Eagle AI – Case Study for Wildfire prevention

Version 5

5th of February

Flexible & early wildfire detection for high risk areas

HIGH LEVEL DESCRIPTION AND SCOPE

Climate change is happening and is fueling wildfires dramatically, period! Damages from the unprecedented fires in 2017 and 2018 are off the charts, the future unpredictable and current efforts do not meet future demands. The 2017 fires in California caused USD 180 billion in damages and the worst air pollution in the bay area ever recorded, according Allianz Global Corporate & Specialty SE.

Fire detection and suppression efforts are not meeting the needs with devastating consequences to property, public perception of forest fire mitigation and economic confidence.

Scientists have warned, that fires will get more frequent and severe, increasing the risk of injury or death for firefighters and the public, property damage, loss of economically forested and wildlife habitats, erosion and reduced water quality as a result too.

CNN reported, the recent wildfires in California have killed 74 people, destroyed 10.000+ homes and more than 100.000 people had to be evacuated. Scientist and weather simulation models are projecting, wildfires could cause up to 30% of our global CO_2 emissions by the end of the century according to BBC. The largest wildfires in B.C. (British Columbia/Canada) on record has emitted an estimated 190 million tonnes of greenhouse gases into the atmosphere — a total that nearly triples British Columbia's annual carbon footprint. In case of a fire, every minute counts, because wildfire can reach an untrollable state similar to a tipping point in climate change. This makes early detection, accurate localization of the ignition and decision making key aspects of wildfire fighting.

In 2018, economic damages including lost property values, taxes, lost jobs and wages, lost business, insured losses and health impacts totalled at $400 billion this year. According to researchers, scientific simulations and trends - it will get worse in the following years. Since everyone should be aware now, discussions are on with influencer and political heavyweight champion Arnold Schwarzenegger taking action in Katowice.

The combined efforts of satellites, fixed cameras, watchtowers and other sensory systems don't meet the needs of early identification of forest fires as well as comprehensive intelligence interaction to empower fire suppression teams with advanced technology to assist in their fire suppression efforts. All existing approaches have been taken into account, and new ones will be further discussed in this document with regards to flexibly deployable drones for early fire detection. This technology is bound to advance in current known uses, once drone and AI technology is put into action and keeps

progressing with the current pace. Surely, drone AI functions can be put into action for direct fire-fighting efforts too, but detection needs to be solved first.

In short, currently used military grade drones, billion dollar satellite programs or sensors and camera are scanning areas and are encountering 2 main problems.
Low-earth orbit satellites revisit times are too long, and geostationary satellites are 36,000 km away and only have kilometer accuracy levels. This means, that satellite data quality is either too low for early detection (Geostationary satellites), or it is too late until a connected satellite passes again (Earth observation satellite). Sensors are great tools for prediction models, but the low coverage and usage or inflexibility with sensors or cameras and will also be discussed below.

Thus, many cost factors from handling, manufacturing, infrastructure, launch, operations and maintenance need to be taken into account, aerial monitoring will address many challenges. [3]

Wildfire risk indexes can already indicate high risk areas, where wildfire is likely to start, quickly spreads and is hard to keep under control. Therefore, flights could only be performed in fire prone regions, rental services, or aerostatic systems, can improve flexibility, range and reaction times for early wildfire detection, protection, documentation, research activities, as well as finding remaining hotspots.

For this purpose, we are willing to collaborate and share know-how with wildlife funds, voluntary preservation teams, fire brigades, state forest departments & national park managers for their surveillance and analytic work to counter wildfires.

TARGET AUDIENCE	CASE DESCRIPTION I RISK AND STAKEHOLDER
Forestry departments, political leaders, business developers and environmental activists, government technology vendors, government consultancies, universities and experts in the forest management and fire brigades	Wildfires are an inevitable threat caused by climate change. Millions of hectares and thousands of structures and buildings are destroyed across many countries and, especially in unmanaged areas, the fires are detected too late to avoid uncontrolled wildfires. Current methods to address wildfires are mainly based on suppression and extinguishing the fires when they occur. Prescribed and observed fire burns, lookout posts, optical sensor and other remote sensing technologies are still subject to research and are becoming very important to reduce impact of climate change. The objective is to reduce the reaction time between the first smoke, during the stage fire, for immediate suppression - before the fire becomes uncontrollable.
Private fire suppression service companies	The drone revolution provides additional opportunities and significant value for insurance companies, public accounts and our society. The ongoing catastrophes fueled by extreme weather patterns recently sparked increasing activities related to this topic. Therefore it needs to be addressed to government representatives, insurances

and re-insurances, NGOs, companies for sponsorships, volunteers, work councils, general public, etc.

Thus the requirements are remaining high, widespread adoption will require time and current methods mainly focus on suppression, we would strongly like to emphasize on the importance of precaution measures for wildfire.

Our goal is to deploy a cooperation with several stakeholder and wildfire suppression teams to use our data and hardware and reduce reaction times significantly.

OPERATIONS AND CURRENT PARTNERSHIPS

The key drivers, to name just a few of them, are extended flight duration, data communication and processing costs reductions that can be solved with aerostatic systems, on-board processing or mesh networks. The key to success will be filtering false alarms, only send and communicate what is needed and flexible and easy deployment without expensive and intense infrastructure costs.

Performance categories	High level performance indicator	Main advantages
OPEX and CAPEX	Reduction of costs for communication, installation, operations and maintenance or human workload	No need for electrical and communication infrastructure, maintenance cycle of 6 - 8 Weeks and no human observation needed.
Efficiency and practicality	Increased range and no limitation to the location	Small fires can be detected in 12 - 15km range, with high accuracy
Value of Information and service	Short time delay, High detection & localization accuracy, decreased false alarm rate, detailed fire behaviour information	Detect fire, smoke and location anywhere with short delays and no information gaps, currently only provided by military equipment, where even satellites are limited

Table 1: Data capturing, costs and advantages of the proposed system

Before operations, risk classification in selected areas can help to decide which area needs to be surveilled. Early wildfire detection to guide firefighter and warn the public will be the first function of the system.
The early detection system processes are automated, scanning the area every 2-3 minutes. The system can detect columns of smoke to report it to the fire suppression teams and fast response firefighters that can decrease the risk even more.

The solution we are developing is designed to solve various technological challenges, and especially increase detection accuracy and flexibility. This will enable rental, lease and entire services to reduce total cost of ownership.

The 4 main factors for differentiation are costs, range, efficiency and flexibility and detection delay.

Competitive product table

Performance indicator	Proposed system	Drones	Fixed optical cameras	Satellite	Wireless Sensor network
Cost (per km²)	Medium	High	High	Very high	Medium
Range	High	Very High	Medium / Low	Very High	Low
Efficiency and flexibility	High	Medium	Medium	Low	High
Detection delay	Small	Small	Medium	Very long	Small
Can be use for other purposes, locations or use cases along the value chain, potentially even finding arsonist	Yes, and has preventive effects	Yes, and has preventive effects	No	Yes	Yes

Table 2: Competitive products and features
Source: A Review on Forest Fire Detection Techniques, Eagle AI - R&D and expert interviews

Clearly, the earlier wildfires can be detected through better coverage, the better. According to Geo-physicists we spoke to, early detection is the whole game and can increase caution and situational awareness.

Even far up north in Sweden, where wildfires have become a threat very recently, autonomous drones have been proposed for wildfire fighting, and were perceived as a prominent solution, until a drone crash has reportedly caused a 335-acre wildfire in Arizona, US.
The ability to use the proposed system or drones for various purposes along the value chain, and increasing awareness can be of major importance.

The main advantages of our aerial systems against fixed cameras or human based observation is the high range and flexibility of deploying it where wildfire risk is high at the current time of the year and due to the previous weather patterns.
These features were delivered by very expensive satellite systems with enormous range until now. Those systems, however have much longer detection delays, because satellites need to pass a certain point on the globe in time and before the fire has spread or already been reported otherwise.

CURRENT PROBLEMS AND PROJECTIONS

Current approaches are dominated by fire suppression services and data from satellite and static camera systems. Fire suppression services are lacking in resources, infrastructure and trained personnel and satellite programs do not meet the needs for early detection. The projections are alarming, because $237 billion in insured property values are at high or very high risk in the US alone.

Climate change or unpredictability is a major contributor to the problem, the current infrastructure is not adequate to meet the current fire detection and suppression needs in macro-economies such as california with devastating consequences.

We believe, that flexibility and partnerships are key to success. Through partnerships and cumulated insurance products and services at scale, resources can be more efficiently managed and data acquisition can be focused to assist governmental units the best way possible.

We recently announced a collaboration with a few suppliers, such as Hybrid Airplane, an aerospace system manufacturer from Germany as well, are looking for influencer and want to move to California, the devils nest and best suited test region worldwide.

PRODUCT & MARKET FIT

Fires are frequently ignited directly or indirectly by humans, due to lack of attention, by intention, power lines or through natural concentration of power, such as lightnings or sun rays and lenses.

Drones and AI technology will provide objective technology to enable centralized command to make more informed choices to detect and attack fire outbreaks.

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<td><u>Time is the most important component</u>

• Automated scanning, 24/7

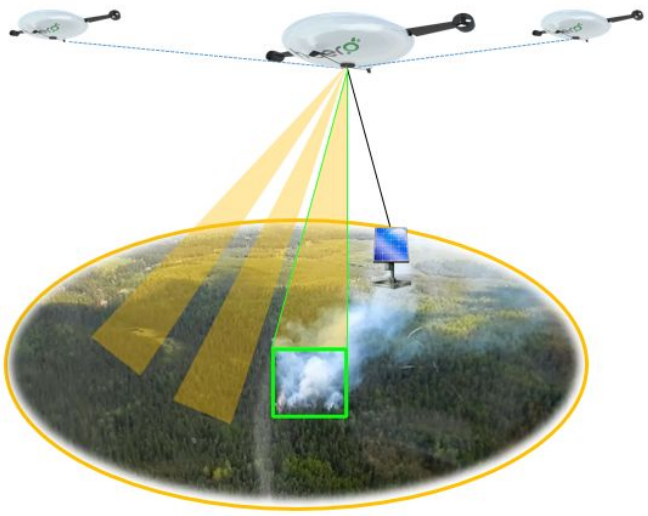
• Accurately locating fires for strategic fighting

• Real-time detection through on-board processing

• No need for a pilot or maintenance for up to 6 weeks

• High quality data can be assessed, low amounts need to communicated

• Smart energy management (charged by solar and wind)

• Can be used before, during and after a fire</td>
<td>  </td>
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<td><u>Scalability</u>

Any array of systems is possible and the system is worldwide scalable.</td>
<td><u>Flexibility</u>

Various communication technologies to increase independence from mobile phone connection</td>
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Researchers say, that “Time is the most important factor, when it comes to fire fighting!”

Time is considered one of the most important factors in fire-fighting planning, strategic operations and resource management.
Therefore, we are aiming for a guaranteed response time reduction to a few minutes, surveillance range of over 45.000 hectares with the current prototype and are confident to increase range to 70.000 hc per system.

This way, we can reduce the costs to surveil one hectare for an entire month to less than one 50 cents.

During our system development, we defined further criteria to reduce time components, and potential for improvement that we would explain in our next case study release.
The most important factor for marketing and sales will be influencer marketing, but the media attention of the topic is currently increasing due to the appearance of several celebrities and even Arnold Schwarzenegger discussing the topic during the Katowice climate conference. Link

Another very important aspect of wildfire fighting methods is **precise and contemporary information during a wildfire.** Accurate fireline monitoring and localization for efficient resource management and water distribution from ground units and air support can support supervisors. From a new viewpoint, **fire jumping over a fire break line and measuring the effectivity and accuracy of fire suppression efforts and fire-fighter or equipment at risk** can be detected in time.

INDICATORS AND IMPACT

The value for emergency management and loss prevention is hard to appraise. However, the indicators for damage and potential improvement potential can be summarized as follow:

Performance category to detect!	Indicator - what needs to be assessed	Negative influence	Summary: How can we reduce damage?
Severity / Time	ROS (Rate of Spread), Sudden changes to…	Direction change, intensity (FLI), Rate-of-Spread (ROS), wind	More data, accurate fire spread analysis
Time & Place	Small fire breakouts, spotting	Intensity, spotting activity distance, FL, location of new fire and surrounding…	Early localizing and extinguishing, tactics and safety for units
Time	Early alert, early classification, location, etc.	Detection delay, Reaction time, resource planning, etc.	Fast emergency response, alerts to public
Cause	Natural or anthropogenic cause (important for claim management)	Natural and anthropogenic ignition, accidental, intentionally, incentivised	Increased awareness, and improved investigations and research

Location Data	Accessibility & mobility, surroundings, local wind	Travel time, impact on FBI (fire behaviour information)	Timely and accurate information, defense plans, tactics, use and protection of machinery (cooling, escaping, etc.)
Potential damage	Risks: WUI, Weather, financial assets	Proximity to forests, vegetation in surrounding area	Finance and insurance information, Geo-data and Fire Danger Indexes
Capacity	Fire fighting resources	Low fire management and HR capacity, high fire intensity, etc. limit the potential for improvement	Infrastructure (Water&Comm), clear orders, better predictions & escape routes, fire-fighter health and safety

DIRECT IMPACT IN ONE REGION AND RISK

The entire costs involved including insured, indirect and environmental damage during the last 2 years can be summarized as follows:

According to various sources, the California wine industry has an overall $57.6 billion in state economic impact, about $114 billion in national economic impact, creates 325,000 jobs in California and paid $15.2 billion in state and federal taxes [6, 7]. This can serve as an example of assets in a relatively small region.

		Financial loss [in million$]		Value of surveilling 15% of the areas and 10% risk reduction [in million$]	
Type of Damage	**Damage to**	**2017**	**2018**	**2017**	**2018**
Direct or insured	Society	16,000	13,000	240	195
Indirect or secondary damage	Society & Gov. Expenses	160,000	400,000	2,400	6,000
Environmental	Future generations	1,266 million hc	1,824 million hc	3165 hc	4560 hc

Table 3: Loss calculation and projection of minimum service value

A risk classification tool is be able to incorporate such data to identify regions to surveil. Here, re-insurances backing the contracts of primary insurance groups can leverage the highest potential, because they are backing more % of the overall assets in a specific region. To enable an easy

calculation everyone can relate to, we gathered data from the Institute for insurance information about the amount of assets at risk to calculate financial impacts.

Risk depends the time factors & rate of fire spreading, fire behaviour information and situational awareness. We believe, that the risk for wildfire damages can be decreased by a few percent, when resource efficiency and awareness increases, and in turn reaction times or accidentally started fires are decreasing.

Table 4 provides a new basis to compare the potential benefits of a small project in Australia (OZ) from March to May and a big mission in California for 12 weeks with the applicable mission costs and pricing.

The mission #2 Cali would be covering ~14-15% of the WUIs in California around 3 main locations. Location #1 stretches from Yosemite, Sacramento to Napa valley, Location #2 is spread over San jose, Santa Cruz and around Red Basin National Park, and Location #3 around San Diego and Ventura County.

System & M#x	Pro-duct costs	Mission equipment costs [k$]	FTEs needed for mission	Weekly mission costs	Mission dura-tion	Price per week / system	Systems in mission	Mission area [thou-sand hc]	Mission price / week [$]	Area price [$/hc]	Total mission price [k$]
On-B - Mission #2 OZ	60k	120	3	13.058	8	7799,99	6	336	46.799	0.139	374.3
On-X - Mission #2 Cali	80k	1.600	40	162.636	12	8599,99	80	7.680	687.999	0.090	8,255.9

Table 4: Mission criteria and costs

A mission including 27 communication balloons or ground stations, 80 detection systems and 40 standby fire-fighters deployed can cost well blow $10 million and deliver **23 times it's direct value or over 700 times the economic value.**

More exact calculations by insurance companies will decrease the monetary risk calculated even further. To relate back to the comparative product analysis from above, we would hereby like to present how the system is adding value in the context of an insurance or reinsurance business.

Performance indicators for 10% risk reduction	Eagle AI system	Sierra, Valley & Southern Cali	Goals, Tasks & Tools	The value for insurances
OPEX and CAPEX	Low maintenance, high flexibility, reduced cost per km²	27 communication & 80 detection balloons for the 3 regions	Risk reduced, awareness increased	10% savings on losses incurred

Range	small fires - 450km², medium fires up to 700km²	3 areas (approx. 3x50 mile radius) but more strategically deployed	Action range and precaution	Precaution measures on top will help
Efficiency and flexibility	Applicable to any place in the world	Deployed where the highest financial and damage risks are calculated	Fall back options	More areas with WUI at risk need more flexible solutions
Detection delay	Max. 2 min detection delay	Quick decision, reaction and response teams	Timing, fast response	Quick detetion and fire response units!
Can be use for other purposes or has preventive effects	Increase awareness and avoid accidentally started fires	Flexible surveillance resource deployment when fires have started in collaboration with government entities	Improve flight capabilities, on-board battery and autonomy	Additional risk reduction especially in this area

The flexibility of the solution can be of primary interest for insurance groups, because a service including effective resource planning, new risk calculations and information are key for their profitability.

PARTICIPANTS AND OUTLOOK

The cooperation currently includes the software development & integration company Eagle AI, the aerospace systems supplier Hybrid Airplane Technologies, and the Fraunhofer Institute IOSB.

The main sources of this case summary can be taken from the case study provided upon request. For feedback, questions and contact to the authors and partners of this project, please contact:

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Additional Sources:

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[3] Hindawi Publishing Corporation - A Review on Forest Fire Detection Techniques Ahmad A.A. Alkhatib – The University of South Wales, UK
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