

Understanding The Dynamics Effects of Flight Patterns on Land Use

Flight Itinerary

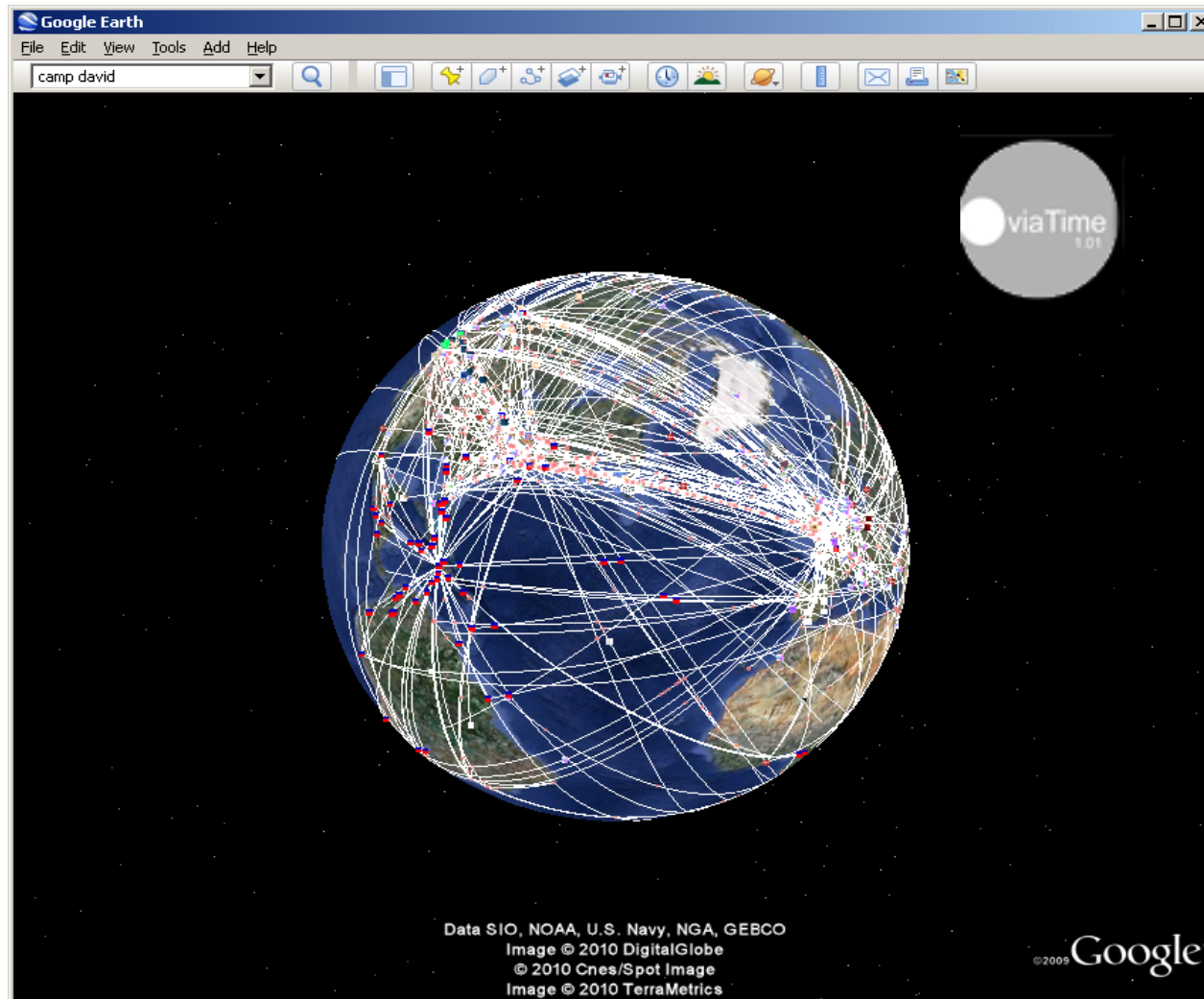
- Motivations (Why Study?)
- Implications
- Background
 - Economy
 - Equity
 - Ecology
- Short Film (3 minutes)
- Technology
- How Measure (Pixel Based)
- Research Question (Hypothesis)
- Study Area
 - Challenges
- Methods
- Results
- Discussion
- Recommendations
- Future Work / Questions

Motivation

***The real voyage of discovery consists not in seeking
new landscapes but in having new eyes.***
(Merce Proust, 1871-1922)

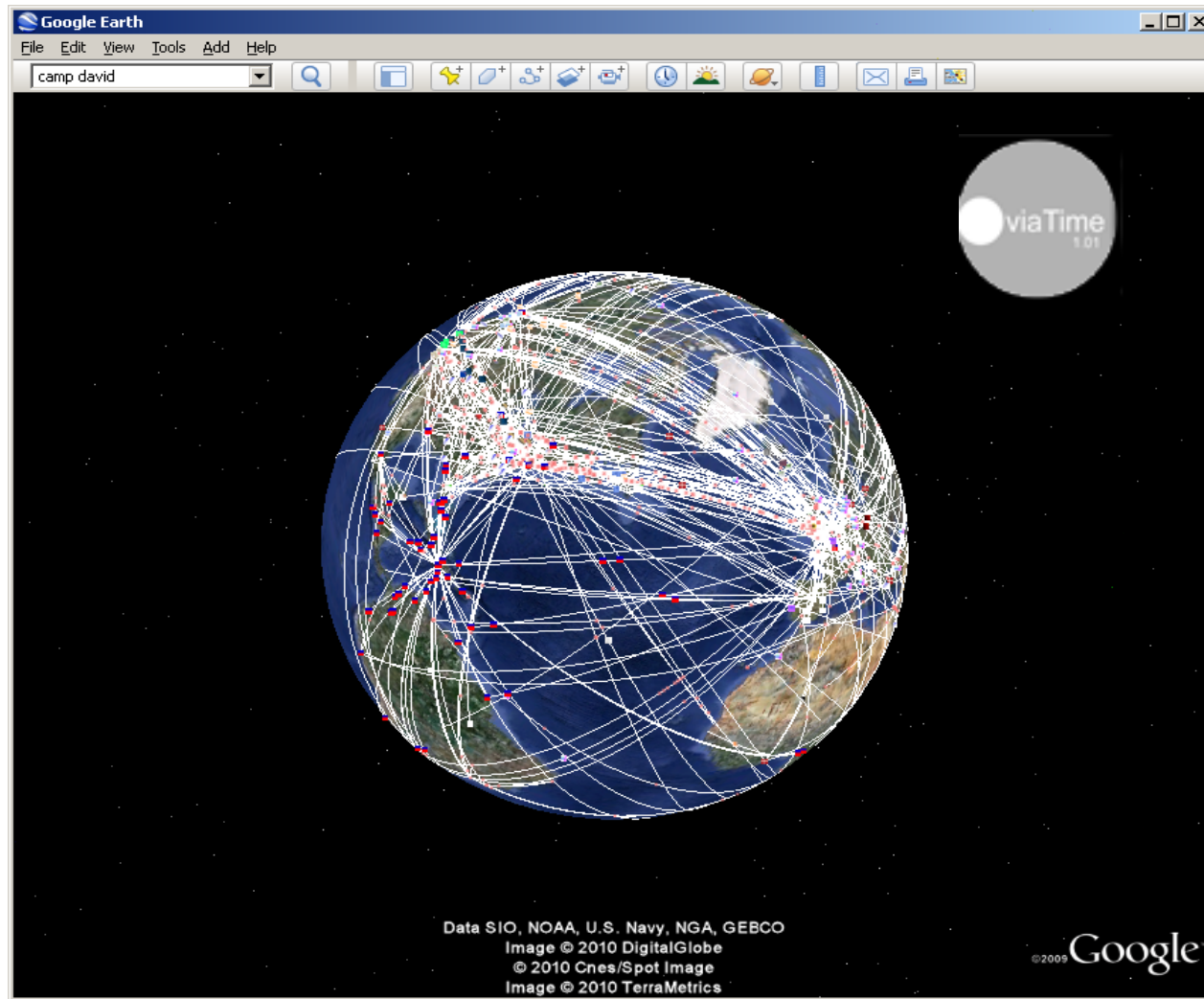
Maybe they just don't know.
Paskus, Alexandra

Motivation

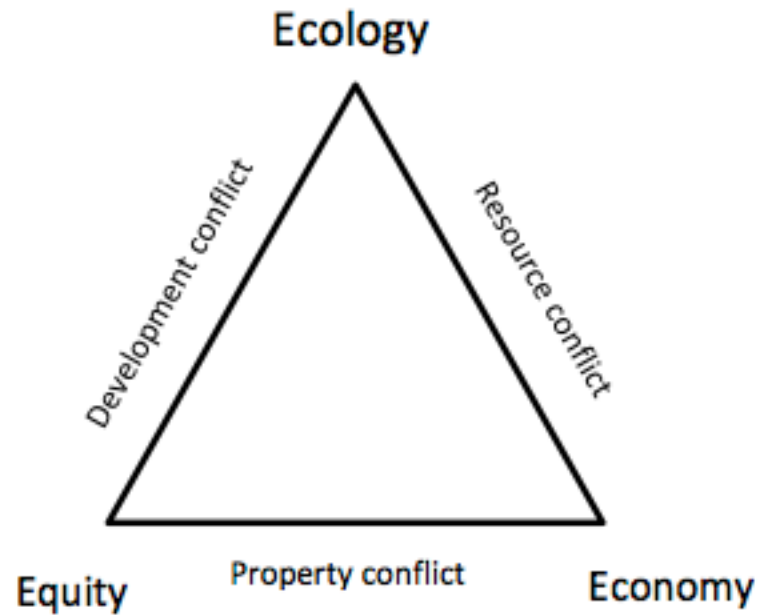


Source: viaTime.org (2010)

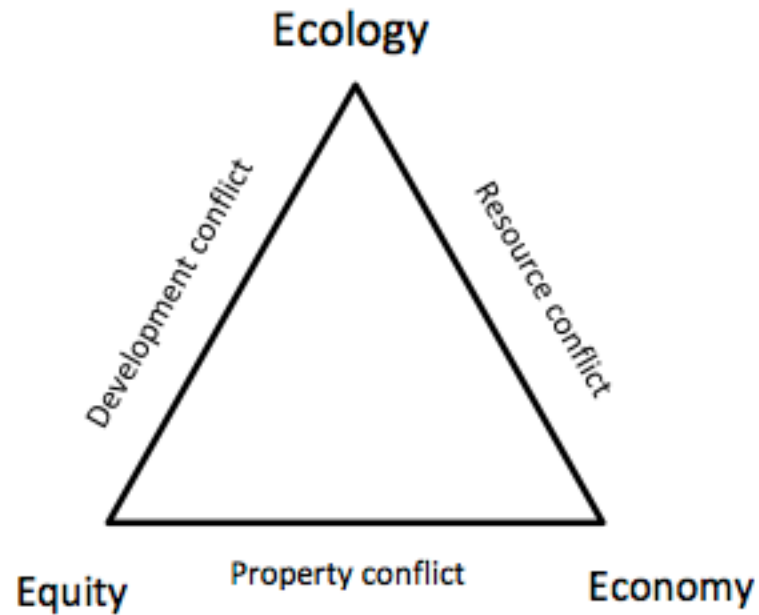
Motivation + Equity (Property Conflict)



Source: viaTime.org (2010)



Source: Sustainability Triangle (Berke, Goldschalk, & Rodriguez, 2006)



Technology

Source: Sustainability Triangle (Berke, Goldschalk, & Rodriguez, 2006)

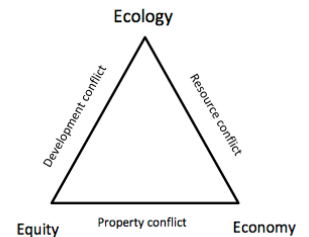
Implications

- Tool for Land Use Planning
 - Better Understanding
 - Model Justification
- Transportation infrastructure
 - Sustainable
 - Multimodal
 - Volume
- Consistency
- Change Laws
- Define New Boundaries
 - Impact
- Restore Control
- Not Expensive

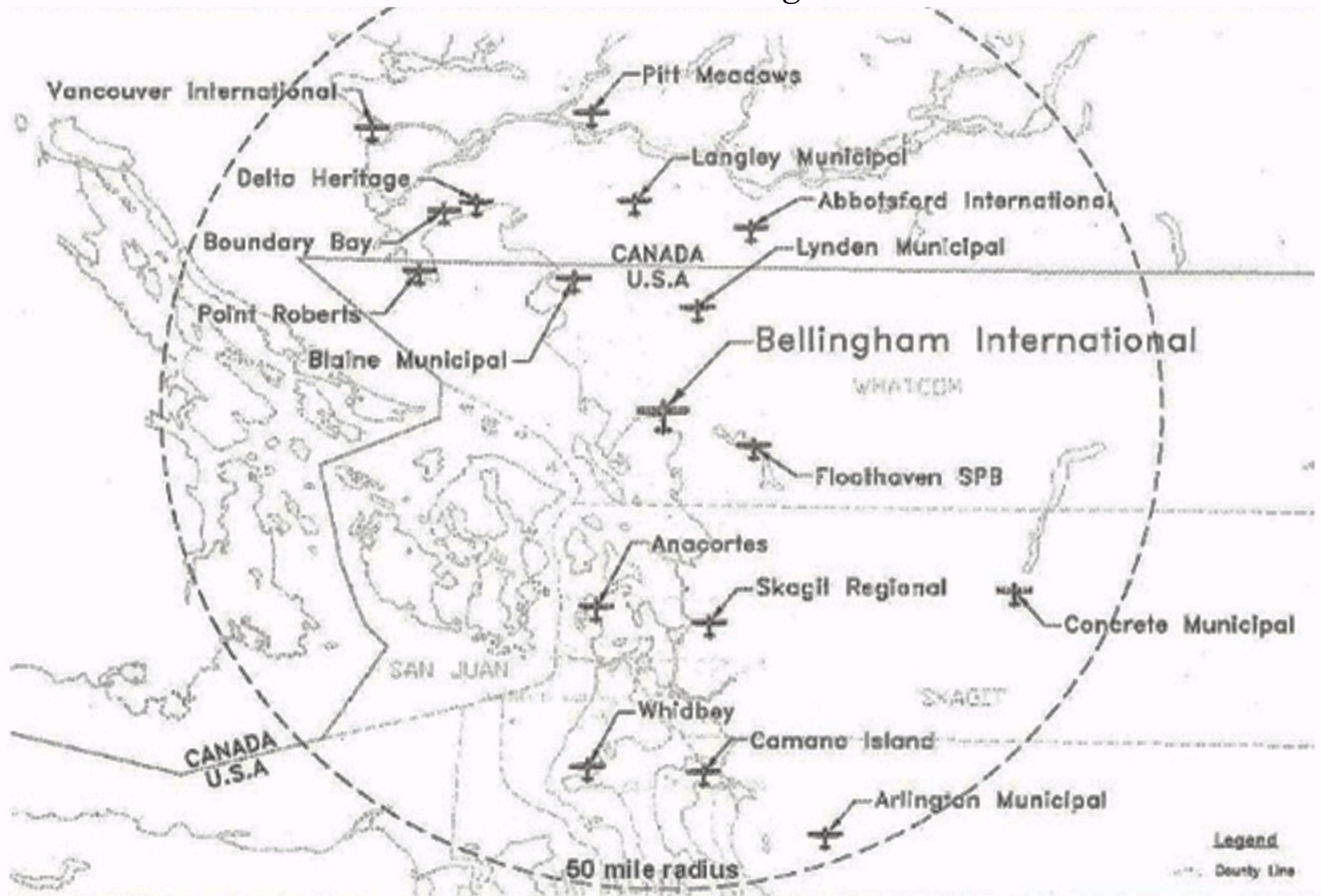
Economy

The easiest way to become a millionaire is to start off a billionaire and go into the airline business.” – Richard Branson, Virgin Founder

Source: Sustainability Triangle (Berke, Goldschalk, & Rodriguez, 2006)

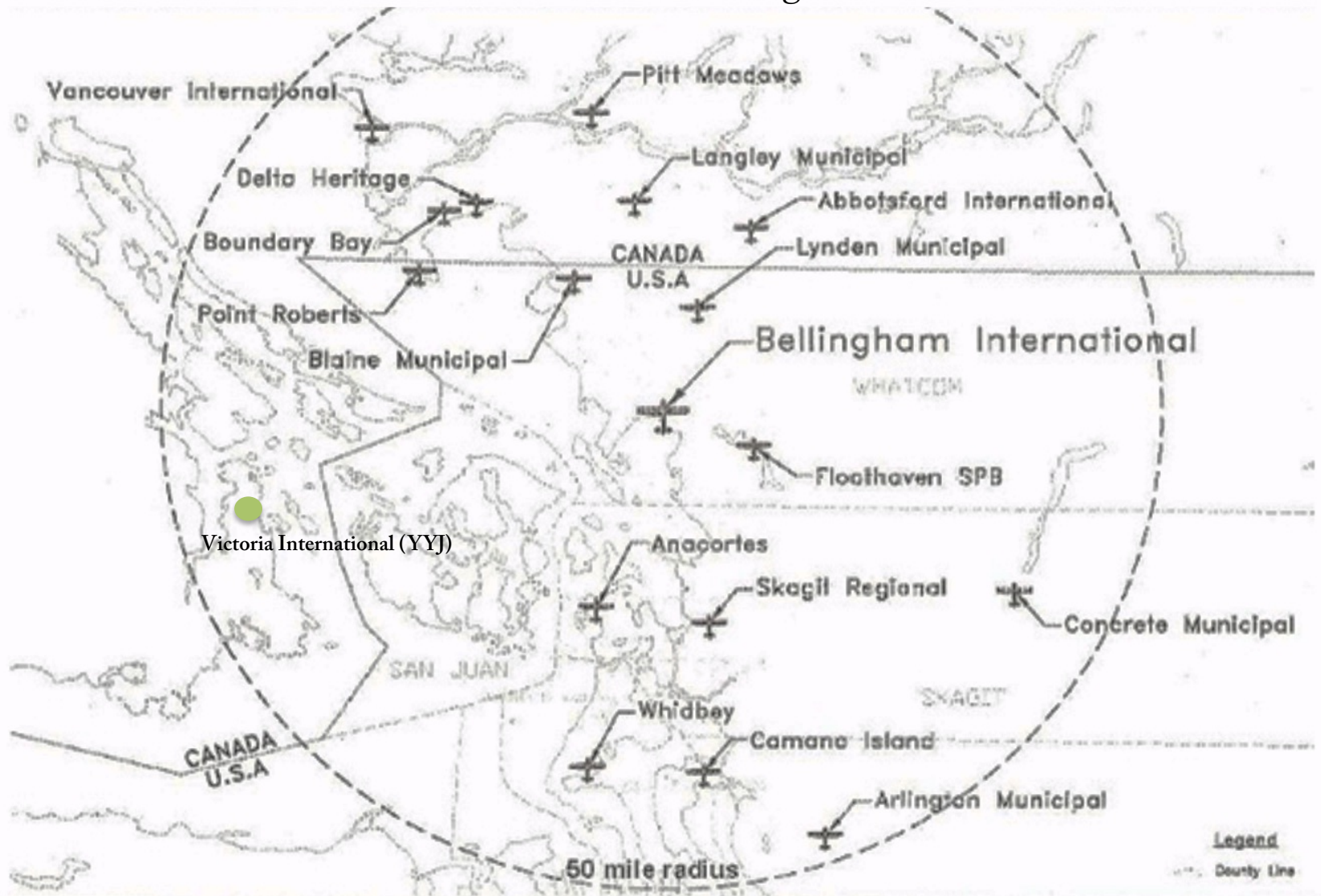


Our Surroundings

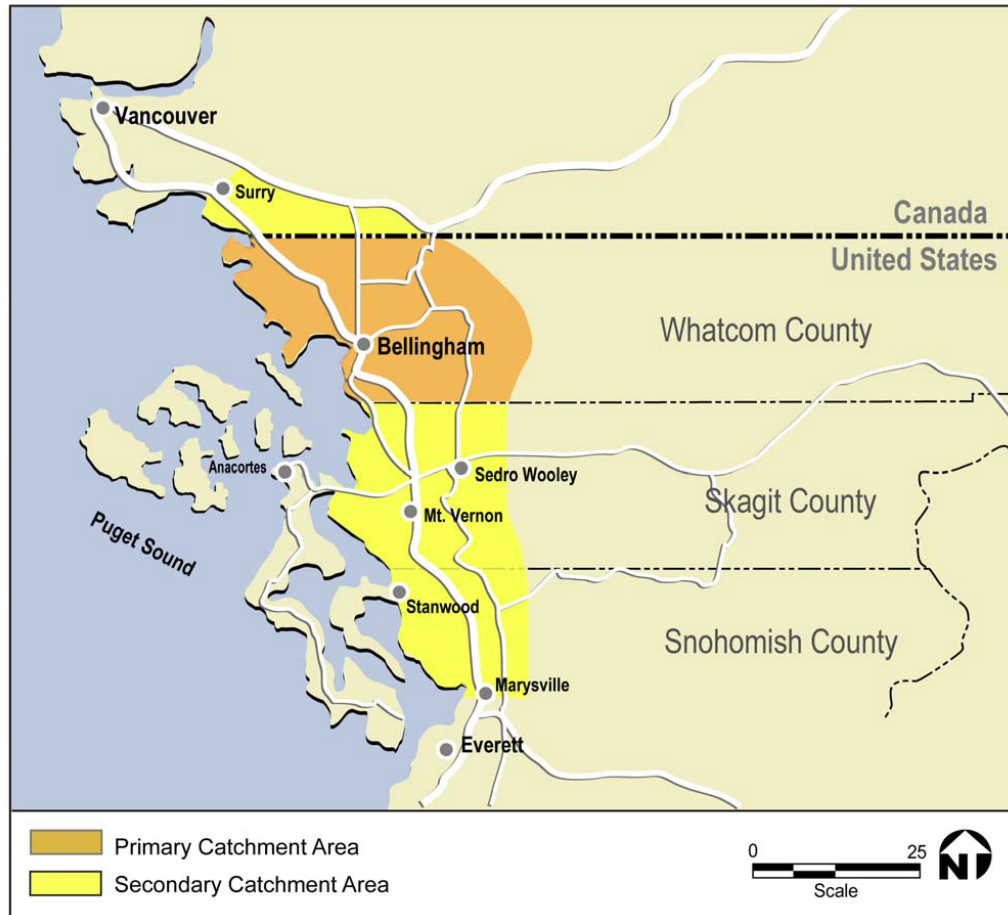


Source: Port of Bellingham 2008

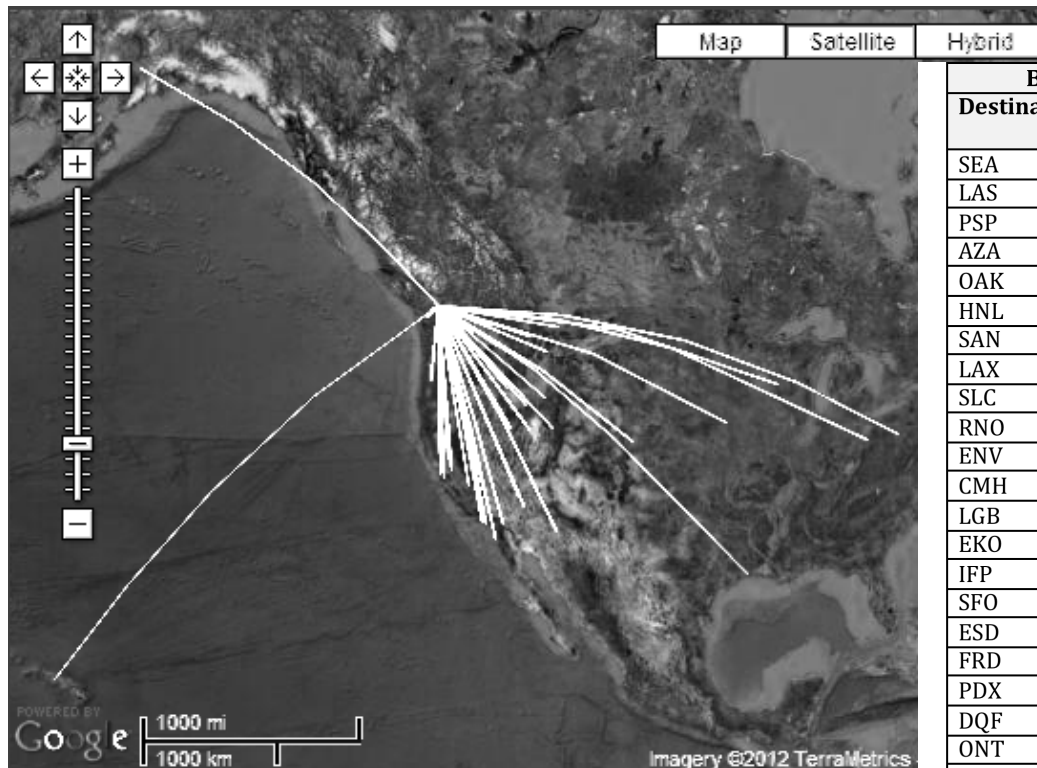
Our Surroundings



Source: Port of Bellingham 2008



Source: Port of Bellingham (2004)

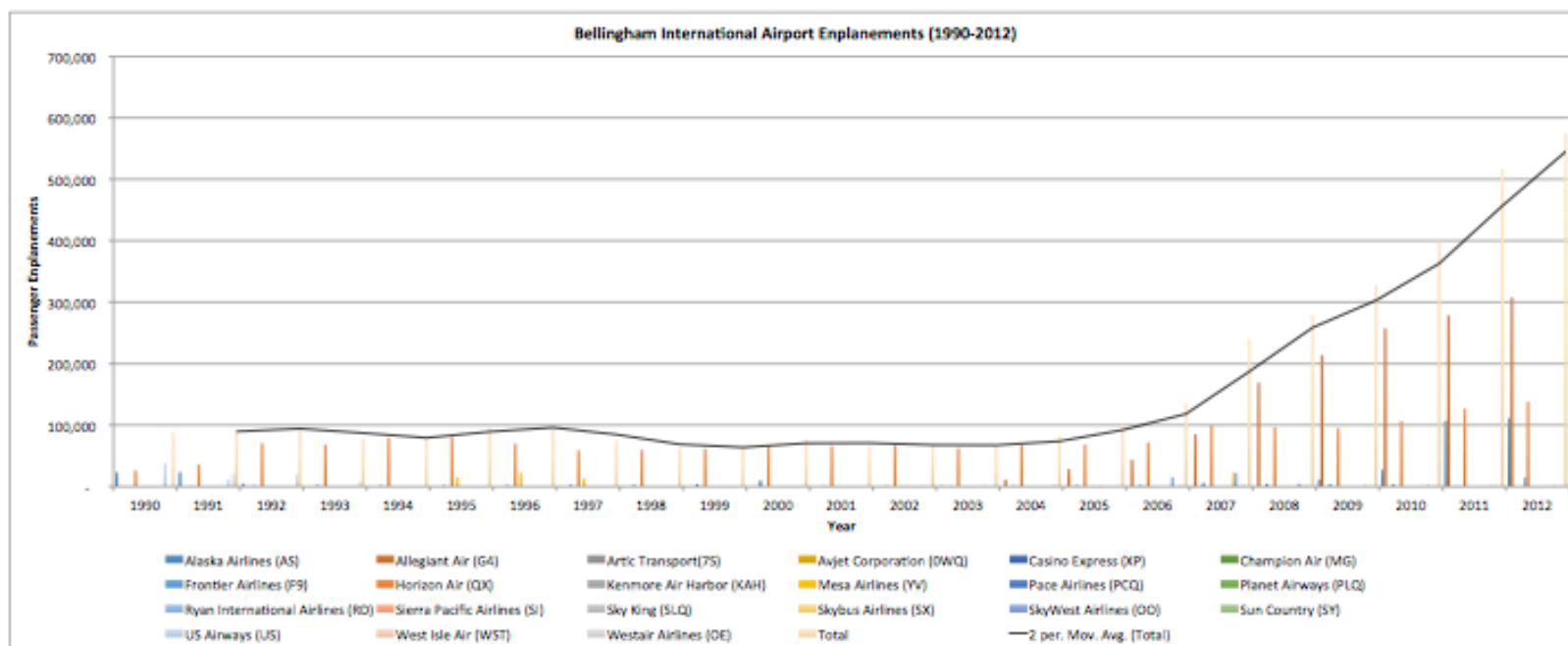


Source viaTime.org/airdoctor(2012)

Bellingham's Top 30 Destinations from 1990 thru 2012*				
Destination	Passengers	Departures	Passengers Departure	Per
SEA	1,852,902	81,972	22.60	
LAS	834,428	6,006	138.93	
PSP	114,602	817	140.27	
AZA	103,390	713	145.01	
OAK	73,125	511	143.10	
HNL	70,064	507	138.19	
SAN	68,859	494	139.39	
LAX	65,563	459	142.84	
SLC	41,561	1,097	35.89	
RNO	41,074	344	119.40	
ENV	25,945	181	143.34	
CMH	23,866	221	105.99	
LGB	20,498	151	135.75	
EKO	19,632	181	108.46	
IFP	17,837	134	133.11	
SFO	12,361	91	135.84	
ESD	10,450	17,844	0.59	
FRD	7,244	11,304	0.64	
PDX	4,752	144	33.00	
DQF	2,908	32	90.88	
ONT	1,059	16	66.19	
DEN	933	9	103.67	
YKM	389	23	16.91	
CLM	387	16	24.19	
SCK	306	2	153.00	
PSC	303	12	25.25	
EUG	290	5	58.00	
TWF	163	2	81.50	
BLI	157	11	14.27	
PAE	152	1	152.00	

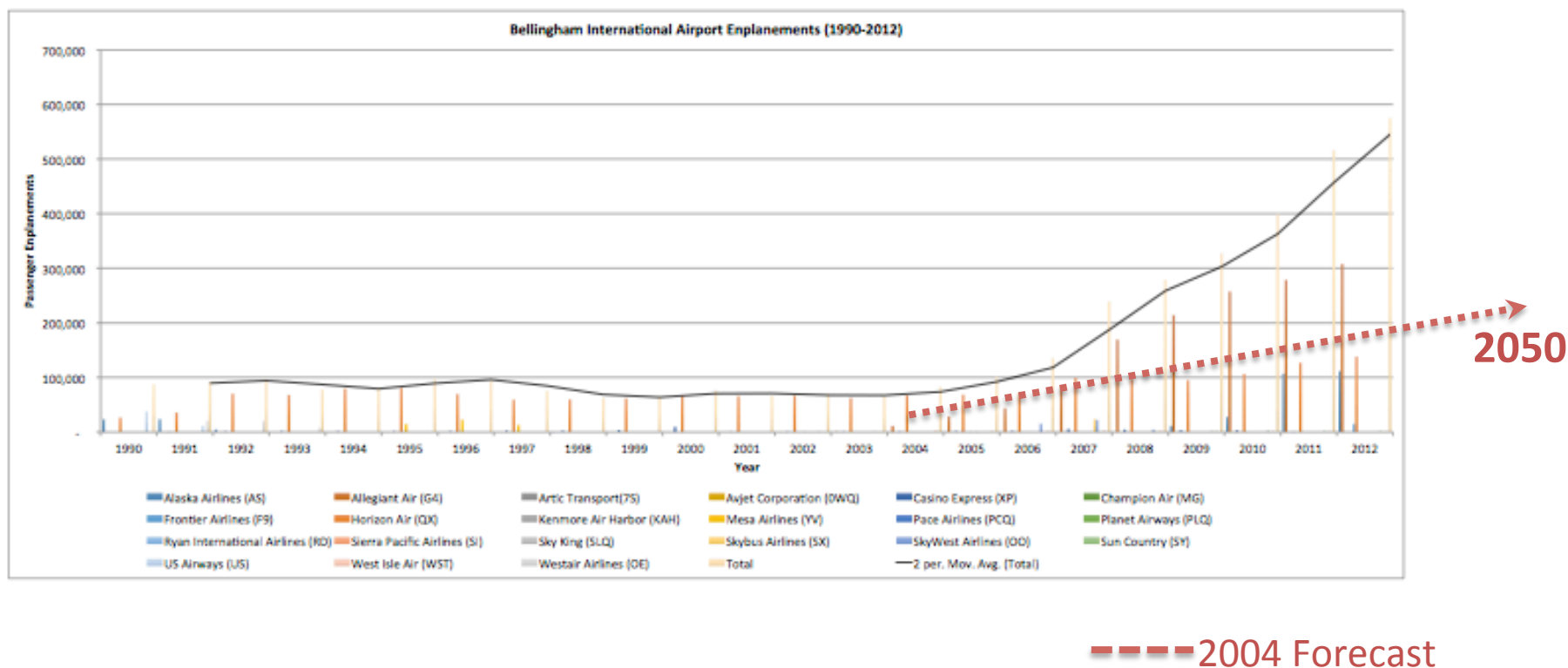
Source: United States Department of Transportation (1990-2012)

Airlines	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Alaska Airlines (AS)	23,350	23,504	4,514						119														
Allegiant Air (G4)													128	1,117	10,979	28,504	43,634	85,029	169,245	213,941	257,263	278,478	307,658
Arctic Transport(7S)																							5
Avjet Corporation (0WQ)																						3	
Casino Express (XP)			517	1,335	1,844	1,543	1,468	1,767	2,631	2,436	3,682	9,693	650	1,015	807	1,123	1,908	2,185	5,730	4,502	3,491	3,317	443
Champion Air (MG)																	145						
Frontier Airlines (F9)																							
Horizon Air (QX)	26,542	35,818	70,103	67,878	79,351	80,849	89,533	89,268	59,806	61,448	65,880	65,589	66,735	62,091	67,132	68,492	71,473	99,461	96,164	94,624	106,331	126,638	137,897
Kenmore Air Harbor (KAH)																7	31	6	3				
Mesa Airlines (YV)						15,087	23,115	13,175															
Pace Airlines (PCQ)																	84						
Planet Airways (PLQ)													507										
Ryan International Airlines (RD)																	336	302					
Sierra Pacific Airlines (SI)																	114						
Sky King (SLQ)																	234	116					
Skybus Airlines (SX)																		23,401		465			
SkyWest Airlines (OO)																	15,171	22,045	4,351				
Sun Country (SY)																		398	1,280				
US Airways (US)													720	622						1,539	2,372	1,430	1,638
West Isle Air (WST)													125	338	3,119	1,688	2,016	2,794	2,493	1,701	1,747	1,298	907
Westair Airlines (OE)																							
Total	87,348	91,755	96,261	77,563	80,894	97,404	94,415	75,074	62,161	65,128	75,553	66,307	69,230	64,975	82,353	101,464	135,073	238,964	278,503	326,996	398,753	515,453	574,601



Source: United States Department of Transportation (1990-2012)

Airlines	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Alaska Airlines (AS)	23,355	23,604	4,614						119														
Allegiant Air (G4)													128	1,117	10,979	28,504	43,634	85,029	169,245	213,941	257,283	278,478	307,658
Arctic Transport(7S)																							5
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Source: United States Department of Transportation (1990-2012)

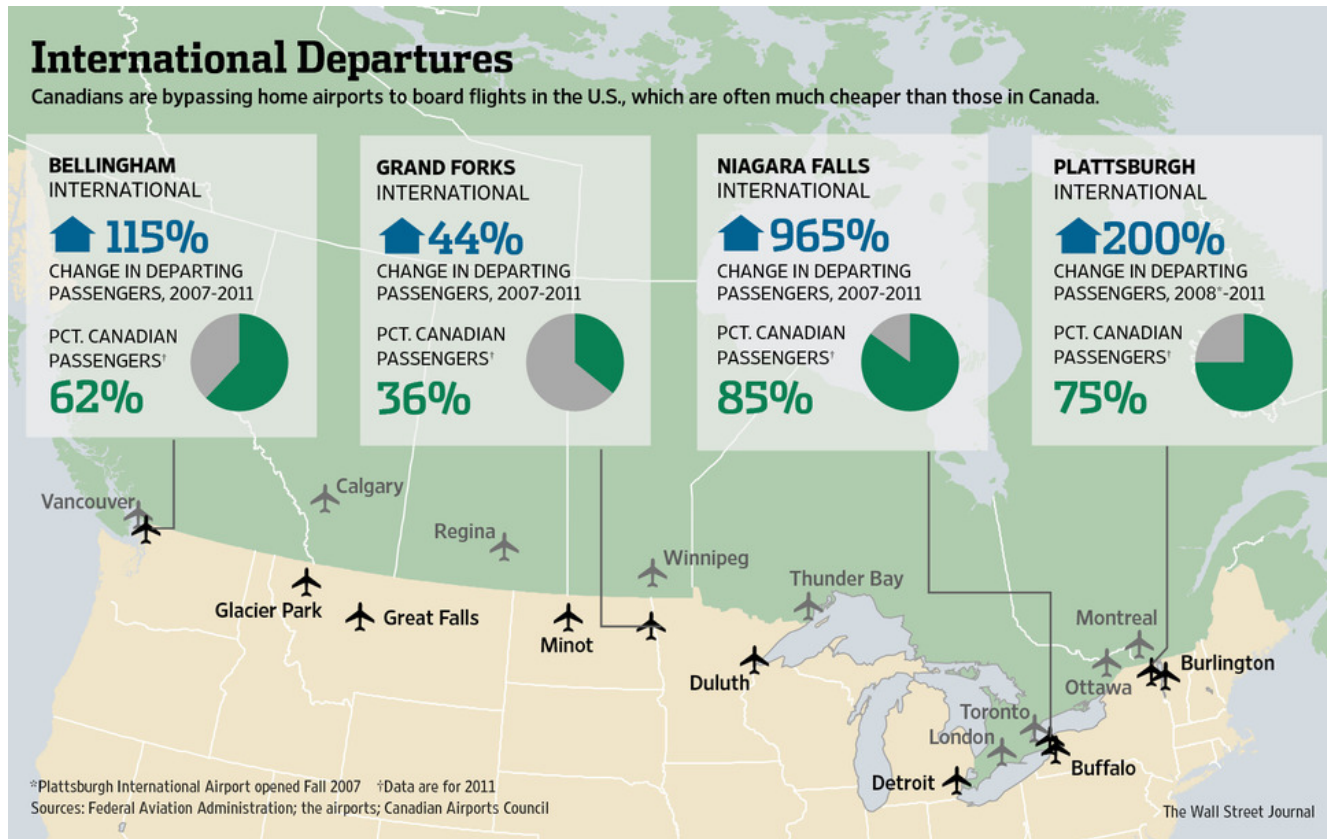
What Are The Uncertainties?

- Changes In The Canadian Dollar
- New Service At Paine Field
- Airline Health/Price of Oil
- Cost Per Enplaned Passenger
- Overall Economic Downturn
- Canadian/US Border – Passports Required



Doug Smith from the Port was quoted in the Bellingham Herald on June 20th of this year(2008).

The whole idea of attracting Seattle travelers to Bellingham to use our airport, I think that would be totally unacceptable to the community,” Smith said.



June 7, 2012, 9:18 p.m. ET Jack Nicas
 Canadians Crowd U.S. Airports. Why? Taxes
Miffed by Rising Fees, Canadian Travelers Flock to Nearby U.S. Airports

Source: Wall Street Journal((2012)

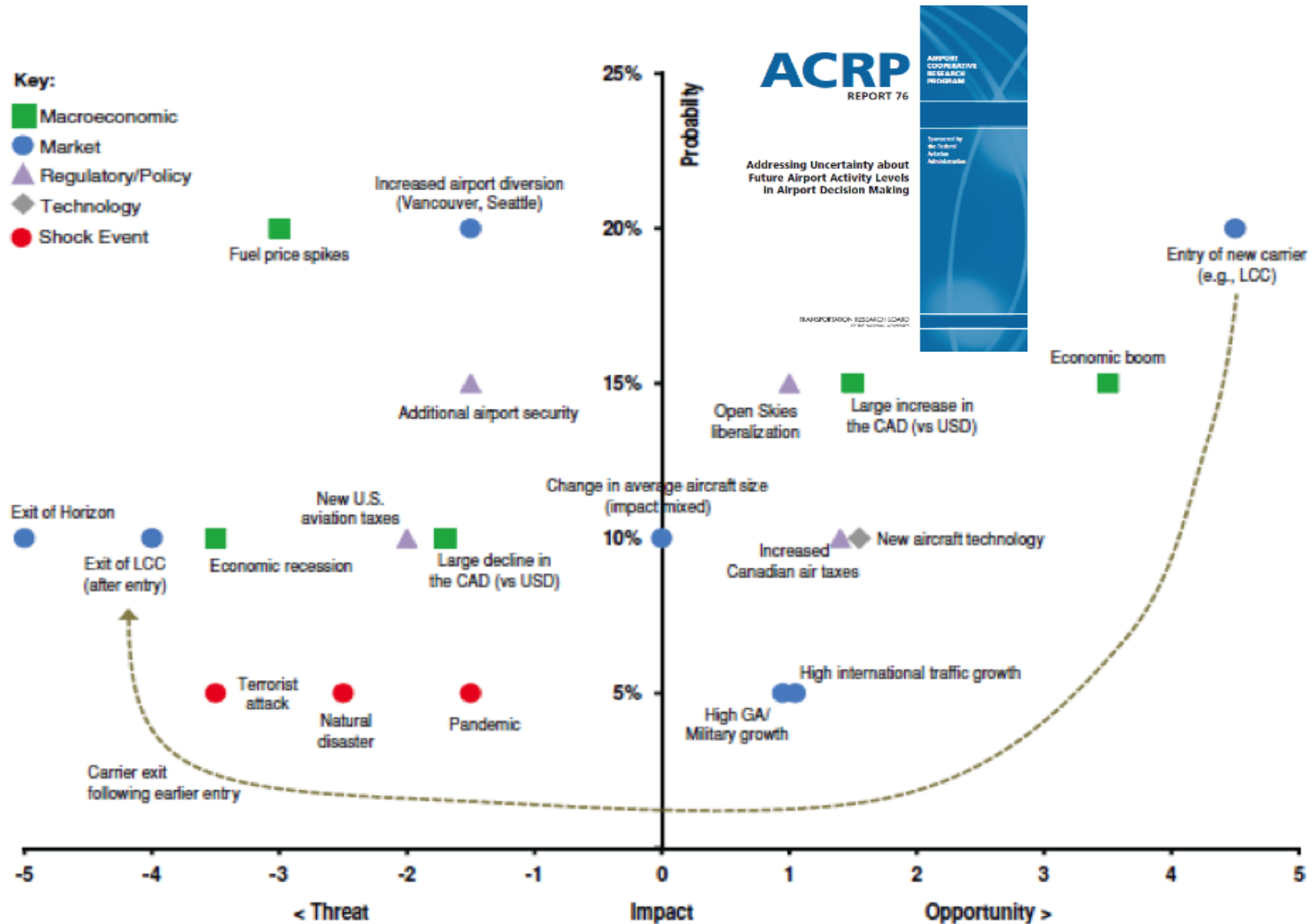
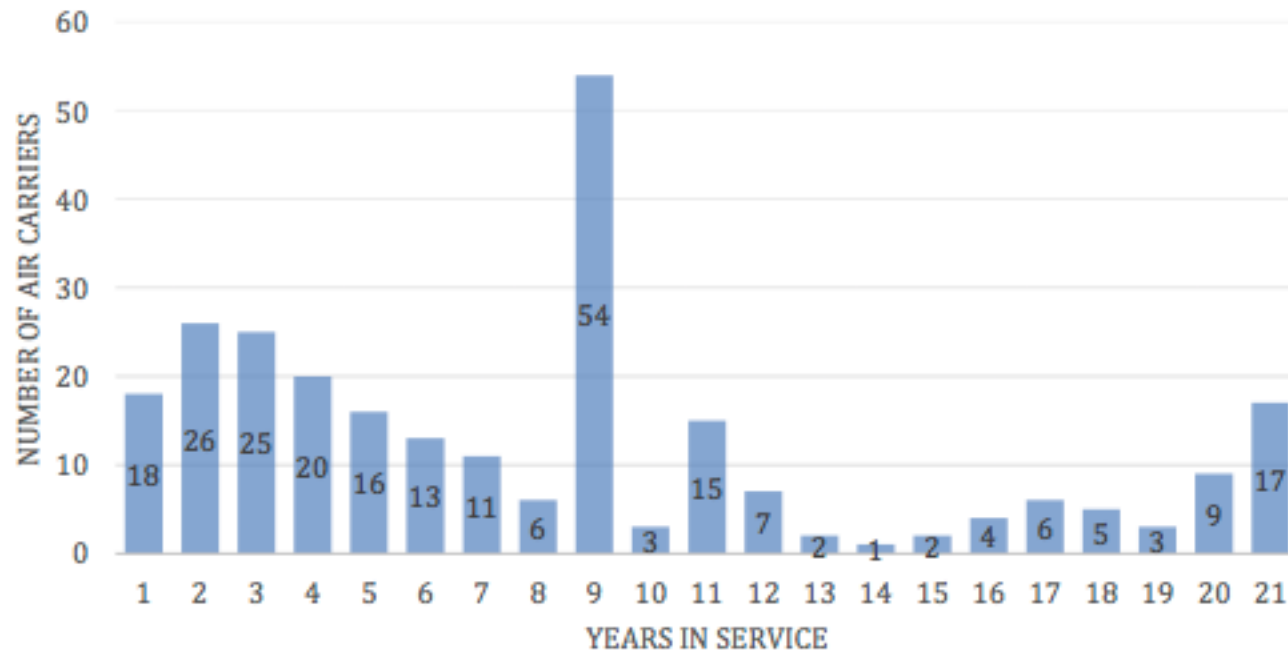


Figure 33. Likelihood and severity of uncertainty at BLI.

	2005-2008		2009		2010		2011		2012		← Selected		2013	
Organization	#	%	#	%	#	%	#	%	#	%	#	%	#	%
Airport Operator	48	14.9%	29	19.7%	27	12.3%	12	11.5%	35	27.8%	30	20%	16	17.9%
State DOT	26	8.1%	4	2.7%	4	1.8%	0	0%	3	2.4%	4	2.6%	7	7.8%
FAA	8	2.4%	8	5.4%	23	10.5%	5	4.8%	5	4.0%	19	12.6%	2	2.2%
Airport Industry Association	26	8.1%	13	8.8%	10	4.6%	7	6.7%	3	2.4%	21	14%	0	0%
Airlines / Airline Associations	1	.3%	0	0%	9	4.1%	5	4.8%	1	.7%	5	3.3%	0	0%
TRB	7	2.2%	6	4.1%	9	4.1%	5	4.8%	4	3.2%	12	8%	1	1.1%
Other airport industry	29	9.0%	19	12.9%	8	3.6%	7	6.7%	10	7.9%	10	6.6%	0	0%
University	67	20.8%	30	20.4%	47	21.5%	12	11.5%	9	7.1%	13	8.6%	9	10.1%
Consultant	85	26.4%	37	25.2%	80	36.5%	50	48.2%	53	42.1%	27	18%	48	53.9%
Other	25	7.8%	1	.8%	2	1.0%	1	1.0%	3	2.4%	9	6%	6	6.7%
Total	322	-	147	-	219	-	104	-	126	-	150	-	89	-

Source: <http://www.trb.org/ACRP/ACRP.aspx>
Transportation Research Board (2013)

US AIR CARRIER YEARS IN SERVICE 1990-2010



Source: United States Department of Transportation (1990-2012)

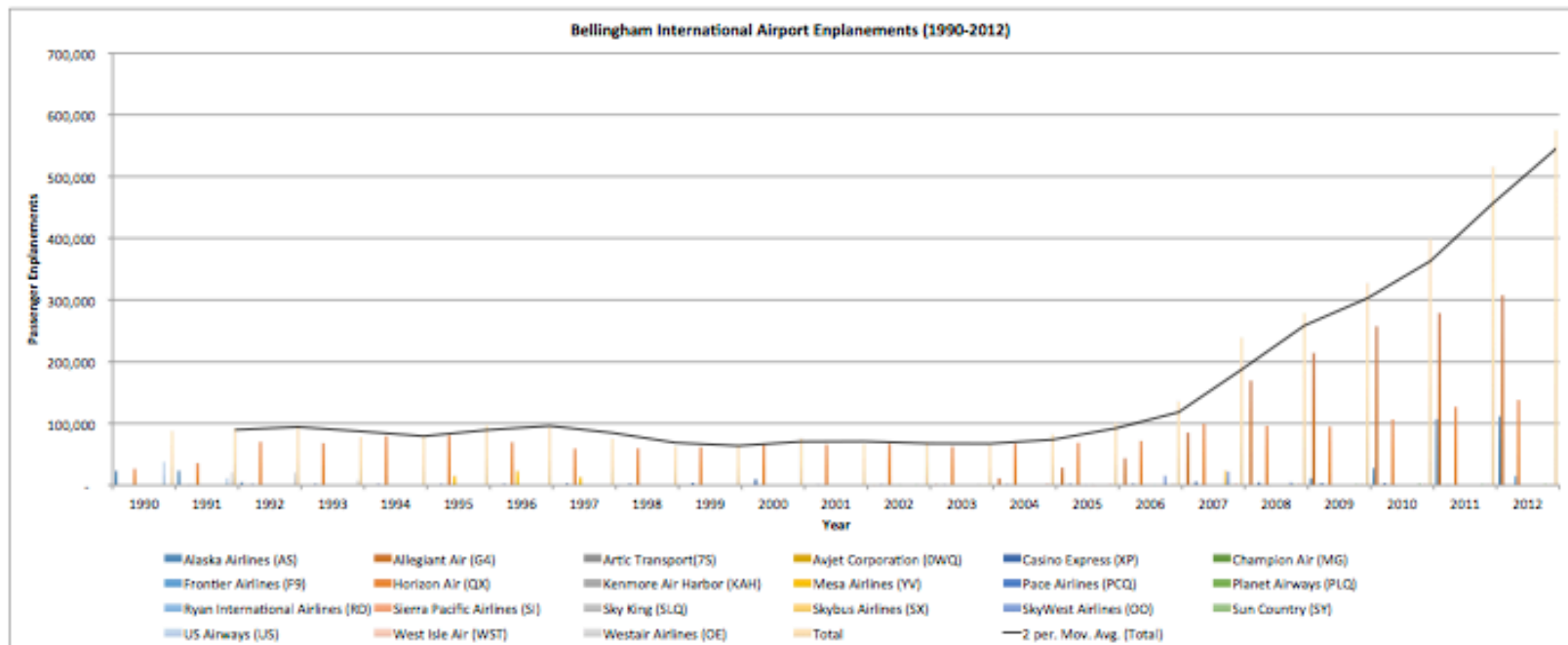
US Airlines in Service Years 1990---2010

Source: DOT(1990---2012 US T100D Flight Segment)

Air Carrier	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Total
40---Mile Air													1	1	1	1	1	1	1	1	1	9
ABX Air													1	1	1	1	1	1	1	1	1	9
ATA Airlines d/b/a ATA	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1			19
Accessair Holdings										1												1
Aerial Transit Company	1		1	1																		3
Aerodynamics Inc.														1	1	1	1	1	1	1	1	8
Air 21						1	1															2
Air Excursions LLC																				1	1	2
Air Greco																			1	1		2
Air Midwest Inc.													1	1	1	1	1	1	1			7
Air South Inc. (1)					1	1	1	1														4
Air St. Thomas														1	1	1						3
Air Transport International	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	21
Air Wisconsin Airlines Corp	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	21
Air---Serve													1									1
AirTran Airways Corporation					1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	17
Airmark Airlines Inc.				1																		1
Alaska Airlines Inc.	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	21
Alaska Central Express													1	1	1	1	1	1	1	1	1	9
Alaska Seaplane Service													1	1	1	1	1	1	1	1	1	9
Allegheny Airlines													1	1	1							3
Allegiant Air											1	1	1	1	1	1	1	1	1	1	1	11
Aloha Air Cargo	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	21
America West Airlines Inc.	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1				18
American Airlines Inc.	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	21
American Eagle Airlines Inc.		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	20
Amerijet International	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	21
Ameristar Air Cargo											1	1	1	1	1	1	1	1	1	1	1	11
Antonov Company																						0
Arctic Circle Air Service													1	1	1	1	1	1	1	1	1	9
Arctic Transportation													1	1	1	1	1	1	1	1	1	9
Arizona Express													1	1	1	1						4
Arrow Air Inc.	1	1	1	1	1		1	1		1	1	1	1	1			1	1	1	1	1	17
Asia Pacific										1	1	1	1	1	1	1	1	1	1	1	1	12
Aspen Airways Inc.	1	1																				2
Astar USA			1		1		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	17
Atlantic Southeast Airlines				1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	18
Atlas Air Inc.				1			1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	16

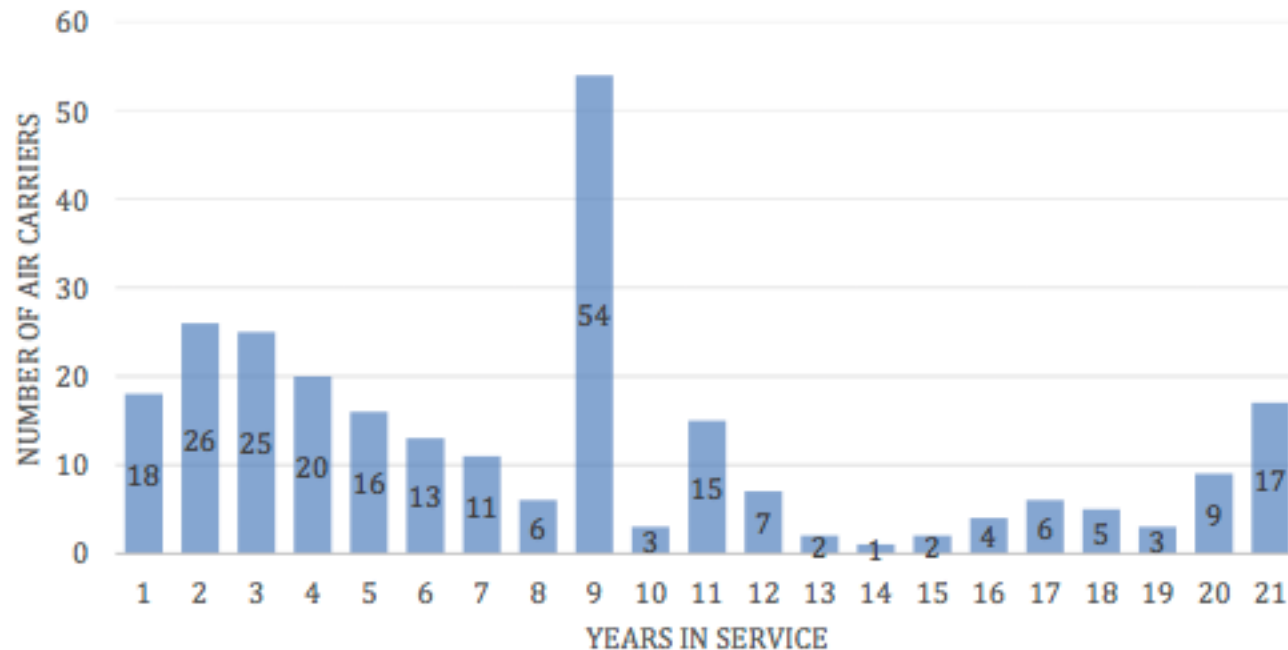
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Total	87,348	91,755	96,261	77,563	80,894	97,404	94,415	75,074	62,161	65,128	75,553	66,307	69,230	64,975	82,353	101,464	135,073	238,964	278,503	326,996	398,753	515,453	574,601	



Source: United States Department of Transportation (1990-2012)

US AIR CARRIER YEARS IN SERVICE 1990-2010



Source: United States Department of Transportation (1990-2012)

Un-Route Map



Source: www.willallegiantbethere.org -
Transportation Workers Union (2013)

IN THE NEWS

Flight attendants take jab at Allegiant Air with 'de-lei' kit

Star Advertiser - March 29, 2011

Flying Allegiant Air has become a matter of survival as far as its flight attendants are concerned.

Route suspensions in seven of the nine markets that fly to Hawaii, aircraft mechanical delays that have stretched as long as 52 hours, and two years of union contract talks without a resolution have prompted the Transport Workers Union, which represents more than 600 flight attendants at Allegiant, to put together an Allegiant Delay Survival Kit.

Airline Refuses to Give Refund to Woman After her Fiance Dies

Travelers Today - April 24, 2013

A low-cost airline refused to give a woman a refund on a flight that she was supposed to take to her wedding, after her fiance passed away.

Flight Attendants Apologize to Cities Abandoned By Allegiant

TWU Press Release - April 11, 2013

"Aloha" means GOODBYE in Boise, Eugene, Fresno, Phoenix, Spokane, Santa Maria and Stockton

Allegiant passengers make emergency landing after engine gives out

By MONA NAIR, 6 News Reporter - April 8, 2013

Passengers on an Allegiant Air flight from Knoxville to St. Petersburg, Florida feel lucky to be alive to talk about some terrifying moments in the sky. [Click here for video](#)

Allegiant flight lands safely at Knox airport after losing engine

NBC WBIR - April 8, 2013

A plane that blew an engine after departing McGhee Tyson Airport returned to Knoxville and landed safely Monday afternoon.

Allegiant Air to Stop Service from Seven Markets

Mauinow.com

The Honolulu-Star Advertiser is reporting today that Allegiant Air plans to cease flights temporarily to Hawaii from seven mainland cities. A spokeswoman for Allegiant Air told the newspaper that it will halt flights beginning Aug. 14 from Boise, Idaho; Eugene, Ore.; Phoenix, Ariz.; Spokane, Wash.; and Fresno, Stockton and Santa Maria, Calif.

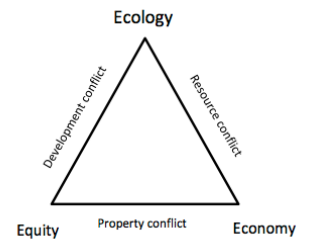
Passenger Load Factor(PLF)

PLF FOR 2012 HI ROUTES BY MONTH					
DEPARTURES	SEATS	PASSENGERS	PLF	MONTH	Index
29	4553	4271	93.81%	6	AS-BLI-HNL
31	4867	4503	92.52%	3	AS-BLI-HNL
31	4867	4457	91.58%	5	AS-BLI-HNL
30	4710	4309	91.49%	1	AS-BLI-HNL
27	4239	3858	91.01%	11	AS-BLI-HNL
18	2826	2567	90.84%	10	AS-BLI-HNL
9	2007	1819	90.63%	12	G4-BLI-HNL
31	4867	4410	90.61%	12	AS-BLI-HNL
17	2669	2412	90.37%	12	AS-BLI-OGG
13	2041	1839	90.10%	11	AS-BLI-OGG
30	4710	4221	89.62%	4	AS-BLI-HNL
31	4867	4357	89.52%	7	AS-BLI-HNL
11	2453	2181	88.91%	12	G4-BLI-OGG
29	4553	3998	87.81%	8	AS-BLI-HNL
6	1338	1158	86.55%	11	G4-BLI-HNL
29	4553	3913	85.94%	2	AS-BLI-HNL
5	1115	943	84.57%	11	G4-BLI-OGG
17	2669	1898	71.11%	9	AS-BLI-HNL

Source: United States Department of Transportation (1990-2012)

Ecology

Source: Sustainability Triangle (Berke, Goldschalk, & Rodriguez, 2006)



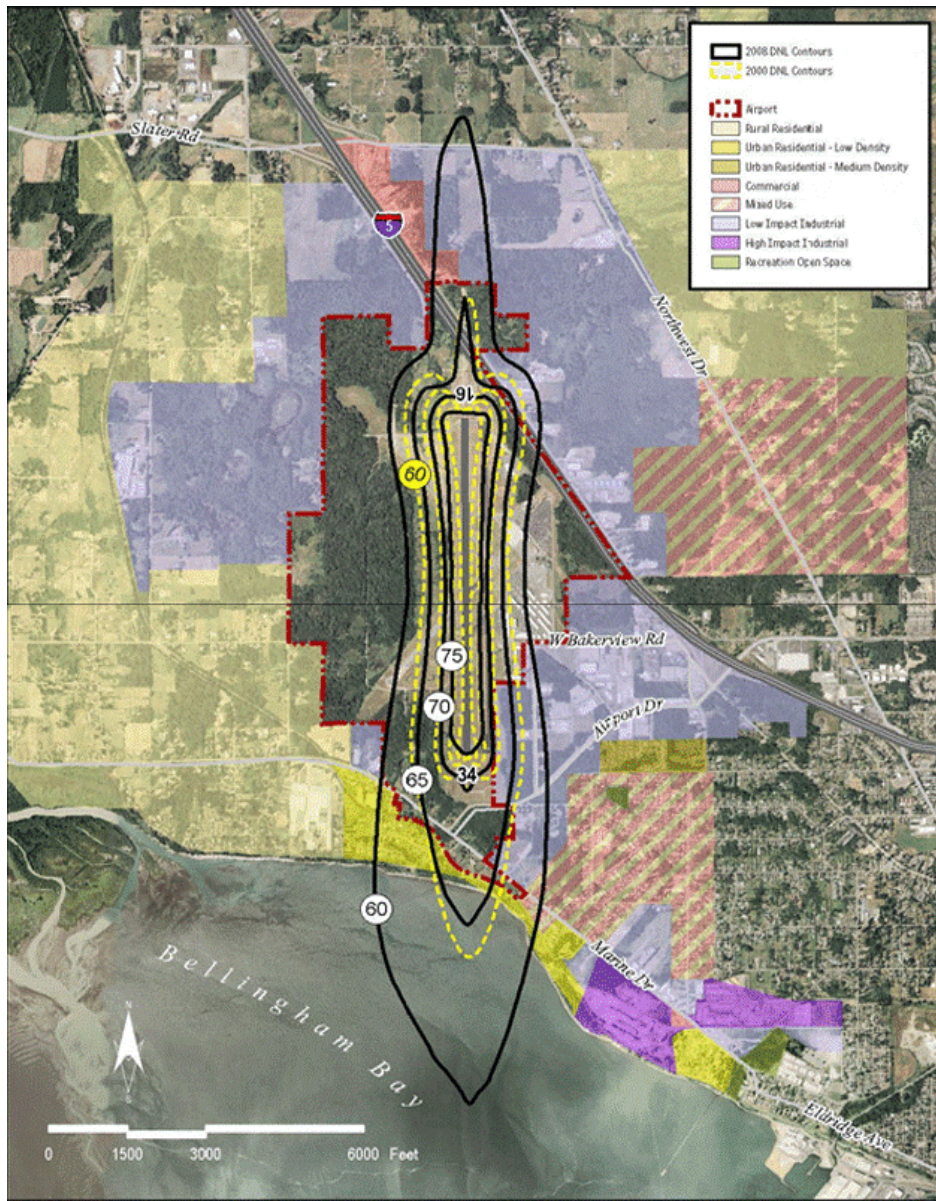
Beaver Dams a Constant Threat to Bellingham International Airport

McClurg,D. Whatcom Watch 2002



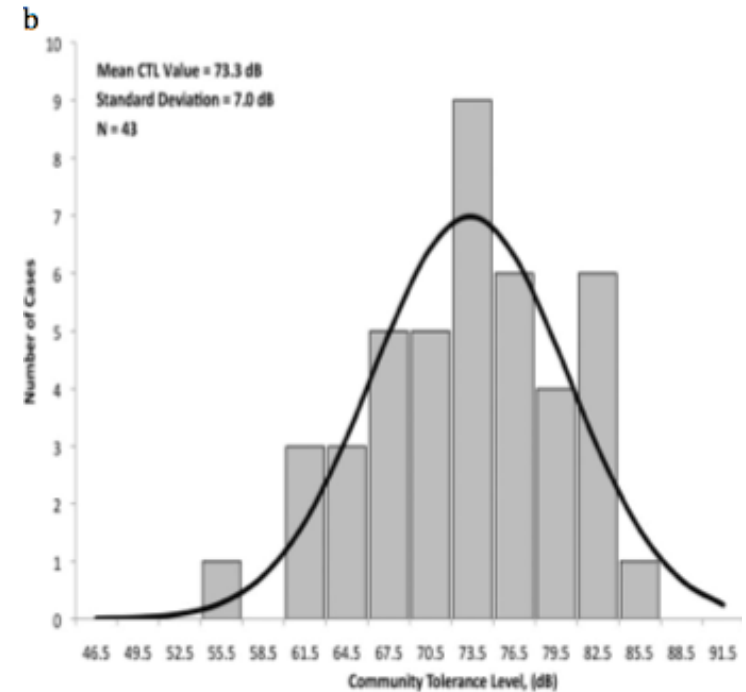
On a New York-to-Denver flight, a commercial jet would generate 840 to 1,660 pounds of carbon dioxide per passenger. That's about what an SUV generates in a month.

~USA TODAY 12/19/2006



Source: Port of Bellingham Noise Study by HMMH (2009)

Integrated Noise Model (INM)



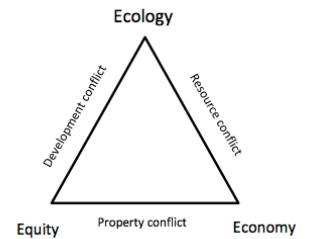
Fidell, A first-principles model of aircraft annoyance, 2011

Sound levels and human response		
Common sounds	Noise level (dB)	Effect
Carrier Deck Jet Operations Air raid system	140	Painfully Loud
Jet takeoff (200 ft.) Thunderclap	150	Maximum Vocal effort
Discotheque Auto horn (3 ft.) Pile Drivers	120 110	
Garbage truck	100	
Heavy truck (50 ft.) City traffic	90	Very annoying Hearing damage (8 ft.)
Alarm Clock Hair dryer	80	Annoying
Noisy restaurant Freeway traffic Man's voice (3 ft.)	70	Telephone use difficult Beginning of ear damage
Air-conditioning Unit (20 ft.)	60	Intrusive
Light auto traffic (100 ft.)	50	Quiet
Living room Bedroom Quiet office	40	Very quiet
Library Soft whisper (15 ft.)	30	
	20	
Broadcasting studio	10	Just audible
	0	Hearing begins

(Source: Harris Harris Miller Hanson, 2013)

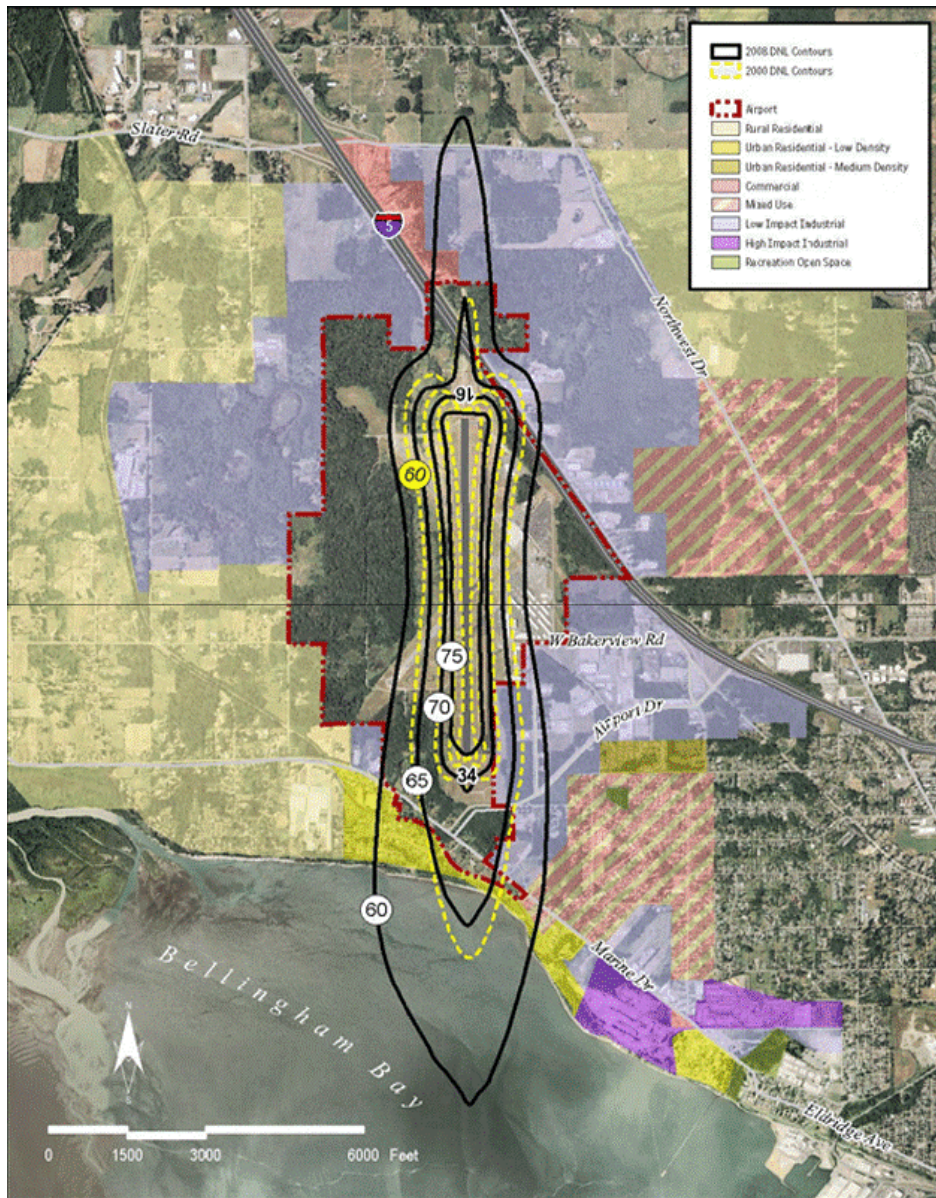
Equity

Source: Sustainability Triangle (Berke, Goldschalk, & Rodriguez, 2006)



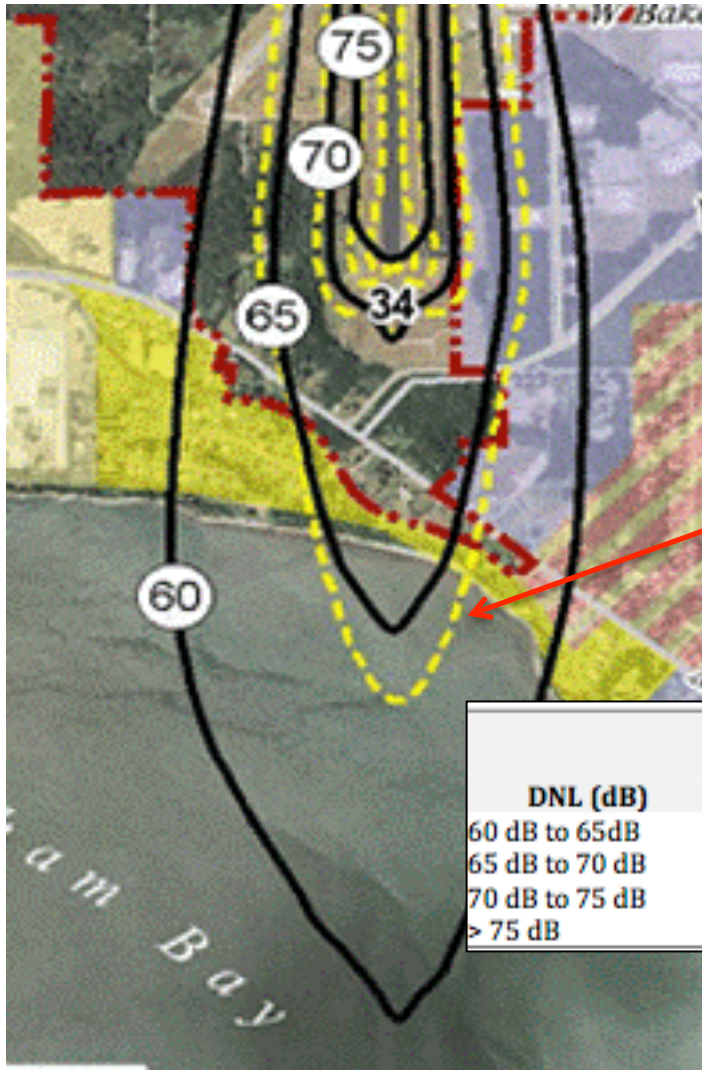
Integrated Noise Model (INM)

It's not the airport, but the airplane
(Airport Operations, Ashford, Stanton,
& Moore, 1997)

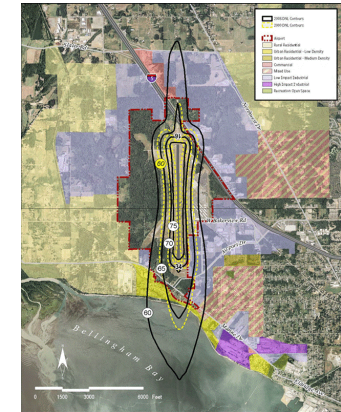


Source: Port of Bellingham Noise Study by HMMH (2009)

Integrated Noise Model (INM)

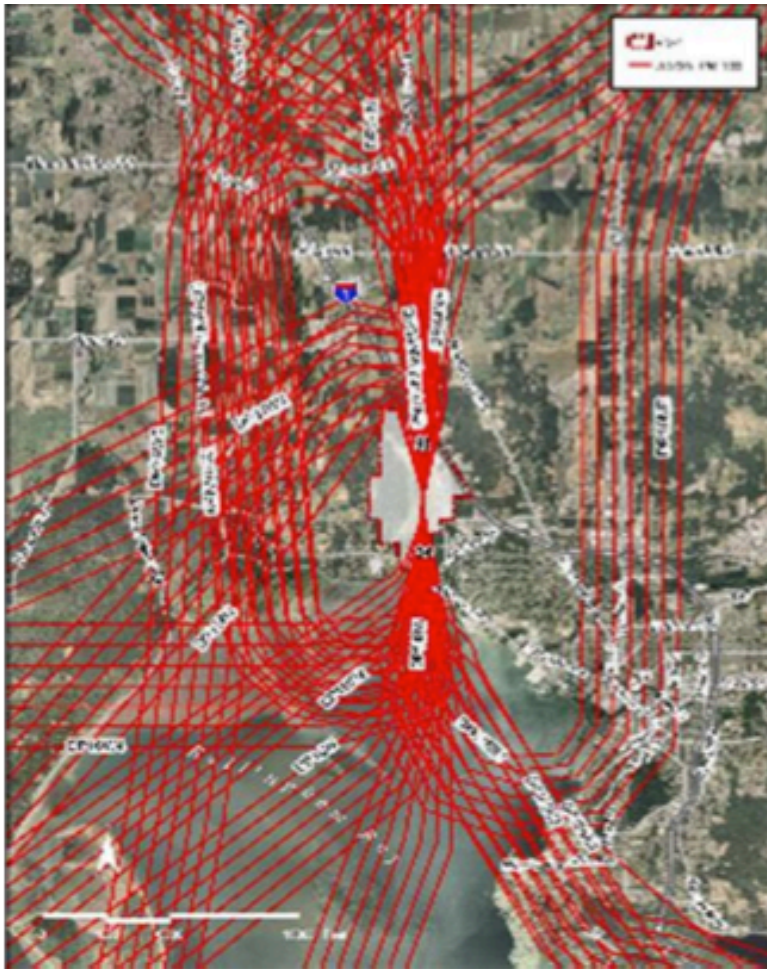


2000 60 dB

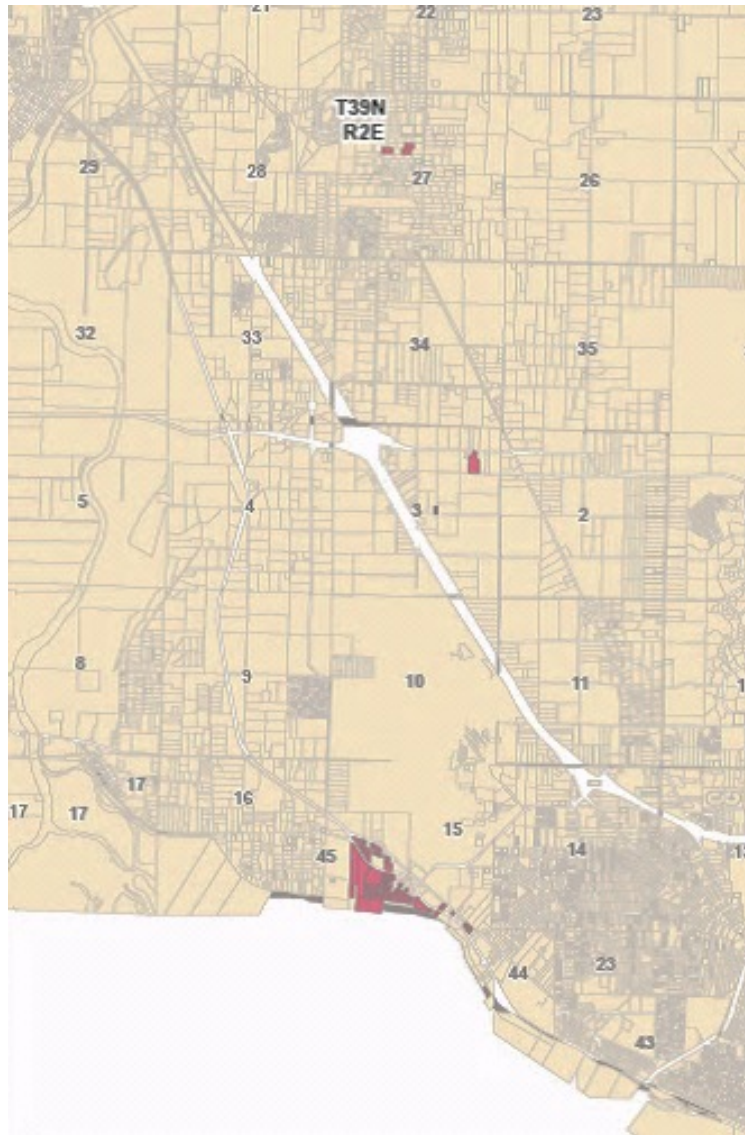


DNL (dB)	Area (Acres)	2008		Area (acres)	2000	
		Population	Housing Units		Population	Housing Units
60 dB to 65dB	591	73	39	275	14	7
65 dB to 70 dB	218	11	5	99	0	0
70 dB to 75 dB	75	0	0	57	0	0
> 75 dB	95	0	0	44	0	0

Source: Port of Bellingham Noise Study by HMMH (2009)

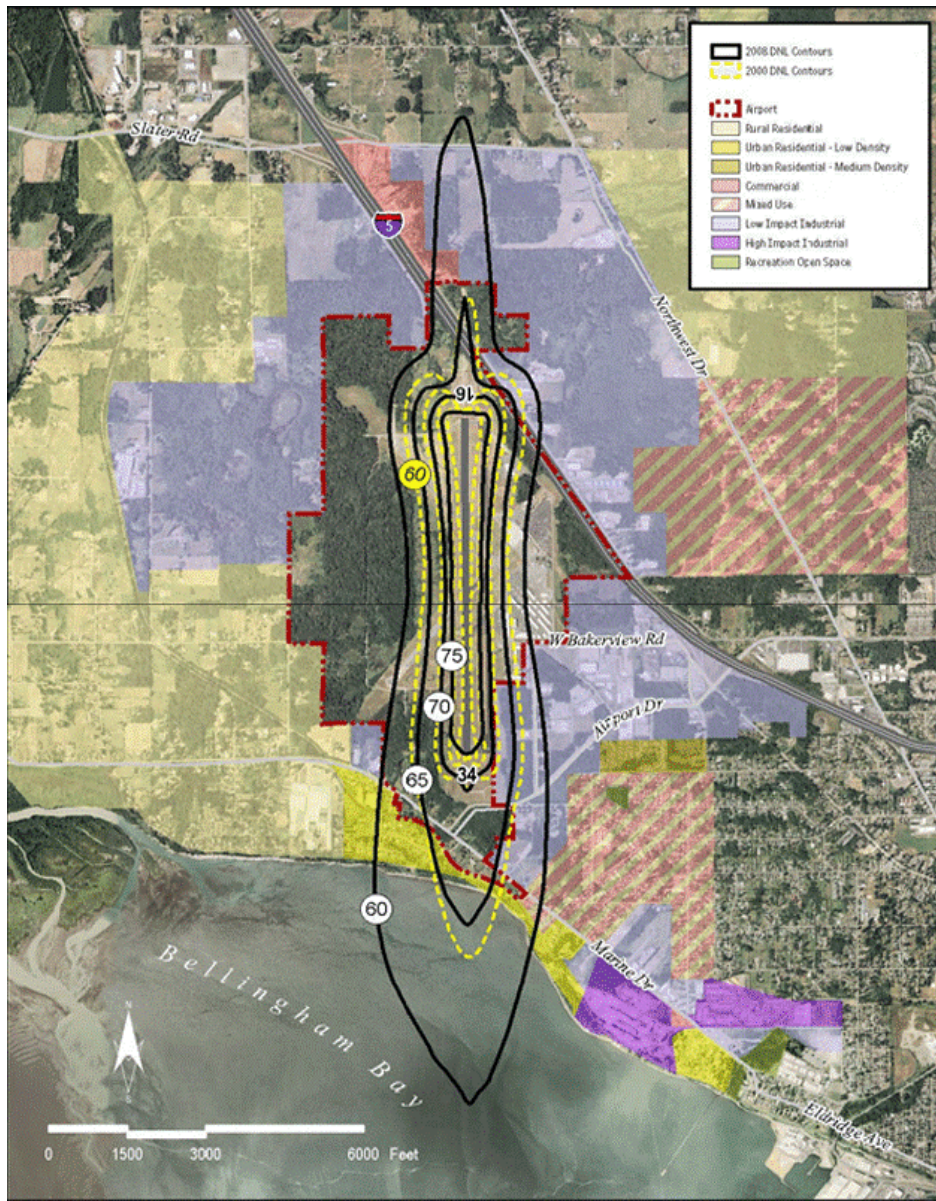


Source: Port of Bellingham Noise Study by HMMH (2009)

[illegible]

Source: Whatcom County Assessor Office (2012)

Integrated Noise Model (INM)



Source: Port of Bellingham Noise Study by HMMH (2009)

Short Film

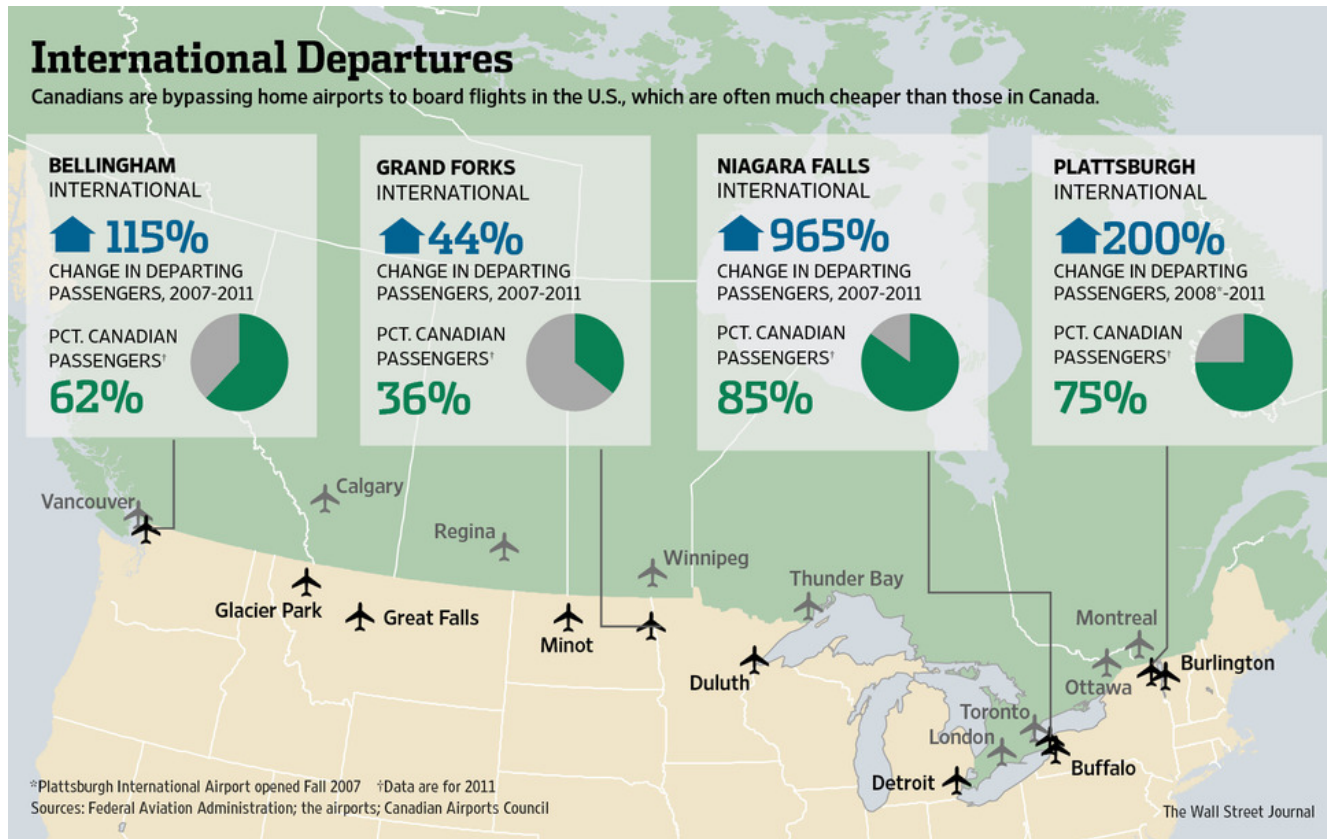
Technology

Tools

- Python Programming Language (2.7.3)
 - Python Image Library (PIL)
- Bash Shell
- Hardware Platform: Apple Mac Mini
- OS: 10.8.3

Hypothesis: If the number of enplaned passengers increases at a small regional airport, land uses inside the airport boundary and the immediately adjacent areas will shift towards urbanization therefor decreasing the grasslands and/or greenbelts.

Study Area



June 7, 2012, 9:18 p.m. ET Jack Nicas
 Canadians Crowd U.S. Airports. Why? Taxes
Miffed by Rising Fees, Canadian Travelers Flock to Nearby U.S. Airports

Source: Wall Street Journal((2012)

Dataset



Bellingham, Washington
Bellingham International (BLI)
Rank: 116
2011 Enplanements: 515,402
2010 Enplanements: 398,368
% Change: 29.38%
Nearest Airport: YVR 29 mi
PAE 74 mi SEA 107 mi



Burlington, Vermont
Burlington International (BTV)
Rank: 108
2011 Enplanements: 636,019
2010 Enplanements: 640,790
% Change: -0.74%
Nearest Airport: YUL 70 mi
PBG 38 mi



Duluth, Minnesota
Duluth International (DLH)
Rank: 202
2011 Enplanements: 146,620
2010 Enplanements: 150,556
% Change: -2.61%
Nearest Airport: MSP 174 mi
YQT 191 mi



Glacier Park, Montana
Glacier Park International (FCA)
Rank: 187
2011 Enplanements: 179,064
2010 Enplanements: 175,222
% Change: 2.19%
Nearest Airport: MSO 119 mi
YXC 139 mi



Grand Forks, North Dakota
Grand Forks International (GFK)
Rank: 211
2011 Enplanements: 118,872
2010 Enplanements: 117,980
% Change: 0.78%
Nearest Airport: YWG 151 mi
FAR 79 mi



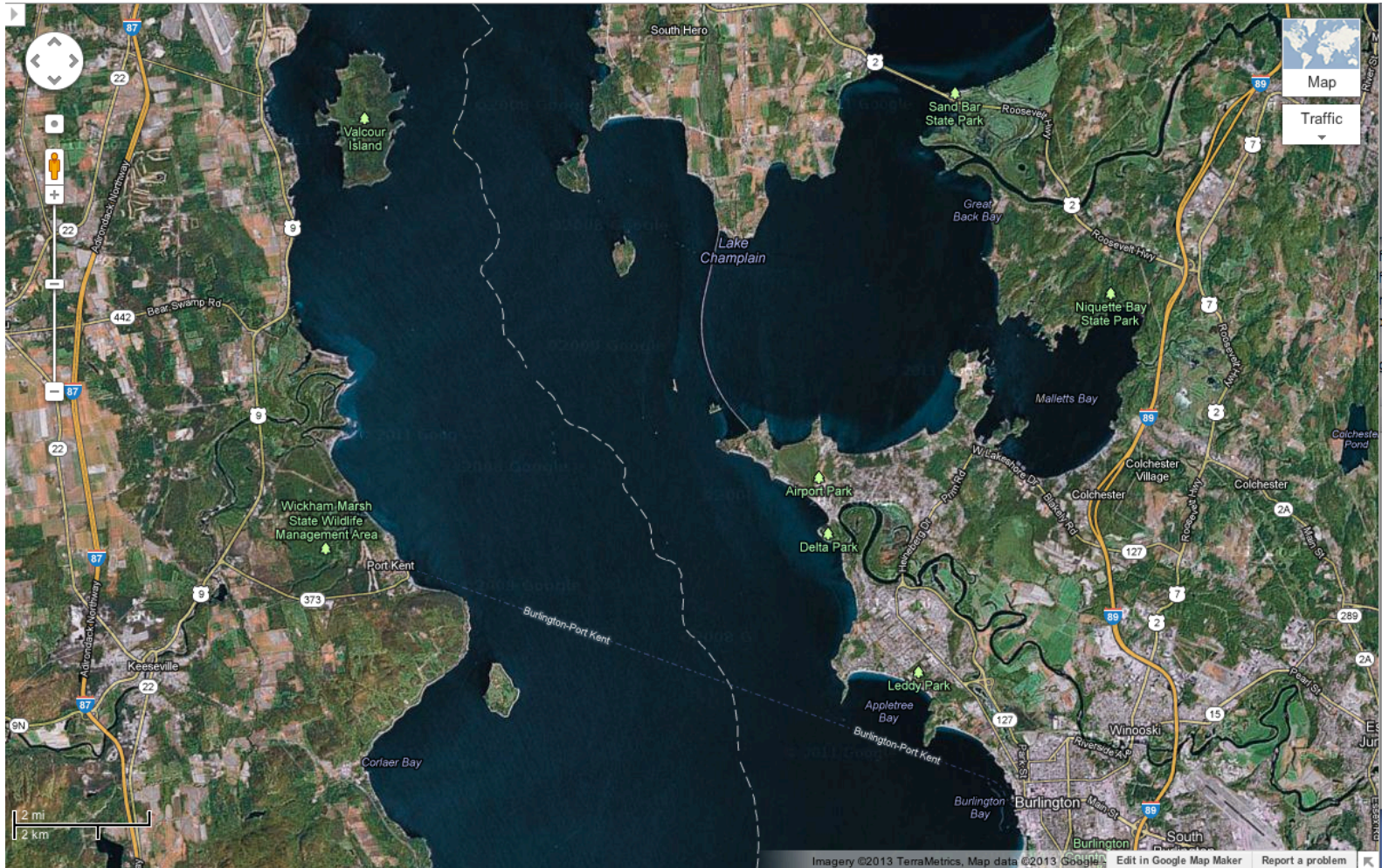
Niagara Falls, New York
Niagara Falls International (IAG)
Rank: 227
2011 Enplanements: 98,982
2010 Enplanements: 23,849
% Change: 315.04%
Nearest Airport: BUF 18 mi
YYZ 84.5 mi YHF 61 mi



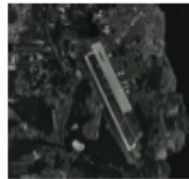
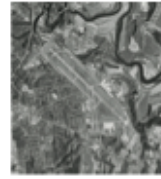
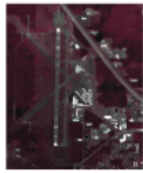
Minot, North Dakota
Minot International (MOT)
Rank: 197
2011 Enplanements: 151,424
2010 Enplanements: 91,120
% Change: 66.18%
Nearest Airport: BIS 118 mi
YBR 167 mi



Plattsburg, New York
Plattsburg International (PBG)
Rank: 204
2011 Enplanements: 129,698
2010 Enplanements: 94,808
% Change: 47.35%
Nearest Airport: YUL 68 mi
BTV 38 mi



Source: Google Maps (2013)



Challenges



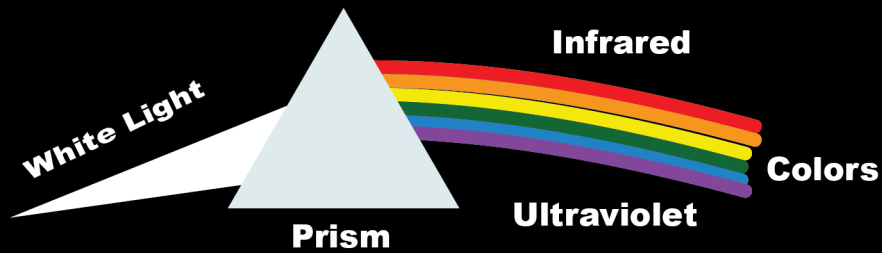
Sorting Colors

Source: City of Bellingham 2013

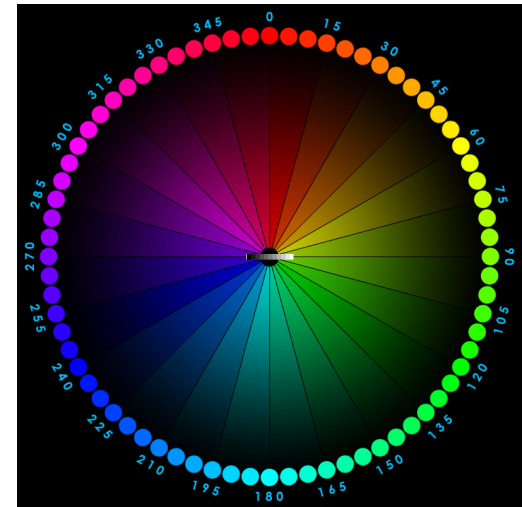
Methodology

Color

Issac Newton Color Prism Discovery (1666)



Color is the aspect of things that is caused by differing qualities of light being reflected or emitted by them (Crayola, 2013).



RGB Color

The colors that humans see are a combination of red, green, and blue light. The RGB color model is based on how humans interpret color. The RGB color model in today's digital age, allows us to retrieve and send images between various types of devices (Gonzalez & P., 1987).

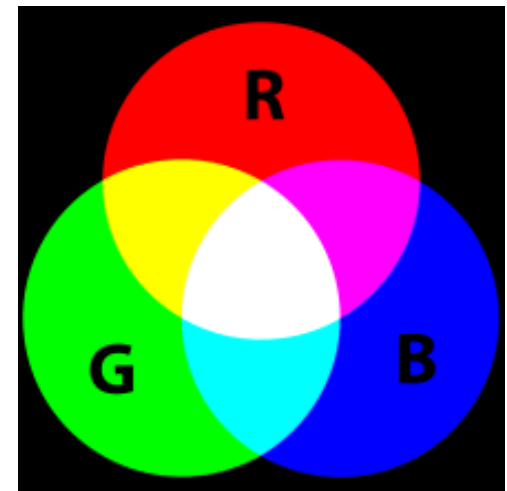
24 bit color $256^3 \sim 16.7$ Million Colors

16 bit color $256^2 = 65,536$ Colors

8 bit color $256^1 = 256$ Colors

Color Conversion Chart

Color	HEX	RGB	HSV
● Black	#000000	0,0,0	0°,0%,0%
● Red	#FF0000	255,0,0	0°,100%,100%
● Yellow	#FFFF00	255,255,0	60°,100%,100%
● Green	#008000	0,128,0	120°,100%,50%
● Purple	#800080	128,0,128	300°,100%,50%
● Blue	#0000FF	0,0,255	240°,100%,100%
○ White	#FFFFFF	255,255,255	0°,0%,100%



Chicken.png 3.9 Megs

2, 025 pixels x or width

1,513 pixels y or height



$1,513 \times 2,025 = 3,063,825$ pixels

getpixel(x,y)
putpixel(x,y)

Chicken.png

2, 025 pixels x or width

1,513 pixels y or height



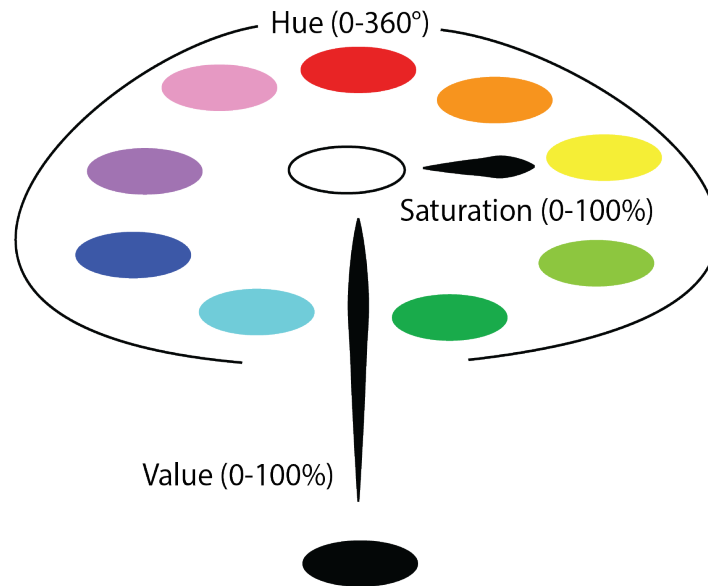
$1,513 \times 2,025 = 3,063,825$ pixels

1,042,475 Unique Colors

getpixel(x,y)
putpixel(x,y)

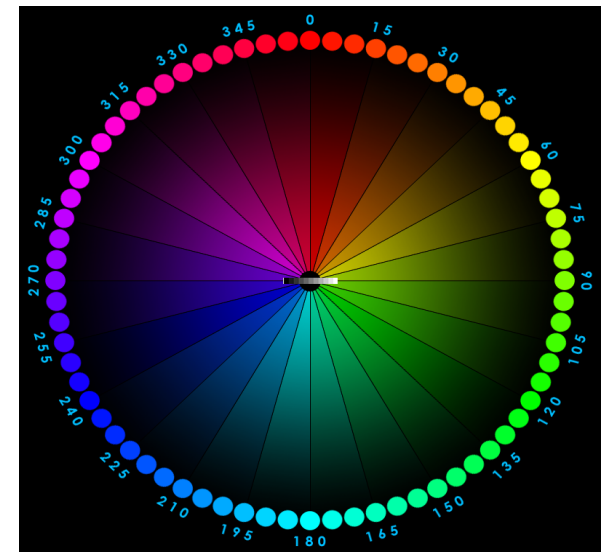
HSV Color

HSV Color Model



Color Conversion Chart

Color	HEX	RGB	HSV
● Black	#000000	0,0,0	0°,0%,0%
● Red	#FF0000	255,0,0	0°,100%,100%
● Yellow	#FFFF00	255,255,0	60°,100%,100%
● Green	#008000	0,128,0	120°,100%,50%
● Purple	#800080	128,0,128	300°,100%,50%
● Blue	#0000FF	0,0,255	240°,100%,100%
○ White	#FFFFFF	255,255,255	0°,0%,100%



```

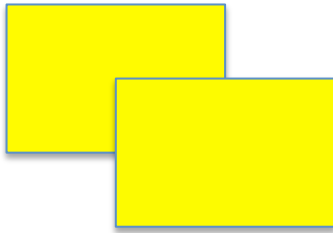
def rgb2hsv(r, g, b):
    r, g, b = r / 255.0, g / 255.0, b / 255.0
    mx = max(r, g, b)
    mn = min(r, g, b)
    df = mx - mn
    if mx == mn:
        h = 0
    elif mx == r:
        h = (60 * ((g - b) / df) + 360) % 360
    elif mx == g:
        h = (60 * ((b - r) / df) + 120) % 360
    elif mx == b:
        h = (60 * ((r - g) / df) + 240) % 360
    if mx == 0:
        s = 0
    else:
        s = df / mx
    v = mx
    return h, s, v

```

```

def hsv2rgb(h, s, v):
    h = float(h)
    s = float(s)
    v = float(v)
    h60 = h / 60.0
    h60f = math.floor(h60)
    hi = int(h60f) % 6
    f = h60 - h60f
    p = v * (1 - s)
    q = v * (1 - f * s)
    t = v * (1 - (1 - f) * s)
    r, g, b = 0, 0, 0
    if hi == 0: r, g, b = v, t, p
    elif hi == 1: r, g, b = q, v, p
    elif hi == 2: r, g, b = p, v, t
    elif hi == 3: r, g, b = p, q, v
    elif hi == 4: r, g, b = t, p, v
    elif hi == 5: r, g, b = v, p, q
    r, g, b = int(r * 255), int(g * 255), int(b * 255)
    return r, g, b

```

The Conversion Process

$\text{rgb2hsv}(255,255,0)=(60.0,1.0,1.0)$.
 $\text{rgb2hsv}(253,255,0)=(60.47058,1.0,1.0)$

Color Conversion Chart

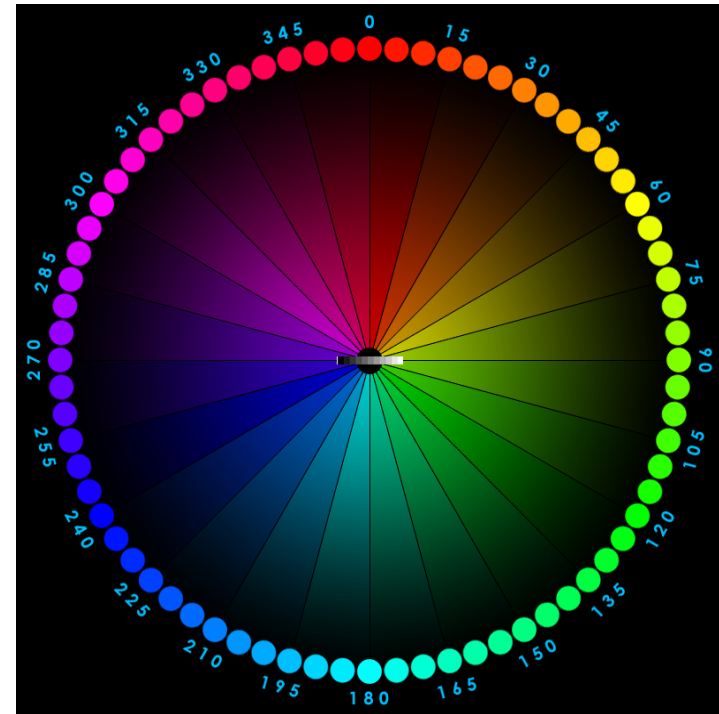
Color	HEX	RGB	HSV
Black	#000000	0,0,0	0°,0%,0%
Red	#FF0000	255,0,0	0°,100%,100%
Yellow	#FFFF00	255,255,0	60°,100%,100%
Green	#008000	0,128,0	120°,100%,50%
Purple	#800080	128,0,128	300°,100%,50%
Blue	#0000FF	0,0,255	240°,100%,100%
White	#FFFFFF	255,255,255	0°,0%,100%

$\text{rgb2hsv}(253,255,0)=(60.47058,1.0,1.0)$

$h,s,v=(60.47058,1.0,1.0)$

$h=\text{int}(h)$ # the int() function turns the h value of 60.47058 into 60.

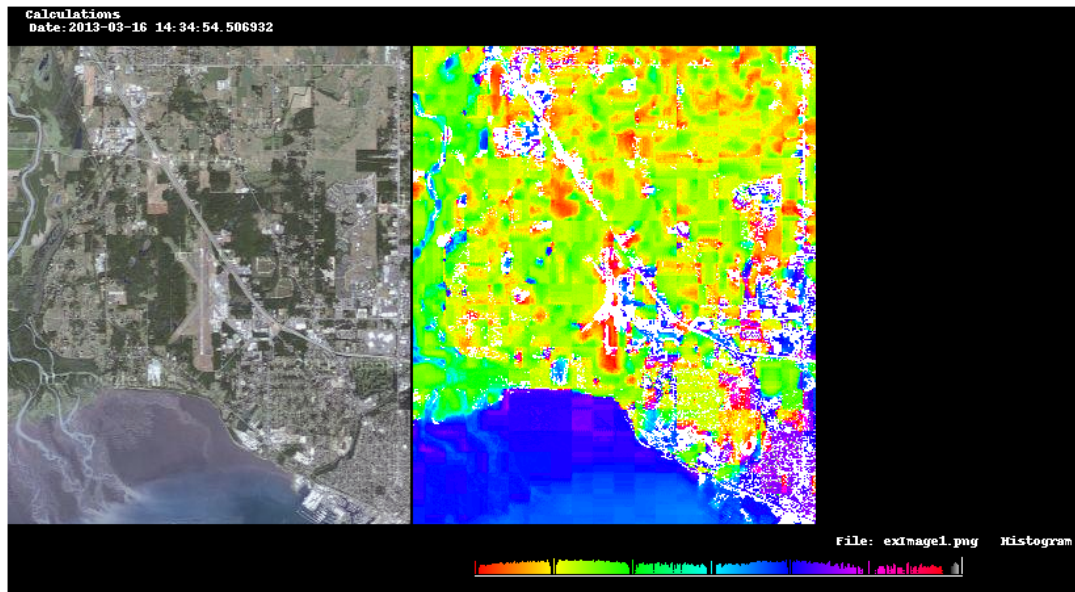
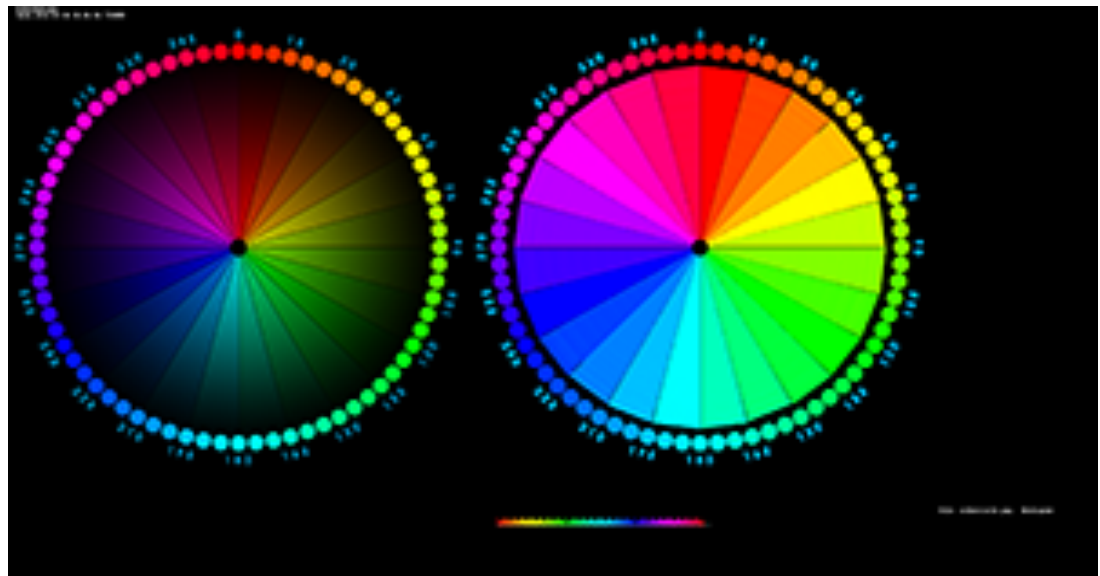
$\text{hsv2rgb}(h,1.0,1.0)=(255,255,0)$ # Convert back to RGB



17,621 unique colors.

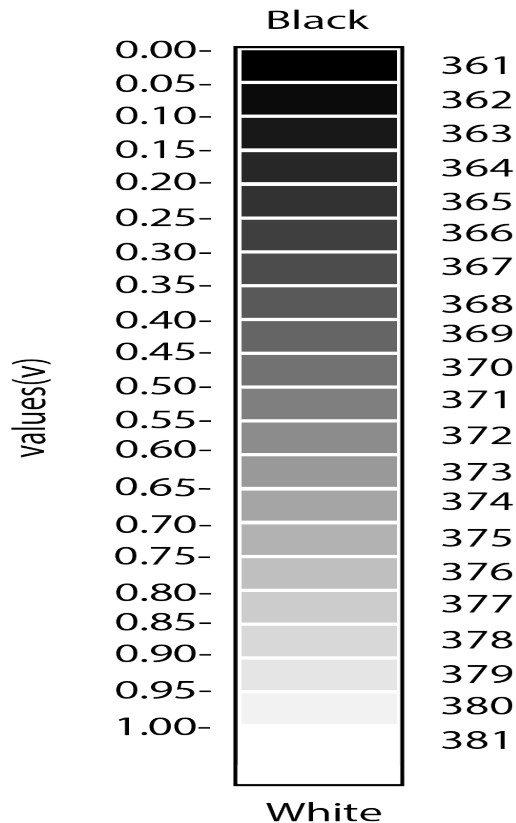
Color Wheel Test

17,621 unique colors.

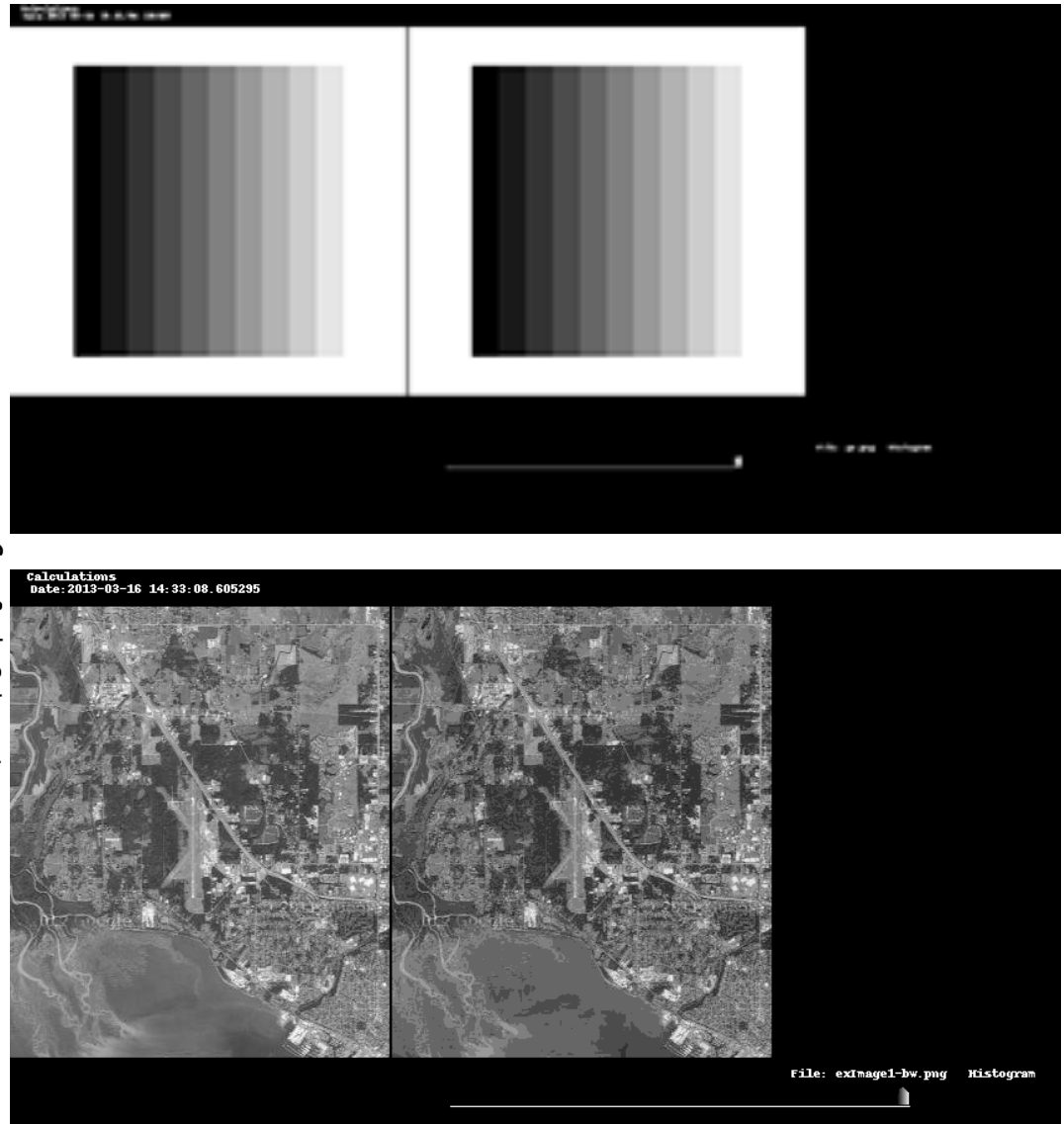


Grey Scale Test

HSV Grey Scale Values
With $h=0.0$ and $s=0.00$



Grey Scale Color Index



Methodology Steps

1 Categorize Images



Category Examples

Population

Economic

Cost

Market

Enplanements

Catchment

Product

Operations

Departures

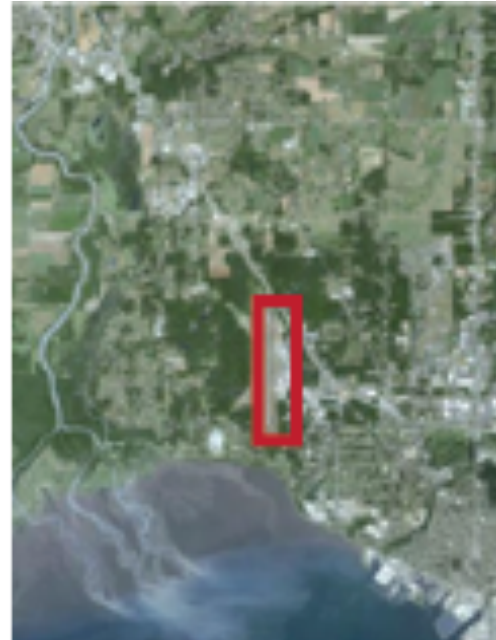
Arrivals

Location

Historical Comparison

Image Differencing

2 Select Common
Object



3 Selecting buffers



SDF.png,98,213,128

SEA.png,114,254,72

SEA.png,114,240,72

.

.

.

SEA.png,114,240,409

SEA.png,114,222,389

SFB.png,98,426,250

SFB.png,98,412,262

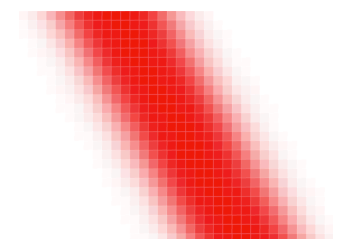
Rings are used to circle a specific area and with two radius variables which control the thickness of the ring.

Circles are points with a specific radius.

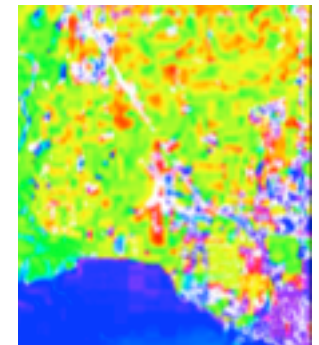
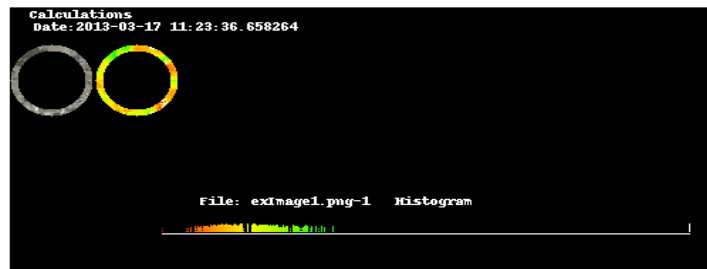
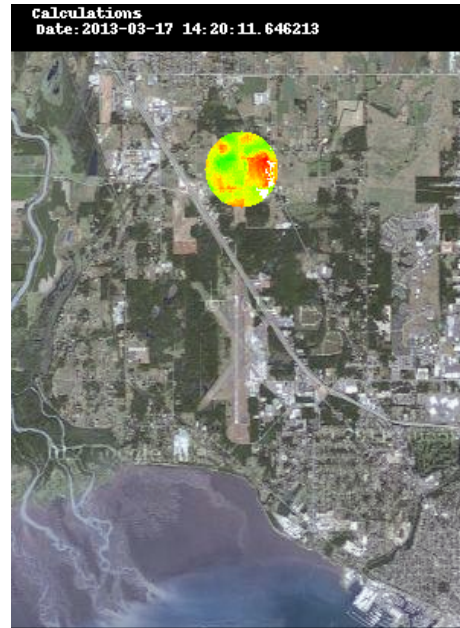
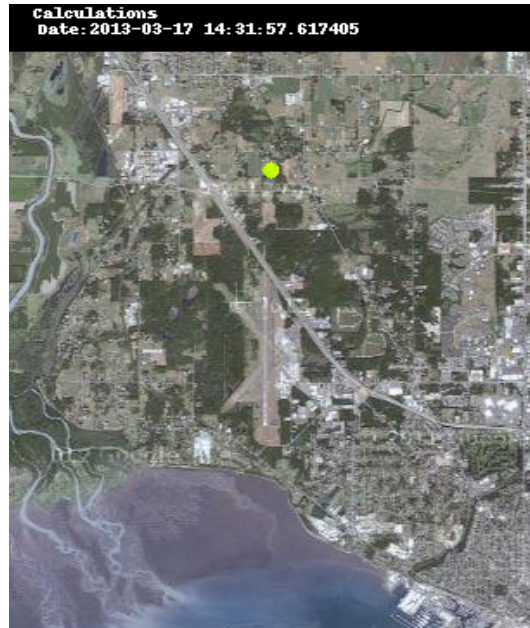
Rectangles or **squares** have a length and width based on the upper left pixel coordinates to the lower right.

Random points are used to help with calibration and gathering random sample of pixels over a specific rectangular region.

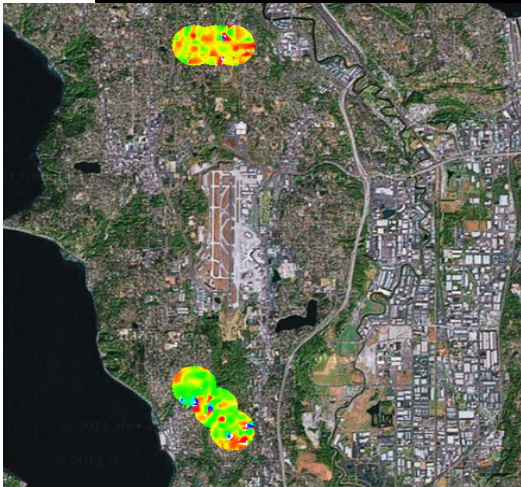
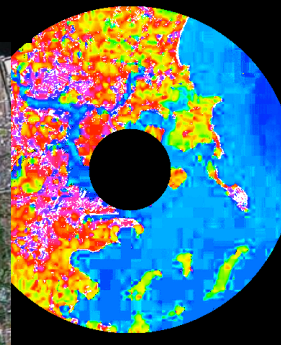
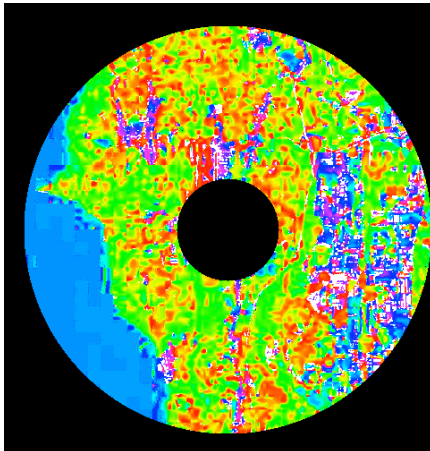
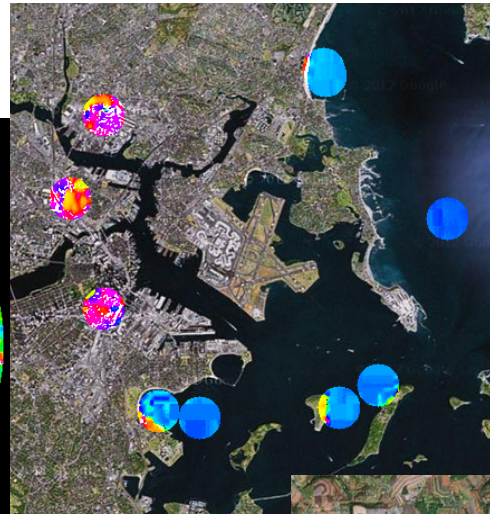
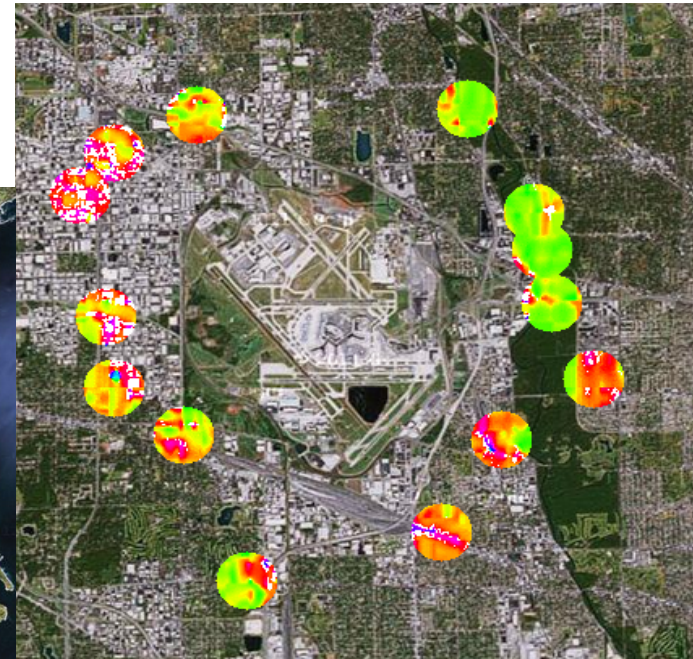
Lines are used with an adjustable width allowing for paths to be analyzed.



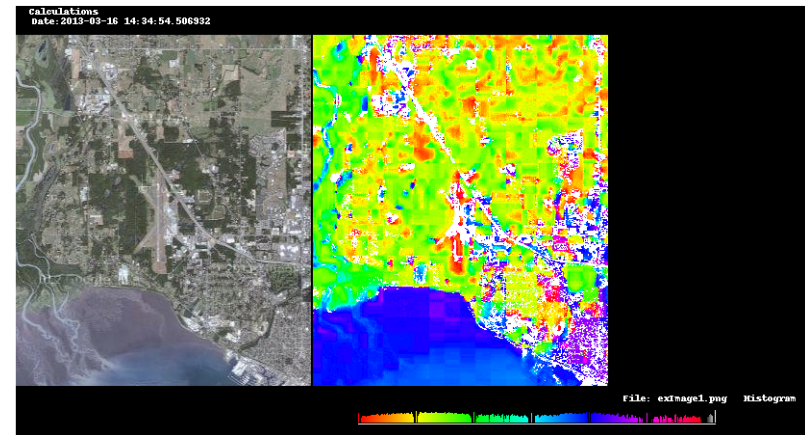
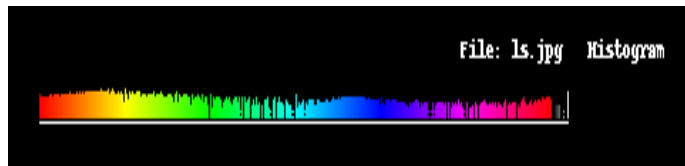
3 Selecting buffers



3 Selecting buffers



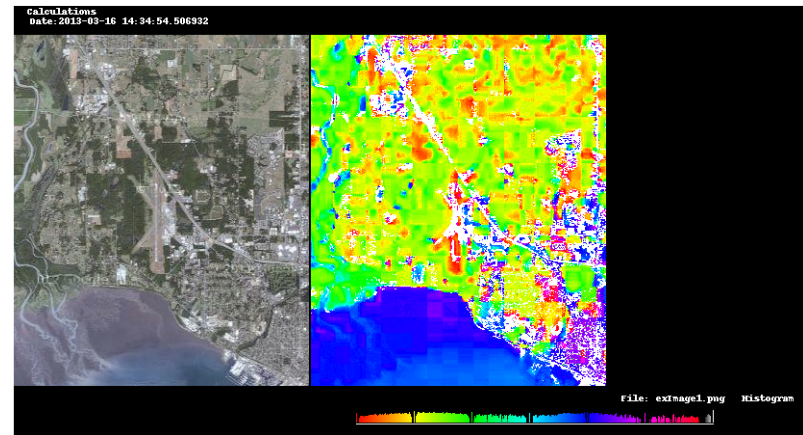
4 Analysis



Land Use Color Total												
0	132	0.04	1	7	0.00	2	1	0.00	4	3	0.00	5
7	2	0.00	8	1	0.00	9	239	0.07	10	220	0.06	11
15	172	0.05	16	1765	0.49	17	106	0.03	18	84	0.02	19
21	6153	1.71	22	137	0.04	23	148	0.04	24	202	0.06	25
27	381	0.11	28	404	0.11	29	1254	0.35	30	1657	0.46	31
33	434	0.12	34	383	0.11	35	229	0.06	36	1	0.00	37
40	93	0.03	41	732	0.20	42	667	0.19	43	424	0.12	44
46	9	0.00	47	23	0.01	48	225	0.06	49	531	0.15	50
52	703	0.20	53	1	0.00	54	35	0.01	55	1372	0.38	56
60	52440	14.57	61	11863	3.30	62	566	0.16	63	253	0.07	64
68	528	0.15	69	4866	1.35	70	2037	0.57	71	27	0.01	72
76	4634	1.29	77	554	0.15	78	2	0.00	79	4	0.00	80
85	518	0.14	86	411	0.11	87	68	0.02	88	119	0.03	89
91	2429	0.67	92	5159	1.43	93	134	0.04	94	3	0.00	95
97	4	0.00	98	132	0.04	99	34	0.01	100	341	0.09	101
103	1604	0.45	104	5	0.00	105	38	0.01	106	100	0.03	107
110	1730	0.48	111	969	0.27	112	423	0.12	113	10	0.00	114
116	13	0.00	117	10	0.00	118	9	0.00	119	4400	1.22	120
124	174	0.05	125	1366	0.38	126	3824	1.06	127	13	0.00	128
131	545	0.15	132	8694	2.42	133	20	0.01	134	30	0.01	135
138	29	0.01	139	38	0.01	140	542	0.15	142	31	0.01	144
146	443	0.12	147	21	0.01	149	316	0.09	150	6121	1.70	160
165	265	0.07	169	13	0.00	170	6	0.00	173	298	0.08	174
184	3	0.00	185	4940	1.37	186	11	0.00	189	1525	0.42	190
192	639	0.18	193	16	0.00	194	2	0.00	195	437	0.12	196
199	9	0.00	200	105	0.03	201	1544	0.43	202	226	0.06	203
205	73	0.02	206	1666	0.46	207	381	0.11	208	524	0.15	209
211	2755	0.77	212	1589	0.44	213	1506	0.42	214	6913	1.92	215
217	4960	1.38	218	4285	1.19	219	641	0.18	220	7394	2.05	221
223	1167	0.32	224	2093	0.58	225	1041	0.29	226	75	0.02	227
229	833	0.23	230	291	0.08	231	2317	0.64	232	2963	0.82	233
235	66	0.02	236	10	0.00	237	4524	1.26	238	91	0.03	240
243	128	0.04	244	147	0.04	245	5694	1.58	246	113	0.03	247
249	171	0.05	250	413	0.11	251	446	0.12	252	26	0.01	253
260	954	0.27	262	106	0.03	263	59	0.02	264	62	0.02	265
267	6	0.00	268	2	0.00	269	8	0.00	270	80	0.02	271
275	6	0.00	276	1415	0.39	278	298	0.08	279	50	0.01	280
282	279	0.08	283	139	0.06	284	3	0.00	285	8	0.00	287
289	1	0.00	290	109	0.03	292	2993	0.83	293	59	0.02	294
300	420	0.12	304	28	0.01	305	101	0.03	306	2457	0.68	309
311	136	0.04	312	10	0.00	313	2	0.00	316	24	0.01	318

195	17	0.76%
201	66	2.95%
207	69	3.08%

5 Categorize Colors



Land Use Color Total									
0	1322 0.04	1	7 0.00	2	1 0.00	3	0 0.00	4	3 0.00
7	2 0.00	8	1 0.00	9	239 0.07	10	220 0.06	11	31 0.02
15	172 0.05	16	1765 0.49	17	106 0.03	18	84 0.02	19	38 0.01
21	6153 1.71	22	137 0.04	23	140 0.04	24	202 0.06	25	1657 0.46
27	381 0.11	28	404 0.11	29	1254 0.35	30	1657 0.46	31	37 0.01
33	434 0.12	34	383 0.11	35	229 0.06	36	1 0.00	37	44 0.01
40	38 0.03	41	732 0.20	42	847 0.19	43	424 0.12	44	531 0.15
46	9 0.00	47	23 0.01	48	225 0.06	49	1372 0.38	50	259 0.07
52	703 0.20	53	1 0.00	54	35 0.01	55	119 0.03	56	27 0.01
60	52440 1.47	61	11663 0.30	62	546 0.15	63	4 0.00	64	100 0.03
68	528 0.15	69	4866 1.35	70	2037 0.57	71	82 0.02	72	341 0.09
76	4634 1.29	77	554 0.15	78	2 0.00	79	119 0.03	80	3 0.00
85	514 0.14	86	411 0.11	87	68 0.02	88	100 0.03	89	10 0.00
91	2429 0.67	92	5159 1.43	93	134 0.04	94	341 0.09	95	10 0.00
97	4 0.00	98	132 0.04	99	34 0.01	100	100 0.03	101	10 0.00
103	1604 0.45	104	5 0.00	105	38 0.01	106	100 0.03	107	10 0.00
110	1730 0.48	111	969 0.27	112	423 0.12	113	100 0.03	114	10 0.00
116	13 0.00	117	10 0.00	118	9 0.00	119	4400 1.22	120	10 0.00
124	174 0.05	125	1366 0.38	126	3824 1.06	127	10 0.00	128	10 0.00
131	545 0.15	132	8694 2.42	133	20 0.01	134	30 0.01	135	30 0.01
138	29 0.01	139	38 0.01	140	542 0.15	141	31 0.01	142	31 0.01
146	449 0.12	147	21 0.01	148	338 0.09	149	6121 1.70	150	298 0.08
155	265 0.07	156	13 0.00	157	6 0.00	158	173 0.05	159	1525 0.42
164	3 0.00	165	4940 1.37	166	11 0.00	167	109 0.03	168	226 0.06
172	639 0.18	173	16 0.00	174	2 0.00	175	109 0.03	176	524 0.15
179	9 0.00	180	105 0.03	181	1544 0.43	182	437 0.12	183	7394 2.05
185	73 0.02	186	1666 0.46	187	381 0.11	188	524 0.15	189	75 0.02
192	2795 0.77	193	1589 0.44	194	1507 0.42	195	6913 1.92	196	296 0.08
197	4960 1.38	198	4285 1.19	199	601 0.18	200	6913 1.92	201	91 0.03
203	1167 0.32	204	2093 0.58	205	1041 0.29	206	113 0.03	207	26 0.01
209	832 0.23	210	291 0.08	211	2317 0.64	212	26 0.01	213	26 0.01
215	66 0.02	216	10 0.00	217	4524 1.26	218	91 0.03	219	26 0.01
223	128 0.04	224	147 0.04	225	5694 1.58	226	113 0.03	227	26 0.01
229	171 0.05	230	413 0.11	231	446 0.12	232	26 0.01	233	26 0.01
235	160 0.04	236	106 0.03	237	19 0.00	238	62 0.02	239	26 0.01
243	6 0.00	244	2 0.00	245	8 0.00	246	60 0.02	247	26 0.01
249	6 0.00	250	1415 0.39	251	298 0.08	252	50 0.01	253	26 0.01
255	279 0.08	256	199 0.06	257	9 0.00	258	50 0.01	259	26 0.01
267	1 0.00	268	109 0.03	269	2999 0.83	270	59 0.02	271	26 0.01
275	420 0.12	276	28 0.01	277	101 0.03	278	2457 0.68	279	26 0.01
282	136 0.04	283	10 0.00	284	2 0.00	285	24 0.01	286	26 0.01

5 Categorize
Colors

Themes

- Global
- local

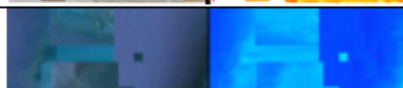
Theme Type	Image sample with rendering	Unique Colors	Color Index Ranges
Grasslands		14,095	0-79
water		12,860	182-228
Green Belt		3,361	80-158
Urban		2,117 256 if Grey Scale.	159-181,361-381

Figure 5.21 Theme Capture or training technique.

Theme Totals	Theme Name	Theme Ranges	Total	PoT%	PoP%
	First Degree of Color	0	217	0.19%	0.43%
	All of the Colors	0-371	50358	43.99%	100.00%
	Gray scale 361-371 w/ B&W	361-371	489	0.43%	0.97%
	48 & 60	48,60	3031	2.65%	6.02%
	Lots of Red	300-359,0-30	9071	8.71%	18.00%
	Blues				
	Couple Greens				
	Lots of Green				
	Last Degree of Color				
	Urban				

```
# Theme File: themes.csv
# Theme Name:Color:Range(s)
First Degree of Color:0:0
All of the Colors:371:0-371
Gray scale 361 thru 371 including Black and White:364:361-371
48 & 60:48:48,60
Lots of Red:0:300-359,0-30
Blues:195:160-270
Couple Greens:69:69,84-86,70,73,77,98
Lots of Green:135:90-150
Last Degree of Color:371:371
Urban:0:0-75,270-371
```

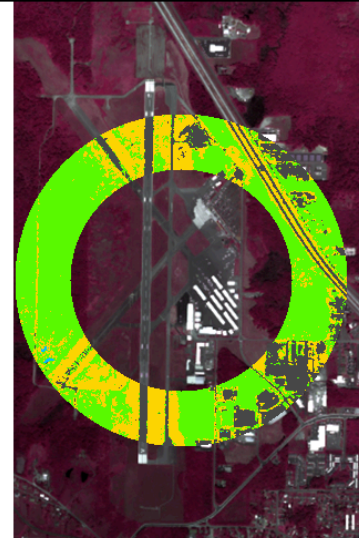
Figure 5.19 Theme File

Training Area
Pixel Based

6 Final Analysis

crmsd Total									
0	0	0.00%	1	0	0.00%	2	0	0.00%	3
6	0	0.00%	7	0	0.00%	8	0	0.00%	9
12	0	0.00%	13	0	0.00%	14	0	0.00%	15
18	0	0.00%	19	0	0.00%	20	0	0.00%	21
24	0	0.00%	25	0	0.00%	26	0	0.00%	27
30	0	0.00%	31	0	0.00%	32	0	0.00%	33
36	0	0.00%	37	0	0.00%	38	0	0.00%	39
42	0	0.00%	43	0	0.00%	44	0	0.00%	45
48	0	0.00%	49	1	0.04%	50	0	0.00%	51
54	5	0.22%	55	0	0.00%	56	0	0.00%	57
60	14	0.62%	61	0	0.00%	62	2	0.09%	63
66	3	0.13%	67	0	0.00%	68	13	0.56%	69
72	0	0.00%	73	6	0.27%	74	0	0.00%	75
78	10	0.45%	79	4	0.18%	80	13	0.55%	81
84	11	0.49%	85	19	0.85%	86	11	0.49%	87
90	47	2.10%	91	66	2.95%	92	90	4.02%	93
96	119	5.31%	97	32	1.43%	98	26	1.16%	99
102	20	1.25%	103	40	0.71%	104	27	1.21%	105
108	7	0.31%	109	11	0.48%	110	6	0.27%	111
114	3	0.13%	115	2	0.09%	116	3	0.13%	117
120	16	0.71%	121	0	0.00%	122	0	0.00%	123
126	2	0.09%	127	1	0.04%	128	1	0.04%	129
132	0	0.00%	133	1	0.04%	134	1	0.04%	135
138	1	0.04%	139	0	0.00%	140	2	0.09%	141
144	0	0.00%	145	0	0.00%	146	0	0.00%	147
150	0	0.00%	151	0	0.00%	152	1	0.04%	153
156	0	0.00%	157	0	0.00%	158	0	0.00%	159
162	0	0.00%	163	0	0.00%	164	0	0.00%	165
168	0	0.00%	169	0	0.00%	170	0	0.00%	171
174	0	0.00%	175	0	0.00%	176	0	0.00%	177
180	0	0.00%	181	0	0.00%	182	0	0.00%	183
186	0	0.00%	187	0	0.00%	188	0	0.00%	189
192	0	0.00%	193	0	0.00%	194	3	0.13%	195
198	237	10.56%	199	71	3.17%	200	93	4.15%	201
204	28	1.25%	205	85	3.79%	206	89	3.97%	207
210	83	2.11%	211	26	1.16%	212	0	0.00%	213
216	0	0.00%	217	0	0.00%	218	0	0.00%	219
222	0	0.00%	223	0	0.00%	224	0	0.00%	225
228	0	0.00%	229	0	0.00%	230	0	0.00%	231
234	0	0.00%	235	0	0.00%	236	0	0.00%	237
240	0	0.00%	241	0	0.00%	242	0	0.00%	243
246	0	0.00%	247	0	0.00%	248	0	0.00%	249
252	0	0.00%	253	0	0.00%	254	0	0.00%	255
258	0	0.00%	259	0	0.00%	260	0	0.00%	261
264	0	0.00%	265	0	0.00%	266	0	0.00%	267
270	0	0.00%	271	0	0.00%	272	0	0.00%	273
276	0	0.00%	277	0	0.00%	278	0	0.00%	279
282	0	0.00%	283	0	0.00%	284	0	0.00%	285
288	0	0.00%	289	0	0.00%	290	0	0.00%	291
294	0	0.00%	295	0	0.00%	296	0	0.00%	297
300	0	0.00%	301	0	0.00%	302	0	0.00%	303
306	0	0.00%	307	0	0.00%	308	0	0.00%	309
312	0	0.00%	313	0	0.00%	314	0	0.00%	315
318	0	0.00%	319	0	0.00%	320	0	0.00%	321
324	0	0.00%	325	0	0.00%	326	0	0.00%	327
330	0	0.00%	331	0	0.00%	332	0	0.00%	333
336	0	0.00%	337	0	0.00%	338	0	0.00%	339
342	0	0.00%	343	0	0.00%	344	0	0.00%	345
348	0	0.00%	349	0	0.00%	350	0	0.00%	351
354	0	0.00%	355	0	0.00%	356	0	0.00%	357
360	0	0.00%	361	0	0.00%	362	0	0.00%	363
366	0	0.00%	367	0	0.00%	368	0	0.00%	369

Calculations Date: 2013-04-21 23:55:24.873580 matt@paskus.net www GEOGRAPHY



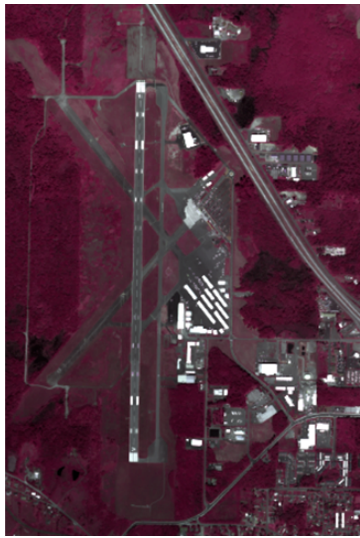
BLI2004 BLI2004

Total Pixels: 39244

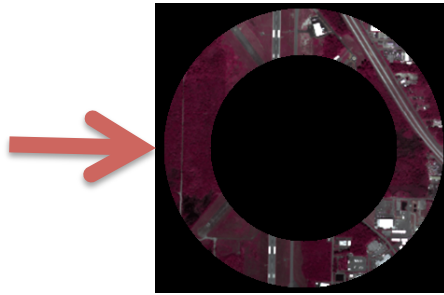
Unique Colors: 17328

Theme Totals	Theme Name	Theme Ranges	Unique Colors	Total	Pct%	Pct%
	Dry Field	388-360	5502	10787	27.49%	27.49%
	Water	361	16	42	0.11%	0.11%
	Greens Belt	330-337	7340	21864	55.71%	55.71%
	Urban	362-381, 0-329	4470	6551	16.69%	16.69%
	Totals		382	17328	39244	100.00%

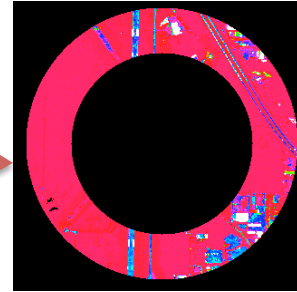
Review Process



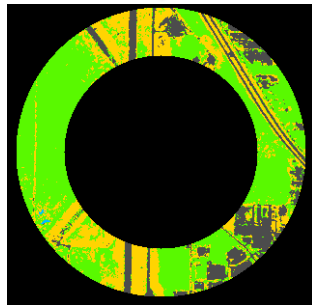
Step 1



Step 2

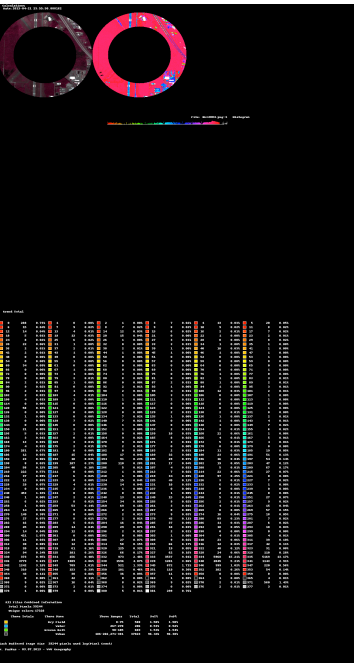
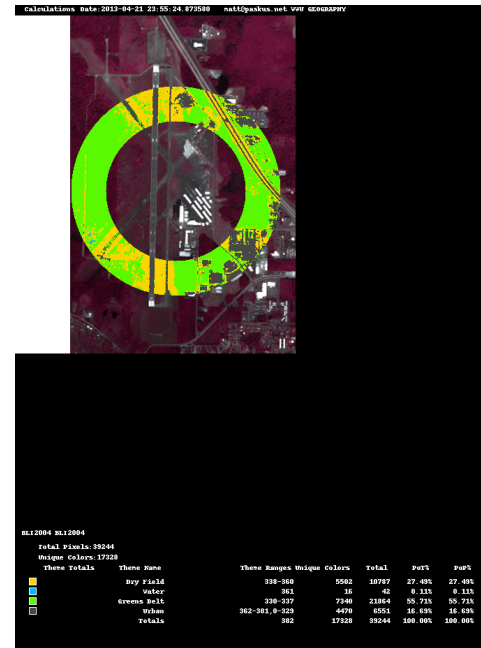


Step 3



Step 5

Total Pixels: 39244
Unique Colors: 17328



Step 4

Step 6

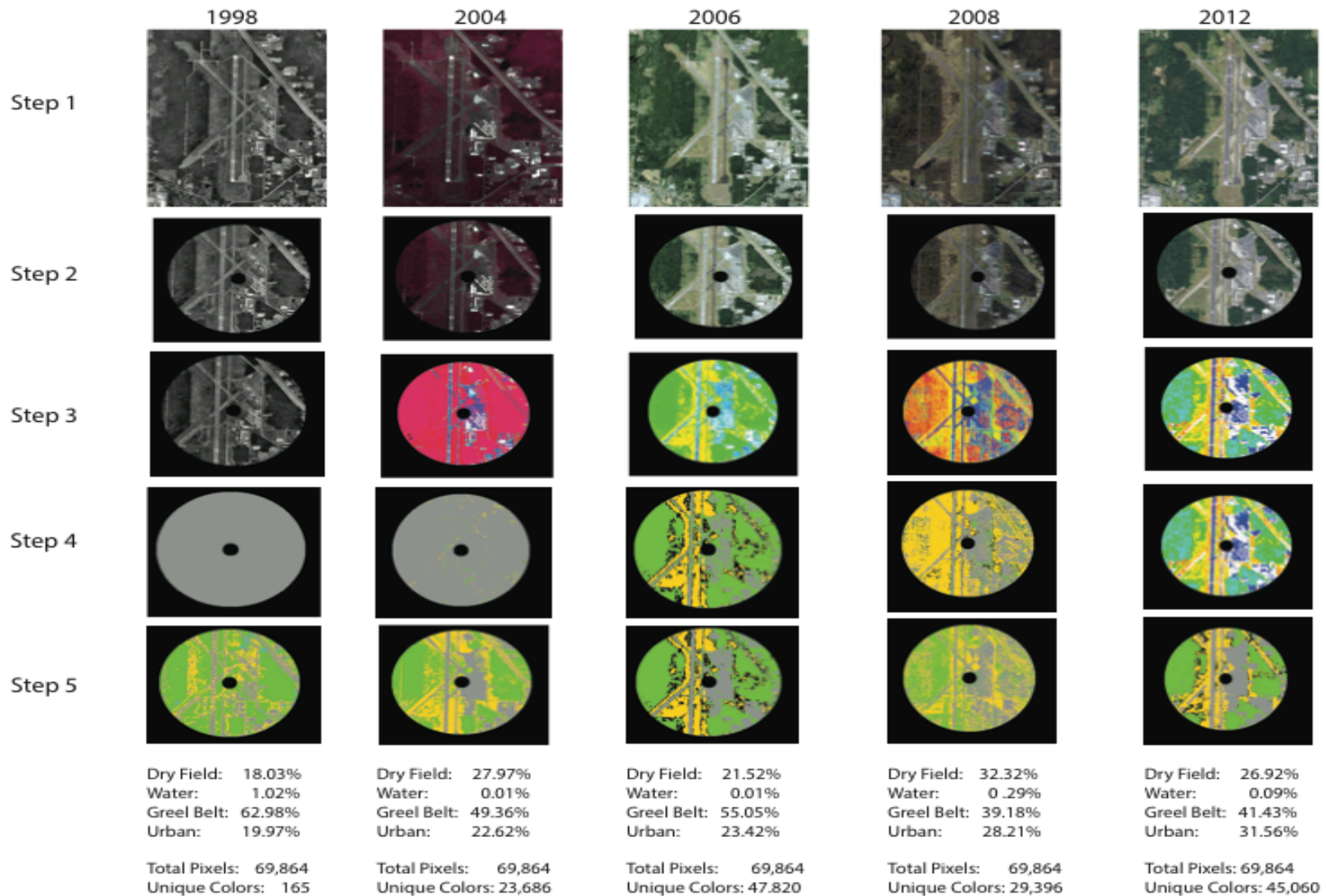
Results

Captured Data

File	D Range	D Tally	W Range	W Tally	G Range	G Tally	U Range	U Tally	Enplanements
BLI1998	367-370	31510	362	537	361,363-366	25,264	371-381	12,553	62,161
BLI2004	338-360	19539	361	42	330-337	34,483	362-381,0-329	15,800	82,353
BLI2006	0-75	13662	267-270	4	90-163	34,956	164-266,270-381	14,871	135,073
BLI2008	0-15,51-179	22582	267-270	204	16-50,240-246	27,371	180-239,247-266,271-381	19,707	278,503
BLI2012	0-75	17931	267-270	61	90-185	27,592	186-266,271-381	21,019	574,601
BTU1999	368-374	48487	361	139	362-367	13,845	375-381	7,393	258,903
BTU2004	0-75	1076	267-270	19	90-185	53,756	186-266,271-381	13,860	623,679
BTU2009	0-89	13171	267-270	21	90-185	36,875	186-266,271-381	19,797	648,613
BTU2012	0-75	9371	267-270	302	90-185	25,055	186-266,271-381	34,488	614,789
DLH1991	368-370	21892	361	279	362-367	19,398	371-381	28,295	103,726
DLH2003	0-75	30319	267-270	187	90-185	14,702	186-266,271-381	23,350	121,392
DLH2008	0-75	28217	267-270	134	90-185	17,470	186-266,271-381	13,564	150,224
DLH2011	0-75	9051	267-270	400	90-185	23,998	186-266,271-381	33,525	131,018
FCA1990	361-362,364-366,370-374,376	41770	360	-	363	10,085	367-369,375,377-381	18,009	88,773
FCA2002	363,366-370	48809	360	-	362,371	7,046	361,364-365,372-381	14,009	165,017
FCA2005	0-75	25389	267-270	404	90-185	22,477	186-266,271-381	18,249	190,909
FCA2012	0-75	26070	267-270	521	90-185	17,616	186-266,271-381	22,420	192,501
GFK1997	368-374	18489	361	184	362-367	40,835	375-381	10,356	89,467
GFK2004	0-75	14388	267-270	17	90-185	32,787	186-266,271-381	13,629	96,704
GFK2011	0-75	24773	267-270	258	90-185	17,760	186-266,271-381	21,685	105,472
IAG1995	365,370-371	25079	360	-	363	962	361-362,366-369,372-381,364	43,823	-
IAG2005	0-75	24487	267-270	712	90-185	3	186-266,271-381	44,662	412
IAG2011	0-75	37577	267-270	12	90-185	7,056	186-266,276-381	10,636	73,438
MOT1995	362,367,365	21421	361	238	363,364,366	29,133	368-381	19,072	68,340
MOT2003	0-89,164-266,271-360	46516	267-270	403	90-163	9,592	361-381	13,353	72,518
MOT2006	0-31,37-39,42-75	44789	267-270	-	90-163	10,702	164-381,32-36,40,41	10,496	74,990
MOT2011	0-75	9127	267-270	151	90-185	38,404	186-266,271-381	19,828	127,628
PBG1995	362,367,365	20664	361	551	363,364,366	32,236	368-381	16,413	-
PBG2003	0-75,186-266,271-380	15101	267-270	84	90-185	13,521	381	37,545	-
PBG2009	0-75,186-266,271-380	26939	267-270	1,332	90-185	10,564	381	30,360	41,489
PBG2012	0-75	20570	267-270	216	90-185	2,871	186-266,271-381	45,444	129,184

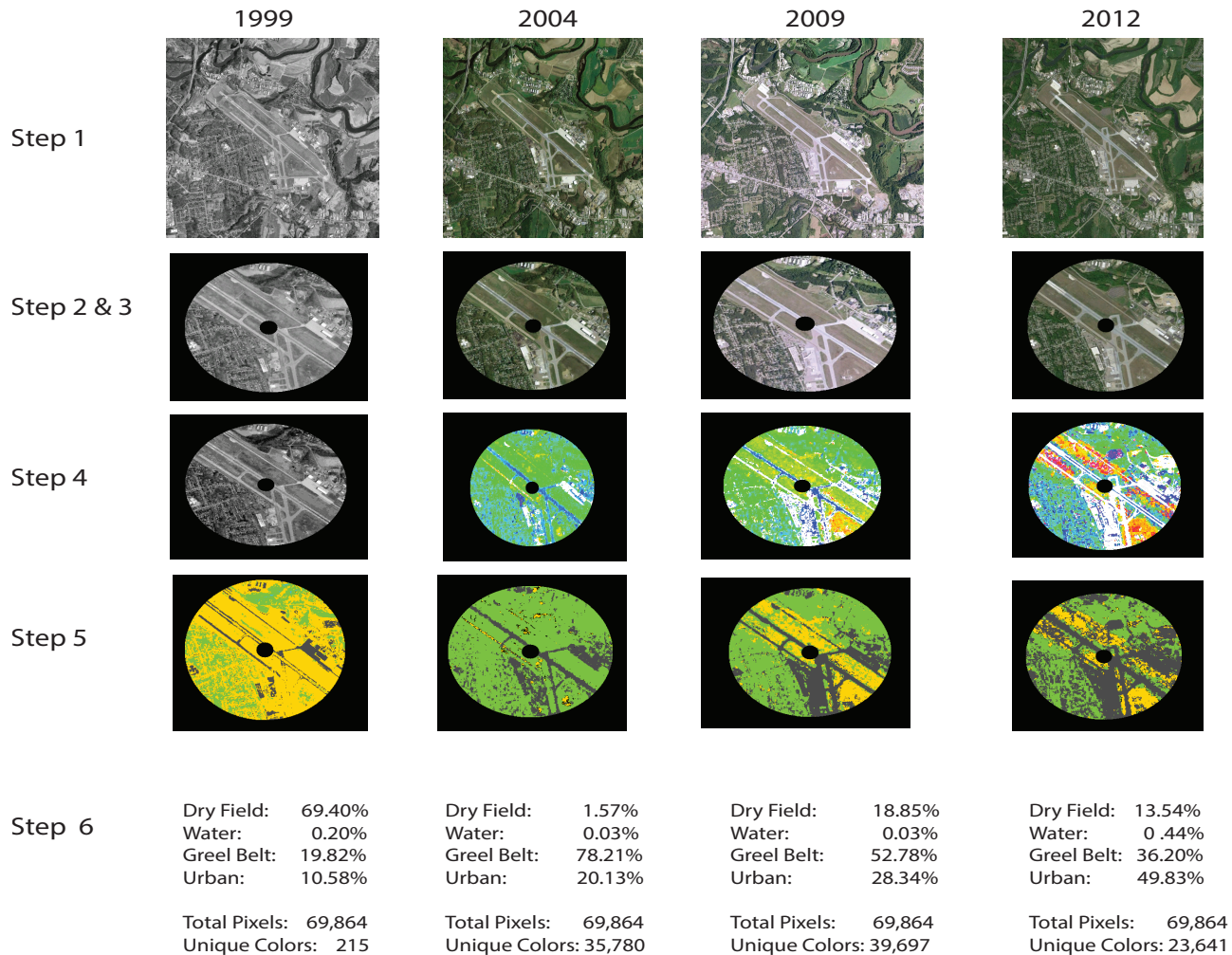
Figure 5.74 Captured Data

Bellingham, Washington (BLI)



(City of Bellingham, 2013)

Burlington, Vermont (BTV)



(Source USGS,2013)

Dultuh, Minnesota (DLH)

1991

2003

2008

2011

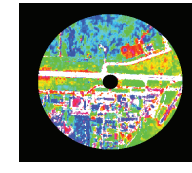
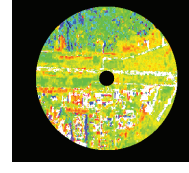
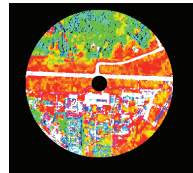
Step 1 & 2



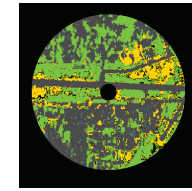
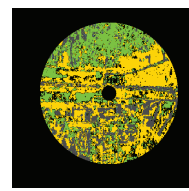
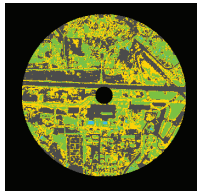
Step 3



Step 4



Step 5



Step 6

Dry Field: 31.34%
Water: 0.40%
Greel Belt: 27.77%
Urban: 40.50%

Total Pixels: 69,864
Unique Colors: 254

Dry Field: 44.22%
Water: 0.27%
Greel Belt: 21.44%
Urban: 34.66%

Total Pixels: 69,864
Unique Colors: 40,457

Dry Field: 47.52%
Water: 0.23%
Greel Belt: 29.42%
Urban: 22.84%

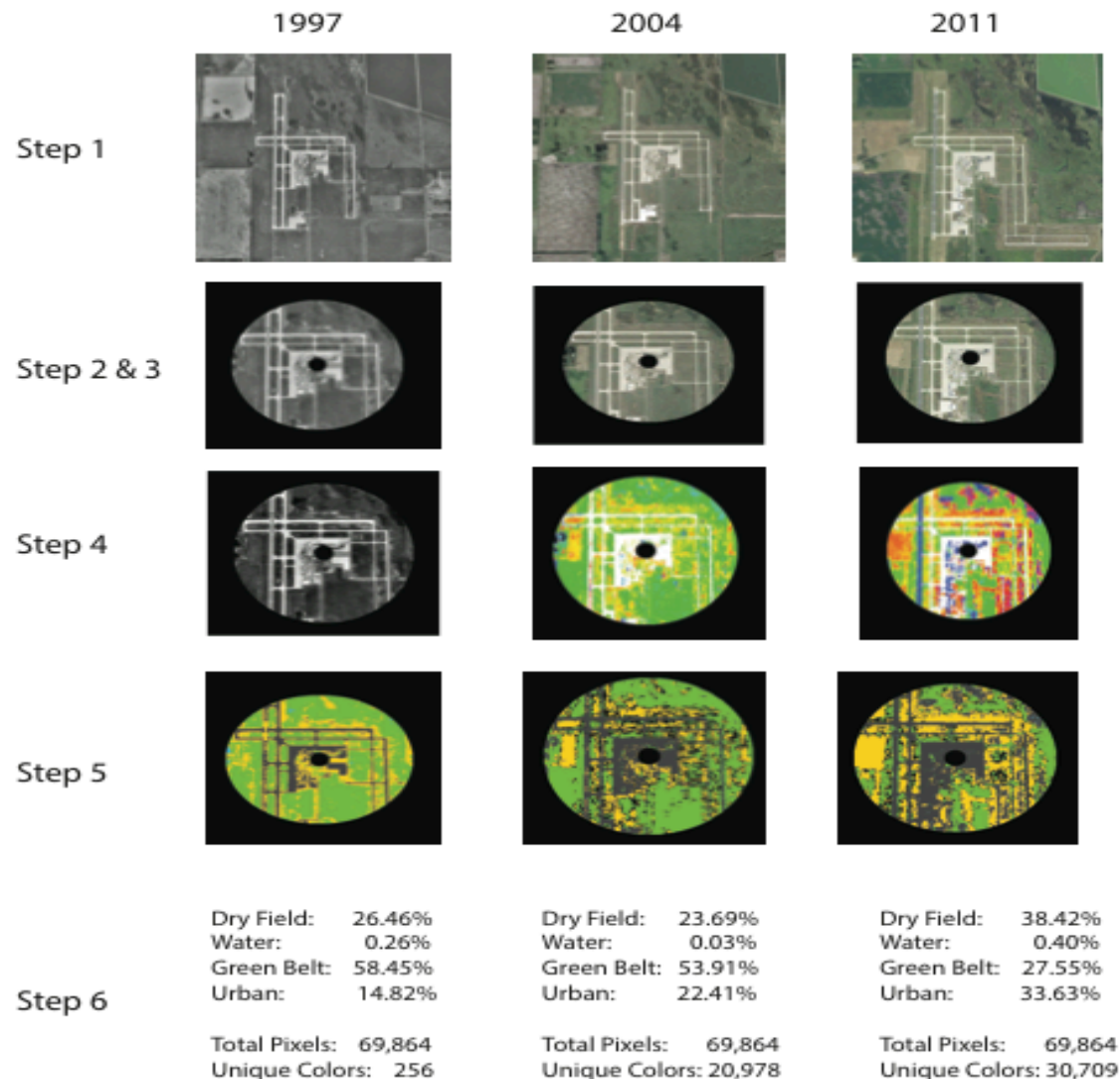
Total Pixels: 69,864
Unique Colors: 27,309

Dry Field: 13.51%
Water: 0.60%
Greel Belt: 35.83%
Urban: 50.06%

Total Pixels: 69,864
Unique Colors: 31,424

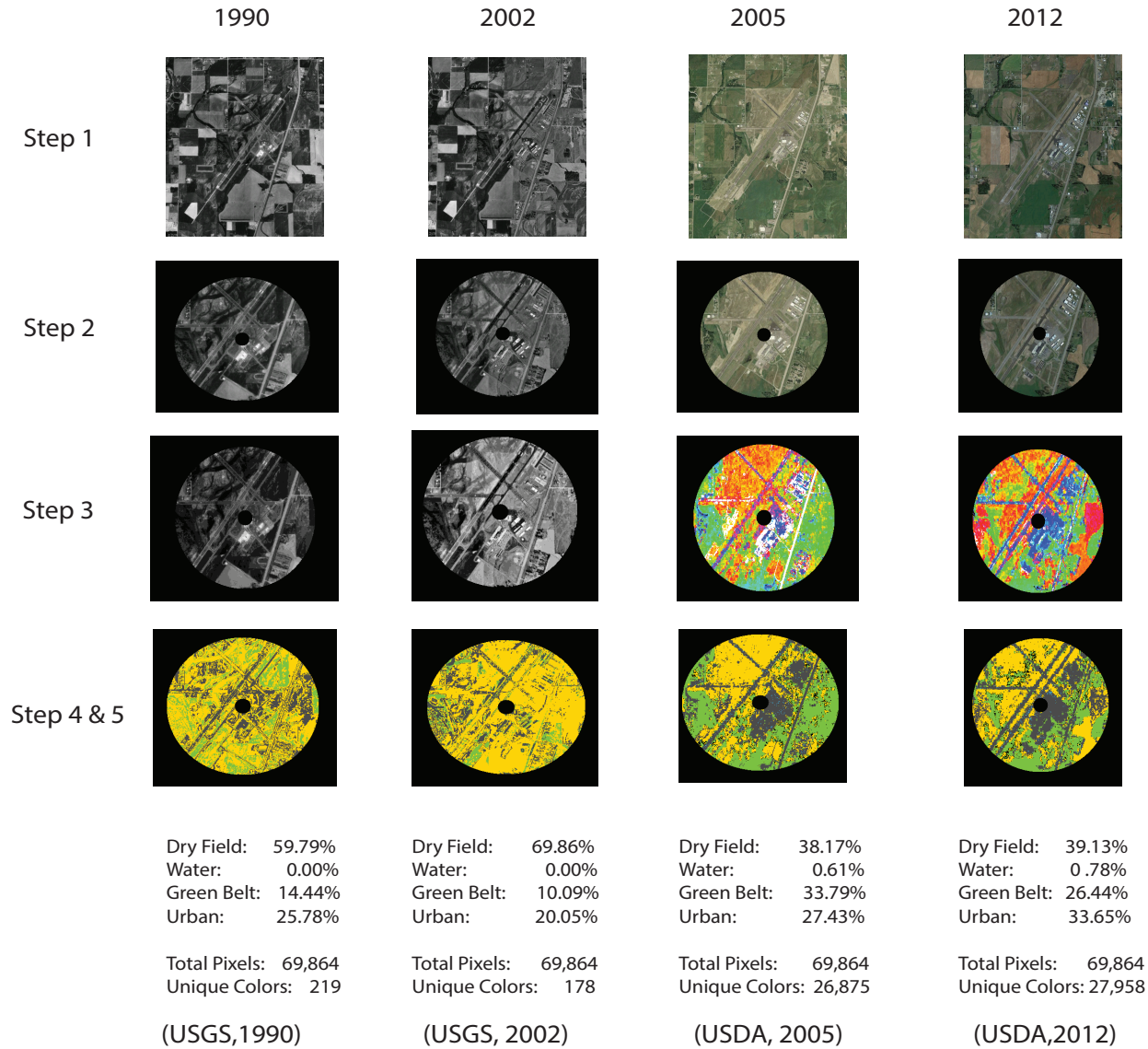
(Source USGS:2013)

Grand Forks, North Dakota (GFK)



(Source Images: USGS, 1997-2013)

Glacier Park, Montana (FCA)



Niagara Falls, New York (IGA)

1995

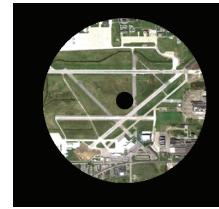
2005

2011

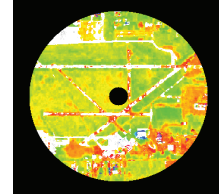
Step 1 & 2



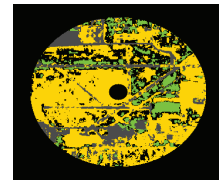
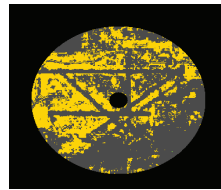
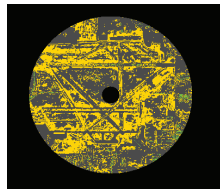
Step 3



Step 4



Step 5



Step 6

Dry Field: 35.90%
Water: 0.00%
Greel Belt: 1.38%
Urban: 62.73%

Total Pixels: 69,864
Unique Colors: 249

Dry Field: 35.05%
Water: 1.02%
Greel Belt: 0.00%
Urban: 63.93%

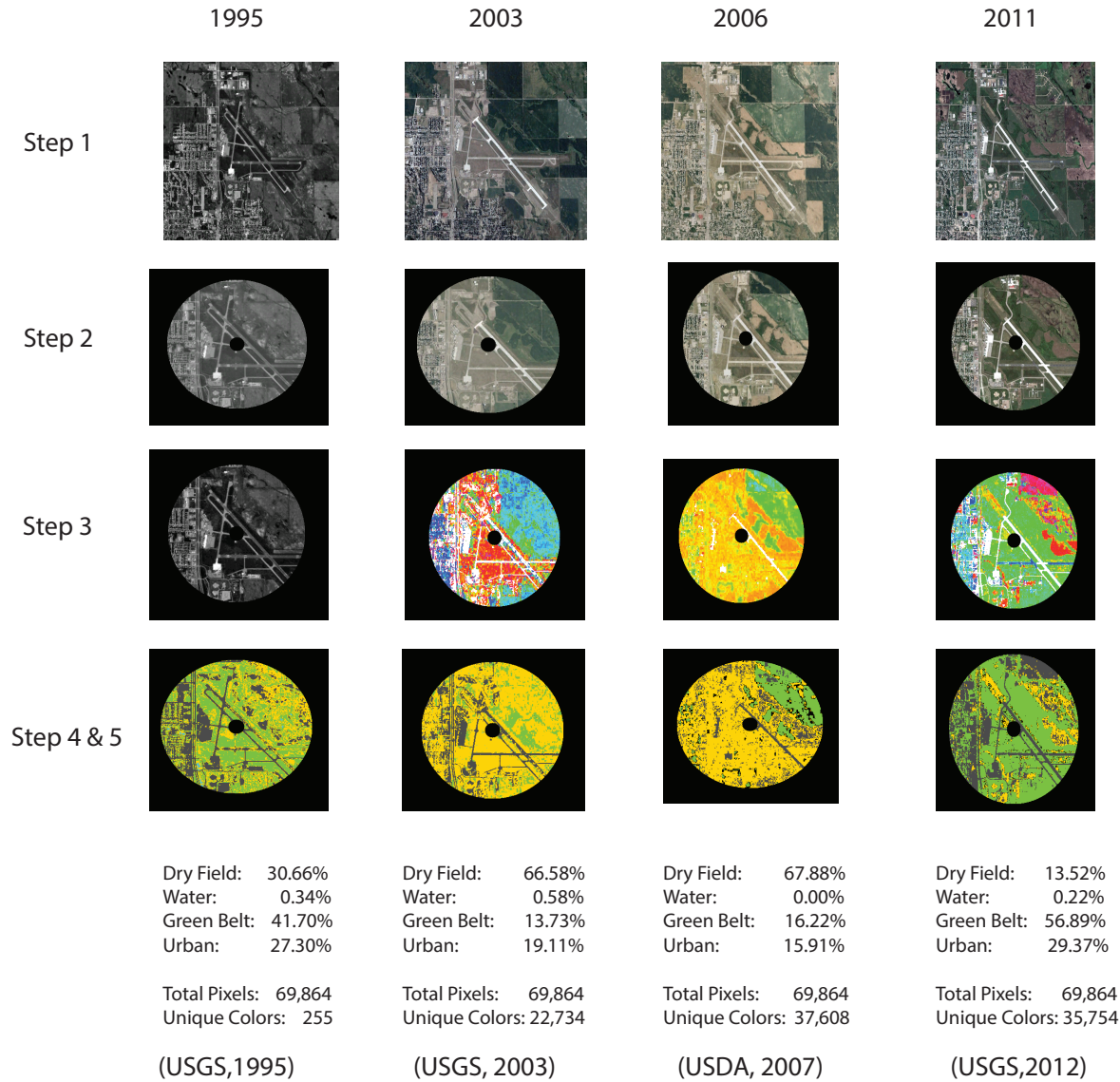
Total Pixels: 69,864
Unique Colors: 42,425

Dry Field: 67.97%
Water: 0.02%
Greel Belt: 10.10%
Urban: 15.27%

Total Pixels: 69,864
Unique Colors: 42,900

(Source Images, USGS 2012)

Minot, North Dakota (MOT)



Plattsburg, New York (PBG)

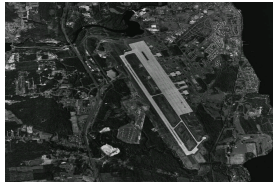
1995

2003

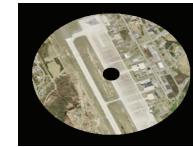
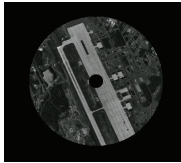
2009

2012

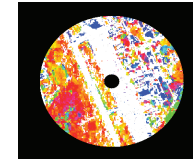
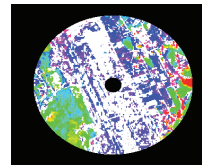
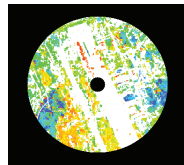
Step 1 & 2



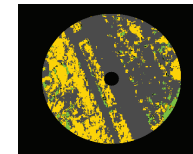
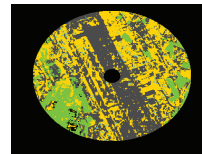
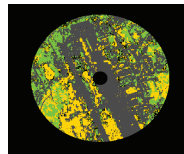
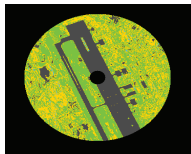
Step 3



Step 4



Step 5



Step 6

Dry Field: 29.59%
Water: 0.79%
Greel Belt: 46.14%
Urban: 23.49%

Total Pixels: 69,864
Unique Colors: 204

Dry Field: 22.79%
Water: 0.13%
Greel Belt: 20.41%
Urban: 56.67%

Total Pixels: 69,864
Unique Colors: 28,149

Dry Field: 38.93%
Water: 1.92%
Greel Belt: 15.27%
Urban: 43.88%

Total Pixels: 69,864
Unique Colors: 34,960

Dry Field: 29.77%
Water: 0.31%
Greel Belt: 4.11%
Urban: 65.76%

Total Pixels: 69,864
Unique Colors: 30,408

Source Images: (USGS, 2012)

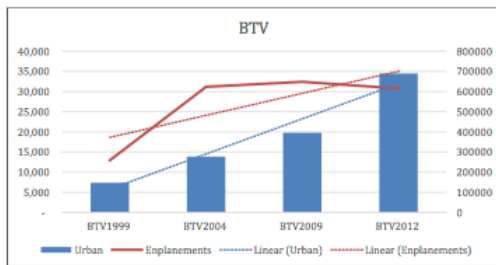


Figure 5.78 BTV Trend Line Results

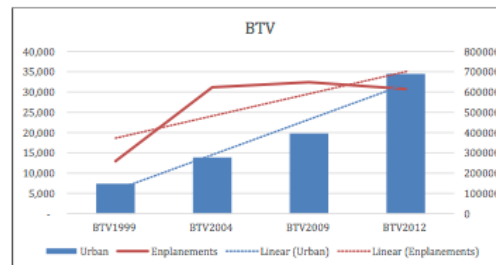


Figure 5.79 BTV Trend Line Results

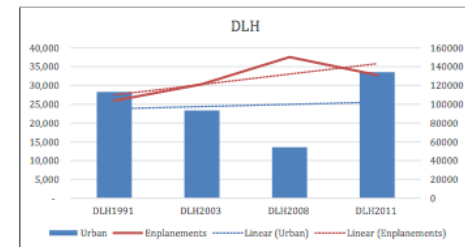


Figure 5.75 DLH Trend Lines Results

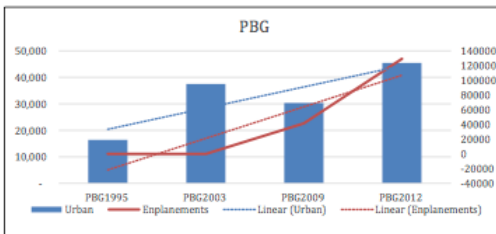


Figure 5.80 PBG Trend Line Results

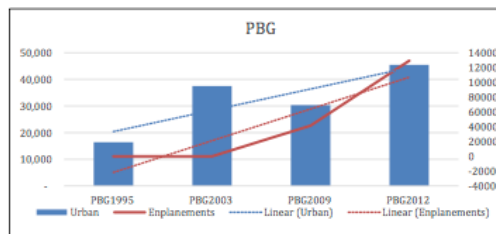


Figure 5.80 PBG Trend Line Results

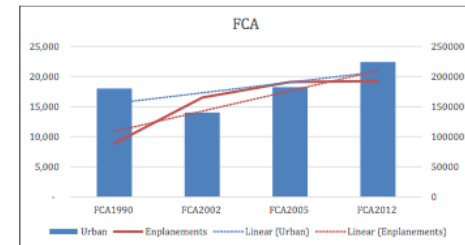


Figure 5.76 FCA Trend Lines Results

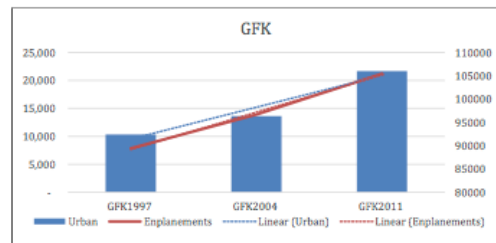


Figure 5.77 GFK Trend Lines Results

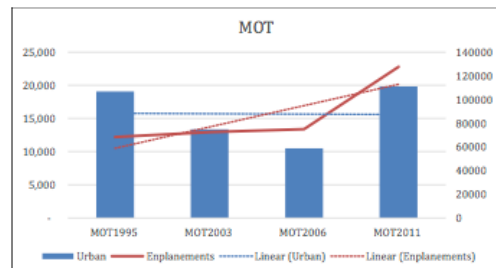
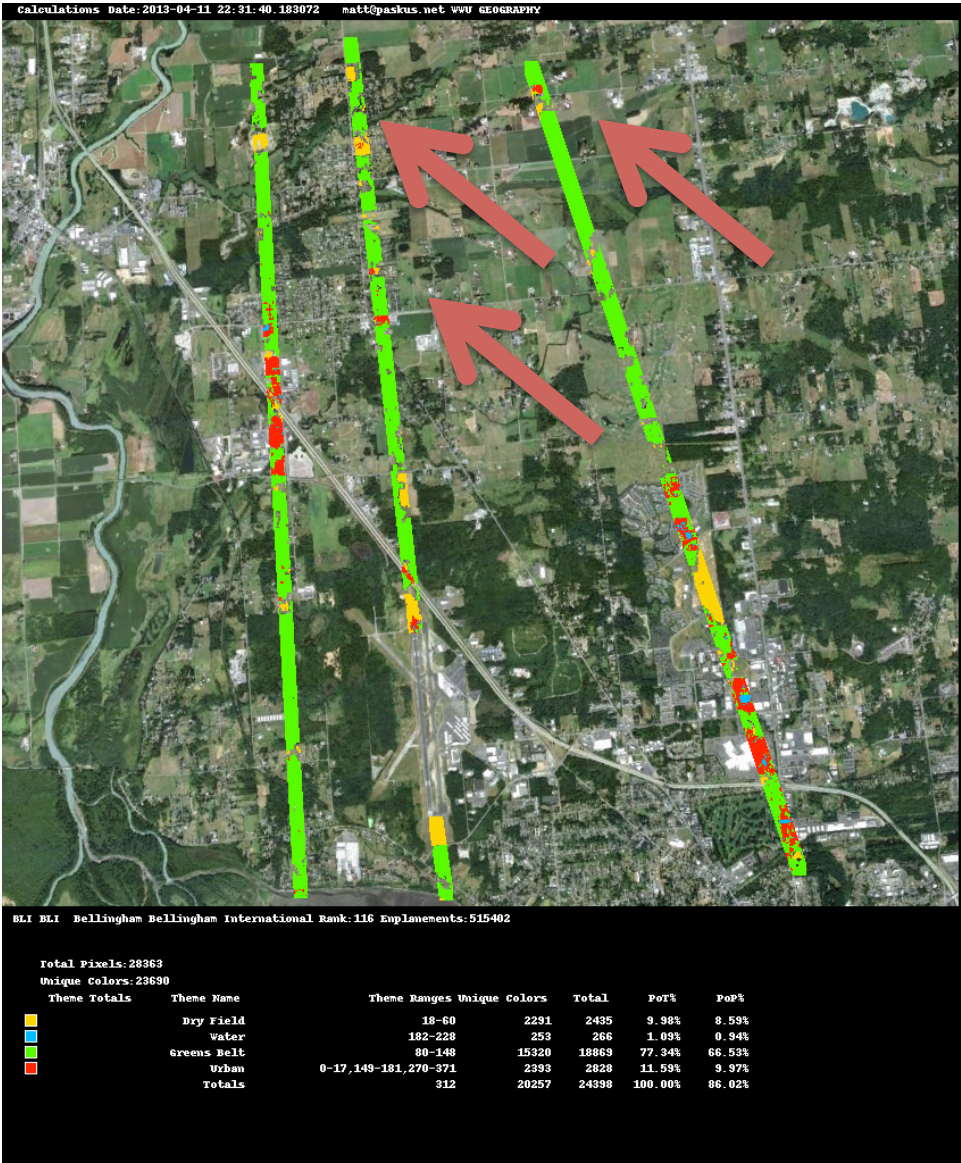


Figure 5.78 MOT Trend Line Results

Trend line Results	Airports								Total
	BLI	BTV	DLH	FCA	GFK	MOT	IAG	PBG	
Urban	+	+	+	+	+	-	-	+	6/8
Enplanements	+	+	+	+	+	+	+	+	8/8

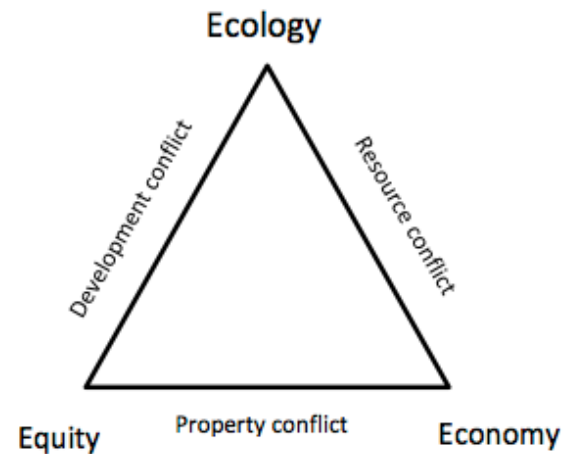
Figure 5.83 Trend Line Results

Discussion



Recommendations

- Use tools like this to determine growth.
- Consistency.
- Impacts outside the boundary.
- Volume.
- Additional equity analysis.
- Stay in center of triangle.



Implications

- Tool for Land Use Planning
 - Better Understanding
 - Model Justification
- Transportation infrastructure
 - Sustainable
 - Multimodal
 - Volume
- Consistency
- Change Laws
- Define New Boundaries
 - Impact
- Restore Control
- Not Expensive

Future Work / Questions?

