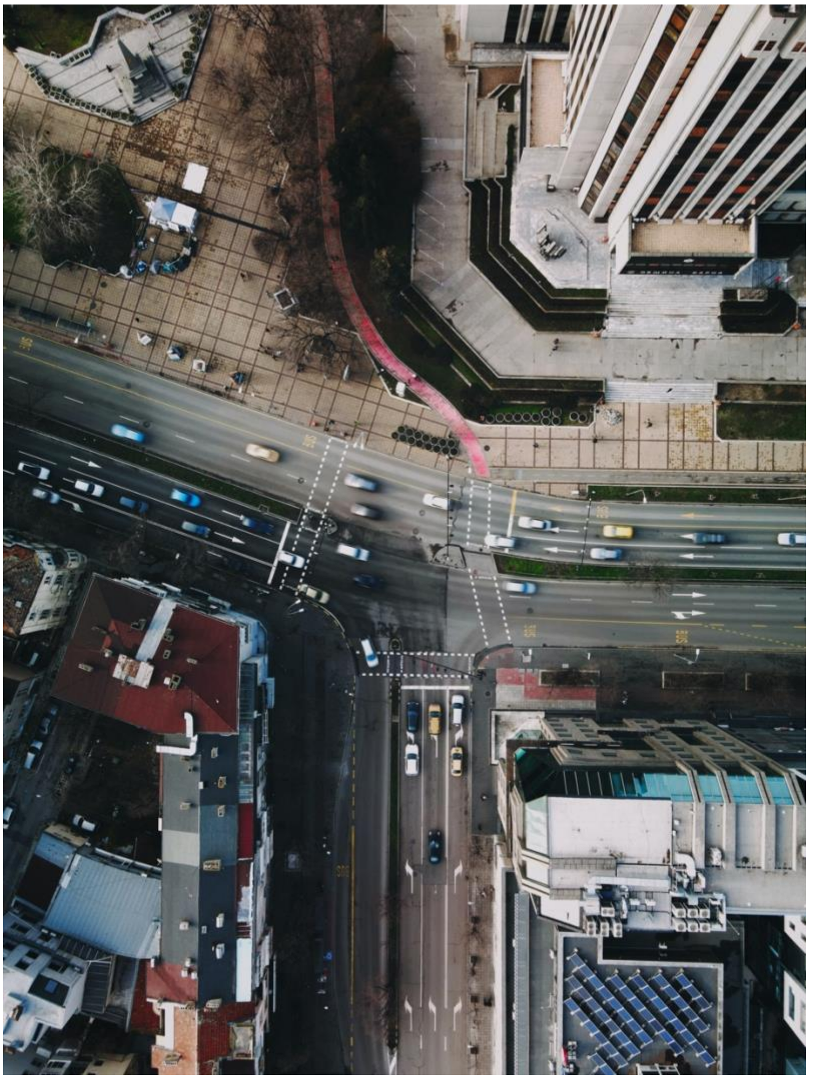
# Current State and Risk Vulnerability of Transport Networks and Related Infrastructural Systems in the Bulgarian Black Sea Coastal Region



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## Purpose and Methodology of Study

**The aim of this analytic segment** is to describe the state, analyse the conditions and interpret the potential vulnerability of transport networks and systems to various integrated risks in the Bulgarian Black Sea Region. Such an investigation is to serve as a substantiated basis which can allow for recommendations for systemic improvements in the state of disaster response mechanisms and overall preparedness of the region. A higher degree of mutual awareness of such transport network vulnerabilities by all communities within the Black Sea Basin will enable a shared response in strengthening infrastructural and organisational capacity for disaster risk handling.

**The target institutions** in this assessment of integrated risks, hazards and vulnerabilities of the transport networks are the main stakeholders which are responsible for regional and local response capacity. These include the Municipalities of Varna and Burgas (as centres of the larger administrative Districts); the District Governor offices (as representatives of the Central Government); the Regional Directorates of the Ministry of Internal Affairs in Varna and Burgas; the Centres for Emergency Medical Services in both urban centres; and the Ministry of Transport and its locally active control agencies.

By accessing directly all **publicly available resources** released by these institutions, our study will serve as a basis for a documented feedback to existing infrastructural and governance realities. Elaborating publicly available information and extensive secondary research resources is a main prerequisite of a quantitatively and qualitatively based position on the state of the transportation networks and the vulnerability of related systems to integrated risk. Such a documented feedback should be suitable and worthy of consideration by both project partners, the public administration and law enforcement agencies.

In addition to **systematic data and statistic sources**, our study will include suggestions and opinions from independent experts in light of existing third-party analytical research, bringing the latter to the attention of our target institutions and serving the purposes of the project implementation. Should the need for additional inquiries arise – in light of missing qualitative or quantitative proof – there is the possibility to carry out complementary investigations, possible meetings with administrative and law enforcement representatives, as well as directly or indirectly involved operatives in the sector or the concerned institutions.

The same line of reasoning is valid in view of top-down (institutional) or Project Partner-initiated feedback which presents recommendations and measures that were not initially part of this analytical paper.

**The methodology** of this study follows a careful planning and implementation of an inductive research strategy. Such an approach includes a series of successive systematic elements within a model of strategic integration.

Each of the sub-categories which are a part of this analysis serves to contribute to a comprehensive assessment of the factors that determine the development, current state and potential vulnerability of the transportation networks and the systems that have a functional relation to such networks. The logical connection between most principal factors – of political, economic, social and technological nature – will outline their impact on the overall readiness of the infrastructural and management systems which are expressions of such transportation networks.

An inductive method requires that our observations (data, statistics, reports, etc.) are analysed as part of global, national and local trends and leading factors – of environmental and anthropic nature. Based on those, we will formulate substantiated opinions and conclusions of a predominantly evaluative nature.

In the assembly of the present analytical paper, our team has been guided, in broad terms, by current “strategic guidelines for the preparation of programming documents” which have been in use by Bulgarian public administration on a national and local level since 2010. They are also important in understanding and interpreting qualitative stances on critical infrastructure, response plans and mechanisms, including those of interaction between public and private entities.

Such methodological guiding principles have led our team to rely on certain phases of successive report elaboration and implementation:

- collecting main (secondary) data;
- analysing of all collected information and its positioning within the instrumental goals of the research
- formulating conclusions, substantiated evaluations and potential recommendations.

Despite the inherent nature and mid-term validity of the present analysis and its conclusions, they should be sufficient to painting a clear picture of the state of the transportation sector in the

Region on focus. Moreover, the present document is intended to allow for interventions of complementarity and factual updates.

Any perceived need to update this sectoral evaluation, its related strategies and operational specifics will be taken in consideration with all seriousness, even during the elaboration of this study. However, since most foreseeable issues and trends in the development of structures and mechanisms require the intervention of public authorities and resources, the analysis should also assess the availability of such resources and administrative capacity, with clear reference to potential capacity for implementation of any necessary changes in infrastructure or governance practices.

## Current State of Transport Networks

One cannot commence an effective assessment of the main **risks, hazards and vulnerabilities of transport networks** along the Bulgarian Black Sea coast without making a **qualitative appraisal** of existing risks and vulnerability of transport networks and logistics channels in the planned coastal area of the project.

Raising questions about the current state of the networks also means understanding how they facilitate or hinder response mechanisms in cases of disasters and accidents. Reciprocal influence with natural factors is also a leading principle in a largely open ecosystem of anthropic and environmental elements.

Both Varna and Burgas Districts have produced quantitative and qualitative data related mostly to the availability of infrastructure, equipment, methods and sources for further inquiries. While risk factors have mostly a natural origin, ultimately one common denominator remains human interference (even unconscientious). This division between the two major groups of risk sources will be exploited further in the description of the main vulnerability categories.

Statistical presented are intended to support not only a detailed analysis of the transport systems and networks but also of ongoing and foreseeable trends and developments within the Black Sea region of Bulgaria. Hereinafter, when we consider the entirety of "**T**ransportation (Networks) and **R**elated **I**nfrastructural **S**ystems", we may often refer to them with the abbreviation **TRIS**. It denotes a wider understanding of the field, a more encompassing view of physical, organisational, financial and other factors influencing the integrated transportation systems and networks.

Undoubtedly, Bulgarian networks and services **rely primarily on land transportation**, as any other logistics modes are responsible for smaller or insignificant shares of both passengers and cargo moved. While the transportation of persons is clearly is more sensitive in terms of visibility and safety, it is the freight transportation which is responsible for a larger share in volumes, routes and economic weight. It often determines the stability and sustainability of the sector. Cargo transportation alone is eloquent in emphasising the dominant position of land movement – 98.51% of the total, with water transportation only taking up 1.49%, despite being statistically very efficient and cost-effective. Less than 0.01% of the total cargo was transported by air.

It should not come as a surprise that Varna and Burgas are not much different in this respect from the rest of the country. Even though they have a direct access to a large water body, it has never been developed well enough, before or after 1989. Partial restoration of water transport options have been sporadic in the past 30 years, and mostly for tourist purposes. Ferries have been used primarily for long-haul cargo shipments to nearby Black Sea countries.

Likewise, the overall relative shares of passenger transport are all skewed towards road transport: car and bus transport have a total share of 96.37% reported in 2015, followed by rail transport, whose share is 3.63% (in total trip numbers). This does not seem a sustainable more of mass transportation in the long term but it is the reality in Bulgaria. We will see below why it is an even more pronounced case along the Black Sea coast.

Transport communications in the coastal areas can be decisively defined as not yet fully and extensively developed. Both in terms of trade infrastructure and passenger transport, linking the north coastline with the south part is a marked problem. There are, instead, several logistic centres which are well-developed locally.

The north-eastern coast has a few widely used and well-functioning ports – the large port complex of Varna, the Balchik port, as well as and the fishing port of Shabla. The southern part is both numerically and economically more well-served: the largest port is Burgas, responsible for 59% of total imports and exports by water at national level. The ports of Nessebar, Sozopol, Pomorie and Tsarevo have primarily tourism functions. As far as integrated logistic terminals, the main transport centres are also Varna and Burgas. Their ports have specialized services for ferries and well-developed connections with railway networks and nationally important airports. The latter serve a large number of charter flights during the holiday season.

Many TEN-T (European transport corridor) elements are still under construction. Parts of the Transport Corridors 4 and 8 are in later stages of completion, while the biggest issue remains the inefficient connectivity between Varna and Burgas. Lacking a direct rail link – as well as a year-round large scale sea connection – the projected “Black Sea” Highway is expected to link the two large coastal cities. Currently, it is only fully completed in 10 out of its 120 projected kilometres in length. This stretch of highway is the last part of European Transport Corridor 8. Other significant transport routes include the Europe – Asia Caucasus Corridor (TRASECA), as well as the Rhine–Main–Danube (Water) Corridor 7.

*Figure 1. European Transport Corridor 8*


The map above traces the main route of the ETC VIII (Durrës/Vlore-Lin-Radozhda-Kičevo-Skopje-Kumanovo-Beljakovtse-Kriva Palanka-Gyueševo-Sofia-Burgas-Varna).

For the Black Sea coastal region of Bulgaria, an essential step would be the improvement of integrated connectivity of the Eastern Axis North-South between Romania and Tukey. It runs from Border Checkpoint Durankulak, through Varna and Burgas all the way to BC Malko Tarnovo, linking Bulgarian Black Sea tourist centres with those in South Romania and North-West Turkey. In comparison to other nationally relevant transport axes, this is the least developed, with only Burgas and Varna being part of a planned highway link.

On the other hand, both as part of ETC 8 (linking the Adriatic to the Black Sea), as well as the proposed highway ring around the Black Sea, an improved infrastructure in the coastal region would facilitate connectivity with neighbouring countries. and regions. Currently, the extension of this axis to the north (Romania) is foreseen only as an upgrade to an Expressway category, while to the south (Turkey) – a planned modernization of an existing first-class road (primarily single lane per direction). Such developments remain currently of importance mostly to the tourism sector and the local socio-economic links along the coast.

Extended TRIS links outside of the urban centres will lead to the improvement of regional level transportation services and strengthening of already existing urban and suburban hierarchies at secondary levels. As for Varna and Burgas, most expert studies suggest that their integrated plans for urban regeneration and development should be centred around the refurbishment and revitalization of the port areas for a more accessible environment and societal use.

## Qualitative Description of TRIS

National logistics realities are mostly valid for the Black Sea coastal region, with the exception of cargo transportation via sea routes. TRIS are planned and maintained according to national space development strategies and existing operations, and as such include (to a different extent) rail, road, sea, air and intermodal transportation means. There is practically no river transportation in the region, if we do not count the freight (and limited passenger) movement along the canals through the lakes of the Varna Port system.

Due to the service nature of the transport sector, as well as its role as an infrastructure integrator on a national level, the characteristics of regional TRIS facilities are of crucial importance to the development and functioning of the transportation sector. Infrastructure units and networks are characterized by their **capacity, physical condition and functional structure**. Despite some perceived gaps in functionality and coverage, the national and regional TRIS is mostly considered as being **relatively sufficient and structurally integral**.

National strategic and sectoral studies agree in one thing: one of the principal shortcomings of the National Transport System (NTS) is the "strong spatial imbalance" in railway, highway and expressway coverage. This, in turn, has a direct impact on current regional socio-economic trends and is the basis of some significant territorial disparities.

Underdeveloped connections with neighbouring countries are another impending problem. Those add to the inconsistency of transport networks' modalities and operational characteristics, decreasing greatly speed and safety of both passenger and freight transportation over longer routes within the country itself, as well as beyond. Renovation and upgrades of the railway lines are a priority, as are higher speed road links, all adding to the ultimate goal of **building a better multimodal TRIS**. Many important economic areas have not even begun the construction of intermodal terminals which would improve the connections between ports, airports, road and railway networks. Varna and Burgas are ahead in planning but decidedly behind on operational integration and facility construction towards such functional links.

**Road transportation**, being the most extensive and functionally relevant, as mentioned above, consists of national and municipal roads. We will list the details of these for the separate districts of Varna and Burgas below. But as for many other parts of the country, the “third-class roads” have the largest relative share in territorial coverage.

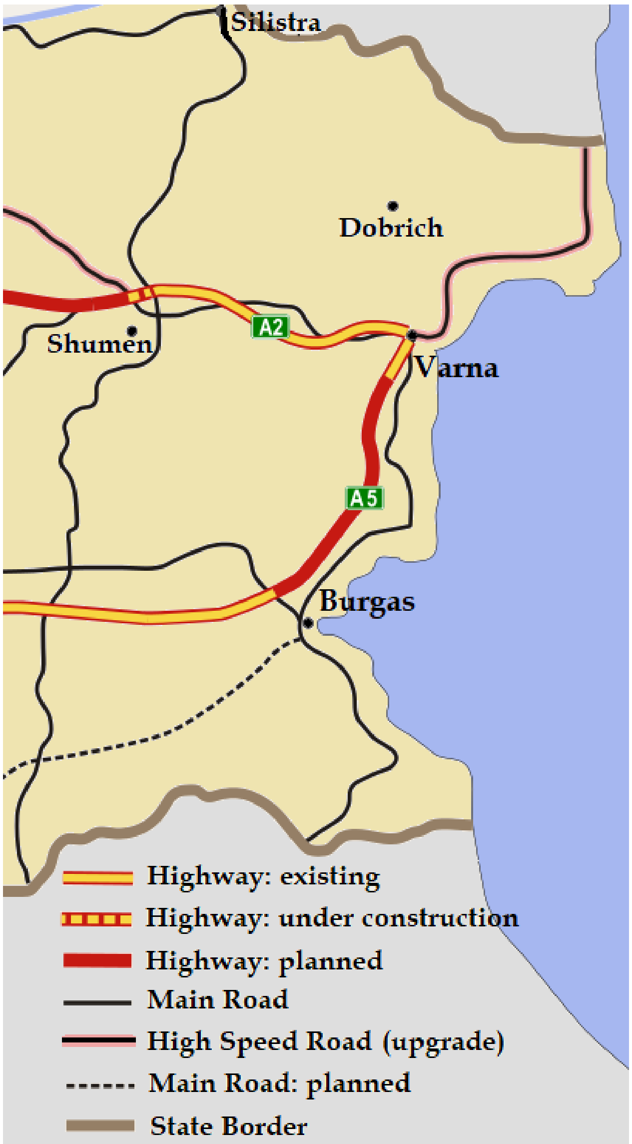
Due to the region’s geographic specifics – bordering on the Black Sea from North to the South; the Balkan Mountain splitting the territory in the middle – there are some pronounced differences in territorial coverage with motorways and first class roads. Road networks running east-to-west are much better developed than those north-to-south. Statistically, there is a higher density in constructed highways and first-class roads in the North-Eastern and South-Eastern regions, immediately linking Varna and Burgas to their districts. This determines a better accessibility, communication and socio-economic integration – albeit as two distinct and separate regional realities, split in the middle by the mountain range.

Despite some public investment in recent years – mostly in the South of the country and the coastal region – it has been largely insufficient to meet the needs for TRIS improvement and there has been no significant improvement in the overall condition of roads, especially regarding connectivity in the North-South direction, even less in the winter. To this day, the National Statistical Institute (NSI) reports an average of 43% of third-class roads being in a mostly deteriorated condition, although those are the most extensive “service arteries” for a large part of the region and the country. Adding to that is the lack of completed highways in most of the coastal region – namely beyond the first 90 km going west from Varna, none at all towards Ruse and almost none between Burgas and Varna. The Sofia-Varna highway (named “Hemus”) should become an absolute priority for financing and construction in upcoming planning periods.

The Black Sea region has an even more prominent and strategic logistic position with respect to many other areas of the country. Considering the total 5 European Transport Corridors passing through Bulgaria, after the country’s accession to the EU, reported road transit nationally has increased 2.5 times since 2007. Sea freight and air transportation have grown in importance as well, mostly to and from Varna and Burgas, within our subject field of analysis.

Ultimately, improving the overall condition of road networks is crucial for most economic sectors. Increasing the load-bearing capacity of road surfaces on the main EU transport corridors, as well as on secondary roads, should also be brought in line with European requirements – road quality and frequency of repair affect efficiency and functional status. And lastly, as much as it is slightly beyond the territorial borders of Burgas, Varna and Dobrich districts, it is of utmost importance to appreciate the significance and volume of the **transit traffic** running from North to South between border checkpoints Ruse and Kapitan Andreevo (**Romania – Turkey**). These are the largest transit traffic volumes registered nationally and they should be accessed, exploited and connected much better – both nationally and with respect to links to the Black Sea coastal TRIS.

*Figure 2. Highway and Speedway roads serving the Black Sea coastal region*



**Railway transportation** is also a major structural component of the NTS. Despite the above-reported uneven distribution between total road and railroad trips registered, railroad logistics remains crucial for the overall development of the national economy. In terms of total length of railway lines, Bulgaria ranks 11th in the EU 27 (according to Eurostat data).

Railways are also not the leading transportation means within the Bulgarian Black Sea region. As the map shows (see below), most links are further inland and not do not service the coastline. Thus, they are also exposed to largely inland/continental risks and potential disaster scenarios which have little to do with sea influence.

The density of the railway network in the Southeast and Northeast regions (the Black Sea coastal districts) is **lower than the national average**. As with road links – and in an even more emphatic manner – there is a critical lack of effective links with both neighbouring countries.

Therefore, we might say that the problematic situation of regional and national railway transport networks is twofold. On one hand, the infrastructure has its technological and purely physical obsolescence. On the other, there is the overall outdated organisational concept of the sector from the period 1950-1989, still in force in many ways and forms. Most importantly, the **spatial configuration and functional connectivity** of all railway systems has been designed and built to serve a presently **non-existent economic structure**. Serving the population was of secondary importance in that period, while transforming the whole sector – tracing and providing new railway links and systems – is not possible given the financial and managerial difficulties that the State Railway Infrastructure operator has been facing for the past 30 years and to this day.

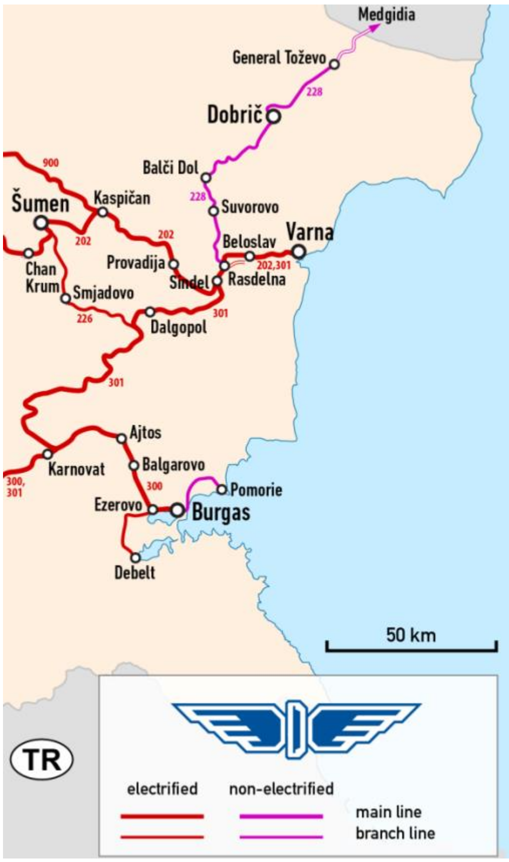
A substantial part of the railway lines were built more than 50 years ago. Their qualities, construction parameters and service equipment makes them operable under speeds up to 100 km/h. Certain railway stretches have even reportedly compromised capacity of maintaining speed and safety levels which would ensure a secure exploitation, up to average European standards. Such characteristics speak not only of functional shortcomings but also of increased vulnerability in everyday operations, without considering external critical factors (whether natural or anthropic).

More specifically, and within our subject area of analysis, railway facilities such as bridges and tunnels present a **high degree of depreciation** in the Varna – Ruse rail link. That is the case, however, in many other sectors, especially outside the main routes Varna – Sofia and Burgas – Sofia. Most security, telecommunication and energy supply systems are reported as obsolete by the State Rail Infrastructure operator, since they are built mostly in the period between 1965 and 1985. Such structural and technological level definitely does not meet contemporary standards of interoperability.

Fortunately, as of the end of 2020 there have been a couple of **new** (Siemens) **locomotive engines** servicing precisely the railway routes Varna-Sofia and Burgas-Sofia. There are also at least 15 newly **recycled train cars** introduced recently in circulation, including along the seaside-bound lines. A rolling stock "recycling" facility builds up the latter from old equipment gone out of service.

We must be aware, however, that despite all of the above serious issues, passenger rail transportation has serious unexploited development potential, especially linking the larger urban areas. Such functionality would largely depend on the modernisation of the railway network, vehicles and management paradigms of the national railway carrier (still state owned). In recent years, passenger train traffic has been gradually decreasing due to overall economic and demographic trends, as much as because of the unsatisfactory quality of service – low average speeds, significant reduction of train capacity, station access and general lack of modern user friendly systems related to customer service and marketability.

*Figure 3. Railway routes serving the Black Sea coastal region*



A key potential driving force for the improvement of operational utility for both road and (especially) railroad networks is the sustainable upgrade and structural development of **intermodality**. Pursuing a more integrated TRIS would mean providing the opportunity to overcome a certain growing congestion of road networks and the outdated state of railroad links. A well-thought multimodal infrastructure would also reduce air pollution, giving **more weight to maritime transport**.

**Most of the ports** along the Bulgarian Black Sea coast have been built in the early 20th century. They serve multifunctional purposes and the overall structural and technical condition of many has already deteriorated. Port operators, State and Regional administrative agencies also report the need to improve the infrastructural connections to said national road and railway TRIS. Once again, the lack of sufficient investment and funds for maintenance and development of the port infrastructure has played a decisive role in hindering the updating and upgrading of ports. Over the years, the obsolete mechanical and transhipment facilities, the poor state and the inefficient management of the quays and port areas have contributed to an unsatisfactory state of many ports, especially the smaller ones or the largely publicly owned and operated infrastructure.

Still, there are those which provide effective operations on a large scale and serve an important economic and social purpose – not only on a regional but also a national scale. Those are the "**public sea ports of national importance**" – Port Varna AD and Port Burgas AD. They are responsible for more than 60% of the national import-export trade volumes. Both are included in the integrated TEN-T network development due to their strategic location, at a crossroads between the EU and Asia. The port of Burgas is part of the "core network" and the port of Varna is formally part of the "extended" TEN-T network. Both ports have **universal cargo handling capacity** – solid and liquid bulk cargo, containers, heavy cargo and Ro-Ro transport facilities.

Industry analyses indicate an average annual usage between 70% and 80% of port infrastructure capacity. A focus on the larger ports (Varna and Burgas), reveals certain **weaknesses** of functional and regulatory nature. Such deficits include an insufficient specialization of the terminals, as well as limits on proposed functional improvements and/or re-development. The latter limitations are due to the fact that both large ports are located in largely central urban zones of Burgas and Varna. However, this is also a valid consideration for most of the smaller ports along the coast and goes beyond any good will of the local authorities.

Additionally, many of the port facilities are outdated – even where not functionally limited, many appear to need an upgrade or repair, with transhipment capabilities and equipment missing in some of the smaller ports. Both larger ports need also be deepened, as per reports approved by the State enterprise "Port Infrastructure" (SEPI), since insufficient water depth of their approach areas limit usability and make them less competitive in handling larger vessels compared to Constanta (Romania) and other ports within the Black Sea basin. SEPI has already started deepening the service canal leading to the industrial part of Varna Port complex, while in 2017 it started consultations on a potential public procurement for doing the same for Port Burgas. Such actions are foreseen in the current national "Strategy for development of the transport system".

Lastly but quite critically, almost all ports report an overall lack of modern logistics and IT systems in their everyday functions – save for a few smaller yacht ports, keeping in mind their limited functional needs. This does not directly compromise their safety but exposes them to natural and technological limitations which hinder response capacity in no uncertain terms.

All Bulgarian ports are used almost exclusively for cargo logistics and other industrial activity. In terms of **passenger transport**, there are only three active ferries in the Black Sea. These link Varna and Burgas to Chernomorsk in Ukraine, as well as Poti and Batumi in Georgia, carrying mostly cargo and offering irregular service intervals during the year. (At the time of writing, two of the three ferries have been stopped from service and expect new operators via public-private partnership procedures). In any case, the total number of water transport passengers is absolutely **insignificant**, at most reaching half a million people annually. Moreover, only **5%** of all passengers carried over water in Bulgaria have passed through **seaports**, the rest have used river ports (mostly along the Danube), as per 2017 data provided by the Ministry of Transport, Information Technology and Communications (MTITC).

Conversely, the majority of **cargo shipments** are handled in Bulgaria's seaports: 78% (an average of 28 million tons annually), compared to only 22% (slightly above 6 million tons) in river ports.

The "Bulgarian Maritime Fleet" shipping company is the largest national maritime carrier and an heir to the former state operator. It has a number of tankers, container vessels and other ships for general cargo with a total reported tonnage of 1,810,000 dwt. It provides a huge boost to the local economy, being responsible for about 90% of the Black Sea region's transport sector revenue.

Out of the five **international airports** in Bulgaria, two are in Varna and Burgas. These are also the second and third largest airport complexes, both operated by the Fraport Group via a long-term concession agreement.

The company reports a total of more than **4.9 million passengers** passing through these two airports in 2019. (The current year, 2020, is not illustrative of the standard trends in the sector due to the limitations imposed on international air travel). More than 35 thousand flights from 97 Bulgarian and foreign airlines have been handled at the Varna and Burgas airports, with traffic growing by almost 50% between 2015 and 2018, followed by a slight dip in 2019.

These airports serve mostly as a gateway to the Bulgarian summer resorts and are intensively promoted as tourist destinations, having established regular routes over from across the EU over the past decade, in addition to the traditional charter flights with organised tourist groups.

As for their safety and security, there have been no crashes or major incidents reported in many years – in the country and in Varna and Burgas in particular. With an experienced foreign company as an operator, their services are deemed generally reliable, with potential problems possible in winter, during heavy snowfall, snowstorms, or in case of thick fog. However, contemporary safety systems in the sector, as well as the mild local weather help avoid natural and technical vulnerabilities.

The issue at hand – both from socio-economic but also from sustainability and safety point of view – is the low integration and underdevelopment of **intermodal transportation**. The efficient merging of transport chains and their respective advantages is key to a more sustainable and profitable passenger and freight policy for the region. A fundamental indicator of balanced transport system development, intermodality also presents opportunities for choosing more **environmentally friendly and secure** modes of transport.

Such developments are a proclaimed priority of the national transport policy. They cover ETC corridors 7 and 8, with Varna and Burgas as key-point Ports with plans for increased and improved intermodal operations capacity.

Clearly, most of the indicated transportation infrastructure is centred around the larger urban areas, with few roads and railroads connecting the region, and airports and ports providing a gate to international transportation.

This is mostly why the majority of challenges to sustainability and resilience capacity are also directly related to the cities and towns in the Black Sea coast. Coastal towns face a number of systematic and daily issues in their strife to achieve a more **sustainable urban mobility**.

The larger cities and their surrounding summer resort sites have problems with congestion, environmental pollution and the harmful noise effects. A manifested need for a more efficient urban public transportation and an all-around better accessibility is also directly tied to the need for an increased and improved security and safety. These problematic aspects are mostly tackled bottom-down through large projects financed by the Central government and EU indirect funding for regional development. However, if we consider the municipal “Plans for sustainable urban mobility” and both (Varna and Burgas) Projects for “Integrated Urban Transport”, most implemented solutions have not produced the results which were initially planned or do not result fully operational at the time of writing. Evident improvements include the purchase of new and more efficient buses, as well as the extension of some bicycle lanes around the cities.

Arguably, some of the immediate steps which can help attract passengers to public transportation vehicles include the improvement of the quality and accessibility to transport services. But they also need to be complemented by an actual optimisation of transport schemes and improved connections between transportation modes and terminals (with coordinated timetables among different modes of transport and a flexible city tariff policy). And in our day and age, the cities need to effectively offer opportunities for the development of small individual mobility and electric mobility by installing integrated charging systems, carrying out stimulating public procurements and partnerships with innovative mobility operators, as well as stimulating or directly participating in smart city mobility applications and services. Varna and Burgas have some steps in existing transport network optimisation (see above) but much is needed yet for achieving better sustainability and system resilience through interchangeable options, both in infrastructure and transportation means.

### Critical Infrastructure in the Coastal Region

Critical infrastructure (CI) may be considered as a separate category, especially in view of our main subject matter. The discipline covers various transportation sites and focal points, infrastructure which is both physical and virtual, as well as the extended functionality of some multi-purpose sites of national and European importance.

There is a public list of strategic sites and activities relevant to national security. In the "Transportation" sector (as of the end of 2016) these are:

- Land/road transport activities including the construction and maintenance of related infrastructure and means of transport;
- Railway transport, including activities carried out by the National Railway Infrastructure Company (NRIC) and the Bulgarian State Railways (BSR);
- Air transport, including activities carried out by "Bulgaria Air" AD;
- Water transport, including activities carried out by "Bulgarian Maritime Fleet" and "Bulgarian River Navigation" shipping companies.

As we can see, these strategic functions and operators (public for railway, private for the rest) include important transport roles and cover the operation of the main TRIS networks. But they do not include explicitly those sites which are part of the definition of Critical Infrastructure on a national or European scale. The latter, in fact, are only the following:

- the **railway junctions** of Sofia, Plovdiv, Gorna Oryahovitsa, **Varna** and Ruse;
- the State enterprise "**Air Traffic Control**";
- the **Airports** of Sofia, **Varna**, **Burgas** (and as of 2011 **Balchik** as well);
- the **Port** complexes of **Varna** and **Burgas**, including the oil port terminal "Rosenets".

Formally, a total of **18 other key sectors** for critical infrastructure (CI) exist in Bulgaria, besides transportation. For all of those there is a similar operating paradigm in terms of security and preparedness mechanisms:

The responsible ministries set up a number of "permanent working groups" to develop and regularly update a general risk management planning methodology, as well as the specific plans for the separate sectors. The CI owners and operators need to regularly complete risk assessments in a shared process of implementing said methods developed by the Government ministries and agencies. CI owners and operators also need to prepare and present for verification their internal risk management plans that serve to reduce the risk of disaster and protect the population.

As far as top-down coordination for main TRIS functions, the Ministry of Transport, Information Technology and Communications (**MTITC**) is one of the principle and natural stakeholders. It is responsible for development and monitoring of national policies and standards on all means of transportation. Its **Executive Agency of Maritime Administration** has Administration Directorates in Varna and Burgas, responsible for ports and navigational waterways.

Naturally, the **Ministry of Interior** has a leading role in security and public safety management, as well as in the Unified Rescue System, serving as a national matrix for all disaster and incident preparedness and response interventions.

## Overall Transport System Vulnerability

Inter-agency reports, national strategic documents and external analytical studies agree that the Bulgarian transport sector can generally be classified as "**highly resistant but with marked insufficiency in adaptation capacity**."

Many crossover analytical assessments regarding critical TRIS factors and qualities are contained in a report called an "Analysis and assessment of the risk and vulnerability of sectors in the Bulgarian economy to climate change". Published by the Ministry of Environment and Waters (MoEW) in 2014, it contains, amongst others, an integrated investigation into the transport sector's overall sustainability and vulnerability. The reason this study was commissioned and published by the MoEW is easily deduced: most of the identified potential threats to TRIS elements and its stability come from **natural and environmental sources**. The random combination of events, factors and stimuli which may cause a disruptive anthropic (human) influence into the system is too big and unpredictable. While natural and environmental factors are largely repetitive and can be prepared for. Additionally, the TRIS resilience or vulnerability is often more generic, structural or operational – that is to say, a state of adequate preparedness and response capacity to natural risks is also applicable to human intervention.

The World Bank Group also has provided a rather recent analysis of the disaster risk response mechanisms of the Bulgarian transport structure. Considering standard or probable disaster scenarios, it also considers almost exclusively **environmental conditions** and **risk factors**. Some of the major findings of the WBG report include important recommendations for TRIS ecosystem improvements.

An **insufficient level of digitisation** and **mapping** is observed on both a national and regional level. Detailed digital maps of transport networks should provide significant aspects such as:

- traffic volume,
- route redundancy (in both logistic and cost benefits),
- surface type and level of maintenance,

- all of the above should be superimposed on detailed flood risk and landslide vulnerability maps (including existing and historical landslide/rockfall locations).

Only the last part of the risk factors are present on a detailed level and are almost never matching the other TRIS aspects – thus, experts face uncertainty when analysing separate factors territorially. Better mapping and digitisation can support evidence-based decision making on road closures, heavy rain and flooding effects, and are especially decisive in routing decisions which aim to optimise logistic solutions.

Many of the local spatial development plans lack an actionable digital map of important infrastructure locations such as bridges and other complex road (and railroad) facilities. Separate facility characteristics provide critical information on their vulnerability to natural events (e.g. seismic or flooding), also contributing to a more efficient decision making. This kind of information should also be provided and integrated into a multi-layer digitised and actionable maps of transport systems, contributing to a more realistic assessment of their vulnerability. It will also support **better decision making** in resilience investment in the sector, according to the WBG report.

Ultimately, when considering investment sustainability, one important finding stands out – the transport sector costs needed to repair "smaller" incidents and disasters (e.g. landslides and rock falls) represent one of the greatest **financial expenditures** for national or sub-national authorities. Naturally, this excludes large interventions and stability investments. However, the overall system efficiency in terms of costs employed to ensure operability should rely primarily on prevention and monitoring leading to an optimal level of planning which can help decrease such costs and the number of interventions. It is even more relevant for smaller public authorities where capacity for reaction and repair is limited, even when there are certain delegated budgets and subsidies available to support TRIS maintenance.

When analysing Municipal Disaster Prevention Plans, national strategies and action plans and external sectoral reports (such as the ones indicated above), generally, **environmental factors** lead in impact, frequency and therefore institutional and expert consideration. Due to direct exposure of most TRIS components to environmental factors, the latter are considered potentially more important in testing the infrastructural (and organisational) vulnerability than any other hypothetical and even historical cause, including deliberate or incidental anthropic intervention. Quite simply, the transport sector remains **highly vulnerable to natural**

**processes and atmospheric conditions** due to their often unpredictable regime and degrees of severity.

Industry experts and professionals stress such determinants in planning and management efforts, especially on a local and regional level. The engineering cycle of design, construction, operation and maintenance of any TRIS element is, by default, made compliant with the average state of natural elements which influence the infrastructure locally. Weather conditions are traced and accounted for, geological specifics remain leading in considering any intervention, upgrade or alteration as feasible or not.

Consequently, we are not to look only towards present natural risks and environmental factors but also towards foreseeable variations to those – most importantly **climate change**. EU, national and even local risk prevention strategies and plans have established it as a cornerstone practice to assess climate change impacts on most of their administrative and regulatory responsibilities, and the TRIS ecosystem is not any different. The evident increase in frequency and severity of extreme weather events, with even unusual, atypical or disproportionate natural events for a given climatic location, have become part of standard practice analysis, as much as they can be hard to predict. Namely because of their irregular and unpredictable nature, they have not been a part of initial calculations and plans when designing much of the transport network years ago. Exemplary cases include extreme temperature differences in both directions (subjecting road and railroad infrastructure to physical strain), intense rainfall and storms, possibly rising sea levels, as much as this would be a limited case in the Black Sea region for the foreseeable decades, as estimated by almost all climate change scenarios. However, the mere **frequency, duration and severity** of such events have begun affecting more seriously all infrastructure in the analysed region as well, even if simply wearing it out and exposing it to unforeseen vulnerabilities. We take a deeper look at climate change factors again, further down our analytic report.

System vulnerability is most frequently measured in potential economic losses. As such, they depend on a number of other factors such as sub-segmentation and the specific profile of the transport sector in the region (e.g. type of transport by share), as well as density and other specific characteristics of the transport network. More precisely, transport vulnerability is traditionally assessed in two main aspects:

- vulnerability of TRIS **infrastructure**;

- **maintenance** (routine and exceptional) and **everyday safe operation** and exploitation of the ecosystem.

  Linking the above two arguments, we often see that institutional and industry expert reports evaluate the vulnerability of Bulgarian transport infrastructure most often by its exposure to atmospheric conditions and natural events. Considering current and foreseeable infrastructure load, this allows to estimate average vulnerability and plan for repairs and preventive works. Exemplary manifestations of environmental wear of infrastructure include asphalt aging, drainage systems clogging and others.

  If we were to indicate the main issue that road infrastructure is facing, it is therefore its maintenance. Regional road network maintenance has been severely underfunded for decades, while the ownership is split between municipalities (inside their territory) and the State (outside of their immediate administrative borders). This, in itself, presents a risk factor for local and regional TRIS, as poor maintenance is likely to lead to increased damage due to extreme weather conditions.

  Statistically "minor" factors that add up to maintenance costs and increase vulnerability include accidental infrastructure damage (mostly human, e.g. traffic accidents), structural defects (as per constructor or operator specifications) and, unfortunately, component theft.

  In **20 of the 25 municipalities** falling within the scope of our analysis, the **urban population** has a much larger share of the total population (by residence). The share of urban population in the two administrative centres (Burgas and Varna) is over 95%.

  Municipal road network maintenance, in such a way, is facing more systemic problems over the years. Varna and Burgas' budget has been growing barely sufficiently only in the past few years, while the small towns do not have the capacity or funding to respond accordingly. The street network remains, therefore, a challenge both in terms of operation and maintenance planning.

  Another typical trait of Bulgarian travel is also valid for the sea coast (especially given the scarce coverage and quality of railways and other options): the share of personal travels by one's own car is much higher than any more of public transport.

  This practice is also directly related to regional population dynamics. Automobile usage and growth is proportional to the growth of urban population to the detriment of rural areas. We might expect that a certain gradual population decline would lead to a reduction in the number of trips over time. However that could not realistically be the case along the coast which is densely populated and intensively exploited socio-economically.

Even for the settlements along the national **railroad** network the situation is not much different. Just as with the road network, if not even worse, maintenance remains the principal problem for railway infrastructure, and the same exact reason – underfunding. This includes outdated signalling, as well as power and telecommunications systems. Inadequate railway infrastructure maintenance presents naturally larger risks for its users, without even considering the combined effects of critical weather events.

**Long-term TRIS sustainability** is something that national legislators, regulatory agencies and significant logistics operators have to cooperate towards. Tackling the glaring deficit in railway links and their substandard operability is something which has been postponed for a long time by a number of governments – in terms of much-needed systemic reform involving (possibly) unpopular measures.

A 2017 study on the quality of rail transport commissioned by the MTITC shows that 62.94% of consumers consider **service quality as poor**. Among the reasons indicated, leading ones are low average speed, poor comfort and low system reliability. There is only one registered passenger railway carrier in the country, the State Railways.

Even though there are more than 10 licensed carriers on the rail freight market, and despite relatively low costs, the above factors are the cause for a much lower share of rail transport for cargo shipments when compared to EU counterparts. The freight carrier with the largest share is still the State Railways company but its share is also gradually decreasing. Most of the other carriers are owned by industrial enterprises, moving mostly cargo to and from them.

If we were to draw a line and summarise the above descriptive and qualitative analysis of regional TRIS, we should emphasise the heavy **reliance on the national road network**, mostly because it is more extensive and allows for more independence in logistics options for individual and companies. Still, it is not always in good condition or covering all needs. Crucially, there are no fully functional intermodal terminals in the study area, at least not according to the generally accepted standards. Such upgrades are planned and ongoing in and around the Varna and Burgas port areas.

The following figure illustrates the road transportation network in the extended Black Sea region area (60-90 km inland).

*Figure 4. Detailed road network serving the wider Black Sea coastal region.*


Based on the integrated statistical data, maps and secondary study sources we presented above, certain conclusions can be made about the quality and efficiency of the coastal TRIS infrastructure:

- The regional TRIS presents and exploits the main types of transport modalities (land, rail, water and air transport); however, connectivity between separate systems is limited and not efficient.
- There are objective difficulties in implementing more efficient transport solutions due to the established location of existing infrastructure, leading to extremely challenging repurposing of land resources for any potential construction of missing transport links.
- Perennially complicating the above two issues is the overall (public) underfinancing of most transport networks and related infrastructure, as much as the almost complete lack of public-private ownership and exploitation partnerships in the sector, save for the Airports in Varna and Burgas and some smaller industrial port facilities.

Broadly defined, road infrastructure in the southern part of the Black Sea region is better developed, while maritime infrastructure is busier in the northern part. Throughout the coast there is **underexploited potential** in maritime sector development, especially considering the following important aspects (in order of decreasing relative importance):

1. Thorough renovation of the **railway infrastructure** in line with EU and global standards with a view to exploiting rail transportation's inherent benefits to passenger and freight logistics.

2. Completion, rehabilitation and upgrade of road infrastructure, including missing connections with **pan-European Transport Corridors**. This activity is particularly sensitive to exerting potential pressure on the surrounding environment and has to be carefully planned for and thoroughly justified.

3. Substantial and targeted investment in constructing fully-functional **intermodal terminals** in Varna and Burgas, including any missing links between transportation types.

4. Constant update and possible expansion of **airport infrastructure**, with a view to a more efficient and secure use of air transport.

## Regional Quantitative Data

Most of the specific traits of the extended TRIS ecosystem are provided for, maintained and regulated by public entities, as they are the owners and operators of the same. This is especially relevant in the case of CI but is also fundamental in understanding the state and conditions which influence system vulnerability to integrated risks.

Automotive transport networks are mostly monitored and maintained by the Ministry of Regional Development and Public Works (MoRDPW), with road infrastructure being the leading segment. Important information is provided by the Ministry of Transport and IT (MTITC) on overall infrastructure state, including rail, water and air. The Ministry of Interior (MoI) is responsible for physical security and public order safety, with all that such administrative functions entail (registrations, monitoring, etc.).

These entities submit mostly centralised information, with less distinction on regional specifics and local data, as the one we need for this study. This is supplemented mostly by Municipalities, District and Regional administrations, sectoral Unions and quoted in a number of topical expert analyses by research groups.

### TRIS Characteristics of Varna District

According to a publication on “Regional Profiles, Development Indicators” conducted in 2019 by the one of the most respectable think-tanks in Bulgaria, the Institute for Market Economics, the **overall level of Varna District infrastructure** is “**very good**”.

The density of the road network is quoted as 18.8 km per 100 sq.km, while the railway network coverage is 5.2km/100sq.km. Both figures are higher than the national average which is 17.9 and 3.6 km respectively.

In terms of motorways and first-class **roads** (27.5%), Varna is behind in coverage only to the districts of Sofia (capital), Sofia (district) and Shumen. This, however, does not reveal the fact that complete highways do not reach the city of Varna, and the sheer distance from Sofia causes logistics difficulties for the substantial tourist influx during the summer. More than first-class roads, the district needs investment in completing the highways to/from Sofia and Burgas. The share of road surface in “good condition” is 42.7% (2018 data), slightly above the national average of 40.5%. In IT, the share of households with internet access is 76.6%, roughly by 4.5% higher than national average.

***Table** 1. Share of road network in “good” condition – Varna District*

| | 2014 | 2015 | 2016 | 2017 | 2018 |
|---|---|---|---|---|---|
| **%** of all district roads in good condition | 43.5 | 44.4 | 44.5 | 43.2 | 42.7 |

According to NSI data, the following is the road network coverage for Varna District:

***Table 2**. Total length of transport network coverage by type – Varna District*

| Indicators for Varna District | 2014 | 2015 | 2016 | 2017 | 2018 |
|---|---|---|---|---|---|
| Highways (km) | 58 | 58 | 58 | 58 | 58 |
| First-class Roads (km) | 139 | 139 | 139 | 139 | 139 |
| Second-class Roads (km) | 42 | 42 | 42 | 42 | 43 |
| Third-class Roads (km) | 479 | 479 | 478 | 478 | 478 |
| Railroad length (km) | 197 | 197 | 197 | 197 | 197 |

Numerically, Varna District has decent **railway network coverage**. Its reported density is the highest in the North-East, besides being higher than the national average. More importantly, more than half of the railway lines have an alternative in locomotive power (electricity or diesel). In fact, the share of the electrified railways (77.7%) is also higher than the national average of 70.3%. However, we already listed a few important factors why railway transport is still not reliable enough, significantly lacking in quality rather than quantity.

Still, quantitative criteria influence quality as well, especially considering railway station coverage for smaller settlements, crucial for wider accessibility and usability. About half of all railway stations serving the NE Region are located within the territory of Varna District, mostly because of its concentration of socio-economic and transport activity.

Significant volumes of cargo to and from the rest of the country are processed within the railway **dispatch station of Sindel – Trastikovo**. It handles freight trains destined for the **ferry** complex; towards the industrial **port** of Varna West (railway Razdelna 2); towards stations Povelyanovo and Devnya which serve the Devnya **industrial** complex; as well as towards the Beloslav, Ezerovo, Topoli and Varna **stations**, implementing thus a systematic and effective dispatch function for joint operation of all stations.

In fact, one of the many prerequisites for the construction of the ferry dock where it is now has been the direct connection to Sindel station, allowing for an operative margin (a leeway track) in railroad infrastructure to and from Varna Station. Such distribution of transport infrastructure and the favourable conditions of the large industrial and logistics complex make Varna a highly suitable collective point for production activities requiring the movement of large cargo quantities.

Varna District holds a key position in some Trans-European Networks – as a port complex and as an relay point in current and future transport corridors. Three pan-European Transport Corridor routes pass through the territory of the North-East region:

- **pETC №8**: Bari – Duras – Tirana – Skopje – Sofia – Plovdiv – **Burgas** – **Varna**;
- **pETC №7**: the river Danube touches the North-East Region in the section Ruse-Silistra. This raises the importance of the land connection Ruse-Varna, representing an alternative segment of pETC №7, as well as a faster connection between the transport Highway "Rhine–Main–Danube", the Ports of Ruse (river) and Varna, going towards the Caucasus and Central Asia, Iran and the Middle East.
- Ruse – Varna is also a functional link with **pETC №9** near Ruse. (Worth noting is the fact that Varna-Ruse was the first railroad link constructed in Bulgaria, back in 1866).

Thus, the Port complex of Varna results a key point in the logistics chain of pETC 8, a tangent element in pETCs 7 and 9, and could potentially become a major logistics and distribution centre between these pETCs and the **TRACECA** transport corridor (Europe–Caucasus–Asia), with active links to ports in Ukraine, Georgia and Turkey.

Focusing on the TRIS ecosystem of **Varna Municipality** alone requires some more specific data. Home of the largest port complex in Bulgaria as part of the **industrial-transport agglomeration Varna-Devnya-Provadia**, it is of national and EU importance.

The municipal road infrastructure is also relatively well developed: its density is 709 km per 1000 sq.km, while its total length is 144.2 km. Out of those, only 12% of the roads on the territory of Varna Municipality are highways and 41% are first-class roads. Around 90% of the road network is reported in good condition.

As for railway infrastructure, its density on the territory of Varna Municipality is 5.14 km/100 sq.km. Three distinct Railway Stations are developed:

- Varna–East Station, mainly as a passenger terminal;
- Varna–West Railway Station, exploited as a freight station and locomotive depot;
- Topoli Railway Station dedicated to port service activity.

Great importance is assigned to the railway Varna–Sindel–Karnobat (towards the south part of the Black Sea coastal Region), as it is the last part of pETC 8. Hence, the already mentioned pivotal role of the Sindel-Trastikovo station.

**The Port complex of Varna** holds a key position in South-Eastern Europe and the Danube region. Linking the Balkans to the Middle East for centuries, its importance has always been considerable for public transport and cargo shipments.

Currently, the Port complex includes some territorially separated but functionally aligned terminals: **Varna-East**, **Varna-West** and the **Port of Balchik**. (The latter is 30 km away by water). The privately operated ports of "**Lesport**" AD, "**BM Port**" AD, "**Naftex-Petrol**" and the **Ferry Complex** of Varna also work in close functional dependence with the main Port complex. Smaller ports and embankments are also found on municipal territory, dedicated to passenger transport of regional importance, yachting or specialised use. There is also a section of the Port limited as a **Passenger Terminal**.

Exploiting an important capacity in a relatively flexibly manner between its Terminals, Varna Port handles all types of cargo, including containers, bulk and general cargo. Having had strong passenger influx in recent years – mostly through large cruise vessels in the summer – it shows a decrease in that segment, due to both the globally insecure period (especially in 2020), as well as regional instability (considering issues with Ukraine, Crimea, Georgia and Turkey, etc.). Varna also serves research ships and yachts, as well as the training fleet of the **Naval Academy** "Vaptsarov".

The **main port complex** has over 450,000 $m^2$ of open and 75,000 $m^2$ of closed storage areas. Facilities include 35 ship berths (with a total length of about 6400 l.m.), 66 gantry cranes and about 400 pieces of various ship-related and warehouse port mechanisation units. As accounted for above, there is a well-developed railway and road network, despite some deficiencies in Ro-Ro and multi-modal connectivity. Quite importantly, the port is quite close to Varna International Airport.

As it is, the Port of Varna is the principal "**container portal**" of Bulgaria. Annually, it processes an average of 45,000 TEU ("twenty-foot equivalent units" of cargo capacity, the regular-size containers). It is also the "grain door" of the country, hence the link to the north-eastern grain-producing area of Dobrudzha via the Balchik port.

The two navigable canals run around a sandy spit between Varna Bay and Varna Lake. The latter is further linked to Lake Beloslav to its west. The length of both lakes and connecting canals is about 30km. This is namely where the **largest transport and port agglomeration in Bulgaria** is located – the Varna-Beloslav-Devnya industrial complex, covering an area of 150 $km^2$.

All port facilities within the district form an integral part of Varna maritime activities. Technology aids the processing of cargo, with combined transport applications used in container, Ro-Ro, railway and ferry transport. Given the convenient connections with the national railway and road networks, the sufficient throughput, all existing IT options and a skilled workforce, a certain better integration of systems and an update of technological solutions would give a substantial push forward in the Port Complex **competitiveness and general security**.

The Port of Varna processes all standard general cargo types, including bulk, Ro-Ro and containers. It offers mooring services and full craft support – supply with electricity, communications, food and other products. Varna-West Port Terminal is the one more industrially oriented and equipped. Significant quantities of cement, clinker, fertilizers and soda ash pass through Varna Port, given its proximity to Devnya Industrial facilities. The port handles all types of liquid and bulk cargo and is now aiming for higher intermodal and technological integration.

**Varna-East** Port Terminal has the following capacity and operational parameters:

- 14 ship berths; Maximum depth: 11.50 m;
- Total quay length – 2 345 m, including 1 km area dedicated to passenger terminal activities;
- Open storage areas: 97 600 $m^2$; Indoor storage facilities: 41 632 $m^2$
- Main Port Equipment: 24 Portal cranes with 32-tonne load capacity; 1 Container lift with 30.5-tonne load capacity; 2 Richstackers, up to 45 t;
- Additional industrial facilities: Railway loading area for grain and similar bulk, with a dedicated installation (Quay overpass for grain and molasses loading and unloading);
- Passenger terminal;
- Storage base ("Dry port")

**Varna-West** Terminal adds the following capacity:

- 19 ship berths; Maximum depth: 10.50 m;
- Total quay length – 3 430 m;
- Open storage areas: 346 397 $m^2$; Indoor warehouse facilities: 20 998 $m^2$
- Main Port Equipment: 25 Portal cranes with 32-tonne load capacity; 2 Container lifts with 35-tonne load capacity; 2 Mobile cranes with 100 t load capacity and 2 other up to 63 t. 8 Richstackers, up to 45 t;

- Additional industrial facilities: 7 Rubber-belt conveyors; 2 Mobile rubber-belt conveyor systems; 2 Loading systems for bulk soda and fertilizers; 1 Loading trestle (overpass) for sulfuric acid.

The smaller, privately operated ports facilities within the wider Port Complex area, are:
The “**Naftex-Petrol**” port terminal is located on the southern shore of the canal linking the Black Sea and the Lakes of Varna and Beloslav. As the name suggests, a petroleum terminal mostly, it handles oil products and other liquid car go. Its total pier length is 500 m, with 3 ship berths and tanks with storage capacity of 56,000 $m^3$.
The “**Oiltanking-Bulgaria**” Terminal (at the west end of the Beloslav Lake) provides additional processing capacity for liquid chemical cargo.
The “**Lesport**” Terminal also handles all types of light general cargo on a smaller scale and capacity. It, however, can handle empty 20-foot containers on stack.
**Balchik** Port terminal – in the town with the same name, 30 km to the north – handles mostly bulk (e.g. grain) and mail cargo.
Some **smaller initiatives** which see the **Municipality** involved in modernization and reconstruction projects currently include the “Quarantine” fishing port in Asparuhovo (co-financed by the EMFF for BGN 13,6 mln) and the Fishing Port “Varna” in the same neighbourhood (former facilities of State Enterprise “Fish Resources”, now privately operated). It is currently able to service 6 large fishing ships with expansion foreseen for accommodate smaller industrial vessels and – possibly – small passenger transport vessels as well. The latter step would require, probably, participation on behalf of public entities, as the service is not entirely justified by market demand at this point.

The management of Port Varna has participated in numerous international projects and collaborations dedicated to operational efficiency and **overall safety and stability** of the Port Complex as part of the wider industrial complex of Varna District. Personnel-wise, it gets substantial support from the **Naval Academy** of Varna, hosting young staff aspirants as trainees and benefitting from the potential and experience of seasoned marine and maritime management staff.
While much could be desired of an improved multi-modal connectivity for the Port area, some steps are already under way – the deepening of the canals towards Beloslav, the infrastructural connection to the Western parts of the urban Industrial zone via new and repaired roads.

Altogether, the current **operational and management standards** of Varna Port leave little to nothing in the way of potential vulnerabilities and exposure to critical events in their normal everyday operations.

There are two main **issues at hand** for the City-based port facilities. On one hand, contemporary port activity requires the development of modern multi-purpose terminals relying on technology. On the other hand, there is the impending need to free the Varna-East part of the Port complex from any loading and unloading activity, since it is an integral part of the historic city centre and the local community will benefit more from the area being more accessible and open to urban use, a true connection to the sea.

Next in regional economic significance – but first in visibility for the district's inhabitants – is the **road transportation network**. Its current state is indicative of potential vulnerabilities and exposure to integrated risks. Road transportation alternatives for a given route or service (and any other multi-modal options, for that matter) point out to important local resilience capacity.

We have already determined the fact that outside of the immediate municipal boundaries the roads are State-owned, regulated and maintained. Within city limits, however, it is City Hall that decides, finances and optimises logistics (the street network). Moreover, **road transportation in Varna has no alternatives** – there are no urban rail options or regular water links between the neighbourhoods and suburban (coastal) zones.

A decisive factor in providing better resilience to the road network and decrease its vulnerability is the amount of **funding** and **maintenance works** that the Municipality can afford to allocate.

A detailed breakdown of the 2019 Municipal Budget shows that Varna has spent slightly over BGN 70 million on construction, repair and maintenance of the street network. Less than 10% of that goes to personnel costs, while **BGN 18 million** are **fundamental repair and maintenance costs**, and BGN 45 million have gone to the acquisition of "lasting material assets" (mostly new buses in that financial year). Other significant costs include personnel for monitoring and control of transport networks (~BGN 1 mln) and a sizeable subsidy to the Municipally-owned Enterprise "Urban Transport" (~BGN 8.4 mln). While delegated budgets form the central government form a substantial part of annual funding of Varna Municipality (around half of the total), transport-related transfers have amounted for only BGN 5.3 mln.

The total budget of Varna Municipality for 2019 has been the largest so far to date – BGN 497 million. Its total is not about to be surpassed by the financial framework of 2020, since the preliminary number was approved as BGN 492 million (including local and national funding for

BGN 384 mln and European financing for BGN 108 mln). Therefore, once the financial year is completed and all figures balanced – in an otherwise difficult period, globally – we can expect spending levels to be near (at best) but not over the above sums.

An important prerogative of the local administration has been the project "**Integrated Urban Transport of Varna**", financed by indirect EU funds (and approved by the MoRDPW). The project's most important deliverables include:

- An automatic ticketing system with machines at each of the 60 urban bus stops;
- An integrated system providing priority to mass urban transit vehicles – exclusive Bus Rapid Transit lanes (BRT, corridor length ~14.85 km along 31 stops) with traffic light priority for BRT vehicles;
- A Real-Time passenger information system including 96 information boards at bus stops and strategic locations in the city;
- A Management Centre for Integrated public urban transport services – including hardware and software for auto-location of vehicles; The system facilitates registering operational statistics – e.g. delays, arrival times, etc. – transmits data to appropriate info terminals and helping management optimise routing. In real-time management this increases greatly **resilience options and response mechanisms** to any inherent or unpredictable critical events.
- Renovated vehicle fleet – a total of 70 new buses with either EURO6 emission standards or above (natural gas);
- Cycling facilities construction and upgrades – three complete new bike lane routes with a total length of 14.5 km, as well as another 1.8 km connecting with existing ones;
- Improvements and upgrades at important bus stop facilities, various accessibility features;
- Upgrades at the production and technical maintenance facilities of "Urban Transport".

Some of the above measures continued their implementation throughout 2020. Others will be finalised in the coming months – not the least of all because of the couple of lock-down periods for many public and private activities during the current year. However, in their integrity, intent and mid-term planning vision, the above measures do indeed contribute to a **greater stability** of the urban transport system, its **improved resilience** and **accountability**, and altogether a **less pronounced vulnerability** to unpredicted events along the TRIS ecosystem.

In 2020 the City administration also completed a significant construction project through the extended central parts of the city, transforming a historic major street in a higher-speed boulevard – “Levski” – for around BGN 115 million of (mostly) state financing. It is intended to link the north exits of Varna (towards the resort areas) to the industrial zone along the north shore of Varna Lake. Although time will tell if that route was the optimal way to cross the urban environment (instead of improving the existent ring road or tracing a less invasive route through the north-west outskirts of the city), still it is a step in a direction which provides more capacity to the transport system and, in turn, stability to new and established logistic solutions.

In the time of writing, Varna Municipality continues performing major repairs of the street network within its territorial jurisdiction, accounting for around BGN 8.1 million of expenditures. These include mainly streets but also an overhaul of transport equipment and infrastructure – an example is the metal flap bridge connecting the island under Asparuhov Bridge to the southern Industrial zone.

Further projects which aim to improve road network sustainability and traffic management include the new ramp linking “At. Moskov” Blvd. to “Hemus” Highway (for about BGN 0.8 mln); as well as the completion of “Levski” Blvd. via local links and exits to neighbourhoods it passes through – all the way to the Industrial Zone along “Devnya” Street.

An important priority for Varna Municipality is the implementation of an **extended “Blue Zone”**, with paid parking regulations encompassing much of the widely outlined central city zones. It had been put off due to systemic problems and administrative obstacles until 2018. The current stage brings regulated parking spaces to 8355 – introducing zonal regulations has proven a well-functioning system which improves traffic flow, provides street order and financial resources to the Municipality. Such integrated plans for sustainable urban mobility also include 31 charging stations for electric vehicles. The charging stations were reported by the municipality as used by 738 different vehicles in 1693 separate instances over a 45-day period in September-October 2020. This shows that despite the lack of alternatives to land transport, the city is able to relatively quickly implement alternatives to combustive-fuel transport, with a small separate electric fleet already functioning for Municipal use.

Completing the mass transportation means and capacities of Varna is the **public enterprise “Urban Transport”** which is the result of Municipal buy-outs of various smaller operators and the large “Transtriumf” which shared the local network until 2018-2019. The total capacity of “Urban Transport” includes currently 161 buses with 22,506 passenger spaces.

Admittedly, Varna experiences difficulties containing some of the **landslides** which manifest themselves just outside the City limits – those in and around "Sveti Nikola" and "Trifon Zarezan" suburban areas north of Varna. Firstly, because they are on State-owned infrastructure (roads) and such an important intervention requires a coordinated response by State and Local Authority. Secondly, because these geological manifestations are extremely costly to face, especially in the steep zones in question. There are some smaller landslides and rock-falls within city limits but they concern hills above Varna with little heavy infrastructure and mostly passageways between low-rise housing. The ones in the areas to the north – bordering important tourist resorts such as Golden Sands – are more sizeable, historically persistent and involving main or secondary roads to these zones.

The current financial year had about BGN 1.5 mln foreseen for the **Sveti Nikola** and BGN 15 mln for **Trifon Zarezan landslides**. The former will hardly provide a lasting solution to the area, while the latter is intended to contain the processes (fortifying the area) for a number of years, while an optimised route or solution is found. In any case, even mid-term solutions would share the traffic burden towards the resorts which between May and September is significant and has a crucial importance for local economy as well. There is currently only one high-speed stretch of road leading to Golden Sands which circumvents the landslide area but that cannot be sustainably exploited – or maintained for that matter – in the long run without the alternative in question. Such limits place a burden on an important part of the district road network and emphasize a **critical point of vulnerability**. The factors leading to the latter will be dealt with again further down the present study.

**Varna Airport** is a direct gate of the North-East region to the world, crucially providing an access to important tourist flows, mostly in the summer period (May-September). It is the second largest airport by capacity (and third by passenger flow, behind Burgas). Flights landing at VAR are mostly international flights (predominantly charter ones over the busy period), with foreign links accounting for 89% of the total passenger traffic.

The Airport is located over a surface area of 2 414 decares and is linked to international roads E-70 and E-87. It is operated by the Fraport Groups, one of the most experienced in the EU and is equipped with modern navigational IT and infrastructure. VAR facilities include two terminals – a renovated one and a recently built one – as well as an automated passenger and luggage handling system. VAR has large capacity large warehouses, providing ample opportunities for cargo flights and small aircraft. While most FraPort investments are aimed at renovation, expansion and modernization of terminals, those include information systems updates, as well as logistics handling, **flight safety and security systems**.

Financial results depend mostly on international passenger charters In the first place in terms of importance for the financial result are the passenger charters followed by international scheduled flights. Domestic scheduled flights to Sofia and Burgas are important for regional connectivity and the attractiveness of the regional economic ecosystem, while cargo charter flights and other general purpose flights are available and relatively easy to fit in the Airport's schedule for serious economic operators.

Varna Airport operations have been given through a long-term concession to Fraport Group, as mentioned above. The Group's local management provides important data for administrative, financial and safety purposes. These statistics indicate that in 2019 Varna Airport has handled **66 airlines** covering **117 destinations** in **45 countries**. Most importantly, **over 2 million passengers** were served, a slight decrease from the record-breaking year of 2018.

VAR links the majority of its passengers to leading EU country destinations – Germany (535,000 passengers, equal to 26% of the total passengers traffic); Bulgarian domestic (260,000); the UK (191,000); Poland (171,000); Russia (165,000) and Austria (124,000). Statistically, leading single destinations for departure flights include Sofia, Moscow, London, Vienna and Tel Aviv. Every year, new destinations are introduced or updated. Winter months see connections to an average of 16 European cities.

The airport infrastructure is up to the highest safety and security standards. The rehabilitation and **extension of taxiway** "Echo" took it to a total of 1,220m in length. Hangar improvements were recently completed, with construction and fire prevention measures in the BGN millions. Works on the **extension and rehabilitation of the apron** is scheduled to begin in the upcoming months, including new apron lighting, in addition to a completely **new Fire Safety & Rescue Service** building.

The Fraport-Twin Star Group reports **over 400 million in infrastructure and technology investments** (total for Varna and Burgas Airports) over the first 14 years of its operations. In 2019 alone, investment projects at both airports amounted to over BGN 8.6 million, providing a **sustainable and secure air transport** infrastructure and working environment.

## TRIS Characteristics of Burgas District

Burgas District occupies a flat plain region without large natural relief limitations. Despite such geographical advantages, Burgas still lags behind (statistically) in terms of infrastructure compared to other districts in the country.

Road infrastructure and Railway network density are lower than the national average (see numbers below). In 2018, NSI reported the quality of road surface as below average levels – 36.9% defined as "good" compared to the national average of 40.5%. An important presence is the Trakia Highway which connects Burgas district with the rest of the South part of the country. That has had a significant positive effect on the recent economic development, as much as it leads to a share of highways and first-class roads exceeding the national average (25.8% compared to 18.4%, respectively).

***Table 3***. *Share of road network in "good" condition – Burgas District*

| | 2014 | 2015 | 2016 | 2017 | 2018 |
|---|---|---|---|---|---|
| **%** of all district roads in good condition | 35.0 | 39.5 | 42.0 | 40.1 | 36.9 |

According to NSI data, the following is the road network coverage for Burgas District:

***Table 4***. *Total length of transport network coverage by type – Burgas District*

| Indicators for Burgas District | 2014 | 2015 | 2016 | 2017 | 2018 |
|---|---|---|---|---|---|
| Highways (km) | 52 | 52 | 51 | 51 | 51 |
| First-class Roads (km) | 249 | 252 | 252 | 252 | 252 |
| Second-class Roads (km) | 261 | 248 | 249 | 249 | 242 |
| Third-class Roads (km) | 624 | 624 | 624 | 624 | 636 |
| Railroad length (km) | 175 | 175 | 175 | 178 | 178 |

The location of Burgas district within South-eastern Bulgaria turns it into an important border area for the State and the EU, much like Varna. Moreover, it shares an external border with an extra-EU country (Turkey). These factors make Burgas district a crossroads of essential transport arteries for national and international traffic.

It is directly part of pan-European Transport **Corridor № 8** (Bari-Vlora-Tirana-Skopje-Sofia-Burgas-Varna). Key pETC elements include the Burgas Border Checkpoint (BCP), first class road E-773, the Trakia Highway, as well as the railroad line from Burgas towards Sofia and the westernmost BCPs. Burgas District is also **near pETC № 9** (from Helsinki to Alexandrupolis in Greece), and is **linked by water to pETC № 7** (Black Sea – Danube).

An focal point of the pETC № 8 is the functionally connected logistics area between Burgas and Karnobat. Within the national TRIS paradigm they are essentially tied, considering the distribution of different infrastructural functions between them – **Karnobat** is the **strategic Railway** dispatch station in the area, while Burgas serves as a land, air, sea and telecommunications centre for the entire South-East region.

Admittedly, communications run mostly in the East–West direction, along transport links between Burgas and Sofia. The transport corridor Burgas–Sredets–Yambol is formed mostly by roads 2$^{nd}$ and 3$^{rd}$ class, while the section Burgas–Aytos–Karnobat–Straldzha is mostly first class roads and the railway serving national and international traffic.

The above considerations for the North-South regional traffic from Varna are mostly valid for Burgas District as well. National road links serve the coastal area, connecting the BCPs of Malko Tarnovo and Durankulak. Still, roads are scarce, overused and underfunded, while rail links are possible only by changing over in Karnobat. Water transportation links between Burgas and Varna are irregular and seasonal.

District and municipal plans indicate the connection between BCP Malko Tarnovo through Burgas and Varna all the way to Durankulak as an essential route, since it is the District link to Romania. Quite importantly, the road to Ruse (bordering Romania and part of pETC № 7 and 9) has an alternative rail link – from Karnobat to Shumen directly, without having to pass through Varna. However, this route is served by 2$^{nd}$ and 3$^{rd}$ class roads.

The Burgas District **road network**, specifically, amounts to 1124.6 km of national roadways. The above considerations on underdevelopment are easily seen by comparing the District share in territory (15% of the Nation) to its road coverage (3.8% of the national total length). Moreover, roads of 2$^{nd}$ and 3$^{rd}$ class are the ones more widely present territorially, more than this is the case nationally. Strategically, the link to Karnobat, at least, is planned and built as a section from the Trakia Highway, improving efficiency between the two logistics centres.

Additionally, the density of the 4$^{th}$ Class road network is lower than the national average. This is not a good trait, however, as the mountainous part of the district is mostly 4$^{th}$ Class 4. This is a further indication of an underdeveloped road network of that kind. Conversely, 3$^{rd}$ Class road density is higher than the national average. It is better developed (at the expense of the fourth-class, but given the terrain, the development of the second-class road network is rather lagging behind, which is evident in the density for the area compared to that for the country.

The following calculations are provided in the 2012 Municipal Disaster Protection Plan of Burgas. We can compare these numbers to the NSI statistics a couple of years later (from 2014 onwards) in the above tables. Inductively we should conclude that the length and density of the transport network has not increased considerably. However, the quality and **condition of the roads have improved** by a significant margin between 2012 and 2017-2018.

***Table 5**. Length, density and condition of the road network in Burgas district as per 2012 MDPP*

| Road Class | Length | | | | District relative share | Density,km/1000km² | | Road condition (Burgas District) as % of total length | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Burgas District | | Bulgaria | | | Burgas District | Bulgaria | | | |
| | KM | % | KM | % | | | | good | ave. | poor |
| Highways | 50 | | 358,8 | 0,9 | | | 2,9 | - | - | - |
| I class | 249,6 | 10,75 | 2886,6 | 7,9 | 8,65 | 32,2 | 26,0 | 50,2 | 18,5 | 31,3 |
| II class | 243,6 | 10,50 | 3718,1 | 10,1 | 6,55 | 31,4 | 33,5 | 22 | 39,4 | 38,6 |
| III class | 622,4 | 26,83 | 6337,6 | 17,3 | 9,82 | 80,3 | 57,1 | 13,4 | 37,5 | 49,1 |
| IV class | 1195,2 | 51,54 | 23277 | 63,4 | 5,13 | 154,1 | 209,7 | | | |
| road linking | 9,0 | 0,38 | 191,6 | 0,5 | 4,7 | | | | | |
| Total | 2319,8 | 100,0 | 36729,7 | 100,0 | 3,8 | 299,20 | 333,0 | 23,3 | 33,2 | 43,5 |

With all the due considerations for the differences between 2012 and the 2014-2018 period, certain characteristics persist. Those are also reported descriptively when comparing State roads of different classes. Those which are considered "first-class" – immediately below highways and speedways (the latter lack service lanes in comparison to the former) – are mostly in good condition. Second-class roads are in average condition (with a comparable percentage of poor as well), while third-class roads are predominantly in a poor state.

The most intensively exploited route in the district is the first class road **I-6 (E-773)**, Burgas - Aytos - Karnobat - Sliven, which is an important southern transport axis between Eastern and Western Bulgaria. Although it is practically **doubled by the A1 Highway** from the village of Vetren onwards, the I-6 is still widely used for service functions, local passenger traffic and freight logistics, and as such is intensively relied upon for cornerstone economic activities.

Similar considerations are valid for the **I-9** first class road (EU road **E-87**) which we have already identified above as the route leading from Durankulak (border with Romania), through

Varna District, south towards Burgas and all the way to Malko Tarnovo (near the Turkish border). As within the Varna District limits, the road here carries important transit flows, both people and cargo, serves crucial economic activities in the tourism and service industries. Yet, it **does not have a valid alternative** as a main link between Varna and Burgas. As mediocre as it has become in some parts, the second-class bypass road (i.e. the Dyulino Pass) which enters Varna District is even worse, much worse in particular sections.

Despite the fact that important traffic routes do not have alternatives, the numbers which speak volumes about the system's vulnerability to disasters and the TRIS exposure to critical events are namely in the condition of those that are in use currently. While 52% of the 1st class roads are in good condition, that simply means the other half are not (18% average, 30% poor).

Second-class roads provide regional transport services and, more importantly, help redistribute traffic from first-class and other roads. Only 21% of the district's second-class roads are in good condition, while almost 80% is below that level (40% average and 39% poor). Parts of the II-73 road (on the territory of Sungurlare Municipality) and the II-79 road (on the territory of Sredets municipality) are particularly poor and need structural intervention and rehabilitation. The former ensures another potential alternative to crossing the Balkan mountain to/from the North, while the latter is without an alternative through much of Bulgaria's underdeveloped and underpopulated South-East.

Third-class roads serve "intra-regional" flows, providing access to smaller towns and villages, industrial centres, tourist and historical sites or simply links to higher class roads. In this case, only about 12% of the district's third-class roads are in good condition (41% average, 47% poor). Notoriously bad illustrations are provided by the III-1014 and III-1015 roads (within Burgas Municipality itself), the same road III-1014 (as well as III-1020) around Kameno Municipality, along with the III-1156 near Sungurlare. An idea of the provision of municipalities with roads and their structure is given in Table. The below table illustrates distribution and condition of road types in all of the Municipalities of Burgas District. We can clearly note the significance and level of maintenance of the road network within Burgas city limits, as well as some of the more prosperous Black Sea coastal towns.

***Table 6.*** *(National) Road Network provision of municipalities in Burgas District, 2012*

| Municipalities | Length, km | | | | Density, km/1000 km² | | | |
|---|---|---|---|---|---|---|---|---|
| | 1stClass | 2ndClass | 3rdClass | Total | 1stClass | 2ndClass | 3rdClass | Total |
| Aytos | 24,1 | | 20,8 | 44,9 | 59,7 | | 51,5 | 111,1 |
| Burgas | 45,2 | 13,0 | 79,4 | 137,6 | 87,9 | 25,3 | 154,8 | 268,2 |
| Kameno | | 7,5 | 73,6 | 81,1 | | 21,1 | 207,3 | 228,5 |
| Karnobat | 28,0 | 11,0 | 45,4 | 84,4 | 34,7 | 13,7 | 56,3 | 104,7 |
| Malko Tarnovo | 40,2 | 30,1 | 39,5 | 109,8 | 50,3 | 37,7 | 49,4 | 137,4 |
| Nessebar | 42,4 | | 39,5 | 81,9 | 100,5 | | 93,6 | 194 |
| Pomorie | 16,6 | | 37,6 | 54,2 | 40,2 | | 91 | 131,2 |
| Primorsko | | 10,2 | 23,4 | 33,7 | | 29,1 | 66,9 | 96,3 |
| Ruen | | | 72,6 | 72,6 | | | 105,2 | 105,2 |
| Sozopol | 24,6 | 32,4 | 32,6 | 89,6 | 47,5 | 62,5 | 62,9 | 173 |
| Sredetz | | 68,4 | 70,1 | 138,5 | | 59,7 | 61,2 | 120,9 |
| Sungurlare | 28,5 | 36,0 | 57,9 | 122,4 | 34,6 | 43,7 | 70,3 | 148,5 |
| Tsarevo | | 35,0 | 30,0 | 65 | | 68,2 | 58,5 | 126,7 |
| Burgas District | 249,6 | 243,6 | 622,4 | 1115,6 | 32,2 | 31,4 | 80,3 | 143,9 |
| Bulgaria | | | | | 26,0 | 33,5 | 57,1 | 116,6 |

Despite the presence of the A1 Highway and a more intensively developed southern sea coast, Burgas district reveals territorial coverage, density and average condition of its roads which indicate a somewhat elevated degree of vulnerability to exposure to elements, as well as the lack of alternatives necessary for resilience and response.

State road network density is determined by demographic, environmental and socio-economic factors. Burgas district is occupied by (low) mountainous terrain in roughly 2/3 of its territory. That could historically be one of the reasons why, despite reporting figures which are higher than the national average – including inaccessible areas – the district road density is evaluated as low by industry and national experts.

The Black Sea coast is also a complex factor in itself, being characterized numerous settlements along the coastline, in an around existing roads. This also contributes to a lower density and higher linearity. Likewise, border areas present lower natural – but often also political – stimuli for expanding the road network and its quality.

Also coherent with such considerations is the fact that the road network's density within Burgas Municipality limits is higher, as is its quality. Many companies that are located just outside the city, prompting the Municipality to cater to a better extended road network quality.

Primorsko has the lowest density, due to small size, mountainous nature and limits imposed by with the Sea. Karnobat also has a density lower than the national average, as does Ruen Municipality – with the latter entirely served by third-class roads only. Essentially, fourth-class roads are municipal property, managed and maintained by the local administrative units. Therefore, they have the main responsibility for the local road condition and, frequently, lack the resources to maintain and upgrade them, leaving the majority of this category of roads in poor condition, and not only in our focus area but throughout the country. This is especially visible in winter conditions.

Further down, we will take a more detailed look on the transport services within Burgas Municipality limits. As for intercity links, these are provided by both state and private companies, provided a certain level of operative and organisational communication with those same local authorities.

The **railway network** coverage in Burgas district is much like the rest of the country – uneven, lacking alternatives and mostly deficient in linking the South to the North part of the country. This is true both for important high-speed rail links between Varna and Burgas (missing whatsoever – logistic links are through Karnobat after changing trains) and diagonal connections between Burgas and the North-Central region of Bulgaria. The latter exist, albeit with a couple of changes in connection and are in fact slow, outdated and winding through the Balkan mountainous range. Another significant shortcoming includes the lack of railway lines in the south part of the district, closer to the border with Turkey and towards the joint border with Greece.

Out of the 13 Municipalities in Burgas District, the railway does not pass through five, four of which are in the southern part of the district. The above-mentioned scarce coverage in the South-East of Bulgaria that we had with road is even more pronounced in Malko Tarnovo, Tsarevo, Primorsko and Sozopol municipalities, being far away from any railways.

Still, the district of Burgas has the advantage of being served by **2 intersecting main railway lines** (out of the three main national parallel directions):

- the №8$^{th}$ main railway line Plovdiv–Filipovo–Burgas (from its km.215 at Straldzha interstation station, through Tserkovski station and up to km 293.500, namely Burgas station); as well as
- №3 main railway line Iliyantsi–Karlovo–Karnobat–Sindel–Varna ferry (from Karnobat to Asparuhovo).

These two railway lines serve international traffic flows, besides being the crucial for regional logistics. Firstly, they are adjunct elements of the pETC passing through and around the Black Sea coastal area. Moreover, they are designated parts of the European Agreement on Important International Combined Transport Lines and Related Installations (AGTC). Hence, as much as we have spoken about the underdeveloped and outdated state of the district and national railway network, it is still an important regional factor in exploiting economic streams and international logistic routes. It remains the cheapest mode of land transportation, especially for cargo shipments, and creates opportunities for the district and the entire Black Sea region, as well as an access to an environmentally friendly alternative to automotive transport.

Burgas district is also served by secondary railway lines between Pavlov and Pomorie stations, as well as 6 industrial railway “branches”. The latter belong to and are operated by essential state and private enterprises, mostly within Burgas city limits – Port Burgas; the Industrial zones "East" and "West"; the “Promet” line between Dolno Ezerovo and Debelt; the heavily exploited track section around “Druzhba” station which falls within Lukoil Neftochim (Refinery) limits; the Kameno sugar factory station of Balgarovo; the “Andesit” stone quarries railway section; and the “State reserve” branching serving storage facilities of national importance.

These railway branches are largely mono-functional (yet bidirectional) deviations from the main rail traffic destinations – they serve local traffic routes of regional importance, mostly related to high profile economic activities (see above).

Much higher visibility to passenger traffic and urban security is assigned to the three large railway stations in the District – Burgas Junction (Main station, Burgas West, Pavlov and Burgas Distribution); Druzhba Station (See petrol refinery Lukoil) and the Karnobat Station (with important exchange functions for the whole Bulgarian East). These junctions have the capacity to assemble train compositions and rearrange rolling stock. They end up being directly involved in a significant percentage of freight moving throughout the country's railway network and not only the Black Sea region.

The table below indicates railway lengths and types located in **both Varna and Burgas Districts**.

*Table 7*. *Total length, type and traction of railway network infrastructure and rolling stock in Varna and Burgas Districts.*

| **NRIC Division** | **District Rail Routes (km)** | **Railroad track types** (electrified/ diesel use) | | **Total intra-city rail tracks, km** | **Station Tracks** | | **Industrial track length** | **Grand Total** railway length, all types |
|---|---|---|---|---|---|---|---|---|
| | | Single track | Double track | | Total within stations | Out of which: electrified | | |
| Varna Division | 52.81 | 35.91 | 16.81 | 69.62 | 7.90 | 7.90 | - | 77.51 |
| Burgas Division | 133.51 | 15.11 | 93.33 | 226.84 | 110.41 | 57.16 | 184.73 | 521.98 |
| Total for Analysed Area | 186.31 | 51.02 | 110.14 | 296.46 | 118.30 | 65.05 | 184.74 | 599.49 |

We can clearly see that the large linear amount of railway tracks dedicated do industrial activity makes the district rail service infrastructure stand out compared to the north Black Sea coast. Moreover, state junctions serve and support such industrial activity through **a denser railway network** on the ground. This is both a quality which confers **more stability and resilience** in terms of **industrial shipment alternatives**, as well as it is more exposed and **vulnerable** to any industrial incidents and natural events which might interfere with such an extended railway cargo network (mostly).

The total railway length in the district (599.49 km) represents about 13.5% of the national railway line infrastructure. The doubled train tracks represent 12% of this category on a national scale, while the electrified tracks are only 8.5% of all electrified rail routes in Bulgaria. Most of the latter lie along pETC №8 linking the Adriatic and Black Seas.

When comparing separately these functional characteristics and quality parameters of the railway network in Burgas district to the average or total for the country, we easily notice that they fall behind on some of the above indicators – except total railroad density per 100 km$^2$.

*Table 8*. *Railroad network type in Burgas District compared with Bulgarian average*

| | **Burgas District** | | **Bulgaria** | |
|---|---|---|---|---|
| | **Length, km** | **% of total** | **Length, km** | **% of total** |
| Total railroad | 599.5 | 100 | 4290 | 100 |
| Double tracks | 110.4 | **18.4** | 964 | **22.5** |
| Electrified tracks | 226.8 | **37.7** | 2645 | **62.0** |
| Density of railway network | 7.7 km / 100 km2 | | 3.9 km / 100 km2 | |

Considering railroad infrastructure apart from dedicated passenger services, services, we can make some conclusions on the railway ecosystem stability, safety and potential. With view of the above indicators, the railway network in Burgas District is indeed quite extended and functional. It presents certain structural shortcomings only when we consider its **uneven distribution in the South-East** corner of its territory – the Municipalities of Sredets, Sozopol, Primorsko, Nessebar, Tsarevo and Malko Tarnovo (the first and last of this list are inland, the rest lie along the Black Sea coast).

Provided an average density of the railway network for the country reported as 3.9 km or railroad per 100 km$^2$ of territory, Burgas district is way above that average, with 7.7 km/100km$^2$. These figures are, however, mostly brought up by the **industrial railway networks**. Local branches are also about 30% of its total length, with Burgas Railway Junction an important pivotal point for cargo shipments in the entire South-East of the country. This is highlighted by the Port Burgas rail connection and the "Lukoil" station (named "Druzhba").

The fact remains that the district falls behind the national average on two aspects. The first is the presence of double rail tracks – serving to provide route stability in terms of passage options and logistics control. The second parameter is the electrification of the routes (especially important with view of infrastructure and rolling stock modernisation and moving towards higher speeds and more comfort for passengers and not only cargo. These indicators show that despite the good performance in quantity and coverage, the South-East railroad network is lacking in some quality aspects leading to potential vulnerabilities and less adaptability.

An important fact for the District is that the stretch **between Karnobat and Zimnitsa** is statistically the **busiest section of the entire national railway network**. Objectively being very difficult to halt operations in the section, many repairs and maintenance works have become overdue. This has not led to objectively higher vulnerability indicators, at least numerically. However, it indirectly and potentially exposes further a part of an important TRIS section which is already under operational strain. Train speeds have been reduced by about 20% in comparison to normal functions of the local infrastructure. Having said that, parts of this section have been maintained more consistently than others, with rehabilitation works performed between Zimnitsa and Straldzha, as well as Straldzha and Tserkovski (as per NRIC reports).

The areas which are served by the largest number of stations and stops, are Karnobat and Burgas. The former, being a small town and considering Bulgaria's socio-economic scale, reports impressive turnover. An average of 15 trains pass through **Karnobat**, including many international destinations. Karnobat serves mainly transit traffic but is one of the most important railway junctions nationally, with significant passenger and freight turnover. There is considerable technical servicing capacity as well – locomotive and wagon depots, electric and railway maintenance facilities. Management and distribution functionalities and technical support at the junction (in terms of equipment, staff, IT systems, etc.) is significantly above national average, improving traffic automation and transport services. This is a point which contributes substantially to the stability and security of the entire District.

Burgas station itself is a cornerstone point of pETC №8 (and in its original route design happens to be the first/last station in the East, subsequently adding Varna as an extension to the corridor's Black Sea coverage.) As with road traffic – and despite not having a complete spatial and technical compatibility in intermodality – Burgas Station in itself remains an important cargo distribution point of national and international importance (especially considering the refinery and port links).

***Table 9**. Railway service access points in Burgas District*

| | Main Railroad Lines | | Railway Branches | |
|---|---|---|---|---|
| | Stations | Stops | Stations | Stops |
| **Burgas** | 6 | 4 | | 3 |
| **Kameno** | 1 | 1 | 1 | 1 |
| **Aytos** | 2 | 2 | 1 | 1 |
| **Karnobat** | 3 | 1 | | |
| **Sungurlare** | 2 | 4 | | |
| **Ruen** | 2 | 6 | | |
| **Pomorie** | | | 1 | |
| **Sredets** | | | | 1 |

**Air transportation** in the district is covered by Burgas Airport, mostly. It is the second busiest in the country, after Sofia. Burgas air traffic Control Centre manages aircraft movement for about a quarter of the national territory. over about ¼ of the country's territory. Used mostly for charter, passenger and cargo flights (in decreasing importance and frequency), it also handles some export and import of agricultural products from Europe, Asia and North Africa. There are only a few military flights being serviced there, as per incidental needs.

On 18 July, 2012, Burgas Airport was the scene of a **terrorist bombing incident**. Seven casualties and 32 injuries marked this sad event which exposed some gaps in security protocols and screening procedures. However, it must be underlined, these shortcomings were related to passenger transfer services, as the incident happened in the parking lot, with the explosive device having been previously loaded in a bus luggage compartment. This man-provoked critical event has little to do with structural capacity of the region's TRIS ecosystem, its infrastructural integrity or management procedures. It is, nevertheless, important that access points and security protocols are extended to locations even as seemingly innocuous and "static" as an external parking lot. This incident risked creating a notorious image of the Bulgarian seaside region, yet, ultimately it did not influence tourist of internal traffic flows.

As for its structural and functional features, Burgas Airport is situated 10 km northeast of the city and maintains important capacity levels which help support tourism and the service industry in the district and coastal region.

Built on an area of 2,604,300 square meters, **Burgas Airport** is home of one of the larger cargo handling centres in the country. A 3,200-meter runway serves the heaviest aircraft types. Member of the ACI, the Airport is operated on a long-term concession by the Fraport Group, just like Varna Airport.

The managing Group reports that in 2019 Burgas Airport operated flights of 72 airlines to and from **132 destinations in 37 countries**. Overall, 2019 saw **2.85 million passengers**, around 40% more than Varna Airport – mostly because of the larger total capacity of the summer resorts around Burgas compared to those near Varna – which still represents a 12% decrease from the record-braking 2018.

The leading (incoming) passenger destinations include the UK (564,000 passengers, roughly 20% of all travellers), Russia (507,000), Poland (399,000), Germany (297,000) and the Czech Republic (266,000). Top destinations departing from Burgas are Moscow, London, Prague, Tel Aviv and Katowice. Year-round, it maintains only London (Luton), Moscow (DMD) and Varna (en route to Sofia), albeit on selected days. 2020 was expected to bring 3 new airlines to operate at the Airport, however, the Covid-19 outbreak put those plans on hold.

Passenger services satisfy most current international standards, with a Terminal capacity of **1200 passengers per hour**. Local and international Agencies and logistics offices provide ongoing and transfer destinations and transport means, even as we have emphasised the need to improve connections for both passenger and cargo movement. The presence of railway, ferry and automotive transport makes the airport an interesting point for reaching various other parts along the Black Sea coast.

An important part of Burgas Airport capacity and business competitivity is its 50,000 sq.m. **cargo area** with an annual capacity of handling 30,000 tons of freight shipments and transfers.

It is located nearby easy access road intersections, offering a relatively quick connection to sea transportation as well. Six on-the-spot refuelling terminals facilitate cargo transfer and reloading at the Airport (As much as they may add a degree of vulnerability to airport operations and the overall area security, these **refuelling stations** are buried underground and meet high operative standards imposed by the Fraport Group and the local and regional authorities.)

When describing airport operations for Varna (above), we already gave reference for the scale and type of investment that the Airport Management has committed towards restructuring and upgrades. Apron reconstruction has already been initiated and will be completed gradually over the next two inactive seasons. Surface areas will be followed by apron lighting. After the 2012 incident, important security and governance improvements to the parking and external transfer areas have been implemented, including a recent expansion.

Transport diversification along the entire Black Sea coastal region is complemented by its **water (sea) transport** and Burgas district is no exception. Six of the municipalities in the District have direct access to the Black Sea. The region is served by **8 ports** for **general** and public transport and **3** with **special designation**. Most are Public, with the exception of "Fish" Port Burgas and some smaller yacht embankments which are not categorised as full-scale ports.

- Classified as Public and General transportation, we have the following ports: Burgas; Ahtopol; Tsarevo; Sozopol; Pomorie; Nessebar; Oil Port - Rosenets; Fish Port - Burgas.
- The following are Special Purpose Ports: "Ship Repair" Port; "Transstroy" Port; "Burgas Shipyards" Port.

Primorsko is the only seaside Municipality which does not have a port on its territory. Naturally, most of the ports (ant the largest) are within Burgas Municipality waters. Occupancy and operational intensity is also incomparable between smaller municipalities and the ports in and around Burgas.

Given its importance in moving and relaying (mostly) cargo from and to the South of the country, **Burgas Port** management plans and implements constant (even if small) upgrades and investment into functional and safety improvements. The investment policy aims at modern port infrastructure and substructure in order to allow for servicing of vessels with significant draft depths, as well as providing conditions for complex loading and unloading operations. Improvements, as per port operator statements, seek both speed and security of cargo handling. The Port of Burgas is certified under International Ship and Port Facility Security (**ISPS**) Code for operations at **Level 1 security**.

The Port's **"East" Terminal** covers the oldest developed water area of Burgas Bay. Fourteen ship berths extend over almost 2 km of pier facilities, while the 10 m draft depth capacity allows the processing of 25,000 ton ships. The "East" terminal has about fifty thousand square meters of open storage areas and around 45 thousand of indoor ones. They are dedicated to handling of mostly packaged cargo of general nature (food, machinery, metal, wood, paper, scrap, etc.). Bulk cargo is also often distributed here (such as coal, sugar, ammonium nitrate, etc.) for the nearby industrial areas, despite the presence of a dedicated terminal (see below). Official reports indicate that "East" Terminal is equipped with 23 portal and mobile truck cranes, 6 gantry cranes, 35 tow trucks, 38 forklifts, 2 truck scales and other service equipment and port mechanisation. Even if not every single one of them is completely up to date, it shows sufficient capacity and alternatives for a number of cargo ships to be safely and efficiently serviced.

Just as for Varna Port, the State Enterprise "Port Infrastructure" plans for an impending deepening of the main port areas.

The "**Bulk Cargo**" Terminal has five specialised berths. Berth 20A is dedicated and equipped for transhipment of **liquid cargo** – mostly fuels, liquid chemicals and alcohol. The quay front is 750 meters long with a draft depth of 11 meters. The port also handles efficiently shipments of coal, coke, iron ore, cement clinker and various matter concentrates. The equipment which services loading and unloading activities includes 6 gantry cranes, a "Sivertel"-type coal unloader, a "Cherry Tanfany" coal unloader, 3 forklifts, 10 bucket loaders, 2 telescopic front loaders, 9 heavy duty rubber-belt conveyors, 3 rotary excavators, 2 bulk shape formers, 2 truck scales and a wagon loading station. Chemicals of various nature can be processed via specialized trestle and pipeline connections. The Terminal's open storage area is 49 thousand sq.m. while its indoor storage area is 5 thousand sq.m.

The Burgas District Disaster Protection Plan (2012) emphasises the importance of the "Bulg Cargo" Terminal for both urban and regional safety and sustainable economic operations. Current security and monitoring procedures, along with the above technical support are evaluated as sufficient and not exposing the district to immediate and foreseeable vulnerabilities.

Burgas **"West" Terminal** has 890 additional meters of quay front, with 6 ship berths and a draft depth of 11 m. It is the sector with the largest storage capacity – about 191 thousand sq.m. of open, 11 thousand sq.m. of indoor and 7 thousand sq.m. of **refrigerated storage** facilities. The equipment listed for Terminal West is 11 gantry, 12 bridge and 2 mobile cranes; 12 tow trucks; 9 container tow trucks; 15 forklifts; 4 specific electric forklifts for the refrigeration storage spaces; 3 container loaders; 4 bucket loaders; a pneumatic grain-handling machine and truck scales.
This being the section with the largest storage space, it serves as the main **container terminal** for processing specialized ships, including **Ro-Ro craft**. Berth 21B has an extended length of 60 m, draft depth of 8.50 m and is used by the ferry line – most frequently between Burgas, Novorossiysk (RU) and Poti (Ge). The container terminal has two other specific ship berths (№ 23 and № 24) which have a maximum draft depth of 11 m. Altogether, there is space for 1330 single container berths.

Last but not in importance, we must consider the **new Terminal "2A"**. Built within a State-financed project for the expansion of Port Burgas, it has 4 quays and 108,000 sq.m. of storage area. With universal cranes (from 3 to 40-ton capacity), bridge cranes (from 20 to 32 ton-capacity) and truck cranes (from 12 to 40 tons), it is also equipped with other multifunctional mobile handling equipment.
This project was also used to connect the terminals through some fresh road links and improve operational connections to already exploited railroad tracks. These interventions facilitated ship approach with various cargo but also helped review security and safety functionalities and improve perceived vulnerabilities and shortcomings in transhipment of sensitive freight.

Shifting our focus back to the city of Burgas, we are reminded that **Burgas city transport provision** is exclusively dependent on road transport links. Most are designed and regulated by the **Municipality** and it owns the largest urban transport operator in town. All procedures regarding safety, security and sustainability are approved by the City Council and enforced by the various municipal administration directorates.
The **public transport network** in Burgas consists of a bus route network that covers the city and its adjacent neighbourhoods. Currently, most of these routes are served by diesel buses (largely new). With the implementation of the significant "Integrated Urban Transport of Burgas" project (**IUTB**, 2013), **67 new "eco" buses** were purchased with EU and State financing. Electric vehicles are the next upgrade which is planned for by the local administration, having

applied for the financing of 56 electric buses the current under Operational Program "Environment".

Two trolley routes connect the urban centre with the large residential neighbourhood of "Meden Rudnik" to the south (they branch out only when they reach Burgas' central parts). The routes to and from Meden Rudnik are an essential part of the **BRT corridor** of the City. Quite importantly, the second stage of the above Integrated Transport project saw the city acquire **22 new trolleybuses** (and 11 new vans for various public services).

The stability and sustainability of a city's urban mobility are also characterised by the number and type of lines and destinations, as much as by the quality of its service and infrastructure. As we already mentioned above, most of the intra-city services are operated by a Municipality-owned operator.

In detail, and according to the municipal public transportation website, passenger service is provided through **28 lines** (26 bus and 2 trolleybus). Some function only in peak hours, while 19 lines are more regular. According to "Integrated Urban Transport", peak hours may see up to 97 vehicles operating out in the streets (65 buses, 12 trolleys and 20 minibuses). The network is designed and implemented in a way that 95% of the population would be served within a five-minute walking distance. This provides significant sustainability to urban mobility, even if the lack of alternatives in the zones outside of the centre do not add to system stability and usability.

As mentioned above, there are three bus companies in Burgas. **Burgasbus** EOOD is the one entirely owned by the local administration. It occupies a dominant position in the market, with a share of over **80%**. All the new vehicles (buses and trolleys) are exploited exclusively by Burgasbus, as the State and EU financing excluded fragmentation of participants in the foreseen integrated service improvement.

Comfort OOD is a private company which operates 3 bus lines and has a 12% market share. Mostly overlapping with some of the Burgasbus routes, the company enjoys a stable market share due to regular service, tariff integration and the nature of the routes themselves (frequently used).

Burgasvolan 95 OOD is another private operator which serves 6 city lines, yet has an estimated market share of 5%. This is because the company services mainly urban lines with low user frequency and traffic. They also offer regional and intercity transport services, albeit with more outdated vehicles.

Lastly, there are some smaller operators, with a notable example being Mini Bus Express OOD. Quite importantly, however, all these private companies participate right along the main operator (Burgasbus) in potentially **necessary emergency response procedures** whenever there is the need to transport large population masses.

The aim of the **IUTB** project was not only to renew vehicles but, quite crucially, to review and optimise the network, its lines and their sustainability and potential TRIS ecosystem vulnerability. Multi-level analyses revealed no ground-breaking shortcomings. However, the intermediary report stated that "the current transport scheme consists of many duplicate routes or parts of routes. [Contrary to some expectations] competition in parallel routes has led to poor efficiency and low line occupancy. The **transport scheme is difficult to understand** and [at times] **illogical**".

One of the main recommendations has been the need to develop an entirely new route network for the city with improved bus line coverage and efficiency. So far, the main improvement consists in the dedicated BRT trolley/bus line which marks a heavily used route between Meden Rudnik and the centre of Burgas (even without significant structural alterations to the ground infrastructure).

Highlighted as an important added value of IUTB implementation and results, the city integrated monitoring system – with a central **surveillance HQ** and dozens of staff working 24/7 – definitely improves safety and protects certain known vulnerabilities and weak points of Burgas city TRIS. Hundreds of cameras serve, however, mostly for monitoring and decision making, with little automation at this stage. Still this places Burgas **ahead of Varna** in one important prevention and response capacity aspects.

**Spatial development** has also been treated extensively by these topical analyses over the past few years – during and after IUTB implementation. Most communications links and TRIS components which need improvement have been identified and are in the process of planning for upcoming programming periods and Municipal/District interventions. These include:

• Much like in Varna, the **proximity of the port to the city** leads to street congestion in the central parts. Current expansions of the port complex increase cargo turnover and supporting freight traffic, worsening the situation. The lack of bypass routes is noticeable, signalling some system vulnerabilities. These, in the summer season, reach significant proportions and requires a gradual introduction and construction of alternative logistic arteries, intersections and nodes which might alleviate the problem. The Local authorities (with much assistance from the Central Government) have implemented some repair and renovation works, partially optimising traffic lanes and routes. A couple of new shortcuts have been constructed and some roundabouts which directed traffic in a more even manner.

• The need to consistently continue designing and constructing **bicycle routes** and lanes is also quoted as evident. The effective promotion of bicycle transport among citizens as an ecological, economical and healthy alternative is on the table for a number of years, with bike stands, signs and certain main lanes in place. Apparently they have not provided sufficient usage so far, with the system in use mostly in July and August and the bicycles being few and far in between.

• The creation of an "**intelligent transport system**" is invoked in expert reports and current planning standards of the city. This regards the already established program for visualization of transport problems through surveillance monitoring. However, it needs to be integrated with simulation and rerouting options, databased optimisation scenarios and the actual technical ability to act upon identified organisational solutions for solving transport problems, possibly with lower-cost parameters.

An attempt to solve the mass transit problems in Burgas is made in the new Master Plan – it entails mainly **bypass roads**, as hard as they are to project and build, given the numerous large **lakes around the city**. The so-called near and far bypass rings should be parts of the national road network, on the other hand, and as such are State prerogative.

Current designs plan to move transit traffic in the direction of Sozopol through the construction of the road overpass over the railway tracks at the freight station and “Odrin” Street. An important role is assigned to the projected double capacity of the road between Burgas and its Dry Port, all the way to Krayezerna Street. This will bring certain industrial traffic as far as possible from the central parts (as far as the presence of those surface water bodies allow).

The transport node Burgas-Sredets-Sozopol envisaged in the Master Plan has already been built. It represents an important step towards the optimisation of transit traffic which is “non-specific” and non-essential to urban socio-economic activities.

Further elements of the Master Plan also include a bridge over Lake Burgas which would greatly relieve traffic towards Sozopol. The latter idea is quite costly and although well-justified might need time and finances which are not within both City and State priorities.

Traffic optimisation in the direction of Varna is one of the essential remaining issues. Channelling much of those flows which do not need to absolutely enter the city is projected at the west and north-west entranced of the city (linked to the Highway to Sofia). Built directly as deviations from Trakia Motorway, they should provide direct connections from E-871/E-773 to existing road capacity along E-87. Once again, national road networks are State prerogative and, hence, solutions should be coordinated with the Central government and justified via substantial proven benefits to the regional TRIS stability, economic and environmental returns to the Black Sea coastal region.

As with Varna, we take a look at the **municipal budget** to understand the scale of involvement and investment that the local authorities dedicate to local TRIS. The last full financial year completed and accounted for (2019) indicates BGN 140 thousand for personnel costs directly related to maintenance, repair and construction services. This kind of salary and insurance spending regards only administrative activities, since actual construction and maintenance tasks are almost always outsourced. OP "Transport" has contributed with slightly above BGN 4 million to actual construction activities (half in staff maintenance), out of a total BGN 10,750,000 dedicated to infrastructure support and upgrade. The figures are comparable to those of Varna, considering the smaller size (and population) of the urban area, as well as the fact that the Municipality is not responsible for roads immediately outside of its city limits.

We must emphasise the complete overlap in our definition of transport network infrastructure and road networks, since there is no viable alternative in Burgas to this kind of logistics (just as it was the case in Varna and the entire Black Sea coastal area).

## Traits and Considerations Valid for Both North and South Black Sea Coast

Both areas – above and below the Balkan mountain range – report **significant similarities** rather than substantial differences. The type of transport network use (**mostly road**, with stronger **rail usage** dedicated increasingly to **industrial activity**); the economic structure and importance of their **export-oriented sea transport** compared to local road logistics; as well as similar problems related to **urban mobility** and **unresolved issues** with planning and long-term optimisation.

The **most characteristic trait** of both districts is, naturally, the **presence of ports** along the sea coast. When we consider aspects which might influence system vulnerability and resilience, we keep in mind mostly the technical infrastructure and networks, including the extended transport infrastructure, directly related to Port infrastructure and intermodal transhipment (with all due considerations for current and potential connectivity and efficiency).

According to information published on the website of Executive Agency "Maritime Administration" (EAMA), as of 2015 there were 61 functioning seaports in Bulgaria. 35 of those (57.4%) were located in the territorial area of jurisdiction managed by EAMA–Burgas, the remaining 26 (42.6%) within EAMA–Varna limits. With the North even more emphatically dedicated to industrial and specialised water transport, statistics show that over 2/3 of public transport ports are located in Burgas district, while about 1/3 are located on the territories of municipalities within both Varna and Dobrich districts.

***Table 10***. *Sea Ports according to Territorial EAMA (2015 data)*

| Type of Port | EAMA Region | | **Total** |
|---|---|---|---|
| | **Burgas** | **Varna** | |
| *Public Transport Ports with **National** Importance* | 9 | 4 | **13** |
| *Public Transport Ports with **Regional** Importance* | 7 | 3 | **9** |
| *Fishing Ports* | 9 | 4 | **13** |
| *Yacht Ports* | 7 | 7 | **14** |
| *Special Designation Ports* | 3 | 8 | **11** |
| **Total** | **35** | **26** | **61** |

Having described the two major Port Complexes of Varna and Burgas, we will outline the functional importance and relation of some of the other mid-size ports to the socio-economic standing of the Black Sea coastal area as a maritime factor in the Region.

As we noticed above, Burgas territorial Directorate of the EAMA is home to most of the secondary ports with national and regional importance:

The Port of **Nessebar** is a public transport facility of regional importance. It offers passenger service; mooring and ship support (water, communication and electricity supply); waste collection and treatment.

The Port of **Ahtopol** is a public transport facility of regional importance. It services fishing boats mostly.

"**Rosenets**" Port Terminal is a public transport facility of national importance. It offers cargo service (oil, petroleum products and other dangerous bulk goods); as well as complex maritime technical services requiring the use of port territory and facilities – mooring, supply of ships with electricity and communications, ship bunkering, technical services, supply with food and other products; waste collection and treatment.

"**Port Bulgaria West**" offers mooring, accommodation and stay of fishing vessels and boats for the purpose of unloading fresh fish, acceptance and treatment of waste.

"**Michurin**" (Tsarevo) Port is a fishing port mostly, servicing fishing vessels,

There are a couple of locations which have some basic port facilities in place – and that have been functioning as such in the past – but that have been eliminated from the Bulgarian Ports Register: "Fish and yacht port" in Burgas and “Black Sea Fishing” in Nessebar.

Considering the specific nature and current state of Bulgarian sea port infrastructure, the following conclusions can be made:

- the Black Sea coastal area has a sufficient number of ports to serve adequately existing passenger, fishing and cargo activities;
- The two largest ports give more economic weight to the regional centres;
- Varna and Burgas possess the necessary capacity and technical capabilities to function and **develop further as multi-purpose port terminals**;

Despite all this potential – and given the fact that the Black Sea is a closed sea basin – the transport of goods is probably destined to remain **somewhat limited** compared to its (trans)-regional European counterparts. This is emphasised further by its borders on extra-EU countries and the increasingly difficult relations with the Russian Federation.

Expert sectoral reports point to certain potential directions for regional development and improvement. Port infrastructure could and should be further modernised in its technical base, including the development of better passenger and tourist transport.

Potential limits to such development are mostly related to the (two-way) environmental impact, as well as to the above limited spatial planning solutions. Still, the maritime sector should exploit fully its present and mid-term potential in the **tourism, fishing** and **aquaculture** and **"blue" energy** segments.

This can be achieved, as pointed out above, through **better intermodal links** which can optimise and improve accessibility and connectivity. The concept is particularly relevant to the area’s functional relation to the pan-European Transport Corridor VIII from Bari/Brindisi, through Duras/Vlora, Tirana, Kafazan, Skopje, Sofia and Plovdiv, reaching Burgas and Varna. Better integration and an actual promotion of common regional exploitation efforts will improve the

**Black Sea coastal safety, stability and resilience** – both in its TRIS ecosystem and the regional economy in general.

Much has been done, structurally. There are, mostly, well-structured institutions and self-sufficient businesses, with experienced staff and management throughout. The Bulgarian Black Sea coast is highly competitive (regionally), yet much can still be improved in terms of efficiency and long-term sustainability. Improved is merely one of the principal example directions of systematic development.

## Critical Event Impacts on Regional TRIS

Transportation and related functional systems are a key structural elements of the modern economy. They provide not only spatial but constantly support socio-economic processes and phenomena. Transportation as an economic sector, moreover, is crucial for regional and national dynamics. It draws significant investment potential, determines regional accessibility and connectivity, largely shaping effectiveness of the economy and the efficiency of everyday life and numerous business models that rely on logistics.

Transport infrastructure and networks, due to their specific physical nature, are highly **dependent on their surroundings, natural and man-made**, along with the processes that characterise and change them. The Bulgarian Black Sea coastal region is even more emphatically characterised by its location and natural exposure to natural processes and conditions, including climatic factors. Considering the environmental diversity in which the TRIS subsystems exist and operate – land, water, air – place the transportation sector among the economic activities that should take increasingly into account (**assess, plan and adapt**) changes in surrounding natural parameters, including **climate change (CC)**.

Most EU institutions have made **consistent recommendations** through the years. The Green Deal plans advance, along with national and trans-regional plans for mid- to long-term implementation of policies and practices necessary to reach common goals. The Offshore Directive, to name one, includes provisions for “limiting the consequences of accidents through risk assessment and management actions”. This includes integrated risk resulting from human activity and natural processes and ongoing changes. The trans-European Transport Networks and Energy Infrastructure guidelines are another set of agreements and policy roadmaps which include provisions to make sure that “all transport and energy projects to be developed are **climate and disaster resilient**”.

National methodological guidelines also indicate **environmental factors** and **climate change** as affecting increasingly the development and optimisation of the transport system. The **economic challenges** they present are segmented into two main areas:

• Economic significance of **infrastructure degradation** due to atmospheric processes;

• Economic significance (shorter-term) of **extreme weather events**.

The latter have numerous manifestations, scope and degree of impact. The principal common characteristic is their "flash" effect – i.e. sudden manifestation as a result of different factors combining.

**Infrastructure decline**, on the other hand, has its overall economic impact measured in terms of necessary additional expenditure required to bring back (and keep!) TRIS at desired operational and safety regimes. That, however, is a longer process and involves additional **investment towards the adaptation and resilience** of TRIS elements to external influence and changing factors of the surrounding environment. We can outline several exemplary types of degradation, as per national and regional maintenance standards:

• Precipitation-induced degradation;

• Thermal stress on infrastructure systems (e.g. asphalt mixtures, geometrical characteristics of railroads, etc.)

• Winter conditions' Impact

It is inevitable to notice that both categories of natural impacts are entwined, acting along the same vector against system vulnerabilities. Severe events occur more often and have a more significant impact on TRIS wear and decline. Hence, infrastructure owners and operators need to consider an integrated approach in preparing and maintaining the long-term integrity of the systems.

The economic significance of extreme weather events, alone, has its various dimensions. Mostly visible (and assessed) through infrastructure damage, they also have important impacts on **costs related to delay and failure of service provision**.

In light it the above deliberations, we consider it best to **divide the impacts** produced by the surrounding environmental on TRIS integrity and vulnerability into **natural and anthropic** (human).

## Major Types of Risks and Vulnerabilities

In addition to European directives, policy and practical recommendations, there are series of analyses and strategic planning documents on a national (and regional) level in the field of transport. Many of those have entered into force, yet their requirements and provisions have not been enacted in many cases. This alone gives industry experts a reason to consider TRIS **adaptation capacity as still insufficient**, at least until recommendations have not been implemented.

An important topical study – serving as a base for institutional planning and governance purposes is the profound "Analysis and assessment on **risks and vulnerabilities** of Bulgarian economic sectors from **climate change**". Commissioned in 2014 by the MoEW, it evaluates critically the **current resilience capacity** of the main economic sectors – including transportation – in light of their vulnerability and adaptability to environmental impacts and particularly climate change processes and scenarios.

*With regards to TRIS resilience, the experts consider the four Representative Concentration Pathways (RCP) outlining the 4 main climate change scenarios. These follow and offer planning guidelines according to greenhouse gas concentration (not emissions) trajectories and are adopted as such by the Intergovernmental Panel on Climate Change (IPCC) at the United Nations. The IPCC's Fifth Assessment Report (AR5) was issued in 2014, establishing the four RCPs (according to radiative forcing values in the year 2100) as 2.6, 4.5, 6 and 8.5. They have since been adapted and integrated by the Shared Socioeconomic Pathways, introducing the new RCP1.9, RCP3.4 and RCP7. However, still under discussion, they will mostly serve as the basis for planning and adaptation of policy and practice initiatives adopted at the next AR6 in 2022.*

Thus, the indicators considered to have more significant impacts on Bulgarian TRIS are those valid for predicting the short- to mid-term planning scenarios (2035). The below table accounts for main factors such as **Temperature change**/amplitude ($\Delta$T°C), **Precipitation change** ($\Delta$P%) and the Expected change in **Extreme events** (increase or decrease, Ex ↓ or ↑). These are estimated to produce a positive/negative/neutral effect on a given subset of Transport infrastructure (+, -, 0).

***Table 11***. *Assessment of climate change impacts on the transport sector vulnerability*

| System/ Indicator | Climate Change Scenario (IPCC, AR5) | Outcome Probability by 2035 | | | Expected Impact: Positive (+), Insignificant or None (0), Negative (-) | | | Degree of Vulnerability 1-Low; 2-Moderate; 3-High | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Transport** | **Scenario** | ΔT°C | ΔP % | Ex↓,↑ | ΔT°C | ΔP% | ΔEx | ΔT°C | ΔP% | ΔEx |
| Railway | RCP 2.6<br>RCP 4.5<br>RCP 6<br>RCP 8.5 | 1.5-2.0<br>1.5-2.0<br>1.0-2.0<br>1.5-2.0 | 0-10 | ↓↑ | - | + | +/- | 3 | 1 | 2 |
| Road | RCP 2.6<br>RCP 4.5<br>RCP 6<br>RCP 8.5 | 1.5-2.0<br>1.5-2.0<br>1.0-2.0<br>1.5-2.0 | 0-10 | ↓↑ | - | 0 | +/- | 2 | 1 | 3 |
| Water-Sea | RCP 2.6<br>RCP 4.5<br>RCP 6<br>RCP 8.5 | 1.5-2.0<br>1.5-2.0<br>1.0-2.0<br>1.5-2.0 | 0-10 | ↓↑ | 0 | - | - | 1 | 1 | 3 |
| Air | RCP 2.6<br>RCP 4.5<br>RCP 6<br>RCP 8.5 | 1.5-2.0<br>1.5-2.0<br>1.0-2.0<br>1.5-2.0 | 0-10 | ↓↑ | - | - | - | 2 | 2 | 3 |
| Pipe-line | RCP 2.6<br>RCP 4.5<br>RCP 6<br>RCP 8.5 | 1.5-2.0<br>1.5-2.0<br>1.0-2.0<br>1.5-2.0 | 0-10 | ↓↑ | 0 | - | - | 1 | 2 | 2 |
| Total Vulnerability Points | | | | | | | | 9 | 7 | 13 |
| Maximum Total Points | | | | | | | | 15 | 15 | 15 |
| **Vulnerability** | | | | | | | | **0.6** | **0.47** | **0.87** |

A first reading of the above table reveals extreme (mostly cold) weather and floods are the phenomena that most significantly contribute to the increase in transport vulnerability. This translates mostly into economic impacts and needs for consistent sector funding to maintain system stability and security. Sea and pipeline transport modes are the ones less vulnerable, while – unfortunately – the ones most used by Bulgarian and Black Sea regional transport systems, especially by passengers (road, rail, air), are more exposed to climatic changes and extreme weather events.

Based on the above report, TRIS vulnerability is given at an average index of **0.64**. This corresponds to a "**very stable**" condition of the transport ecosystem and its exposure to the expected climate change impacts by 2035. Such high transport system resilience is mostly due to the fact that in the period in question there are **no drastic changes** expected, regionally, in the climate components. On the other hand, regional transport systems are designed and built in accordance with **local climatic conditions**. In view of direct TRIS exposure to external influences and the expected long-term increase in temperature and intensity of extreme thermal events, serious efforts are needed to adapt the sector in the next decades, especially extending planning to a longer-term horizon of year 2100. What we said above remains valid – the **TRIS ecosystem is stable**, currently, yet **not quite adaptable** on its own.

The **main types of risks and vulnerabilities** that affect the transportation sector and its infrastructure are listed and explained below (not necessarily in order of importance or probability).

**Extreme heat** affects **asphalt** by softening its crucial fastening component – bitumen – reducing the roads' load-bearing capacity. Heavy vehicles may thus deform and create "tracks" in the asphalt. Subsequently, rain fills those tracks and worsens the already dangerous conditions for vehicles traveling at higher speeds.

Heat and sunlight combine, moreover, to increase the oxidation of bitumen. This reduces its elasticity which not only leads to the creation of the above "tracks" but also reduces the overall durability of asphalt pavements. Such temperature dynamics will increasingly need to be taken into account when designing and placing road pavement.

Excessive heat also causes deformation to **railway infrastructure**. Continuous Welded Rail (**CWR) is not yet widely used** along Bulgarian railway networks. Although performing better under normal conditions, CWR is more vulnerable to extreme heat and more susceptible to deformation than older rail pieces. . The type of railroad ties (sleepers) also affects deformation vulnerability, whether they are wooden or concrete. Naturally, standard protocol requires that under thermal pressure, given the risk of deformation, maximum operating speed is reduced to avoid possible train derailment.

In the long run, railroad depreciation due to **heat deformation reduces track life**. Limited CWR length and usage decreases the immediate importance of heat-related considerations in railway network planning and maintenance. However, the impact of thermal factors is expected to increase with time as modernization projects and any new TEN-T construction sites in Bulgaria require CWR railways. The latter provide more high speed and comfort and will simply require more frequent checks, quality installation and higher investment and maintenance costs. Excessive thermal pressure is inevitably taken in consideration at the design and construction stages nowadays. Ultimately, extreme and sustained heat is projected to impact significantly both road and railroad adaptation and maintenance costs in the long run.

**Extreme cold** also has its negative effects on asphalt pavements. Similar to heat, it also impairs bitumen elasticity, resulting in surface cracks. Water enters deeper pavement layers and freezes (increasing in volume), significantly damaging as a result asphalt structure, as well as surrounding concrete pavements.

Extreme cold may cause **traffic control equipment** damage, impairing a significant element of transport infrastructure and its safety. While this aspect is rarely a major problem for TRIS, it is common to all transport modes, especially during severe winters.

One important case is railway signalling, navigation and telecommunications equipment. Railway switches are a physical part which is particularly vulnerable to cold and related frost. Many junctions and switch points use actual integrated heaters to maintain temperatures above freezing point. Even so, certain sections where traffic is heavy and there is surrounding ice, freezing may occur, threatening safety and reliability of operations.

Sustained low temperature has additional negative effects on various types of **vehicles**, for example by reducing car battery charge of affecting elasticity of certain structural matter. Even though, as a rule, vehicle problems related to extreme cold are more common in old cars, this is the case of many vehicles in Bulgaria, and the Black Sea coastal area is not an exception.

**Torrential rainfall** is also problematic to regional TRIS, with increasing frequency. It is actually one of the most problematic extreme weather types. Prolonged and heavy rains lead to floods, often to landslides. Floods alone cause road and railway damage by disrupting surrounding facilities and underlying structure. Flooding reduces road bearing capacity at the base, causing potentially catastrophic damage to road surfaces. Lastly, excessive presence and flow of waters is able to damage and destroy supporting or main infrastructure such as bridges, embankments and pillar foundations.

Similar issues raise the importance of **surface and groundwater drainage** – possibly at the design stage of roads and railways, often during reconstruction projects. Quality drainage facility designs allow for adequate capacity in conducting larger incoming water volumes. Infrastructural stability and resilience is also improved by using better, durable materials which help keeping water from penetrating into functional and structural layers – both regarding road surfaces and railway lines.

Moreover, heavy rains complicate the maintenance of the drainage facilities. Keeping them clean of deposits which reduce passage becomes critical and a part of an integral approach. Clearly, a systematic approach to quality control of design, construction and maintenance allows **reducing structural depreciation and system vulnerability**.

Heavy rainfall has its negative effect on road use as well, as it reduces traction and general visibility. Most rain-related accidents are due to wet surface conditions rather than anything else. Unfortunately, national and regional statistics dedicated to road accidents do not keep a separate register for meteorological conditions and their types as an incident cause. The Law requires drivers to match speed consistency with road conditions, even when it is not explicitly shown on traffic signs. Foreign best practices show, however, that there is an undeniable link between precipitation and wet surfaces on one hand and road accidents on the other. The US Federal Highway Administration, for example, reports that as much as 73% of weather-related road accidents are due to wet surfaces.

In our case, we have the statistics which confirm that floods and heavy rainfall impact not only road performance but also railway logistics. They cause substantial delays and even temporary disruption in rail services. The below table reports the annual number of train delays due to floods, even with the exclusion of those cancelled due to critical conditions.

***Table 12***. *Railway service delays (and duration) due to heavy rainfall (2012-2016, NRIC)*

| *Year* | *Delays (National)* | *Total Delays (min.)* | *Average Delay (min)* |
|---|---|---|---|
| 2012 | 5 | 140 | 28.0 |
| 2013 | 1 | 43 | 43.0 |
| 2014 | 122 | **5,054** | 41.4 |
| 2015 | 21 | **617** | 29.4 |
| 2016 | 27 | **1,660** | 61.5 |

We can clearly see that the **rain-plagued 2014** – which caused severe flood damages all over the country, including casualties in Varna – has brought an important number of railway service delays, without even considering total cancellations and other major disruptions.

In fact, this does not even come close to describing the magnitude of the problems that floods cause to the railway network. Train delay statistics only consider confirmed cases of train compositions near flood-affected areas at the time of the particular weather event. What comes afterwards – **damage control, repairs and traffic restoration** – leads to further interruption of services with consequent economic and social effects.

A list of the most typical potential direct **risks and vulnerabilities** related to **weather events and climate change** is featured in the table below. The transport sector's state and adaptation capacity is most comprehensively analysed in the topical "**Assessment of the Transport Sector**", commissioned by the MoEW and published in 2019 as part of the National Strategy on Adaptation to Climate Change.

The risk and vulnerability categories below take into consideration the classification of meteorological factors and related impacts (by mode of transport) published by the European Environment Agency (EEA) in 2017. Adapted to specific local of the Black Sea region, it presents a relative redistribution of importance between the separate factors – e.g. the milder seaside climate softens the gravity of some temperature extremes and events. However, all factors and their standard impacts are completely applicable in the region as well. Quite importantly, such an analysis and related classification have been provided within the PESETA II Project (2012) which deals directly with the local specifics and, as such, will be presented in its essence below.

***Table 13.*** *Main Weather and Climate-Change Related Risks to the TRIS ecosystem*

| Event | Risks | Potential Positive Impact |
|---|---|---|
| **High Temperatures** (peaks; hot periods and heat waves) | Increasing asphalt and concrete pavement damage | Reduced winter maintenance costs for roads, railways and airports |
| | Increasing airport pavement damage | |
| | Railway track deformation | |
| | Equipment overheating | |
| | Cost and energy consumption increase for cooling (all transport modes) | |
| **Low Temperatures** (peak bottoms; cold periods and cold waves) | Asphalt and concrete pavement damage | |
| | Failure of vehicles and traffic control equipment | |
| | Icing of trains, electrical network and direction switches | |
| | Damage to navigation signs and infrastructure | |
| | Water transport disruption (very unlikely in the Black Sea Region) | |

| | | |
|---|---|---|
| | Damage to airfield pavements | |
| | Icing of Aircraft | |
| **Intense Rainfall** and excessive air humidity | Increased frequency and impact of floods and landslides on road and railway infrastructure | Increased periods with water flow sufficient for normal operation, wherever necessary |
| | Reduced visibility and road traction | |
| | Reduced airport capacity due to air traffic disruption | |
| **Drought** | | Lower underground water level – less damage to ditches and embankments, less landslides |
| **Blizzards/ Snow Storms** | Snow and related obstacles on roads and railways leading to serious traffic accidents | |
| | Reduced visibility and traction of roads | |
| | Failure of road, railway and aviation traffic management systems | |
| | Damage to the railway's electric network and signalling equipment | |
| | Increased air turbulence | |
| | Safety risks in ground handling airport activities | |
| | Damage to aircraft and related equipment | |
| | Disruptions in port and airport activities | |
| **Intense Snowfall** | Snow and related obstacles on roads and railways leading to serious traffic accidents | |
| | Reduced visibility and traction of roads | |
| | Failure of road, railway & aviation traffic management systems | |
| | Damage to the railway signalling and navigation / direction equipment | |
| | Disruptions in port and airport activities | |
| | Reduced airport capacity due to air traffic disruption | |
| | Icing of Aircraft | |
| **Storms and Hail** | Obstacles on roads and railways leading to irregular or unsafe exploitation | |
| | Reduced visibility | |
| | Damage to railway signalisation and | |

| | | |
|---|---|---|
| | arrow switches | |
| | Increased air turbulence | |
| | Safety risks in ground handling airport activities | |
| | Damage to aircraft and related equipment | |
| | Disruptions in port and airport activities | |
| **Fog** | Reduced visibility on roads | |
| | Reduced airport capacity due to air traffic disruption | |

## The (Growing) Importance and Impact of Natural Disasters

EU statistics indicate that road transport infrastructure suffers weather-related stress factors, as anywhere between 30% and 50% of road maintenance costs go towards dealing with them (a total of EUR 8 to 13 billion annually, depending on the year). Around 10% of these costs (yet, still close to a EUR billion) is incurred due to extreme weather events alone. **Heavy rainfall and floods lead** in this category across the continent, and the Bulgarian Black Sea coastal region is not an exception, as municipal maintenance reports can be traced directly to the impact of floods events.

Flood-induced damages, on the other hand, is conversely predicted to have a decreasing effect on **road infrastructure** maintenance in the longer term (2070-2100) when we consider Bulgaria and the Black Sea alone (South-East Europe and South Europe report similar simulation outcomes. A possible decrease of around 16% - given that global warming scenarios will stay under the 2°C mark – indicate that precipitation in the region will remain more or less stable. This projection has a surprisingly simple explanation: a potential **cost reduction related to even milder winter conditions** is expected to offset and exceed the costs of asphalt binder upgrades in the region.

A different outcome is reported in projected interventions for the maintenance and protection of **river bridges** and similar infrastructure. Rain and flood risks are expected to bring about an average of 20% damage and cost increase (not counting inflation) over the next few decades, as both intensity and peaks increase excessive river flows and surface water discharges.
Similar considerations see heat-induced **rail buckling risk** and **derailment risk**. Currently, the response measures applicable in Bulgaria (and largely throughout the EU) most commonly are

limited to **speed limitation**. Adaptation initiatives are being studied and current relative costs are acceptably small for individual transport customers. However, more intense heat and frequent hot waves might further increase trip delay frequency and duration – in fact, rail transport simulations indicate a double or quadruple increase under climate change scenarios A1B and RCP8.5 respectively.

It is also time to seriously consider estimate of future risks related to **sea level rises** and **sea storm surges**. Those will have a significant impact on road transport infrastructure which needs to be better estimated and planned for. Bulgarian and Black Sea regional authorities have limited resources for adaptation initiatives, yet research and planning capabilities are sufficient (Bulgarian Academy of Sciences and its Varna Oceanology Branch; the Naval Academy; private Universities) and any advance preparation activities will decrease future response costs.

Even considering the Black Sea as **closed water body**, certain severe consequences at local or regional level are not excluded. They would imply a significant increase in repair and maintenance costs of transportation infrastructure. And it will potentially lead to other undesired consequences such as fatalities and collateral damage due to related critical events.

An important systemic research into the impacts of weather events and climate change scenarios on Bulgarian and regional infrastructural vulnerability has been conducted as part of the implementation of the **PESETA II Project**. Its detailed topical publication on transport infrastructure assessment (Nemry and Demirel, 2012) has become somewhat of a cornerstone document for national and regional planning mechanisms.

The study considers the effects of **gradual but consistent rises in temperature, precipitation, storm surges, river floods and sea levels**. Those have been matched against potential future costs of road and rail network construction, repair and maintenance. Exposing road and rail infrastructure to weather-induced risks alters significantly projected outcomes when considering climate change trends in two separate future time periods: 2040-2070 and 2070-2100. Infrastructural deterioration and associated TRIS damage and exploitation costs make the case for **sustainable adaptation approaches**, namely where local, regional and national authorities report some deficiencies. Considering different climate change factors and infrastructure types, both policy and cost planning allows for realistic adaptation scenarios.

Most of the **environmental impacts** and damages to TRIS elements reveal potential and actual vulnerabilities in the system. Reported and likely damage to **roads, railways and bridges** has been retained as a prime example and a veritable indicator of vulnerability of the extended transport infrastructure. Other types of transportation infrastructure have not suffered considerable damages – statistically and with less probability in the short-to-midterm scenarios – namely airports, ports and pipelines. Their specific structural vulnerability is not explored in detail, as most of the traffic for both passengers and cargo utilise the former types of transport.

**Intense precipitation** is analysed in the PESETA II project by adjusted estimates of current costs they incur to road infrastructure maintenance. Naturally, this takes into account future precipitation scenarios and conditions as well. Impacts of **increased** surface (road) **temperature** is analysed on – one hand – in terms of the **maintenance costs** it incurs to road infrastructure (particularly asphalt binders and related upgrades, according to a methodology proposed by Chinowski et al. in 2013). On the other hand, there are certain evident consequences of **milder winter** conditions for road maintenance costs (as estimated by the US Highway Administration, 2006). In both cases, reports are confronted with the EU road network statistical information according the methodology of the Transtools model.

Regional analyses confirm the increased risk **of heat-induced rail track buckling**. Thermal stress affects rail transport mainly by leading to **speed limits** to decrease vulnerability due to geometry alteration of the railway lines. All climate change scenarios are expected to have an impact on this particular transport segment, including an increase in **additional costs** necessary to deal with the problem. Such costs are also incurred by the days needed for maintenance and restoration of the railroads. Hence, calculations have been carried out estimating the number of standard “stress-free” temperature days that end up being exceeded for a specific country and region. Those are converted into total hours of transportation delays (e.g. due to speed restrictions) and paired with the separately reported maintenance and upgrade costs. Ultimately, all delays are estimated in monetary terms, as per average EU value-of-time basis wherever national standards are not indicated.

**Bridge damages** – mostly in foundations and pillars – are typically the result of increased water flow. Higher-level rivers and other **flooding** water bodies mostly end up removing sediment. Their impact is estimated with the guidelines of the LISFLOOD hydrological model (Wright et al., 2012), integrated with local transport network information and statistics. Final estimates are reported in terms of additional expenditure for bridge reinforcement (mostly concrete or “riprap”, i.e. large stones at the foundation).

Road transport networks are also vulnerable to **possible sea level rises**. While there is little probability that the Black Sea will rise 1 meter (even in the mid-to-long term climate change scenarios), this is the standard hypothesis for similar simulations and research. A **permanent 1 meter inundation** – or even **episodic inundation**, e.g. after storm surges – has been analysed by the PESETA II project by using digital elevation data from the NASA Shuttle Radar Topography Mission (SRTM) and overlapping storm surge estimates from the DIVA model database, as well as road network data from Teleatlas. The resulting vulnerability of the Bulgarian regional transport network to coastal inundation has been estimated in terms of reconstruction costs.

Ultimately, the report indicates that the southern (Central) part of Bulgaria will be most affected, while the **least affected** would be the so-called **Black Sea Climate Influence Zone**, where all of the above categories have come back with the lowest indexation values in all climate scenarios.

The above approach adds up to the body of knowledge on the subject and confirms one soundly established sector fact – in economic terms, extreme weather events have significantly less **long-term impact** than (gradual) **changes in multiannual climate regimes**. Most extreme phenomena have short-term effects and territorial scope. They also vary in intensity and (possible) recurrence, making them hard to predict and almost impossible to assess and prepare for economically – not only in the transportation sector but in public and private operational practices in general. The same project quoted above reveals that South-Eastern Europe should not expect drastic changes in current trends, under all climate change scenarios. Then again, there is a general increase in indications of extreme heat phenomena but a probable **decrease in cold** ones. This is likely to have a greater impact on design, structure and road and railroad works in the long run, increasing additional costs gradually but in a sustained manner. Peaks in critical events and spending are expected to be less of a norm in the East part of Bulgaria compared to the rest of the national territory (and the continent).

One particular natural phenomenon will continue exercising more pressure than others – **intense precipitation**. Reported indices for heavy rainfall and related floodings are expected to have a substantial influence **in the long run** as well, as per all explored scenarios and simulations. An important factor for road surface depreciation and destruction, floods are a phenomenon which is characterised by fluctuations, yet always leading to **increased costs** annually. Once again, however, as these additional costs caused by extreme precipitation

events are estimated to incur an annual spending increase between 3 and 9 million – with a horizon **up until 2100** and including the entire Eastern European macro region – simulations and estimated for Bulgaria always come back with figures **below the average** for the region.
One important consideration has to be made while reviewing the above data. Bulgaria has been included and studied as precisely as possible in the above initiative. However, that has been done mostly as part of the larger South-East EU macro region and on the basis of climate maps and extended environmental impact simulations. The country could not have been covered adequately by more precise calculations in the analysis, since the **water bodies** had not been reported as required and were **missing within the GISCO dataset**.

Having established that **extreme precipitation** is the most common and influential natural phenomenon that influences the TRIS ecosystem in the long run, we need to explore further its distinct effects on the Black Sea coastal region. According to a survey of municipal data (cited by Ruse University in a 2014 study and complemented by statistics from regional structures of “Fire Safety and Civil Protection”, as well as the State enterprise “Irrigation Systems”), there have been **761 floods** on the territory of the **Black Sea region** for the period between **1914** and **2010**. Those are officially registered and sufficiently relevant floods. Main reasons reported are torrential rains, followed by the sea and “human negligence”. The EU “Flood Risk” Directive 2007/60/EC recommends the addition of flood classifications that are specific to local climate and territorial characteristics. Therefore, national classification includes “lake floods” and “sloping floods” which are reported as consistently relevant.
Out of the 761 floods in the extended Black Sea region (within the coverage of the “Black Sea Basin” Water Management Directorate), there have been five types of flood causes. The main ones which cover almost all cases are:
• **river floods –** 423 (55.59%);
• **sloping floods** – 279 (36.66%);
• **infrastructural floods –** 38 (4.99%);

Although the last type of flood (cause) is mostly related to human activity and/or technical malfunction, that is still a relevant number and is included as a separate main cause. All of the above cases have incurred **substantial damage** to the region, destroying tourist **facilities and infrastructure**, causing economic outflow and bad image. Some have led to casualties.

In recent memory, the **2014** series of heavy rains caused a number of floods in the country, with a notorious outcome for the Black Sea region – at least 18 people died nationally, with **13 in Varna and Dobrich** alone, and **3 in Burgas**. Total damage is estimated at more than EUR 300 million. Many homes and public buildings have been destroyed and heavily affected, in addition to closed roads closed, infrastructure damages and the intensification of consequent landslides.
Among more regular albeit less dramatic cases we can cite the annual river floods which spill over to the road network between Burgas district coastal areas such as the campsites "Zlatna Ribka" and "Gradina". A cause for substantial material damage, these floods create obstacles to transportation and response capacity and reveal perennial vulnerabilities of the particular Burgas District area.

**Snowstorms** are also a particular type of extreme precipitation which regularly affects the coastal region, despite its milder climate and somewhat shorter winters. They cause icings, disrupt air communications, block roads and often put people's lives at risk. A more pronounced vulnerability to snowfalls and snowstorms is reported mainly in populated areas, as transportation means and networks are frequently blocked, electricity and water supply disrupted and general conditions present numerous challenges for food and medical supplies' provision to affected areas.
Extreme and sustained **low temperatures** often cause **icings** along Asparuhov Bridge which is the main connection of Varna with the southern part of the coastal region. Icing is also reported almost annually on power lines and other open communication links. The village of Kamenar (a Varna suburb) is inevitably affected by annual snowfall, storms and icing. Connections between Kamenar, Vaglen, Kumanovo and Yarebichna are often cut off completely.
Besides low temperatures, an important factor in causing icings in the coastal areas is the pervasive **humidity from the sea**. Although containing a higher salt saturation than rain water, this kind of atmospheric influence causes the typical seaside icings, especially in the early hours of the day. Often, this leads to chain accidents, with transport arteries being blocked and important connections to peripheral city neighbourhoods and settlements cut off. This represents a typical vulnerability of the area, making it difficult for the population to rely both on personal vehicles and public transportation options.

Heavy snowfall ends up almost always causing catastrophic effects in populated coastal areas. A direct correlation can also be found in the general **under-preparedness** of the region to regular winter and snow impacts, unlike mountainous regions, for example. Yet, heavy snowfall comes back once every few years and impedes or completely blocks transportation services and networks in some areas for different periods of time, especially those which are situated slightly beyond the immediate "softening" effects of the Black Sea, 30 km inland and more.

As a result of heavy snowfall (and often along with strong winds and low temperatures), Varna municipality has regularly reported critical conditions and practically disastrous events which have completely halted transport capacity along secondary and even main streets and municipal roads. Transport connections which are **particularly vulnerable** are to and from the city zonal districts of "Vladislav Varnenchik", "Mladost", "Vinitsa", "Asparuhovo", "Galata", as well as the settlements/suburbs immediately outside the City – Zvezditsa, Kamenar, Konstantinovo, Rakitnika, Borovets and Dobreva cheshma. These areas tend to form snowdrifts with lengths of 12 to 20 metres, temporarily cutting off all transport options to the local population, along with all related important public services.

Blizzards regularly cause long-term traffic disruptions throughout Bulgaria's **North-East**. Split between Dobrich and Varna districts, this region is particularly prone to winter traffic disruptions due to **high wind speeds** combined with snowfall. Earth relief in this sub-region is mostly flat and without natural wind barriers. Vegetation is generally low and sparse, as both the coastal region and the fertile Dobrudzha lands have little use of forests and instead rely on summer tourism and agriculture. In the past, there have been attempts to plant "tree belts" near roads and railways to prevent snowdrifts and excessive wind drifts (with mixed success). To this day, **snow protection equipment** is placed in certain crucial areas, mostly around railway junctions. However, both natural and technical snow protection installations have not been maintained in recent years, leading to their depreciation and resulting lack of protection against frequent transport disruptions. Snowstorms inflict heavier and more regular negative effects on road traffic.

As mentioned above, one particular (limited) mitigating effect of current climate change trends is the **milder winters** it may bring, along with less snowfall. This is not something to be overly content about, yet it facilitates some of the road and railroad maintenance protocols. This effect, however, is also rather gradual and even in the medium term heavy snowfall is expected to continue causing problems for transport services.

A recent period of heavy snowfall was recorded in **January 2017**, as it affected practically the entire national territory. Intense snowfall and storms closed roads in six North-Eastern districts –

Targovishte, Ruse, Dobrich, Razgrad, Shumen and Silistra. Many of those are not located in the area of our study, yet the roads and railways which lead **to and from the Black Sea region** remained heavily affected. Many first class **roads were closed**, as well as sections of the Hemus and Trakia **highways** (the latter leading to Burgas). Quite significantly, the entire **road between Varna and Burgas** was practically closed off until heavy winter equipment could clear it properly. Varna **Airport** was also temporarily closed.

The Bulgarian Ministry of Interior (MoI) does not keep a separate and specific statistical register for road accidents caused by snowfall. Nevertheless, both empirical data and EU experience show that there is a strong correlation between road accidents and snowfall.

One particularly critical and vulnerable point we should mention again to illustrate coastal infrastructure vulnerability to winter conditions is the **Asparuhov Bridge** in Varna. Exposed to icings – due to its altitude and size drawing wind currents, as well as immersed by surrounding sea humidity – it is the only practicable link between Varna and the rest of the country to the South coastal areas. While possible, circumventing this road to go around the Varna and Beloslav lakes will mean an additional 60-70 km length added to the route between Varna and Burgas and is realistically never an option for passengers and drivers. Along with city overpasses, this bridge is a prime example of important urban infrastructure which is **systemically vulnerable and hard to maintain** in a better condition through pre-emptive measures besides anti-icing pre-treatments. This is rarely the case, as such critical points are more than a few, heavily used and quickly wearing possible chemical treatments. Additionally, **fogs** and other visibility issues in humid coastal areas are not uncommon, aggravating an already difficult situation.

As a result, such areas report single or chain car accidents more often than other city and coastal transport networks. Accidents, in turn, lead to traffic congestion and – in the case of Asparuhov Bridge – to the practical detachment of the city area south of the navigable canal. Such facilities can only be rendered less vulnerable to the described critical events through **constant monitoring** by road maintenance companies, local public authorities and the traffic police units.

Finally, just as it was estimated for rain-induced delays, **rail services** also end up being disrupted, delayed and cancelled because of snowfall and winter storms. Snowdrifts are not uncommon in the area, as we indicated the inability of local authorities to maintain related protection facilities. Even without a precise economic estimate for such disruptions, we can see in the table below that on a national scale this is a consistent vulnerability. With the above-described conditions created by snowstorms almost every year (especially in the North-East), we need to emphasise the significance of snow and icings exposure of the regional railway network.

***Table 14**. Railway service delays (and duration) due to snowfall (2012-2016, NRIC)*

| *Year* | *Delays (National)* | *Total Delays (min.)* | *Average Delay (min)* |
|---|---|---|---|
| 2012 | 136 | **20,889** | 15.6 |
| 2013 | 10 | 375 | 37.5 |
| 2014 | 72 | **4,114** | 57.1 |
| 2015 | 88 | **2,115** | 24.0 |
| 2016 | 38 | **2,985** | 78.6 |

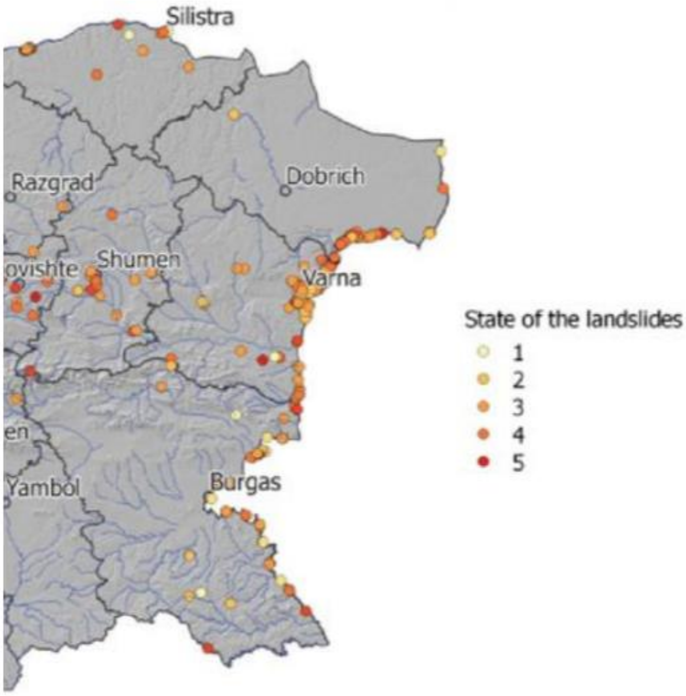
**Precipitation-induced geological processes** are also directly related and important to this review. Although less frequent, they may have important short-term impacts and reveal another persistent vulnerability of the transport network. Landslides, rockfalls and other landmass instability events are largely unpredictable. They endanger the safety of urban areas, as well as resorts and suburban residential complexes, farms and industrial buildings, as well as – quite significantly in our case – technical and road infrastructure.

Out of the entire Black Sea coastal area, the **highest percentage** of **active landslides** is located in **Varna District** – namely 31 or 56% of all active landslides in the coastal region.

As already mentioned, landslides are more likely to occur during and after heavy precipitation. There is a strong correlation between intense rainfall and the activation of shallow and medium-depth landslides (Bruchev et al., 2007). Heavy precipitation also affects deeper landslides, however it is more difficult to measure and confirm numerically).

The number of landslides reported as currently “stable” along the Black Sea coast is 38, roughly 18% of all national landslides rendered “stable” (through structural works and construction intervention). The table below shows the current state of the major landslide areas along the extended Black Sea coastal area – more intense colorations indicate a more active state of instability.

*Figure 5. Current status of landslide activity in East Bulgaria.*

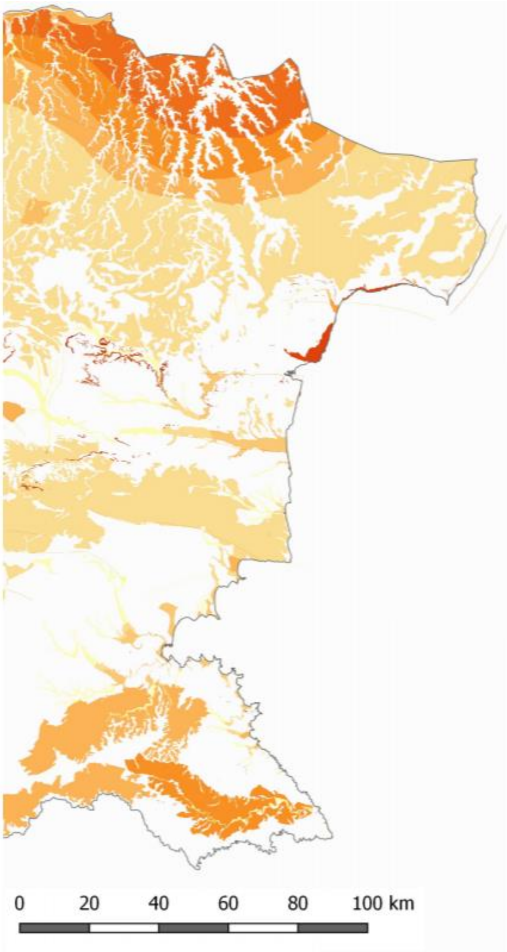



Numerous coastal areas result under significant threat from major landslides, exposing transport network infrastructure. As we can see on the above map, **high probability** of landslide activation is reported in the sections between Balchik and Kavarna, Golden Sands and Kranevo, near Ravda and Sarafovo. An average level of landslide probability is reported in the entire coastal area between Cape Galata (just south of Varna) and Cape Emine (in the middle of the Black Sea region, effectively splitting the coast).

All "secondary seismogenic deformations" observed along the coast are defined as determined by "**seismogravity**" – weighed down by land mass itself, as well as by initially unrelated phenomena such as intense rainfall which make them heavier than they already are. The major landslides included in the above mapping are monitored and included in national and regional "priority" lists. This concerns both currently active landmass areas and those which are periodically active yet affect and threaten residential and public buildings and their surroundings. **All roads** from the national and municipal road networks, as well as collateral infrastructure sites and facilities, are included in the priority list when they are even remotely involved by landmass instability areas.

The below map of integrated geological risks presents a more accurate picture of the overall landmass instability and the vulnerability it incurs on land-based transportation.

***Figure 6.*** *Map of integrated geological risks in East Bulgaria*




Geological risks directly impact buildings, roads, railways lines and all types of communication and infrastructure facilities. Heavily populated areas frequently fall within the activity scope of landslides, rockfalls and mudslides, occasionally suffering damages of various magnitude. The category of “secondary seismic impacts” include new land collapses, landslides, liquefaction of weak soils, leakage and collapse of loess (sediment).

Ultimately, the entire Black Sea coastal zone between the cities of Varna and Burgas is considered an exemplary area for surface land instability. Different progression speeds of **mechanical abrasion** affect its various sub-zones of interaction with landslides, sea-land contact areas and other processes which influence basic geological conditions. In most cases, man-made activity adds up to the negative generally impacts.

The stretch of coast between Varna and Burgas is divided into the following areas: Galata-Kamchia, Emine, Nessebar, Sarafovo, all corresponding to the actual tectonic structure and “petrographic composition” of the underlying rocks which determine the active and potential land processes. The coastline is largely oriented in a North-South direction, while the main Balkan mountain structure it crosses is oriented along a mostly West-East axis. The Shabla Plateau (in the North), the Burgas Depression and the Srednogorska area (in the South) also clash in their orientation with the dominant mountain and the determinant role of the sea contact. Thus, abrasion and landslide impact is experienced along all coastal slopes and even lower lands, exposing land transportation infrastructure throughout the region to the said geological processes. The Kamchia river valley, as well as the heterogeneous sediment types along the coast additionally increase abrasion and seismogravity.

Having analysed some particular specifics of climate and natural events in Varna District, we now turn our attention to its southern counterpart, **Burgas District**. In a comparative degree, if not more, rains are registered as one of the major and most persistent climatic traits throughout the year which has a direct influence on TRIS vulnerability.

Burgas, as well as and most of the seaside municipalities, are experiencing pronounced Mediterranean precipitation regimes on their territory. This means a peak in precipitation in late autumn and early winter, along with minimums in the summer. We have already established in the table with the main risk types that exposing the TRIS ecosystem to drought does not raise additionally its vulnerability.

**Rains**, on the other hand, **cause floods** – especially when intense and prolonged. The coastal region does not observe floods related to snow-melting alone, as snow quantities are considerably less than the rest of the country. Nevertheless, combining the phenomena may become quite dangerous. Soaked soils, the accumulation of new, melting of old snow, together with spring (rain) precipitation can cause catastrophic conditions.

Burgas district registered precisely such a case in the winter of 2010. From mid-December through the end of March snow was frequent and accumulated in different quantities and parts of the district. Sub-zero temperatures and subsequent rainfall led to the flooding of numerous neighbourhoods and villages in the immediate vicinity of Burgas municipality. The worst hit areas – "Dolno Ezerovo", "Lozovo", ring road E-87 along Lake Vaya and the road junction before "Meden Rudnik" – important and populated parts of the extended Burgas urban area. Additionally, the villages of Rudnik, Bratovo, Ravnets, and Dimchevo were also severely affected. The road network is situated mostly in low points and is vulnerable to similar repeat floods.

**High sea waves** can also cause flooding of areas along the coast, including important facilities, residential neighbourhoods and transport infrastructure. Most recently, in early February of 2012, a critical combination of factors exposed the Burgas seashore zones to the harmful effects of high sea waves. Specialized heavy equipment was deployed to clean the roads and other essential city infrastructure from **sand deposits** reaching a total length of almost 2 km and width of up to 6 meters.

Post-event analyses showed that the flood (with mud and sand deposits) was the result of high sea waves, with sea water flooding completely the municipal road from the Sea Garden leading to the “Black Sea Saltworks” company salt pools. As the road was covered sand almost completely, it was practically impossible for standard vehicles to drive upon it; yet, it is an important transport artery of the city, including because it brings vehicles to load up on lye (sodium hydroxide) and sea salt mixtures from the pools and landfills of "Black Sea Saltworks" necessary for road maintenance throughout the entire South Bulgaria. Thus, such a critical event not only highlights **local transport network vulnerability** but it also impacts maintenance efforts in **wider areas** across the country.

In the end – after the initial drainage of flooded roads and sand clean-up activities – urgent restoration works were performed on the **sand dikes** which protect the land from the sea – in 20 separate sections. Those parts were destroyed by the strong sea waves and were unable to stop the flooding of adjacent terrains. These clean-up and restoration efforts required the cooperation and contribution of resources on behalf of entities (local companies, above and beyond Unified Rescue System units) which possess the necessary specialised equipment capable of operating in such conditions.

## Anthropic Causes: Man-Made Incidents and Technical Malfunction

Despite being statistically less relevant, man-made causes of infrastructural vulnerability are inevitably part integrated risk factors. As such, they need to be taken into account for TRIS preparedness and any collateral effects – whether causative or secondary.

Quite often, human interventions **combine with natural causes** to put transportation and other infrastructure at risk. A relevant exemplary factor which causes the occurrence and activation of landslides is **construction activity**. This may be related to deep excavations, road construction, extraction of minerals and inert materials as well as other dynamic impacts on earth layers' integrity.

Complete analyses of anthropic influence on geological vulnerability requires a careful look at **spatial planning** and **urbanisation** trend. Regional and local planning priorities – including areas with forthcoming intensified urbanization such as the Black Sea coast – frequently clash with environmental sustainability and go against infrastructural safety, even with the best of intentions. We have already outlined several landslide areas along the Black Sea coast which are activated also because of human activity and construction (north of Varna, e.g.), often unregulated or insufficiently verified in advance.

On the other hand, provided that there are adequate safety measures in excavation and construction activities, those may be sufficient to ensure that transport infrastructure and other important facilities may be safely built and installed. Ultimately because, as important as this is to plan and foresee, most incidents and critical events are statistically related to other factors.

Another factor which links the two types of vulnerability sources is the transport sector **dependability on petroleum products**. A major user of fossil fuels, transportation contributes to the growing share of carbon dioxide emissions, a major greenhouse gas. Currently, about **21%** of the global amount of carbon dioxide emissions into the atmosphere comes from the transport sector. Even with significant technological improvements and the slow transition to alternatives, these emissions are expected to keep rising according to the International Energy Agency in Paris. Bulgaria's Black Sea region is also relying primarily and almost exclusively on fossil fuels. While true that some of the railways are electrified, most regional lines are not and statistically most of the passenger and cargo transport is carried by automobiles and trucks.

In turn, transportation, despite being still fossil-fuel dependent, is also a major catalyst of changes and improvements spilling over to other economic sectors. As it is, transportation, especially road and air transport, is a major human activity which worsens its own surrounding conditions causing climate instability and corresponding systematic vulnerability. Probably this will change within a decade or so, if global efforts persist and start producing some of the foreseen positive effects on climate change.

A major category of critical events which highlight system vulnerability is formed by **industrial (and road) accidents**, especially those accompanied by **explosions, fires**, **destruction** of buildings, hydraulic facilities or other types of damages to the integrity of transport and communication networks.

Most of those are not segmented sufficiently enough to estimate total regional effects in terms of economic losses and public network repair needs. What we can compare is the trend which shows **transportation accidents** – mostly **road collisions** – and their relevance to the exposure of the Black Sea area to such events.

Nationally, we have seen a practically stable number of road incidents, with a comparable number of total cases, casualties and wounded citizens. These numbers still mark a significant improvement over the previous decade, when there were about 1000 casualties annually, and more than 10-12 thousand total traffic incidents on a regular basis.

***Table 15.*** *Number of wounded and deceased from traffic incidents, Bulgaria (2011-2017)*

| | **2011** | **2012** | **2013** | **2014** | **2015** | **2016** | **2017** |
|---|---|---|---|---|---|---|---|
| **Deceased** | 657 | 601 | 601 | 660 | 708 | 708 | 682 |
| **Wounded** | 8303 | 8193 | 8774 | 8640 | 8971 | 9374 | 8680 |
| **TOTAL** | **8960** | **8794** | **9375** | **9300** | **9679** | **10082** | **9362** |

To acquire a comparable sense of the Black Sea region’s road safety and overall system vulnerability, we will provide the number of deceased and wounded in traffic accidents – by separate Municipalities – over the past year of 2019.

***Table 16.*** *Distribution of wounded and deceased citizens after serious accidents in **Burgas District**, by Municipality (**2019**, NSI and MoI)*

| | **Serious Accidents** | **Deceased** | **Wounded** |
|---|---|---|---|
| **Burgas District (Total)** | **436** | **29** | **551** |
| Aytos | 32 | 2 | 41 |
| **Burgas** | **213** | **13** | **253** |
| Kameno | 9 | 2 | 11 |
| Karnobat | 36 | 4 | 40 |
| Malko Tarnovo | 6 | 0 | 8 |
| Nessebar | 52 | 3 | 62 |
| Pomorie | 27 | 1 | 43 |
| Primorsko | 8 | 1 | 9 |

| | | | |
|---|---|---|---|
| Ruen | 14 | 1 | 22 |
| Sozopol | 14 | 1 | 28 |
| Sredets | 4 | 0 | 4 |
| Sungurlare | 14 | 1 | 21 |
| Tsarevo | 7 | 0 | 9 |

***Table 17.*** *Distribution of wounded and deceased citizens after serious accidents in* ***Varna District****, by Municipality (****2019****, NSI and MoI)*

| | Serious Accidents | Deceased | Wounded |
|---|---|---|---|
| **Varna District (Total)** | **667** | **46** | **865** |
| Avren | 19 | 0 | 28 |
| Aksakovo | 57 | 7 | 94 |
| Beloslav | 11 | 3 | 20 |
| Byala | 6 | 3 | 12 |
| Varna | 473 | 22 | 556 |
| Vetrino | 13 | 2 | 17 |
| Valchi Dol | 9 | 2 | 28 |
| Devnya | 12 | 1 | 24 |
| Dolni Chiflik | 22 | 2 | 26 |
| Dalgopol | 9 | 3 | 13 |
| Provadia | 31 | 1 | 40 |
| Suvorovo | 5 | 0 | 7 |

In order to evaluate the weight of these statistics as part of national totals and averages, we need to keep in mind that in **2019 Bulgaria** had a total of 7730 serious traffic accidents, resulting in **8499 wounded** and **628 deceased**. More importantly, Bulgaria is **second** in the entire EU in the tragic list of traffic **deaths per 1 million** inhabitants – with 89 – and only after Romania, with 96 ppl / 1 mln.

As per 2020 data provided by the state directorate “Civil Registration and Administrative Services”, the District of Burgas has 460,835 inhabitants (the city itself – 233,796), while Varna District – 513,266 (and the city – 378,213). In the table below, we present statistical shares of the districts and cities’ population and their respective share of serious traffic accidents, casualties and deaths.

*__Table 18__. Share of accidents, wounded and deceased for Varna and Burgas Districts compared to national traffic accident statistics (2019, MoI)*

| 2019 | *Population %* | *Wounded %* | *Deceased %* | *Serious Traffic Accidents %* |
|---|---|---|---|---|
| ***Varna District*** | 7.38 | **10.18** | 7.32 | **8.63** |
| ***Varna City*** | 5.44 | **6.54** | 3.50 | **6.12** |
| ***Burgas District*** | 6.63 | 6.48 | 4.62 | 5.64 |
| ***Burgas City*** | 3.36 | 2.98 | 2.07 | 2.76 |
| ***Bulgaria (100%): Total Figures*** | 6,951,482 | 8,499 | 628 | 7,730 |

The above table clearly leads to some conclusions. Last year's statistics show that Varna's road network – both District and City – has been more dangerous to drive upon. The regional police departments have registered high number of serious traffic accidents, as well as wounded participants. Fortunately, casualties are not higher or even lower than expected. Despite this being a cross-section of only a year in driving behaviour and recorded events, 2019 does not stand out as peculiar in any particular of the above segments – both nationally and regionally. Hence, the numbers clearly indicate that **Varna roads are more vulnerable to traffic accidents** than they should be and much should be done to **improve their overall safety**. Burgas District (and City), on the other hand, manages to avoid high shares in all of the above negative statistics.

Moreover, we need to highlight one particularly unsatisfactory fact about the main road linking the cities of Varna and Burgas. According to **Traffic Police** (publications and annual rankings), the **Varna–Burgas road (E87)** remains **one of the most dangerous in the country**. While this is a short stretch of land road, a little over 120 km out of the thousands of kilometres of roads in both districts, in 2016 alone it has seen over 100 traffic accidents with 6 deceased and over 50 wounded. We have raised the issue of this being a potentially **vulnerable road link**, since it **does not have a viable alternative**. It is the only direct surface link, with railway options requiring a slow connection in Karnobat (hence rarely used, if ever), and water connections inexistent. (Air traffic options are impracticable, since the direct distance between the cities is less than 100 km.)

Traffic Police data has always been there for drivers to see and Public Authorities to act upon. The list of “highly dangerous” road sections includes more than 120 stretches of road but Varna–Burgas is the only one in the region that we are exploring. There are somewhat fewer incidents on the route between Burgas and Sunny Beach but once vehicles start climbing the Balkan mountain, safety conditions decline. This urges local, regional and national authorities and road management agencies to act sooner rather than later and widen the two-lane road, possibly finishing the **“Black Sea” Highway** as much and as soon as possible. Otherwise, low road safety standards compromise significantly the overall transportation network vulnerability.

Other road sections which present high probability of traffic accidents and other incidents (again, according to MoI’s traffic police reports) are:

- **Burgas - Karnobat - Sliven** (mostly from Burgas towards Sofia);
- from "**Lukoil-Neftohim**" Refinery to "**Rosenets**" Oil Terminal;
- **Aytos – Provadia**;
- **Karnobat - Shumen**.

**Pipeline transport** also is mostly vulnerable to human and technological factors, mistakes and incidents. Naturally, this does not exclude geological phenomena such as landmass instability of all types which may harm and threaten the safety of pipeline transport. However, most statistically relevant threats to pipeline integrity are related to **industrial incidents and technical malfunctions**.

Regional Industrial production which requires pipeline logistics is most emphatically characterised by "Lukoil-Neftochim-Burgas" AD, its large refinery complex, storage facilities and related equipment. Liquid petroleum raw materials are transported along a network of pipelines to and from the refinery site, with the diameter of the main pipes reported as Φ 325/8 mm and product pressure at 64 atm. There are 12 compressor stations in Burgas district alone, since there are roughly 75 cubic meters of oil products in 1 km of pipes.

There is also a main pipeline leading from Lukoil-Neftochim (Burgas) to Polymers (Devnya, the industrial settlement just west of Varna). The pipe is carrying Ethylene. This substance also forms explosive mixtures when in open contact with air, and its explosive limits range from 3 to 32 % by ethylene volume. Other industrial sites and household installations also use liquid gases and other explosive liquids. However, the capacity of the pipes that transport them and, in turn, their regional significance to infrastructure vulnerability is much less.

By providing secure exploitation – systematic protection, control and monitoring of the operational parameters of the facilities and elements of the product network – most perceivable relevant risks of accidents and industrial incidents may be reduced. Private and public infrastructure operators present regular **safety plans**, with preparedness, mitigation and response measures for both failures of an operational nature and acts of possible (deliberate) human nature: mistakes, terrorist acts, theft, etc.

**Railway accidents** and collateral damages are part of everyday safety protocols and mechanisms in the sector. We have described extensively the state of the regional railway transportation network, its shortcomings and vulnerabilities.

However, when there are railway accidents taking place, certain **collateral effects** expose territorial vulnerabilities beyond immediate damages and structural impacts. The national operator, "Bulgarian State Railways", is the one transporting most of the chemicals and explosive products of different nature and quantities.

Once again, the main industrial client and producer of chemicals is Lukoil-Neftochim-Burgas AD. Besides a railway stop within the Refinery limits, the main loading and unloading complex for such sensitive land cargo is Port Burgas. Karnobat is an important distribution Station where railway tanks with different chemical loads are parked, stored and manoeuvred. These two stations are more vulnerable to critical situations related to transhipment and transportation of dangerous cargo.

Naturally, auto-cisterns are also just as vulnerable as railway ones, if not more. The transport of chemical products by road may and occasionally does lead to accidents. However, those are counted within the number or serious "accidents" reported above. Their gravity is evaluated and recorded on the basis of human life and health, while economic losses and effects to the transportation network is not faithfully registered because of the multitude of interested parties and the fragmentation of impact types.

Railway accidents are, in addition, considerably more serious and with further reaching impacts. Quite recently, on 10 December **2016**, a freight train derailed, exploded and caught fire in **Hitrino** station (a village in Shumen Province, roughly 80 km direct air distance from Varna to the West). The incident killed 7 people and injured seriously 29 others, as a few of the tank cars spilled propylene which then exploded and almost completely destroyed 50 nearby buildings. Once again, railroad safety and maintenance standards should be emphasised as determining factors in such incidents, even as the investigation remained inconclusive and human error was not ruled away. This case, however, is indicative of the state of vulnerability of much of the regional and national railway system, its infrastructural network and rolling stock.

The most characteristic type of transport for the region – sea transportation – also carries its collateral risks and vulnerabilities. **Port activity** implies certain operational vulnerabilities stemming from the risk factors of industrial cargo handling and its inherent potential threats. And oil products and related derivatives remain the most high profile type of dangerous port cargo. **Oil treatment facilities** that pose accident risks include seaports, oil terminals, pipelines and other oil-related infrastructure.

**Burgas Port Oil Terminal** carries out risk assessment on the basis of a capacity of 1 tanker at a time. It handles oil product: crude oil, heavy and light ship fuel, petrol and diesel. The Terminal has its internal and updated safety protocols. The ground pipelines of the same Terminal also carry crude oil, ship fuel, petrol and diesel. Quay "20A" in the main part of Burgas Port also accepts 1 tanker at a time. 20A berth handles only ship fuel, petrol and diesel.

The Oil Depot of "**Petrol" AD** in **Varna** holds various amounts of fossil fuels and mineral oils at a time – gas and crude oil, as well as ship fuel. It also presents to the URS and regional authorities a risk management plan with prevention, mitigation and reaction activities. "Lesport" Terminal in Varna has its risk assessment prepared on the basis of 1 tanker capacity, loading mazut (fuel oil) and gas oil.

Additionally, the roadstead territorial waters of the two ports can handle and provide secure operations for up to two large tankers with the same above mineral fuel oils and derivative products.

**Human influence is not static** in its nature. Usually premeditated, it allows for planned impacts on both conditions and infrastructure. Most factors influencing transportation networks and related infrastructural systems (TRIS) are accounted for in the **local disaster response capacity** – planning, strategic preparedness and operational capacity. There are certain TRIS traits and exploitation characteristics which **help mitigate** disaster potential, as well as accident response capacity. Those are markedly related to security and safety or possess an emphatic level of safety and integrated resilience and response characteristics, inherent to their nature and functional purpose – e.g. road safety systems or fire prevention and response equipment in transport units. Such resources are included in City and Regional Disaster Protection Plans and are largely shared by URS elements and relevant institutions.

There are also those parts of TRIS which **obstruct** or **complicate** local disaster response capacity. While most elements present a relative degree of exploitation and maintenance risks and vulnerabilities, those which are more heavily used, as well as those which are significantly **outdated** and **under-funded** for repair and maintenance, can and will naturally impede the overall system efficiency and integrated response capacity to exterior factors (besides their own vulnerability).

Introducing new, contemporary and safe TRIS elements raises security standards and decreases operational vulnerability. A good practice example is the security system of the Coastal Centre for **Ship Traffic Management in Burgas**. It is also connected to the video surveillance system of the Municipality. The State Enterprise "Port Infrastructure" thus shares monitoring resources and expert personnel with the city. The introduction of new equipment and trained personnel has started after the 2012 attack on the airport. Currently, the system has 1,000 cameras in a 24-hour video surveillance centre.

Furthermore, innovative systems based on advanced technology can help control risk and increase security. Another example is given by the EU-financed project on risk prevention and security enhancement in seaports which allowed **two traffic towers** to be built in Burgas and Varna. Actually, the coverage of the security system unifies the three ports: Varna East, Varna West and Burgas East 1. As a rule, the state enterprise “Port Infrastructure” operates a series of high-tech systems related to shipping, i.e. Vessel Traffic Monitoring & Information Systems (VTMIS).

Airports, as we analysed, are privately operated. The Fraport Group also employs top level security systems, certified by national and international regulators.

Unfortunately, one of the most used traffic networks, Varna streets, are largely left without 24-hour monitoring coverage. There are currently elements of three separate **street surveillance systems in Varna** and neither one is working. Most have been placed in 2007 along the principal arteries and have become municipal property after an initial paid subscription period. Outdated and unused, now they have to be replaced, especially as we saw that Varna as a city and district does not own and operate a safe automobile traffic infrastructure.

## How TRIS and Human Activity Together Impact Our Surroundings

Even in a relatively passive state, TRIS elements (in a wider) context have sufficient presence and influence on surrounding conditions and the environment. They interact with both natural elements and anthropic factors all around them.

Should a system be designed and implemented with view of avoiding harm to the environment – as best as humanly possible – and not aggravating natural risks inherent to the scene, then the more relevant factor remains **everyday operations** in terms of regular and irregular human behaviour around TRIS objects.

Human intervention risks are defined by their impact on the physical environment, predominantly in and around inhabited and industrial areas. A **2019** publication by the Bulgarian Institute for Market Economy (IME) named "**Regional Profiles, Development Indicators**" reveals some of the virtues and shortcomings of district and regional systems, including economic, infrastructural and spatial planning aspects. The study confirms that – according to both experts and daily users – **urban technical infrastructure networks do not adequately meet urban needs** in most cases. They often present a serious problem for municipalities both in the core of the agglomeration areas and in the outskirts.

Urban physical environment and a large share of the buildings are depreciated in significant parts of the regional territory, especially in the **smaller towns**. Urban centres are in a somewhat better shape because of municipal and private initiatives. Along the entire Black Sea coast, "only the city of Varna offers a highly aesthetic and well-developed urban environment" and that is mainly in the central part and some other areas. Consistent efforts in improving urban settings are needed in almost all towns in the analysed region.

Another process which is constant and ongoing is the active **expansion of urbanised territories** and **construction sites** with various destinations: tourism, housing or industrial production and services. Particularly intense around the entrance-exit road arteries of the larger towns, it is especially relevant along the entire Black Sea coast.

Intensive coastal urbanization is in sharp conflict with the need to preserve coastal resilience and environmental integrity. A prime example is provided by construction activities which awaken landslide processes. Rising urbanization of suburban coastal areas – especially in the absence of a sufficient will to protect the public interest over private and corporate interests – decreases and mismanages much-needed public spaces. Ultimately, this presents critical problems to infrastructure planning and exploitation, mostly a municipal responsibility within settlement limits.

Illegal or poorly planned and supervised construction impedes the establishment and operation of quality street networks, water and electricity supply, sewage and other public utilities and services (including schools and green areas). Some experts see the Law on Spatial Development of the Black Sea Coast as not providing sufficient protection of the public interest in such cases. However, all agree that improper application of even the existing norms is the main cause for congestion of public spaces.

The implementation of the so-called "**Integrated urban regeneration and development plans**" can contribute to a positive development of urban environments. Unfortunately, small towns in both districts are not envisaged as beneficiaries making it hard to develop and implement a larger scale spatial regeneration initiatives centred on their public needs, including fundamental transport sector developments and improvements. This is expected to increase an already pronounced gap between the bigger urban centres and smaller peripheral municipalities.

In fact, this remains an important outstanding priority for the Black Sea coastal region (much like in other parts of the country): the need to **alleviate disproportional development** – especially infrastructural – between urban centres and peripheral areas. The expanding centres are in contrast with the declining periphery and the structurally beneficial influence of Varna and Burgas on their district settlements needs to extend to **better transport and communication**, **access to public services** and culture offered by the bigger city. The peripheral municipalities have the vital socio-economic potential of being core areas of coastal tourism. A sustainable development of their territory, in line with environmental and safety standards and public needs, provides a chance for their transformation into support centres – serving further outside rural settlements and improving "town-village" connections in unison with the European policies for social and territorial cohesion.

## Current Trends and Macro Factors which Affect TRIS State

The current national "Strategy for Transport System Development" published by the MTITC outlines some of the **main threats for the development and stability** of the transport network, valid also for the country's coastal region. In light of all of the above data and considerations, those which influence Black Sea regional transport network vulnerability and sector stability are:

• **Delaying territorial and policy reforms** – according to EU and nationally identified priorities – may hinder restructuring and modernization of the transport sector or some of its particular segments; Moreover, a delay in priority regional infrastructural projects may redirect international transit through neighbouring countries and alternative service providers;

• In the light of a difficult 2020, the **decrease in international transit flows** through the country and region is a realistic concern; Less resources means also less investment in system stability;

• An **excessive focus on international transport** may neglect local and regional public needs, holding back the development of the region in the long run;

• A decrease in transport services demand as a result of **structural changes** in the EU and Bulgarian economy; Although a direct threat in the short term, repositioning towards services and communications may simply shift attention and investment to such sectors instead of industrial activities requiring the movement of large quantities of raw material;

• **Lack of support and financing** for certain crucial yet small-scale regional transport services on behalf of public authorities with less organisational and financial capacity;

• Increasing negative **environmental and climate change** impacts of transport activities

• Inability to **decrease fossil fuel dependence** of regional and international transport means; this threat goes hand in hand with an increase in prices of petroleum and other related products;

• Further **deterioration of transport infrastructure** (lack of maintenance, operation and development resources);

• Maintaining or increasing **private motor vehicle travel**, leading to depletion of road network capacity in/around Varna and Burgas, including an increase **in time, costs, congestion and harmful emissions**;

• Outflow of qualified **personnel**.

All of the above trends and threats have been outlined by the numbers and reports in this study. There are adequate approaches and means to tackling them. Providing the social and political will to enforce them, as well as the diligent and sustainable investment of public resources, much can be done to prevent such **integrated system vulnerabilities**.

## Prospective Methods of Analytical and Systemic Improvement

Among the most visible and far-reaching improvements that the regional authorities should encourage and enact are some proven best practices and innovative approaches to **public urban transport** and **mobility**. A positive example sees four municipalities (**Burgas**, Smolyan, Sofia and **Varna**) involved in an URBACT initiative supporting sustainable urban development through six out of the total 15 thematic networks.

We noted above that transport still represents about a quarter of EU's **greenhouse gas emissions**, crucially being the main cause of city air pollution. More importantly, transport emissions **in Bulgaria increased by 10%** between 2012 and 2016 alone (as per the European Environment Agency's Greenhouse gas data viewer).

Significant progress must be made in the cooperation and involvement of societal factors and businesses. **Increasing stakeholder engagement** in transport network safety and improvements means involving the private sector and NGOs in the risk management process. A viable good practice is inviting transport or shipping companies to risk management exercises. Closer cooperation with the Bulgarian Red Cross in the Region could support such initiatives.

As it stands, many of the region's cornerstone transport services (e.g. rail) or infrastructure operators (e.g. ports) are **publicly owned or exploited**. Without going into detail on such an approach in terms of operational efficiency and quality, this has its important consequences on TRIS safety and extended ecosystem stability.

Many of the public regulators, infrastructure and service operators need to review and improve operating and maintenance standards. Maintaining an "acceptable" level of service is often not enough when we consider network vulnerability and long-term safety. **Reducing transport service interruptions** due to extreme meteorological events, for example, requires far reaching changes in management, resource planning, prevention and mitigation activities.

Still, stakeholders need to go about implementing any meaningful changes rather methodologically. The **Level of Service** (LOS) concept is widely used in transport engineering to measure the quality of services. It consists of formally defining a set of operating conditions corresponding to different "levels" of services. The holds true of maintenance standards as well. Reducing infrastructure damage requires planning and implementation according to extreme weather events and operational depreciation.

Improving operational and maintenance levels requires, in turn, familiarity with the **critical sections** of the transport network. Experienced infrastructure managers tend to develop and monitor local-level detailed data on extreme weather events – e.g. number and duration of meteorological disturbances and related financial and economic costs (material damage, accidents, casualties, injuries, delays, etc.). This information is used to **assess the integrated**

**vulnerability** of a given section within the transport network. Not only does this rank and help focus maintenance and safety activities, it also helps plan response mechanisms to emergencies and maintenance needs. These considerations are largely valid for all main types of passenger and cargo transport.

For example, snow blizzards are frequent in the North-East, causing dramatic service and infrastructure disruptions. A useful initiative would be to carry out a **detailed study identifying the most problematic areas**. Based quantified vulnerability, infrastructure managers will be able to prioritise further interventions.

A **review of viable practices and guidelines related to operation and maintenance** of various transport sub-sectors requires the analysis of some principal issues, related mostly to the scope and frequency of:

• **planned pavement repairs** (e.g. heat stress on roads and airport pavements);

• **drainage facilities maintenance** (e.g. capacity to absorb torrential rains);

• **railway switches maintenance** (e.g. colds and snowfall);

• maintenance **inspections on electric network** and other **traffic management equipment** during winter months (again, mostly effects of low temperatures, snowfall and blizzards on railway and road infrastructure);

• **port equipment inspection and maintenance** (winter impacts);

• identification of **potentially critical landslides**, **embankments or excavations** (for anticipated intervention).

The purpose of such practice and guideline reviews is strategically important in view of implementing **Performance Based Maintenance Systems** (**PBMS**). Establishing such an integrated **data-driven approach** will help employ more efficient tools (of monitoring and intervention) which can ensure a more reliable and cost-effective maintenance. Ultimately, relying on measurable indicators and proven algorithms tends to always **decrease system vulnerability** and **improve stakeholders' adaptation capacity**.

While true that such a top-down approach is present in national and regional strategies and mid-term plans. However, it has to be enforced with **more consistency** and **measurable feedback** indicators. Several exemplary interventions are relatively easy and cheap to implement, and merit a more engaged participation of responsible institutions and public-private stakeholder groups.

Given the importance of road infrastructure – especially for the coastal region, once established the lack of alternatives on most routes – experts suggest consistently **analysing the effects of halting all heavy freight vehicles on vulnerable road sections** when air temperature exceeds **35°C**. While this is an "adaptation measure" that has been applied for many years, its effects are **unproven against economic and structural effects**. The cost of road component improvements has not been matched to the economic losses to carriers and inconvenience to customers, including graded taxation of heavy users to compensate public spending needed to maintain and improve the road network. Now that there is a toll system in place for all heavy traffic in Bulgaria, the effects of similar measures need to be analysed, justified and updated.

Much has also been done and planned for in regional and national procedures for reacting to critical and extraordinary situations. Further efforts should possibly be implemented in view of proven best practices in EU counterpart institutions.

- development and establishment of **specific efficiency parameters – by type of transportation** – related to extreme weather conditions;
- regular review and improvement of **contingency planning procedures** for all transport subsectors, going beyond general response mechanisms of regional URS;
- implementation of **Intelligent Transport Systems (ITS)** – possibly with a priority on road infrastructure – as an integrated system of management and mitigation tools able to monitor and react to TRIS vulnerabilities.

The last point above brings us to an important final consideration. A coordinated development and installation of **ITS** would involve a considerable level of coordination and collaboration between public and private owners and operators of the TRIS ecosystem. However, it inevitably brings consistent benefits, practically immediately, to decrease infrastructure vulnerability and overall systemic safety. The development and establishment of monitoring parameters related to extreme weather conditions, other natural and anthropic risk factors requires coordinated actions on behalf of **state agencies** such as "Road Infrastructure", state enterprise "Port Infrastructure", the National "Railroad Infrastructure" Company, along with the above-indicated port and airport operators. A sectoral review of plans, rules and procedures segmented between stakeholders needs also go in the direction of joint standards, trainings and response actions of public institutions, private services and all other stakeholders. Finally, and most essentially on a local level, Bulgarian Black Sea coastal municipalities will benefit from developing and acting upon a coordinated mutually approved plan to **implement and link local and district ITS systems**.

## Conclusions

The Bulgarian Black Sea coast regional TRIS ecosystem has particular **vulnerabilities.** Reviewing those, as well as its **adaptation capacity** requires the adoption of a relatively simple review and maintenance methodology, yet increasingly substantiated via **measurable indicators and ITS tools**.

The region's transport sector is assessed as **largely stable** and **essentially sustainable**, at least up until 2035, in all current topical reports. However, both our analysis and cited expert reviews show that its **adaptation capacity is fundamentally insufficient**.

A careful assessment of types of risks and existing vulnerabilities leads to the conclusion that the high current stability of the sector is due mostly to expected **moderate climate change scenarios** in the region over the next 10-15 years. District and local transport solutions are built to face **mild seaside climatic conditions**, and the temperature and precipitation amplitudes facilitate an inherent short- to mid-term TRIS stability.

The lack of drastic climate fluctuations and related impacts on regional transport systems extends also to the **short-term economic efficiency** of the sector. In the medium and long term, however, **climate change** will have inevitably the most **significant impact** on road and rail transport development and costs, as they remain the essential logistic means within the region. Said impact is mostly related to an expected increase in "**thermal stress**" on ground infrastructure. **Sea transportation** is the one **least affected** by upcoming changes.

Consistent adaptation expenditure is foreseen as needed to deal with thermal stress related issues. Average annual growth (nationwide) in **adaptation costs** is forecast between 0.4 and 0.6% for roads interventions and up to 1.6% for rail transport (up until 2070). On the other hand, increasingly milder winter conditions may bring a minor decrease in maintenance costs – especially along the Black Sea coast – which may partially or completely offset the above increase in expenditure. **Extreme natural phenomena** exercise largely local impacts and, in view of the above climate scenarios, they are expected to have a **significant impact** mostly **on operating costs**, rather than general system operability.

However, the sheer fluctuation in investment and maintenance, the **unpredictability of increasing extreme events** and the need to raise the level of system stability in outdated infrastructural subsectors spells a **challenging period ahead** for transport infrastructure owners, operators and regulators.

Ultimately, considering all of the above **historical data**, interaction of **factors which have an influence** on the **current state and risk vulnerabilities** of transport networks along Bulgaria's Black Sea coastal region, we can outline some of the **major points and conclusions**:

**1. Natural phenomena** have a much greater importance and statistical probability of impacting regional TRIS; anthropic influence, where present, usually adds up, triggers or amplifies them:

- **Floods**, while second most common among critical weather events, cause the greatest damage to transport infrastructure. Flood frequency, irregularity and impacts are expected to increase under all projected climate change scenarios;
- **Landslides** (fourth most common critical weather event) are second in terms of infrastructure damage. Moreover, **precipitation** remains both a determinant and a trigger factor in landslide development;
- **Blizzards and snowfall** cause service interruptions in the winter. Although annual snowfall is forecast to decrease, they continue being the main winter cause of vulnerability and transport disruptions in all subsectors;
- **Extreme heat** is a factor mainly impacting infrastructure and facility design and construction in the transport sector. Heat stress is expected to raise costs both for road and railway subsectors.
- Implementing **Intelligent transport systems** (**ITS**) for monitoring, control and prompt stakeholder response will help mitigate external risk factors and react to heightened vulnerability indicators.

**2. Spatial planning and territory urbanisation** need to be monitored and implemented according to environmental standards and topical planning. A balanced approach must be sought between **urbanisation** and **environmental integrity**, avoiding uncontrolled and continuous coastal urbanisation and anthropogenic congestion provoking environmental degradation. This is a particular regional challenge, since natural resources are the specific source attracting much of the region's economic activity, hence preserving the contact between land and sea is crucial, including in resort areas. On the other hand, providing quality transport and communication links to settlements in the extended hinterland will bring substantial benefits to the rural and peripheral areas. Institutional and public-private efforts are needed to overcome the gap in functional and territorial development between the two realities, including and especially in engineering and technical infrastructure and the full spectrum of TRIS solutions.

**3. Climate Change Adaptation** requires institutional capacity first and foremost. A comprehensive review of regulations and protocols should include the assessment of gaps and adaptation mechanisms within the institutional framework designated for responding to TRIS vulnerabilities by transport sub-sector – on local, regional and even national level. Such a paradigm shift will introduce a set of meaningful responsibilities related to Climate Change adaptation within internal rules and cooperation mechanisms of major transport sector stakeholders, including training programs and public awareness initiatives related to climate change and individual contributions to transport sector adaptation capacity.

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