Corso di Dottorato di Ricerca in Scienze della Vita e dell'Ambiente - Ciclo XXXVIII

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Analysis of Climate Change Impact on the Aviation and Safety Strategies in the European Airports

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AIM OF THE STUDY

This research aims to analyze data on extreme atmospheric events that have impacted air traffic in Europe, and considering the ongoing climate changes, propose strategies to mitigate the risk of aviation disasters.

INTRODUCTION

Numerous studies have highlighted the global increase in climate change, and its particular impact on aviation; a sector highly susceptible to **extreme weather events** such as storms, turbulence, wind shear, microbursts, and low visibility (Chovgalenko, 2018).

These events, resulting from global warming and climate change, pose **significant safety risks to aircraft**. Although studies suggest an increase in Clear Air Turbulence (CAT) due to climate change, the overall picture of these phenomena is unclear (Williams, 2017).

This study aims to assess **airport defense mechanisms and emergency plans** against adverse weather conditions and anticipate future challenges posed by climate change. It also purposes to provide a critical analysis of strengths and weakness of the current modus operandi and possibly provide recommendations to enhance aviation safety, mixing the **technological advances** yet not forgetting the importance the **human role in avoiding disasters**.

METHODS

The initial phase of this study focused on identifying severe **incidents** involving aircraft triggered by intense meteorological phenomena such as wind shear and microbursts (Figg.1,2,3,4 and 5).

Subsequently, reports confirming the substantial increase of such extreme events due to **climate change** were collected and reviewed (Fig.2). During the second year of the doctoral program, a 50-hour internship over a 6 months was conducted with the multinational company **Leonardo SpA** to better understand the operation and limitations of avionic sensors and meteorological radar.

A visits to the Leonardo factory in **Germany** was carried out. Additionally, the airports of **Milan Linate** and **Palermo Punta Raisi** were visited, as well as the Aerospace Meteorology and Climatology Center of the **Italian Air Force**. Participation to the Flight Safety Forum to be held at **Eurocontrol** in **Brussels** is planned for the near future. Finally, to explore the human dimension of the issue, **questionnaires** will be administered to pilots to obtain feedback from those directly involved.

1st YEAR

- The first step of the research was to review the scientific literature that correlated the effects of climate change with accidents or incidents in the aeronautical sector.
- Statistics about climate change and extreme weather event have been collected and analyzed.
- Subsequently, attention was focused on the technological and regulatory organization of airports regarding the meteorological hazards.

2nd YEAR

- The second year is focused on the overall data collection. Numerous visits to airports, radar centers, and meteorological facilities are being conducted to gain a better understanding of protocols and dynamics of the civil aviation world.
- Close collaboration with Leonardo S.p.A. has been developed with the Leonardo Germany GmbH is Research to understanding modern technologies developed for flight safety

RESULTS

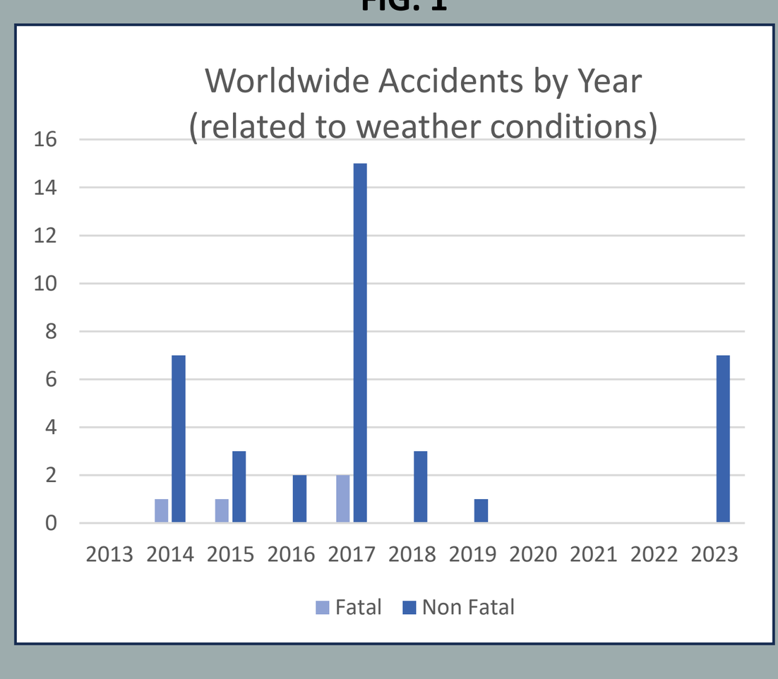
The data collected so far shows a steady increase in the frequency of wheatear events hazardous to aviation (Figg. 1 and 2). Statistics about flight safety show a significant correlation atmospheric phenomena and accidents (Figg 4 and 5). At the same time forecasts **of traffic volume** over the coming years anticipate a gradual but steady increase (Fig. 6).

The **visits** to airports, the Weather Center, and the meteorological radar factory of Leonardo Germany GmbH are showing that on the one hand new technologies are continuously developed yet on the other hand their installation and use in airport is inconsistent (the reasons are various ranging from cost to modus operandi of airport personnel).

The **questionnaires** to be administered to pilots are expected to provide both a snapshot of the current state and insights into pilots' expectations for flight safety in the context of climate change.

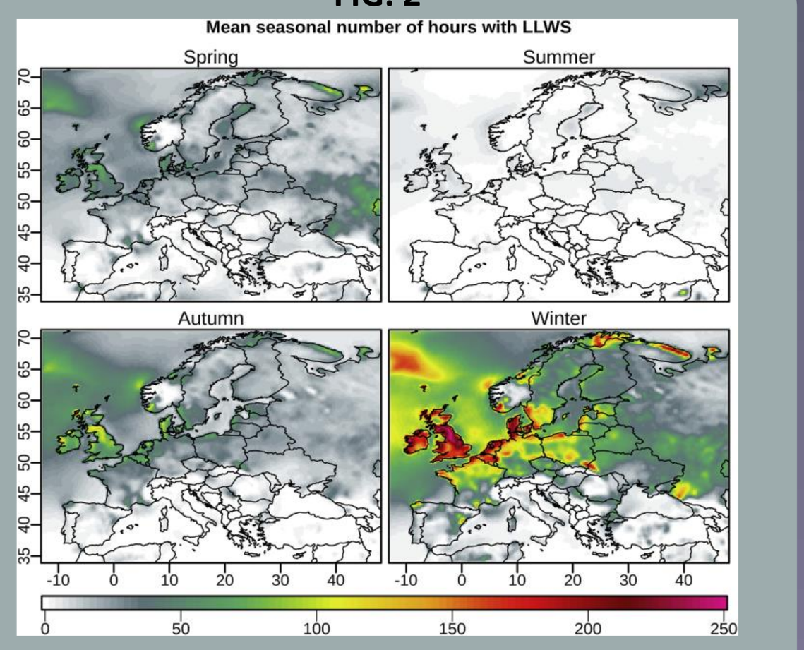
The **Brussels Forum** is expected to provide confirmation and additional insights on how to increase airports weather resilience.

FIG. 1



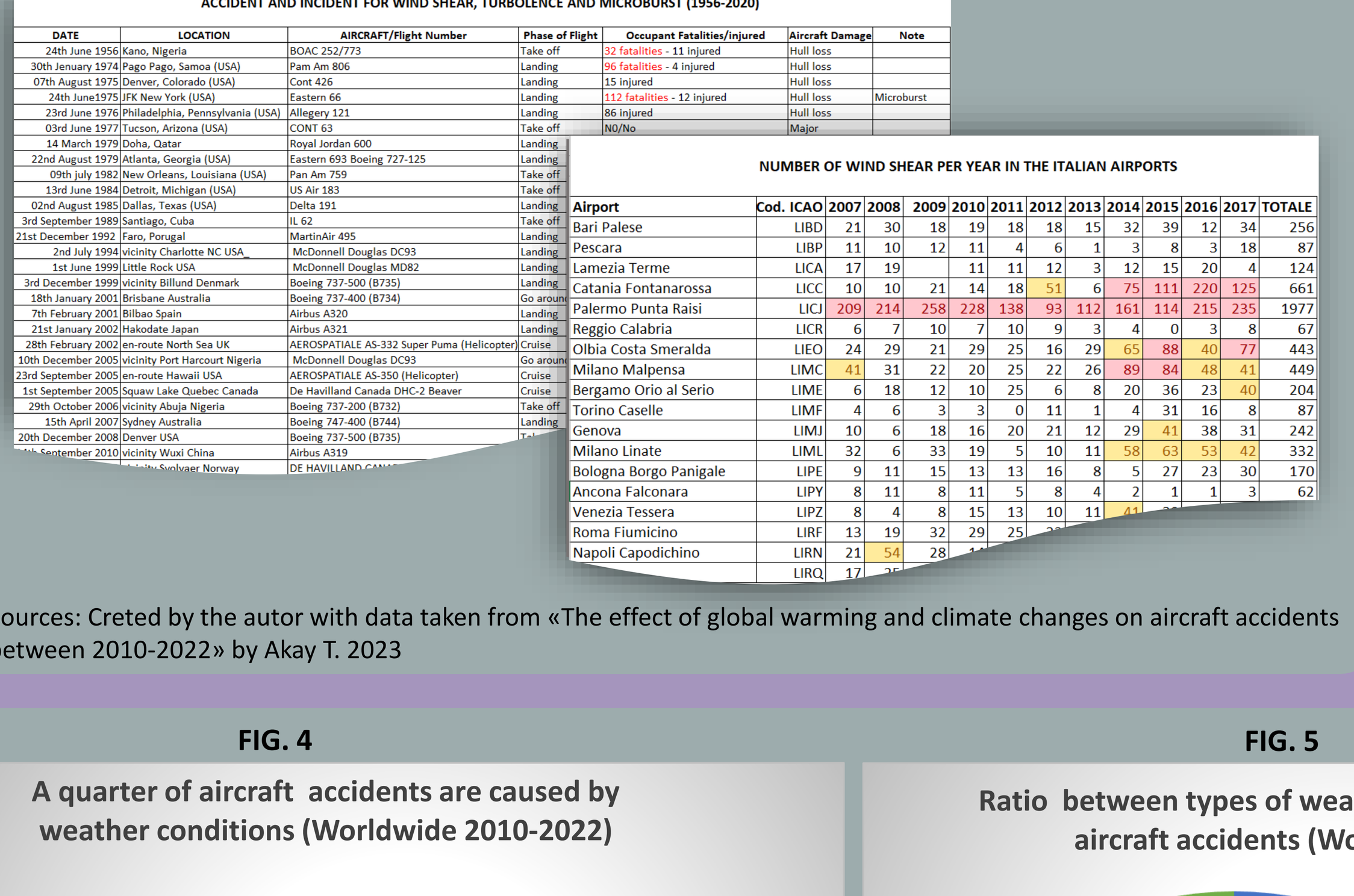
Sources: Creted by the autor with data taken from https://www.icao.int/safety/iStars/Pages/Accident-Statistics.aspx. [Consulted. 22/04/2024]

FIG. 2



Source: "Hazardous weather affecting European airports: Climatological estimates of situations with limited visibility, thunderstorm, low-level wind shear and snowfall from ERA5" by Taszarek M. (2020)

FIG. 3



ACCIDENT AND INCIDENT FOR WIND SHEAR, TURBOLENCE AND MICROBURST (1956-2020)

DATE	LOCATION	AIRCRAFT/Flight Number	Phase of Flight	Occupant Fatalities/injured	Aircraft Damage	Note
24th June 1956	Kano, Nigeria	BOAC 252/773	Take off	32 fatalities - 11 injured	Hull loss	
30th Jenuary 1974	Pago Pago, Samoa (USA)	Pam Am 806	Landing	96 fatalities - 4 injured	Hull loss	
07th August 1975	Denver, Colorado (USA)	Cont 426	Landing	15 injured	Hull loss	
24th June1975	JFK New York (USA)	Eastern 66	Landing	112 fatalities - 12 injured	Hull loss	Microburst
23rd June 1976	Philadelphia, Pennsylvania (USA)	Allegery 121	Landing	86 injured	Hull loss	
03rd June 1977	Tucson, Arizona (USA)	CONT 63	Take off	N0/No	Major	
14 March 1979	Doha, Qatar	Royal Jordan 600	Landing			
22nd August 1979	Atlanta, Georgia (USA)	Eastern 693 Boeing 727-125	Landing			
09th july 1982	New Orleans, Louisiana (USA)	Pan Am 759	Take off			
13rd June 1984	Detroit, Michigan (USA)	US Air 183	Take off			
02nd August 1985	Dallas, Texas (USA)	Delta 191	Landing			
3rd September 1989	Santiago, Cuba	IL 62	Take off			
21st December 1992	Faro, Porugal	MartinAir 495	Landing			
2nd July 1994	vicinity Charlotte NC USA_	McDonnell Douglas DC93	Landing			
1st June 1999	Little Rock USA	McDonnell Douglas MD82	Landing			
3rd December 1999	vicinity Billund Denmark	Boeing 737-500 (B735)	Landing			
18th January 2001	Brisbane Australia	Boeing 737-400 (B734)	Go aroun			
7th February 2001	Bilbao Spain	Airbus A320	Landing			
21st January 2002	Hakodate Japan	Airbus A321	Landing			
28th February 2002	en-route North Sea UK	AEROSPATIALE AS-332 Super Puma (Helicopter)	Cruise			
10th December 2005	vicinity Port Harcourt Nigeria	McDonnell Douglas DC93	Go aroun			
23rd September 2005	en-route Hawaii USA	AEROSPATIALE AS-350 (Helicopter)	Cruise			
1st September 2005	Squaw Lake Quebec Canada	De Havilland Canada DHC-2 Beaver	Cruise			
29th October 2006	vicinity Abuja Nigeria	Boeing 737-200 (B732)	Take off			
15th April 2007	Sydney Australia	Boeing 747-400 (B744)	Landing			
20th December 2008	Denver USA	Boeing 737-500 (B735)				
September 2010	vicinity Wuxi China	Airbus A319				
	vicinity Svolvaer Norway	DE HAVILLAND CANA				

NUMBER OF WIND SHEAR PER YEAR IN THE ITALIAN AIRPORTS

Airport	Cod. ICAO	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	TOTALE
Bari Palese	LIBD	21	30	18	19	18	18	15	32	39	12	34	256
Pescara	LIBP	11	10	12	11	4	6	1	3	8	3	18	87
Lamezia Terme	LICA	17	19		11	11	12	3	12	15	20	4	124
Catania Fontanarossa	LICC	10	10	21	14	18	51	6	75	111	220	125	661
Palermo Punta Raisi	LICJ	209	214	258	228	138	93	112	161	114	215	235	1977
Reggio Calabria	LICR	6	7	10	7	10	9	3	4	0	3	8	67
Olbia Costa Smeralda	LIEO	24	29	21	29	25	16	29	65	88	40	77	443
Milano Malpensa	LIMC	41	31	22	20	25	22	26	89	84	48	41	449
Bergamo Orio al Serio	LIME	6	18	12	10	25	6	8	20	36	23	40	204
Torino Caselle	LIMF	4	6	3	3	0	11	1	4	31	16	8	87
Genova	LIMJ	10	6	18	16	20	21	12	29	41	38	31	242
Milano Linate	LIML	32	6	33	19	5	10	11	58	63	53	42	332
Bologna Borgo Panigale	LIPE	9	11	15	13	13	16	8	5	27	23	30	170
Ancona Falconara	LIPY	8	11	8	11	5	8	4	2	1	1	3	62
Venezia Tessera	LIPZ	8	4	8	15	13	10	11	41				
Roma Fiumicino	LIRF	13	19	32	29	25							
Napoli Capodichino	LIRN	21	54	28									
	LIRQ	17											

Sources: Creted by the autor with data taken from «The effect of global warming and climate changes on aircraft accidents between 2010-2022» by Akay T. 2023

CONCLUSIONS

These **preliminary results** highlighted the importance of considering the impacts of climate change on aviation safety. Meteorological monitoring and forecasting technologies will undoubtedly play a crucial role in the aviation safety of tomorrow; however, human input is and will remain indispensable. The remaining part of this year and next year research activities will focus o the human dimension of flight safety focusing particularly on commercial airline pilots, who will be asked to identify the weather hazards they dread the most. This further layer of information will provide insights about **prevention strategies** currently used by European airports, fostering the discussion on how to enhance directives on air traffic management, and how enable airlines and regulatory authorities to assess the potential impact of climate change on specific flight routes, airports, and aircraft types.

FIG. 4

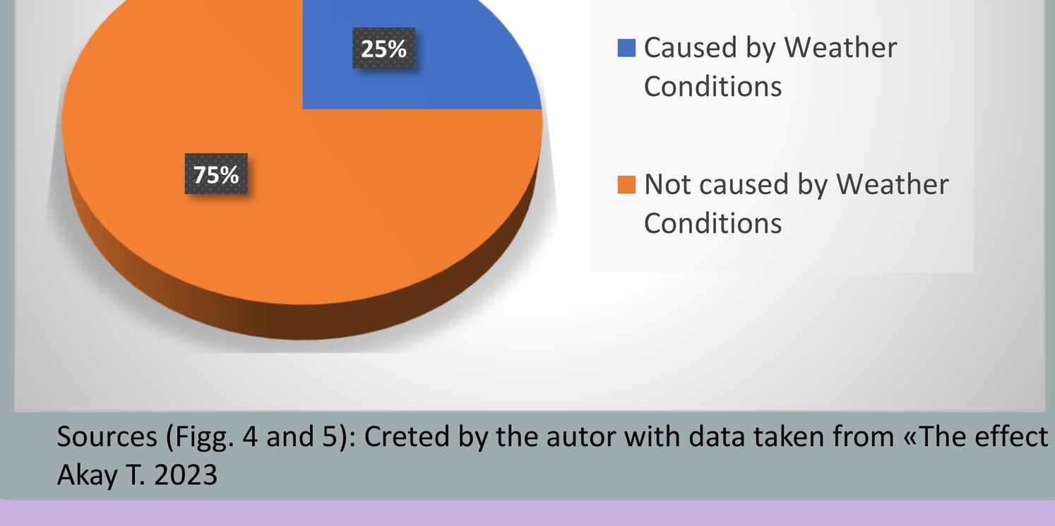
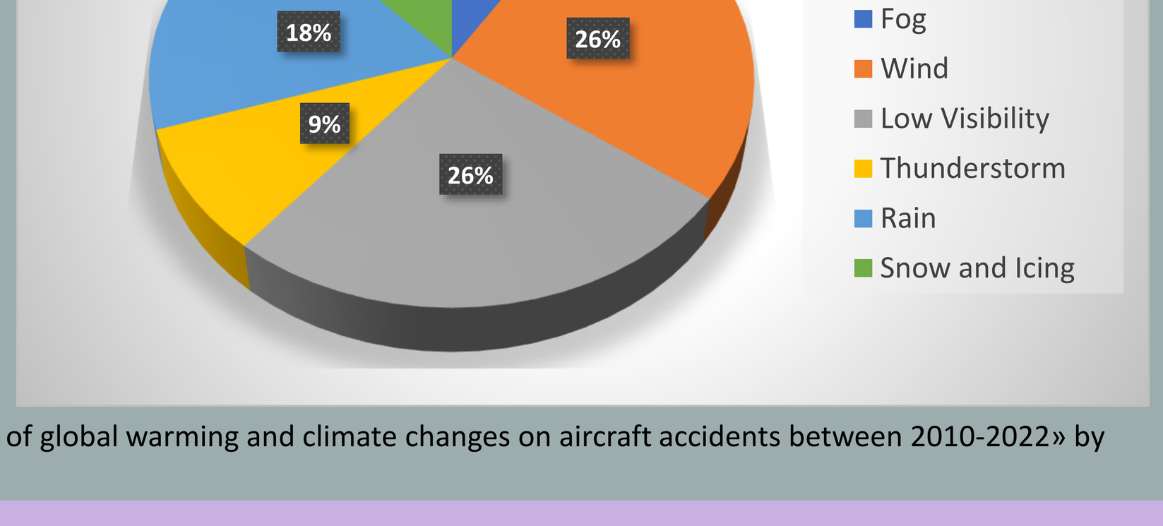
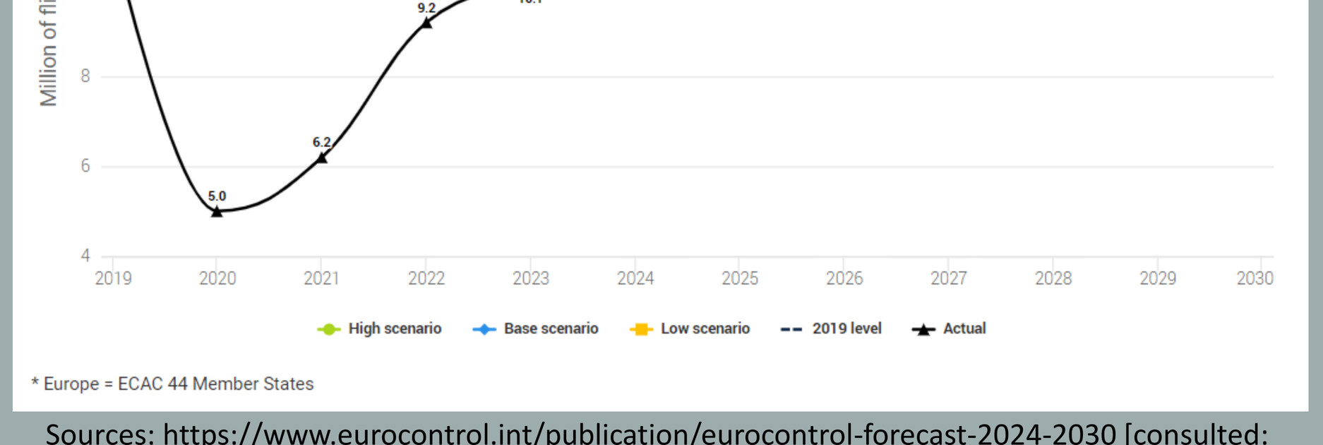


FIG. 5



Sources (Figg. 4 and 5): Creted by the autor with data taken from «The effect of global warming and climate changes on aircraft accidents between 2010-2022» by Akay T. 2023

FIG. 6



Sources: https://www.eurocontrol.int/publication/eurocontrol-forecast-2024-2030 [consulted: 22/04/2024]

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Informations and Contacts