Valsts aģentūra
"Civilās aviācijas aģentūra"

Final Report of Riga CTR Airspace Assessment

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List of Abbreviations

AGL	Above Ground Level
ANSP	Air navigation service provider
ATC	Air Traffic Control
ATM	Air Traffic Management
BVLOS	Beyond Visual Line of Sight
CARS	Common Altitude Reference System
CNS	Communications, Navigation, Surveillance
CTR	Controlled Traffic Region
EASA	European Agency for Safety Aviation
ICAO	International Civil Aviation Organization
IFR	Instrument flight rules
JARUS	Joint Authority on Rulemaking for Unmanned Systems
MEDUSA	Methodology for a U-space Safety Assessment
NAA	National Aviation Authority
SERA	Standard European Rules of the Air
SORA	JARUS Standard Operational Risk Assessment
UA	Unmanned Aircraft
UAS	Unmanned Aircraft System
UTM	Unmanned traffic management
USSP	U-Space Service Provider
VLOS	Visual line of sight
VFR	Visual flight rules

Executive Summary

The unmanned aircraft system (UAS) industry is growing rapidly in sectors as diverse as agriculture, mining, construction, filming, surveying, policing, delivery, etc. as well as for the better-known military and general leisure uses. Managed integration of UAS into the airspace is now an absolute necessity and an airspace assessment is a critical part of this.

The role of an airspace assessment is to determine which areas of an airspace are to be assigned to which airspace classes, themselves defined by the services offered in each class. Assessments in the case of UAS will also specify where UAS are allowed to fly, what equipage they need and how they must interact with manned traffic.

The assessment described herein is unique in that the national aviation authority worked with non-aviation institutions towards the common goal of safe integration of UAS into a volume of airspace. This assessment will provide the basis for future airspace design considerations for UAS operations in a CTR.

The airspace assessment starts by identifying the stakeholders and decision-makers involved, the regulatory and environmental considerations necessary, the preferred methodologies, and any assumptions to be made. A list of data sources (from aviation and non-aviation stakeholders) is drawn up, stating what information needs to be collected and from whom.

A reference scenario is then defined based on the current situation in the area under study. Several processes, including airspace re-design, the definition of CNS requirements and geo-fencing requirements, and the re-assignment of different airspace classifications, are then applied to this scenario, ensuring that existing operations are not negatively affected by any changes envisaged. Air-risk and ground-risk classes are evaluated using the Specific Operations Risk Analysis (SORA) method or similar, based on the reference scenario, and assigned to each volume of airspace. Eventually, a new design concept will be proposed in which aspects such as U-Space and UAS geographical zones will be included.

1 Introduction

The main purpose of the Riga CTR airspace assessment is to build the full picture, which means taking a critical look at a certain airspace volume to identify the restrictions, operations, air and ground risks and collect sufficient data to determine what requirements are set to enable safe operations (CNS, ATS etc.). Having done the Airspace Assessment can advantage Riga to re-design the airspace, set CNS requirements and establish geo-fencing requirements.

1.1 Problem statement

Besides its obvious military uses – reconnaissance and attack over land or at sea - the UAS industry is undergoing rapid and diverse growth in sectors as diverse as agriculture, mining, construction, exploration of resources, surveying, environmental protection, border surveillance, policing, mapping, cargo delivery, aerial photography and many others, including general leisure. Managed integration of UAS into the airspace is now an absolute necessity and an airspace assessment is a critical part of this.

According to the Standardised European Rules of the Air (SERA), the lowest height at which aircraft flying under visual flight rules (VFR) or instrument flight rules (IFR) may fly is 500ft above ground level (AGL) and for many UAS operations this is then considered the maximum height, thus creating a buffer between manned and unmanned aircraft. However, many flights have authorisation to fly below 500ft, for purposes such as landing and departure, emergencies, search and rescue, etc. Unfortunately, many remote pilots are not aware of the SERA or of any of the national restrictions that can be found in the electronic Aeronautical Information Publication (eAIP). This poses a serious safety threat to society, airports and other airspace users.

Each UAS flight is unique, with a diverse set of operations in different types of airspace, and the air and ground risks involved need to be closely examined. It is crucial to determine which zones of airspace are safe for a given UAS to fly in and which they should be excluded from. It is highly recommended therefore to undertake an airspace assessment, especially within an airport control region (CTR). The acceptable means of compliance (AMC) guidelines for UAS geographical zones that the European Aviation Safety Agency (EASA) will soon publish should enable member states (MS) to more easily identify requirements for airspace assessments that will enable safe UAS integration into their national airspace.

The role of an airspace assessment is to determine which areas of an airspace are to be assigned to which airspace classes. However, whereas traditional airspace classes are categorised according to the services provided to pilots in those airspaces, in the case of UAS the categorisation will also specify where those UAS are allowed to fly, what equipage they need to fly there and the means of interaction with manned traffic.

Until now, safety assessments in the aviation sector have been conducted in close collaboration with aviation institutions alone. The assessment described herein is unique in that the national aviation authority must also work with non-aviation institutions towards one common goal – the safe integration of UAS into an airspace. This assessment will provide the basis for future airspace design considerations for drone operations in a CTR.

1.2 Background

The primary task of this project is to ensure the safe integration of UAS into European airspace, using RIGA CTR as an empirical study. To facilitate harmonised, interoperable rules and scenarios, airspace assessments need to be conducted and maintained and can be seen as an extension to, or a component of, the "traditional" airspace assessment. They will enable operations at a local level, especially at low height, where not all dangers/obstacles are identified in aeronautical maps.

1.3 Objective/scope

The objective of the RIGA CTR airspace assessment is to have an overview, called a reference model, of how traffic is handled within the RIGA CTR. This reference model is the baseline against which any change or optimisation is measured to ensure that safety is not negatively affected and that all operations can be conducted as foreseen. In addition, the result of this airspace assessment will provide real value to the SORA air and ground risk assessments.

The airspace assessment covers the whole airspace volume of the CTR, including ground operations, as well as populated areas such as the city of Riga. The project addresses only the first phase of a total airspace design, without any actual re-design of the airspace. A core team of local experts and occasional support from external experts have been necessary to develop this reference scenario. The airspace assessment addresses the following aspects:

- IFR, VFR and other manned traffic operations (military, police)
- UAS operations
- ground operations
- communication, navigation and surveillance (CNS) infrastructure and other critical infrastructure aspects
- obstacles and populated areas
- SORA air and ground risk allocation

1.4 Intended audience

This report is intended mainly to be used by stakeholders to whom it is intended to convey the method of performing a UAS airspace assessment or its results. Stakeholders include civil aviation authorities (CAAs), Air Navigation Service Providers (ANSPs), and Unmanned Traffic Management (UTM) system providers. It should also provide useful background information for users wanting to understand the impact of such assessments - UAS operators, manned aircraft operators, UAS manufacturers, etc.

1.5 Structure of the document

This document breaks down into 9 sections and has 2 annexes. A discussion of the general considerations to be taken into account for an airspace assessment (section 2) follows this introductory section. This is followed in turn by a brief description of the method that will be applied (section 3) and of the tasks necessary for the preparation of an assessment (section 4).

The actual airspace assessment performed at Riga CTR is described in section 5, with section 6 giving a summary of the findings of the study.

2 General considerations

When preparing for an airspace assessment, it is imperative to start by identifying the stakeholders and decision-makers involved, all regulatory and environmental considerations, the preferred methodologies (SORA, MEDUSA or other), and any assumptions to be made (such as flight rules and CARS at a national level). In addition, a list of sources (aviation and non-aviation stakeholders) must be drawn up, stating what information needs to be collected and from whom.

2.1 Stakeholders and decision-makers involved

To ensure data quality and validity, it is imperative that data be collected from reliable sources. This might be easy inside the Single European Sky framework, but working with entities outside the aviation sector could be challenging. When entering a new sector - railway, maritime, military, etc. – it is essential to work at the level where decisions can be made and data quality ensured. The aviation sector and ground-related sectors are not necessarily interoperable at present and so communication is the key.

The aviation stakeholders involved are the national aviation authority (NAA), ANSP, U-space service provider (USSP), airlines, airports, UAS manufacturers, etc.

Non-aviation support may be required inter alia from emergency services, ground operations, security services, UAS operators, UAS associations.

2.2 Regulatory considerations

A regulatory gap analysis is one of the main starting points for covering all aspects of the area where the airspace assessment is conducted. The goal of the gap analysis is to understand the main problems and areas where harmonisation has not been achieved between different ATM regulations in relation to the integration of UAS into a volume of airspace.

2.3 Assumptions

Many assumptions have to be made about aspects where there is room for interpretation. Two of the main unknown factors are flight rules and the Common Altitude Reference System (CARS).

2.3.1 Flight rules

Flight rules are an essential enabler for UAS integration, and a harmonised approach through the definition of a set of common European flight rules is one of the main challenges. Current flight rules state that aircraft may fly below 150m (500ft) for take-off, landing and emergency procedures. Other exceptions can also be authorised by the competent authority at any time, without notifying any other body (e.g. EASA). Additionally, current rules do not account for the greatly different speeds of manned and unmanned aviation. Consequently, a safer and more efficient set of right of way rules than current SERA requirements needs to be developed.

2.3.2 CARS

Different altitude systems are used in different volumes of airspace and by different aircraft. For example, conventional manned aviation uses pressure altitude from barometric readings whereas UAS may use other systems such as satellite-derived altitudes. It is generally considered that the small UAS altimeters are global navigation satellite system (GNSS)-based, and it is assumed that that the "home" altitude is set to zero at the start of each flight. It is essential for this airspace assessment to have a common understanding of the altitude reference systems in use.

2.4 Risk assessment methodology

Taking into account the seriousness of the safety and security threat a UAS can pose, it is critical to ensure that a UAS flies only in airspace volumes deemed safe. There are a variety of risk assessment methods that can be used during the airspace assessment. In the scope of the Riga CTR project, two methods were used - SORA and MEDUSA – as well as the traditional safety assessment method. When the air risks and ground risks have been finalised, risk levels should be assigned to the airspace volumes assessed. The next steps should ensure that the static data evolves into dynamic data, which would then ensure an up-to-date situation.

2.4.1 SORA

The Joint Authorities on Rulemaking for Unmanned Systems (JARUS) have developed a risk assessment guideline called Specific Operational Risk Assessment (SORA). According to EASA, SORA will be adopted as an Acceptable Means of Compliance (AMC) by the end of the 2019 and used for the risk assessment appropriate to the specific category of UAS operators.

One main objective of SORA is to provide a methodology to guide both the applicant and the competent authority in evaluating whether an operation can be conducted in a safe manner. To ensure safe UAS operations, SORA will find the most appropriate mitigation means and thus reduce risk to an acceptable level. The SORA accommodates a method for minimising environmental impact (safety of people or of property).

Even though SORA is constructed in a way that looks at the risks from the operator's viewpoint, it is a methodology that can be extended to other perspectives, such as an NAAs, ANSPs, industry, etc. In this assessment it was advised to use SORA as one of the methodologies, if not the core methodology, with a view to evaluating risks and mitigations and empowering the authority to authorise given operations.

A SORA air risk level should be assigned to the airspace volume assessed. This should be done through accurate analysis of the results and reflected on the map to be used by drone operators when undertaking a SORA risk assessment.

A SORA used in the scope of an airspace assessment means not only evaluating the risks related to given operations but also enabling the competent authority to avoid repetitive individual approvals.

2.4.2 MEDUSA

The Methodology for a U-space Safety Assessment (MEDUSA) is a method proposed by the CORUS project, based on the SESAR Safety Reference Material (SRM) that identifies and manages hazards posed by drone traffic in U-Space. The MEDUSA process sets out a holistic approach to a U-Space safety assessment, not just from the operator's perspective but also from that of the USSP, taking the interoperability of these services with the ATS/ATM into account.

3 Methodology

This methodology starts with a reference scenario and applies several elements, including airspace re-design, CNS requirements, geo-fencing requirements, and the assignment of different airspace classifications. Some applications and assumptions may be similar to the terminal airspace design methodology within the design process. Eventually, a new design concept will be proposed in which aspects such as U-Space and UAS geographical zones will be included.

3.1 Reference scenario airspace assessment

An airspace assessment is similar to a traditional terminal assessment. This methodology is based on qualitative analysis with a continuous cross-checking process to ensure that safety and performance criteria are met and that assumptions and enablers are consistent with the airspace design. Qualitative analysis involving expert judgement is essential for the analysis to be relevant and meaningful, since simply working through a basic checklist will most probably not be sufficient. The planning methodology used in this process needs to be constructed through a clear set of objectives and a realistic view of both present and future airspace operations. In the worst case, failing at this level could lead to an unrealistic approach for the new airspace design, and in any case the risk of failing the operational needs will remain.

Several elements of an airspace assessment are similar to the traditional assessment. However, since this case is different because of the work conducted in collaboration with non-aviation entities, the safety and performance criteria may differ. The airspace assessment covers the following phases:

- Airspace analysis - airspace users, airspace structure, CNS
- Identification of positive and negative aspects
- Identification of required UAS operations
- Design of airspace - airspace volume, routes, geo-fencing, CNS requirements
- Safety approach and safety case
- Development of supporting procedures
- Validation (simulation)
- Implementation
- Feedback loop and improvements

The airspace assessment conducted in Riga CTR will provide input for the future development of UAS Airspace Design Manual.

4 Preparation for an airspace assessment

Preparing for an airspace assessment means building a "reference scenario": the operations performed within the volume of airspace being assessed. The assessment will build a real time perspective of what and how the operations are conducted at present, and what requirements (ATS, CNS, etc.) are defined to enable safe operations. Furthermore, it will define a variety of requirements (geo-fencing, U-Space, etc.) necessary to ensure existing operations are not negatively affected by any changes envisaged. This includes assigning the evaluated air-risk classes, based on the reference scenario, to each volume of airspace.

The reference scenario plays a considerable role in the validation process. The real-time simulation planned, during which several scenarios will be assessed next to the reference scenario, will be part of the validation, ensuring that the upcoming operations do not pose new safety concerns.

4.1 Current activities

On 17 August 2019 the national regulation "Procedures for the Performance of unmanned aircraft and other types of aircraft which do not qualify as aircraft" came into force. This national regulation was drawn up as part of preparations for the common EU regulation. Proposals were made by the participating governmental and non-governmental organisations, thereby facilitating the transition towards the new European framework and national regulation. The national regulation applies to all unmanned aircraft operators, both professionals and those who are willing to conduct unmanned aircraft flights for recreational purposes. The national regulation bans drones from several areas in Riga and other Latvian cities and in the vicinity of airports and other strategically important objects and places. In accordance with the national regulation, the aeronautical information related to specific drone areas which is needed for safe and secure unmanned aircraft flights (e.g. drone exclusion airspace volumes and any restrictions or areas where unmanned aircraft may perform flights from 2 January 2020) should be provided for UA pilots in a separate, easily understandable, electronically accessible format. From July 2020, the national regulation will be replaced by a common EU Regulation, while essential provisions for drone operations will be maintained at national level.

Integrating UAS into ATM without confusing the existing arrangements and rules will be another considerable challenge. Regulatory gap analysis has outlined a few substantial challenges, one of these being the creation of a software application for UAS operators. Work on such an application has already been started by LGS (national ANSP), and several meetings have been held between LGS (software demonstrations) and the CAA. Some questions do, however, remain unanswered.

4.2 Creation of an assessment team

Lack of communication and collaboration between aviation and non-aviation organisations and institutions can lead to unsafe conditions and result in invalid data being provided for the airspace assessment. Creating a strong team is therefore important for the successful execution of an assessment. When the scope of the assessment becomes clear, it will be evident which organisations and institutions need to be involved in this team and a meeting should be arranged, with each of their focal points present.

4.3 Regulatory assessment

The existing rules and regulations for UAS operations must be analysed to understand current limitations and areas for improvement. This will also require an examination of the new EASA opinion, delegated and implementing act, as well as the SERA and other relevant documents if necessary.

4.4 Operational and infrastructure assessments

4.4.1 Urban perspective

An analysis of the urban aspects of the airspace will provide a clear overview of the populated areas and their boundaries. Manned operations are also conducted inside some cities and this also needs to be covered. Areas where drone operations are prohibited or limited should also be identified and documented. It is important to ensure that geophysical data are relative to WGS84 if possible. There is also a need to map future urban air mobility (UAM) intentions.

The URBAN perspective of the assessment will address the following aspects:

- Identify dynamic and static population density areas;
- Identify boundaries of populated areas;
- Identify specific drone zones (restricted, closed, etc.);
- Identify manned aircraft operations, locations, and routes within an urban environment;
- Identify environmental requirements (noise, etc.).

4.4.2 Ground risks

A ground risk assessment determines all aspects of the integration of UAS into a certain airspace volume that could affect the safety of people and property on the ground. It requires a critical look at populated areas, areas of special interest and volumes where access to the airspace must be restricted for safety or security reasons. Geophysical data obtained should be relative to WGS 84.

Ground risk addresses the following aspects:

- Airport ground operations

    - Taxi tracks;
    - Platform operations;
    - Identify actors;
    - Identify critical areas (such as ILS sensitive zones, radar, etc.).
- Generic airspace restrictions
    - ATZ, TRA, TSA, CBA, CDR;
    - Restricted airspace and no UAS zones;
    - Nature reserves.
- Populated areas
    - Cities and suburbs;
    - Boundaries;
    - Recurring events.
- Critical infrastructure
    - High-tension power lines;
    - Nuclear and conventional power stations;
    - Water treatment plants.
- Interference locations
    - Mobile phone antennas;
    - Satellite disks (TV transmissions);
    - Radar;
    - HIRAD;
    - Solar panel and wind farms.

These data are validated through analysis, interviews, meetings and workshops.

4.4.3 Air risks

An air risk assessment determines all aspects of UAS integration that could affect the safety of operations in the air. It requires a critical look at existing manned and unmanned operations. The volume of airspace that is being assessed needs to be described relative to the WGS-84 ellipsoid.

Air risk addresses the following aspects:

- Airport operating hours, dimensions and location
- IFR operations
    - Arrival and departure routes;
    - Transit routes;
    - RV vectoring areas;
    - Deviations from the above;
    - Altitudes.
- VFR operations
    - VFR routes and corridors;
    - Operations below 150m/500ft;
    - Low-altitude military operations;

  - Altitudes.
- Model aircraft club location, operating hours and airspace dimensions.
- Generic operations
  - Gliders;
  - Balloons;
  - Parachuting, parasailing, etc.
- State-specific operations
  - Police;
  - Customs;
  - Fire brigade;
  - Military;
  - Military police;
  - Search and rescue, etc.

These data are validated through interviews, workshop or meetings with:

- ATC;
- Airlines;
- General aviation;
- Airport operators;
- Airspace designers and planners;
- Airspace managers (AMC);
- AIM;
- PANS-OPS specialists.

4.4.4 Communication, Navigation and Surveillance (CNS)

An infrastructure assessment determines the CNS infrastructure coverage and limitations to set the required access requirements for UAS, e.g. the radio coverage and/or radar coverage might require additional requirements or even restricted airspace for UAS. In addition, operations close to radars will have an impact on the ability to control a UAS.

An infrastructure assessment addresses the following aspects:

- Communication
  - Identify the communication requirements for the airspace volume to be assessed;
  - Identify the level of coverage;
  - VHF and UHF;
  - Data link requirements;
  - Coverage of 3/4/5G network.
- Navigation
  - Identify navigation requirements for the airspace volume assessed;
  - Identify navigation critical areas;

- Identify GPS outage reports;
- Assess RAIM availability.
- Surveillance
    - Identify surveillance requirements for the airspace volume assessed;
    - Identify critical surveillance areas (coverage, etc.);
    - Identify alternate use means of surveillance (FLARM, etc.);

These data are validated through analysis, interviews, meetings and workshops.

5 Performing the airspace assessment

5.1 Data collection

It was initially decided to collect extensive information from the different stakeholders directly and indirectly concerned by UAS operations in the Riga CTR. This would provide an overall situational awareness of the issues involved.

Data collection is a challenging process and several issues must be addressed before the data are collected and used. A clear definition is needed of the data required and the format it must be obtained in (interview reports, statistics, geographical data). This must be limited to no more data than is necessary; unnecessary data or data that are too complex require additional resources for processing and can lead to confusion. The relation between the cost of acquiring data and the benefit it brings to the issue must be kept in mind. Similarly, the trade-off between static data and dynamic data is important; while dynamic data may seem to better represent the present situation, in many cases it is difficult or too expensive to obtain it, and places too heavy burden on resources for processing it.

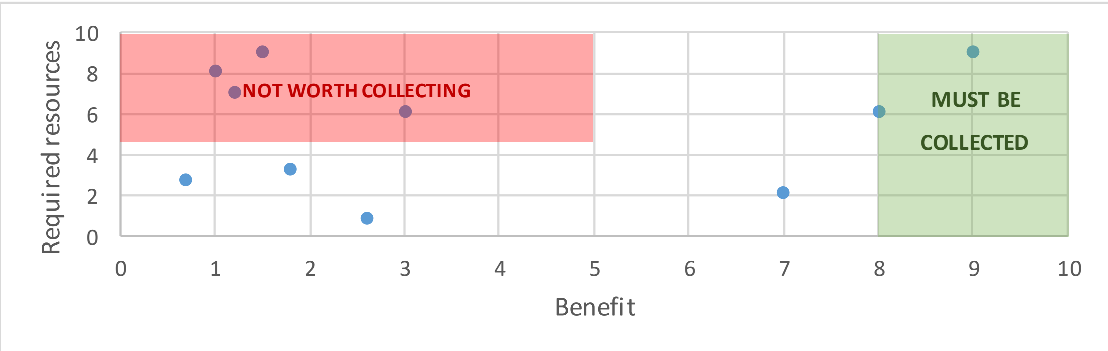

Figure 1 - Example of relation between the required resources vs benefit

Similarly, the trade-off between static data and dynamic data is important - while dynamic data may seem to represent the present situation better, in many cases it is difficult or too expensive to obtain it and places too heavy a burden on resources in terms of processing.

Qualitative data collection for comprehensive risk assessments (especially on ground risks) is affected by different factors:

- Ground risks are dynamic;
- It is often impossible to identify threats and damage remotely;
- Local risk assessment is more effective and more related to the actual situation - or requires much fewer resources - than using a common methodology;
- Risks in different locations with seemingly the same conditions might be different than initially predicted; it is important to distinguish continuous and temporary risks.

In light of these constraints, data collection should be kept simple and not go deeper than:

- Ground risk categories (according to SORA-GRC):
  - Sparsely populated environments;
  - Populated environments;
  - Gatherings of people;
- Ground relief, including buildings or any other objects or hazards on the ground that may affect the performance of UAS or may cause significant consequences in the event of a UAS crash;
- Critical infrastructure and objects related to national security (state security areas, prisons, railway, power lines, etc.).

5.2 Aeronautical Data

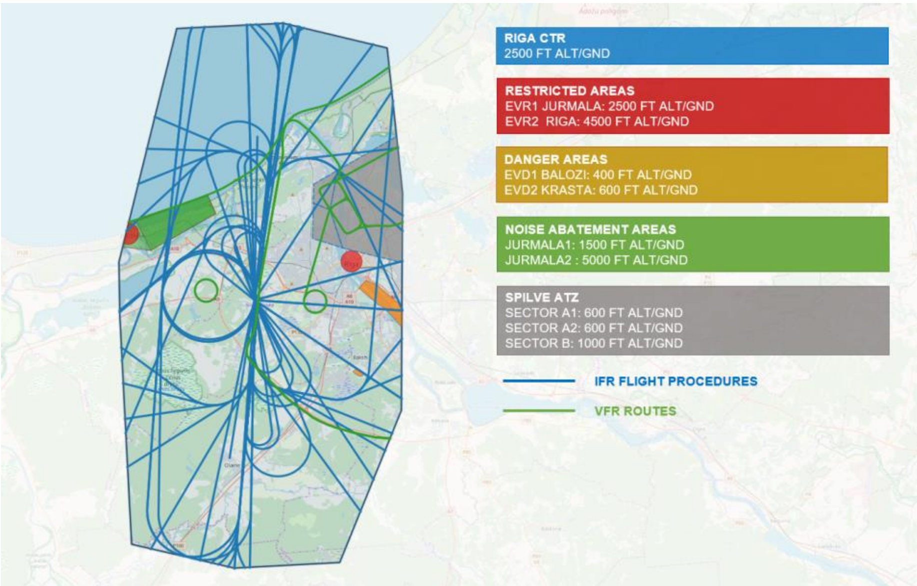

Figure 2 - Existing approved flight trajectories and special use areas within Riga CTR

It is a huge task to collect all available aeronautical data from sources such as AIPs, including approved flight trajectories and special use areas obtained from the local ANSP such as:

- Geographical dimensions of airspace structures;
- IFR flight procedures;
- VFR routes.

5.3 Airfields, critical infrastructure and objects related to national security

It was observed that UAS operations close to airfields, critical infrastructure and objects related to national security are restricted and require agreement from the relevant authority.

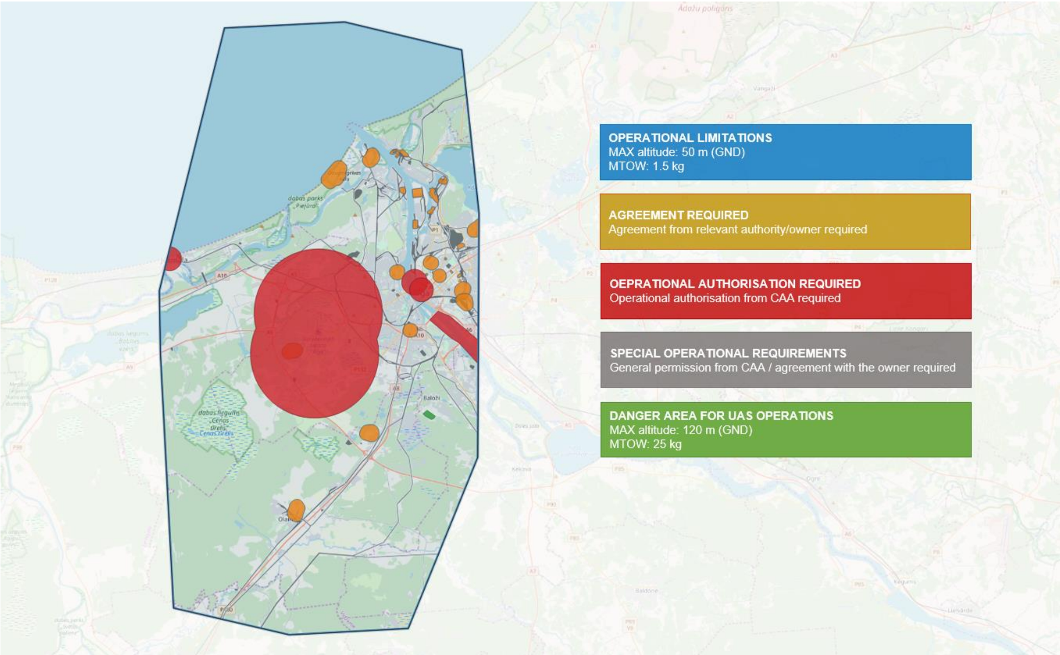

Figure 3 - "No-fly" areas around critical infrastructure and objects related to national security

The collection of data on critical infrastructure and other security-related objects was divided into 3 categories:

- Operational authorisation from national authority required:
    - Certified airfields
    - Restricted and dangerous areas
- Agreement with object owner or possessor required :
    - Industrial accident risk objects;
    - Objects of the Bank of Latvia;
    - Military infrastructure objects;
    - Infrastructure objects related to the safeguarding of public order and security, state border security and civil protection;
    - Prisons of the Latvian prison administration.
- Special conditions apply:
    - Roads, streets, bridges (not collected);
    - Railway;
    - High-voltage power lines;
    - Cemeteries.

The collection of geographical data requires a lot of resources and in many cases the data does not need to be represented on a map. It is important to have a filter, for example roads and streets consist of too many coordinates, with special areas represented around them, and this does not bring much added value. During the data collection process it was decided to exclude some of those restrictions.

5.3.1 Flight data monitoring

The monitoring of UA activities in Riga CTR took place at irregular time intervals and at different physical locations for the detection system. The data collected required post-processing to filter out errors and repeat information and to set the tolerances for geographical location (presuming the vertical precision of flight altitude drift to be at least 5m), but the resulting data gave a comprehensive overview of airspace usage by UA.

5.3.1.1 Results of 37-day continuous monitoring

The longest continuous period of monitoring was 37 days in the vicinity of Riga International airport. Even though this monitoring was performed in the autumn 2018 under adverse weather conditions, 174 UA flights (99 unique UAS) were detected.

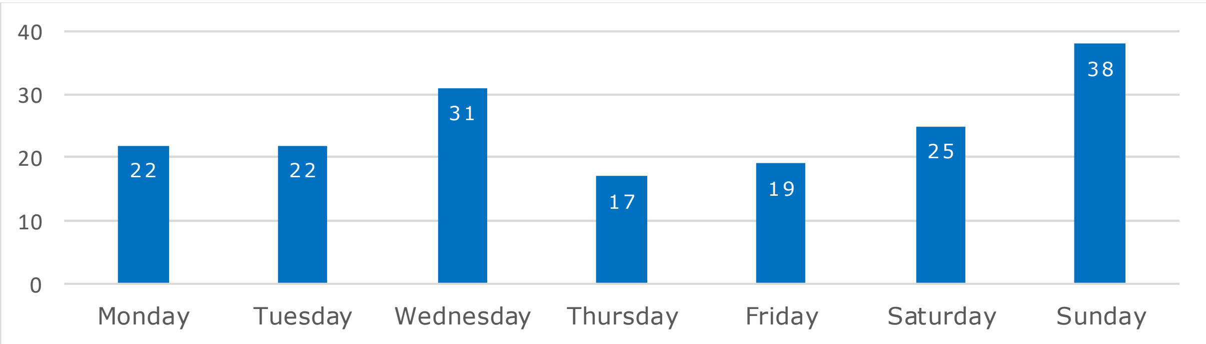

Figure 4 - UAS detected by day of week

Even though it was expected to detect more UAS activities during the weekend, the results did not show any significant tendencies for increased number of flights by any day of the week.

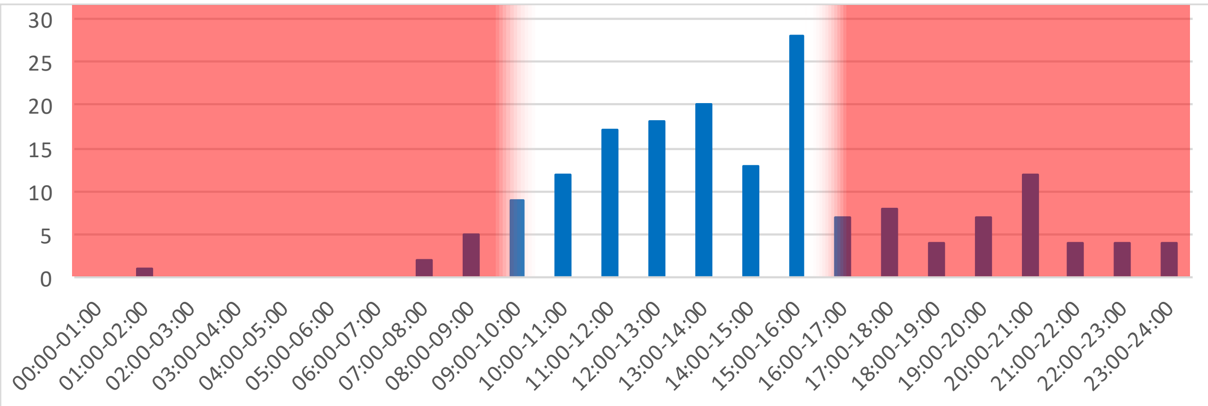

Figure 5 - UAS detected by time of day

74% of the flights were detected during allowed operational hours.

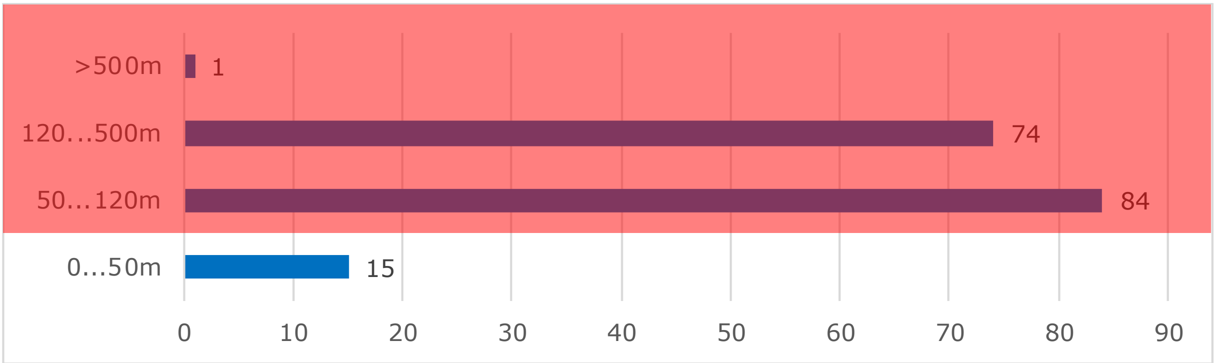

Figure 6 - UAS max detected flight altitude (above take-off point)

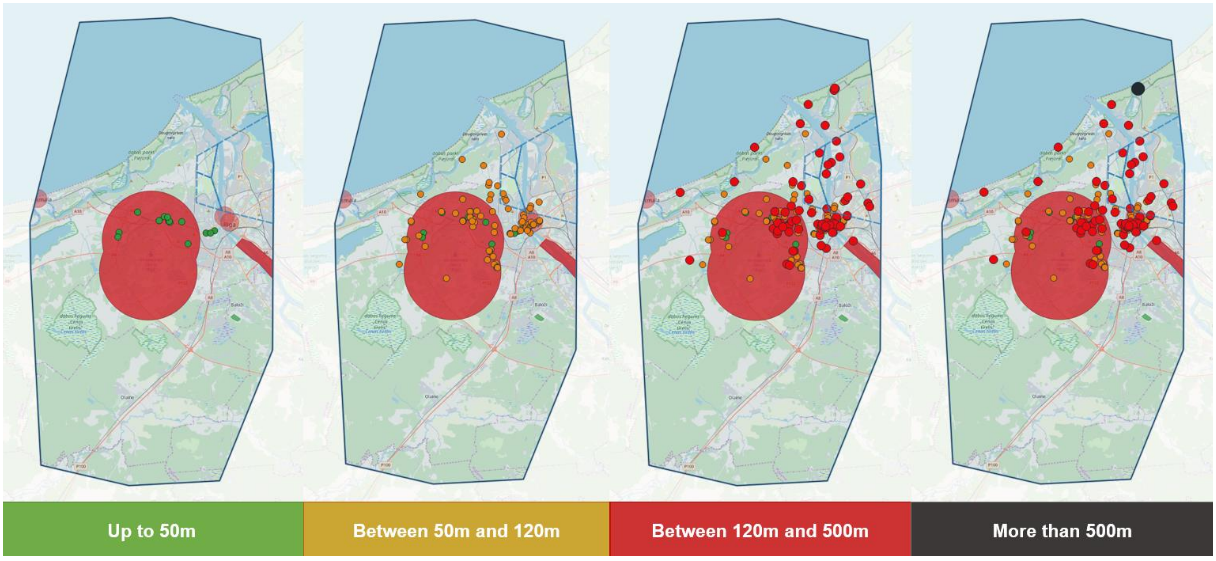

Figure 7 - Locations of UAS max detected flight altitude (above take-off point)

During 37 days of continuous monitoring:

- 71 UA flights were detected closer than 5km to the runway threshold at Riga;
- most of the UA flights detected exceeded the maximum flight altitude allowed of 50m:
    - 84 (48%) UA flights were detected at 50 – 120 m above take-off point;
    - 74 (43%) UA flights were detected at 120 – 500 m above take-off point;
    - 1 UA flight was detected at 723m above take-off point.
    - the average maximum UA flight altitude was 156m above take-off point;
- of 174 UA flights, only 2 were authorized by CAA;
- according to national regulations 159 (91%) UA flights are to be considered as illegal;
- the maximum UA flight altitude detected in Riga CTR was 723m above take-off point.

5.3.1.2 Results of full monitoring

The monitoring of UA activities was limited by the distance between the detection system and the UA as well as obstacles and other technical factors that affect this process. Therefore, the monitoring was performed at different times at different locations both to obtain data and to gain experience in the detection and prevention of illegal UAS operations.

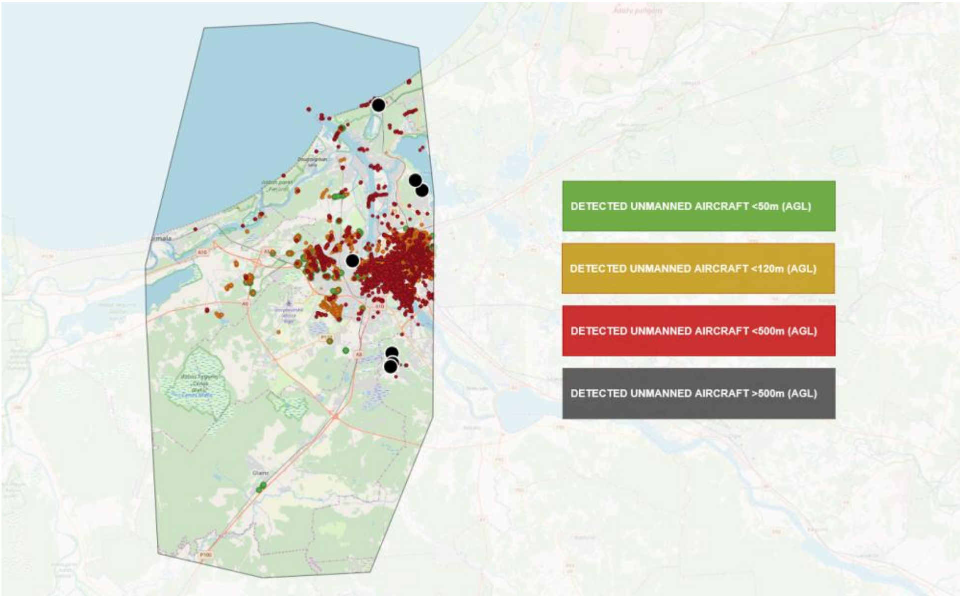

Figure 8 - Detected UA flight paths

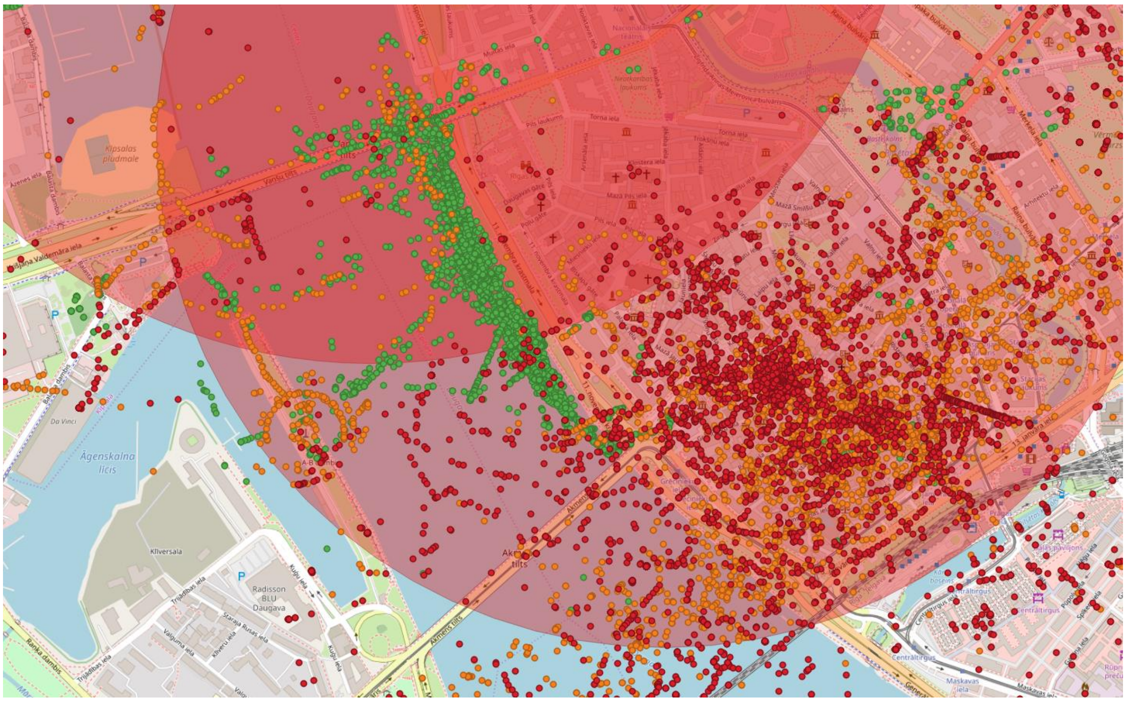

Figure 9 - Close-up look at detected data

5.4 Specific Operations Risk Assessment (SORA)

5.4.1 Air risks

For flight safety purposes it is critical to locate and identify flight path deviations flown in practice in comparison to the published approach and departure IFR flight procedures (see Figure 5). Considering that Riga CTR airspace and a small portion of uncontrolled airspace under Riga CTR over Spilve (G class) operating area is often used by local VFR air traffic, it was also important to learn about frequently flown VFR flight routes by general aviation pilots.
Additional concerns during air risk identification were:

a) If approved by ATC, pilots can file any entry/exit point along the Riga CTR boundary for aircraft entry and exit into Riga CTR.
b) In accordance with SERA, the CAA as a competent authority can authorize aircraft operations below 1000 ft over populated areas. Cabinet of Ministers Regulation No 26. prescribes basic criteria for aircraft operators to apply for such individual short-term exemptions. Usually, such exemptions relate to special aerial works.
c) The location of the Riga CTR is conducive for general aviation transit flights from east to west coast, as there are fuel, time and overall flight cost savings if a shorter, direct route is flown through Riga CTR. If such flights are performed outside Riga or other large populated areas in the Riga CTR, they may be performed at 500 ft.

Air risk is determined using air risk classes (ARC) “a” to “d” and categorised into 13 aggregated collision risk categories as defined in the SORA. These classes were assigned within the Riga CTR based on residual ARCs. At this stage of Riga CTR airspace assessment, the air risk strategic mitigations (mitigations in the form of operational restrictions and common structures/rules) and tactical mitigations - to apply tactical mitigation performance requirements (TMPR), robustness, integrity and assurance levels for operations - have not been applied due to the more complex application of SORA required for this.

5.4.1.1 Air risk data analysis

Data has to be analysed in order to understand its relevance, to categorise and transform it according to the purpose it serves and to model and arrange it to obtain useful information with a view to contributing to conclusions and supporting decision-making.

In the course of the airspace assessment, it was challenging to classify atypical airspace in Riga CTR. Ultimately, the only segment of airspace in RIGA CTR categorised as atypical airspace was the danger area established for unmanned aircraft operations which extends 400FT AMSL vertically. In this airspace the manned aircraft encounter rate is expected to be extremely low.

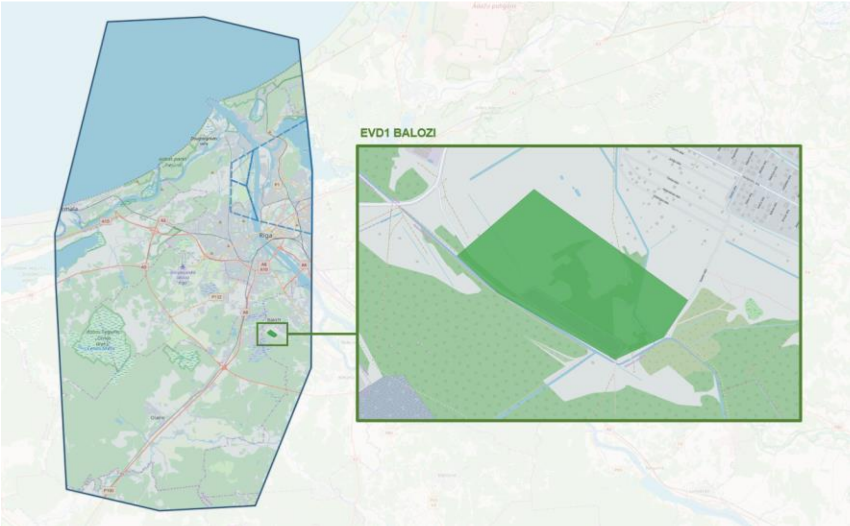

Figure 10 - Atypical airspace – danger area EVD1 BALOZI

In addition, the airspace more than 5km away from the runway thresholds at Riga at very low altitude (50m AGL) in CTR can be defined as lower-risk airspace than the rest of Class C airspace in CTR, which gives lowest value ARC-c.

5.4.2 Ground Risks

Ground risk classes (GRC) in Riga CTR were determined by the operational scenario applied and the maximum characteristic dimensions of the unmanned aircraft (UA) that define the lethal UA area, as specified in the SORA.

Operational scenarios could be:

Over	VLOS	BVLOS
Controlled ground environment	✓	✓
Sparsely populated environment	✓	✓
Populated environment	✓	✓
Gathering of people	✓	✓

The typical kinetic energy expected is correlated to the maximum characteristic UA dimension. However, in the event of a mismatch between them, justification should be provided for the GRC chosen.

Maximum characteristic UA dimension (metres)	Typical kinetic energy expected (Joules)
1	<700
3	<34k
8	<1084k

>8	>1084k

According to the SORA, a CTR is considered to be ARC-d (ARC-c, if taking into account usually required flight altitude (<500ft) by UAS operators) airspace if either the manned aircraft encounter rate is high or the strategic mitigations available are limited, resulting in a high residual collision risk and high TMPR.

According to existing EU Regulation 1035/2011 as well as EU Regulation 2017/373, which is applicable to ATS providers from 2020, before implementing any changes to the functional system affecting safety risks within Riga CTR, a safety assessment of these changes must be carried out and acceptance from the competent authority must be received. The integration of a new airspace user into the Riga CTR airspace, where the ANSP bears responsibility for separation between various airspace users, requires a safety assessment, which would have to be combined with the outcome from ground risk assessment to ensure that the resulting conclusions for UAS operations at very low altitudes in Riga CTR are mutually acceptable. Therefore, a SORA and a safety assessment have to be conducted in close coordination.

5.4.2.1 Ground risk categories (according to SORA-GRC)

According to SORA, the intrinsic Ground Risk Classes (GRC) are determined at the intersection of the max UA characteristic dimensions and applicable operational scenario. There are four operational scenarios, namely flights:

- over controlled area (for example construction site);
- in sparsely populated environments;
- in populated environments;
- over gatherings of people.

5.4.2.2 Controlled ground area

A controlled ground area is defined as the intended UAS operational area that involves only active participants - those persons directly involved with the operation of the UAS or fully aware that the UAS operation is being conducted near them. Active participants are fully aware of the risks involved with the UAS operation and have accepted these risks. Active participants are informed on and are able to follow relevant effective emergency procedures and/or contingency plans. Controlled ground areas can be declared only by the UAS operator, therefore during data collection this operational scenario was not considered.

5.4.2.3 Gathering of people

Gatherings of people are dynamic data. Even though there are locations where we might assume that gatherings of people at specific times are usual, it is still a variable factor and therefore static data will not determine the actual operational scenario.

To gather dynamic data, the tracking of mobile data usage was considered, but current technological solutions and the regulatory framework on privacy and data protection prevented us from analysing this methodology further.

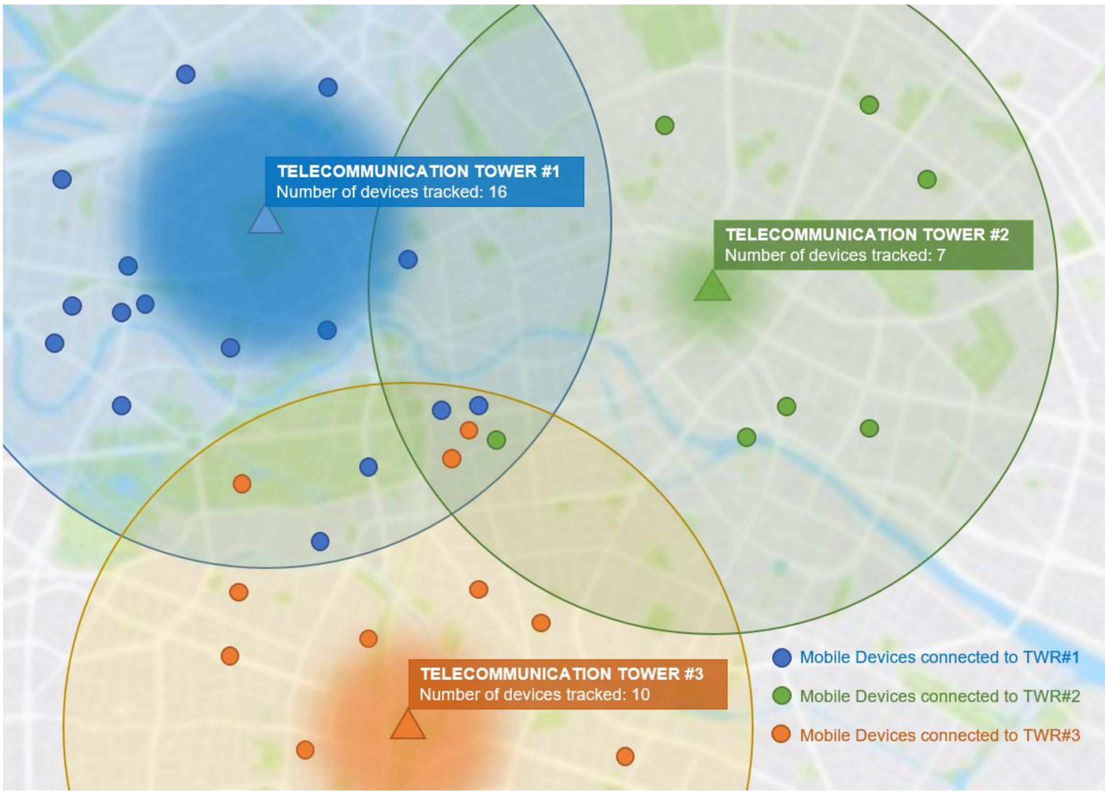

Figure 11 - Simplified example of data gathered based on mobile data usage tracking

Currently it is possible to obtain data on how many devices are connected to a specific telecommunication tower but this does not pinpoint the actual location of people. Even though it would be technically possible, more precise determination of the location of individual devices is not allowed by law. Based on feedback from Riga municipal police, every year there are some 1,000 public gatherings for various public events like commemorations, state government events, celebrations, etc. Some of these events regularly occur in the same location while others are planned specifically and take place at various sites.

5.4.2.4 Populated and sparsely populated environments

As a result of our inability to identify controlled ground areas and gatherings of people, it was decided to divide and collect geographical data on operational scenarios in two parts - populated environments and sparsely populated environments.

Even though Latvia has nationally defined "populated areas", these areas do not qualitatively reflect actual data on "populated environments" – e.g. there are many crop fields, marshes and forests which do not pose higher ground risks than sparsely populated areas. In addition, actual ground risks in sparsely populated environment might be higher than in populated environment (e.g. nature trails, recreation parks).

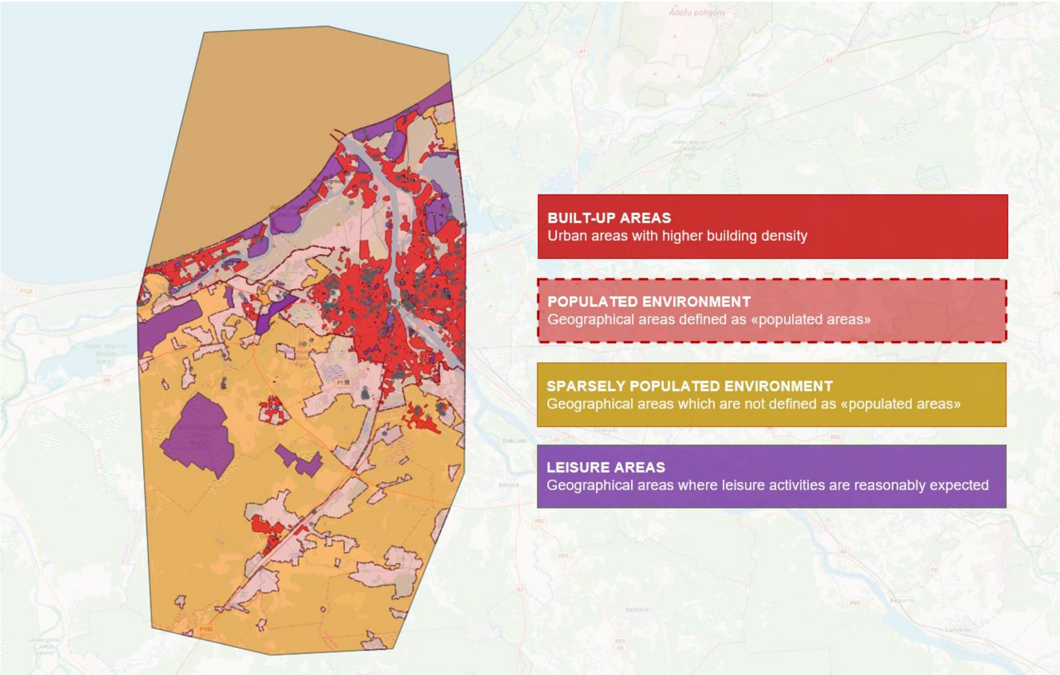

Figure 12 - Geographical data about built-up, populated, sparsely populated and leisure areas

In the course of the ground risk data collection process, interviews with representatives of municipalities were very useful – demonstrating that there is no harmonised approach in data collection or shared perception of regulations on the use of unmanned aircraft, for example:

- they have a different vision of safety, security and privacy aspects;
- they have strategic plans on their territories, updated only every 12 years, e.g. even though some of the territories are reserved for private residential housing, in reality they are used for different purposes;
- they do not have actual information on buildings (this information is updated in real time by a different authority, but the data is not open and it requires a lot of processing);
- the same criteria for required data will not work for all municipalities or require too many resources – geographical data is not categorised in the same way.

Collecting information about all possible hazards meant that there was too much information. Separate research is required on the best methodology for determining more precisely the actual areas where ground risks are higher, taking into account the time component too. As a result, a decision was made to collect data on ground risks based only on two criteria:

- Populated environment:
  Geographical areas which are defined as “populated areas”;
- Sparsely populated environment:
  Geographical areas which are not defined as “populated areas”

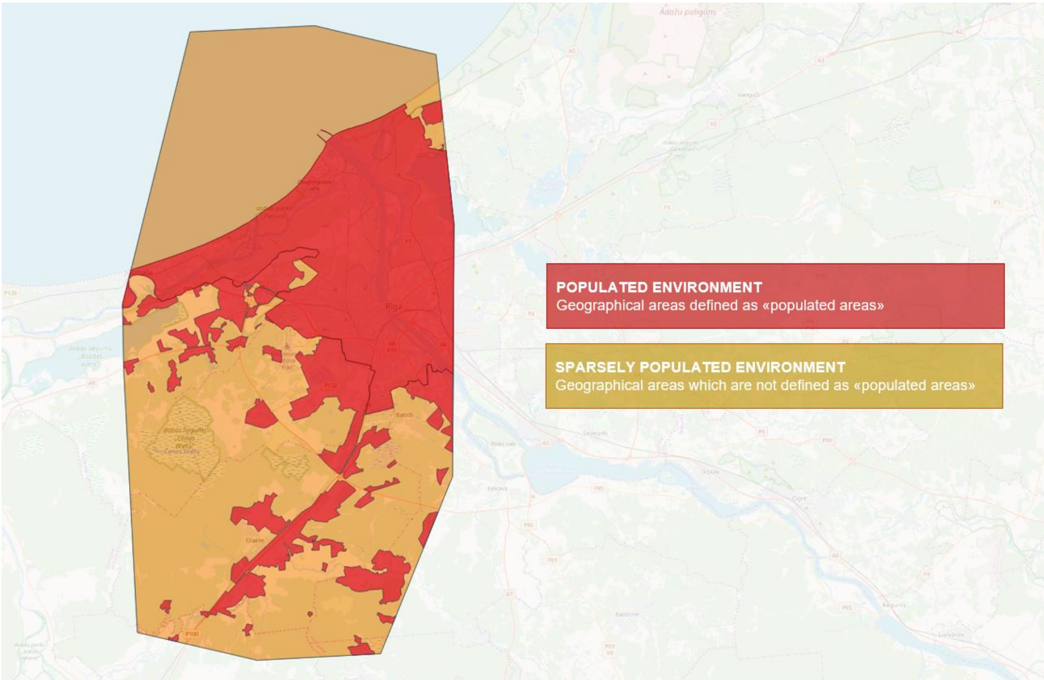

Figure 13 - Geographical data on populated and sparsely populated areas

5.4.2.5 Ground data

The following ground data were collected for further analysis:

- Digital terrain model;
- Significant transmitting antennas and Global Maritime Distress and Safety System (GMDSS) radars;
- “Black spots” (in progress).

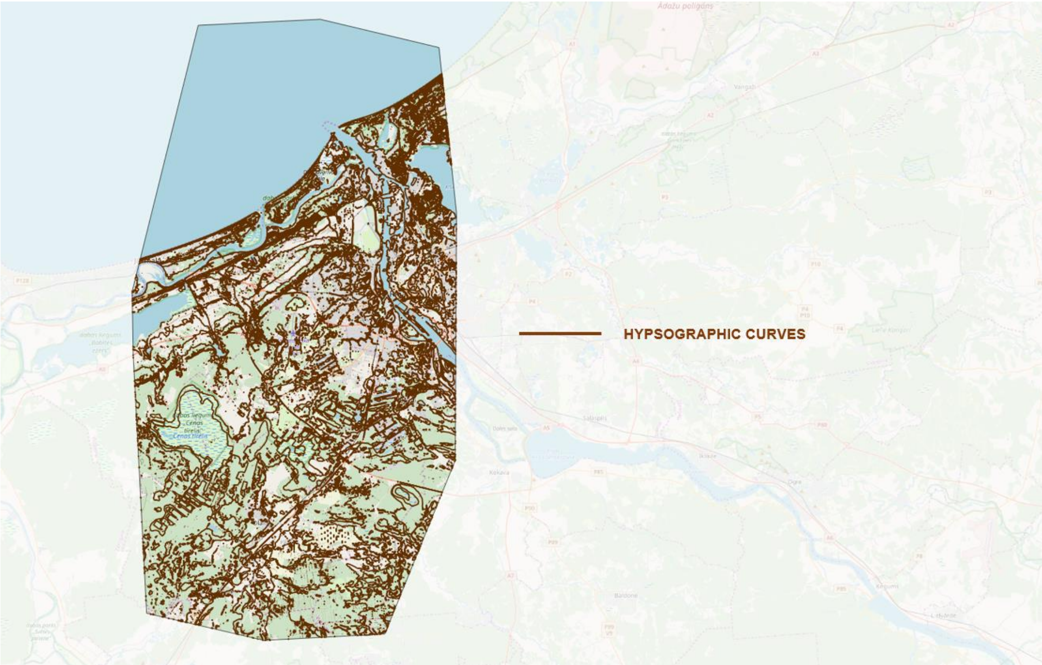

Figure 14 - Visualization of digital terrain models in the form of hypsographic curves

Digital terrain model with vertical precision of 5m was collected from JSC Latvia's State Forests region geospatial data layers.

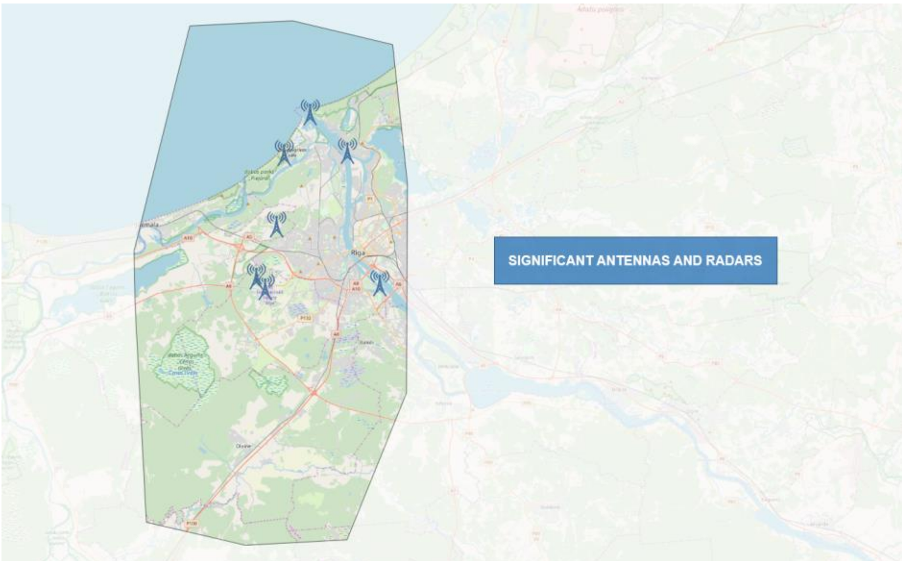

Figure 15 - Significant transmitting antennas and GMDSS radars

Information about significant transmitting antennas and Global Maritime Distress and Safety System (GMDSS) radars was obtained from Freeport of Riga and Latvian Naval.

5.4.3 SORA tool

At the moment it is not clear how ground infrastructure can impact unmanned aircraft operations (C2 link performance, compass accuracy). Some infrastructure, such as significant transmitting antennas, relay antennas and Global Maritime Distress and Safety System (GMDSS) radars, as well as large metallic structures like maritime vessels and power lines do create local disruptions to unmanned aircraft navigation functions and operational capability in close proximity, as described by Riga Freeport.

Since many threats on the ground are considered to be dynamic, fully comprehensive data cannot currently be obtained remotely. However, the requirement to assign ground risk classes for UAS operation has prompted the conclusion that this process needs to be digitalised and automated to make significant resource savings for UAS operators and authorities, at least for determining the intrinsic UAS Ground Risk Class (GRC).

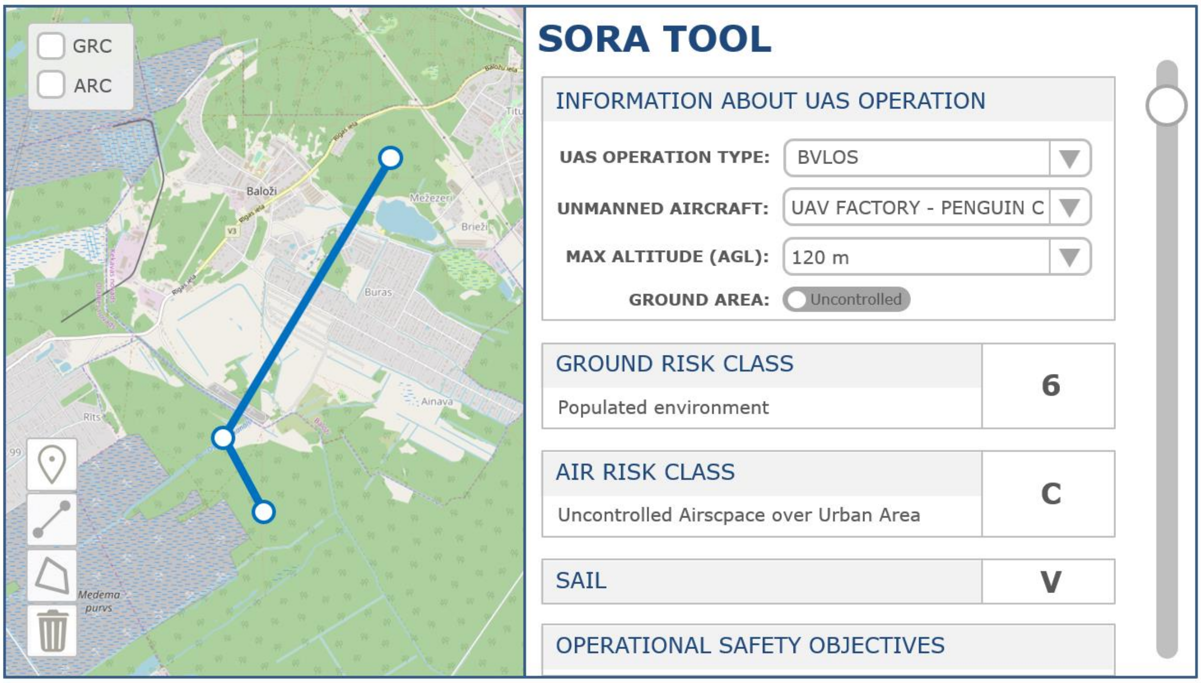

Figure 16 - Conceptual example for SORA Tool – UAS operation planning

One solution could be development of the SORA tool, which helps to determine the Specific Assurance and Integrity Level (SAIL) and appropriate Operational Safety Objectives (OSO). Figure 16 shows a conceptual example of how to determine initial GRC and ARC, excluding mitigations that could decrease the final SAIL. However further development of U-space services and additional input from UAS operators might be useful in supplementing this tool.

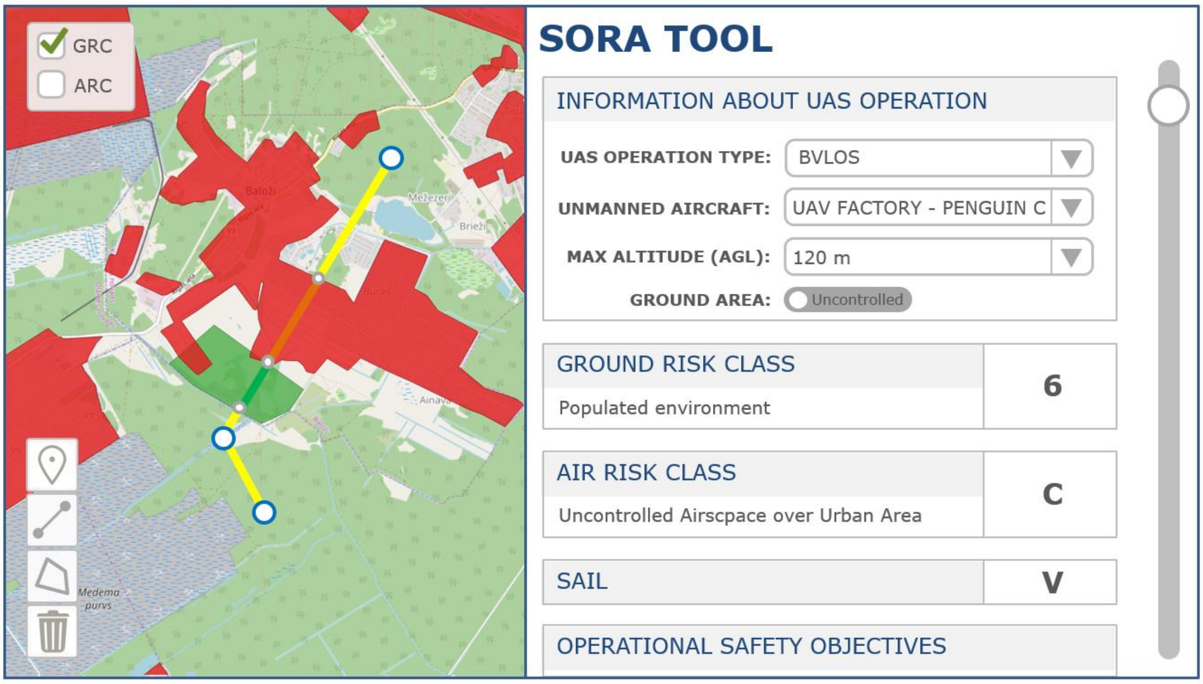

Figure 17 - Conceptual example for SORA Tool – geographical data on GRC

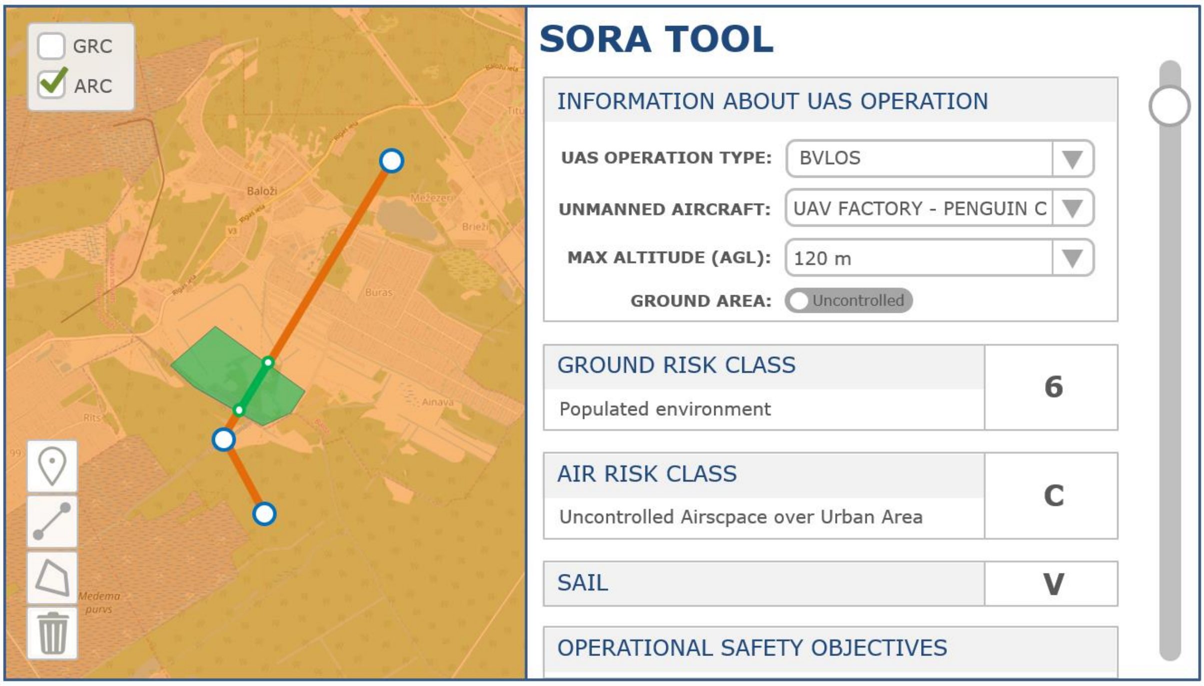

Figure 18 - Conceptual example for SORA Tool – geographical data on ARC

As SAIL directly depends on the operational scenario and airspace volume, which are both partially determined by geographical data, it is important to visualise this data, because slight corrections in flight trajectory might significantly change the required operational safety objectives.

The more risks are assessed qualitatively and quantitatively, the more information is required to be processed, therefore a need for automated data processing is crucial. In addition, qualitative and up-to-date risk assessment is one of the key factors for the implementation of more autonomy in UAS operations.

Grid determination

Analysing data grouped according to SORA shows that ground and air risk values can be assigned to specific defined grids. Initially the size of each grid was defined on the basis of the smallest scalable type of operation, which is VLOS operation.

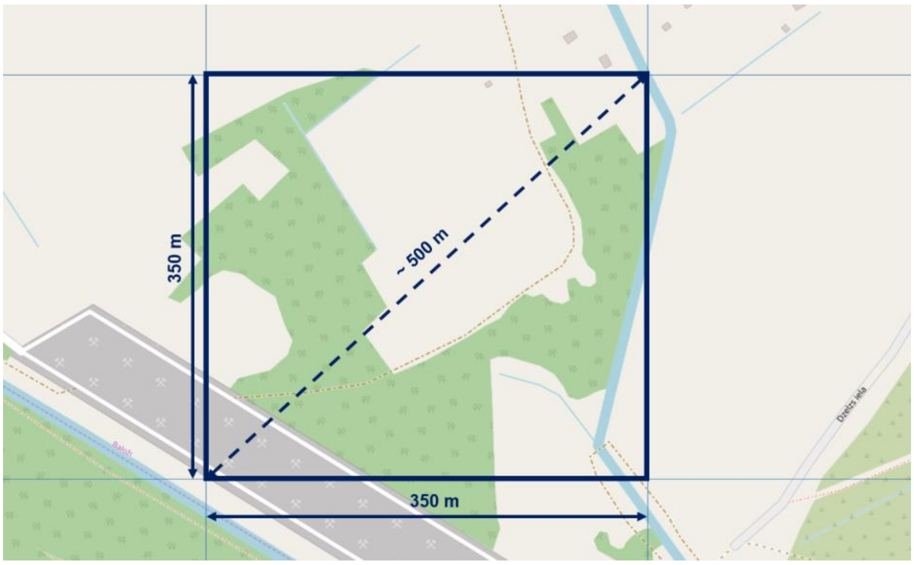

Figure 19 - Example of grid element size determination

In our national regulation, VLOS operations are limited to a distance of 500m between control station and unmanned aircraft, therefore the diagonal of the grid element was limited to this distance, resulting in grid dimensions of 350 meters x 350 meters.

Figure 20 - Example of dividing area into grids

More detailed analysis of actual cases showed that the use of grids is not always effective as their size is not necessarily suitable – especially when determining risks or regulatory requirements, in which case even small volumes of airspace play an important role (especially in populated environments).

Also, since the dynamic data might consist of small, short-term geographical areas with special conditions overlapping each other, this environmental data has to be as precise as possible (with certain conditions and limitations on the description of geographical data).

6 Findings

Certain initial assumptions were made about specific data being readily available for further analysis of the impact on UAS operations in specific locations. Unfortunately, this did not materialise since there has been no thorough analysis of the seamless integration of UAS into the existing urban environment. Operations over water have to be considered from the perspective of safe and secure shipping operations, especially in those areas where international civil and military water-faring vessels are present. In the case of Riga CTR and Spilve aerodrome airspace under the CTR, a considerable part of the airspace is located above popular recreational areas next to a river (or on the river) and over the Riga bay beach areas.

As a new entrant into airspace operations, UAS lacks standardized operational safety requirements with respect to other air traffic and infrastructure, with no set separation minima requirements. As a result, there is insufficient recorded data to draw conclusions and generalize about flight safety performance requirements for UAS in the case of operations at very low altitudes over populated and industrial areas.

Similarly, insufficient data is available to set operational UAS safety requirements for flight operations over large bodies of water with various vessels and over port infrastructure objects. As a general rule, objects like radars and known hazardous cargo loading and storage areas were considered as restricted airspace volumes for very low altitude UAS operations. Within the scope of Riga CTR, operations at Riga Freeport in river Daugava and Latvian Navy base operations were investigated with respect to mutual impact on UAS. Electromagnetic interference factors, privacy and security in UAS operations when in the vicinity of large civil or military ships should be investigated further to enable conclusions to be drawn about safe airspace volumes for UAS flight operations over ports and large bodies of water.

The analysis conducted for the purposes of the Riga CTR assessment for UAS and existing air traffic management (ATM) regulations indicated that the absence of a clear and harmonised legal framework for UAS with regard to the airspace at EU level does not currently allow fully ATM integrated UAS operations. The analysis in question highlighted the following:

- ATM is still not sufficiently regulated to mitigate all the risks attaching to UAS operations in controlled airspace;
- Integration of UAS in urban environments;
- Technological adaptation of UAS operations.
- Integration of UA performing state-designated functions like firefighting, search and rescue operations, etc.
- In order to apply SORA, it is important to ensure that the airspace user and the authorities use the same dynamic and static data. As the SORA methodology requires a large amount of comprehensive data analysis, automation is necessary.
- Existing or new rules need to be updated/supplemented for VLOS and BVLOS based on IFR and VFR;
- Low-level/high-level general flight rules must be developed/supplemented for the open, specific, and certified categories of UAS (as defined in EU Reg. 2019/947);

- A harmonised format is needed for the publication of aeronautical data and for the accuracy and clarification of these data;
- There are no requirements or technical specifications for any fleet management software for UAS operations (e.g. restricted areas, UAS geographical zones);
- Airspace volumes need to be classified for UAS;
- Existing or new rules need to be updated/supplemented for flights over the high seas;
- Existing or new EU and national rules need to be updated/supplemented concerning controlled UAS operations in, and close to, aerodromes;
- Communication between UAS operators, ATC, and manned aviation needs to be improved.

7 Overview of the assessment conducted

7.1 Critical review of the reference scenario

A critical overview of the reference scenario, which is a qualitative exercise, involves operational experts coming together and critically reviewing the results. Mitigation enablers are required if operational problem areas are identified.

7.2 The challenges identified

This project has not looked at the prevailing seasonal and diurnal meteorological conditions. Isolated local weather phenomena (high intensity whirling winds, low altitude fog, wind gusts, etc.) do arise in the Riga CTR due to its location next to Riga bay on the Baltic sea. It would be advisable to identify minimum weather conditions that would be safe for operations by each category of UAS.

Discussions have been initiated with municipalities and Riga Forest Ltd to identify parks and forests of cultural significance in order to obtain a better understanding of their cross-impacts with UAS operations and any ground risks, as well as the seasonality of such considerations.

Specific restricted UAS geographical zones over Riga Freeport need to be designed for the Riga CTR assessment, and potentially sensitive infrastructure areas have to be discussed with the Latvian navy.

Defining clear criteria for ground risk categories and the qualitative representation of data are two of the most demanding challenges. For example, “populated areas” are defined in existing Latvian national regulations. However, these include fields, swamps and forests, which should not be considered as populated.

If we are to obtain a clearer picture of daily flight trajectories at different altitudes, identify certain military open-air training areas and learn about their potential cross-impacts, while considering other non-aviation infrastructure objects and activities and drone operations, it is clear that an ANSP safety assessment of UAS operations is just one of the many methods we need to deploy when assessing limitations and basic operation scenarios with a view to integrating a new airspace user in seamless manner. The dialogue that has been initiated as part of the Riga CTR assessment is just the beginning of communication with new stakeholders, who will play a significant role in addressing flight safety in this airspace.

8 CONCLUSIONS AND RECOMMENDATIONS

In order to ensure that readily available and correct UAS flight safety information is available for all airspace users in the long term, a permanent process or a series of mechanisms would have to be developed and implemented to ensure that the airspace volume data (geographical zones in the future) is relevant and correct for the airspace users. As a first step, in the Riga CTR study the CAA of Latvia took a snapshot (a small sample) of existing or potential UAS hazards and associated risks. This database should be maintained and regularly reviewed with the same rigour as other air navigation information essential to flight safety.

The airspace volumes identified should serve as a basis for the future definition of geographical zones where UAS operations could be safely performed for leisure or commercial purposes or where UAS operations should be restricted in time or in space. For the Riga CTR study, the classification of airspace volumes was limited to the identification and description of high-risk area locations, not the whole high-risk impact area surrounding the object on the ground.

Considering that there are no standardized UAS operational flight safety testing requirements for flight operations in various environments, the airspace volumes off limits to drones operations as provided for in Cabinet of Ministers Regulation No. 368 were determined on the basis of best judgement, educated guess and our overall limited experience with acceptably safe UAS operations.

For this reason, more structured and systematic testing and analysis of the mutual influence of UAS and ground-based infrastructure would be highly desirable if we are to make informed decisions about effective and safe airspace use for UAS at altitudes from the ground up to 100 m.

For the purposes of obtaining more information about the location of “black spots”, feedback from a wide variety of UAS operators would be very desirable in order to identify potentially unsafe areas for UAS operations in a more targeted manner and to investigate each “black spot” more closely.

The analysis conducted for the purposes of the Riga CTR assessment highlighted that:

- UA should be regulated to achieve the same level of safety as manned aircraft;
- UAS regulation must involve all the major groupings, e.g. UA pilots for safety and competence, UAS manufacturers for ATM innovation and flight safety, public interests for safety, security, privacy and environmental protection;
- For safe UAS management in controlled airspace, consideration must be given to UA commercial value, UA usage goals and the current international and national regulatory framework;
- UAS airspace categorisation should be reviewed and defined with specific operational criteria (integration of UAS – low airspace limits);
- Information on airspace must be UA pilot-interpretable and user-friendly;

- UAS must be separated safely from each other and from manned aircraft;
- Information on industrial accident risk objects must be included in the overall identification of airspace for safe UA operations.

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A.1 Current examples of airspace zoning

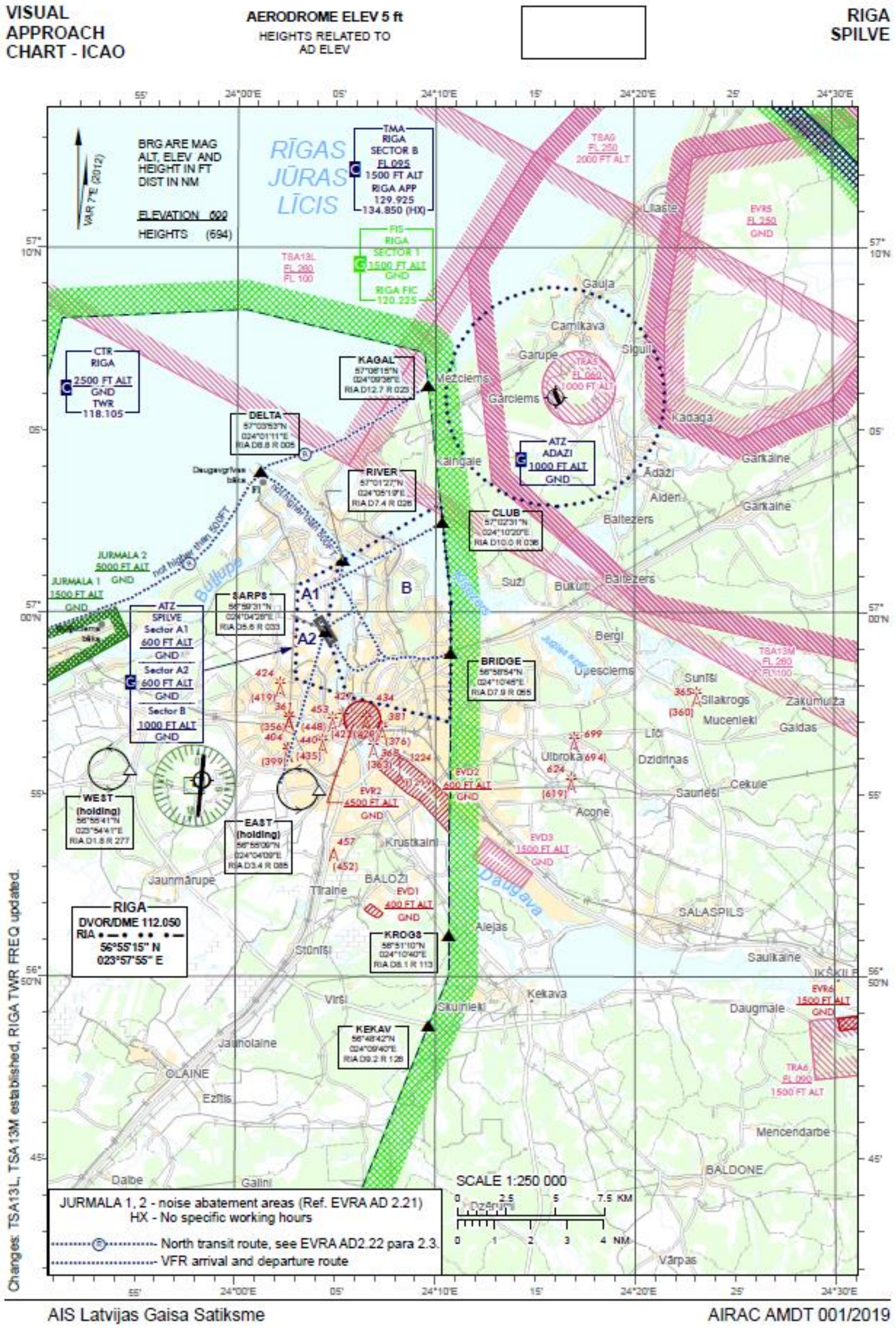

Figure 21 - Visual Approach Chart

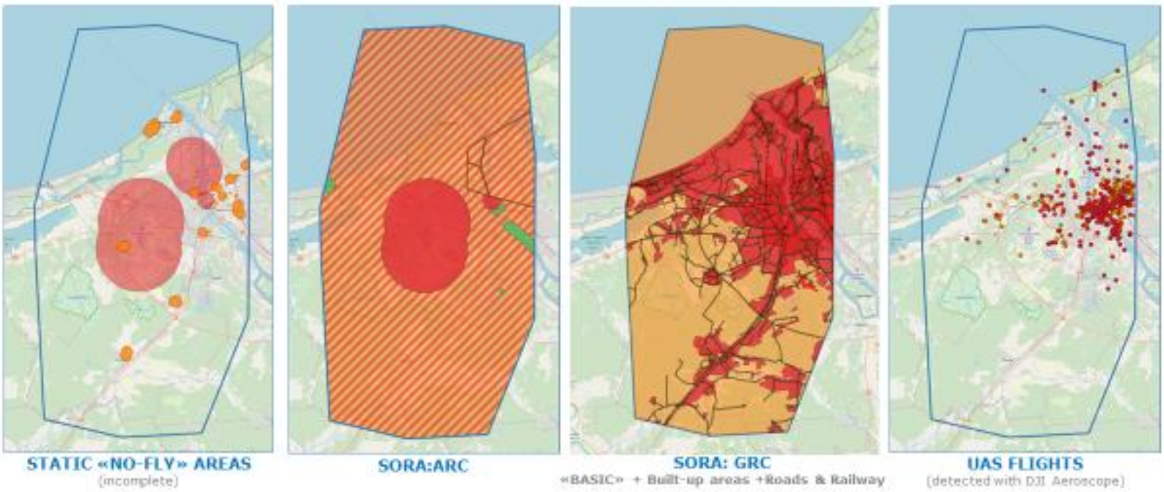

Figure 22 - ARC & GRC Map

A.2 Layered CTR Map

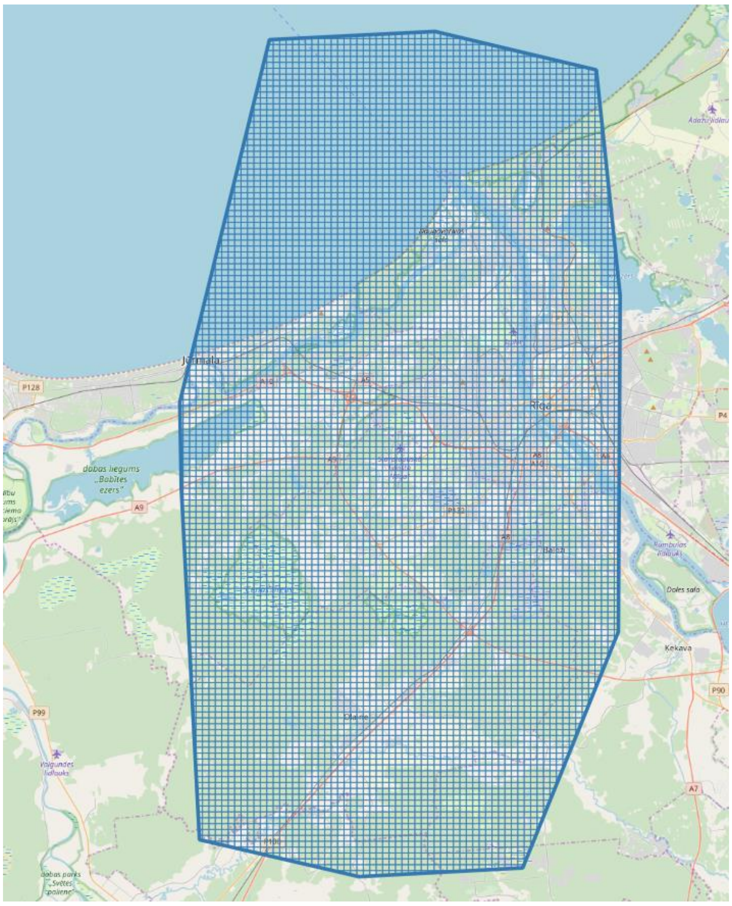

Figure 23 - Grid/Chart of CTR

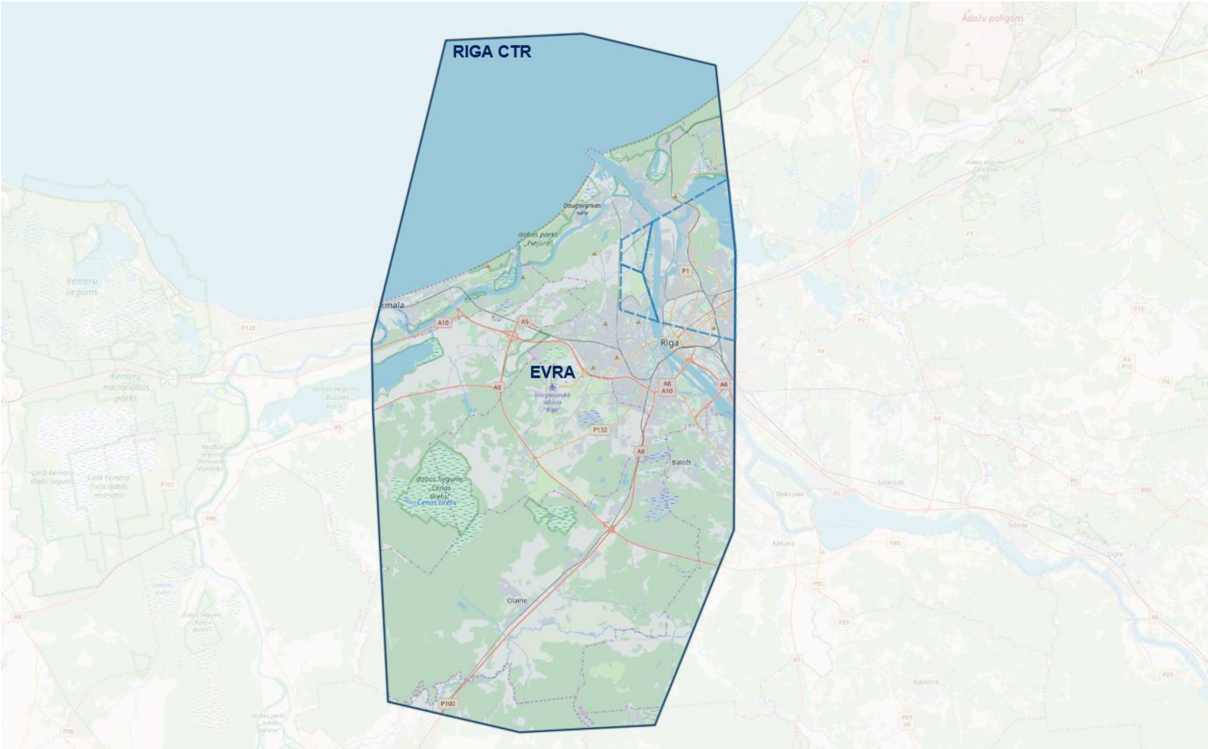

Figure 24 - Riga CTR

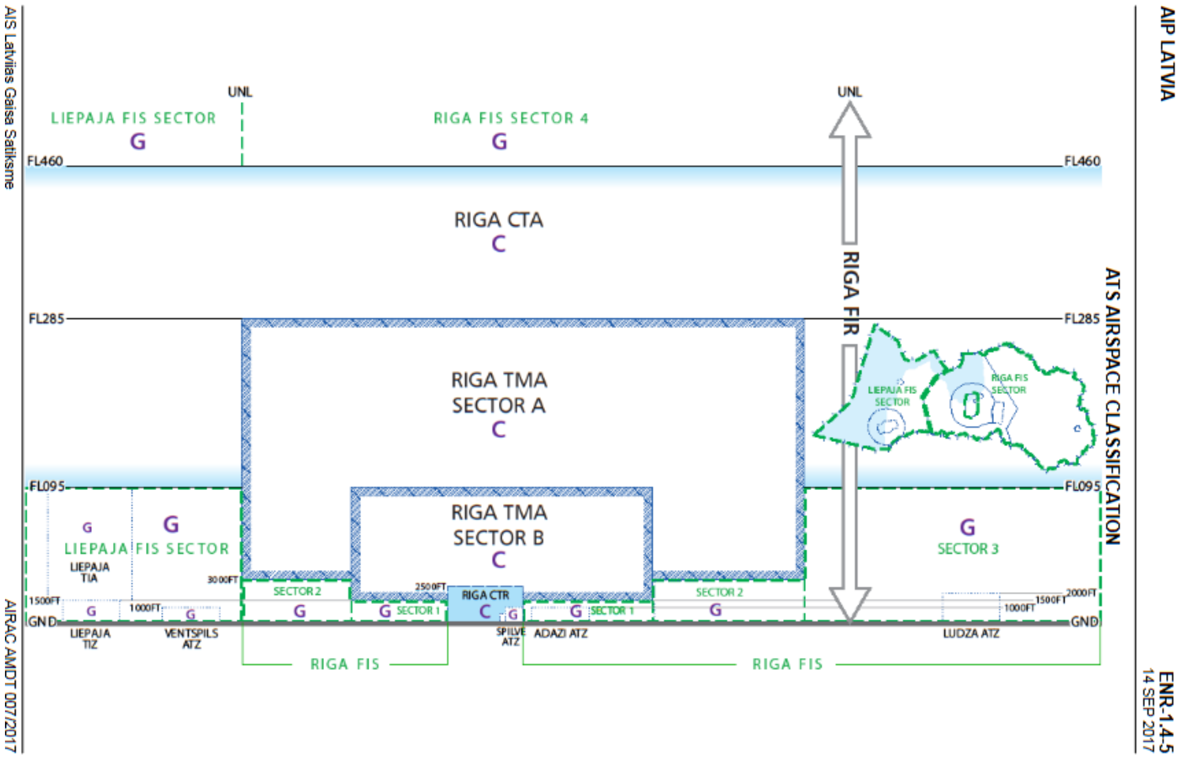

Figure 25 - Riga Flight Information Region

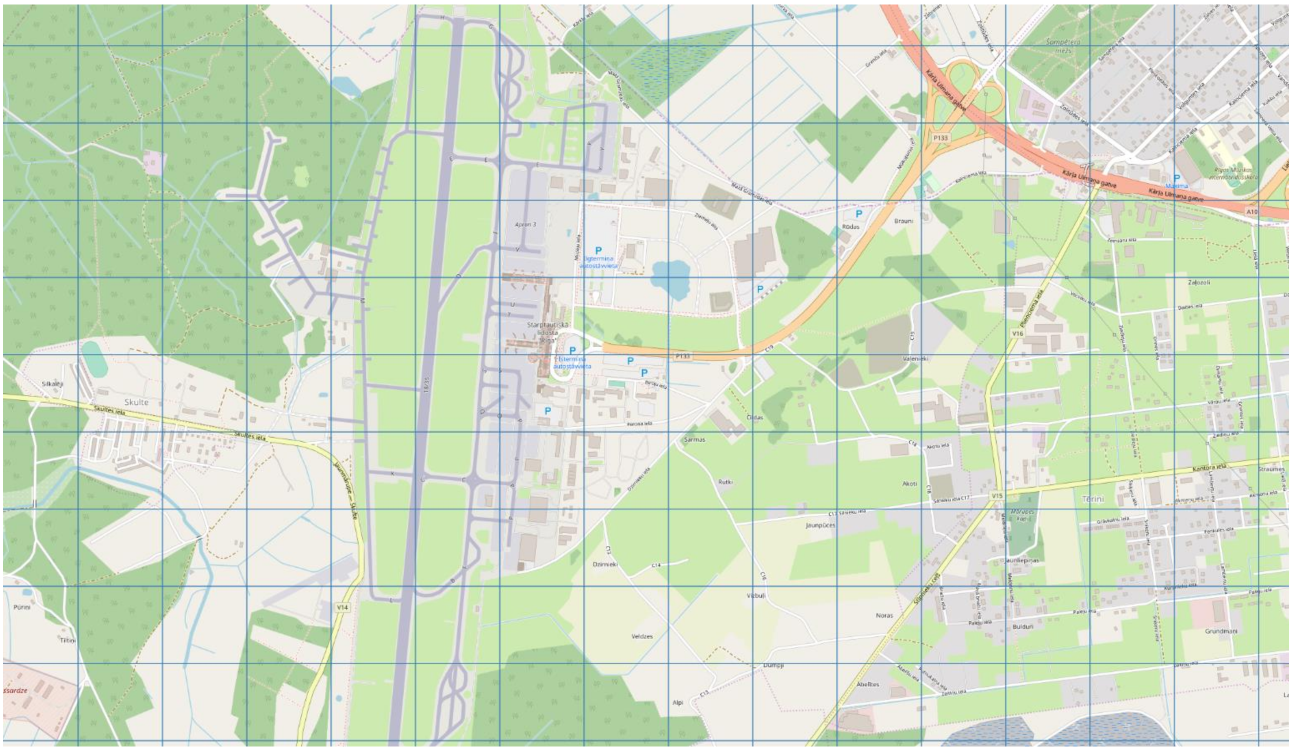

Figure 26 - Runway Chart