POLICY RECOMMENDATION FOR INTEGRATING SMALL UNMANNED AIRCRAFT SYSTEMS WITH AVIATION FACILITIES IN NORTH CENTRAL TEXAS

by

MIKE BRANUM

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Abstract

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Mike Branum, MCRP

The University of Texas at Arlington, 2016

Supervising Professor: Jianling Li

Prevalent availability and use of small unmanned aircraft systems (sUAS) have placed this technology at the forefront of federal, state, and local policy discussions. With the Federal Aviation Administration’s (FAA) August 2016 release of regulatory conditions for civilian and commercial uses of unmanned aircraft, states and local governments are seeking to enact their own regulations to protect citizens, vital infrastructure, and economic assets including airports.

This study analyzed results of aviation stakeholder and public safety professional responses to a survey, administered by the North Central Texas Council of Governments (NCTCOG), to identify municipal concerns about the integration of sUAS with manned aircraft near aviation facilities. The survey responses concluded there is support for the growth of this modern technology. Additionally, the survey concluded practical municipal policy to address misuse is viewed as an important consideration. This study provided content analysis for the dimensions and limitations of existing federal, state, and local UAS policies specific to safety, operational requirements, and privacy. Byproducts of the study’s content analyses led to a local-level policy recommendation utilizing geographic information system (GIS) software.

The findings of this research are intended to assist municipalities identify an effective policy approach to regulating small unmanned aircraft activity near aviation facilities. GIS was utilized for this study as a broadly available tool and model to assist planning efforts that can articulate and visualize a suitability analysis for sUAS operations in close proximity to airports.

Table of Contents

List of Illustrations

List of Tables

Chapter 1 Introduction

1.1 Introduction

National, state and local interest from various entities and groups to utilize unmanned aircraft systems (UAS) for military and civilian purposes has prompted widespread growth of this industry. Unprecedented growth in small unmanned aircraft system (sUAS) platforms has been especially far-reaching. The primary reason for this growth is that numerous applications exist and their use is on the rise globally as organizations report increasing work efficiencies and lower operating costs while at times reducing the risk to human life. For example, utility companies can patrol pipelines and inspect oil rigs using battery-operated UAS as opposed to manned aircraft, and the benefits of this approach are the decreased use of fossil fuels thereby shrinking the carbon footprint and reduced noise near customers' homes (Lundin, 2015).

However, there are concerns surrounding misuse of this technology in terms of impacts to privacy from public and government agencies and local law enforcement as these agencies integrate unmanned aircraft technology into daily operations (Friedenzohn, 2014). For instance, it is well known the United States has used unmanned aircraft for years in combat environments primarily for surveillance and reconnaissance missions to assist public agencies fulfill their respective duties. Due to research and investments to meet these mission requirements leading to miniaturization of sensor and other technological advances, the accessibility and cost of ownership appears to have reached beneficial economies of scale. As a result, significant pressure has been placed on Congress, and subsequently the Department of Transportation and the Federal Aviation Administration, to establish federal policy for the safe integration of sUAS into the national airspace system with manned aircraft.

Another concern about broader unmanned aircraft integration is a growing trend of unauthorized flights in controlled airspace with manned aircraft operations, i.e. airline transportation (Fischer, 2014). In an attempt to prevent a devastating accident or collision between manned aircraft and unauthorized unmanned aircraft activity, state and local governments may be able to seek policy solutions aligned with FAA regulations.

1.2 Problem Statement

The unmanned aircraft system is a relatively new phenomenon for many people. The widespread use of and rapid growth in small unmanned aircraft system (sUAS) present many unique challenges to policy makers - especially at the local level. It is unclear if policy makers, such as the aviation industry stakeholders, airport managers and public safety professionals are fully aware of the technology and the challenges before them.

Furthermore, Texas' local governments – broadly defined as towns, cities, counties and districts - are without an appropriate local-level policy framework to accommodate the introduction of small unmanned aircraft systems (sUAS) into their jurisdictions to align with Federal Aviation Administration (FAA) rules. Local planning and policy to address unmanned aircraft operating near airports will be critical due to forecasted exponential increases in unmanned aircraft use and operations, especially when accounting for unmanned operations near aviation facilities accommodating large amounts of air traffic.

1.3 Research Objectives

The research will explore the awareness and concerns of sUAS activity near airports. In addition, it will analyze the current unmanned aircraft policy at various levels of government to identify the primary elements of what local governments might consider locally to address issues with sUAS integration and activity near airports. Furthermore, it will illustrate the data and tool that can be used by planners to communicate with decision- makers on issues related to the use of sUAS near airports. Based on the findings, this research will present recommendations that may aid local governments develop their own policy for sUAS activity near aviation facilities.

1.4 Research Questions

To achieve its objectives, this study will investigate the following questions:

1. What are the levels of knowledge about, and support of, growth in sUAS among aviation industry stakeholders, municipal airport managers/directors, and public safety professionals?
2. What are the concerns about the impacts of sUAS?
3. What is the level of support for local policy in dealing with the impacts of sUAS?
4. What principles and/or components should be included in a municipal policy to deal with potential issues of sUAS?
5. What data and analysis tool can help municipalities identify suitable land uses for the takeoff and landing of sUAS?

1.5 Methodology

Due to time and geographic area constraints in addition to limited access to data, this study will focus on use of small unmanned aircraft in the North Central Texas (NCT) region with Naval Air Station Fort Worth Joint Reserve Base (NAS Fort Worth JRB) as a case study. The primary data for this research include a survey of stakeholders in the North Central Texas Council of Governments (NCTCOG) region. The survey was administered by NCTCOG, during a NCTCOG-hosted UAS workshop, on April 1, 2015, with members of the Air Transportation Advisory Committee (ATAC), regional aviation industry stakeholders, policy makers, first responders, and other interested parties. The survey instrument contains a series of questions presented to workshop attendees using a proprietary survey software. Responses to the survey were collected anonymously using electronic collection devices. These devices reduced the chance for error while collecting responses, and increased accuracy of post-survey analysis. Data from the survey will be used to guide focus areas for this research.

The Federal, state, and local-level small unmanned aircraft policy and statutes, collected electronically through web research and peer-reviewed journal content, are also studied. The study of these three tiers of government policy and regulations for unmanned aircraft will help identify logical sense of relationships to factors and variables that could impact North Central Texas' municipalities' ability to develop local policy.

Finally, a GIS model is used to study the land uses and parcel use around NAS Fort Worth JRB. The results of this GIS analysis may be used as a communication, visualization, and analytical tool to help local governments implement their own policies for unmanned aircraft activity near airports.

1.6 Significance and Limitations

The focus of this study will be application of content analysis to multiple layers of government policy for unmanned aircraft integration. Due to the volume and diversity of states' policies pertaining to unmanned aircraft, application of this study is intended only for the North Central Texas region. Additionally, the survey instrument and questionnaire to be analyzed as part of this study represent responses only from North Central Texas stakeholders. However, it may be possible to replicate the study's model in different regions of the United States. Potential application of geographic information system (GIS) software modeling to visually study results and recommendations will be dependent on access to municipal land use data.

1.7 Summary

In summary, this research will study policy and data that may lead to a local ordinance or zoning recommendation to increase public safely, privacy, and understanding of appropriate operational aspects of small unmanned aircraft activity near airports. A GIS-based approach to model analysis of land use and parcel uses for areas suitable for unmanned aircraft activity near municipal aviation facilities will also be studied.

Ultimately, this study's local policy recommendation for small unmanned aircraft integration will be important due to the forecasted exponential increases in sUAS operations. Its relevance and importance may also be attributed to a growing trend of sUAS operators flying in an unauthorized and sometimes reckless nature near manned aircraft and airports (Fischer, 2014).

The structure of this research is outlined below.

- Literature Review: A comprehensive review of unmanned aircraft market demand, design and uses, and federal, state, and local policies and related issues was conducted. This research of scholarly studies and unmanned aircraft industry resources and materials identifies gaps within the existing knowledge base and guided the direction of this study.

- Method – This study’s method of research is structured into three parts: A qualitative content analysis of three pillars of governments unmanned aircraft policy; a quantitative analysis for stakeholder responses to an anonymous NCTCOG survey, collected using a proprietary survey software and electronic collection devices; finally, a quantitative analysis of parcel and land use data, acquired from a county and metropolitan planning organization respectively, using Microsoft Excel and ESRI GIS software to conduct a suitability analysis of unmanned aircraft activity near a case study airport, the Naval Air Station Fort Worth Joint Reserve.
- Analysis and Results – An analysis and practical interpretation of the results from the study of the dimensions of unmanned aircraft policies and issues identified, responses to the NCTCOG survey about sUAS growth and anticipated local policy need(s), and maps of parcel and land use data as they apply to the GIS suitability analysis are presented.
- Conclusion – A summary of this study’s results and findings are explained and specific policy recommendations to address unauthorized unmanned activity near airports, including opportunities for additional research.

Chapter 2 Literature Review

2.1 Industry Growth

Unmanned aircraft, initially researched, developed, and manufactured for military purposes almost exclusively, has demonstrated promise for civilian applications, too. Due in large part to progressive technological advancements, i.e. miniaturization of sensors, UAS have become increasingly affordable in recent years bolstering their demand. As a result, this industry is positioned to grow significantly during the next several decades as the technology becomes widely available for use by the private sector as well as state and local governments. Estimates from a research firm, Lucintel, suggest the civilian market for this growing industry can be valued at over $7 billion from 2015-2025 (U.S. DOT, 2013). Furthermore, FAA estimated that one million consumer UAS were purchased for gifts in Christmas of 2015 (Karp, 2015) and, published in their 2015 market study, Teal Group “estimates that production of unmanned aerial vehicles (UAV) – another name for UAS that carry a camera or other payload – will soar from current worldwide UAV production of $4 billion annually to $14 billion, totaling $93 billion in the next ten years (Finnegan, 2015).”

Job growth projections from a 2013 Association of Unmanned Vehicle Systems International (AUVSI) report, *The Economic Impact of Unmanned Aircraft Systems Integration in the United States*, suggests unmanned aircraft integration into the national airspace will create more than 23,000 jobs from 2010-2025. The economic impact of the UAS market is expected to directly or indirectly effect other industries such as:

- Simple and complex navigation systems
- Aircraft engines and composites
- Software and radar systems
- Imagery, camera, and sensor technology

In the FAA's 2011-2031 Aerospace Forecast (AF) 100 United States companies, academic institutions, and government organizations were recognized as developing over 300 UAS designs to fill the potential opportunities and demand for UAS in the civilian market. This forecast also projected development of the sUAS fleet as follows:

- 10,000 active units in the next five years
- 25,000 active units in the next ten years
- 30,000 active units by 2030

Due to the aforementioned projections, and the dramatic increase in wide-spread accessibility to the general consumer, the small category of unmanned aircraft, i.e. weighing under 55 pounds, will be the focus on this research.

2.2 Design and Uses

To further the discussion of how to address local-level integration of this technology, it is necessary to understand, at least in broad terms, unmanned aircraft designs and uses. The term unmanned aircraft system (UAS), aka drone or UAS, refers to a system of components that FAA recognizes as including (Friedenzohn and Branum, 2015):

- Ground control stations and other hardware,
- Software, and
- Human elements

Small UAS, in particular, have capabilities that are heavily dependent upon onboard equipment, payloads, and sensors. As such, smaller unmanned platforms can vary greatly in terms of size and shape and the FAA defines small unmanned platforms as weighing 55 pounds or less (Federal Aviation Administration, 2016). According to Kharchenko:

> “[An] unmanned aviation system is a sophisticated aviation technical system which includes one or more unmanned aircraft, control point and communication facilities, equipment startup and rescue service, as well as transportation” (Kharchenko, 2012).

Figure 1 depicts a simplified visual depiction of the relationship between major components of an unmanned aircraft.

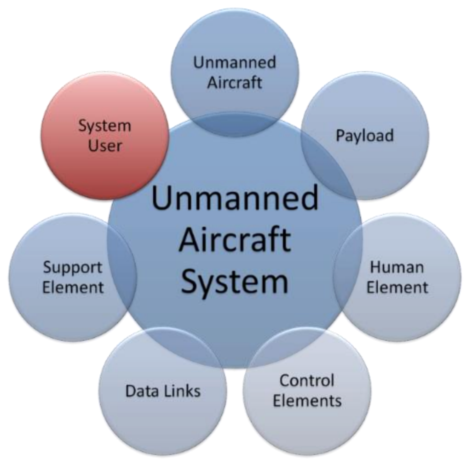


Figure 1: Primary Components of Unmanned Aircraft (NCTCOG, 2011)

As previously noted, a primary catalyst of the exorbitant push for widespread unmanned aircraft integration is largely tied to decreasing costs and increasing economic growth; especially appealing to a global environment where government fiscal policy and monetary resources continually shift towards more conservative trends. Consequently, this has led to goals for reducing operating costs leading to an increased attractiveness for miniaturization of sensors, batteries, global positioning systems (GPS), and sophisticated laptop-powered ground control stations (Kharchenko and Volodymyr, 2012). This objective to reduce costs bodes well for driving up demand for unmanned aircraft (Kharchenko, 2012).

Additionally, with modernized, reliable, and proven aerospace technology as the backbone of unmanned aircraft's growth, many countries are openly accepting the introduction of this new industry. However, the uses and complications associated with this technology is much broader than the hardware, software, and human elements of the command, control, and communication process (Kharchenko, 2012).

Generally speaking, issues with UAS are not tied to the equipment itself given many unmanned aircraft applications are derived from existing, reliable aerospace and aeronautical engineering and designs. Briefly mentioned by Kharchenko and Prusov, is that a "regulatory base of common use of airspace by the unmanned aircraft systems and by the manned aircraft" is underway world-wide. These authors go on to explain an opinion of limitations for the success of regulatory initiatives and suggest a regulatory base will be possible in connection with research and development of systems that will prevent collisions between manned and unmanned aircraft (Kharchenko, Prusov, 2012). This might be true for large and middle-sized unmanned platforms, but what about small UAS?

As previously mentioned, small UAS are defined by FAA as weighing less than 55 pounds. Most platforms in this category are battery powered. This approach, in lieu of using combustion engines, increases safety while decreasing weight and, subsequently overall costs, to propel and control the unmanned system. With the common practice of leveraging electric/battery powered aircraft, there is an inherent limitation on the size and weight of on-board components.

Therefore, Kharchenko and Prusov could have broadened their theory of suggesting a regulatory base is contingent on collision avoidance systems. This is due to limitations of battery life and that many unmanned operators will be unable to integrate costly collision avoidance hardware into their platforms.

To summarize, current limitations of electronic powered small unmanned aircraft is not conducive to a potentially costly and battery restrictive hardware solution designed to prevent collisions from unmanned aircraft's broader integration into congested airspace near airports. However policy, implemented in conjunction with regional and local planning experts, has the potential to permit access to airspace near aviation infrastructure, and its airspace, while avoiding a potentially devastating collision between manned and unmanned aircraft.

2.2.1 Military Uses

Aligned with fiscally conservative spending, the Department of Defense (DoD), has identified cost-effective solutions for a variety of unmanned missions including:

- Reconnaissance – providing reliable battlefield intelligence
- Combat – attack capability for high-risk missions
- Research and development – development of technologies for practical applications in field deployed aircraft (DOD, 2011)

In addition, DoD has commented that realizing the full potential of unmanned systems is dependent on "tactics, techniques and procedures" that will improve unmanned systems interoperability with the "manned force" (Volner, 2012). Successful implementation will require advances in policy and technology solutions i.e. data-driven analysis and decision making using geographic information systems (GIS) software.

Table 1 displays DOD's organization of UAS into five groups; Groups 1 and 2 meet the FAA definition of a sUAS. Typically unmanned aircraft in these categories are hand launched, or catapulted, for short distance reconnaissance.

Table 1: Department of Defense UAS Categories (DOD, 2011)

<table>
<tr><th>UAS Category</th><th>Max. Gross Takeoff Weight (lbs.)</th><th>Normal Operating Altitude</th><th>Speed (KIAS)</th><th>Example Aircraft</th></tr>
<tr><td>Group 1</td><td>0-20</td><td>< 1,200 AGL</td><td>< 100</td><td>Puma, Wasp, RQ-11 Raven</td></tr>
<tr><td>Group 2</td><td>21-55</td><td>< 3,500 AGL</td><td>< 250</td><td>RQ-21A ScanEagle</td></tr>
<tr><td>Group 3</td><td>< 1320</td><td rowspan="2">< 18,000 MSL</td><td>< 250</td><td>STUAS, RQ-7 Shadow, MQ-5 Hunter</td></tr>
<tr><td>Group 4</td><td rowspan="2">> 1320</td><td rowspan="2">Any</td><td>A160T Hummingbird, MQ-8B Fire Scout, MQ-1C Grey Eagle, MQ-1B Predator</td></tr>
<tr><td>Group 5</td><td>> 18,000 MSL</td><td>MQ-9 Reaper, RQ-4A/B Global Hawk</td></tr>
</table>

2.2.2 Commercial Uses

A variety of applications exist for commercial operators such as agriculture, conservation, real estate, construction, transportation, maritime and shipping, and media. These industries have been largely represented by the Association of Unmanned Vehicle Systems International (AUVSI). As one of the leading international unmanned aircraft industry groups, AUVSI has been actively engaging with the federal government on implementation of rules and regulations leading to small unmanned integration (McMahon, 2016).

The private sector interest to incorporate unmanned technology in day-to-day airspace operations has grown exponentially as seen by the rise (see Figure 2) in issuance of Certificates of Authorizations (COA). A COA is granted to sUAS operators by FAA authorizing legal access to fly in the national airspace system. Until August 2016 when FAA published the final rules for small UAS operations, a COA was the primary FAA mechanism to grant public and private unmanned aircraft operators the authorization to fly. Greater analysis about unmanned policies will be discussed in Chapter 4.

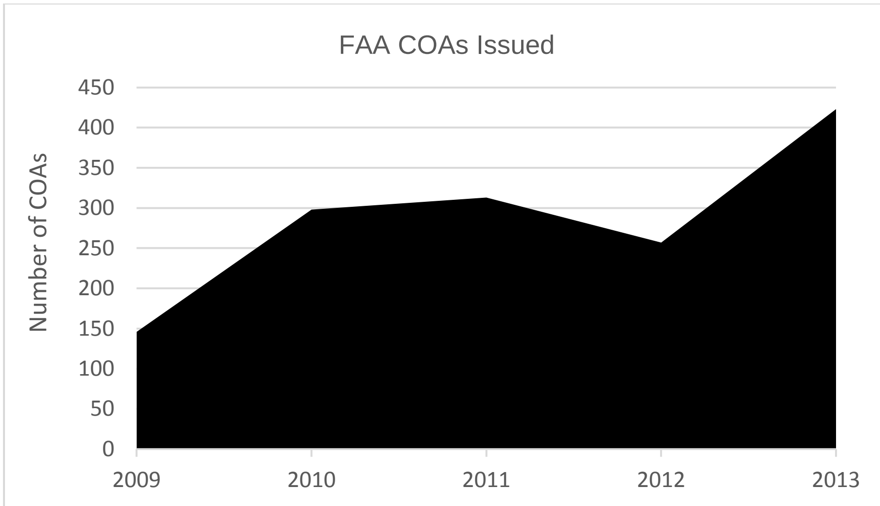


Figure 2: FAA COAs Issued 2009-2013 (NCTCOG, 2016)

2.2.3 Civilian Uses

Similar to the DOD, civilian organizations and public service agencies have been leveraging unmanned aircrafts' capabilities. One of the United States Customs and Border Protection (CBP) focus for its unmanned aircraft operational capability is anti-terrorism. This is accomplished through aiding in identification and interception of potential terrorists and illegal cross-border activity (U.S. Customs and Border Protection, 2016). CBP's unmanned programs also support disaster relief efforts with Department of Homeland Security (DHS) partners including the Federal Emergency Management Agency (FEMA) and the U.S. Coast Guard (USCG). Others in the civilian category with active UAS programs include:

- National Aeronautics and Space Administration (NASA)
- Department of Interior
- National Oceanic and Atmospheric Administration (NOAA)

An academic leader in the use and implementation of small to large unmanned platforms is the University of North Dakota (UND). UND has partnered with industry and military stakeholders to develop a UAS Center of Excellence in addition to the university receiving a designation as one of six coveted FAA UAS Test Sites (Dorr and Duquette, 2013). Other examples of universities with involvement in UAS research and education include:

- Kansas State University
- University of Florida
- Texas A&M University at Corpus Christi

In short, demand and growth for the use of unmanned aircraft exists at numerous levels ranging from the military to the commercial and civilian sectors. The military has been actively using the technology for decades whereas commercial and civilian uses have only recently taken root, but are growing at a dramatic rate. As a result of new found interest in this technology and related concerns, it has been necessary for the government to step-in to craft policy addressing numerous issues.

2.3 Issues and Policy

The aforementioned growth and demand in the military, commercial, and civilian markets have inserted the unmanned aircraft industry to the forefront of discussions on policy and regulation and multiple issues.

For example, in a Journal of Law Enforcement article *The Fear of Drones: Privacy and Unmanned Aircraft* the authors review privacy concerns related to public the use of unmanned aircraft technology. They suggest part of the issue is the public's misconception, and at times hysteria, surrounding privacy concerns of drones. Often times public misconception is sparked by inflated media coverage (Friedenzohn, Mirot, 2014). However, a more realistic interpretation of the public's common viewpoint can be observed in responses to a 2012 Associated Press National Constitution Center poll. Americans, when asked about degradation of privacy from use of UAS responded with mixed reviews – 35% concerned, 24% somewhat concerned about privacy issues (Friedenzohn, Mirot, 2014).

Additionally, even though there is considerable interest from many entities and sectors to utilize unmanned aircraft, FAA has been reluctant to permit operations over densely populated areas – often where law enforcement or private corporations may frequently seek to operate this technology (Balcerzak, Hiegel, 2013). These limitations can be attributed to a fundamental function for the FAA: ensuring safety of airspace. Certainly a policy that eliminates the risk of a collision with buildings, people, or other aircraft, can significantly reduce the possibility of an incident.

There are, however, technological solutions to help prevent collisions by enhancing situational awareness. Transponders, a device on manned aircraft providing positional information to air traffic control and pilots of other aircraft may eventually be a viable technical solution. However, as previously discussed, transponders are only available in a limited capacity for smaller unmanned platforms due to negative impacts on battery life and flight performance (McAdaragh, 2014).

In the absence of a viable technology solution to address airspace conflicts between manned and unmanned aircraft, especially in close proximity to airports, policy may be a feasible solution. For instance local ordinance or zoning could be effective tools for reducing the risk of small unmanned platforms' access to the airspace system.

A local policy solution would help municipal officials and local law enforcement address this technology as it has matured quickly and outpaced the "regulatory landscape" of the three prisms of government – federal, state, and local (Zoldi, Groff, Speirs, 2016). A thorough assessment of relevant policies was conducted and is described in Sections 4.3.1 and 4.3.2 of this study.

To summarize, this study will focus on four key areas: privacy, safety, technology, and regulation.

1. The issue of privacy will be studied in terms of what types of properties are more sensitive to imagery collected using unmanned aircraft.
2. Safety will be considered from the standpoint of where development on the ground and aircraft operating near airports are most sensitive to a collision with a small unmanned aircraft.
3. Technology, in the form of a GIS tool - in lieu of additional hardware installed on an unmanned platform, will assist with data-driven analysis and visualization for where the most sensitive areas are located at a case study airport.
4. Regulations at the Federal, state, and local levels will be studied to identify policy solutions for municipalities to address unauthorized unmanned activity near aviation activity and airports.

The significance of this study can be linked to increasing reports FAA has received from pilots reporting unauthorized unmanned aircraft activity flying near manned aircraft.

Chapter 3 Methodology

3.1 Study Design

As mentioned in chapter one, demand for the use of sUAS have inserted this technology at the front of policy discussions at three pillars of government – federal, state, and local. More specifically, since August 29, 2016 when FAA published Part 107 detailing the regulatory conditions for civilian and commercial uses of unmanned aircraft, there has been growing interest at the state and local levels to enact statues and policies to protect citizens, vital infrastructure and economic assets from unauthorized unmanned aircraft activity.

This study includes a qualitative content analysis of governments' unmanned aircraft policy, quantitative analysis for stakeholder responses to an anonymous survey of Air Transportation Advisory Committee members conducted by the North Central Texas Council of Governments, and quantitative analysis and visualization, using ESRI geographic information system (GIS) software. GIS will help map parcel and land use data from Tarrant County and the metropolitan planning organization, respectively, to help identify land uses suitable, or less sensitive, to unmanned aircraft activity. The Naval Air Station Fort Worth Joint Reserve will serve as the case study airport for this research given its location in an urban area and frequency of high-performance aircraft utilizing its airspace.

3.2 Data Collection Method

The public policy information for this study was obtained from the Federal Aviation Administration, Texas State Legislature, and primarily local governments in Texas. Air Transportation Advisory Committee (ATAC) survey responses and data were obtained from the North Central Texas metropolitan planning organization, North Central Texas

Council of Governments (NCTCOG). Land use data, updated in 2013, surrounding the Naval Air Station Fort Worth Joint Reserve Base (NAS FW JRB) was obtained from the NCTCOG Regional Data Center and parcel data, dated July 12, 2016, was obtained from the Tarrant County Appraisal District. Table 2 provides a quick reference of data sources and information acquired for this study.

Table 2: Primary Data Collection Sources

Survey Data	*Questionnaire*	NCTCOG Aviation Technical Advisory Committee Survey
UAS Policy	*Federal*	Federal Aviation Administration
	State	Texas State Legislature, National Conference of State Legislatures
	Local Policy	City of Kerrville, Addison, Texas
GIS Data	*Land Use*	NCTCOG Regional Data Center
	Parcel	Tarrant County Appraisal District

Simply put, the logic for this study's approach is that in order to craft a viable policy recommendation for local governments, it is prudent to understand first responder and aviation stakeholders' concerns about small UAS integration with manned aircraft near airports. Additionally, existing Federal and state policies must be examined as it relates to operational requirements and privacy. Lastly, technology, such as use of GIS tools and analysis, may provide the opportunity to guide the understanding and communication of areas around airports that may be sensitive to small unmanned aircraft activity.

Chapter 4 Analysis

4.1 NCTCOG sUAS Survey

On April 1, 2015 the North Central Texas Council of Governments (NCTCOG) hosted a Small Unmanned Aircraft Systems (UAS) workshop. The workshop was attended by Air Transportation Advisory Committee (ATAC) members, aviation industry stakeholders, and public safety professionals. During the workshop a survey was administered by NCTCOG staff. Appendix B contains a copy of the survey.

4.1.1 Survey Analysis

The survey instrument was a series of questions presented to workshop attendees using proprietary survey software. Responses to the survey were collected anonymously using electronic collection devices. NCTCOG staff constructed and proctored the survey for the workshop. Nine total questions were asked. There were 35 total survey participants (N=35). Table 3 shows the distribution of this cohort by attendees.

Table 3: NCTCOG Survey Participant Distribution

Title	**n**
Airport Directors/Managers	9
First Responders	16
Aviation Industry Stakeholders	10
Total (N)	**35**

The first two questions of the questionnaire provide responses to this study's question about the levels of knowledge about and support for growth in UAS among aviation industry stakeholders, municipal airport managers/directors, and public safety professionals. The study's question about impacts of UAS and level of support for local UAS policy is addressed by questions 3 and 9, respectively, of the questionnaire.

4.1.2 Survey Outcome

Results of the anonymous survey revealed what respondents indicated their level of knowledge about sUAS to be (see Table 4).

Table 4: Survey Outcome - Knowledge of UAS

Response	Percent	Count
None	3.13%	1
Limited amount	40.63%	13
Fair amount	37.50%	12
A great deal	18.75%	6
Totals	**100%**	**32**

A majority of the workshop attendees, over 78%, responded that they knew a "limited" or "fair" amount about unmanned aircraft. Slightly under 20% indicated they knew "A Great Deal" about this technology. Only one person indicated their level of knowledge was "None."

Another question showed there was overwhelming support for the growth of the unmanned aircraft industry (see Table 5).

Table 5: Survey Outcome - Support UAS Growth

Response	Percent	Count
Yes	91.43%	32
No	8.57%	3
Totals	**100%**	**35**

Specifically, over 90% of those participating in the survey support UAS growth. Only 3 out of 35 respondents were against growth of this new industry.

Answers provided to these questions represents a need to further educate municipal and industry staff about unmanned aircraft technology since over 80% or those surveyed indicated they know “a fair amount” at best. Growing this knowledge base with experts would be beneficial in crafting local unmanned aircraft policy so they could make more informed decisions about unmanned aircraft policy and its implementation.

Table 6 displays the percentages of workshop attendees who believed local ordinances or land use and zoning strategies for UAS would be valuable.

Table 6: Survey Outcome - Value of Local UAS Planning

Responses	Percent	Count
Yes	91.43%	32
No	2.86%	1
Unsure	5.71%	2
Totals	**100%**	**35**

Specifically over 90%, or 32 people, responses indicate there is a perceived value in crafting local-level unmanned aircraft policy. Only one person indicated there was “No” value with two responding they were “Unsure”. Combined these two responses accounted for less than 10% of the participants.

Table 7 details survey participants’ thoughts regarding top concerns for UAS policy.

Table 7: Survey Outcome - Top Concerns for UAS Activity

Responses	Percent	Count
Privacy	9.90%	10
Safety (Airspace Conflicts)	28.71%	29
Notification, Approval Process	11.88%	12
Standardized Training/Certification	26.73%	27
Not Enough Regulation	9.90%	10
Too Much Regulation	12.87%	13
Totals	**100%**	**101**

For this question participants could choose up to three responses. The outcome shows that the primary concerns are safety – airspace conflicts, and standardized training and certification with 28.71% and 26.73% respectively. This accounts for nearly two-thirds of the 101 responses provided. Almost 13% of responses indicated there was a concern about too much regulation with a notification and approval process coming in with the fourth amount of responses at 11.88%. Not enough regulation and privacy received the same number of responses at 10 and accounted for 9.90% each.

To summarize the results of the survey, there is a positive outlook for and interest in the growth of this technology; however, a firm foundation for knowledge about unmanned aircraft is lacking, and would be useful among decision makers given their concerns for safety of airspace. Overall, the responses display a willingness of respondents to accept growth of this technology, but there is a belief that policy could be useful to regulate its uses within a municipality's jurisdiction. The appropriate policy recommendation will be, in part, contingent on outcomes of the policy analysis in Section 4.2.

4.2 Policy Analysis

An analysis of current small unmanned policy will guide the answer to this study's question regarding what principles and/or components should be included in a policy recommendation for a municipal policy to address small unmanned aircraft activity near aviation facilities. Table 8 provides an overview of Federal and State of Texas policies for unmanned aircraft regulation.

Table 8: Unmanned Aircraft Policy Overview

Level of Government	Agency Name	Policy	Purpose	Relevant Study Focus Area
Federal	Federal Aviation Administration	Advisory Circular (AC) 91-57A	Provides operational guidance to model aircraft operators	Safety, Operations
		Title 14 Code of Federal Regulations Part 107 - Small Unmanned Aircraft Systems	Regulates operational activity and FAA authorizations for commercial unmanned aircraft	
		Title 49 U.S.C. §§ 40102(a)(41) and 40125	Regulates operational definitions of non-model unmanned aircraft and authorizations for related activity	
State of Texas	N/A	Chapter 423 Texas Government Code - Texas Privacy Act	Regulates how imagery captured by unmanned aircraft can be acquired	Privacy
	Texas Department of Public Safety	Chapter 411.062 Part (d) Texas Local Government Code - Law Enforcement and Security Authority	Permits adoption of rules governing use of unmanned aircraft in the State Capitol Complex	Safety, Operations

More detailed discussion for each policy highlighted in Table 8 is provided throughout Section 4.2 of this study.

4.2.1 Federal Policy

In 1981 the FAA published Advisory Circular (AC) 91-57 regarding operating standards for recreational unmanned aircraft operations. The primary intent behind this

AC “was safe operation of model aircraft” (Cho, 2014). Until the twenty-first century, this policy served as the basic guidance for operating unmanned aircraft. The operating standards of AC 91-57 required hobbyists take precautions to ensure operations were less than 400 feet above the ground, away from crowded areas, and operators were “advised to notify the airport operator or control tower“ when flying within 3 miles of an airport (Cho, 2014).

However, AC 91-57 contained no enforceable authority as it was intended to be advisory in nature for recreational activity and, in June 1981 when FAA first published AC 91-57, widespread opportunities to leverage UAS technology as a public agency or for commercial activity had not been established or materialized (Cho, 2014).

On February 14, 2012 the United States Congress mandated the FAA develop plans for the integration of UAS in the national airspace via passage of H.R. 658 – FAA Modernization and Reform Act (FMRA) of 2012. Furthermore, this legislation required FAA develop plans for the integration of unmanned aircraft in the NAS by September 30, 2015 (NCTCOG, 2015).

Finally, after much anticipation from the aviation industry, August 29, 2016 FAA published their final rule, Title 14 Code of Federal Regulations - Part 107 (Part 107), for the operation of small unmanned aircraft. Through this regulatory process, FAA reviewed and updated the guidance for model aircraft and worked to develop a complete policy mechanism for broader small unmanned flight activity.

As a result of this process, FAA now categorizes small unmanned aircraft systems (sUAS) population into three subpopulations – model aircraft/recreational, commercial, and other non-model aircraft. Thru the current FAA authority, as it applies to this study, pilots receive authority to operate under the commercial and other non-model aircraft subpopulations through Title 14 Code of Federal Regulations Part 107 - Small

Unmanned Aircraft Systems and Title 49 U.S.C. §§ 40102(a)(41) and 40125. An overview of each are provided below.

1. 14 CFR Part 107: A regulatory framework addressing airspace restrictions, remote pilot certification, visual observer requirements, and operational limits for commercial small unmanned aircraft operations.
2. Title 49 U.S.C. §§ 40102(a)(41) and 40125: § 40102(a)(41) provides the definition of “Public Aircraft” and § 40125 provides the qualifications for public aircraft status Combined these provide the statutory provisions for legal operation of public aircraft (FAA, 2012).

It is important to note that both commercial and non-model aircraft operators e.g. public aircraft, must receive an FAA certificate of authorization (COA) prior to performing operations. The COA requirements are nearly identical for each of these subpopulations.

Under the FAA authority that governs them, commercial and non-model aircraft subpopulations are subject to the greatest scrutiny in terms of training and operational requirements (FAA, 2016). For example, Part 107 training requires a remote pilot certificate (RPC), attained by completing an FAA Aeronautical Knowledge Test. With this privilege comes accountability – RPC holders are subject to enforcement action by the FAA. Similarly non-model aircraft operations as a public aircraft operator require stringent initial and recurrent training as part of the process to receive FAA authorization. When considering the amount of time and money invested in training and purchasing professional equipment, it is reasonable to expect commercial and non-model aircraft operators will operate in a manner that would lead to their FAA authorization being revoked.

Conversely, the model aircraft/recreational subpopulation are permitted to operate without FAA authorization or any formal training. The FAA “governs” the model aircraft subpopulation thru Advisory Circular 91-57A (91-57A) - *Model Aircraft Operating Standards*. AC 91-57A merely provides guidance to model aircraft operators; for example, when flown within five miles of an airport (see Figure 3), a model aircraft operator is asked to provide the airport operator and the airport air traffic control tower (when an air traffic facility is located at the airport) prior notice of the operation (FAA, 2016).

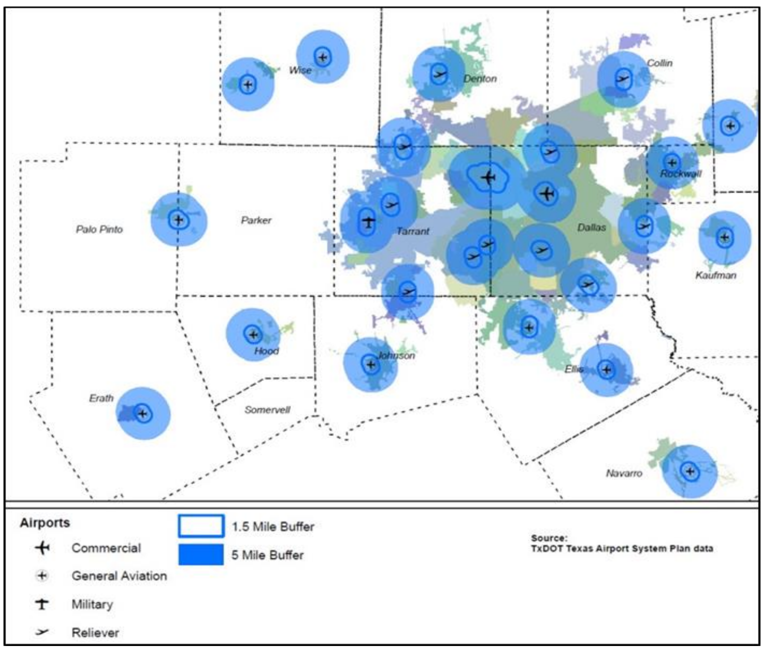


Figure 3: Five Mile Buffer - North Central Texas Airports

If a model aircraft operator abides by guidelines set forth by FAA in AC 91-57A there is limited risk to airports and related aviation activities. However, the relaxed, non-existent enforcement authority of AC 91-57A's guidance leaves airports exposed to unauthorized model aircraft activity from a range of veiled threats such as organizations or people linked to terrorism, with hidden malevolent intent, or individuals ignorant of FAA policy and/or unaware of their geographic proximity to an airport.

4.2.2 Federal Policy Outcomes

To summarize, the federal government has structured their regulation of unmanned aircraft activity into three types of operations – model aircraft/recreational, commercial, and other non-model aircraft.

The commercial and non-model aircraft operators are subject to the highest standards and scrutiny by the FAA. As a result the commercial and other non-model aircraft subpopulations are not deemed a concern in terms of unauthorized operations. The logic for this reasoning is that there is a high degree of degree of training, regulation, and enforcement mechanisms required to receive FAA operational approval and authorization for operations. On the other hand, FAA's model aircraft guidance in AC 91-57A, with its lack of enforcement authority, provides limited action for officials and law enforcement to take in response to unauthorized and unsafe recreational unmanned aircraft flights near airports.

Table 9 synthesizes FAA's unmanned aircraft policy requirements and guidance for each of these subpopulations as discussed in Section 4.2.1.

Table 9: Federal Unmanned Aircraft Policy (FAA, 2015)

<table>
<tr><th>Federal Policy and Regulation</th><th>General Emphasis</th><th>Key Guidance and Requirements*</th><th>Missing Elements</th></tr>
<tr><td>Advisory Circular (AC) 91-57A</td><td>Provides operational guidance to model aircraft operators</td><td>1) Fly at a local model aircraft club
2) Inform self of safe flying techniques
3) Recommend contacting airport control tower when flying within 5 miles of airport
4) Do not operate near manned aircraft
5) Do not fly beyond line of sight
6) Aircraft cannot be over 55 pounds
7) Do not fly for payment or commercial purposes
8) Operations must remain below 400 feet above ground level
9) Must register aircraft with FAA</td><td>1) Privacy requirements
2) Enforceable safety/operational requirements</td></tr>
<tr><td>Title 14 Code of Federal Regulations Part 107 - Small Unmanned Aircraft Systems</td><td>Regulates operational activity and FAA authorizations for commercial unmanned aircraft</td><td rowspan="2">1) Aircraft must weigh less than 55 pounds
2) Do not fly beyond visual line of sight
3) Operations must be during daylight
4) ATC approval required before flying in controlled airspace
5) Flights not permitted directly over people not participating in the flight
6) Must be registered if weighing between .55 and 55 pounds
7) Operations must remain below 400 feet above ground level (unless granted a waiver by FAA)
8) Airmen certification or remote pilot certificate required before flight</td><td rowspan="2">1) Privacy requirements</td></tr>
<tr><td>Title 49 U.S.C. §§ 40102(a)(41) and 40125</td><td>Regulates operational definitions of non-model unmanned aircraft and authorizations for related activity</td></tr>
</table>

*Note: Commercial and non-model unmanned aircraft requirements are nearly identical.

Reviewing details presented in Table 9 show the guidance for model aircraft operations is close in many respects to that of commercial and non-model aircraft activity. Commonalities exist when considering visual line of sight, altitude, registration, or weight restrictions, although there is large dissent between requirements for training and communication with air traffic control towers. As previously stated in Section 4.2.1, commercial and non-model aircraft activity must adhere to specific, and enforceable, airmen certification and training requirements. These requirements are not applicable to model aircraft which is a concern when accounting for activity in close proximity to airport and manned aircraft. Privacy is an element that was not addressed in FAA's policies and is largely based upon rights to address privacy concerns at the state and local government level. Section 4.2.3 will discuss privacy in more detail.

It would be remiss not to mention in January 2015 FAA released *Law Enforcement Guidance Concerning Suspected Unauthorized UAS Operations*. However, this guidance to law enforcement simply explains to first responders how to document and report careless or reckless small unmanned activities to FAA for their own administrative safety enforcements. The guidance does not offer any suggested solutions for local law enforcement to take action within their jurisdictional responsibility. Without a vetted state or local standard to address unauthorized activity near airports, local governments across the United States continue taking steps of their own to ensure the safety of their municipalities from unauthorized unmanned activity.

4.2.3 State and Local Policy

When taking into account UAS growth projections discussed in Chapter 2, it is understandable why states and local municipalities have an interest in creating statutes and policies regarding UAS operations. Appendix A provides an inventory of unmanned aircraft legislation for the fifty states in 2015.

During Texas' 83rd State Legislature the state enacted a statute referred to as the Texas Privacy Act (TPA), addressing privacy from imagery acquired using unmanned aircraft. Advocates for Texas' unmanned aircraft legislation argued the FAA has limited experience and purpose in the realm of privacy protection noting that the regulation and safety of airspace is FAA's jurisdiction – not personal privacy. Proponents for this bill suggested the State is best suited to establish laws protecting Texans' rights. Those opposing the bill primarily argued for the consideration of preemptive powers, stemming from final FAA regulations for sUAS (House Research Organization, 2013).

Signed by the Governor and subsequently enacted, the TPA added Chapter 423 to the Government Code. It defines an “image" captured by unmanned aircraft, and creates a class C misdemeanor offense if a person uses an unmanned aircraft to capture an image of a person or privately owned property. A Class B misdemeanor is also created for the disclosure, display, distribution or other use of the images. As defined by the TPA, an image is defined as any capturing of sound waves, thermal, infrared, ultraviolet, visible light or other electromagnetic waves, odor or other conditions existing on a property or an individual located on that property.

The TPA also details how individuals may lawfully capture an image using an unmanned aircraft to include images captured:

1. For professional or scholarly research and development by a person acting on behalf of an institution of higher education;
2. In airspace designated as a test site or range authorized by the Federal Aviation Administration for the purpose of integrating unmanned aircraft systems into the national airspace;
3. For an operation, exercise, or mission of any branch of the United States military;
4. By a satellite for the purposes of mapping;
5. For an electric or natural gas utility;
6. With the consent of the individual who owns or lawfully occupies the real property captured in the image;
7. Pursuant to a valid search or arrest warrant;
8. By a law enforcement authority or a person who is under contract with or otherwise acting under the direction or on behalf of a law enforcement authority;

9. By state or local law enforcement authorities, or a person who is under contract with or otherwise acting under the direction or on behalf of state authorities;
10. At the scene of a spill, or a suspected spill, of hazardous materials;
11. For the purpose of fire suppression;
12. For the purpose of rescuing a person whose life or well-being is in imminent danger;
13. By a Texas licensed real estate broker in connection with the marketing, sale, or financing of real property, provided that no individual is identifiable in the image of real property or a person on real property that is within 25 miles of the United States border;
14. From a height no more than eight feet above ground level in a public place, if the image was captured without using any electronic, mechanical, or other means to amplify the image beyond normal human perception;
15. Of public real property or a person on that property;
16. By the owner or operator of an oil, gas, water, or other pipeline for the purpose of inspecting, maintaining, or repairing pipelines or other related facilities, and is captured without the intent to conduct surveillance on an individual or real property located in this state;
17. In connection with oil pipeline safety and rig protection;
18. In connection with port authority surveillance and security.

According to the TPA, unlawful capturing of an image is when a person uses an unmanned aircraft to capture individual or privately owned real property in this state with the intent to conduct surveillance on the individual or property captured in the image. It is also an offense to possess, disclose, display, distribute or use an image (Gooden, Riddle, Burnam, Stickland, 2013).

Specific rules for Law Enforcement require the Texas Department of Public Safety (DPS) to adopt rules and guidelines for the use of an unmanned aircraft by a law enforcement authority in this state. Additionally, a municipal or county law enforcement agency located in a city or a county with a population of greater than 150,000, or a state law enforcement agency, that used or operated an unmanned aircraft would be required to issue a written report to each member of the Texas Legislature and retain the report for public viewing and post the report on the entity's website (Gooden, Riddle, Burnam, Stickland, 2013).

It is permissible for states and municipalities to establish law enforcement agencies and regulate activities deemed hazardous, intrusive, or otherwise having a negative impact on the health and welfare of citizens (Friedenzohn, Branum, 2015). While FAA was preparing its long awaited small unmanned aircraft regulations, state and local governments were actively taking action to enact laws of their own (Breitenbach, 2015).

For example, states have crafted legislation to regulate and even prohibit certain types of unmanned aircraft operations. During the 2013 state legislative sessions, 43 states considered 96 bills. Nine of these states moved forward with enacting legislation (Bohm, 2013). Another 35 states considered UAS bills and resolutions in 2014. Figure 4 displays 2013 (left) and 2014 (right) UAS legislation as of September 16, 2014 (NCTCOG, 2015). Appendix A provides an inventory of state unmanned aircraft legislation for 2015.

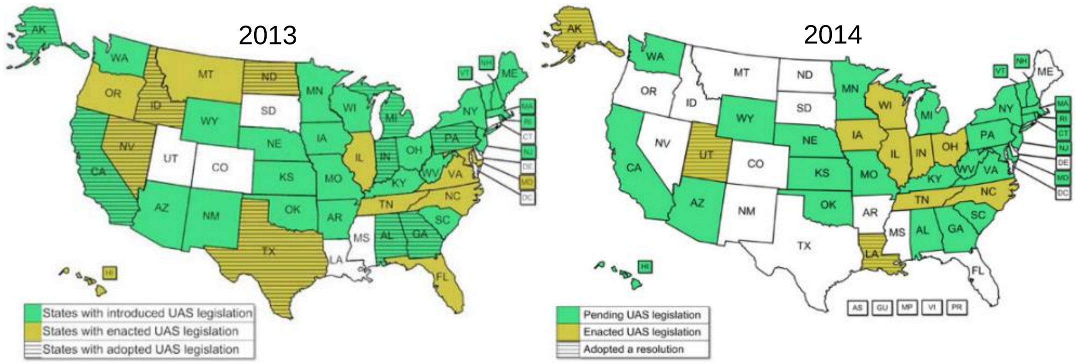


Figure 4: UAS State Legislation Maps (Essex, 2016)

During the regular session of Texas' 84th Legislature, several bills addressing unmanned aircraft were introduced. Three were enacted. HB3628 amended Chapter 411 of the Texas Government Code (TGC) to adopt rules governing use of unmanned aircraft in the Capitol Complex – with a Class B misdemeanor as penalty for an offense. Two of the bills, HB1481 and HB2167, amended Chapter 423 of the TGC. HB1481 added the prohibition of operations over critical infrastructure facilities e.g. electrical power generating facilities, a dam, and telecommunications switching offices. Provisions for operations over critical infrastructure were made if the unmanned aircraft are operated by the government, city, or a person under contract with a law enforcement agency (House Research Organization, 2015). HB2167 was a simple amendment that added engineering and surveying to the list of lawful uses to obtain imagery (NCTCOG, 2015).

4.2.4 State and Local Outcomes

While each of the bills from the 83rd and 84th Texas Legislative add value towards the goal of protecting the population from voyeurism and malicious activity targeting key utilities and energy infrastructure, none go so far as to recommend how local municipalities can address unauthorized unmanned operations near airports. Table 10 synthesizes Texas' unmanned aircraft statutes as discussed in Section 4.2.3.

Table 10: State Unmanned Aircraft Policy (House Research Organization, 2015)

State Statutes	General Emphasis	Key Requirements	Missing Elements
83rd Regular Legislative Session - HB912	Relating to images captured by unmanned aircraft and other images and recordings; providing penalties	Added Chapter 423 to the Texas Government Code with nineteen permitted uses for imagery collected using unmanned aircraft to protect privacy (outlined in Section 4.2.3).	Enforceable safety/operational requirements
84th Regular Legislative Session - HB1481	Relating to certain images captured by an unmanned aircraft	Amended Chapter 423 to create an offense for unmanned operations over "critical infrastructure facilities" such as refineries, electrical grids, chemical manufacturing facilities, dams, etc.	Privacy requirements
84th Regular Legislative Session - HB2167	Relating to prohibiting the operation of an unmanned aircraft over certain facilities; creating a criminal offense	Amended Chapter 423 to include imagery captured by a professional land surveyor or engineer as permissible	Enforceable safety/operational requirements
84th Regular Legislative Session - HB3628	Relating to the adoption by the Department of Public Safety of rules governing the use of unmanned aircraft in the Capitol Complex; creating a criminal offense.	Amended Chapter 411 of the Texas Government Code prohibiting or authorizing limited use of unmanned aircraft activity in the Capitol Complex	Privacy requirements

Details presented in Table 10 show the State's approach to regulate unmanned aircraft would apply to all subpopulations previously identified in this study. This is a step in the right direction as Texas' legislature has worked to enact several bills addressing privacy and safety/operational requirements for flights. However, none of the bills passed by the State provide local governments with authority to address unauthorized model aircraft activity near airports.

This is an important point of emphasis as FAA has reported 15% of unauthorized UAS sightings near aircraft have taken place in Texas. In October 2014 an unmanned aircraft crashed within Dallas Love Field's airspace (Russell, 2014). Figure 5 shows the crash site was merely 2.5 miles from the active runway which handled over 4 million passengers in 2014 (City of Dallas, 2015).

Figure 5: UAS Crash Site Near Dallas Love Field Airport (NCTCOG, 2015)

A primary cause for cities taking action themselves stems from numerous reports detailing dangerous operations near airports. Multiple sightings near John F. Kennedy International Airport were reported by the Wall Street Journal with Delta pilots quoted as seeing a drone come within 10 feet of their aircraft (Tangel, Nicas, 2014). Of the few cities that have drafted resolutions and/or an ordinance, safety of airspace and privacy are often the chief concerns. February 2013 Charlottesville, Virginia took action by implementing a two-year moratorium for unmanned aircraft activity (Swanson, 2013).

This mirrored a decision by the Virginia General Assembly (Friedenzohn, Branum, 2015). In Texas, there are two known examples of a local government implementing regulations to address sUAS activity.

1. Kerrville, Texas: currently working to write the city's first regulations which would ban unmanned aircraft use in city parks (Reiley, 2016).
2. Addison, Texas: Section 58-41 of the City Code states no person shall propel an object such as a model aircraft in park or recreational areas (City of Addison, 2016)

However, precedence has been set by numerous court rulings regarding preemption and federal authority regarding airspace regulation (Friedenzohn, 2015). Court findings provide an important perspective into the limitations and exceptions afforded state and local governments when attempting to regulate aviation activity. For example, cases have proven there are instances where the federal government does not have entirely exclusive powers to regulate aviation activity. Specifically, the Ninth Circuit Court of Appeals, on Santa Monica Airport Association v. City of Santa Monica, held the city's ordinance for a night curfew and restricting helicopter training was not an action of regulation or airspace or flight (Friedenzohn, Branum, 2015).

In summary, Texas has enacted several bills addressing privacy and certain types of operational safety concerns in specific locations such as the Capitol Complex and over critical infrastructure facilities. Unfortunately none of the safety- related policies address unauthorized activities near airports. Only one city in Texas at the date of this study has written policy which addresses unmanned activity in parks, with another soon to follow with a similar approach. This reveals a gap in existing State and local policies to enable municipalities to effectively address unauthorized unmanned aircraft near airports.

4.3 GIS Suitability Analysis

One of the goals for this study is to leverage a case study and develop a tool using GIS which will establish a suitability analysis of appropriate locations to takeoff or land unmanned aircraft near Naval Air Station Fort Worth Joint Reserve Base (NAS Fort Worth JRB).

Suitability of an area for this study will be defined as a function of the land use or parcel use located within the clear zones (CZ) or accident potential zone one (APZ-I) or APZ two (APZ-II) at NAS Fort Worth JRB. CZs and APZs are imaginary areas extending off the ends of NAS Fort Worth JRB's runways. Per Navy's OPNAVINSTRUCT 11010.36C – Air Installations Compatible Use Zones (AICUZ) Program, published October 9, 2008 (see Appendix C), the CZ is shaped like a trapezoid. This Navy document defines dimensions of APZ-I as 5,000 feet in length by 3,000 feet in width and APZ-II as 7,000 feet by 3,000 feet in width. Publically owned municipal airports, owned by local governments, define similar areas as runway protection zones (RPZ). Table 11 shows the sensitivity of these areas in relation to land use and parcels.

Table 11: Geographic Areas for Suitability Analysis at Case Study Airport (Navy, 2008)

Geographic Area	**Dimensions**	**Sensitivity to Development**
Clear Zone (CZ)	Trapezoidal, fan shaped extending immediately off the runway end	High
Accident Potential Zone I (APZ-1)	5,000 feet long by 3,000 feet wide	Med-high
Accident Potential Zone II (APZ-II)	7,000 feet long by 3,000 feet wide	Medium

Table 11 helps explain the Navy's AICUZ Program recommendations; the more dense development is in a compatible use zones (CZ, APZ-I, APZ-II) the less suitable it is near aviation activity due to potential risks to public safety, health, and welfare. This same assumption will also be leveraged for analysis in these areas for small unmanned aircraft activity. The study will account for physical development, geographically located within the bounds of the compatible use zones, in terms of land use and parcel data.

For the study GIS was used to export geocoded land use and parcel data, using unique identifiers, within the NAS Fort Worth JRB's CZs and APZs that are defined by the Navy's AICUZ program. Following the export process, a crosswalk (see Table 13) was created to match broader, and typically geographically larger, land use categories to state parcel use categories. Manual, random checks of addresses were used to confirm parcels and land uses were categorized appropriately during the crosswalk. There were a total of N= 436 land uses and N= 2,499 parcels within the CZs and APZs.

In keeping with Navy OPNAVINST 11010.36C guidance, calculating the scoring for land use and parcel suitability, the sensitivity weight of a given land use or parcel was assigned a value of one thru eight based upon density of development. This corresponds with suggested land uses for development in the CZs and APZs as defined by the Navy:

- High Density Residential (single family, multifamily housing) = 8 (highest sensitivity weight)
- Low Density Residential (acreage property) = 7
- Billboards = 6
- Retail, Commercial Services = 5
- Manufacturing, Trade, Industrial = 4
- Utilities = 3
- Cultural, Entertainment, Recreational = 2
- Vacant, Undeveloped Land = 1 (lowest sensitivity weight)

Table 13 provides a simplified overview of the assigned sensitivity weights. Figure 6 visually describes the relationship of the dependent variable, sensitivity, to the independent variable, density of development.

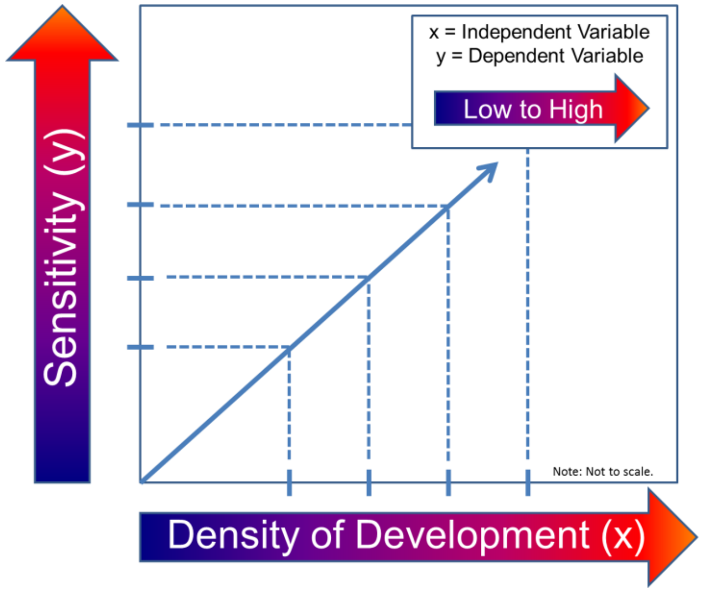


Figure 6: Independent and Dependent Variables

The United States Code (USC) Title 32: National Defense, Part 256 - Air Installations Compatible Use Zones defines the greatest sensitivity to development, and highest priority for protection, is within the CZs, followed by APZ-1 and then APZ-2. Using the standards established by USC Title 32, for this study land located in a CZ correlates to a multiplier of three, APZ-1 receives a multiplier of two, and APZ-II receives a multiplier of 1.

Using this approach, based upon Federal guidelines, the final weighted scores of the suitability analysis could range from one to twenty four. For example a high density residential use, with an assigned weighted factor of eight, located in the CZ, with its multiplier of three, would yield a 24 - equating to a least suitable rating (see Table 12). In short, a higher weighted score corresponds with less suitability for the activity of unmanned aircraft in the CZ, APZ-1, or APZ-II. The methodology for weighted scoring could be described in an equation such as:

f(x) = weighted suitability score

X = sensitivity score per land use or parcel category

Multipliers: a = 3 (CZ), b = 2 (APZ-I), c = 1 (APZ-II)

where f(x) = Xa or f(x) = Xb or f(x) = Xc

In short, the multipliers, land use and parcel sensitivity weights were derived from policy and guidance within USC Title 32 and Navy OPNAVINST 11010.36C guidance.; Table 12 describes the suitability rating assigned based upon final weighted scores.

Table 12: Suitability Rating Matrix

Weighted Score	Suitability Rating
1-8	Somewhat Suitable
9-16	Less Suitable
16-24	Least Suitable

Table 13 delineates the crosswalk analysis, related sensitivity weights by land use and parcel categories, and the number of land use and parcels located within the North and South runway CZs and APZs for NAS Fort Worth JRB. Excel's IF function calculated the weighted scoring for land use and parcel values. Unique identifiers were utilized during the import and export process to ensure accuracy of importing altered data back into GIS.

Table 13: Land Use and Parcel Analysis

Sensitivity Weight	Parcel State Code	Category	CZ Count	APZ-1 Count	APZ-2 Count	Land Use Category	CZ Count	APZ-1 Count	APZ-2 Count
8	A1	Single-Family	13	271	943	Single family	1	37	109
	A2	Mobile Homes	0	0	0	Multi-family	0	0	5
	A3	Condominiums	0	0	0	Mobile home	0	0	3
	A4	Townhomes	0	0	0	Hotel/motel	0	0	1
	A5	Condominiums	0	0	0	Education	0	0	6
	BC	Residential	0	0	4	Runway	3	1	0
	B1	Multi-Family	0	0	14	Water	1	1	2
	B2	Duplex	0	0	0	Institutional/semi-public	1	1	13
	B3	Triplex	0	0	0		0	0	0
	B4	Quadraplex	0	0	0		0	0	0
	AC	Church	0	1	45		0	0	0
	M3	Mobile Home	0	0	0		0	0	0
7	E1	House + Limited Acres	0	0	0		0	0	0
	E2	Mobile Home + Limited Acres	0	0	0		0	0	0
6	F3	Billboards (Obstruction)	0	0	0		0	0	0
5	F1	Commercial	12	66	248	Commercial	3	30	73
		Commercial	0	0	0	Retail	0	2	0
	L1	Commercial	11	207	239	Office	0	1	1
4	L2	Industrial	0	1	5		0	0	0
	F2	Industrial	0	0	2	Industrial	0	0	2
3	G1	Oil/Gas/Mineral Reserves	0	0	0		0	0	0
	J1	Water Systems	0	0	0		0	0	0
	J2	Gas Companies	0	0	0		0	0	0
	J3	Electric Companies	0	15	0		0	0	0
	J4	Telephone Companies	0	0	3	Communication	0	0	2
	J6	Pipelines	0	0	0		0	0	0
	J7	Cable Companies	0	0	0		0	0	0
	J8	Other Utility	0	0	0	Utilities	0	3	4
2	E3	Other Improvements	0	0	0	Small water bodies	0	1	4
		Other Improvements	0	0	0	Parks/recreation	0	3	5
1	C1	Residential Vacant	27	130	224	Vacant	3	47	67
	C2	Commercial Vacant	0	1	9		0	0	0
	C3	Rural Vacant	0	0	0		0	0	0
	C6	Vacant Exempt (Right-of-Way)	0	0	0		0	0	0
	D1	Ranch Land	0	7	1		0	0	0
	D2	Timberland	0	0	0		0	0	0
	D3	Farmland	0	0	0		0	0	0
	J5	Railroads	0	0	0		0	0	0
	D4	Undeveloped	0	0	0		0	0	0
		Total	63	699	1737	Total	12	127	297
		Total Parcels	**2499**			**Total Zoning Count**	**436**		

Using GIS, land use and parcel data in the CZs and APZs were selected based upon location within the CZs and APZs. The Clip function was applied to confine the visualization to the appropriate geographic coverage. Figure 7 provides an example of this process using ESRI GIS' model builder. The outcome of the data selection process was exported to Excel for the previously mentioned categorization, scoring, and weighting to define suitability. Next the weighted data was imported and joined to its respective feature using the unique identifiers.

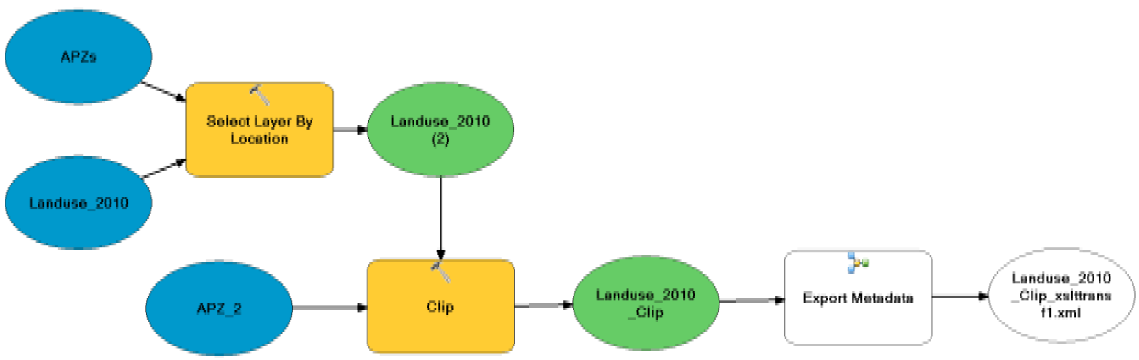


Figure 7: GIS Data Model Builder Process

4.3.1 GIS Suitability Analysis Outcome

Figures 8 and 9 are results of the suitability analysis of weighted land use and parcels located in NAS Fort Worth JRB's CZs and APZs. By comparing the two figures, the suitability analysis results using zoning data is more conservative than use of the parcel data.

Initially it was thought that the parcel use data would yield more conservative results following the analysis. However, further analysis of the data, including a quality check, confirmed results; zoning data to delineate areas suitability for unmanned aircraft activity near an airport provides more conservative protections than that of parcel use data.

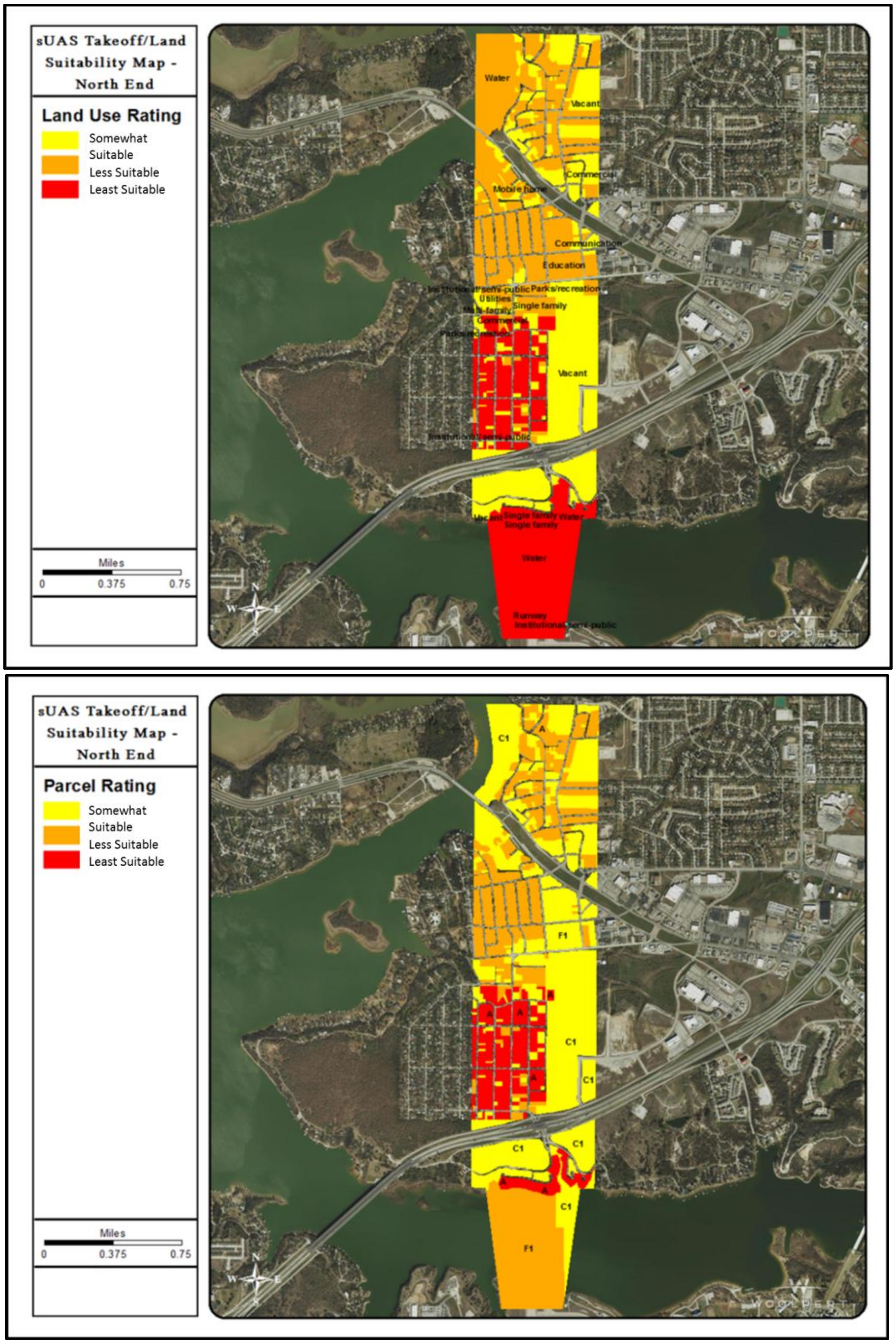
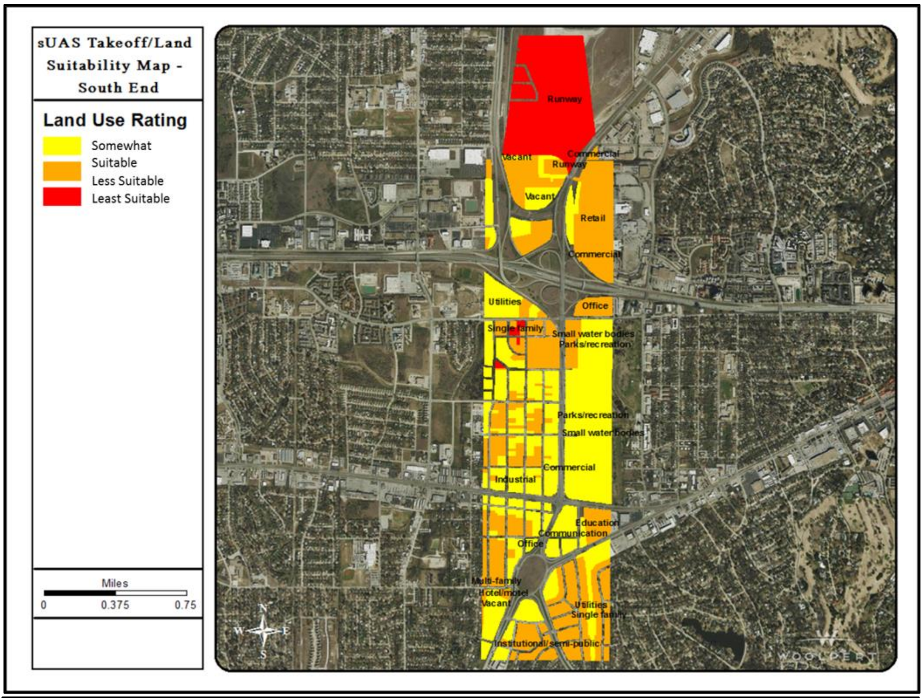


Figure 8: Land Use, Parcel Suitability Analysis (Northern Runway)



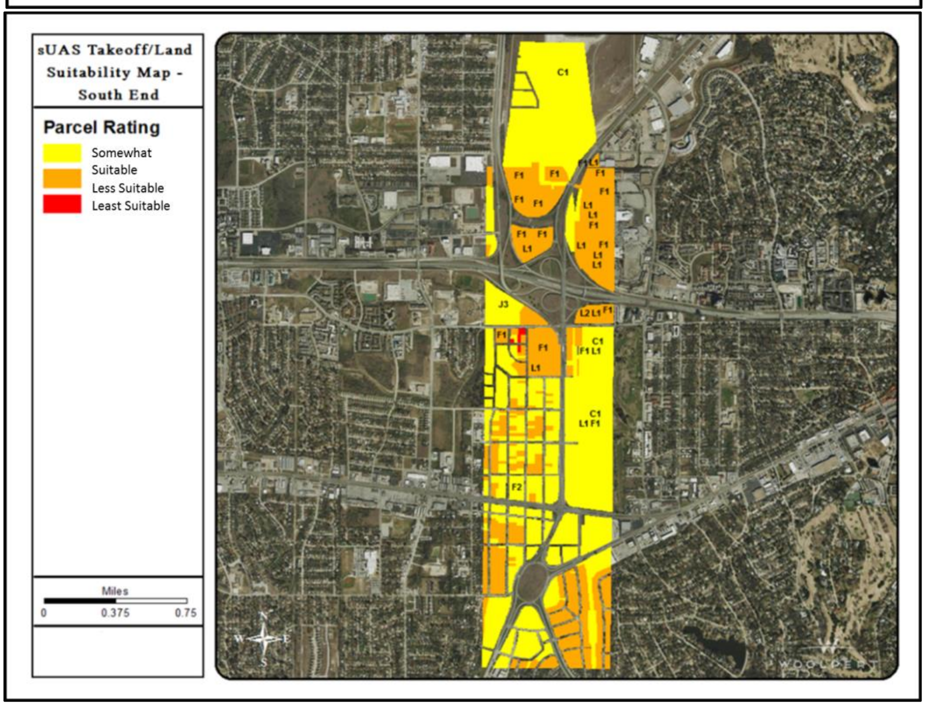


Figure 9: Land Use, Parcel Suitability Analysis (South End)

To summarize, sensitivity to unmanned aircraft activity was a function of density of development. The greater the density of development, the greater the risk to public health and welfare was leading to a lower suitability rating. Similarly, privacy concerns can be assumed to be greater in higher density areas since a population concentration will naturally increase the overall privacy sensitivity in that location.

4.4 Summary of Analyses

Results of the NCTCOG survey indicate there is a positive outlook and interest for the growth of unmanned aircraft, although more knowledge is needed and will help guide decision makers make policy decisions regarding their concern for safety of airspace.

The federal government has structured their regulation of small unmanned aircraft activity into three types of operations – model aircraft/recreational, commercial, and other non-model aircraft. We know commercial and non-model aircraft operators are subject to the highest standards and scrutiny by the FAA and, as a result, are less of a concern for unauthorized operations. On the other hand, policy for model aircraft, operating with a general lack of FAA enforcement, provides limited action for officials and law enforcement to take in response to unauthorized and unsafe recreational unmanned aircraft flights near airports.

The State of Texas has accomplished a great amount of work in two legislative session towards the goal of protecting the population from voyeurism, or violations of privacy, and malicious activity targeting key utilities and energy infrastructure. However, more can be done to assist local municipalities address unauthorized unmanned operations near aviation activity and infrastructure given only one known municipality has drafted an ordinance to address unmanned operations within its jurisdiction.

Finally, United States Code and Navy recommendations for development near aviation activity in compatible use zones was used to conduct a GIS suitability analysis. The result showed that land use data would provide a more conservative approach to protect airports and higher density development from privacy concerns and risks to public health and welfare from the possibility of a collision between a manned aircraft and unmanned aircraft. As previously mentioned, municipal airports would be able to use a similar approach to conduct a suitability analysis based upon FAA defined runway protection zones – similar to the compatible use zones used in analysis for this study.

Chapter 5 Recommendations

The advent and growth of UAS technology for civilian purposes is recognized by many as far-reaching. Private corporations, industry groups, the general population, and politicians see the economic potential for this new aviation industry. As a result, significant pressure was placed on Congress, and subsequently the Department of Transportation and the Federal Aviation Administration, to establish a comprehensive plan for the safe integration of UAS into the United States air traffic system. However, this ultimately fell short in terms of equipping states and local governments with adequate privacy and safety solutions.

When considering outcomes of this study's analyses, there is overwhelming support for growth of unmanned aircraft growth. There is also significant support for local policy solutions to address unauthorized unmanned activity that may negatively impact safety in terms of airspace conflicts between manned and unmanned aircraft, and lack of adequate training and awareness prior to access and use of the airspace system.

Aligned with communicating areas more appropriate for the takeoff and landing of unmanned aircraft near an airport, the GIS analysis showed use of land use data provides a more conservative approach when to better understand suitability ratings. As a result, GIS maps delineating geographic areas in the compatible use zones of an airport e.g. CZs and APZs, could be provided to city staff and officials. Municipal officials could then determine the best approach for their constituents and local law enforcement's ability to react and address unauthorized unmanned aircraft activity.

A metropolitan planning organization (MPO) could be a valuable resource to coordinate regionally specific unmanned aircraft issues with FAA. An MPO may also have the capability of preparing suitability or zoning maps, and publishing them electronically, for reference by the general public. These maps could indicate acceptable areas to operate small unmanned systems or even show where restrictive operational buffers might exist around special use facilities e.g. a prison or critical infrastructure for example.

From a policy standpoint, codes or ordinances may be leveraged by local law enforcement in order to respond adequately to unauthorized unmanned activity. Examples of possible codes or ordinances include disorderly conduct laws, nuisance/noise laws, reckless endangerment, and criminal trespass. Hosting public meetings for input on the most acceptable approach would support development of a regional policy approach that several municipalities might adopt. The benefit of facilitating a policy regionally, adopted at the local level, is that it simplifies the interpretation of municipal restrictions for unmanned aircraft operations from one city to the next.

Further research could include a Delphi method with airport sponsors and municipal staff and officials to identify suitable takeoff and landing areas within the approach corridors and flight tracks for individual airports. Additional GIS analysis could leverage inputs from the Delphi method to further study flight and airspace sensitivities around airports. Air quality impacts from the increased use of combustion engine sUAS may also be of merit.

In closing, the implications of this research are anticipated to be an improved capacity for local governments to address concerns of UAS activity in close proximity to airports.

Appendix

A. 2015 State Unmanned Aircraft Legislation

State	Bill	Summary
Arkansas	HB 1349	Prohibits the use of UAS to commit voyeurism.
Arkansas	HB 1770	Prohibits the use of UAS to collect information about or photographically or electronically record information about critical infrastructure without consent.
California	AB 856	Prohibits entering the airspace of an individual in order to capture an image or recording of that individual engaging in a private, personal or familial activity without permission. This legislation is a response to the use of UAS by the paparazzi.
Florida	SB 766	Prohibits the use of a drone to capture an image of privately owned property or the owner, tenant, or occupant of such property without consent if a reasonable expectation of privacy exists.
Hawaii	SB 661	Creates a chief operating officer position for the Hawaii unmanned aerial systems test site. It also establishes an unmanned aerial systems test site advisory board to plan and oversee test site development and appropriates funds to establish the test site.
Illinois	SB 44	Creates a UAS Oversight Task Force which is tasked with considering commercial and private use of UAS, landowner and privacy rights and general rules and regulations for the safe operation of UAS. The task force will prepare recommendations for the use of UAS in the state.
Louisiana	SB 183	Regulates the use of UAS in agricultural commercial operations.
Maine	LD 25	Requires law enforcement agencies receive approval before acquiring UAS. The bill also specifies that the use of UAS by law enforcement comply with all FAA requirements and guidelines. Requires a warrant to use UAS for criminal investigations except in certain circumstances and sets out standards for the operation of UAS by law enforcement.

Maryland	SB 370	Specifies that only the state can enact laws to prohibit, restric, or regulate the testing or operation of unmanned aircraft systems. This preempts county and municipal authority. The bill also requires a study on specified benefits.
Michigan	SB 54	Prohibits using UAS to interfere with or harass an individual who is hunting.
Michigan	SB 55	Prohibits using UAS to take game.
Mississippi	SB 2022	Specifies that using a drone to commit "peeping tom" activities is a felony.
Nevada	AB 239	Includes UAS in the definition of aircraft and regulates the operators of UAS. It also prohibits the weaponization of UAS and prohibits the use of UAS within a certain distance of critical facilities and airports without permission. The bill specifies certain restrictions on the use of UAS by law enforcement and public agencies and requires the creation of a registry of all UAS operated by public agencies in the state.
New Hampshire	SB 222	Prohibits the use of UAS for hunting, fishing or trapping.
North Dakota	HB 1328	Provides limitations for the use of UAS for surveillance.
Oregon	HB 2534	Requires the development of rules prohibiting the use of UAS for angling, hunting, trapping, or interfering with a person who is lawfully angling, trapping, or hunting.
Oregon	HB 2354	Changes the term "drone" to "unmanned aircraft system" in statute.
Tennessee	HB 153	Prohibits using a drone to capture an image over certain open-air events and fireworks displays. It also prohibits the use of UAS over the grounds of a correctional facility.
Texas	HB 3628	Permits the creation of rules governing the use of UAS in the Capitol Complex and provides that a violation of those rules is a Class B misdemeanor.
Texas	HB 2167	Permits individuals in certain professions to capture images used in those professions using UAS as long as no individual is identifiable in the image.

Texas	HB 1481	Makes it a Class B misdemeanor to operate UAS over a critical infrastructure facility if the UAS is not more than 400 feet off the ground.
Utah	HB 296	Allows a law enforcement agency to use an unmanned aircraft system to collect data at a testing site and to locate a lost or missing person in an area in which a person has no reasonable expectation of privacy. It also institutes testing requirements for a law enforcement agency's use of an unmanned aircraft system.
Virginia	HB 2125 and SB 1301	Require that a law enforcement agency obtain a warrant before using a drone for any purpose, except in limited circumstances.
West Virginia	HB 2515	Prohibits hunting with UAS.

B. NCTCOG Air Transportation Advisory Committee sUAS Survey Polling Results

C. Department of Defense – Navy OPNAVINSTRUCT 11010.36C – Air Installations Compatible Use Zones (AICUZ) Program

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