How much damage is caused by storms in Europe?

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Contents

Data Collection

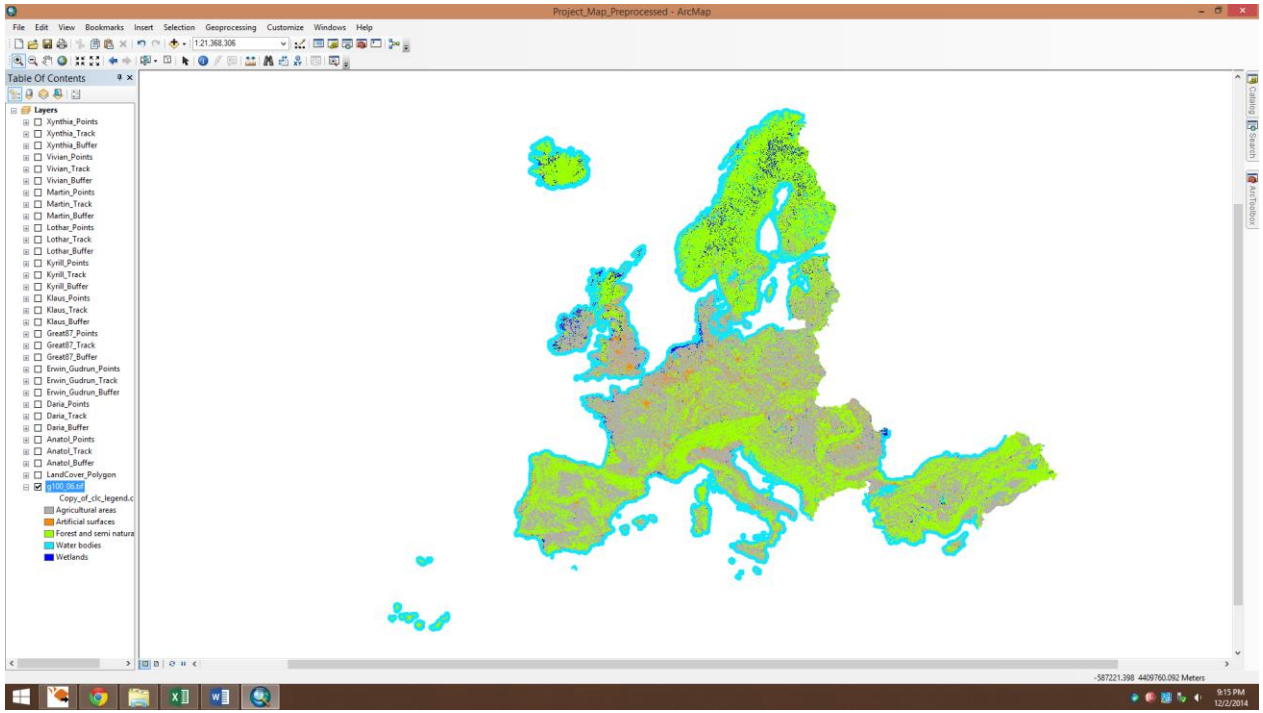
For this projects two types of data are needed, land cover data and storm trajectories. The land coverage data was obtained from the European Environment Agency. The Corine Land Cover 2006 rater data is a TIFF file containing raster data. The Metadata can be found at the website listed in the References.

The storm trajectories were downloaded from the Extreme Wind Storms Catalogue Database. From this only the ten most severe ones, based on insured losses, are used. The data is provided as CSV files containing track points in a three hour interval. Their Metadata is also provided via a website mentioned in the References.

Loading Data into ArcGIS

Step 1: import land cover

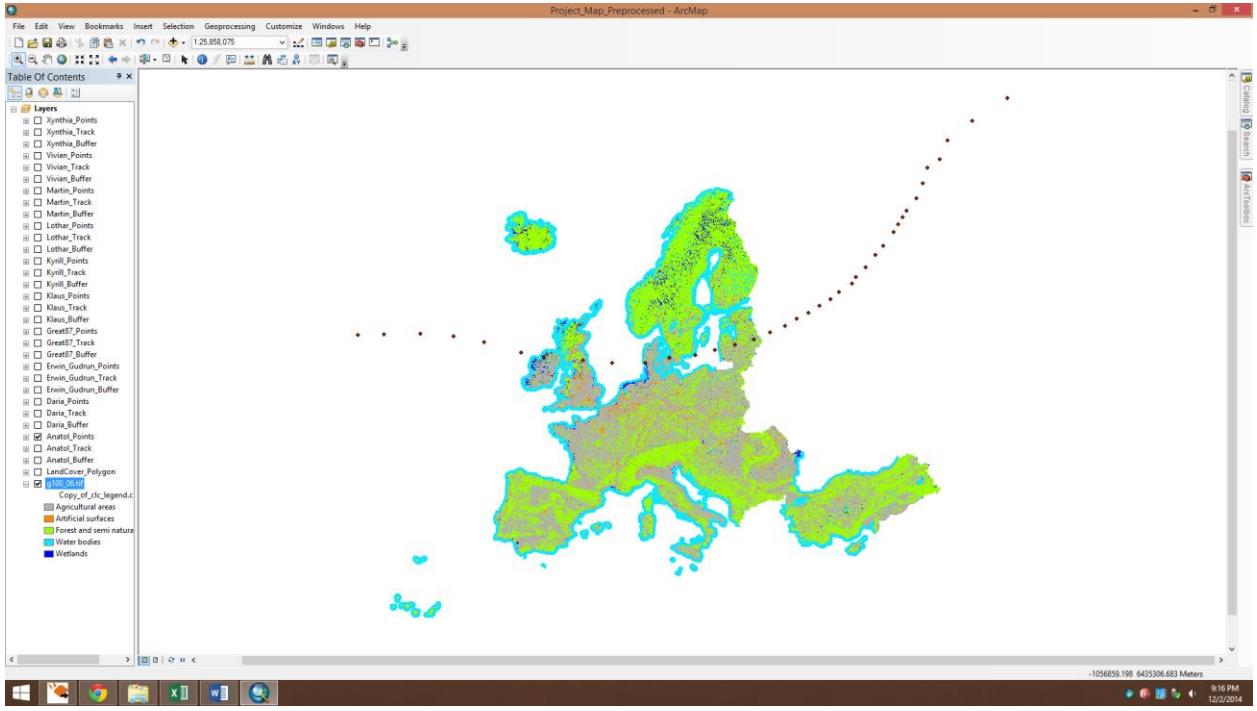
The land cover data was added to the map, which led to the problem of a missing fields in the attribute table to label and determine the land cover type. To solve this problem the Add Attribute Index and Add Join tools where used. With Add Attribute Index I indexed the value field of the attribute table, which allowed me to join this field to the GRID_CODE field of the join table with the Add Join tool. The visualization is improved by changing the Symbology to Unique Values with the Value Field Lable1 of the join table. The result is shown in Screenshot 1:



Screenshot 1: Land Cover data in ArcGIS

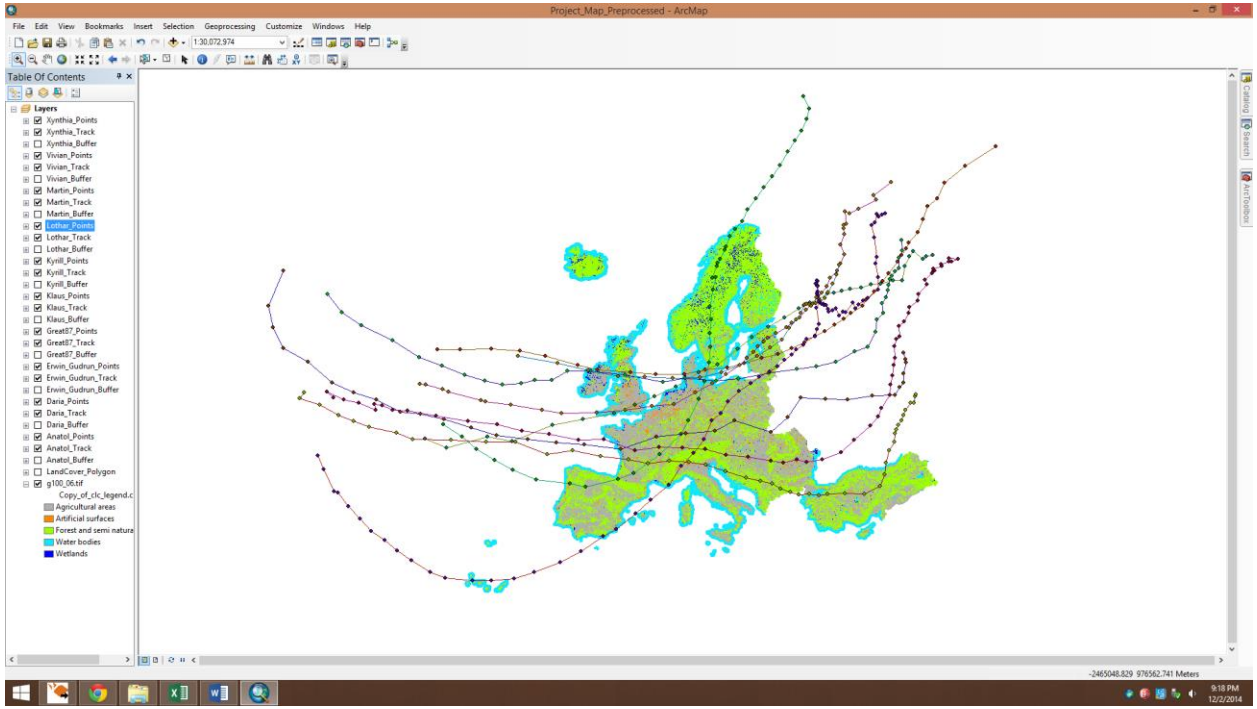
Step 2: import storm trajectories

Furthermore Add XY Data was used to add the storm tracks. To be able to do this the downloaded CSV files had to be preprocessed. I deleted all unnecessary columns and added a column to convert the given longitudes into a compatible form for ArgGIS. From all values from 180 to 360 347 degrees where subtracted, 13 degrees where added to values from 0 to 180. Also a title row was inserted. The resulting CSV files than were added with Add XY Data, with the longitude for the X Field and the latitude for the Y Field. Important for this step is to specify the Coordinate System of Input Coordinates, which is in this case the GCS_WGS_1984 System. The result of adding the data for the storm Anatol and exporting the Events to a point feature class is shown in the Screenshot 2 as an example:



Screenshot 2: Land Cover and Anatol Point Feature Class

Next the Events have to be exported to a Point Feature Class into a Geodatabase with Export data and subsequently a Line feature class created of them with the Points To Line tool. Now a Point and a Line feature class exist in the Geodatabase and can be used for further data processing. Screenshot 3 shows the result, when all storm tracks are loaded into ArcGIS.

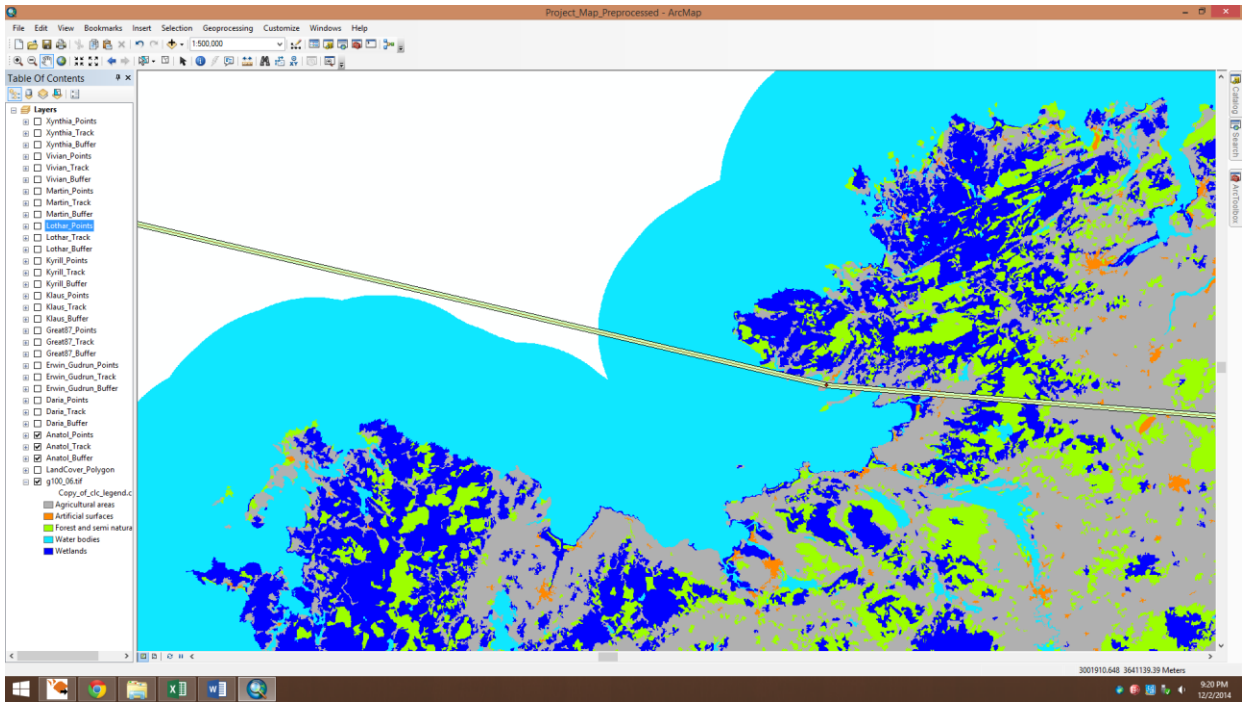


Screenshot 3: Land Cover and all Strom Point and Line Feature Classes

ArcGIS Processing

Step 3: buffer storm trajectories

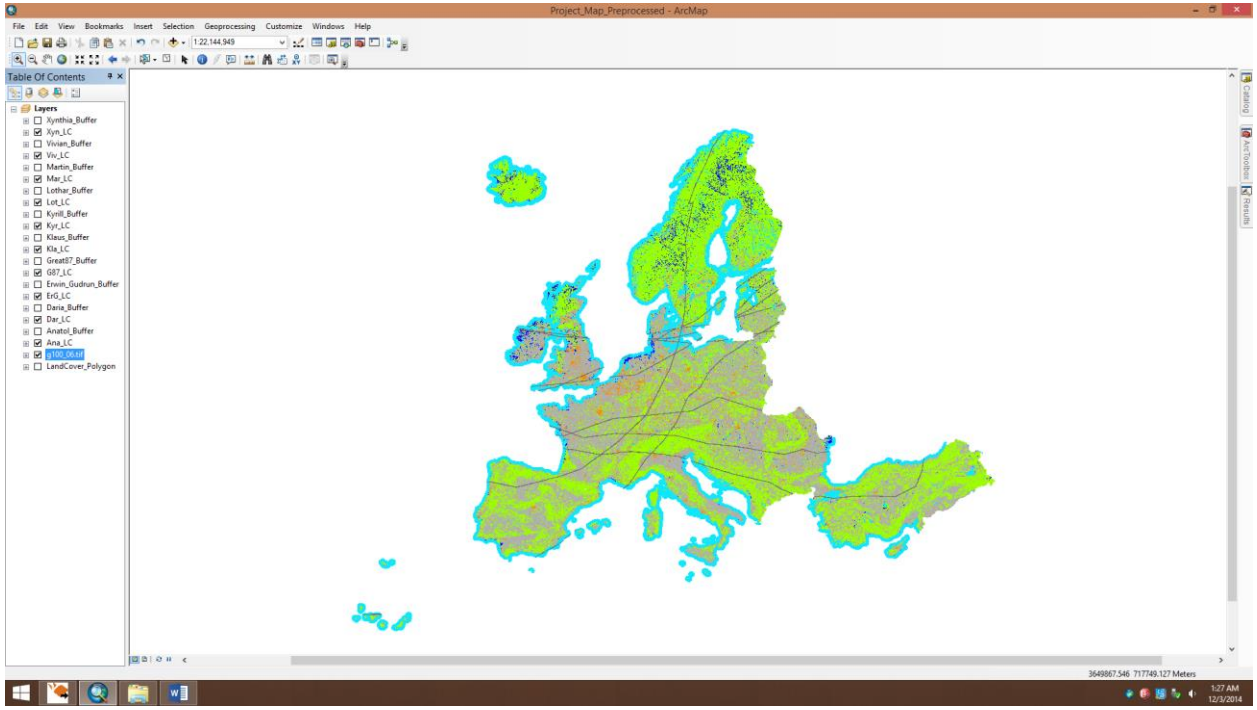
To take into account, that windstorms are based on cold fronts a buffer zone was created. The total width of such a storm is assumed to be about 1 kilometer. The Buffer tool is used to create a new feature class for each storm, which has the buffer zone of 500m distance to each side. As an example the result for the buffer zone for the Anatol storm is shown in a detailed view of the Irish Atlantic coast in Screenshot 4.



Screenshot 4: Anatol buffered Polygon Feature Class (Irish coast)

Step 4: determine damaged area

To be able to combine information from the land cover data and the buffered storm tracks, the land cover data has to be converted to vector data. The Raster to Polygon tool was used for that and the values of the LABLE1 field were assigned to the new polygons. Furthermore the Intersect tool was used to create feature classes that contain the information of the land cover for the buffered storm tracks. For each storm a feature class is created using a XY Tolerance of 100 meters. Screenshot 5 shows the result.



Screenshot 5: Land Cover and intersect Polygon Feature Classes (grey lines)

From this new feature classes the affected area for each storm track can be obtained as well as the affected area of a specific land cover. To do this the Statistics of the Shape_Area field of the attribute table has to be opened, the value listed as sum equals the affected area for this storm. To get the value for a specific land cover Select by Attribute was used, so that the Statistics window only shows the sum of the selected land cover. Table 1 gives the affected area of each land cover for each storm, the unit is square meter.

		Land cover					
	unit: m²	**Artificial surfaces**	**Agricultural areas**	**Forest and semi natural areas**	**Wetlands**	**Water bodies**	**Total**
Storm	**Xynthia**	110614212.5	1002450335	910522378.3	3076155.674	539911095.3	2566574176
	Vivian	26041241.56	539868126.8	315278635.7	63817790.5	618329351.7	1563335146
	Martin	132768095	1362799520	873758940.4	11904969	165726835.8	2546958361
	Lothar	131483159.7	1126949284	589332261.6	3011444.736	75403892.26	1926180043
	Kyrill	38772168.1	530070612.6	196469372.8	75272280.82	611656217.4	1452240652
	Klaus	116076623.8	1283848925	1463987631	6594164.637	380246308.5	3250753652
	Great87	128474424.6	1450026892	2236801506	86009902.22	567313346.1	4468626072
	Erwin_Gudrun	101416894.5	567058874.3	397167720.6	20704887.82	758614103.4	1844962481
	Daria	116430657.8	845822867	395302684.2	15226795.47	547070422.7	1919853427
	Anatol	34899599.46	662558374.7	344419460	40940291.87	465624618.9	1548442345
	Total	936977076.9	9371453811	7723040591	326558682.7	4729896192	

Table 1: affected area per storm and land cover (derived from attribute table)

Step 5: calculate the damage:

Land Cover	Damage (%)
Artificial surfaces	10
Agricultural areas	20
Forest and semi natural areas	50
Wetlands	20
Water bodies	0

Table 2: Land Cover classification and associated damage

Table 2 shows the land covers and how much damage is considered to occur to them. Based on Table 1 and 2 the amount of damage can be calculated. Since no exact data could be found on how much damage occurs to different types of land coverage, approximated and researched based damage percentages are applied as summarized in Table 1. The results are shown in Table 3.

Results

As shown in Table 3 the damaged area is varying a lot for each land cover and storm. Thus no exact prediction of storm damage can be made. However it can be said, that all land covers suffer severe damage and therefore adaptation measures should not be limited to specific ones. Also a good prediction of the storm trajectories is helpful since no storm can be considered to be especially week. For this statement on the other hand it is important to notice that only the ten storms with the highest insured losses are part of this evaluation.

All in all areas of several square kilometers are effected by each storm. Thus if storm damage is not recovered before the next storm, which is highly likely, a accumulation of damaged area has to be expected.

	unit: m²	Land cover Artificial surfaces	Agricultural areas	Forest and semi natural areas	Wetlands	Water bodies	Total
Storm	Xynthia	99552791.22	801960267.6	455261189.2	2460924.539	539911095.3	1899146268
	Vivian	23437117.41	431894501.4	157639317.8	51054232.4	618329351.7	1282354521
	Martin	119491285.5	1090239616	436879470.2	9523975.198	165726835.8	1821861183
	Lothar	118334843.7	901559427.4	294666130.8	2409155.789	75403892.26	1392373450
	Kyrill	34894951.29	424056490.1	98234686.4	60217824.65	611656217.4	1229060170
	Klaus	104468961.4	1027079140	731993815.5	5275331.71	380246308.5	2249063557
	Great87	115626982.1	1160021514	1118400753	68807921.78	567313346.1	3030170517
	Erwin_Gudrun	91275205.08	453647099.4	198583860.3	16563910.26	758614103.4	1518684178
	Daria	104787592	676658293.6	197651342.1	12181436.38	547070422.7	1538349087
	Anatol	31409639.52	530046699.8	172209730	32752233.49	465624618.9	1232042922
	Total	843279369.2	7497163049	3861520295	261246946.2	4729896192	

Table 3: damaged area per storm and land cover (derived from Table 1 and 2)

References

Land cover:

http://www.eea.europa.eu/data-and-maps/data/corine-land-cover-2006-raster-2

http://www.eea.europa.eu/data-and-maps/data/corine-land-cover-2006-raster-2#tab-metadata

Trajectories:

http://www.europeanwindstorms.org/cgi-bin/storms/storms.cgi?sort=loss&opt

http://www.europeanwindstorms.org/~extws/database/dataDesc/

All from 12/03/2014