# 2. Research Method

*2.1 Data*

*2.1.1 Research Area*

***AFBEELDING LOCATIE NEDERLAND ERBIJ ZETTEN***

As stated in the introduction, the Netherlands is the research area of the study. The spatial data about the country is downloaded from a service, named the Public Services on the Map (NL: Publieke Dienstverlening op de Kaart; PDOK). It is an open data platform where people find various governmental related spatial datasets and frequently updated. From the PDOK, the borders for the Netherlands is downloaded from https://www.pdok.nl/geo-services/-/article/administratieve-eenheden-inspire-geharmoniseerd (last accessed: 04-05-2020). Information about the infrastructure is also downloaded from PDOK downloaded from the national road file (Nationaal Wegen bestand; NWP). This file contains information about the Dutch infrastructure. It can been found from https://www.pdok.nl/introductie/-/article/nationaal-wegen-bestand-nwb- (last accessed: 17-08-2020).

*2.1.2 Fire dataset*

Active fires around the world are observed deducted from various satellite sources. One of these satellites is the Suomi National Polar-orbiting Partnership (S-NPP), which has the Visible Infrared Imaging Radiometer Suit (VIIRS).

The satellite orbits around the earth at an altitude of 829 km and crosses the twice equator when ascending around 13:30 (Greenwich time) and descending around (01:30). VIIRS-instrument measures the surface of the earth with 22 different spectral bands and has a swath width of 3060 km.

The instrument has 16 moderate resolution bands (M-bands), 5 imaging resolution bands (I-bands) and one panchromatic day night band (DNB). The DNB-and M-bands have a resolution of 750 meter, while the I-bands have a resolution of 375 meter. With an unique approach of pixel aggregation, VIIRS pixels observe the surface with earth with a pixel size of 375m (Cao et al., 2017).

An algorithm by Schroeder et al.(2014) is developed to deduct active fire information from the instruments its data. This algorithm uses data from the I4 sensor of VIIRS. This sensor measures the mediumwave infrared (MIR) spectrum between 3.55 - 3.93 µm. The specific colour temperature of the electromagnetic radiation indicates if there is an active fire or not. Several other sensors are used to verify the active fire and if data quality is good. With the help of the DNB, it measures active fires at day and night. This data is acquired for each month and saved in an ASCII file with the file name VNP14MLIMG. The aggregation scheme keeps therefore the resolution of the dataset at 375 m and has a low commission error (< 1.2%). The algorithm is influenced by the various land cover types and the different sizes and time span of the observed fires. The fire algorithm detects a smaller (lower than 100 ha) fires and improved on the detection of boreal fires and savannah fires, while agricultural fires has a lower performance in comparison against the boreal and savannah fires. Overall, the dataset is suited for the detection of natural active fires (Oliva and Schroeder, 2015).Therefore, is the active fire dataset is used to get information wildfires in natural areas in the Netherlands.

These dataset are downloaded from [*ftp://fuoco.geog.umd.edu/VIIRS/VNP14IMGML*](ftp://fuoco.geog.umd.edu/VIIRS/VNP14IMGML) *(last accessed on May 2020)*. The data cover a period from 01-2012 to 05-2020.

*2.1.3 Land cover datasets*

Land cover data are the Corine Land Cover (CLC). The dataset is the result of satellite date of the SENTINEL 2 and Landsat-8. The SENTINEL-2 is part European earth observation program that is used for acquiring high resolution data of the land surface (**BRON ZOEKEN).** The Landsat-8 is part of the LANDSAT and has the same goal of the SENTINEL-2 satellite (**BRON ZOEKEN)**. The SENTINEL-2 provides the main dataset, while the data of the LANDSAT-8 is used for to fill in the gaps. The CLC 2018 dataset has been developed between 2017 to 2018 and the CLC 2012 dataset between 2011-2012. The datasets have both an equal or greater 85% thematic accuracy with a minimum mapping unit of the polygon is 25 ha and it has a minimum pixel size of 100 meter. Furthermore, all changes that are greater than 5 ha must be mapped into the dataset (Büttner *et al.*, 2017).

The datasets from 2012 and 2018 are used and are downloaded from [https://land.copernicus.eu/pan-euro pean/corine-land-cover/clc2018?tab=download](https://land.copernicus.eu/pan-euro%20pean/corine-land-cover/clc2018?tab=download) (last accessed on May 2020) and <https://land.copernicus.eu/pan-european/corine-land-cover/clc-2012?tab=download> (last accessed on September 2020). It is open access.

*2.1.4 Natura 2000 and National parks*

The European Union (EU) set up a program to protect endangered species to ensure, sustain and increase European biodiversity. The network with these sites has been set out over the EU with the help of the Birds- and Habitats-directive and is called Natura 2000.

162 areas in the Netherlands that part of the Natura 2000 network. It supports the biological diversity in various landscapes and protects breeding areas for various specious. The preservation of the natural processes and habitats strategies (LNV, 2006) in these areas have influenced the spatial distribution of wildfires in the Netherlands. The relationship between the Natura 2000 and the wildfire is that the preservation of the habitats could result in specific land cover which could be affected by the wildfires caused by climate change. With the quantification of fire pixels in these areas, it could give insight how the fire regime impacts the various landscapes and habitats and how it can be prevented.

The shapefile of this areas is downloaded from PDOK as the administrative borders.

*Overview of the methods*

Two different methods, which are visualized in flowcharts (see figure 1 **and X)** have been developed for this research. The first method is for acquiring the data from the VNL14ML, CLC-rasters and administrative borders of the Netherlands. For each method, there will be given an overview what the reasoning is behind the different choices are

The scripts that are developed for parsing and analysing the VIIRS, CLC, and PDOK files can be found on <https://github.com/CUniversityaccount/ForestFireNetherlands>.

*Acquiring the data for the Research*

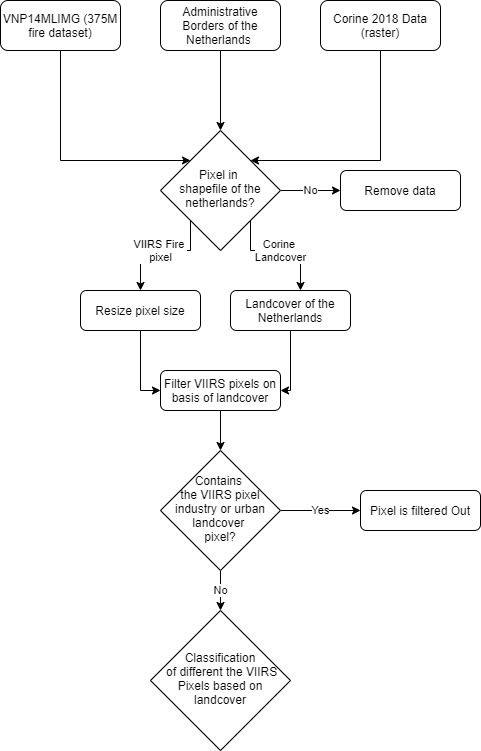


Figure 1 Flowchart on how the data from the data sources are used and are selected. The outcome if this flowchart are a shapefile and a rasterfile containing information about the land cover and the size of the fires.

The general overview of the method for acquiring the data can be seen in figure 1. The VIIRS dataset contains information about the size of the pixel, the classification with the help of the Corine landcover, the year and the month of observation.

*Filtering of the VIIRS Fire pixels based on location*

The data from the VIIRS dataset is filtered based on the location of the centre of the pixel. If the pixel is not in the administrative borders of the Netherlands than the pixel is filtered out.

After the non-relevant pixels are filtered out, the size of the pixel is determined. This is done with the horizontal position of the pixel in the dataset, whereby the starting point of the observations is the nadir.

The change in angle, observation distance and curvature of the earth causes the increasing size of the from the centre of the measurements. VIIRS compensates the factors with the help of multiple bands and aggregation scheme. This keeps most the pixel sizes 375 meter up to the 960th observation .After this observation, the aggregations scheme and sensors only can compensate the pixel size up to 750 meter (Cao *et al.*, 2017). This effect is applied to the filtered pixels. All observations whereby the observation count is lower than 960 gets a pixel size 375 and after this observation it gets a pixel size of 750 meter.

*Filter and classification of the fire pixels*

The fire type classification of the pixels has two purposes. It filters fire pixels which has most dominantly agricultural and urban landcover beneath the pixel and it determine what kind of fire type the pixel is. The used landcover dataset is the CLC dataset. The 2012 CLC dataset is developed between 2011 – 2012 and the 2018 CLC-dataset is developed in 2017-2018. The 2012 CLC dataset is used until 2016 and the 2018 dataset from 2016. This is to keep the land cover as accurate as possible. These datasets has a three levels hierarchy (Kosztra *et al.*, 2017). The levels that are used to filter the pixels are seen in table **X**. A pixel cannot only exist out of water, does not have a single artificial area pixel and doesn’t exists for at least 50% out of agricultural area.

|  |
| --- |
| 1. Artificial Area |
| 1. Agricultural area |
| 1. Waterbodies |

After these pixels are filtered out, the fire type is determined (see table **X**). The fire type is the most occurring amount of land cover pixels in the fire pixel. If a pixel has two fire types, which have the same amount of landcover pixels in a fire pixel, then the pixel gets the fire type combined nature, because it is mostly unclear what kind of fire type the fire pixel is.

*Measuring the distance between the fire pixel and road network*

The distance between the Dutch infrastructure NWB and the filtered pixels are calculated with the help of the program QGIS with the NNJOIN plugin. There will be no distinction between the roads in road activity, size of the road, and general use of the road. The type of the road is not mentioned in the NWB file.

The program that is used QGIS with a plugin named with NNJOIN. This program with this plugin will combine the closest datapoints and calculates the smallest distance between those two data points.

*Fires in natural designation areas*

The quantification of pixels based on location is done with the Nature 2000 areas and natural parks. All pixels are counted when they are in a Natura 2000 or natural park. So we get insight about how spatial policy decisions about designated natural areas has influenced the fire regimes in the Netherlands