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ASSESSMENT OF EMERGENCY LANDING OPTIONS: CASE STUDY OF RIGA FLIGHT INFORMATION REGION

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Abstract. The aim of this research, titled "Assessment of Emergency Landing Options: Case Study of Riga Flight Information Region" is to explore and analyze the feasibility of emergency landings within the Riga FIR and evaluate the necessity of an additional runway. The theoretical section of the study covers various types of aviation accidents and emergency landing procedures. The empirical part includes a thorough analysis of meteorological aerodrome reports (METAR) to assess whether weather conditions are conducive to safe landings at Lielvarde military airfield. Based on the findings, conclusions are drawn regarding the need for an additional runway. The study also examines other potential airfields, not listed in the Republic of Latvia's Aeronautical Information Publications, which could serve as emergency landing sites. To enhance pilots' situational awareness, digital maps have been developed to display these alternative airfields.

Keywords: emergency landing, aeronautical information, cloud base, registered airfields, non-registered airfields, air navigation service.

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1. Introduction

During the flight an aircraft passes various phases of flight–taxiing while in the maneuvering area of the airport, take-off, gaining altitude, followed by cruise flight at the most suitable altitude at the most suitable speed, followed by descent on approach to the destination, landing and taxiing to a gate (International Civil Aviation Organization [ICAO], 2007). From 2007 to 2021, the US company Boeing compiled statistics on aircraft threats, fatal aviation accidents or serious incidents, depending on the flight phase (Boeing, 2024).

Statistics indicate that the most dangerous phase of a flight is the approach and landing. The landing process, using the instrument landing system (ILS), begins at the initial approach fix (IAF), followed by the final approach fix (FAF), and continues with the approach along the glideslope. According to Boeing (2024), 16% of all fatal accidents occur between the IAF and FAF, while 46% take place as the aircraft approaches the runway along its centerline extension during landing. These statistics reflect the phase during which the accident occurred but do not specify whether the failure leading to the incident took place before or during that phase of flight (Thomas, 2018).

The above statistics show, how important it is for a pilot to know how suitable the conditions at the destination are for landing. Before approaching an airport, pilots have access to a wide range of aeronautical information, including runway condition, radio beacon performance, landing system performance and type, as well as extensive meteorological information, including wind speed and direction, hazardous weather, atmospheric pressure and dew point, and more (LR Ministru kabinets, 2011). During the flight, it is possible to obtain additional information from air traffic controllers or flight information service providers about existing restrictions or other activities at the destination. After gathering all relevant information, the pilot must make a decision, whether landing at the destination is possible or it is necessary to go to an alternate airport (ICAO, 2024).

In critical situations, when a failure is detected while being airborne and it seriously affects the safety of the flight and limits its ability to land, the pilot's actions are essential, because time is the most critical component, which requires immediate decision and action (ICAO, 2022). The situation becomes even more complicated if the aircraft in distress is not able to fly to a suitable airfield or if the weather conditions at the planned airfield are not suitable for a safe landing. In emergency situations, aircraft will land not only in weather conditions, which are worse than the defined minima, but also will land in places, which are outside the airfield – on highways, in meadows, even on water, trying to avoid densely populated areas (ICAO, 2024).

According to the aeronautical information publications of the Republic of Latvia, there are nine officially registered airfields in the Riga Flight Information Region – Adazi EVAD, Cesis EVCA, Lielvarde military airfield EVGA, Liepaja EVLA, Limbazi EVLI, Ikskile EVPA, Riga EVRA, Spilve EVRS and Ventspils EVVA-, and three helipads – Nakotne EVHN, Ludza EVLU and Lielvarde M Sola (Aeronautical Information Publication of Republic of Latvia, 2024). Are these options sufficient for pilots to make the safest possible emergency landing on a runway rather than on other surfaces? It is known that there are many airfields in the territory of Latvia, which were actively used in the past, but are currently not used due to various circumstances. Knowing these airfields would give pilots opportunity in emergency situations, while being too far from officially registered airfields, to choose the most appropriate place for the emergency landing from a much longer list.

The purpose of the study is to investigate and analyze emergency landing possibilities in the Riga Flight Information Region (hereinafter referred to as FIR) and to evaluate the need for an additional runway.

Research tasks:

- Define the concepts of emergency situations, provide a classification of aviation occurrences related to safety;
- Investigate landing possibilities in the Riga Flight Information Region (airfields and heliports included in the Flight Information Publications of the Republic of Latvia (AIP);
- Explore landing options not included in the AIP. Create easy-to-use visual material for emergency landing site selection;
- Investigate the need for an additional runway in Riga FIR (runway direction, length, width, etc.).

2. Methodology and theoretical framework

The classification of aviation occurrences include information about the type and nature of the occurrence, as well as their causes and possible outcomes. During flight, aircraft are in a dynamic environment which depends on many factors, such as:

- Weather, especially CB clouds, which may include heavy downwashes, unstable air masses, severe turbulence;
- Low and dense clouds that severely limit visibility when approaching the runway;
- Fog, sleet, freezing rain, and other weather phenomena;
- Changes to the flight plan as a result of geopolitical situations;
- As a result of sabotage, terrorist attacks and other similar activities;
- Due to technical reasons of the aircraft that occurred during the flight;
- Due to the airline's request (Lavalley, 2020).

Under normal circumstances, the flight is conducted in accordance with a flight plan submitted at least one hour before departure. A flight plan is an official document that follows an internationally defined ICAO (International Civil Aviation Organization) format, which is detailed in ICAO PANS-ATM Doc4444 (ICAO, 2007).

2.1. Classification of aviation non-standard situation

Non-standard situations have uniform characteristics, thus it is possible to determine to which of the classes the non-standard situation belongs. The main factors by which situations are characterized are:

- Degree of danger to the safety of the aircraft;
- Injured people, passengers;
- Serious structural damage to aircraft;
- Whether the aircraft during landing or in connection with a non-standard situation has threatened or damaged other infrastructure, including other aircraft;
- Fatal outcomes (ICAO, 2016).

There are three situations when aviation occurrence is classified as aviation accidents:

a) A person is fatally or seriously injured

The reasons are, first of all, a person is in the aircraft. Second, it comes into contact with one of the components of the aircraft, where it can also be separated. Third, comes under the jet blast. The main finding is that injuries obtained by passengers or crew are observed.

b) The aircraft has structural damage

This section covers damage that affects the structural strength, performance, or flight characteristics of the aircraft and requires repair. It also includes damage affecting propellers, wings, antennas, tires, brakes and holes in the airframe. This section indicates the actions to be taken in a situation where the aircraft has a certain problem with its operation or body and technical personnel determines, what measures to take to prevent and repair the respective issue.

c) The aircraft is lost or completely inaccessible (ICAO, 2016).

Incidents and serious incidents are two distinct events that are clearly explained in international regulatory documents such as ICAO. They also consider situations in which an accident almost happened, but in the end, did not cause serious consequences (ICAO, 2013). In contrast, serious incidents involve situations, in which the aircraft was at high risk, but it did not lead to the accident. The main conclusion is that these occurrences are different, but they have common characteristics, which can be assessed and reported to prevent high risk to flight safety in the future (Mickeviciute, 2023).

Forced landing is a situation where an aircraft must make an immediate landing. Mostly, this type of landing is related to, for example, one engine failure, fire, smoke in the aircraft, etc. There are also situations where a forced landing is not defined as an emergency – when a military interception is carried out (Joint Chiefs of Staff, 1993). In this situation, it is important to find the most suitable airport. Safety landing is a situation in which it is not recommended to continue the flight, and it is required upon request. These types of incidents can be related to difficulties that are not as dangerous as accidents, but attention shall be paid to prevent them from developing further, so it does not turn into a situation where a "MAYDAY" shall be activated. For small aircraft, these factors can be, for example, bad weather, problems with navigation, etc. The difference with a forced landing is that in this situation the aircrew can continue the flight to find the most suitable place to land, while the opposite is the situation when actions must be taken immediately (Tikkanen, 2019). Depending on the situation, different security and safety procedures may be activated after the search and rescue services reactions. The most important thing is that no emergency is activated if a safe landing is made, and this is the aim of aviation (ICAO, 2016).

MAYDAY is explained as the most dangerous situation for aircraft. It is also definitely life-threatening and is classified as a general emergency. It is activated in situations where the aircraft, the crew or a passenger is in a situation that requires a quick response and threatens safety and life. According to ICAO Doc4444 (ICAO, 2007), an aircraft is in an emergency if one of the following occurs:

- The pilot of the aircraft has declared the emergency word MAYDAY three times on the relevant air traffic control frequency of the air traffic control unit or sector:
- The pilot of the aircraft has set the secondary surveillance radar code 7700 in the transponder, which corresponds to a general emergency condition;
- The air traffic control officer has received a message from a nearby air traffic control center that the specific aircraft is in an emergency situation.

Knowing that the aircraft is in an emergency, the next step is to determine the nature of the emergency and act accordingly (ICAO, 2024).

2.2. Classification of aviation non-standard situation

The work involved data analysis of METAR reports from 2020 to 2022. This data is essential in aviation, as it provides information about current weather conditions at the airport and its surroundings (ICAO, 2016).

The parameters such as wind direction, wind speed, cloud height, air temperature, dew point and barometric pressure are important factors which can affect flight planning and flight control (ICAO, 2010). For example, knowing wind direction and speed helps to estimate accurate flight paths and time periods, in which aircraft will reach certain points, as well as estimate potential changes in flight commence (Annex 11, 2018b). Cloud height is important for visibility and flight safety, as low clouds contribute to worse flight conditions. Air temperature and dew point are important factors affecting air density and visibility. Barometric pressure is used to correct altimeter readings and provide accurate altitude measurements (ICAO, 2018).

This analysis will provide insight into the weather conditions in and around the airport Lielvarde in chosen time period. At the beginning, a list of the abbreviations is included to understand the meaning of the codes, which are summarized in Table 1. In general, METAR message is

Table 1. Description of METAR report content (source: ICAO, Annex 14, Chapter 2, 2018a)

Field	Description	Example
Type of Report	METAR: hourly (scheduled) report; SPECI: special (unscheduled) report.	METAR
Station Identifier	Four alphabetic characters; ICAO location identifier.	KABC
Date/Time	All dates and times in UTC using a 24-hour clock; two-digit date and four-digit time; always appended with Z.	121755Z
Report Modifier	Fully automated report, no human intervention; removed when observer signed-on.	AUTO
Wind	Direction in tens of degrees from true north (first three digits); next two digits: speed in whole knots; as needed Gusts (character) followed by maximum observed speed; always appended with KT to indicate knots; 00000KT for calm; if direction varies by 60° or more a Variable wind direction group is reported.	21016G24KT 180V240
Visibility	Prevailing visibility in statute miles and fractions (space between whole miles and fractions); always appended with SM to indicate statute miles; values <1/4 reported as M1/4.	1SM
Runway Visual Range	10-minute RVR value in hundreds of feet; reported if prevailing visibility is £ one mile or RVR 6000 feet; always appended with FT to indicate feet; value prefixed with M or P to indicate value is lower or higher than the reportable RVR value.	R11/ P6000FT
Weather Phenomena	RA: liquid precipitation that does not freeze; SN: frozen precipitation other than hail; UP: precipitation of unknown type; intensity prefixed to precipitation: light (–), moderate (no sign), heavy (+); FG: fog; FZFG: freezing fog (temperature below 0 °C); BR: mist; HZ: haze; SQ: squall; maximum of three groups reported; augmented by observer: FC (funnel cloud/tornado/waterspout); TS (thunderstorm); GR (hail); GS (small hail; <1/4 inch); FZRA (intensity; freezing rain); VA (volcanic ash).	-RA BR
Sky Condition	Cloud amount and height: CLR (no clouds detected below 12000 feet); FEW (few); SCT (scattered); BKN (broken); OVC (overcast); followed by 3-digit height in hundreds of feet; or vertical visibility (VV) followed by height for indefinite ceiling.	BKN015 OVC025
Temperature/ Dew Point	Each is reported in whole degrees Celsius using two digits; values are separated by a solidus; sub-zero values are prefixed with an M (minus).	06/04
Altimeter	Altimeter always prefixed with an A indicating inches of mercury; reported using four digits: tens, units, tenths, and hundredths.	A2990

coded and includes words and combinations of letters that are used to describe weather. In these images, you can see the abbreviations that are used to create a METAR report. It is important to understand the coding of this report, because weather reports from Lielvarde airfield were maintained during the data analysis (ICAO, 2010).

2.3. METAR data analysis of Lielvarde airport

In the following part, an analysis of METAR reports has been carried out to determine whether meteorological conditions impose a threat to aircraft landing possibilities at the Lielvarde military airfield. The analysis uses data from METAR reports for the period from January 1, 2020, to December 31, 2022, which were obtained from SJSC "Latvijas Gaisa satiksme" at the request of Latvian National Defense Academy. Since a three-year period has been examined, the obtained results reveal tendencies of the situation at the examined airfield.

The data measures for the production of the METAR report are taken several times a day, so the total amount of data analyzed was more than 50,000 record units. The available METAR data were arranged in columns in order to highlight those records that potentially affect the ability of aircraft to land at Lielvarde airfield. The following were highlighted separately:

- Wind speed and wind direction;
- Cloud amount and lower limit. Because the greatest impact on flight safety is caused by OVC clouds, which according to the classification cover practically the entire sky – 8 octas (SCT corresponds to 3–4 octas, and BKN – 5–7 octas). In a METAR report, the cloud ceiling, or lower limit, is expressed in feet (ICAO, 2010);
- Air temperature and dew point, which can be used to determine the amount of water in the atmosphere, which can cause various types of meteorological phenomena that can pose a threat to flights, such as freezing rain, fog, haze, etc. (ICAO, 2010);
- QNH value, or atmospheric pressure above sea level, which is the pressure set in the altimeter to determine the vertical position of the aircraft in space, according to the barometric height, or altitude ALT (ICAO, 2010).

The obtained data, after being divided into columns, were organized by years and by months in each year, in order to see the trends of the indicators in different seasons. Mode and min values were calculated for each month. The mode is defined as the value that occurs most frequently in the given list. This value gives an idea of the conditions that are most common at Lielvarde airfield. Also, the minimum values of the values are determined, or in the case of temperature, the minimum air temperature in the winter period, which is the maximum minus temperature, and in the case of positive temperatures, the maximum temperature above zero. It should be mentioned that high temperatures are more dangerous for aircraft, because in that case the air density at low altitudes is lower and aircraft need a longer approach path and gain altitude more slowly compared to conditions at lower air temperatures (European Union Aviation Safety Agency, 2024).

The Excel software enables extensive mathematical analysis of the data, so the Excel program, MODE(x) and MIN(x) functions were also used to process this data. For a reasonable representation of the data, the corresponding columns were collected in graphs, which are also included in the work.

3. Results of the research

3.1. METAR data analysis results

Results obtained are shown in Table 2 as an example. Wind direction shows the prevailing winds that were most common during the time period under review. Prevailing winds make it possible to determine which runway was used – RWY18 or RWY36. Considering that aircraft land and take off against the wind, in cases where the prevailing winds have been close to 360 degrees (the prevailing winds determine the direction from which the wind has blown) RWY36 was used, but if the prevailing winds have been 180 degrees or 200 degrees means the runway used was RWY18 (Aviation Intelligence Unit Portal, 2024).

Table 2. Example of a METAR data collection, year 2020 (source: Author's developed table)

	Wind direction, deg	Wind speed, kts	OVC cloud base, ft	Air temp, deg	Dew point, deg	QNH
January	200	7	500	–2	1	1011
February	200	9	400	–1	–1	1004
March	200	5	1400	–4	–3	1019
April	310	5	500	6	1	1004
May	330	7	4800	9	5	1012
June	100	5	400	16	16	1014
July	200	3	800	15	12	1009
August	360	4	400	16	15	1009
September	200	5	500	16	11	1017
Oktober	170	6	500	9	7	1016
November	200	6	400	3	1	1022
December	120	11	500	1	1	1025

Statistical data show that the prevailing winds in the territory of Latvia in the summer months have had a mode value of 100–110 degrees, which in the case of RWY18/36 runways is a strong crosswind, for example:

- In June 2020, the mode of the prevailing winds was 100 degrees, and the wind speed was 5 knots, which is a relatively small value;
- In December 2020, the mode of the prevailing winds was 120 degrees and the wind speed was 11 knots, which is also a relatively small value in aviation.

In other cases, crosswind strength has been even lower. From the examples mentioned above, it follows that, although there have been months when the prevailing winds have been crosswinds, their strength has not been sufficient to create difficulties and limit the possibility of landing at Lielvarde airfield.

For a clearer picture of the obtained results, the values are shown in charts, where the data of each year in the time period under review is represented by a curve.

Wind direction at Lielvarde airport from 2020 to 2022, breakdown by month. The mod values that are the most common values are shown in Figure 1.

Year 2020:

- Average wind speed in degrees: 182.5°
- Minimum wind speed in degrees: 100° (June)
- Maximum wind speed in degrees: 360° (August)

Year 2021:

- Average wind speed in degrees: 183.75°
- Minimum wind speed in degrees: 100° (July)
- Maximum wind speed in degrees: 330° (September)

Year 2022:

- Average wind speed in degrees: 204.17°
- Minimum wind speed in degrees: 100° (August)
- Maximum wind speed in degrees: 360° (March)

Analyzing these data, it can be observed that the fluctuation of the wind direction is noticeable in all years, but the indicators remained on average from 180° to 200°, which indicates the prevailing wind direction. In aviation, in the process of creating an airport and runway, one of the main things that is taken into account from the beginning of planning is the effect of weather on the existing environment and the infrastructure of the potential airfield. The results show that the average indicators at Lielvarde airfield match the direction of the runway and do not impose additional; threat. There were no records when it was impossible to land due to extremely strong crosswinds. Wind magnitude modes and minimum values are shown in Figure 2.

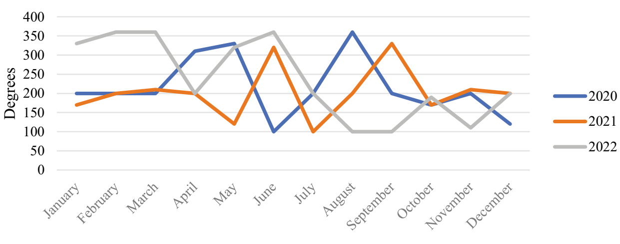

Figure 1. Mode values of wind direction, degrees (source: Author's developed figure)

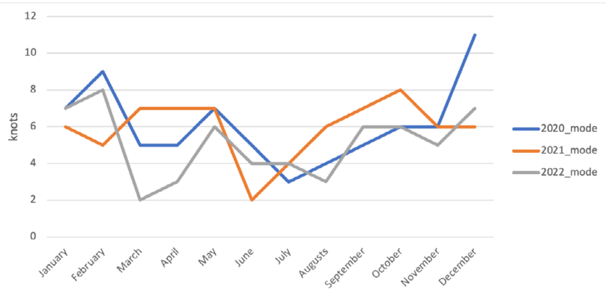

Figure 2. Wind speed – min and mode values at Lielvarde airfield from 2020 until 2022 (source: Author's developed figure)

Another important factor is the height and extent of the cloud base. In aviation, the amount of clouds is expressed in octas. OVC means that virtually the entire sky is covered by clouds. And if this factor also coincides with the height of low clouds, then it can mean to the pilot that when approaching the runway, it will not be possible to see it due to clouds. OVC cloud mode and minimum values for Lielvarde military airfield are summarized in Figure 3.

Although the height and amount of clouds are not related to the hypothesis that tests the need for an additional runway, this indicator shows how often the cloud base causes difficulties to land of makes it impossible to land at the airport.

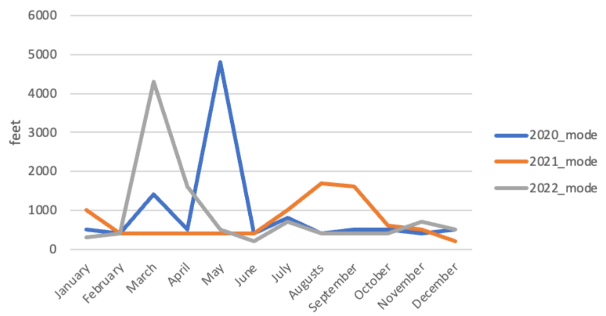

Figure 3. OVC cloud base- mode values at Lielvarde airfield from 2020 until 2022 (source: Author's developed figure)

Year 2020:

- Average OVC cloud height: 1,353 feet
- Minimum OVC cloud height: 400 feet (August)
- Maximum OVC Cloud Height: 4,800 feet (May)

Year 2021:

- Average OVC cloud height: 929 feet
- Minimum OVC cloud height: 200 feet (December)
- Maximum OVC Cloud Height: 1,700 feet (August)

Year 2022:

- Average OVC cloud height: 1,201 feet
- Minimum OVC cloud height: 200 feet (April)
- Maximum OVC Cloud Height: 4,300 feet (March)

The results of this data show that cloud cover lower than 500 feet is often observed at Lielvarde airfield. This proves that this runway cannot be operated in such weather as the relevant ILS CAT 1 does not allow landing in such low vertical visibility. Based on these data, the work proposes to consider raising this type of category to a higher one, for example, taking Riga Airport, where it is ILS CAT 2. ILS CAT 2 gives the opportunity to land at a lower decision-making height and at lower visibility on the runway. The decision height DH (Decision Height) is the height at which, using the ILS, the pilot makes a decision – either to continue the approach and land on the selected runway, or go to the second circle, taking the height again. Runway visibility or RVR (Runway visual range) is the distance at which objects can be seen on the runway. The lower the permissible values of DH and RVR, the safer and more accurate the ILS category should be (ICAO, 2015).

3.2. Creation of maps of registered and non-registered airports

In the further process of developing the work, a research has been conducted on unregistered airfields, or places that are not registered in the Aeronautical Information publication. Two maps were created separately. Unregistered airfields/runways were searched separately on one map. On the second map, the airfields that are official and operational even now were highlighted. This study was conducted on the basis that pilots do not officially have access to all airfields/runways where they could make an emergency landing in the event of an emergency. Restoration of runway condition. The maps were created using a site available on the Internet, where the map is available and, as an option, the locations of objects are displayed on it, as shown in Figure 4 and 5.

Map development process:

- Airports and runways were examined based on the information available on Internet resources and the satellite map.
- A map of the territory of Latvia was prepared on which to carry out further activities.
- Geographic coordinates were recorded for each runway on the map plan, which can be seen in Figure 4.
- During the creation process, the author of the paper checked each airfield with the pictures available from the satellite, and the known airfields were seen in person.
- Airports were numbered.

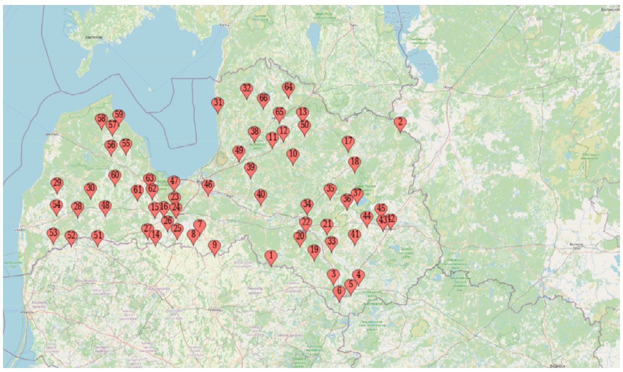

Figure 4. Map of non-registered airfields in Riga FIR (source: Author's developed figure)

Figure 5. Map of registered airfields in AIP in Riga (source: Author's developed figure)

- In the process of developing the further work, a name was written down for them.
- As a result, when opening this available map, any user will see where it is located and what its name is by clicking on one of the points.

This map (Figure 4) contains places that are not available on the official AIP platform. A total of 66 places were collected throughout the territory of Latvia, where it would be possible to make a decision to land in an emergency situation. Items that include information about its location and name were postponed. Next, there is an opportunity to develop it as a mobile application that would facilitate the actions of the pilot in an emergency situation. During research and data collection, the author of the paper came up with a recommendation for resurfacing runways of this type in the future. The development of the recommendation could serve as a significant safety improvement in aircraft operations, providing additional options for aircraft in unforeseen situations that would require an emergency landing of aircraft.

Map development process:

- Separately, airfields that are registered in the Aeronautical Information Platform, were fixed.
- Based on the data of the publication, nine airfields were collected, which are available to any pilot and user.
- In Figure 5, these airfields were divided, and each of them was assigned a number and location.
- As a result, similar to the map in Figure 5, each user can see their location and name using this map, providing additional information and resources for pilot navigation and decision-making in emergency situations.

This map collected the airports available in the Aeronautical Information publication. These airfields are easily accessible to pilots, and when flying over Latvia, they would be used primarily. It can be concluded that only using these when arriving at airfields may not be sufficient in an emergency. When an aircraft declares a state of emergency, the situation may develop that the landing must be carried out immediately, and being in the SE (southeast) part of the territory of Latvia, there is no place available for it to do so. Based on this information, the author of the work has also collected airfields that are not officially available to provide additional options in emergency situations when a landing is urgently needed and a closer landing site cannot be found. These additional airfields, which the author of the work has compiled, can serve as an important additional tool for aircraft commanders/pilots to ensure safe and effective action in an emergency situation.

4. Discussion and interpretation of results obtained

The analysis of the "Aviation Safety Report for 2022" report of V/A "Civil Aviation Agency" shows that the number of serious aviation accidents in Latvia has not increased between 2010 and 2022, its trend is unchanged – an average of 2 serious accidents per year – but there is a cover-up of aviation incidents, reporting and reporting only on incidents whose consequences cannot be concealed.

The analysis of the literature shows that there is no map or any other alternative source of information available in the Riga FIR showing places where an aircraft could make an emergency landing outside the certified airfields included in the AIP. It is permissible to make an emergency landing at an aerodrome that is not certified and not included in the AIP.

At Riga Airport and Lielvarde military airfield, the runway directions are the same (RWY 18/36), but METAR data analysis shows that the prevailing winds are 180–200 degrees and they do not impose a threat to landing at the mentioned airfields.

Analysis of METAR data shows that the mode value of prevailing winds in the summer months in Latvia has been temporarily 100–110 degrees, which in the case of runways RWY18/36 is a pronounced crosswind, for example:

- in June 2020, the mode of the prevailing winds was 100 degrees, and the wind speed was 5 knots, which is a relatively small value;
- in December 2020, the mode of the prevailing winds was 120 degrees and the wind speed was 11 knots, which is also a relatively small value in aviation.

It follows from the above-mentioned examples that, although there have been months when the prevailing winds have been crosswinds, their strength was not sufficient to create difficulties and limit the possibility of landing at Lielvarde airfield. Thus, hypothesis number one about the need for an additional runway in Riga FIR is not confirmed.

The most dangerous for flights is OVC (low clouds of 8 octas), which reduces the chances of landing due to poor visibility. Because OVC clouds are observed at Lielvarde military airfield every month and their height is below 200 feet. It has been concluded that it would be advisable to increase the ILS CAT I to a higher category that would allow landing in poorer runway visibility and lower clouds.

The lowest QNH values for the time period under review were observed in the winter months, indicating colder weather conditions when the air is denser due to lower air temperatures. It should be mentioned that at lower QNH values, aircraft performance indicators at takeoff are significantly better – they gain altitude faster, and reach the set flight level.

5. Conclusions

This study aims to explore and assess the potential for emergency landing options within the Riga Flight Information Region (FIR), while also evaluating the necessity of an additional runway for military aircraft operations. Emergency situations present significant challenges for pilots. These challenges arise primarily due to the atypical nature of the situation and the limited time available to assess the circumstances, make informed decisions regarding the appropriate course of action, and execute the landing procedure safely and effectively.

Given that emergency situations may require landing outside designated runways, this research considers alternative infrastructure, including airfields not registered in the Aeronautical Information Publication (AIP), which could serve as viable emergency landing sites. To enhance pilots' situational awareness, this study proposes the use of digital maps displaying such unlisted airfields. The study has revealed that there are not only 9 airfields that are registered in AIP of Latvia, but also additional 63 airfields, that are not registered officially in AIP, but in case of emergency, they could serve as a safer place for landing compared to rural areas. The creation of a map that shows position of all possible registered un unregistered airfields in Latvia, increases situational awareness of pilots in flight, especially in case of emergency.

During emergency landings, there is a heightened risk to other infrastructure, including buildings and structures, as well as to individuals who may be in the vicinity. If an emergency landing is performed at an airfield that, although not meeting AIP criteria, is unoccupied at the time of the landing, the risks to both the aircraft and people on the ground may be reduced. By familiarizing themselves with maps of alternative landing sites, as provided by this research, pilots can improve their preparedness and decision-making capabilities. This proactive approach adds a new dimension to aviation emergency management, ultimately enhancing the safety of the landing process – for both the pilot and passengers, as well as minimizing risks to the surrounding infrastructure and individuals.

The study also highlights the significant impact of weather conditions on flight safety. In particular, factors such as visibility, wind direction, and wind speed can substantially influence the outcome of an emergency landing. Analyzing these factors helps identify potential risks that might otherwise remain unrecognized, as hidden threats in an emergency situation may have a greater impact than initially anticipated. Consequently, the research recommends that Lielvarde airfield consider upgrading its landing category to better accommodate emergency landings. Additionally, it advocates for increased situational awareness among pilots by familiarizing them with maps that include airfields in Latvia that are not officially listed in the AIP, particularly for use in challenging in-flight situations.

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