THE ARCTIC SEA ICE EXTENT

Analysis of the pattern in the sea ice extent in Arctic between 1980 and 2015

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INTRODUCTION

In the last few years, Arctic's surface ice increased slightly, but that is not the only feature that should be considered in studies about this area, the sea ice extent is also important. Therefore, in this project, I want to discuss about the sea ice extent on Arctic that includes its changes in extent over the past few decades and the most affected by those changes. In Antarctic, the sea ice extent is seasonal*, so it can be interesting to study the Arctic in order to determine if the same pattern found in Antarctic is also seen in the Artic. In addition, the variations in the sea ice extent can provide a good proxy to study climate changes that is something concerning nowadays.

PROBLEM AND GOALS

This project seeks to study the Arctic sea ice extent, processing some data using the ArcMap in order to study how the pattern for sea ice decreased and/or increased over the past few decades. For this purpose, we will address the following questions:

1 – Which areas of Arctic display clues about the sea ice's retreat and/or advance?

2 – By how much it changed since 1980?

3 –Does the pattern represents a linear decrease and/or increase?

4 – How the pattern in the Arctic's sea ice extent compares with the one in Antarctic?

It is important to say that the data chosen was from the same month of the year, that in this case was March, and it was stablished that the study would cover an interval that starts in 1980 and goes through time in an interval of 5 five years until 2015. Therefore, in this case, the changes in extent are cumulative for the interval of 5 years. Also, an animation will be made using the ArcMap in order to compare the differences in the sea ice extent over the period covered, it can be useful because it is easier to visualize the changes when you can compare the differences in a short period and have a visual appeal. It is important to say that this project will not address the causes of the decrease and/or increase in the sea ice extent just, project has as main objective promote an insight about the variations in the sea ice extent in Arctic.

DATA COLLECTION

The data was get from National Snow & Ice Data Center (NSIDC) on their website. http://nsidc.org/data

From this website, it was possible to get data for this project and it was pretty easy to process this on ArcGIS because they already have data in several formats that are compatible with the program or can be converted. In this case, it was possible to get the data in the shapefile format. They have data since 1979 for the sea ice extent in Arctic and they are still retrieving more data nowadays*, and it is catalogued not just by year but by months too. It is a great range to work for the objective of this project. They have data for both Arctic and Antarctic, the data named with an N belongs to Arctic and the data named with an S belong to Antarctic. The first 4 number represent the year and the 2 last number the month. The month of march was not chosen randomly, it represents the month of the year when the sea ice extent reaches it maximum. So, we will compare the difference between maximums over decades.

*The NSIDC announced recently that the sea ice index processing is suspended, the last date available is 31 March 2016 but the collection of data will return after they take necessary measures in order to provide reliable information again.

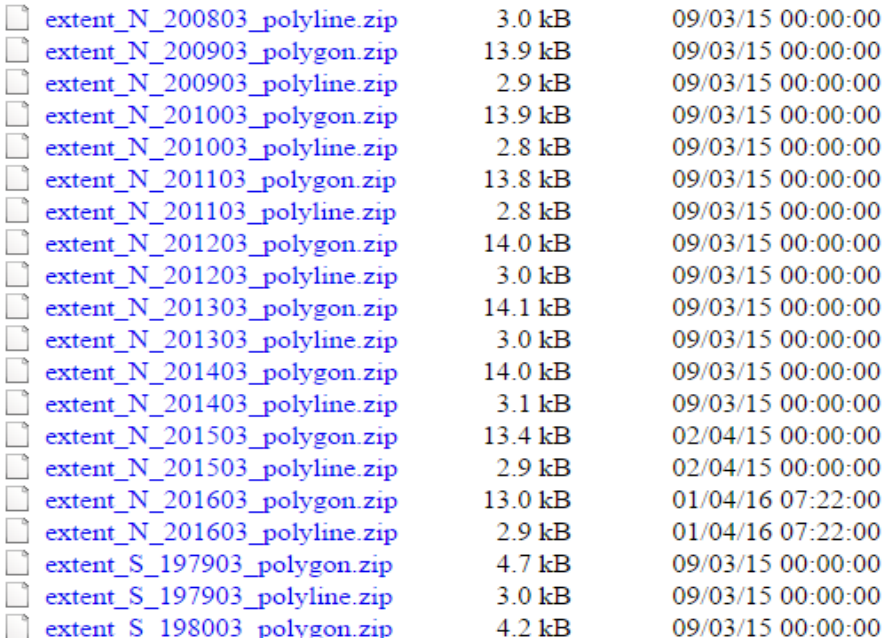

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Figure 1 – The data was available as polygons and polylines.

DATA PREPROCESSING

For this project, the data was already in a compatible format (shapefile) so it was not difficult to work with that on ArcGIS. It was necessary just to unzip the file and posteriorly add to ArcGIS. The shapefile has its limitation, but it was enough for the purposes of this project.

ArcGIS PROCESSING

First, the data was added to ArcGIS, from this point it was possible to start the work with that. The Geographic Coordinate System for the files was GCS_WGS_1984 and the Projected Coordinate System was Stereographic_North_Pole. Initially, 8 layers were added but other 4 layers were necessary in order to cover one unexpected situation of the project.

The second step was to calculate the areas of the polygons in square miles for each of the shapefiles. For this, it was necessary to create a new attribute field for the shapefile that I named Area and then I calculated the areas' geometries using tools present in the attribute table. There are several areas because there are several discontinuities in the sea ice, so each polygon represents different parts of the sea ice that are not connected.

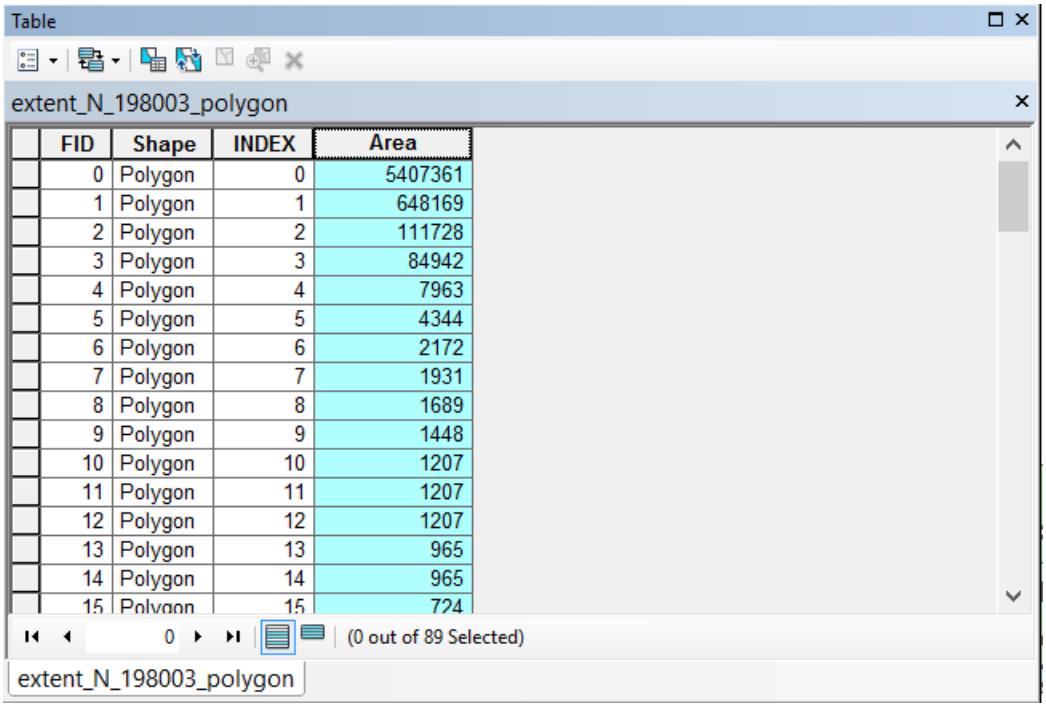

Figure 2 – Attribute table showing the new field (area) and the geometries calculated.

After the calculation of geometries, it was possible to calculate the statistics and got the sum of the total area. The values found and the cumulative changes in percentage for the intervals of 5 years are bellow (chart 1).

Year	Extent (sq mi)	Change (%)
1980	6301417	-
1985	6285008	0.261081609
1990	6201268	1.350368989
1995	5973708	3.809359279
2000	5948131	0.430000617
2005	5722022	3.951557684
2010	5858600	-2.331239545
2015	5562271	5.327482246

Chart 1 – Chart with the extent for each year and the variations in percentage.

The negative values represent an increasing in the sea ice extent, so it was necessary to do the same process to get the values for the period between 2005 and 2010 but in intervals of one year, aiming to figure out when it started to increase, the values found are bellow.

Year	Extent (sq mi)	Change (%)
2005	5722022	-
2006	5576747	2.605013281
2007	5682443	-1.86004505
2008	5945475	-4.42407041
2009	5887797	0.979619372
2010	5858600	0.498361383

Chart 2 – Chart with more detailed values about the sea ice extent advance.

In order to stablish which areas were most affected by the loss of sea ice, every single file was displayed with no colors but borders (Fig. 3), so it was possible to verify where the variations in the limits of the sea ice extent occurred. It is important to clarify that the areas dominated by the red line (extent in 2015), in the central area, represents the extent that matches with the extent of the other years. Four areas have representative changes in their limits: NW (Fig, 5), East (Fig, 6), South and SE areas (Fig. 7).

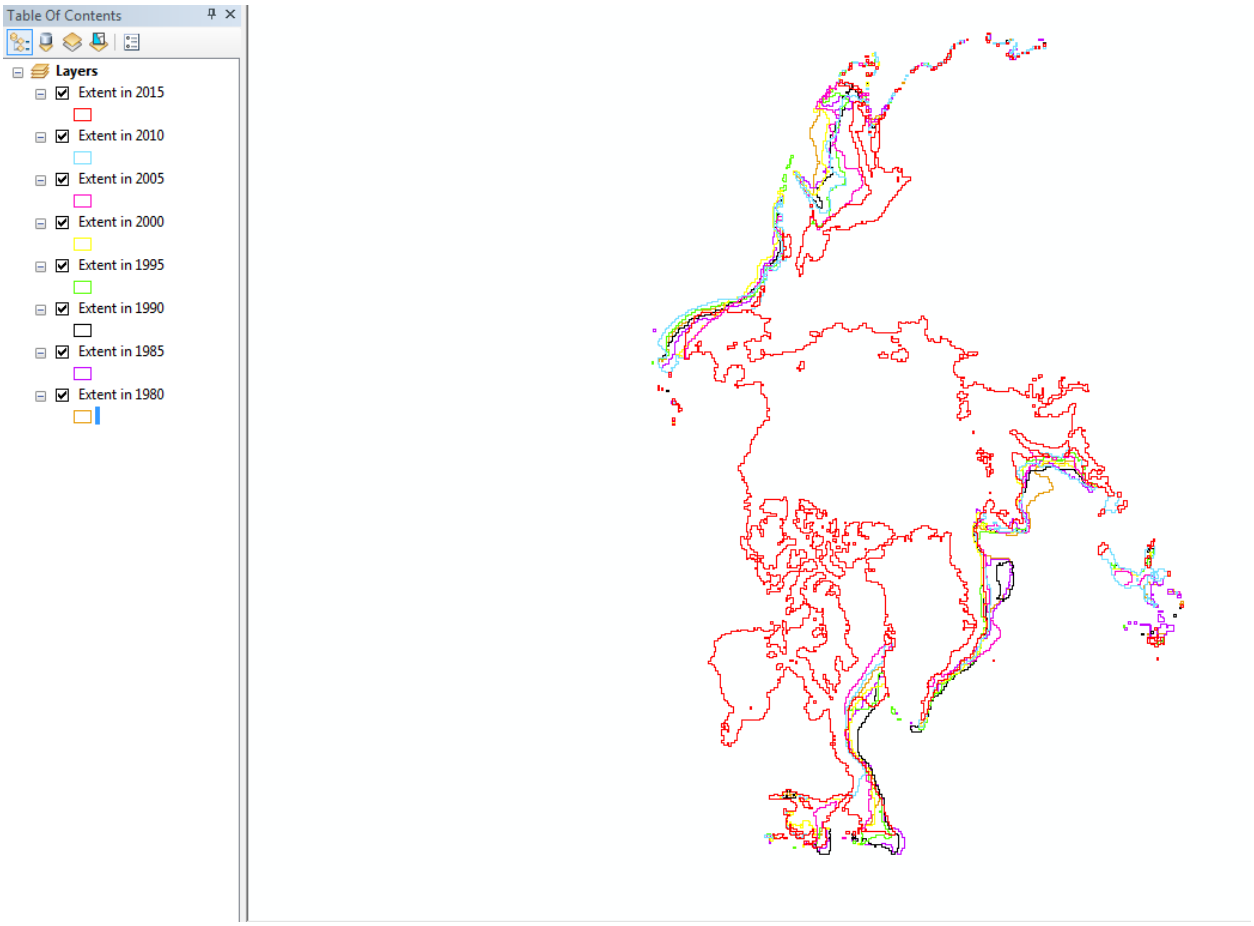

Figure 3 – Polygons processed in ArcGIS and the shapefiles used.

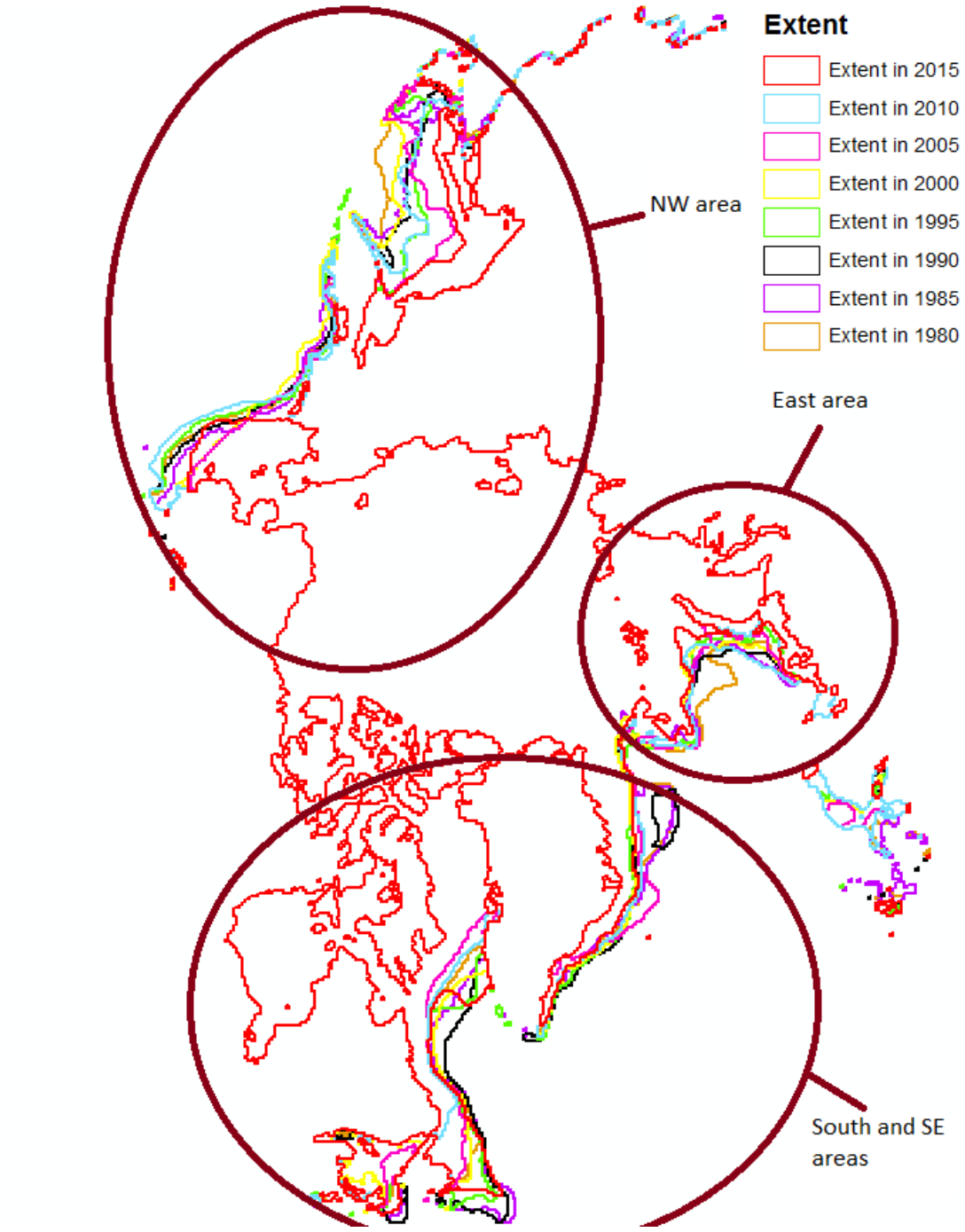

Figure 4 – An overview of the total Arctic's extent area and borders variations.

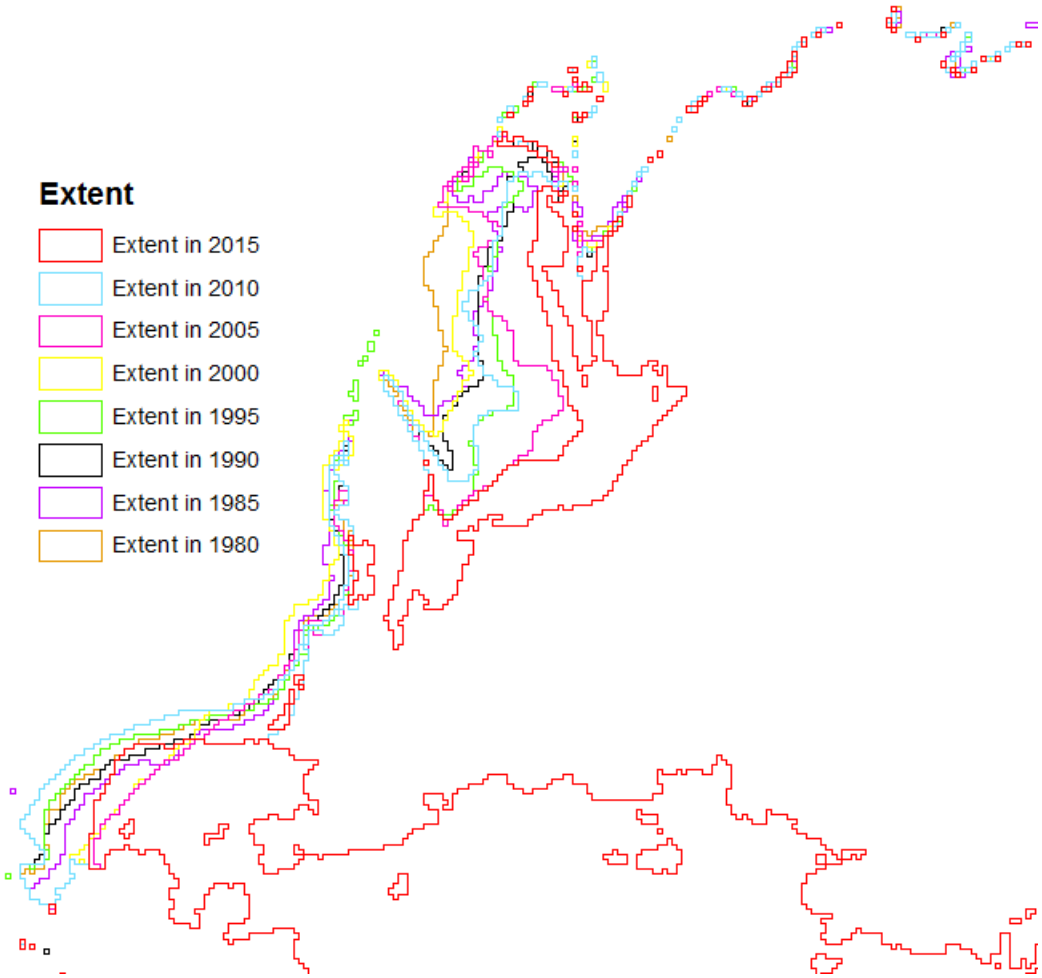

Figure 5 – Zoom in the NW area.

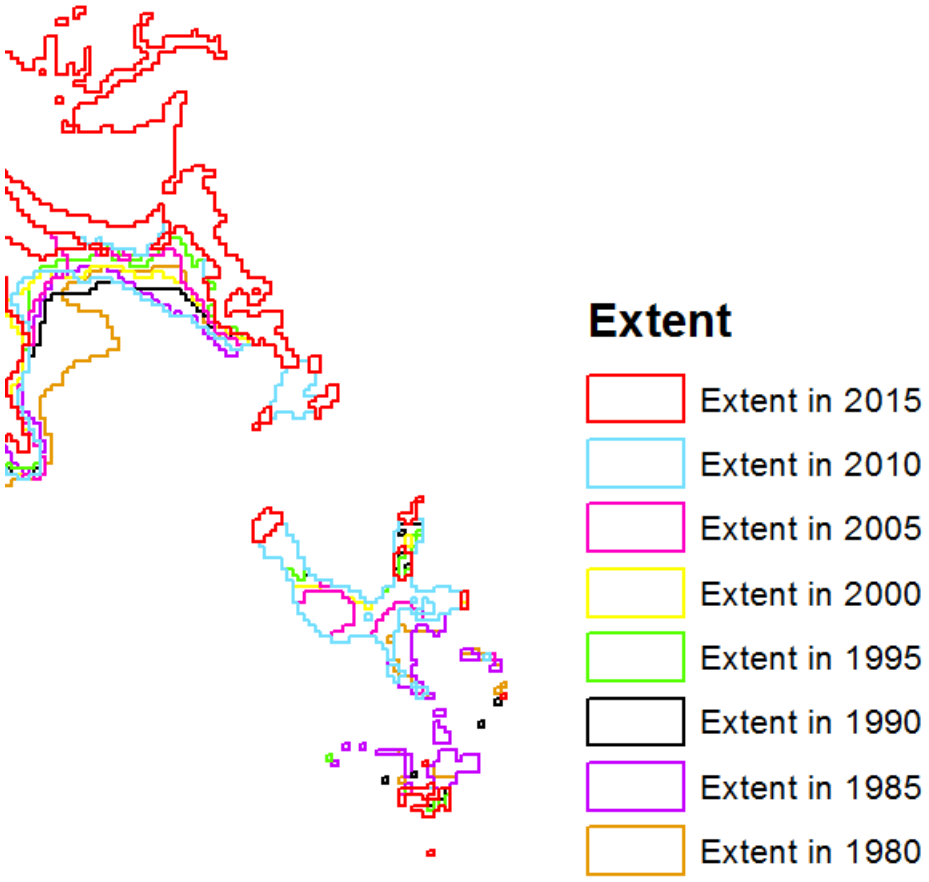

Figure 6 – Zoom in the East area.

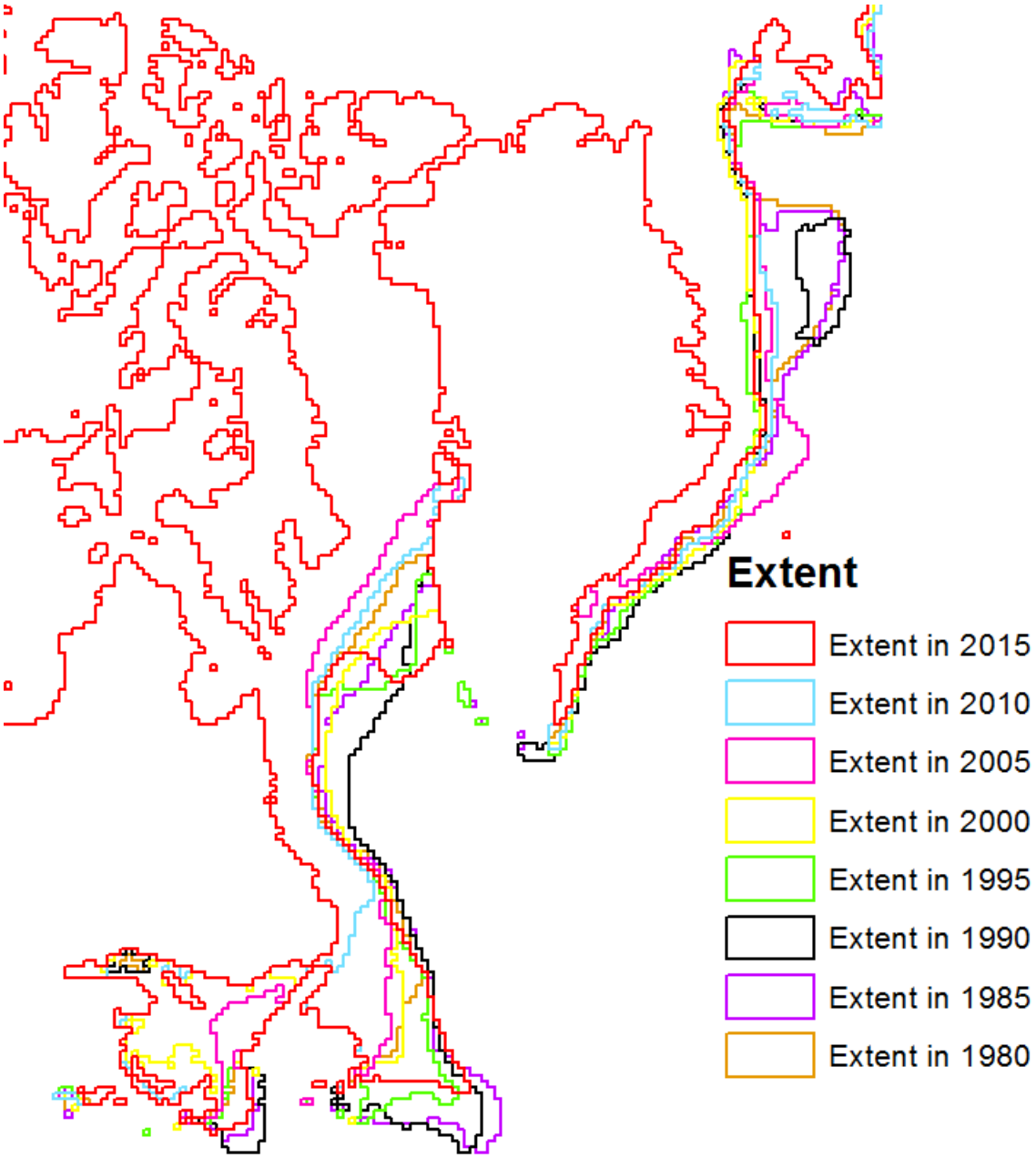

Figure 7 – Zoom in the South and SE areas.

ANIMATION CREATION

In order to provide something that could have a visual appeal, I created an animation comparing the areas from 1980 until 2015 in the same interval of 5 five years. It was possible to be done through the ArcMap using the Animation toolbar.

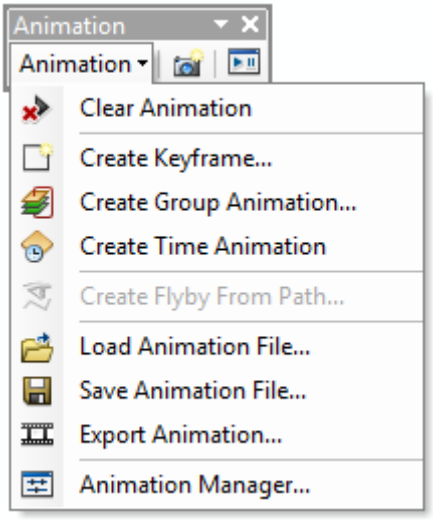

Figure 8 – Animation toolbar tools.

The animation was created using the Create Group Animation tool, because it allows us to display each layer separately in the period of time chosen. For this, I worked with 8 layers, so the interval of 1 second for each layer seemed reasonable (i.e. each layer is displayed for 1 second), so the animation has 8 seconds. The animation starts showing the sea ice extent for 1980 and each second represents an interval of 5 five years.

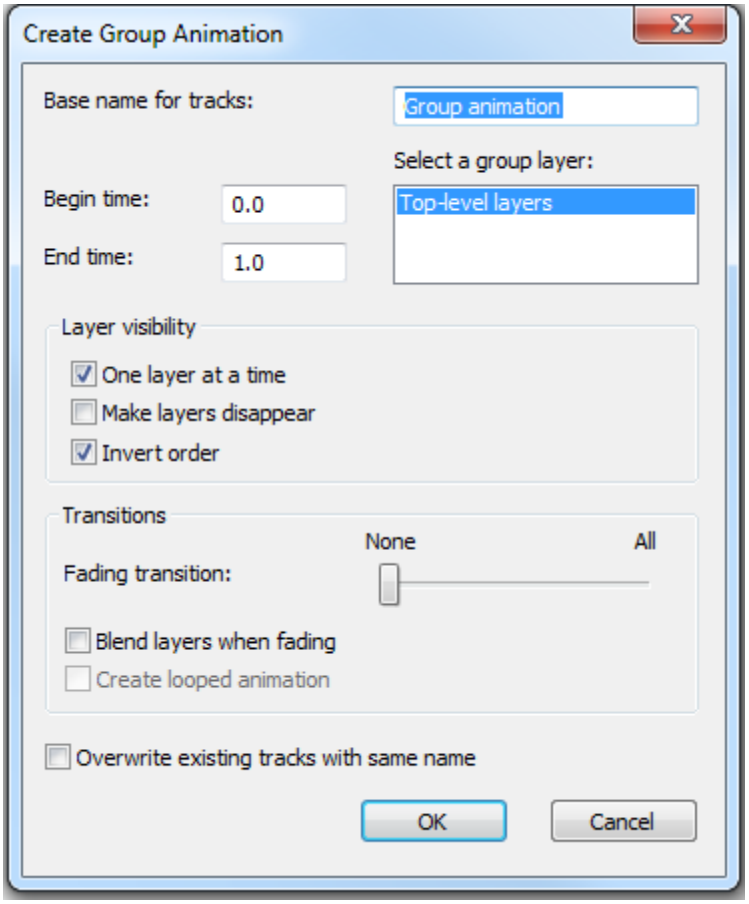

Figure 9 – Create Group Animation tool and its features.

In the figure 3, it is possible to see that the extent in 2015 is the top-level layer so in order to goes from 1980 to 2015 the option invert order was used, and the option one layer at time was used to make the previous layer disappear when a new one comes up.

The legend present in the animation was made on ArcMap, and the grid was downloaded from http://www.naturalearthdata.com/downloads/10m-physical-vectors/10m-graticules/ in a 10 degrees interval (it was downloaded as a shapefile, so no major processing was needed). It was necessary because when we create a grid using ArcGIS, we just can visualize this in the layout view and the reproduction in the layout did not keep the grid statics.

The animation can be found in this link: https://drive.google.com/file/d/0B4g6YAyOaNftUFVCWkhsTH

RZSmM/view

DISCUSSIONS AND CONCLUSIONS

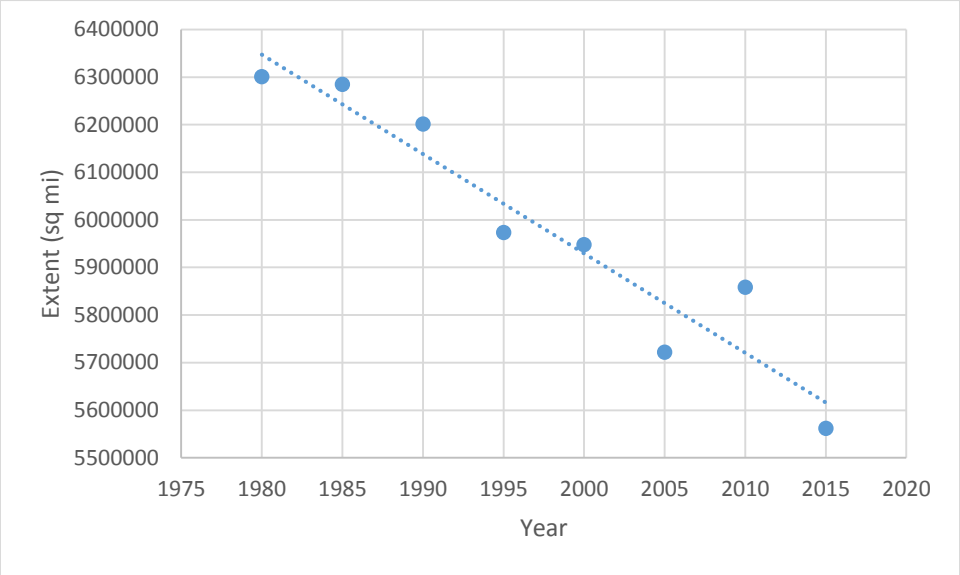

Figure 10 – Representation of the Arctic's sea ice melting trend.

As shown in the graph above, the pattern present in the Arctic differs from the one found in Antarctica. In the Arctic, some sea ice persists year after year, whereas almost all Southern Ocean or Antarctic sea ice is "seasonal ice," meaning it melts away and reforms annually. While both Arctic and Antarctic ice are of vital importance to the marine mammals and birds for which they are habitats, sea ice in the Arctic appears to play a more crucial role in regulating climate. The biggest change in extent was between 2010 and 2015, but it can be explained by the unexpected increase in extent between 2005 and 2010. In a deeper analysis, it is possible to affirm that the first increase occurred between 2006 and 2007, reached its maximum extent in 2008 and started to decrease again after this year. The Arctic's sea ice extent in 1980 was 739146 square miles bigger than today, it represents a 13.3% change. The cumulative change can be seen in the map below. The areas most affected by the variation in the sea ice extent are clearly showed in figure 4 and in figure 11, which are NW, East, South and SE areas. The Arctic's sea ice decreased a lot over the past decades, but as occurred between 2006 and 2008 that pattern can change over a small timescale. Therefore, it will be important to keep collecting data in the next decades and see how the pattern evolves, but so far it is expected a decreasing in the extent in the future.

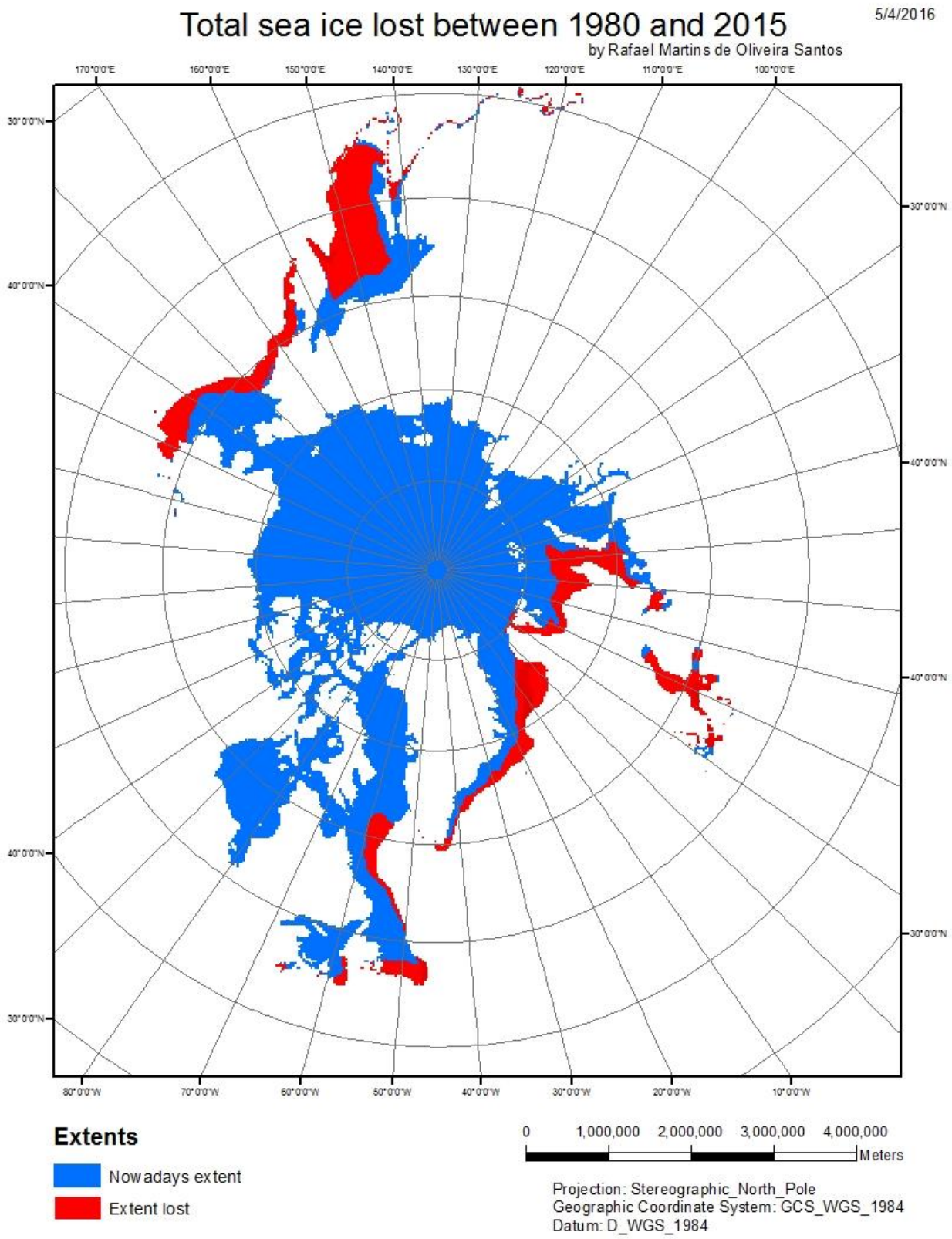

Figure 11 – The map represents the total extent lost since 1980 until nowadays.