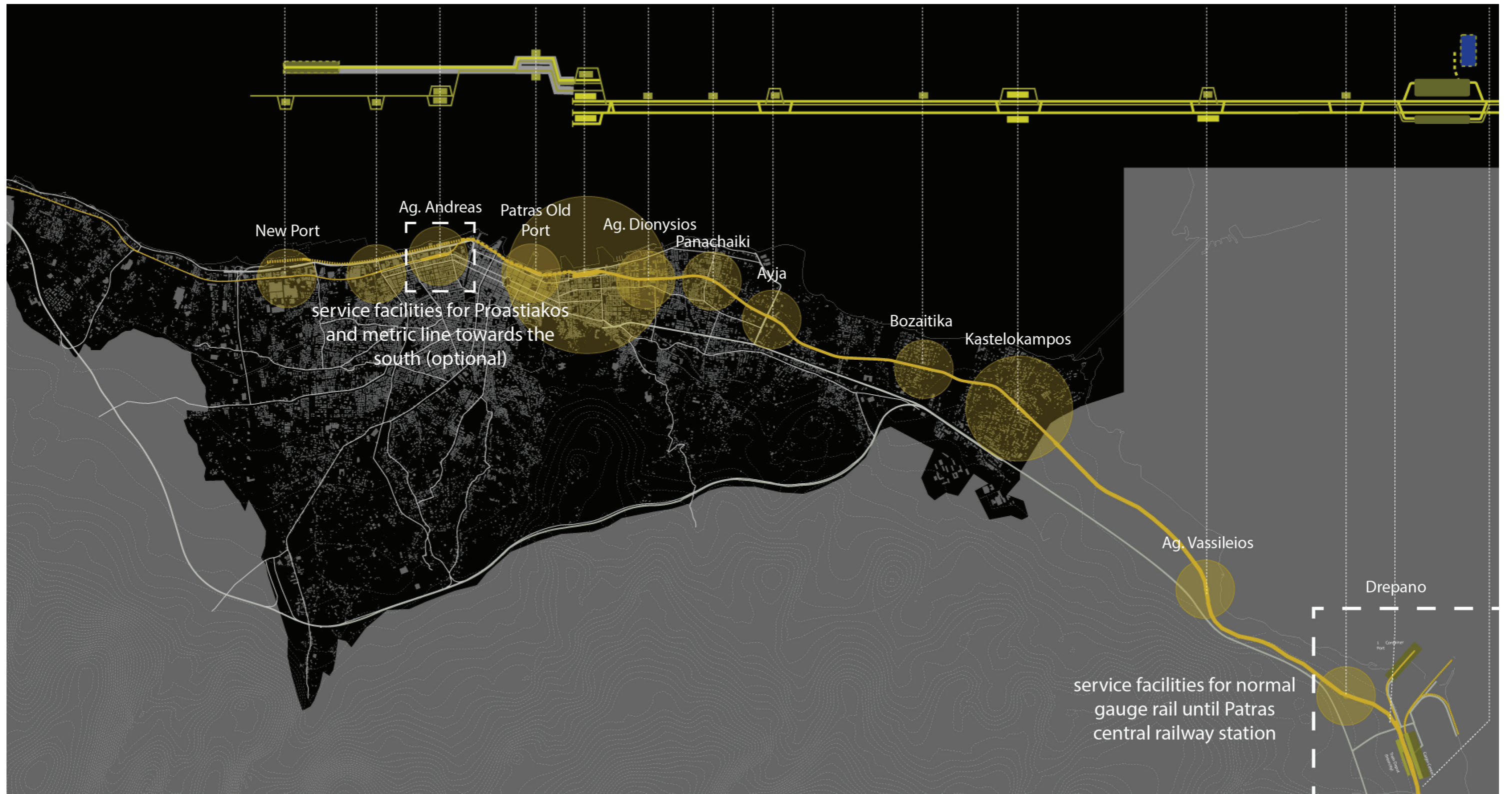


Fig.A.2-4 Possible locations of maintenance facilities in Agios Andreas and Drepanon area, (source: TPP 2015, Inetrantional University team, elaborated by MN, IT)

