# Introduction

Wildfire have been an important part for various ecosystems around the world, such as savannahs and boreal forests. They have taken a vital role in these ecosystems in term of development and sustainability. Most of the natural ignition of natural fires has been caused by lighting (Komarek, 1964), but for the last millennium, fires have been increasingly used and ignited by humans. It has been used for various tasks such as to modify their surrounding areas to prepare for agricultural activity or domestic purposes or for war strategies. For the last 300 years, fire regimes have been drastically influenced or even caused by human activity with goals as a great expansion of farmland and the accumulation of fuel in fire sensitive climates because of fire management. This resulted with other various environmental changes that 55% of the ice free surface has been modified for humankind (Bowman *et al.*, 2011). This lead to a decline in the amount of global burned area over the last 18 years, because the protection of high value property and vast amount of agricultural land (Andela *et al.*, 2017).

Besides the useful purposes of fires for humankind, it also has a great negative impact, for example the environment, the socio-economic situation of the local population, (Morton *et al.*, 2003; Ganteaume *et al.*, 2013) and the effect on respiratory system for a short and long period of time (Reid *et al.*, 2016; Cascio, 2018). It destabilized the local political situation, sometimes resulting in rioting, habitat loss for various species in the region and the severe damage on structures and properties in the region (Morton *et al.*, 2003; San-Miguel-Ayanz, Moreno and Camia, 2013).

For over the last century, climatological effects are influencing the risk of the fires and are part of the cause in changes in the fire seasons and locations of these fire regimes. The rise of the mean temperature on a global scale has been observed and its effects has been noted. This increase in temperature is caused by several greenhouse gases, such as methane and carbon dioxide, that are emitted by human activity. The effect of the warming is observed in various atmospheric and biochemical cycles (Hartmann *et al.*, 2013). The rise of temperature has impacted the burning seasons of various fire regimes around the world and could possibly introduce new fire regimes previously known low risk fire areas. The predictions of these effects are that the fire seasons are going to be longer, the frequency of fires is increasing over the 21th century (Flannigan *et al.*, 2009) and the risk of the fire is going to be higher. This could be amplified by the changes in the local landcover as a response to the warmer and drier climate (Liu, Stanturf and Goodrick, 2010).

These effects of also going to influence the European region. Currently, around 70% of the fires and 85% of the burned surface area in are in the Mediterranean Region in Europe. Therefore, wildfires and the consequences in the Mediterranean area has been extensively researched by various researchers such as San-Miguel-Ayanz and Camia (2010), Oliveira *et al.* (2012) and Ganteaume *et al.(*2013). However, the changes in climate does not only effect Southern Europe, but also increase the risk of fire in currently wetter climates in Europe. Therefore, it is important to get more insight about how these wildfires are burning, how these fire regimes have developed over the last decade and on which vegetation type these fires mostly have burned in an European country where fire is predominantly present.

The chosen country to research is the Netherlands. This is one of the countries which has an increasing risk of forest fires if the rise in temperature is going to continue for the following decade (Lung *et al.*, 2013). It has several unique characteristics that could greatly impact how wildfires start and give insight into how policy and population are influence future wildfires. The spatial policy of this country has a rich history in spatial planning and in general water management. This lead in the 20th century to greatly improving the Dutch waterworks to protect cities and the various spatial policies to stimulate economic growth. These developments resulted in a highly fragmented landscape and high dense highway infrastructure (CBS, 2016)(Janssen-Jansen, 2016; De Mulder, 2019). Another characteristic of the Netherlands is that it has the highest population density per square kilometre in Europe with 513 people / km2 ‑(CBS, 2016), which illustrates that the population impacts the designated natural areas.

In the 2000’s was also a European policy named the Bird and Habitats directives; whereby several designated landscapes are indicated with the intention to preserve the European biodiversity. In the Netherlands, was this mostly done by local and regional local instruments (Beunen, Van Assche and Duineveld, 2013). This policy also contributed to the development of the current Dutch landscape. These natural areas are also interesting to observe wildfires, because these fires have access to limited fuel and natural resources to burn.

These characteristics can be highly effecting the current and future fire regimes of the Netherlands, because most forest fires are indirectly caused by human agents (Ganteaume *et al.*, 2013), which are related to the distance to human infrastructure. Therefore, the chance of fire is higher, when the natural is closer to human infrastructure (Oliveira *et al.*, 2012). Furthermore, these natural areas are in designated areas, which also could be related how spatial policy has affected the trend in fire regimes.

The information about these fire regimes can be useful for spatial policy, human health, and biodiversity. With knowledge about the burning location fires, governmental institutes could anticipate these fires, so the loss in economic damage, ecological damage and effected human health is reduced (Morton *et al.*, 2003; San-Miguel-Ayanz, Moreno and Camia, 2013). Furthermore, the study shall provide insight into how the current rise in temperature (Hartmann *et al.*, 2013) has impacted fire regimes in European countries with a temperate climate.

The study provides new insights about when fires are burning, where they are burning, on what kind of natural land cover they are burning and if there are reoccurring temporal cycles observed in the Netherlands. Furthermore, it presents a spatial aspect such as the Natura 2000 areas, to observe how these policy are influencing fire regimes.

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