Migrant Boats
A geo-temporal analysis and visualization of migrant boats

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Abstract

This particular paper tries to solve one of the mini challenges of VAST challenge 2008 where the task is to find the changing pattern of migrants using boat from Isla Del Sueno to Florida over three years. This paper focuses on geo-temporal analysis of the synthesis data and its visualization using info visualization technique.

1. Introduction

Migration is a common scenario in today's world. People are migrating from one place to another for better life. Sometimes those migration are legal but most of the time they are not. Desperate people force the law to find ways to stop them. As a consequence we need to find the relationship of different data with the help of visualizing system to aid the law man. This particular paper focuses one of those issues but the data set is a made up one for the VAST Challenge 2008. In this paper I have analysed the migration pattern of migrants who were trying to escape from Isla Del Sueno using boats to Florida and embedded those analysis in my visualizing system.

The mini challenge of VAST 2008 data set contained the data of landing and interdiction of the migrants over the years 2005, 2006 and 2007. There were three specific tasks for analysis.

1. Characterize the choice of landing sites and their evolution over the three years.
2. Characterize the geographical patterns of interdiction over the three years.
3. Find the successful landing rate over the time period?

The data set contained the following fields.

EncounterCoords: Where the migrant boat was intercepted or where it landed, in longitude-latitude format.

RecordType: Interdiction (the Coast Guard intercepted them) or Landing (the boat made it ashore).

Passengers: Number of passengers in the migrant boat.

USCG_Vessel: Name of the Coast Guard who was involved in the interdiction.

EncounterDate: Date when the boat was interdicted or landed.

RecordNotes: A list of passenger names.

NumDeaths: The number of migrant deaths.

LaunchCoords: If known, the starting latitude and longitude of the boat.

VesselType: Either a "Go Fast", a Raft, or a Rustic vessel which was used by the migrants.

Taking these data into account I have analysed their relationship and showed those in my system.

2. Related Work:

The related work of pattern finding for migrant boats problem can be divided in two categories. One type of work which focuses on geo-temporal pattern and one type of work which was specifically done for this mini task in the entries of VAST challenge 2008. Migration patterns for humans and moos were done in [1] and [2]. The tasks were in broad sense same but our data set was relatively small comparing to the geo-graphical area. In [1] it was the whole world and in [2] it was southern Finland. In our case it's only the coastal area of Florida. In [2] they also tried to show the relationships of factors affecting migration of moos. In VAST entries there were some significant analysis taking a general approach of lat/long positions of landing and interdiction. In [3] used multiple histograms to show the frequency of data according the year for analysis. In [4] used their own system with the aid of google earth where they could see the text format data and the point in the earth side by side depending on different category. [5], [6], [7] used google earth to analyse the data in relative lat/long position format. [8] used the same lat/long format but they used a time line positioning so that they could see the relative position of the data in a time line. For this they categorised the data set into different zones of landing. To solve this migrant boat problem my analysis was a compact system where I put together all the analysis tools in one simple system where a user can see the data according to different category so that the user don't need to treasure hunt through the data. In this system I have used multiple views so that user can compare his data in a single window. I call my system a collective effort of different visualizations used before in different VAST 2008 entries where mine used a more depth analysis of the data.

3. Analysis of data and Info Visualization Solution

For the analysis of migration pattern over the three years I have chosen to use multiple views so that I could do side by side analysis of the data for each year. In my solution I have used four views of the place three for each of the years and one for reference and further analysis of the data. For further analysis I have used colour coding to differentiate the landing/interdiction according to the years. For use of colours I took help from "colourbrewer" which is a software giving possible colour solution for map. Though, mine was not a typical map colouring problem as I was using colour and glyphs to show a specific lat/long position. I chose the mixed hew colour coding with relative progression in the colour. This choice have me two facilities. For mixed hew I could differentiate the colours yet their relative progression gave me the chance to show progression in year and season. The colour choice was colour blind friendly. I used two different glyphs to represent two different incident the landing and interdiction (Figure 1).
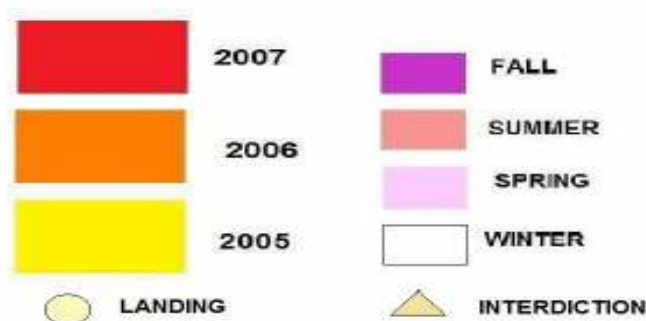

Figure 1: Choice of Colour coding

For the size of the glyphs I had to do some trade offs. As the glyphs were used to represent only a lat/long data it was representing only a point in the whole map of the costal area of Florida. So when I was looking at the points as a whole it was not saying much even when I zoomed out to see the whole map at a time. To solve this problem I changed the size of the glyphs so that their relative positions in the map come closer. As a result when I looked at the map as a whole, from the window size I used for each map, the positions around one kilometre apart came on top of each other.

Figure 2: Points seen from normal view and zoomed view
(Around 1 km apart)

For solution of each of the problem I broke the dataset into yearly and seasonal manner so that I can see not only the yearly trend but also if there were any seasonal trends. For landing site I broke the landing sites into different zones and tried to find whether there was any particular choice of landing site over the three years. For showing the success rate I have used bar charts and analysed the data in yearly, seasonal and zone wise rates.

For further analysis of the landing data I calculated the interdictions which took place very near the shore. The motivation was only successful landings does not provide data were the migrants were heading. Even if they were caught by the coastguards in the one kilometre range from the shore it clearly meant that they were heading to the nearest shore. For this I calculated the interdiction which took place in five kilometre range from the shore.

In the whole analysis part the most interrelated part was finding the pattern of interdiction. For this first I analysed the interdiction data. Then find the relative rage of interdiction in each year. Then I took both interdiction and landing data to figure out their relationship and span over the year. For last analysis I did an animation to see how the landing and interdiction were happening over three years. It helped me to see how the position of land was changing over time other than trying to figure out the relationship from rather static image.

4. Implementation

For implementation I used google earth, google chart, google earth api and google chart api. I have also used ark2earth during the trials but in the final implementation part I did

not use it. For creating each of the maps of Florida I used a google earth instance. I have used google earth apis for embedding other features (as kml) in the map. For showing the success rate I have used google chart and its apis. For getting it altogether I have built my system on a web base solution where user can interact with the system. For interaction with the system I have used Javascript and HTML. The user can select different pattern options from the list and can see the relative changes. User can switch back and forth to see each of the options. As each of the maps is created using instances of google earth user can zoom in and out each of the maps just like google earth.

5. Results:

For landing pattern I found the landing patterns over three years as in figure 4. It shows the span of landing in the coastal area of Florida in the year 2005, 2006 and 2007. From the figure I identified the main sites of landing and divided into six zones. The multiple views used here let me clearly see the span of landing in each year.
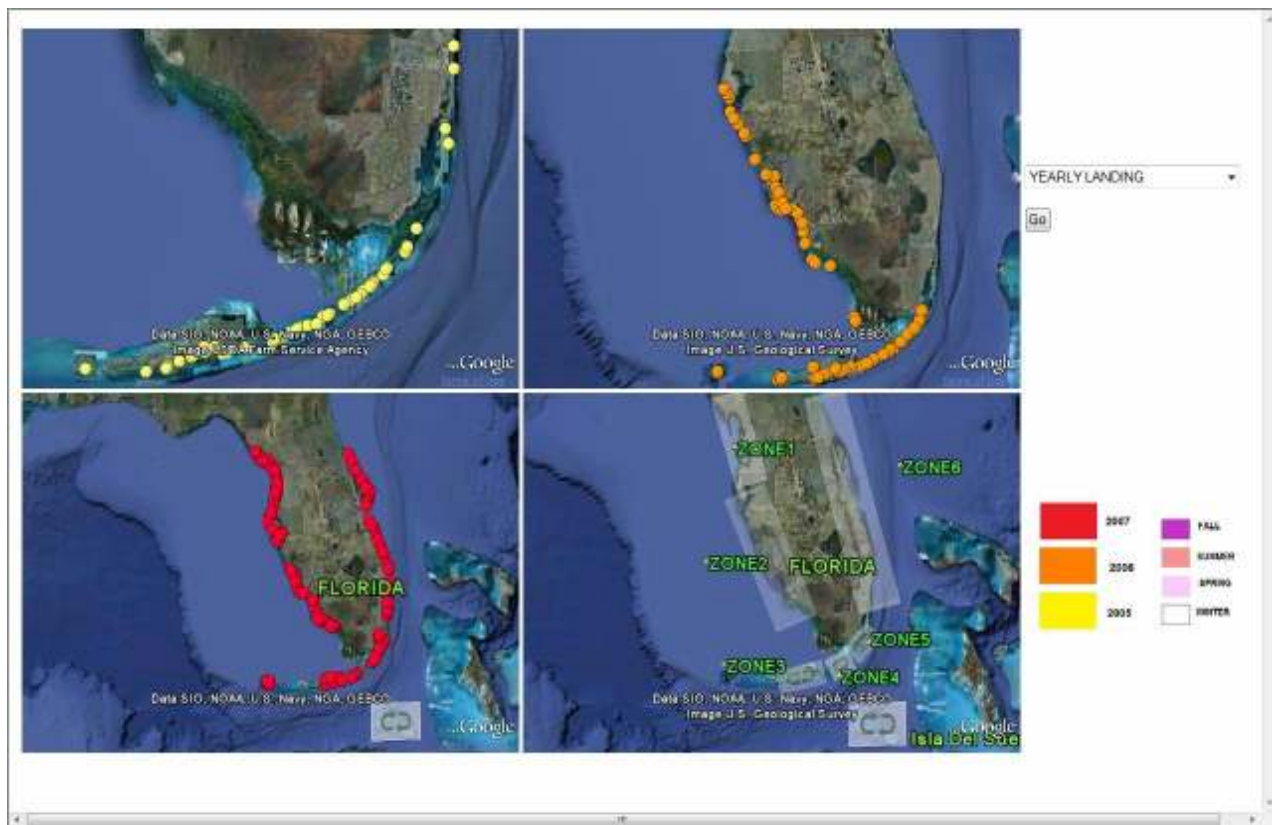

Figure 4: Yearly Landing Pattern

For the seasonal landing first I divided the data into yearly data to see whether there was any choice of season in each year. Then I reversed the data to see whether there was any year which was used by the migrants in a specific season. The results are in figure 5 and figure 6. From figure 6 it can be clearly seen that in year 2005 fall was the prominent season for landing, in 2006 it was summer and spring and in 2007 it was spring.
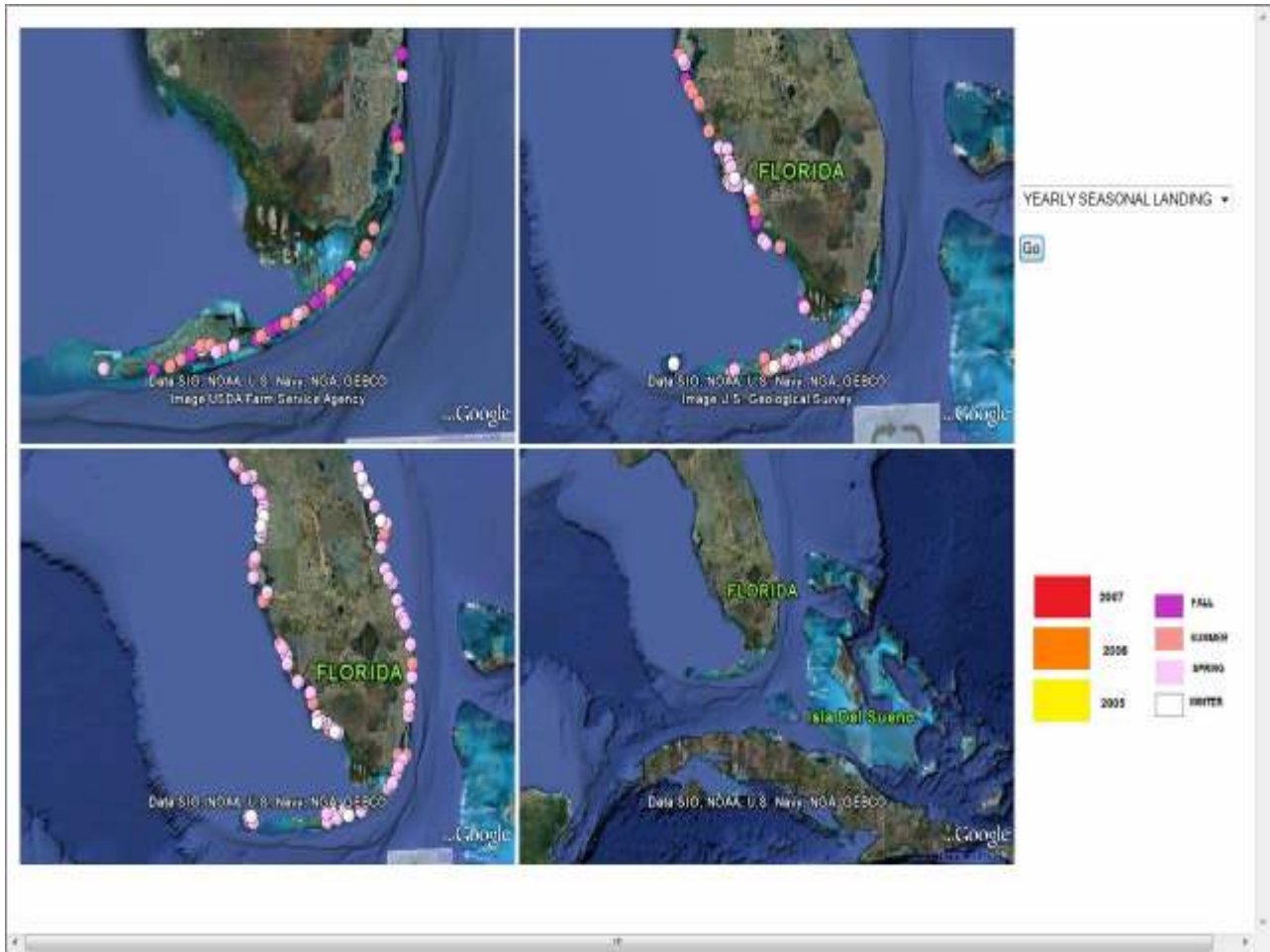
Figure 5: Year wise seasonal landing

From figure 6 one can see two sets of result. First one can see in which season which year had the prominence, again the location of the landing. The figure tells that spring and summer was the seasons which were mainly used for landing. Again it shows that other than the winter season the landing took place in all over the coastal area which might be a bad news for the cost guards because other than winter season they have look around the whole costal area for migrants.
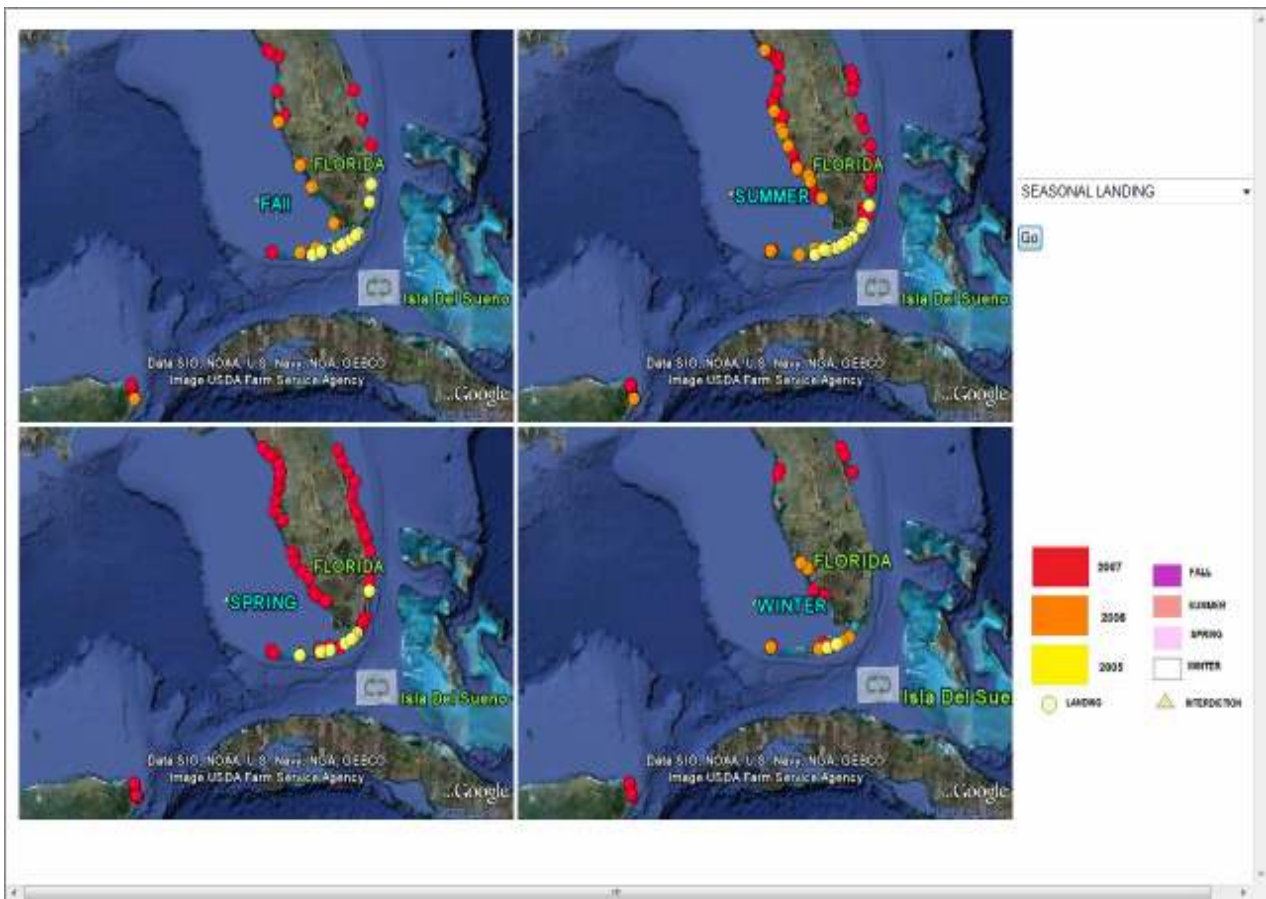
Figure 6: Season wise landing

For interdiction I found the following result in figure 7 where the interdiction and landing are shown side by side. As a result I can compare the span of landing and interdiction through the years 2005, 2006 and 2007. Figure 7 show that in year 2005 the interdiction was mainly in the lower-east part of Florida and upper part of Isla Del Sueno. In that year the landing site was the lower-west of Florida. In the year 2006 it spanned the whole lower part and the migrants started to chose the mid-west Florida for landing. In the year 2007 the interdiction spanned its area and migrants found their way up the Florida. This particular result shows that if the coast guards were looking for migrants they must increased the guard to the whole coastal area of Florida. This view gave me another interesting result. The year 2007 shows that the interdictions took place all around the Isla Del Sueno which is impossible. Definitely the US coast guards can not go in the area of Isla Del Sueno to find the migrants. This confirmed me that it was only a made up data!
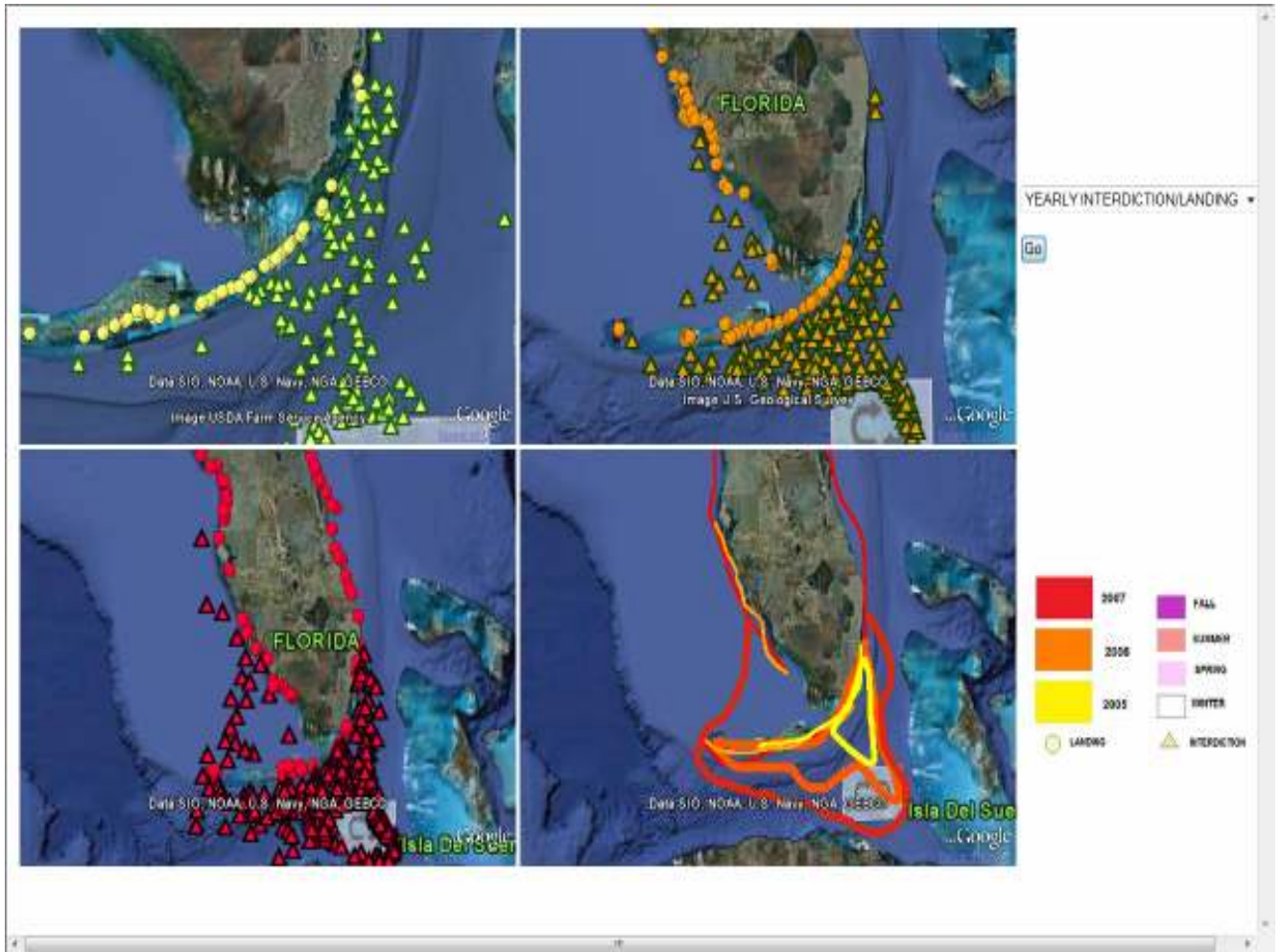
Figure 7: Interdiction Pattern

Figure 8: Cat and mouse in action

For detail analysis of the landing and interdiction I did an animation of the landing and interdiction over time which shows how they are influenced by the each other. As in the figure 8 user can zoom in the time or zoom out in the time to see the effect slowly and fast in action to see how the interdiction and landing were taking place as a cat and mouse game. The user can see the effect for each of the years.

In the figure 9 the success rate has been shown. The most important result found here is the zone wise success rate. Clearly the upper costal area of Florida was the most successful landing site as we have seen there was no interdiction seen in that area. The least successful area was zone 3, 4 and 5 which are the lower part of the Florida.
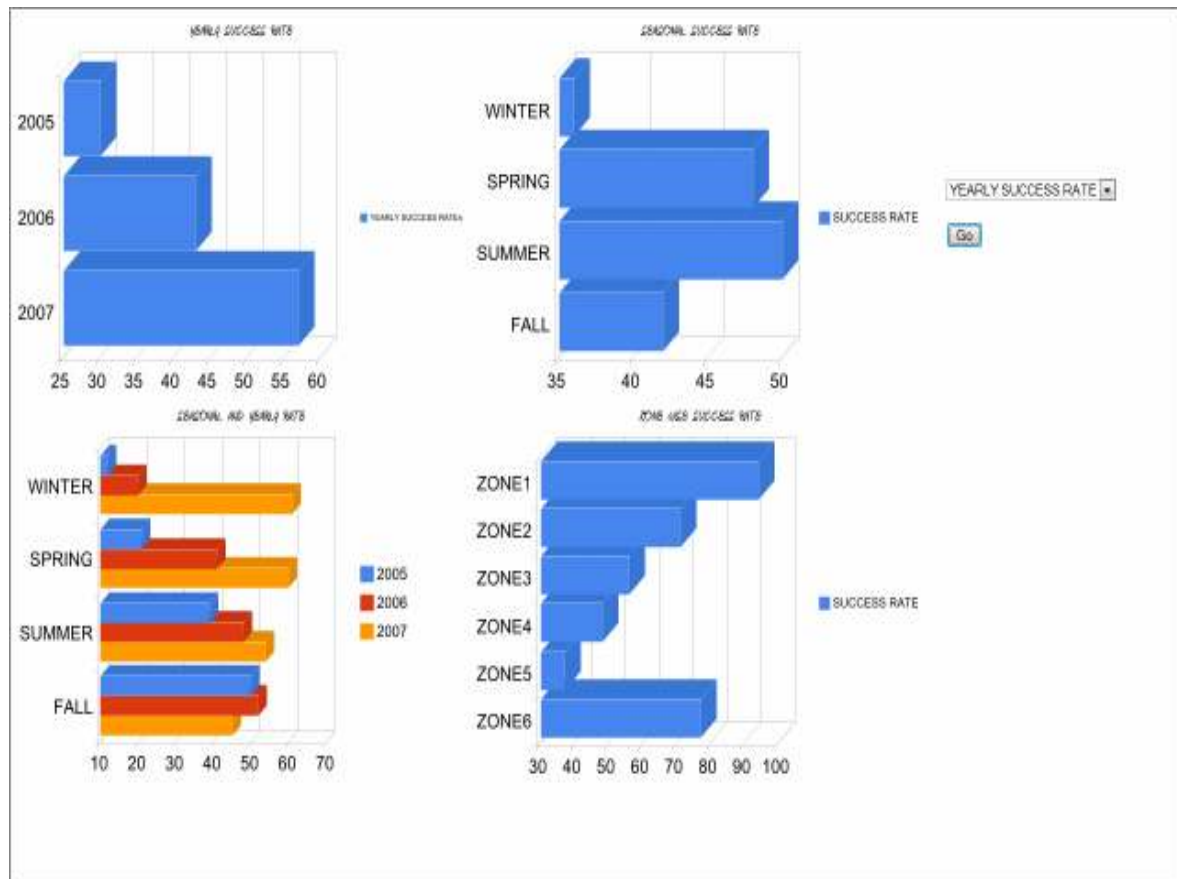

Figure 9: Success Rate

For the most probable landing sites I did my 5 km area from the costal Florida analysis and found the result in the figure 10. It shows that the zone 3, 4 and 5 had the most interdiction in that 5 kilo meter range. As result in figure 9 they also had the lowest success rates for landing. This analysis clearly shows two things that people were trying to take the shortest path from Isla Del Sueno to Florida most often and as the guards were mostly active in that area over the three years the success rate was the lowest in these zones.
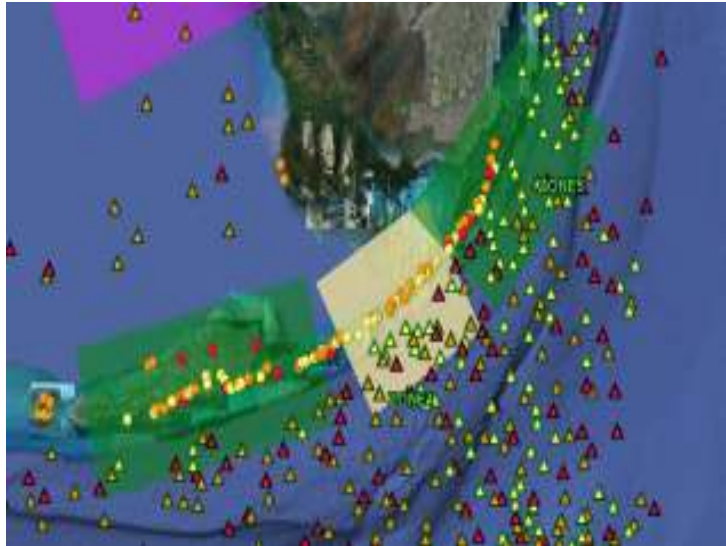
Figure 10: Most wanted landing site

The user can choose different patterns discussed above from the drop up menu and the corresponding visualization is shown. The user can switch between different options. Initially it takes a few seconds to load the google earth. Once the earths are loaded the user can carry on in between different options.

6. Discussion and Future work

As I mentioned in the related work section my system is a compact system for this problem which tried to show all the analysis in one system. More over I did some in depth analysis of the relationship of the relative area which was occupied by the glyphs and also did in depth analysis of the interdictions happening near the coastal area. The main weakness of my system is it could not overcome the data occlusion which is happening for the glyphs used to represent the lat/long data. In that case my system is nothing better than the VAST entries most of which (except [8]) have the same occlusion problem.

The most important lesson I learned is that tool does matter. My experience when solving this problem was highly confined by the tools which were free and had documentation. For this reason so many times I had to compensate my ideas. The second lesson was though different ideas boost new idea in my case it was the opposite. Though my solution was not initiated by the VAST entries but they definitely gave me the idea that I was heading towards the right direction, at the end of the day I am thinking if I just did something absolutely different.

If I had more time I would have done more analysis of the given data like the tentative route, the choice of boat etc. I would love to solve my current occlusion problem by finding a relative measure of the landing position so that I can convert the position data into an area data so that I do not need to bother about using glyphs to show positions and used relative rates in the colours.

7. Bibliography

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