Blinded By the Light

A study on how different actors frame light pollution

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Preface

Before you lies the thesis Blinded by the Light: A study on how different actors frame light pollution. This study was carried out to fulfil the graduation requirements of the master's degree in Spatial Planning: Cities, Water & Climate Change, at the Radboud University Nijmegen. It was written between March and July 2021.

During my bachelor in Human Geography and Urban Planning at the University of Amsterdam, I became more interested in environmental issues. For my master's thesis I chose to focus on a particularly interesting environmental issue and one that is very local for me. I have lived my whole life near greenhouses and used to ignore the immense skyglow they caused. Hopefully, this thesis can help bring about change and improvement.

I would like to thank my supervisor, dr. I.V. Barba Lata, for his helpful feedback and guidance during this study. I would also like to thank my friends and family for their help and for motivating me. At last, I want to thank the respondents for sharing their experiences with light pollution. As suggested by the time of writing, this thesis was done during the COVID pandemic. This was not always easy. Nevertheless, I managed to pull through and was able to finalize this thesis within the set time.

I hope you enjoy reading this thesis,

Huub Diepens

Summary

Humanity has overcome the darkness and has been able to illuminate the night fully. However, excessive lighting has severe effects on both humans and animals. Adding on to that, lighting accounts for around 12.5 per cent of the global electricity consumption. This phenomenon is called light pollution. The Netherlands is one of the most light-polluted countries in the world. Currently, there is a lack of information on how people frame this unique pollution. Understanding how people frame certain things can help us understand reality better. This research tries to fill this gap, by studying how different groups of actors in the Netherlands frame light pollution. The groups analysed are civil society-, market- and state actors. The main research question entails: "*How do different actors in the Netherlands frame light pollution?"*.

To answer the research question multiple theories are used. Crucial to the analysis of framing, three framing tasks are used. The first framing task used in this thesis is that of diagnostic framing. Here, the definition of the problem is analysed. Clear differences between experts and the other actors appeared. The expert actors indicated that light pollution and light nuisance are very different things, whereas the other actors used to mix both concepts. An overlapping theme between civil society and state actors was that there are many political challenges in tackling light pollution, such as local environmental agencies not being honest in their cooperation.

Next, the prognostic framing. For this framing task solutions for the problem are analysed. One of the findings here is that LED lights are seen as a solution by both state and civil society actors, whereas the experts instead foresee a potential problem in it. LED lighting is more affordable and energy-efficient. As a result, the costs decrease and more light can be used. This might lead to more light pollution, the experts claim. Another overlapping theme was that of updating the policy, by making it more strict or enforcing it more rigorously, and to increase awareness on the topic of light pollution.

Thirdly, the last framing task is that of motivational framing. For this task, the reasons to tackle light pollution are investigated. Protecting nature and animals was often argued as a reason to try and solve light pollution. Civil society actors focussed on humans, whereas the other groups focussed on the effects of light on animals and nature. Safety is another common argument in light-related discussions mentioned by civil society actors, instead, it is used to argue for more light.

Finally, it appears that there are some slight differences in the frames. For example, civil society actors see light pollution more as an individual problem, and subsequently, propose individual solutions like moving the problem. Some of the interviewed state actors reveal to act for the desire of the public, yet some of the other state actors reveal that there is a lack of awareness. If there is little awareness of the problem among the general public, then logically there will be little desire of the public for change. Then, experts again emphasise this lack of awareness, and as a result the lack of experts at the right places. Their suggested solutions fit this existence of a gap of knowledge, as they suggest to increase awareness and to update the policy, which is also due for an update due to the lack of importance or awareness of the problem.

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Chapter 1: Introduction

1.1 Prologue

Light is everywhere, especially in our modern age. Our technological skills have advanced to the point where we no longer need to fear the dark, and as a result, our economy can operate every hour of the day. Unfortunately, our ability to use light has caused almost 1/3 of the world's population to lose sight of the starry skies (Falchi et al., 2016, p.1). The Milky Way has become an impossible sight for 99% of Europe's population. The title of this thesis reflects upon the excessive amount of lighting at night, and how this has blinded many of us by it being perceived as normal.

This phenomenon can be called light pollution, which Gallaway, Olsen & Mitchell (2010, p.658) define as *excessive or obtrusive artificial light, caused by bad lighting design*. This unique form of pollution is central to this thesis. It is unique in that it can easily be solved, by simply turning off the light the pollution disappears (Gelder, 2004, p.1).

In this thesis, it is studied how three groups of actors in the Netherlands frame this phenomenon of light pollution. The research question for this study is:

How is light pollution framed by different actors in the Netherlands?

The Netherlands ranks among the most light-polluted countries in the world (Falchi et al., 2016). The groups analysed are civil society-, state- and expert actors. Central to this framing are three framing tasks (Benford & Snow, 2000, p.615: Snow, Vliegenthart & Ketelaars, 2019, p.396). Diagnostic, which involves how the problem is defined. Prognostic, which involves what solutions the actor suggests to solve the problem. And finally, motivational framing involves the call to arms, why action is required.

1.2 Problem statement

Light is everywhere, and many perceive it as harmless. Yet, it does come with several potential health risks for both humans and nature, as well as requiring energy and destroying a traditional cultural good by decreasing the number of stars visible. Following is a brief overview of why excessive lighting is not necessarily a minor inconvenience, but a major problem.

1.2.1 Light pollution and the Netherlands

The Netherlands is among the most light-polluted countries in Europe (Falchi et al., 2016). See for example figure 1. Visible is the Randstad in the Netherlands glowing up. Not just this dense urban region lights up the sky, the greenhouses play a crucial role in this as well. There are no pristine skies in the Netherlands, except for some dark sky parks like that of Lauwersmeer (Nationaal Park Lauwersmeer, n.d.).

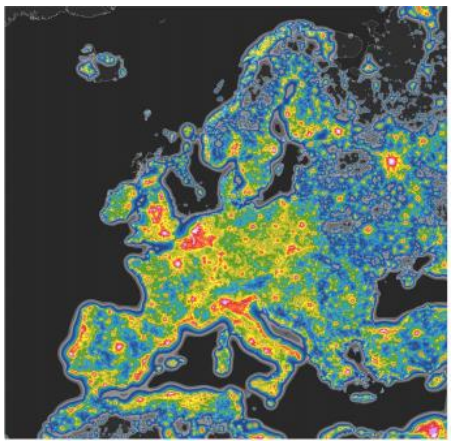

Figure 1: Sky brightness in Europe (Falchi et al., 2016, p. 5).

1.2.2 Public desire for regulatory policy

Around 8 in 10 people in the Netherlands want advertisement and office lighting to be turned off at night (Nacht van de Nacht, 2015). This indicates that there is a desire for change within the Dutch population. But at this moment there has been little action to set up a more strict policy. Without a further investigation, these numbers cause little action, as the report has been there since 2015. It is time that these voices are taken seriously, and to do that a deeper understanding is crucial.

At present, there is a lack of strict policy on light pollution (Rijkswaterstaat, n.d.). Looking at the website of Rijkswaterstaat it is very strange to see that there is even a lack of definition of *lichthinder*, Dutch for light pollution. It appears that light pollution is not perceived as being a problem, which can be seen as a reason for the lack of a strict policy. It also appears to be quite easy to solve light pollution, or at least decrease it (Gelder, 2004). For example, shielding light sources, so that the light does not escape to unnecessary places (Falchi et al., 2011) or by changing the type of light (Gaston et al., 2012, p.1262: Tabaka & Fryc, 2016).

On the website of Nacht van de Nacht (n.d.) many people have reported light pollution. These reports are all spread over the country. However, we lack a deeper understanding of these individual reports. It is crucial to understand the experiences of different actors before implementing solutions because doing so without this understanding can lead to problems. Light has multiple positive effects, it symbolizes the modernity and other great steps we as humanity have taken (Hölker et al., 2010). Attempting to reduce light pollution without taking into account people's values will lead to conflict, as the positive values and attitudes towards light need to be considered. It shows that it is important to understand the underlying reasons when setting up a policy, as simply enacting a policy that has no regard for people's notions will lead to a lack of understanding from the general populace

The Netherlands itself is one of the most light-polluted countries in the world (Falchi et al., 2016). The lack of policy can surely be one of the reasons for this. It is, therefore, crucial to study experiences with light pollution of different actors.

1.2.3 Effects of light pollution

Light can be harmful if not used carefully. Next are many of the different effects light pollution can have.

Health effects

A dangerous effect of light pollution is that of increased breast cancer and prostate cancer in women and men who work at night (Davis, Mirick & Stevens, 2001: Haim & Portnov, 2013:Chepesiuk, 2009:Walker et al., 2020). Those who had worked night shifts see an increase in the chance for breast cancer or prostate cancer, as their exposure to light at night surpresses the production of melatonin. Humans are not used to new forms of wavelengths in illumination, and thus our pineal melatonin production is disrupted.

Not only is the risk for these two forms of cancer increased, sleep and metabolic disorders are also influenced by excessive lighting at night (Falchi et al., 2011, p.2715: Van Poll & Kantermann, 2013:Walker et al., 2020). This is because our circadian clock is disrupted by this lighting, much like animals who are also affected.

Economic effects

It's almost impossible to put a price on the ability to see the stars and galaxy in the sky at night, as the causes and effects are far too complex to calculate (Henderson, 2010). However, it is possible to calculate the costs of the energy needed for lighting, and Gallaway, Olsen & Mitchell (2010, p.659) have done so. Roughly 6% of all electricity produced in the United States is used for outdoor lighting, and of this 6% around 30% is wasted. The authors calculate this waste of energy to cost $6.9 billion a year. The unnecessary electricity needed amounting to around 66 million metric tons of co2, which would be around 9.5 million cars. It is even estimated that to light up the entire world we use 2 trillion kilowatt-hours annually, almost 12,5% of all global energy consumption (Mills, 2008). Not all of this light is needed, and the emissions and the economic costs are thus wasted and could have been used in more pressing matters (Hunter & Crawford, 1991).

Previous research has indicated that around 72% of companies in the Netherlands have their lights on at night (Nacht van de Nacht, 2020**)**. Shockingly, 88% of offices in Noord-Holland had lights on at night for no particular reason. The energy usage of this unnecessary lighting amounts to the energy consumption of 150.000 households every year. These numbers indicate that there are significant gains to be made when we can decrease the number of lights on at night. If other sources of unnecessary lighting can be dimmed or removed it would greatly decrease the amount of energy required.

Environmental effects

Animals are affected by light pollution, as their rhythms are disrupted (Ouyang et al., 2017, p.4988: Heilig, 2010, p.269: Dominoni, 2015). For example, birds who build their nest too close to streetlights will face more difficulty sleeping than birds who do not. An abundance of light will cause them to have more stress, making these birds more susceptible to diseases like the West Nile virus (Pennisi, 2018). Plants are at risk due to light pollution as well, as these have a circadian clock too (Gaston et al., 2013, p.919). By using their *zeitgebers*, environmental cues that influence this clock, they adapt to and track the daily cycle. Artificial lighting can harm and reset this clock.

Even animals and fish living in the sea aren't safe from light pollution. The light coming from boats and harbours affects these creatures as well, their rhythms are disrupted by the lights (Navarro-Barranco & Hughes, 2015). The functioning of ecosystems is thus in danger because of light pollution.

Migration patterns are also affected state Longcore and Rich (2004, p.193). Animals are attracted by the light and change their journey. For instance, baby turtles, who have just emerged from their eggs on the beach, will be blinded by lights on their way to the ocean or even turn around to crawl to these lights (Longcore & Rich, 2004: Gelder, 2004, p.2). Another example is that of the disorientation of migratory birds, these birds become confused by the bright lights and get trapped among the buildings (Gelder, 2004, p.2). Some fly into the buildings whilst others drop dead from exhaustion. The CBD of Toronto kills around 10.000 birds every year as a result of their excessive use of lights. It is even estimated that around 5-50 million birds die each year from collision with communication towers in the US (Chepesiuk, 2009, p.2).

Cultural effects

The night sky has been a cultural resource for ages and now is no longer possible to be seen for a major part of the world's population (Gallaway, Olsen & Mitchell 2010: Falchi et al., 2016). Newer generations will grow up without knowing what a starry sky looks like. This unique scenic resource has been part of culture and science worldwide. Only a few places are unaffected by the skyglow of light pollution. Dark sky parks have come into existence, as a way of trying to re-enact the older the days, see for instance the dark sky park Lauwersmeer (Nationaal Park Lauwersmeer, n.d.). Even those parks are no longer safe, the dark skies in these parks are slowly being affected by the skyglow of neighbouring areas (Gallaway, Olsen & Mitchell, 2010).

One of the first groups to observe light pollution were astronomers (Crawford, 2000). This is not a surprise, as the skyglow that occurs as a result of light pollution severely impacts their visual abilities. Astronomers, both amateur and professional, are noticing limited visibility of galaxies and other celestial objects (Gallaway, Olsen & Mitchell, 2010, p.659).

The night sky can thus be seen as a cultural resource, yet it does not have the same rights as other cultural resources have. Hamacher, De Napoli, and Mott (2001) even call this a cultural genocide, as it destroys the ability of indigenous groups to adhere to their traditions. These groups still use the stars to gather information about navigation, weather and to inform their social structure.

1.3 Societal relevance

Societal relevance is the extent to which a study is expected to contribute to the solution of social problems (Van Thiel, 2014, p.187). As was mentioned before, light pollution has severe health and other risks for both humans and our ecosystem. If light pollution can be reduced it would benefit society. Not just the health risks are important for society, the costs and emissions this lighting brings with it are crucial. This thesis could be used as support for future policy on light pollution, the experiences investigated could reinforce the desire for more strict policy and help improving this policy. Officials in the Netherlands can use the thesis to learn from other cities or regions on what they can do to tackle light related issues and might help them realise the presence of framing in their daily work.

By setting up a more strict policy regulating this light pollution the emissions decrease and the Netherlands gets closer to reaching the goals set up in the Paris Climate Accord (United Nations, 2015). To reach this a better understanding of the experiences of light pollution is needed, as simply enacting policy will not be effective (Soga & Gaston, 2018: Hölker et al., 2010). Also, by learning how people frame light pollution, the reality of this pollution can be better understood (Benford and Snow, 2000, p.614).

Nacht van de Nacht intends on setting up a citizen initiative to address light pollution in national politics, by presenting a plan to the Tweede Kamer, the Dutch House of Representatives. The initiative is to consist of multiple points on which light pollution can be tackled in the Netherlands. This thesis can be used to support this initiative, as the experiences investigated in this thesis reinforce the need for action to be undertaken regarding light pollution. It also leverages several interesting new solutions if these are brought up during the gathering of data.

1.4 Academic relevance

Van Thiel (2014) states that the scientific relevance of research varies with the extent to which it contributes to the already existing body of knowledge.

Stone (2017, p.290) suggests that through the frame of light pollution regulations and strategies will be established, similar to the three framing tasks central in this thesis (Benford & Snow, 2000, p.615: Snow, Vliegenthart & Ketelaars, 2019, p.396). Stone suggests to first clarify the debate on light pollution. This thesis aims to do so, by analysing how different groups of actors interpret and perceive light pollution. In that sense, it aims to clarify how the different actors are standing in this debate.

Stone's (2017) work is one of the very few articles on the frame of light pollution. This thesis thus helps to fill this gap by adding to this discussion. It thus explores a yet unknown topic.

Academics can use this thesis as a framework on which to base future research on the framing of actors' experiences with light pollution Not just for light pollution-related studies, other environmental issues can be analysed in the same manner by altering the studied actors and questions.

1.5 Research aim and research questions

This research aims to find out how different groups of actors in the Netherlands frame light pollution. This framing exists of three dimensions: what is the problem, what are solutions for this problem, and why are we to address this problem? This study attempts to find out whether there are key differences in these frames between the three groups of actors: civil society, state, and expert actors.

1.5.1 Research question and sub-questions

The main research question is as follows:

How is light pollution framed by different actors in the Netherlands?

To answer the main question, the following sub-questions will be used:

1. How do the different actors define and perceive light pollution?
2. What solutions do the different actors mention to solve light pollution?
3. What are the motivations of the different actors to address light pollution?

Chapter 2: Theoretical framework

2.1 Light Pollution

Light has served humanity well throughout history, starting with just using the light of the moon and stars. Ancient cultures such as the Minoans used the stars to navigate the Mediterranean sea around 5000 years ago (Rutledge et al., 2011). With the arrival of the gas lamp in 1792, the exteriors of buildings could now be lit at night (Trembley, 2015). People were amazed at how our society has conquered the dark, no longer was night-time dangerous to go out due to the lack of light.

Light pollution; *excess or obtrusive artificial lighting, in the wrong place at the wrong time* (Gelder, 2004, p.2: Gallaway, Olsen & Mitchell, 2010, p.658), has been of concern since the 1930s. Our society has gone to the extremes in the usage of lighting at night, causing the sky to glow at night. See for example figure 2, here the last remaining areas without skyglow in Europe are marked with blue. More than 80% of the world population is no longer able to see a starry sky, and more than 99% of European and US populations live under light-polluted skies (Falchi et al., 2016, p.1).

Figure 2: Last remaining pristine skies in Europe (Falchi et al., 2019, p.4)

2.2 Perspectives on light pollution

There are multiple perspectives on light pollution, some see it as lighting shining directly into people's eyes, others see it as a specific number of Kelvin lighting, as shown in a survey done by Schulte-Römer, Dannemann & Meier (2018, p.177). In this survey experts on light from all over the globe were asked different questions about light pollution. One of the key reasons to reduce light pollution according to the surveyed experts were the negative effects on animals and ecosystems, with the effect on people's sleep coming at second. Most experts are thus concerned about the effects on the health of both people and animals.

"*Everyone assumes that 'more light is better' and that 'all light is good light'. These perceptions are the biggest obstacles shown, which must be challenged and shown to be false.*"

- (Schulte-Römer, Dannemann & Meier, 2018, p.187).

Schulte-Römer, Dannemann & Meier (2018, p.185) reveal the political conflicts light pollution entails. Light is something taken for granted by many in the Western world, as obviously seen on the artificial sky brightness maps presented by Falchi et al. (2016, p.2). How can light be bad? A question raised by many, as it is believed that more lighting can only improve safety and aesthetics (Schulte-Römer, Dannemann & Meier, 2018, p.187). The quote above summarizes these notions very well. This belief in the lack of negative effects of excessive lighting originates from a lack of awareness and further reinforces the new baseline in which abundant lighting is normalized. 86% Of the surveyed experts indicate that unawareness is one of the key barriers to mitigating light pollution, with the negative effects of LED effects not being considered coming at second (Schulte-Römer, Dannemann & Meier, 2018, p.193). We have become accustomed to our modern 24/7 economy, where it does not matter if it is daytime or nighttime through the use of excessive lighting (Chepesiuk, 2009). Not just the economy can use the illumination to extend its worktime, social and cultural activities are also able to be done at night. It is, however, a valid question to ask whether the current amount of lighting used at night is necessary.

The belief in the positive effects of lighting is slowly but surely losing its strength according to Schulte-Römer, Dannemann & Meier (2018, p.188). It is often argued that lighting increases security, but reports found out that crime decreases when lights are turned off (Gelder, 2004, p.3). Thieves are not able to see at night due to the lack of lighting, and when they bring torches or other sources of light they become a clear target. Traffic safety is another argument often brought up, but by having too much light it becomes more of a traffic danger (Schulte-Römer, Dannemann & Meier, 2018, p.188), as the glare coming off the bright lights causes commuters to lose attention.

It leads to the question: What amount of lighting is seen as acceptable or needed? It would be foolish to ask for completely dark nights, as that is not within society's demands (Chepesiuk, 2009). The amount of lighting is even influenced by the local culture: Schulte-Römer, Dannemann & Meier (2018, p.196) reveal that for example, East Africans prefer modern looking bright neon lights, whereas Western tourist prefer dark skies. Thinking further on the accepted amount of lighting at night brings us quickly to the shifting baseline syndromes, which influences this deemed amount by making people forget about the previous circumstances (Soga & Gaston, 2018, p.5).

2.3 Framing

Social problems are not static conditions, instead, they are developed based on collective definitions and experiences, and thus can be seen from different perspectives (Hannigan, 2006, p.63: Chong & Druckman, 2007). These collective experiences form collective action frames, coherent sets of action-oriented beliefs and meanings that inspire and legitimize social movement campaigns and activities (Snow, Vliegenthart & Ketelaars, 2019, p.395). There are multiple goals of these collective frames. Action mobilization attempts to mobilize and activate adherents to take action, whereas consensus mobilization converts bystanders into adherents and thereby broadening the base of the movement (Snow, Vliegenthart & Ketelaars, 2019, p.395). Counter-mobilization implies neutralizing and demoralizing opponents.

There are two discursive mechanisms that create and modify collective action frames suggest Snow, Vliegenthart & Ketelaars (2019, p. 397): frame articulation and frame elaboration. The first one focuses on connecting or dissecting experiences so that they can be put together in a coherent and meaningful way. Frame elaboration instead involves emphasizing and highlighting certain events or ideas more than others, leading to them becoming more important in discussions (Snow, Vliegenthart & Ketelaars, 2019, p.398). Therefore, some topics might not get the same attention as others. Adding on to these two is frame alignment (Snow et al., 1986, p.464). This combines the individual interpretations and that of the broader movement. Through this alignment both orientations become congruent.

Crucial to comprehending the experiences of individuals is the ability to understand the way it is framed. Benford and Snow (2000, p.614) see frames as a method of helping to understand reality, it organizes experiences and guides action. Framing occurs during discussions, meetings and other forms of communication (Snow, Vliegenthart & Ketelaars, 2019, p.398). It does this by simplifying or condensing certain aspects, whilst focusing on other aspects to gain support and demobilize antagonists.

Framing is key to defining the need for change and articulates who or what is to blame, as it creates attention to what is within the frame and that which it 'out-of-frame' (Benford & Snow, 2000, p.615: Snow, Vliegenthart & Ketelaars, 2019, p.393). These frames play a major part in how people tackle problems, it constrains the range of possible solutions and strategies people take (Benford & Snow, 2000, p.616:Stone, 2017, p.281).

Framing consists of three core framing tasks: diagnostic framing, prognostic framing, and motivational framing (Benford & Snow, 2000, p.615: Snow, Vliegenthart & Ketelaars, 2019, p.396). In table 1 these tasks are further explained. These tasks have different functions in framing and are often in dispute with one another. Where diagnostic framing aims to define what the problem is, motivational framing tries to find a rationale for why collective action is needed as a way of motivating others to join their cause. It does so by looking at the vocabularies used in framing the phenomenon. Key to this framing task are emotions, as they fuel the desire for change (Schrock, Holden & Reid, 2004). Benford and Snow (2000, p.617) suggest that some vocabularies can amplify or diminish the urgency or severity of the phenomenon.

Core framing tasks	
Diagnostic framing	- How can the problem be defined?
Prognostic framing	- How can the problem be solved?
Motivational framing	- Why do we need to undertake action? - Constructing vocabularies of motive/agency

Table 1: Core framing tasks (Benford & Snow, 2000, p.615-617).

2.3.1 Diagnostic framing

As mentioned before, diagnostic framing entails defining the problem and its attributions (Benford & Snow, 2000). The definition of a problem has broader implications for the other dimensions of framing. It also focuses on the blame or responsibility of the problem. Bardwell (1991, p.606) argues that having an adequate definition of the problem is the first step to solving the problem. Therefore it is the framing task that is at the base of the other two, without a clear definition of the problem and those who are to blame it is hard to frame solutions and incentives for action. Important to keep in mind for this framing task is that there is no good or bad definition, as neither guarantees that the right solutions are used (Bardwell, 1991, p.606).

2.3.2 Prognostic framing

Solutions for environmental issues are more than just technical ideas, they reflect societal values, politics, and expectations (Bardwell, 1991, p.604). This links to the framing of environmental issues, especially the prognostic framing task mentioned by Benford & Snow (2000). People frame not only their experiences and thoughts on issues but the solutions for these problems are framed as well. These solutions are affected by the way people perceive and frame certain issues; the diagnostic framing task. For instance, if an issue is framed as being controllable it might not be logical for many to see drastic measures be enacted (Dweck & Legget, 1988, p.266). This also relates to the concept of frame elaboration (Snow, Vliegenthart & Ketelaars, 2019), as when certain dimensions of the issue gain more attention than others the way we perceive the usefulness of solutions changes as well.

2.3.3 Motivational framing

Motivational framing is about providing incentives for action and creating vocabularies of agency (Benford & Snow, 2000, p.617: Smith, 2020, p.4: Snow, Vliegenthart & Ketelaars, 2019). It attempts to answer the question of why people should take action, and why free-riding is a problem. It does so by emphasizing the importance and urgency of the problem. It thus directly links to the prognostic framing task, as the definition of the problem shapes the urgency of the problem.

Central to the motivational framing are emotions (Schrock, Holden & Reid, 2004: Snow, Vliegenthart & Ketelaars, 2019). To make people join your cause emotions are crucial, as by playing into those emotions people can be motivated to take action. Snow, Vliegenthart & Ketelaars (2019, p.397) mention the slogan of Marx and Engel as an example: “Workers of the world unite! You have nothing to lose but your chains!”. This quote is a good example of such framing, as in this very sentence it is easy to notice the importance, severity and why an individual should join that cause. Linked to these emotions is the feeling of responsibility and solidarity (Fleishman, as cited in Klandermans, 1984, p.585). If one feels connected to his or her surrounding area, then that person will likely undertake more action than if there is no connection.

Klandermans (1984, p.585) lists two more factors important to motivational framing. For instance, people undertake action as they believe that nothing will happen if everyone sat back (Gamson & Schwarz, as cited in Klandermans, 1984, p.585). The probability of success is another one.

There are different forms of mobilization as Klandermans suggest (1984, p.586). Consensus mobilization involves obtaining support for an organization’s viewpoint. Another form is that of action mobilization, which involves calling up people to participate in that organization’s social movement (Klandermans, 1984, p.586).

Motivational framing can thus mobilize individuals to take action, but it can also demobilize or demotivate opponents (Smith, 2020, p.4). Demobilization can occur when opponents are convinced through arguments that their position is not correct, demotivating them from moving forward.

2.3.4 Link to light pollution

To sum up the framing tasks and show how they would work in regards to light pollution. The diagnostic framing task would define the issue of light pollution and the acceptable amount of lighting at night, who's to blame for the lighting and the negative effects of it. These effects can range from economic costs to the impact on sleep for both humans and animals.

Prognostic framing would discuss the solutions mentioned by actors for light pollution, these inherently reflect the diagnostic framing task, as these solutions are influenced by the perception of the problem and the societal value's. Some might see light pollution not as a big problem, and therefore might only accept little changes, whilst others demand radical changes in our current usage of lighting at night.

Motivational framing would list the effects of light pollution as well, but use it to motivate others and to show the urgency of the matter. Listing the number of birds killed every year by illuminated skyscrapers could for example show the severity of light pollution.

2.4 Social construction of environmental problems

Hannigan (2006, p.67) suggest that there are three key tasks used for the social construction of environmental problems: assembling, presenting and contesting claims.

2.4.1 Assembling environmental claims

The assembling of environmental claims entails naming and distinguishing the problem from other similar problems, and determining who is responsible (Hannigan, 2006, p.67). The author goes on to argue that many environmental claims originate from scientists, as through new findings and technology problems are discovered. An example Hannigan mentions is that of the ozone layer, as most people would never find out about the problematic situation of the layer. However, some environmental issues stem closer to everyday life. Light pollution is one of those everyday issues, as it is something that people face and experience every day in their life. Think of street lights being too bright near your house, causing you a hard time falling asleep. Even then, full knowledge of the risks and the solution is most often not available, or very hard to assess due to the complexity of the issue (Knol, Briggs & Lebret, 2010).

2.4.2 Presenting environmental claims

Hannigan (2006, p.70) argues that in presenting environmental claims presenters need to both attract attention as well as legitimize the claim they propose. The arena in which claims are presented is highly competitive, it must be novel, important and understandable. Easy to grasp visuals and verbal communication are key to this (Hannigan, 2006, p.70). Events or incidents can highlight the urgency of the matter, such as the nuclear accident at Chernobyl showing the dangers of nuclear reactors. These events help in assisting claim-makers, they reveal the potential outcomes of the claim.

This key task can be linked to the motivational framing task (Benford & Snow, 2000). By presenting it in a useful and motivating manner it can encourage others to join the cause and take action. The communicator plays an important role in this, it must be able to get a podium to announce these claims.

To successfully motivate others Hannigan (2006, p.76) suggests looking at marketing models, and how they use them to market their goods successfully. It can be applied to the presenting of environmental claims. Four factors are mentioned: uniqueness, relevance, stature, and familiarity. Uniqueness entails the way the public perceives the problem as separate from other similar problems. Light pollution is very different compared to other forms of pollution, such as air or water pollution. The relevance of an environmental claim refers to the degree to which it forms a problem to the ordinary citizen (Hannigan, 2006, p.76). Negative frames are often more successful, as the idea of losses weighs heavier than that of gains (Davis, 1995, p.286).

It can be hard to show citizens the problems of light pollution, as many are used to the current amount of lighting at night and therefore it might be hard to emphasize the relevance to them. Stature is about the attitude of the public towards the place or species under threat, in this case, it will often be public space (Hannigan, 2006, p.76). In that sense, there is little true ownership of the problem of the citizens and it is influenced by the way people perceive lighting at night right now. Familiarity is the final factor and refers to how well-known the environmental problem is (Hannigan, 2006, p.76). These four factors are all influenced by the shifting baseline syndrome, which will be touched upon later.

These claim-makers often use frame alignment to broaden the appeal of their claims (Snow et al., 1986: Hannigan, 2006). By making sure the interpretations of both the individual and the claim-maker are not in conflict and are complementary it helps support the attractiveness of the claim. Claims which are rational within your frame or interpretation are easier to grasp and agree with than those which clash with your view. Movements often try to seek non-divisive topics, so that popularity isn't affected negatively (Hannigan, 2006, p.71).

2.4.3 Contesting claims

It not easy to present your claim, nor is it to make change happen by setting up policies. Hannigan (2006, p.74) argues that it is a challenge to successfully contest an environmental claim. It is more a matter of politics than having an actual environmental problem and requires the knowledge and skill to work around this political arena. Merely putting out your claim will not lead to action according to Hannigan, instead, it is a combination of agreements and bargains between political actors.

Kingdon (As cited in Hannigan, 2006, p.73) identifies a handful of basic criteria that are needed for policy proposals to survive. The proposal must be technically feasible, or at least appear scientifically sound and administrable. It must also be compatible with the values of policy makers suggest Kingdon. Here there is much room for framing, and especially frame alignment (Snow et al., 1986: Hannigan, 2006). Neutral and non-divisive proposals will be much more successful than radical and ideologically tinted proposals, as they will likely not fit into the collective frames of the policy makers. Finally, Kingdon (in Hannigan, 2006, p.74) suggests that proposals must be made with a clear indication of the costs at hand, by showing these statistics environmental claims will have more chance of succeeding.

Light pollution can be a hard problem to solve in the political arena, mainly due to the lack of awareness on the subject by many (Stone, 2017), and can even lead to conflict. With much pressure on making our lives more sustainable opportunities arrive to discuss our usage of light. It is up to the environmental claim-makers to present a neutral and feasible approach to light pollution.

2.5 Shifting baseline syndrome

Our night sky has been polluted for so long that most people in urban areas have forgotten what the natural levels of lighting at night should be (Stone, 2017, p.290). This issue is called the shifting baseline syndrome (Sheppard, 1995: Soga & Gaston, 2018): the baseline on which we compare our conditions are gradually changing as our perceptions are changed. We have become so familiar with the current skyglow that we no longer know what the 'pre-man condition' even looks like (Sheppard, 1995, p.1).

This syndrome has three main consequences according to Soga & Gaston (2018, p.4). First of all, this syndrome causes an increased societal tolerance for progressive environmental degradation. Secondly, it changes people's expectations of what a desirable state of the environment is. Sustainable and healthy are terms which are defined by people's own experiences (Soga & Gaston, 2018, p.4-5). Finally, the false perceptions of environmental conditions will lead policymakers to set inappropriate targets for policy standards.

This in turn sets up a negative feedback loop (Soga & Gaston, 2018, p.5), in which improper targets lead to not being able to reduce environmental degradation, and that results in even more degradation. It also becomes harder for people to care about their environment as they fall more and more out of touch with their environment (Soga & Gaston, 2018, p.5), resulting in even less motivation to act and prevent degradation. This reflects the argument mentioned earlier in the framework, the accepted amount of lighting at night is influenced by the shifting of baselines, resulting in more acceptance of excessive lighting. Another concept to reinforce this is that of *deliberate unawareness* (Lyytimäki, Tapio & Assmuth, 2012, p.601): light pollution is not seen as a problem, or changes are seen to be too radical, resulting in little to no action being undertaken to decrease it.

Especially with light pollution, this phenomenon is a risk for actually implementing policy, as our framing influences the methods and strategies we view as viable or needed. This directly relates to the diagnostic and prognostic framing tasks mentioned by Benford & Snow (2000). Stone (2017, p.29) argues that enacting policy regulating light pollution might lead to conflicts, as many people still see light as a way of creating safety. This is partly due to the loss of familiarity with the natural environment (Soga & Gaston, 2018), which is quite prevalent with light pollution as many people have become accustomed to the current amount of lighting at night (Lyytimäki, 2013, p.46).

The notion of lighting at night being more safe has been debunked (Gelder, 2004, p.3: Schuler, Schatz & Berweger, 2018), yet feelings of safety increase with more light (King, 2010). Noticeable in this discussion is the presence of diagnostic framing: due to the loss of familiarity with the natural environment the amount of acceptable lighting has increased. As a result, proposed solutions are affected. It is understandable, as it is hard to see through the shifting baselines, especially with lighting. Many take it for granted, and through that are not able to see the issues excessive lighting brings with it.

2.6 Conceptual model

Crucial to this thesis on the experiences on light pollution is thus the concept of framing. The three framing tasks as suggested by Benford & Snow (2000), the social construction of environmental problems (Hannigan, 2006), and the shifting baselines syndrome are also illustrated in the conceptual model (Soga & Gaston, 2018). The three framing tasks will be used to answer the main research question. The conceptual model is shown in figure 3.

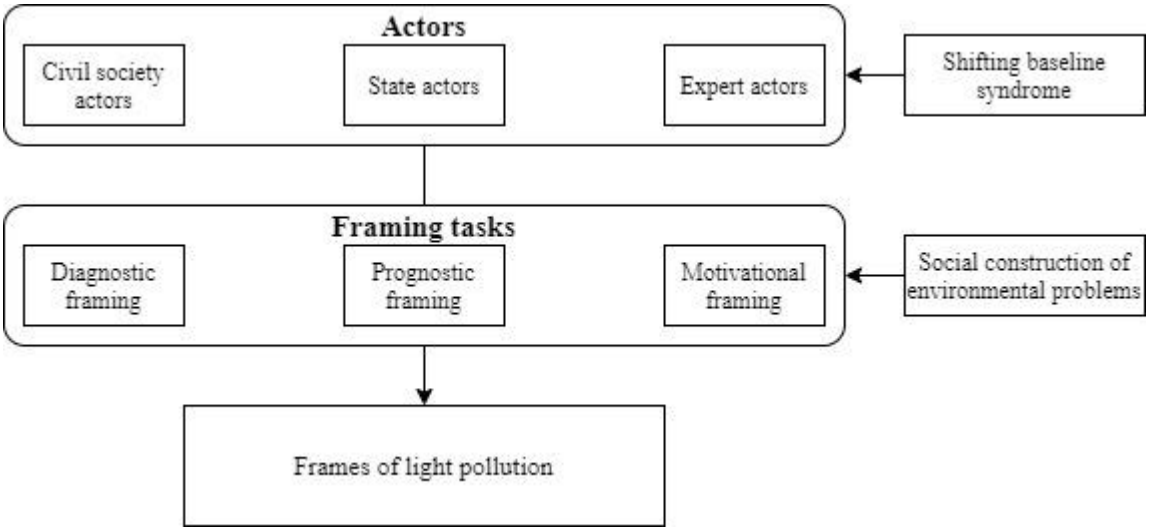

Figure 3: Conceptual model

Chapter 3: Methodology and research philosophy

3.1 Research paradigm

There are many different research paradigms or worldviews, and every researcher is affected by these basic belief systems (Guba & Lincoln, 1994, p.107). There are four main paradigms set up by Guba and Lincoln: positivism, post-positivism, critical theory, and constructivism. These paradigms are based on their ontological, epistemological, and methodological assumptions. The ontological question is fixated on the form and nature of reality, and what can be known about it (Guba & Lincoln, p.108). The epistemological question focuses on the relationship between the knower and that what can be known. At last, the methodological question entails how the researcher goes on his or her way to find out what he or she believes can be known (Guba & Lincoln, 1994, p.108).

This research fits the paradigm of constructivism. Central to this paradigm is that there are multiple realities, which are in multiple forms and different for each individual or group (Guba & Lincoln, 1994, p.110: Moses & Knutsen, 2012, p.9: Chong & Druckman, 2007).). These realities are constructed through our experiences and views. Here the values of the investigator influence the outcome of the inquiry, as his or her viewpoints shape the understanding of the realities being researched. These realities can only be elicited and refined only through interaction between the investigator and respondents (Guba & Lincoln, 1994, p.111: Moses & Knutsen, 2012, p.10). This fits research on framing, as these realities frame and shape the experiences of light pollution. Interviews were selected as the main source of data. Through these interviews, the realities could be investigated.

Currently, there is little known on how different groups of actors frame light pollution. This thesis aims to investigate and explore this gap, it, therefore, fits the category of exploratory research (Van Thiel, 2014, p.15). This research is used to investigate subjects about which little knowledge is available. This form of research is also reflected in the open-ended research questions. These questions are common in exploratory researches.

There are two main accepted forms of research: deductive and inductive. Whilst inductive research focuses on observing the empirical world and creating a theory to generalize the found data, deductive starts with existing theories to analyse observations (Van Thiel, 2014, p.24-26: Bryman, 2016, p.21).

This research is a mix of both inductive and deductive. It is deductive, as the framing tasks mentioned by Benford & Snow (2000) are used as guidelines for the chapters and to analyse the data. Furthermore, this research is also inductive in the sense that the findings are used to generate a theory about the differences between groups of actors and an environmental problem, in this case, light pollution.

3.2 Research methods

3.2.1 Data collection

The data gathered for this research has been done with qualitative methods: interviews and content analysis. Interviews are an integral part of this research, as it suits best with the research aim of understanding the experiences of the different actors. The interviews have been conducted semi-structured (Van Thiel, 2014, p.94: Bryman, 2016, p.10). These interviews have a topic list as a guideline, but still allow for flexibility in the questioning as some questions can be skipped or the order can be changed during the interview if found necessary. The three tasks of framing are reflected in the interview guides, with each tasks having several questions. The interview guides are present in the appendix, on page 3. During these interviews, most questions were focused on finding out how actors have experienced light pollution and how they framed it. So, for example, some actors might purely emphasize the economic aspect of light pollution in their interviews whilst others have different experiences they find more important. Actors were also asked as to what they see as fitting solutions. Not all interviews had the same questions, experts for instance were asked other questions than civil society actors.

With the current pandemic in mind, most interviews have been done online. Preferred would have been to do these in real-life, to see the emotions and make it more personal, but by having it online it is much more accessible for both the interviewer and the interviewee, as travel time is non-existent.

Content analysis is also part of the research. Van Thiel (2014, p.110) states that content analysis is used to establish facts and opinions and to reconstruct the arguments used. This fits well since these documents can indicate the way actors frame their experiences with light pollution. For instance, reports of experts on light pollution were used to validate and supplement arguments appearing from interviews with experts.

3.2.2 Selection respondents

The interviews have been conducted with different actors: civil society, state actors, and experts. For further clarification of the actors see table 2.

The original research proposal included market actors or the commercial sector. However, during the research, it quickly became clear that this group is different to the others. First, it often plays a different role compared to the others. Much like the state actors, they can be the ones polluting, but in contrast to state actors, they are privately owned and are not completely subject to the public's opinion. Secondly, it would be hard to measure a company's stance on light, as with an interview usually only one person can be interviewed. It then raises the question of whether that person represents the thoughts of an entire company or just that person's experience. It is in contrast to municipal parties that were interviewed, who represented their party's ideals. Finally, Nacht van de Nacht indicated that many companies, which are accused of excessive lighting, often are not interested in the topic.

Actor	**Definition**
Civil society actors	Residents and organizations who have experienced, or still do, light pollution
State actors	State officials or city councillors, who are part of the decision-making process of policy and plans, and have indicated having worked on light pollution, i.e. public servants/government workers
Expert actors	Experts on the effects of light and light pollution, i.e. light experts/consultants

Table 2: Definitions of actors

The interviewees were selected on basis of a few criteria. First of all, they had to have had an experience with light pollution or light nuisance. This to make sure that they are aware of what light pollution is. As a result, newspapers, web searches, and the network of Nacht van de Nacht were used to find interviewees. Secondly, these interviewees were to be located in the Netherlands, as that is within the geographical area of this study. Furthermore, for each group different definition were used. As visible in table 2.

3.2.3 List of interviewees

Next is a list of the interviews done for this study, visible in table 3. Among the names are some anonymized, as they preferred to remain anonymous. Most of the interviewees, if not all, are representing their organisation. Their respective opinions should thus not be seen as personal, but instead as representing their organisation.

Actor group	**Interviewees**
Civil society actors	- Richard Smokers, Milieu en natuurorganisatie Pijnacker-Nootdorp - Huub van 't Hart, KNNV Delfland - Harry Hendriks, KNNV Delfland - Johan Molenbroek, Bewonersvereniging Delfgauw - Resident of Overbetuwe - Resident of Ermelo
State actors	- Rianneke Mees, De Bossche Groenen – Den Bosch - George van Keulen, GroenLinks – Medemblik - Gerard Pelgrim, Stadspartij Zutphen-Warnsveld – Zutphen - Harry Horstman, environmental policy worker – Zutphen - Harry Matser, alderman – Zutphen - Environmental policy worker, Veere - PLOP, Assen
Expert actors	- Wim Schmidt, Sotto le Stelle - Ellen de Vries, Het Lux Lab / Chairwoman expertgroep Lichthinder NSVV - Jaklien Vlasblom, Licht en Donker Advies

Table 3: List of interviewees

Unfortunately, not all interviews could be recorded. Those who were recorded have been transcribed and are in the appendix. Those not transcribed are added as well, but just the notes that were taken at that time.

3.2.4 List of other data used

The main data for this research was retrieved from the interviews, but other sources were used as well to support certain findings, or as a source on their own. Following is a list of the other sources of data used, seen in table 4.

Type of data	**Title**
- Policy documents	- "Zicht op Nijmeegs Licht" - municipality of Nijmegen (Van Koppen, 2011).

	- "Beleid voor Donker in het kustgebied van Veere inclusief Natura2000 gebieden" - municipality of Veere (2018). - "Openbare verlichting, provinciale wegen Drenthe" - province of Drenthe (2007). - "Participatie & Openbare Verlichting". Licht en Donker Advies (2020). - "Richtlijn Lichthinder". NSVV (Alferdinck et al., 2020). - "Handboek licht/donker". RIVM (2010). - "Visie op Licht" - municipality of the Hague (2017).
- Newspaper articles	- "Bezwaar tegen ontheffing verlichting" – Telstar Online (15-5-2019). - "Operatie duisternis in Deurne: nog 'n paar lampen te gaan" – Broers, D., Eindhovens Dagblad (11-01-2019).

Table 4: List of other data used

3.3 Ethics

Diener and Crandall (1978, as cited in Bryman 2016, p.125) suggest there are four main areas of ethical principles. First of all, whether there is harm to participants. Secondly, whether there is a lack of informed consent. Thirdly, whether there is an invasion of privacy. And finally, whether deception is used.

Starting with the first principle, it can be noted that for this study no one has been harmed to generate data. The interviews were done online. This, as the world is still living in the COVID-era, and meeting in person, could potentially harm one by spreading the virus.

The interviewees were informed of the goal of the research at all times. First, by mentioning this goal in the email sent to them, and by again mentioning this at the start of the interview. Bryman (2016, p.129) argues that prospective research participants should be given as much information as possible before participating in the study. The goal communicated was that the interview was used for a graduation thesis for a master in Spatial Planning at the Radboud University Nijmegen.

Next, the interviewees were asked whether they preferred to be anonymized or not. If not, their name is used. As visible in the appendix and table 3, with the names of those interviewed, not everyone preferred to have their name publicly used. The degree of anonymity was discussed with them. Finally, the interviewees were sent the final results before handing in the thesis, so that, if needed, their quotes or cases could be altered to better fit what they were suggesting.

On the topic of privacy, again, the names are only used if those give consent. In that sense, their privacy is not invaded. They were also asked to introduce themselves so that they would only tell the private information they would like to give. During the interviews, they were asked personal questions on how they frame and experience lighting at night. None of the questions involved gathering personal information.

Finally, the goal of the research was clearly stated and how the data was used was also discussed after the interviews. To add to this, the thesis is sent to those interviewed so that they can see the result. Concluding, there was no deception involved for those interviewed.

3.4 Validity and reliability of the research

Van Thiel (2014, p.48) defines reliability as a function of both the accuracy and the consistency with which the variables are measured. Accuracy refers to the measurement instruments, and that they measure the variables as clearly and precisely as possible. The consistency revolves around being able to repeat a study with similar outcomes. This is often hard to reach in social sciences and in this thesis as well, as it revolves around people. A repeating study with people will not always lead to the same outcomes, as people learn from previous experiences (Van Thiel, 2014, p.48). Yet, by having a diverse group of actors similar themes quickly appeared. After multiple interviews, little new themes were appearing, and thus the data was becoming saturated.

As for accuracy, the interview questions were specifically designed to gather data about the three framing tasks. The questions asked are visible in the appendix (p.3). In that sense, they measure these variables are precise as possible. Next, the consistency is likely similar. If the research were to be done again, most of the themes would probably appear again. This as the themes suggested in this study are applicable and active in the discourse on light pollution.

Validity has many different forms, but the two main types are internal and external validity (Van Thiel, 2014, p.49). Internal validity revolves around whether the researcher is investigating the effect they intended to measure. The external validity refers to the extent to which a study can be generalized: whether the results of this study be used in other places (Van Thiel, 2014, p.49).

As mentioned before, multiple methods of gathering data are used. By using multiple forms of research findings can be validated, which is also known as triangulation (Van Thiel, 2014, p.92: Bryman, 2016, p.386). This is important since 15 interviews were done. With a small number of units, the reliability and validity might be in danger (Van Thiel, 2014, p.92), but by using a diversified approach such as using both interviews and content analysis this can be tackled effectively. Especially for the group of experts with only 3 interviews done, multiple sources were needed to effectively investigate the framing. Furthermore, the questions asked during the interviews are dedicated to the three framing tasks, and in that regard investigate the effects intended thus assuring the internal validity.

This thesis focuses on just the Dutch context and therefore might seem to not be as applicable in other countries. This is not true, light pollution is not only in the Netherlands problematic, see for examples the many figures on light pollution per country in Falchi et al (2016). The Netherlands might be unique compared to other countries in the number of greenhouses. However, these greenhouses are not the sole focus in this research, instead, all potential sources of light pollution and those reporting it are interviewed. Furthermore, the interviewees were chosen randomly, as long as they had an experience with light pollution. This led to a geographically diverse group of interviewees. With these geographical differences, different sources of light pollution were mentioned in the interviews. This reassures the external validity, as it confirms that the data from this thesis can be used outside of the Netherlands. For example, the unique greenhouse industry is not the only source of excessive light. In this sense, the data gathered here can be used in other places, since light pollution is almost everywhere, at least in Europe (Falchi et al., 2016).

Chapter 4: Diagnostic framing

4.1 Summary

In this chapter, the dimension of diagnostic framing is analysed. The themes mentioned by the different groups of actors are illustrated in figure 4. These themes are not the only things analysed here, the definition and responsibility of the problem are explained per actor group as well.

An overlapping theme here is the presence of a political arena, with on the one side the civil society actors encountering hardships in working alongside the environmental agency. On the other side are state actors who encounter the same problem but also experience bureaucratic barriers in the lack of capacity and funds to address light pollution.

Civil Society Actors

The two main themes that came across here is the influence of the local horticulturalists in the case of Pijnacker-Nootdorp, greatly affecting the way the town approaches the issue of light pollution, and the irritation excessive lighting causes.

State Actors

Four themes were brought up during the interviewees and data analysis with state actors. First of all, the bureaucratic barriers, which many of the interviewees actively encountered, making it often hard to actually address light pollution. Secondly, regional differences were noticed. Mostly between rural and urban areas in how they use light. Rural areas, more used to the darkness, undertake more action to preserve this. Third of all, lighting is often perceived as being important for social and traffic safety. Different viewpoints on this are described. Finally, the non-excludability of light pollution is mentioned. Animals are not able to take shelter from excessive lighting, whilst humans are.

Expert Actors

The expert actors interviewed highlighted two themes. First of all, awareness of light and its effect is increasing in the Netherlands. Secondly, there is a lack of knowledge within municipalities. If there is no civil servant or alderman familiar with light and how to carefully use it, there will not be any consideration in how the municipality uses light in public spaces.

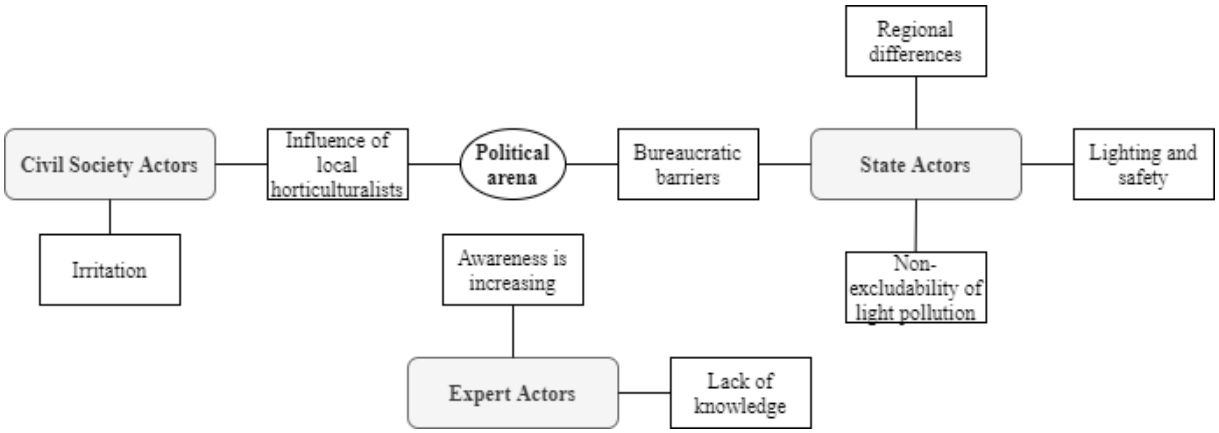

Figure 4: Themes of diagnostic framing

4.2 Civil Society Actors

4.2.1 Definition of the problem

Something which was brought up often in different interviews is the purchase of dark curtains, to keep unwanted light outside their bedrooms. In that sense, many people appreciate sleep and associate darkness with it. Molenbroek, the chairman of Bewonersvereniging Delfgauw, has experience as a yoga teacher for students, and is aware of the great potential sleep has on being productive. The current amount of lights at night make it much harder to fall asleep. According to the interviewees, it's not just that it has an impact on sleep, Richard Smokers from Milieu en Natuurorganisatie Pijnacker, MNP for short, illustrates this nicely:

"*We live here since 1996, and I remember during the first week we didn't have any curtains. You could even read a book without having lights on back then.*"

Molenbroek simplifies it by suggesting that light pollution is when it's not dark at night. It indicates a clear awareness of the difference between night and day, which is currently lacking due to the influx of light at night.

Light pollution can thus be defined according to civil society actors as:

Unnecessary and irritating light with effects on the sleeping patterns of humans and animals

The responsibility of this light pollution is often attributed to the commercial sector, but the government should set up clear guidelines to regulate them many argue.

4.2.2 Influence of local horticulturalists

The case of Pijnacker-Nootdorp and the residents attempt to address light pollution is illustrated by the interviews with Smokers (MNP), Molenbroek (Bewonersvereniging Delfgauw), Hendriks and van 't Hart (KNNV Delfland). Each representing their respective organisations.

This town is located in South Holland and is known for the many greenhouses it hosts. One of the key light polluters in the area are the rose nurseries, which require more light than other crops. The municipality gives these nurseries annual exemption, as the light emitted far exceeds the allowed amounts. In 2019 five local organisations tried to address these exemptions, and asked for them to be stopped (Telstar-Online, 2019).

A key theme here according to MNP and KNNV Delfland is the influence the owners of these greenhouses have. This town, and many others like it, have a rich history with these horticulturalists, and their companies employ many of the local residents. Through this, they have gained much power in local affairs. Smokers argued that this influence has allowed these light polluters to remain in the dark in having to subject to regulations, as the local environmental agency turns a blind eye. These horticulturalists influence many organisations within the town, further giving them power in local topics. It is further reinforced by the fact that there is an alderman specifically representing the horticulturalists. The political arena in which environmental claim-makers are active is visible.

"*If it's not a problem, you don't have to preserve it*"

- Richard Smokers on the authority of local horticulturalists

These organisations state that there is little reason to tackle other sources of light pollution. The sky glare emitted from the greenhouses is so much that the other sources of light are dwarfed in comparison. Trying to decrease the number of streetlights or advertisement signs does so little compared to tackling the greenhouses. Huub van 't Hart even mentions the International Space Station, and the famous pictures of light pollution taken by astronaut André Kuipers: Decreasing streetlights will not change those pictures, only by approaching the greenhouse problem can they try

and improve the situation. In the case of Pijnacker-Nootdorp, it is thus the greenhouses that get the most attention.

The responsibility, in this case, is hard to narrow down exactly, but at least two actors stand out: the municipality and the local greenhouse companies. The government has set up guidelines, but it is up to the local state actors to enforce these. This is lacking suggest the MNP. In the case of Pijnacker-Nootdorp, it is not clear who is to take responsibility, as the interviewees suggest the great influence the local greenhouse owners have over local affairs. So, if argued that the municipality is to blame it raises the question of whether they were influenced by the greenhouse owners in their decision-making or not. As a result, it is not easy to pinpoint who holds the responsibility here, the influence of the local greenhouses is not easy to notice and therefore a clear answer is not possible.

4.2.3 Irritation

Light can be irritating, a resident of Overbetuwe remarks. That person's attention was grabbed by the overflow of light coming from an industrial area, see figure 5. It contrasted with the local darkness, the person remarks. There is little need for so much light, as it holds little value. Especially in the region of the resident, Overbetuwe, there is already much darkness and it holds much value for this person in particular:

> "*If I stand in a grassland I should be able to see a starry sky.*"

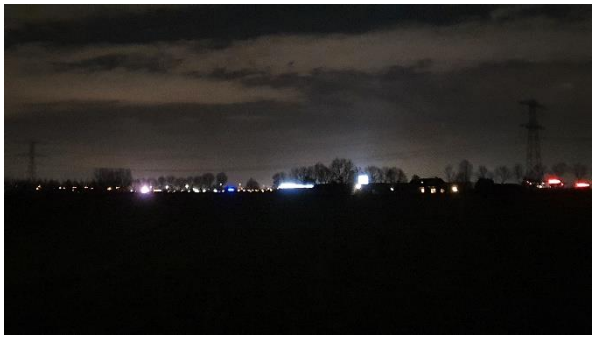

Figure 5: Picture of the excessive lighting in Overbetuwe (Nacht van de Nacht, n.d.).

In this case, the companies themselves are responsible the resident argues. They are the ones turning up the lights, whilst in this person's opinion, the amount of lights is unnecessary high.

This person's view on light is not unique, another person reinforces this notion. In this case, an elderly home in Ermelo has its lights on all day and night. It becomes an irritating issue he remarks, as the ones responsible for it undertake little action. His main claim as to why it's a problem is that it is a waste of energy and that his neighbour experiences light from this building coming into his bedroom. The solution mentioned by the elderly home was to install curtains in their building, stopping the light from travelling outside. However, the resident doesn't see any use in this so-called solution. Instead of turning off the lights, they keep them on but stop the light nuisance the residents experience. The interviewee showed that he cared most about energy waste, and this would thus not fit. In this sense, light pollution is not purely about the perceived light but also about the actual energy costs. Whilst the elderly home with its curtains shows to be very unaware of the problem at hand.

4.3 State Actors

4.3.1 Definition of the problem

Often mentioned when asked what light pollution is according to these actors is excessive lighting at night. A unique definition is mentioned by Mees, as she sees light pollution as something that grabs your attention without you wanting it. It links to other definitions mentioned as more suggest that it is unnecessary lighting. Van Keulen sees light pollution as too much light in the dark, with Matser and Horstman confirming this by suggesting it is light that is not necessarily needed to maintain the current levels of safety. In this definition the idea of safety is thus again brought back, emphasizing the importance of this argument for many.

Many interviewees have explained the effects light has. For example, Van Keulen mentions the effects of light on birds, affecting their migration patterns, and Pelgrim mentioning night butterflies becoming extinct by having more light. The RIVM (2010, p.9-11) can summarize the effects of light clearly by emphasizing the effects on nature, biodiversity, energy, health, darkness, landscape, astronomy, traffic safety, and social safety. Mees brings in a unique take, whereas humans can go home and protect themselves from light pollution, animals have little possibility to do so. In that sense, light pollution becomes more of a topic for animals and nature, than that it affects humans.

To be summed up, the general definition of light pollution according to the interviewed state actors and documents is:

Unnecessary and excessive lighting in the night, with effects on human, nature, and ecosystems

Interesting to remark is that there is no definition of light pollution in most of the policy documents analysed. This again reiterates the point brought up by Matser and Horstman, that it becomes a complex discussion if light pollution and light nuisance are mixed, as well as the idea that lighting is often more of a sub-theme. It is only in the hand guide of the RIVM (2010), where light pollution and light nuisance are divided. With pollution being seen as horizon pollution, and sky glare. Light nuisance is a nuisance on an individual level by having direct lighting, i.e. advertisements lights shining into your house (RIVM, 2010, p.18).

4.3.2 Non-excludability of light pollution

Something interesting that Rianneke Mees mentioned in the interview with her was the non-excludability of light pollution, and especially that of illuminated advertisements. Whereas with other forms of advertisements you can ignore it, illuminated advertisements do not give you that opportunity. Commercials on the television are easily ignored by switching the channel and advertisements on the radio are quickly muted, this does not apply to advertisements in public space. In this sense, light pollution is not an equal problem and has clear ‘losers’. For example, birds cannot take shelter from lighting at night.

4.3.3 Bureaucratic barriers

Pelgrim’s and his municipal party’s story is a clear example of the political struggles environmental claim makers experience. His motion to the municipality of Zutphen to create awareness on lighting was accepted, whilst a motion on actually decreasing the amount of lighting at night was not. However, in an interview with municipal alderman Harry Matser and environmental policy worker Harry Horstman, both working at the same municipality of Zutphen, it became clear that the story wasn’t as clear cut as Pelgrim made it out to be. Both Harry’s indicated that the discussion became complex and hard to follow due to the different understandings in the definition of light pollution. Two frames collide here.

Matser and Horstmann argued that it was not possible to fulfil Pelgrim’s idea, as there is too little capacity to work on it, both financially and a lack of experts and staff. In that sense, lighting is not

framed as crucial and receives less attention than others. The article of Simons (2021) further highlights this in Zutphen, with a local politician suggesting that enacting the idea of Pelgrim would lead to civil servants having to ask every company in Zutphen if their lights can go out. It is not just that there is a lack of capacity, there is also no juridical basis to work on according to Matser.

The case of Medemblik illustrates this point as well, where the *omgevingsdienst*, the environmental agency, is supposedly in cahoots with the greenhouse owners according to a local political party.

> "*He wanted to ignore the matter. Well, we wanted to do it for the general trust and honesty in business. We had to go to his boss, that we wanted the research to be done. If we hadn't asked his boss it would have not happened, indicating the unwillingness of the environmental agency.*"
>
> – George van Keulen, about a civil servant not wanting to research excessive lighting emitted from the greenhouses.

This quote not only indicates the unwillingness of those in control but in contrast, also the willingness of those concerned with the current amount of lighting. It shows that to achieve change often a lot of work is required, to go a step further. Light pollution is not seen as a problem by the civil servant nor environmental agency in Medemblik suggests van Keulen. The challenge of addressing light pollution is further reinforced by Mees, who had to use almost every possible option to ask for attention on light pollution. Ultimately, it led to success, with her party realising a new advertisement bill: new advertisements in public space have to turn off their lights after 11 in 'S-Hertogenbosch.

4.3.4 Regional differences

Something which can be noticed throughout the data is that the regions which are more used to darkness, such as rural areas, often have more or extensive lighting policy. The municipality of Veere is a good example of this, with their website extensively explaining the uses of both dark and light (Gemeente Veere, n.d.). It indicates the presence of knowledge on the matter, as many other municipalities in the Netherlands do not have an explanation of policy.

During an interview with an environmental policy worker of the municipality, it became clear that awareness of the use of light is important in the town. Kids are given the opportunity to read about night-time animals and the effects of lighting on them. In collaboration with local beach-club owners the municipality experiments with lighting, trying to fit it in the landscape without disturbing the local animals such as bats. To try and help the bats they for example used amber lighting, which is claimed to be better for these animals. This awareness of the problem is also reflected upon in their nota on darkness (Gemeente Veere, 2018, p.6), where users are prohibited from having certain colours and intensity of lights used. Lighting within buildings, advertisements and other lights on buildings are supposed to be turned off after closing, and lighting for safety is only allowed if dimmed or with motion sensors.

Another example is that of the province of Drenthe, where darkness is part of one of the key factors (Provincie Drenthe, n.d.: Provincie Drenthe, 2007). In their plan on lighting on public roads, they suggest that too much light is not wanted and has severe effects on nature, leading to them being very aware of the decisions they make on their use of light.

Compared to the urban area of Nijmegen, where lighting is seen as important to establishing the character of the city (Van Koppen, 2011, p.3). It does not just establish the character, it also fulfils an economic and recreative function. For example, by having advertisement lit up, or by lighting up sports fields (Van Koppen, 2011, p.6). The Hague follows this notion of identity being reinforced through illuminating public spaces, historical figureheads are for example illuminated to emphasize the character of the city and its residents (Gemeente Den Haag, 2017, p.5). They argue it is important for both residents as well as tourist.

Lights in public spaces can help create a welcoming feeling, important for the Hague as it plays a major role in international relations by being both the Dutch centre of politics and the presence of the International Criminal Court. The Hague, however, divides the city into four regions (Gemeente Den Haag, 2017, p.6-9):

- Eco light: the darkest areas within the municipal borders
- Road light: Streetlights with bright white lights to create safety
- Living light: Warm lights to create a cosy surrounding, in residential areas
- City light: Illuminating buildings and trees on squares, mainly in the centre

The Hague acknowledges that light is not deemed necessary everywhere. The attractiveness of the city centre, which is illuminated well, is boosted whilst the more calm nature areas are exempt from artificial lighting. The municipality of Veere (2018, p.3) uses a similar tactic of dividing its regions but are much stricter in their definitions of necessary lighting, and even then only allows careful usage of lights.

These examples show the shifting baseline syndromes in action, as it becomes clear that those reminiscent of the dark undertake action to stay in the dark, whilst those used to the amount of lighting will not try to change. The baseline in Veere is very different compared to that of Nijmegen, where citizens are happy with the current high amounts of lighting in public spaces (Van Koppen, 2011, p.9). In Veere the municipality is much more careful with its use of lighting, whereas in Nijmegen little effort to undertake action is visible.

This idea of geographical differences in perception of light is further emphasized by the RIVM (2010, p. 24): the provinces of Groningen, Friesland, Drenthe and Zeeland, which are still somewhat dark see more value in preserving this dark sky, especially compared to the light-polluted provinces of for example Utrecht, and Zuid- and Noord-holland. The different baselines thus clearly influence the way people perceive light pollution and the necessary amounts of light.

A local political party, PLOP in Assen, asked the municipality about its use of supposedly smart lighting in new cycling paths (Willemsen, 2021). These paths would only light up when cyclists were present, however, this seemed to not work effectively as the bike paths were lit up all night. This political party alerted the municipality about this and the light pollution it entailed. When asked whether this incident had changed the party's perception of light pollution in an interview it appeared that it did little. Only if residents experience nuisance due to lighting would they undertake future action on excessive lighting. The party did become more aware of the issue. An interesting remark added is that there is a slight difference between locally organized parties and those of bigger national parties.

These national parties, which are also active on the municipal level, are ruled from the parties main vision, whereas the local parties enact only on local matters. For example, VVD is a political party that also operates in municipal elections. These municipal parties are influenced by their national counterpart's stance on topics. Thus, if there is little recognition of light pollution from the main parties the local parties will often not undertake action.

4.3.5 Lighting and safety

A key discussion when talking about light pollution is safety and light at night. Matser argues that lighting is needed for both traffic safety, and social safety. The city of Nijmegen agrees (Van Koppen, 2011, p.3), suggesting that public lighting is key to resident happiness due to improving perceived safety. Both social and traffic safety is not up for trade. It is what people want. It appears that there is a clear relation between lighting at night and the perceived safety.

In contrast is the vision of Mees, who argues that lighting does not save an individual, it is much more nuanced.

"*The alderman said during the meeting: do you realise that if you are at a bus stop at night, and there is no light there, that you are unprotected? First of all, there are no busses at night. Secondly, why am I protected by lighting? It would be more about my ability to run and talk my way out of it.*"

- Rianneke Mees, when talking about the argument of light and safety.

She argues that it is hard to counter the argument of safety, as most see lighting as necessary to demotivate potential thieves. Many companies have their lights on at night, even when they have a security system in place already. Both sides have valid points, and thus it becomes more of a discussion on how much light is necessary. The province of Drenthe (2007) is between these two sides of the story, by remarking that lighting isn't always good, but that it is necessary to keep up a certain degree of traffic safety. The RIVM (2010, p.112) argues that there is little evidence that lighting leads to less crime or more social safety. Instead, it is much more up to social control in that area. Lights are only useful for social safety when those nearby have to help you. Even then, these lights could instead help those with less positive mindsets to enacting their plans, as you become more of a target when visible by the light.

To sum up, light at night can be helpful if it is needed. But if that is not the case, it might lead to an actual decrease in social safety. Safety is more reliant on other factors than light, for example, the presence of bystanders and the abilities of individuals.

4.3.6 Who is to blame?

When asked who is the one responsible for causing light pollution reactions were diverse. Van Keulen suggests that it is up to the companies causing this light pollution. In his case, vast amounts of light are emitted by greenhouses opening up their roofs at night. He suggests that previous guidelines on light are outdated, but even that those companies are responsible for causing light pollution in that region.

Mees shares this notion as well, arguing that it is the commercial sector responsible for light pollution. Again, in her case, the focus was on commercial and advertisement lighting. She argues that everything in this world drives around grabbing attention. By having more bright lit up advertisements more attention is grabbed.

Pelgrim suggests that it is more of a collaboration between the municipality and the commercial sector. It is up to the municipality to change the local laws, and they are the ones handing out permissions, yet it is up to the commercial sector to be aware of the effects.

To clarify these three visions, they are all challenging their local municipal councils on the matter of light, and in that sense frame their opponents as causing it. Compare this to that of the municipality of Veere, where they hand out permissions to new buildings but they closely work together on the aspect of light, to be sure that it is not neglected and misused. In that way, they take the 'blame' for causing light pollution if it occurs.

Looking back at what Matser and Horstman mentioned, the use of light is more of a sub-theme for many. By seeing light as a sub-theme it directly becomes less important for those to act on, and lead to a lack of responsibility since it's so low on the ladder of importance. This is also visible in what Matser and Horstman used to counter Pelgrim's motion on addressing light pollution, by pointing at the actions they're already undertaking, in this case changing existing streetlights to new LED lights. In this sense, it can be argued that they try to jump away from the responsibility, and instead show what they're achieving within the topic of light. It is however the question of whether changing streetlights is equal to addressing light pollution as suggested by Pelgrim. The RIVM (2010, p.21), however, sees darkness as an important factor and visions it as a key element of provincial environmental policy. Light is seen as much as important as air and sound.

Light pollution is a very complex form of pollution in the sense that it travels over borders. Van Keulen for example mentioned that the lights of greenhouses are visible throughout Noord-Holland and that it often occurs outside their municipal borders. The RIVM (2010, p.22) reinforces this, arguing that it is more than a local issue and that the issue is playing a role in most municipalities within the Netherlands.

Thus, the responsibility for light pollution is not set in stone according to the many interviews, and it should be noted that it differs from municipality to municipality or province to province. Yet, it is often perceived that is the commercial sector's fault for causing light pollution, as they hold the responsibility to act sustainably and ethically.

4.4 Expert Actors

4.4.1 Definition of the problem

Light pollution is not as a clear cut of a concept as thought by other actors, instead, there are clear differences between both *lichthinder* (light nuisance), and *lichtvervuiling* (light pollution).

Light nuisance is about the direct impact on humans and animals according to Vlasblom, de Vries and Schmidt. For example, as a commuter having trouble seeing the road due to the glare of the lights, or in your bedroom having trouble falling asleep as a result of the excessive lighting. The NSVV (2020, p.9), a scientific and expert community focussed on light, defines light nuisance as:

"The occurrence of nuisance to humans, plants or animals as a result of light from a lighting installation."

Then, light pollution is about the effect of light on the stars and the sky. Vlasblom suggests that it is more about the sky glare, which are the results of excessive lighting. De Vries joins this as well, seeing light pollution as all the light which is not wanted in the sky. Schmidt suggests it is hard to define light pollution and its effects. The NSVV (Alferdinck et al., 2020, p.9) defines light pollution as:

"The sum of all negative effects of artificial lighting on the environment, including the effects of obstructive light."

De Vries suggests that light is everywhere and is so common that most people have gotten used to the current degree of lighting at night. Light is also unreachable, in that it is hard to feel. Air or water pollution is for instance more tangible. A result of this getting used to is that people have trouble distinguishing necessary light from excessive lighting. She further explains that people are bad at defining problems and that most believe in the malleability of the world: that the world will have to adapt to our needs, not the other way around. In that sense, more light can only solve our problems. It raises the question of whether this belief does more harm than good.

Schmidt sees all artificial light as dirty, most of it is negative. Only for the user can it be positive. There is thus a negative relationship between the users and the non-users. The users, often humans, use light to guide their path or to be able to have social interactions at night-time, but the non-users, the animals and insects, are the ones who experience the problems associated with this lighting. Not just the relationship between non-users and users is something he remarks, he suggests a potential relationship between different religions and how they tackle environmental issues. Protestant municipalities have a much different role compared to their Catholic counterparts. These Protestant municipalities see themselves as caretakers of the landscape, and therefore manage light much more carefully. In the Catholic south, this is less of a thing Schmidt argues.

4.4.2 Awareness is increasing

The discussion on how we use light originated from when the first talks about energy reduction started around the 1970s according to Vlasblom and de Vries. In that period, provinces in the Netherlands became very interested in reducing their lighting at night, yet that interest dwindled suggests Vlasblom. Nowadays, there is little push for it.

Schmidt argues that in 2000 to 2005 there was little attention for light, but that in 2005 energy reduction became a big discussion and light was part of it. Most people can understand the effects of light on animals and biology suggests Schmidt, yet there is little to show for that understanding. In the last ten years, the awareness of the effects of light has grown.

4.4.3 Lack of knowledge

Municipalities in the Netherlands used to have more knowledge on how to tackle light related issues, but that has disappeared suggests de Vries: it is very dependent on the local alderman or civil servant

to have knowledge of light, and to acknowledge that is a problem if let loose. Vlasblom agrees and mentions that it is very important that there is someone in the municipality who is aware of the effects of light. Light is more of a topic for those working in nature or policy workers who focus on light.

Not just the lack of knowledge is a problem in addressing excessive light, municipalities have become *verzuild*, pillarised, according to de Vries. Every department within the municipality has its political agenda. It becomes more of a political arena in which environmental claim-makers have to operate than an actual discussion based on facts. The pillarization of municipal departments leads to longer talks.

Chapter 5: Prognostic framing

5.1 Summary

In this chapter, the dimension of prognostic framing is analysed. To see the different solutions mentioned by the different actors, see figure 6. Immediately visible are the similar overarching themes some solutions mentioned fit in: regulations, understanding the problem, LED lights and community action. The solutions mentioned to solve or address light pollution were diverse, and that is logical since there are great differences in the forms of light pollution that have been discussed in interviews. With sources ranging from greenhouses to municipal buildings, streetlights to advertisements signs.

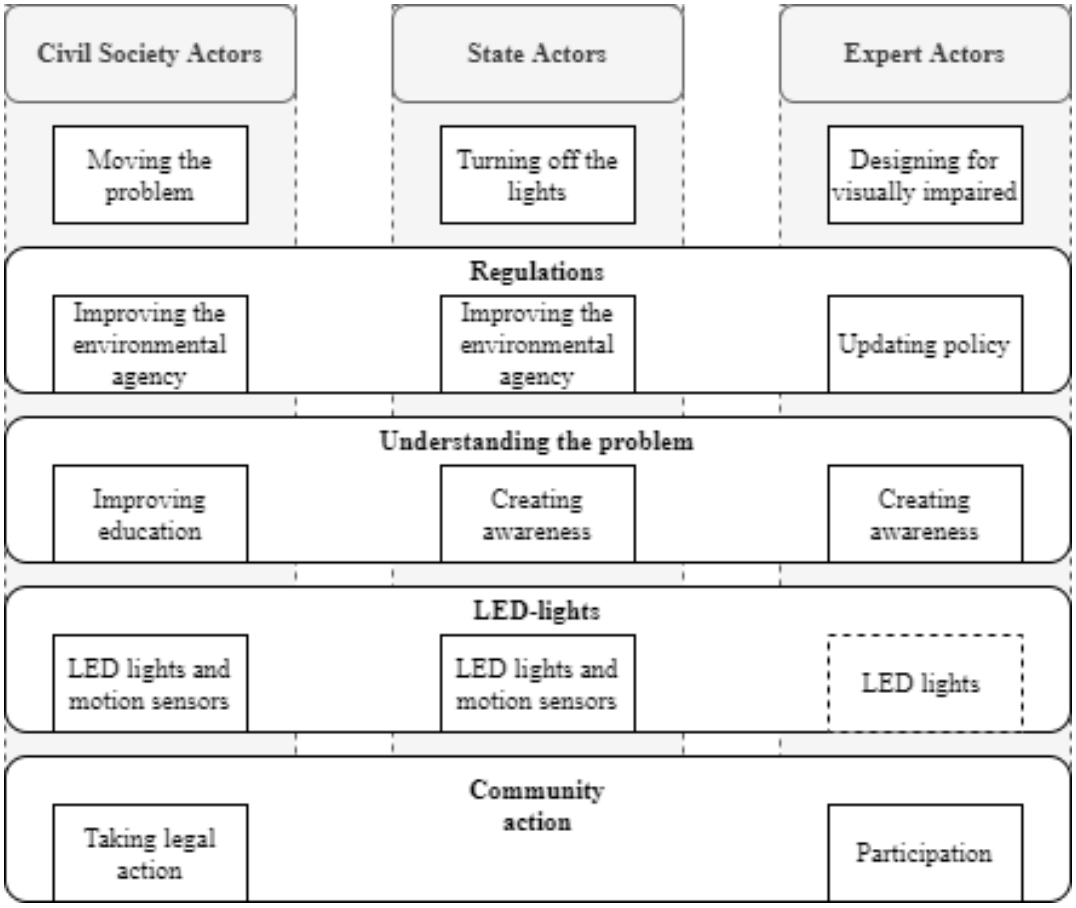

Figure 6: Themes of prognostic framing

Civil Society Actors

Five solutions were mentioned by the civil society actors interviewed. First of all, to move the greenhouses to better-fitting locations so that fewer people would experience light nuisance. Secondly, improving the environmental agency by making them less dependent on the local horticulturalists, so that regulations are enforced. The next solution suggested is to improve the education of horticulturalists, making them more aware of the potential effects of light. Subsequently, LED lights and motion sensors are mentioned as being a solution for both greenhouses and public lighting. Finally, a parallel to the nitrogen lawsuit in the Netherlands is drawn. A similar solution, a lawsuit, is suggested.

State Actors

First of all, simply turning off the lights is seen as a solution, contrasting the argument of safety and light. The second solution is improving the environmental agencies. The lack of capacity and

knowledge is often mentioned, and the solution is to improve this so that regulation can be upheld. Next, the state actors suggest to create awareness about light pollution and its effects. It would be the first step into solving the issue. Finally, similar to civil society actors, LED lights and motion sensors are seen as a potential solution for light pollution. These new LED lights are much cheaper and are less warm. Together with these lights mentioned are motion-sensors which would make lights not be on unnecessarily

Expert Actors

First of all, designing for the visually impaired is recommended. If done correctly the amount of light needed is decreased, yet the public space still functions for both those visually impaired and those not.

Secondly, a need for an update of the current policies is needed. These can be much more strict, as the previous guidelines are no longer applicable. Next, creating more awareness is once again mentioned as a solution. Awareness has increased, yet little is happening. More awareness can lead to action.

LED lights were mentioned once again. But here, the dotted line in figure 6 implies that the experts don't see LED lights as a solution, instead it forms more of a problem due to the cheaper price of light. With fewer costs the economic argument diminishes, resulting in more light according to the experts. Finally, participation is seen as a solution in both creating awareness and making more informed decisions on lighting in public spaces

Overarching themes

As suggested by two groups, state and civil society actors, some of the local environmental agencies are not willing to act on light pollution. Instead, favouring those polluting and covering up for them. They argue for a change in these agencies so that they enforce the national regulations. An expert, Vlasblom, mentions that the current regulations in place are lacking in strictness. An update for these regulations is in place. In this sense, improving and enforcing the rules is mentioned by all three groups.

Next, an understanding of the problem is needed as suggested by both civil and state actors. The one argues for a better education for upcoming horticulturalists, the other argues for creating awareness in general.

LED lights are seen as a potential solution to the problem of light pollution by both state and civil society actors. Yet, it clashes with the vision of experts. These suggest that it might be a problem instead of a solution.

Finally, community action is seen as another solution. The experts see potential in using participation in light-related plans so that the community can help give shape to these plans. The civil society actors see use in taking their respective municipality to court over not adhering to the rules when handing out permissions. Both indicate a solution that involves the community taking action.

5.2 Civil Society Actors

5.2.1 Moving the problem

A solution for the greenhouse problem is to move the greenhouses elsewhere suggests KNNV Delfland. Why do these polluting greenhouses have to be so close to people? Instead, they argue that these greenhouses should be placed in less densely populated areas. He remarks that it forms a bit of a NIMBY solution, by moving the problem elsewhere. Yet, this does not have to be true, as Hendriks argues that it is warmer elsewhere, and as such greenhouses have to use less light to grow the crops. It also indicates that there is little solution, except for moving and LED lights for the greenhouses and their emitted light pollution, according to these civil society actors.

Another example is that of a municipality close to Pijnacker-Nootdorp: Lansingerland. Here, greenhouses are located close to each other mentions Hendriks. In Pijnacker-Nootdorp the greenhouses are placed everywhere, with little regard for residents. A potential fix would be to group all greenhouses away from residential areas, to reduce the potential light nuisance.

5.2.2 Improving the environmental agency

A solution mentioned by Smokers and the local nature organisation is to fix the issues with the local *omgevingsdienst*, the environmental agency. They are controlled too much by the greenhouse companies, making them loosen up their enforcement. If that can be changed, and that the regulations are enforced, it could do much. Molenbroek voices his support for this, as well as making it harder to get permits from the municipality. He suggests it's engrained in the Dutch culture, enforcing rules is no longer a real thing, as visible in the national level of politics.

If the regulations on lighting at night in greenhouses were to be enforced, the amount of sky glare would diminish in the region of Pijnacker-Nootdorp. Right now, the rose nurseries get exemptions annually and can neglect the rules set up by the government. Making it harder to get these exemptions would help, suggests the Bewonersvereniging Delfgauw.

5.2.3 Improving education

Molenbroek and the resident organisation of Delfgauw reveal a unique solution: educating the horticulturalists. He remarks that during the studies of new horticulturalists they should be educated about the effects of light on people and animals, and shown the many movies revealing these. Nacht van de Nacht could play a role here, he suggests, by giving them lectures on this very topic. By starting with educating them they can become more aware of the issue.

5.2.4 LED lights and motion sensors

To decrease the amount of heat emitted from the greenhouses at night, the MNP suggests the use of LED lights. These LED lights are according to the interviewee much colder and could decrease the degree of light pollution. Van 't Hart supports this development. Yet, on the other hand, these lights are more expensive, leading horticulturalists to expand their greenhouses to make the use of these lights profitable. In either way, it is believed that this development can reduce the light pollution in the region.

Motion sensors are another way of reducing light in public space, the Bewonersvereniging Delfgauw suggests. Regulating the amount of light is necessary, as light is necessary at certain places to maintain both traffic and social safety.

5.2.5 Taking legal action

The municipality of Pijnacker-Nootdorp is not active enough in its approach on light pollution, argue the four organisations interviewed. To put more pressure on them, van 't Hart suggests it can be seen as similar to the nitrogen lawsuit, which occurred in the Netherlands. This case resulted in nitrogen having to be greatly reduced within the country, for example by limiting the allowed speed on highways. It led to many protests by farmers and construction workers.

In the working is a letter to the municipality, in which it is argued that the municipality is inactive. The municipality is to enforce the regulations and no longer allow exceptions. If they do not accept, the local organisations will take the town to court. The municipality has shown that they understand what they do is no longer acceptable, as annually extending exemptions cannot be done forever, yet they do not show any other forms of willingness to cooperate and fix the problem. This led the organisations to put more pressure on the municipality, and threaten them with a potential lawsuit. KNNV Delfland and Bewonersvereniging Delfgauw foresee that their letter will not be taken seriously unless a lawyer is helping them.

Similar to nitrogen is the administration the organisations would like to see implemented. Nitrogen has to be administrated carefully, and van ‘t Hart suggests this would fit light as well: make companies administrate how much light they have to use.

5.3 State Actors

5.3.1 Turning off the lights

As mentioned before, Rianneke Mees was able to set up a new bill in 'S-Hertogenbosch prohibiting new advertisements signs from being lit up between 11 pm and 7 am. Her main focus was on advertisements, and her solution mentioned is thus to limit the number of lights on at night. Older advertisements still are free to do what they want, but at least the new ones are taken care of. In this case, just turning the lights off was the solution. In a sense, very easy and logical but still hard to grasp for many. It becomes more true when confronted with the safety argument as seen in the case of Mees. The city of Zutphen chose to change existing streetlights to newer LED lights, but turning off certain streetlights was not part of the solution. Noticeable is thus the presence of the safety argument, turning off the lights is not okay as many residents prefer more lights at night.

The city of Nijmegen visions much ground to be made in dimming and turning off several lights, which is part of their *meerlampenprincipe* (Van Koppen, 2013, p.12-13). Several parks in Nijmegen, which are closed after sundown, have no lights on at night.

"*The municipality of Nijmegen does not illuminate public space, unless social or traffic safety is at risk or if there are identity determining objects of the city. This approach prevents light nuisance and saves energy.*"

- Van Koppen (2013, p.12) about the city of Nijmegen's vision on using light in public spaces.

Nijmegen's vision on the use of light in public space is thus greatly influenced by two major factors: safety and identity (Van Koppen, 2013), as mentioned in the chapter before. These influence the way the city tackles light-related issues, if there is a risk that safety would decrease due to a lack of light the lights would not be altered.

5.3.2 Improving the environmental agency

Indicated by Harry Matser and Harry Horstman of Zutphen is that the capacity to address light pollution is often lacking. There are insufficient funds and civil servants to adequately address or even research lighting in the municipality. Their solution instead is to change streetlights to newer LED lights, cheaper and more sustainable according to both. The lack of capacity also influences the possibility to address local issues with light.

Even if there is the capability to work on light, it might not lead to results as revealed by both van Keulen and the municipality of Veere. Where in Medemblik the local environmental agency is suggested to be loyal to the greenhouse owners, blatantly trying to stop studies that could show the greenhouses exceeding the legal limits. Van Keulen argues that the environmental agents are aware of light pollution, and just choose not to act. In Veere this awareness is lacking according to the interviewee: the environmental agents do their patrols in daylight, thus not being able to see potential excessive lighting, and even then, lighting is not something that needs to be controlled according to them. Van Keulen suggests that stricter controls are mandatory to reducing light pollution.

The municipality of Veere helps with plans for new buildings and facilities to fulfil their lighting needs sustainably. By starting at an early phase in the design process it helps the client become more aware of lighting, and gives it more priority. Often seen is that lighting is an issue that comes up last, and with that receives very little attention and is given place without careful consideration. The municipality thus counters this by starting early. By helping out it reduces the chance that people will have problems with lights from that source in the future.

5.3.3 Creating awareness

As mentioned before, the RIVM (2010, p.9-11) listed many of the effects of excessive lighting at night and sees it as an important topic. They argue that it is up to the provinces to make policy, which is

further influenced by their perception of the importance of dark skies. Dark provinces such as Groningen and Zeeland undertake more drastic action to prevent the sky from getting too bright. The first step the RIVM advises is to undertake is to create awareness. They argue it is a relatively new topic and is therefore not known by most officials (RIVM, 2010, p.26). To start undertaking steps they argue to make a good overview of the current situation, by for example making maps of the sky brightness or investigating sources of excessive lights.

The provinces have a role in advising municipalities on how to tackle light related issues according to the RIVM (2010, p.52). They mention three elements of which this role exists. First of all, creating awareness by spreading folders or by discussing lighting during the creation of development plans. Secondly, by helping the municipalities with making new policy where darkness is emphasized. Finally, by enacting projects together with the municipality on the topic of darkness. The municipalities revealed that they would prefer an unambiguous policy on lighting. Further, by emphasizing the role of provinces and municipalities in tackling light related issues it becomes more clear that they see light as a local or regional problem, with region-specific solutions. Also because light pollution is not bound to municipal borders, the RIVM envisions an approach on a provincial level.

The RIVM (2010, p.64) suggests several methods that could be undertaken from an environmental perspective to tackle light pollution:

- Again, creating awareness by spreading information on the importance of darkness
- Financial supports of new development contributing to dark skies, or financing new projects
- Juridical support, by selecting regions prohibited from having sky beamers or a certain amount of lux at night
- By making certain areas regions of darkness, prohibiting lighting in general.

It becomes clear that the RIVM sees the potential in awareness, hoping that after creating awareness provinces will undertake action themselves. When awareness is created, it will spread and lead to the development of new policy and tools (RIVM, 2010, p.26). A good case of this awareness is the municipality of Veere, Zeeland. Awareness here is spread by hosting many events showing the usefulness of dark skies, schools are given lessons on animals in the dark and such. At local fairs there are even stands promoting the policy on light they have, creating further awareness and helping out locals with problems. By creating this awareness the municipality can garner the support of locals for their policy on lighting. Adding to this, the province of Drenthe sees potential in setting up night-time activities, where residents can experience darkness and other related topics, to create awareness.

The role of awareness is further emphasized by the motion of Pelgrim, which was focussed on garnering awareness in Zutphen. It might seem like very little effort to acknowledge such things, but as mentioned by the RIVM (2010) starting with creating awareness can lead to new policy. Pelgrim and his party's other motion where companies have to present a plan on lighting to the municipality. Horstman and Matser argued that there was too little capacity to implement this

5.3.4 LED lights and motion sensors

Often mentioned in interviews are the development of new forms of lights, mainly LED lights. In Zutphen, these new lights are used to replace the existing streetlights. Nijmegen (Van Koppen, 2013, p.12) intended on using these lights for experimental purposes back in 2013, it was estimated that these lights could save between 5-20% in energy usage. The Hague even envisions a reduction of energy needed of 40%, if LED lights are used (Gemeente Den Haag, 2017, p. 12). If motion sensors and LED lights are installed, a potential reduction of 52% could be realised.

Van Keulen mentioned these lights as well, as a way to solve the enormous amounts of lights emitted from greenhouses. LED lights are supposedly not just cheaper, but also less hot. For greenhouses, this

would mean that there is less heat in the greenhouses, and thus they would not need to open the roof at night to release this heat according to van Keulen.

Horstman and Matser also support the use of LED lights and are currently replacing many of the older streetlights with these newer lights. They foresee the usage of LED lights to be crucial in the coming years. At this moment these new lights are too expensive for the municipality of Zutphen to implement elsewhere, especially in the already hard financial times.

Motion sensors are also very present when discussing solutions for light-related problems. The city of Assen implemented a new bicycle path with lights working via motion sensors next to it. The problem here was that these lights did not work correctly, but instead lighting up all day. PLOP, a local political party, demanded that these lights would be made to work correctly, as plans were made to extend these cycle paths. The local political party thus saw the solution for light pollution in having motion sensors. The city of Zutphen uses this new technology already in certain locations, indicating that they too see potential in it. Nijmegen sees potential in these developments as well (Van Koppen, 2013, p.12).

5.4 Expert Actors

5.4.1 Designing for visually impaired

De Vries suggested three aspects of public lighting during her interview:

- What are you doing there? And with how many?
- Is the space readable (i.e. for traffic)?
- What is the identity or function of the space?

With those three in mind, she argues that public space should be designed like done for the visually impaired: less light used, as that causes glare, but still fulfilling those three aspects. In that sense, it greatly reduces the amount of light needed in public space, but still allows it to function well. Both the visually impaired and those who are not being able to use public space in the way it is designed to be, without causing light pollution.

5.4.2 Updating policy

There are already laws in place regulating the amount of light allowed at night, yet these might be outdated suggests Vlasblom. The amount of light mentioned in those laws should be looked at and updated, as the values are no longer realistic or acceptable. Newer technologies have allowed for much less light to be needed, Vlasblom argues we should be much more strict with how much light should be acceptable. By having new guidelines on how to use light carefully the number of new reports on light nuisance of residents can be decreased. The lack of an update might be due to the perceived lack of importance on light, policy workers have bigger problems to solve and therefore lighting policy remains in the dark.

It is once more emphasized that the policy is due to an update by the NSVV (2020, p.73-74): the regulations in place for greenhouses have been there since the ’90s, and even the new model is based on a theory from the ’80s. It raises the question of whether these are relevant for the amount and forms of artificial light there is now.

5.4.3 Creating awareness

Schmidt suggests that perhaps the biggest barrier to addressing light-related issues the unwillingness of those in control. Most people perceive light pollution and related topics as a non-issue, and that there are many more important problems to address. In that sense, increasing awareness of the effects of light pollution seems to be a fitting solution to overcome that barrier. That lack of awareness is further reinforced by Vlasblom, who suggests that not enough people ask about light and that therefore there is little push from those with power to do something.

Awareness is useful, but leave the actual planning to the experts de Vries suggests. Many organisations and municipalities undertake action to solve light related issues which they suppose are good actions, yet it lacks an actual understanding of the problem If non-experts try and tackle light-related issues it might lead to more problems later. For example, when these plans fail because it was not carefully executed, then it might lead to a demand for more light: public space gets new lights, but it wasn’t implemented correctly leading to a perceived unsafe place, leading to a demand for more lights to solve this issue of safety. Light is much more complex than often thought, and require a designated and balanced approach.

5.4.4 LED lights

LED lights are often mentioned as being a solution to light pollution, as it is much cheaper and supposedly colder than older lighting technologies (Alter, 2021). However, it is this cheapness that Ellen de Vries suggests is the problem. By being so much cheaper than older lights it becomes hard to say no to extra lighting, as the costs aren’t that high. In that sense, LED lights have made it much easier to have more lighting, as the discussion on costs has become less relevant. De Vries suggests that with this cheaper light the general public will not say no to extra lighting. Again here, the non-

users versus user relationship becomes clear. More light is what the user seeks, yet it clashes severely with the desires of the non-users who prefer less lighting. It also poses a link to what de Vries mentioned earlier: that many believe in the malleability of the world, that humans change the planet and not the other way around. By having more light this human control is further increased, and the planet loses its natural darkness.

The costs are lower, but the temperature of the LED lights is still high according to de Vries. Greenhouses opting for these newer LED lights are, in her opinion, thus not enforcing a feasible solution. Greenhouses will still be warm as a result of the lights, and will occasionally need to open their roofs at night, causing a massive sky-glare. LED lights are therefore not an actual solution for solving the light pollution emitted by greenhouses according to de Vries.

5.4.5 Participation

Licht en Donker Advies (2020) suggest that solving light related problems should be done with the public in mind and with close collaboration. Citizen participation helps the municipality or other officials to make well-informed choices, based on the needs and desires of those living there. It also connects the residents to their areas, by giving them a voice in how it should be designed. This fits the consideration of light according to Licht en Donker Advies, as light is used by those living there and thus it makes sense that they get a say in the discussion.

For instance, the municipality of Dalfsen used this approach, allowing its residents to join the discussion (Licht en Donker Advies, 2020, p.47). Resulting in new information for the municipality on potential improvements of light in public space, and the residents were able to voice their opinion on the proposed changes. A poll indicated that most residents were happy with those changes.

Involving the general public in urban planning is not something new, but in this case with light it might help create awareness of the effects of light for the residents. Vlasblom mentioned that having those information sessions plus experimental light setups greatly helps the residents make an informed decision.

Chapter 6: Motivational Framing

6.1 Summary

In this chapter, the dimension of motivational framing will be analysed. The different motivations mentioned by the actors are illustrated in figure 7. Some of the motivations of course overlap, but the focus is not always completely the same. For instance, the effects on animals and ecosystems are mentioned by all three groups of actors, yet the focus is different. Another overarching theme are the needs of the community, resembled in the safety and public desire themes. These overarching themes are further illustrated by the green and blue dot, in figure 7.

Civil Society Actors

The link here to nature is the focus on preserving the local nesting areas in Pijnacker-Nootdorp, which are invaded by the lights of greenhouses. Secondly, sleep and the effects light has on it are mentioned as reasons to tackle light pollution. Thirdly, safety is seen as an important reason for light and in that sense deters from tackling light pollution. A different call to arms is suggested here. Finally, breaking the habit of annually extending the exemptions the greenhouses get in Pijnacker-Nootdorp is seen as a motivation to take action. If nothing is done the cycle will continue.

State Actors

Ecosystems are affected by light suggest the different state actors. To stop the local ecosystems from being damaged by excessive light action is required. Following is the process of an energy transition which is currently happening. It provides room for discussion on how we use light. Finally, public desire is a key motivator for state actors to take action. If those that they represent file complaints about light pollution then they will try and make change happen.

Expert Actors

Experts argued that the decline of insects and animals is at hand if little action is taken against light pollution. The current amount of light is not sustainable in this regard. Next, the scale of the problem might only increase, if no discussion is started. With new and cheaper forms of lighting, the problem could increase.

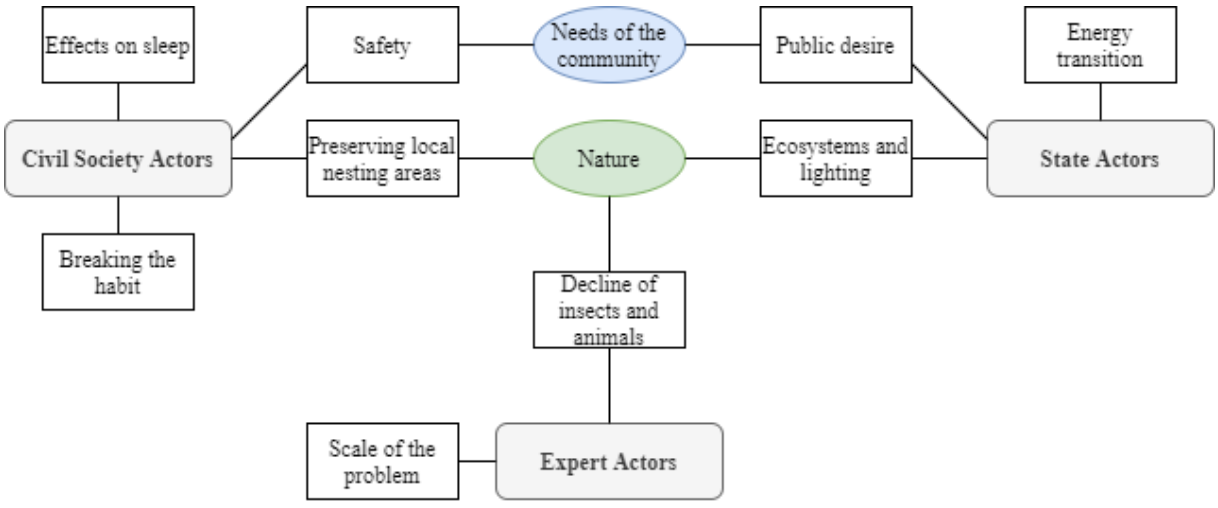

Figure 7: Different motivations to tackle light pollution

6.2 Civil Society Actors

6.2.1 Preserving local nesting areas

Close to the greenhouses in Pijnacker-Nootdorp is a local nesting area Smokers reveals. These birds are greatly influenced by the sky glare originating from the greenhouses and are the main reason Milieu en Natuurorganisatie Pijnacker and KNNV Delfland are critical of the local greenhouses. Hendriks even mentions that the greenhouses are located directly at the borders of these nesting areas, further showing that the local horticulturalists have little respect for their surroundings.

Animals and humans are affected, but the animals have little way to voice their critique van 't Hart says. Residents can file a complaint at their municipality, however, animals cannot do this. KNNV Delfland sees itself as the one representing this group. To stop the light from harming the local animals light pollution is to be tackled according to these two organisations.

6.2.2 Effects on sleep

Often brought up during the interviewees are the purchase of darker curtains: sleep is greatly affected by the sky glare emitted from the greenhouses in Pijnacker-Nootdorp, MNP and Bewonersvereniging Delfgauw suggest. To stop this unnecessary light from invading people's bedrooms change is required they claim. Residents are burdened with buying efficient curtains to sleep in the dark.

6.2.3 Safety

A poll on the current amount of lighting, done in Eindhoven's Dagblad (Broers, 2019), indicated that 79% of residents of Deurne have felt more unsafe due to the removal of several hundred streetlights. It reveals the severity of the argument of safety, many residents feel like lighting is something necessary to stay safe.

Lights are needed for traffic safety, especially for the elderly suggests Molenbroek. Elderly eyes need much more light, and currently, some roads are not illuminated to save energy costs. The lack of light could cause accidents. The social safety gained by light in public spaces is also necessary he mentions, for example, to deter less friendly persons from engaging in criminal activities. Here he mentions that light should be considered carefully and that it should be regulated in an acceptable manner. You can have too much light, but also too little.

In this sense, there is a clear motivation as to why some lights should stay on. Citizens prefer public space to be illuminated to maintain social and traffic safety. Light pollution is an issue for many civil society actors, but they perceive light to keep them safe. The call to arms here is a call to maintain. It brings up a discussion on how much light is acceptable to maintain safety.

6.2.4 Breaking the habit

In the case of Pijnacker-Nootdorp and the light pollution stemming from local rose nurseries, there is a certain unwillingness from the horticulturalists to take action according to the different interviewees. As to why action is needed, Molenbroek suggests breaking the habit. Right now, the horticulturalists already expand their greenhouses and their light emissions without even having a permit. There is a lack of resistance to this action and they know they can get away with it. Molenbroek argues this cycle should be broken. This of course is hard to achieve, as the other players in this discussion are greatly influenced by the horticulturalists, like the alderman and environmental agency.

Hendriks reveals that there is little push from both the horticulturalists and the municipality. The horticulturalists are not changing their way of producing, and the municipality is not discussing the matter with other cities as promised nor are they investigating the matter closely. If they do not take action, little will change. The greenhouses will continue to pollute the skies of Pijnacker-Nootdorp and the surrounding regions, which conflicts with the public's opinion on the matter Hendriks argues. In a recent poll in Pijnacker-Nootdorp nature was seen as much more important than the horticulture

industry. A clear clash between the public's interest and that of those in control is at hand. Hendriks continues and mentions that there is little room for discussion with the municipality.

"*We need to change things, but we are not on the same track*"

- Harry Hendriks on attempting to reduce light pollution

Municipalities have to take action the KNNV Delfland suggests, but politicians as well. A lot has been said but little has been done. They also see a bigger role for Nacht van de Nacht here, a much more active role.

6.3 State Actors

6.3.1 Ecosystems and lighting

A key reason for some actors to undertake action are the severe effects light can have on animals and ecosystems. Mees, for example, argues that there is an uneven relationship between mankind and animals, in that animals cannot escape the excessive lighting at night. For this reason, we should try to diminish the amount of lighting used at night. Animals cannot solve the issue themselves either, it is up to humans to fix it. Especially with regards to advertisements at night, it becomes a hard statement to argue for suggests Mees. There are few people outside at night who can see these bright advertisements. With a night curfew existing for several months, it becomes a very valid question why no one asked for these advertisement boards to be turned off at night.

Pelgrim supports this, with his example of the night-butterfly. This butterfly is attracted to the light and becomes prey for other species as a result. Biodiversity is at risk, as such species have a much harder time surviving in these bright nights.

The city of Veere aims to reduce lighting to preserve nearby nature, as they vision dark areas without any artificial lighting. The Hague follows this notion to a certain degree. As mentioned, before some parts of the Hague are deemed dark areas and are exempt from having artificial lights (Gemeente Den Haag, 2017, p.6-9). The Hague hopes to reduce its light output to save and protect the vulnerable urban ecology. Effects on nature and animals are once again re-emphasized by the RIVM (2010, p.21), and for that reason, it is crucial to be included in provincial environmental policy.

6.3.2 Energy transition

Many municipalities are currently undergoing a very critical process: an energy transition for a more sustainable future. Pelgrim sees for this very reason potential in reducing the amount of light. Of course, with the arrival of better and more efficient LED lights, the aspect of costs and energy loses its power, yet de Stadspartij Zutphen-Warnsveld still argues for it. Every little bit that can be reduced would benefit.

The city of Nijmegen also foresees lighting to be a part of the plan in reducing the energy needed (Van Koppen, 2013). Yet, it clashes with their perception of the use of light. Their importance on establishing the character of the city with the use of light is thus deemed more important than addressing excessive lighting and attempting to decrease the used amount of energy.

6.3.3 Public desire

Matser & Horstman argue that lighting is only a problem if residents experience problems as a result of this lighting. People can get used to less light, but at this moment if there is no report of excessive lighting little action will be done. When newer and better-optimized technologies are more affordable, like motion sensors, they will use them. PLOP, a political party in Assen, agrees. If there are no complaints about the lighting at night then they too will not pursue action. This is linked to their definition of light pollution, in that they have bigger problems to solve. If light pollution is not high on the list of things to do, then it will naturally receive less attention in the attempt to addressing it.

In a nationwide survey for residents on the importance of darkness(Provincie Drenthe, 2007, p.6). In the province of Drenthe, 65% of those who filled in the survey want the regions outside urban areas to be dark, compared to the average of 52% nationwide. Showing that the regional differences are ever-present, those areas already dark put in more effort and are more dedicated to saving their darkness at night.

It continues: 12% of those surveyed in Drenthe see the night as a romantic phenomenon (Provincie Drenthe, 2007, p.6). Nation-wide, two-third of people in the Netherlands would like that certain regions are designated as dark areas, prohibiting artificial light from these places. The number of people that experience nuisance through excessive lighting has doubled in the past 10 years (Provincie

Drenthe, 2007, p.6). Now in 2021, 14 years later the number of problems might have increased and support for policy on regulating light at night could have possibly grown. The province is thus motivated to undertake action, as a result of its residents' opinion on darkness.

6.4 Expert Actors

6.4.1 Decline of insects and animals

One of the key reasons light pollution is to be tackled according to Schmidt is that it severely harms the insect populations. For example, light attracts moths, becoming a target for other species, but it also influences the way some insects find mates. Insects are crucial to our ecosystem, and Schmidt argues that we will find out when it's too late. The effects on humans and animals are little compared to the destructive impact light has on insects. There is a great decline in insect populations already happening, with 75% of the population gone already, yet it is still unclear whether night-time insects and artificial light play a role in this (Alferdinck et al., 2020, p.87).

Not just insects are active at night, 100% of all bats are, 20% of birds and more than 90% of all reptiles. Their visual systems are much more sensitive than that of humans (Alferdinck et al., 2020, p.84). A slight increase in light is thus greatly felt by those creatures. Their habitats are at risk due to this, when more light is present they get scared away and lose their natural habitat. Especially with most people already having a hard time acknowledging light pollution as an influential form of pollution, the effects on insects are again far away. All in all, lighting is very negative for our ecosystems and animals according to the NSVV (Alferdinck et al., 2020, p.88). Positive effects of light are often only for the user.

6.4.2 Scale of the problem

With lighting becoming much cheaper with the use of new technologies like LED lights, lighting can be used much more whilst being less expensive. Artificial lighting increases the scale it operates on, and with that more problems arrive due to more lighting (Alferdinck et al., 2020). It brings questions on whether lighting is always necessary, and that to maintain safety other measures can be taken. The same was mentioned by Ellen de Vries, with the arrival of cheap LED lights, these lights will be used much more frequently without careful consideration. If there is no action undertaken, more and more artificial light will be used. In that sense, de Vries and the NSVV argue for a discussion on how we use light now, to prevent the high amounts of lighting that could come.

Chapter 7: Discussion & Conclusion

Reflecting on this study, it becomes clear that there are clear links to the existing theory. Following are some of the main themes that were identified, and how the theoretical framework applies to these findings.

7.1 Reflection on research questions

7.1.1 How do the different actors define and perceive light pollution?

The premier sub-question investigated how the different groups of actors defined and perceived the problem of light pollution. It identified several themes, with one theme overlapping between two of the groups: the political arena in which the claim-makers operated, and the local horticulturists in Pijnacker-Nootdorp using their political power to maintain their operations. The experts indicated that there is a big difference between light pollution on the one hand, and light nuisance on the other. For the other groups, this is much less nuanced. The residents interviewed often saw light pollution as a more individual thing, with its effect on them purely mentioned. The other groups, almost every interview, discussed the impacts of light on animals or ecosystems. There is no good or bad definition, as having the right definition does not imply that fitting solutions are used (Bardwell, 1991, p.606).

Many environmental claim-makers operate within a so-called political arena (Hannigan, 2006, p.74). The results reinforce this notion, with many of the civil society and state actors having to work around this arena. Take for example Pelgrim and his Stadspartij in Zutphen, trying to pass their motion on addressing light pollution. The light pollution in Medemblik and the case of Pijnacker-Nootdorp are also good examples of this arena, where local civil servants are in cahoots with the local greenhouse owners according to them. Here it is once more indicated that to have your environmental claim survive, it needs to be able to stand its ground in this arena (Hannigan, 2006). Adding to this, light is seen as a token of our human capacity (Schulte-Römer, Dannemann & Meier, 2018, p.185). We take it for granted, and as such do not act on anything with it. It relates to the notion of the malleability of the world, mentioned by de Vries. We, humans, are the ones to change the world, and the world should adapt to that, not the other way around.

These environmental claims often clash with the frames of those making policy (Snow et al., 1986: Hannigan, 2006). This was also revealed to be true in the cases of light pollution analysed. The frames of the environmental agency and the municipality clashed with those of GroenLinks in Medemblik. Little action was undertaken, and even then much pressure was required from the political party to have the environmental agency check to see if the greenhouses exceed the regulations.

An individual example of experiences with light pollution are that of the resident in Overbetuwe, who filed a complaint at Nacht van de Nacht about an industrial region have too bright lights. She saw light pollution as stopping her from seeing a starry sky, which was a normal thing to expect in her region. The shifting baselines syndrome is in that sense very present (Soga & Gaston, 2018), and very visible in a geographical way. Rural areas consider darkness as important as seen in Veere and Drenthe, whereas this is less so in urban areas, illustrated by the plans of the Hague (2017) and Nijmegen (van Koppen, 2011).

As Stone (2017) and Schulte-Römer, Dannemann & Meier (2018, p.193) suggest, a lack of awareness can make it a hard problem to solve. The lack of awareness is further translated into light-related issues being a sub-theme for many organisations or municipalities. The city of Zutphen has bigger priorities, and with already hard financial times, taking a better look at the current amount of lighting was not within their financial capacity according to Matser and Horstman. Milieu en Natuurorganisatie Pijnacker-Nootdorp also indicated that light is not high on the agenda, but still important. Many groups have bigger issues to take on, and light often comes at a second or later place. In that sense, there are certain borders to the frame of light pollution by these actors. Within these frames of

environmental problems light pollution is often 'out-of-frame' (Benford & Snow, 2000, p.615: Snow, Vliegenthart & Ketelaars, 2019, p.393).

The theme of deliberate unawareness mentioned by Lyytimäki, Tapio & Assmuth (2012, p.601) is also present in the topic of light pollution. Light pollution is not seen as a problem by the municipalities, greenhouse owners and environmental agencies in Pijnacker-Nootdorp and Medemblik. They are aware of the effects it can has on animals and humans, yet they show little motivation in attempting to mitigate it.

7.1.2 What solutions do the different actors mention to solve light pollution?

The second question focussed on the different solutions mentioned by the actors. Here, lots of shared themes seemed to appear. Whereas the actors mentioned several solutions unique to their group, like moving the greenhouses elsewhere or designing public space as if for those visually impaired, four bridging themes were reported. Starting with improving the current regulations, with civil society and state actors arguing for a more fair environmental agency and the experts suggesting that an update is due for the policy the environmental agencies enforce. Another theme of solutions is to create a better understanding of the problem, as suggested by both state and civil society actors.

Next are the LED lights, which brings up a very interesting difference in perceptions. Civil society actors and state actors saw much potential in the development of LED lights, often combined with motion sensors. These lights are supposedly cheaper and less warm. Although, one of the experts argued this could form a problem. With the economic aspect of light being less important due to the decrease in costs it could lead to an increase in lighting. Especially combined with a lack of awareness this can be very realistic. This discussion again reinforces that light needs to be carefully considered, as solutions that look like an easy fix might become problematic if not used optimally. Another theme was the use of community action, both by taking legal action or using participation when evaluating light usage.

These LED lights relate to the concept of frame elaboration (Snow, Vliegenthart & Ketelaars, 2019), where certain dimensions of the problem are highlighted more than others and thus influencing how they are interpreted resulting in different strategies. If focussed on the economic aspect of light then LED lights are a very suitable solution, as seen in the case of Zutphen. Here, financial aspects were seen as important and resulting in them seeing much potential in LED lights now and later down the line. With that perception, light pollution is very easily fixed. As Dweck & Legget (1988, p.266) suggest, if a problem seems simple in solving it then drastic measures will not be taken. Changing older lights to LED lights is a simple solution in that sense, compared to more drastic measures like turning off the lights. Furthermore, LED lights are branded as sustainable and green, yet these terms are defined by people's experiences and these are influenced by the shifting baselines syndrome (Soga & Gaston, 2018, p.4-5).

Creating awareness was seen as a solution by all actor groups, with civil society actors focussing more on improving the education of greenhouse owners. As indicated in the survey of Schulte-Römer, Dannemann & Meier (2018, p.193), unawareness is a key barrier in attempting to solve light pollution. Setting up informational campaigns on the effect of light could prove useful in increasing awareness.

Furthermore, light pollution is often seen as a sub-theme, both by civil society and state actors. The marketing model suggested by Hannigan (2006, p.76) can play a role here. With light pollution and other light-related issues not being very popular, a new way of presenting can be used to garner support and interest. Creating awareness was suggested as a potential solution as well, by both the RIVM (2010) and the Stadspartij Zutphen-Warnsveld's motion for example. The four factors of this marketing model could potentially have much use in creating awareness around the topic: uniqueness, relevance, stature and familiarity (Hannigan, 2006, p.76). By further utilising these four factors the topic of light pollution could increase its outreach, for example by campaigning.

A theme that came up are the regional differences and how that affects their perception and approach to light pollution. Often, urban regions have less consideration for light pollution than the rural regions, which are more used to the darkness. These regions know what a dark sky looks like, and actively try to maintain this. An example of this is the municipality of Veere, in Zeeland. This municipality actively creates awareness for light and considers well in advance how they use lighting in public space. The municipality is located in a rural region and is aware of what darkness is.

The shifting baseline syndrome is thus very active in light pollution (Sheppard, 1995: Soga & Gaston, 2018). For instance, in urban areas, the conditions have gradually changed and now many residents are used to the high amounts of lights used at night, whilst those in rural areas have had fewer changes in light.

It is active in all three framing tasks. Solutions and strategies are greatly impacted by one's view on the problem (Dweck & Legget, 1988, p.266). Urban regions will often leave light as it is, whilst rural regions will actively try and maintain their pristine skies. In Zutphen, for example, less emphasis was put on turning off the lights, instead focussing on changing the lights to more sustainable LED lights as the residents of the city preferred to have lights on. These urban residents differ in their perceived importance of light compared to that of more rural regions, implying the existence of different baselines (Soga & Gaston, 2018).

7.1.3 What are the motivations of the different actors to address light pollution?

With the third question, the call to arms for tackling light pollution were explored. Two overarching themes came up. First of all, the focus on the effects of light on nature is a reason to tackle light pollution. Secondly, perhaps more a call to defence: fulfilling the needs of the community. The safety argument brings a contested discussion, as many request lighting to maintain a sense of both traffic and social security.

The severity of the problem can be part of the reason why action should be undertaken (Benford & Snow, 2000, p.617: Smith, 2020, p.4: Snow, Vliegenthart & Ketelaars, 2019). However, little of this appeared in the interviews. Effects on animals and insects were mentioned, but no concrete numbers were mentioned. In that sense, the urgency and severity of light pollution is quite understated. Hannigan (2006) suggests that easy to grasp visuals and a clear relevance of the problem are key when presenting environmental claims. For example, the number of insects killed every year as a result of excessive light could perhaps be a motivator for many, yet, there is a lack of this right now. Adding to that, a lack of what it means for the ordinary citizen is missing (Hannigan, 2006, p.76) and as a result, is not very approachable as a topic.

Suggested by some of the interviewed state actors was the reason to tackle light pollution in the context of the upcoming energy transition. Rethinking about light could save energy. This claim fits the criteria of Kingdon (as cited in Hannigan, 2006, p.73) for policy proposals. It appears scientifically sound and administrable. It is likely compatible with the values of policy-makers, as they want to decrease energy consumption. And finally, the costs at hand can be calculated. Presenting new light policies in this context of an energy transition could be the right moment for it.

As mentioned, safety is often brought up as a counter-argument in discussions on attempting to tackle light pollution. However, the facts are not in line with this argument (Gelder, 2004, p.3: Schulte-Römer, Dannemann & Meier, 2018, p.188). Traffic and social safety are the reasons why lights are supposed to be on at night, however, little evidence that this is true. It could potentially be the other way around, with more lights causing more incidents. As figured, this argument is remarkably hard to go up against, many state actors suggest. Light is perceived as necessary, and trying to counter that is hard. It becomes a subjective discussion on how much light is necessary for society. This amount of light needed is once again different for each region, as the shifting baseline syndrome (Soga & Gaston, 2018) comes into play here. It can possibly be argued that the demand for light at night due to safety is

greatly impacted by the shifting baselines syndrome. People have become used to a certain amount of light at night, and perceive that to be creating safety. If less light is used, then they might find it odd and intimidating due to their baseline having much more light.

7.1.4 How is light pollution framed by different actors in the Netherlands?

As expected, the three framing tasks that are central in this thesis are all related to each other. The way one sees a problem directly impacts how one would tackle it (Benford & Snow, 2000: Dweck & Legget, 1988). The definitions of the problem of light pollution were mostly similar for the groups, with one group, the experts, indicating a clear difference between light pollution and light nuisance. It might have been expected that through this differentiation different solutions would have appeared, but they did not appear. This since light pollution and light nuisance are very related, in the way that one cannot be without the other, leading to solutions being fit for solving both.

Civil society actors had perhaps a more individual take on the definition, which influenced their solutions. For example, the idea of moving greenhouses elsewhere as suggested by KNNV can be seen as selfish, which they acknowledged as well. Moving the problem is not a solution for everyone, since someone else will instead have to face the problems now. This individual take on light pollution is once again reinforced by the mention of the effects on humans as a reason to tackle light pollution.

State actors faced bureaucratic barriers in their work similarly to some of the civil society actors, and as a result had trouble achieving results. Regional differences were present in the way they approach light-related issues. The solutions mentioned fit into their frames, many state and also civil society actors still see light as a sub-theme, especially compared to other more pressing matters. As a result, many drastic measures are not taken. This confirms what the theory (Benford & Snow, 2000: Dweck & Legget, 1988) suggested. Drastic measures like turning the lights off are rare since the light is required to maintain traffic and social safety. Were it not for this argument, then simply turning off the lights would likely have more support. LED lights are instead seen as a solution, which could be very simple. Instead, it showcases the decreased importance of light for the state actors, as simply changing the source of light does not directly influence the number of lights at night. More direct changes are needed to decrease the amount of light at night.

Furthermore, framing it as something which is linked to the public desire can be seen as dodging their responsibility. As long as the public does not want it, they do not have to act. Again, this public desire is driven by the shifting baselines syndrome and a general lack of awareness of light pollution, as the public is mostly unaware of light and its effect or has gotten used to it. It can be seen as strange, that some of the state actors see creating awareness as needed whilst some of the others are using this unawareness to maintain the current amount of light. Even within this one actor group, a sort of clash is occurring.

Continuing, the frame of the experts on light pollution was often far from that of the other groups. With most of their focus being on that there is a lack of awareness on the topic, and similarly a mismatch of people in charge concerning light. Their solutions very much fit these frames, with the focus being on creating awareness about light pollution in general, but also about LED lights. That even those most obvious solutions could instead be problematic. The need for an update of policy furthermore fits this focus on the lack of awareness, as those making the policy are thus not aware that there is a need for an update. The policy is based on data from the 80s and 90s and has had time to update its contents. Their motivations to address light pollution were similar to the others, to protect animals and insects.

Finally, there are thus differences in the frames of actors. Yet, these do not clash with each other. Except for the usage of LED lights, which isn't completely a problem according to the experts as careful usage could be effective, but more consideration about the usage of these new lights is needed. Safety is another small dispute, with state actors arguing that light does not make an area safe as many

other factors are doing so. Some civil society actors see it as needed but acknowledge that careful consideration of how the lights are used is needed. The actors are generally aware of the effects on humans and animals. Adding to this, all actors suggest that there is an uneven relationship between those using light, humans, and those not, animals and insects mostly. This last group cannot voice its critique on the current usage of light, and therefore organisations such as KNNV and local political parties have to represent them.

7.2 Reflection on research approach

Looking back on this research, the amount of interviews done is sufficient. Although, it was hard to find certain actors. The state actors were often easily contacted, by searching in newspapers municipal cases quickly came up. Civil society actors were difficult to arrange interviews with, as many emails went unanswered.

Instead, I sought resident organisations and other active citizens on light pollution. Finding civil society organisations was a fitting solution to the problem. A different approach to arranging data from this group would have been to use a survey for those who filed a complaint at Nacht van de Nacht, as this would have been much more accessible than making time for an interview. It would lack depth, which is the main plus of doing these interviews, but more respondents could be reached.

At first, the idea was to include the commercial sector in this study. However, it seemed that this group was different compared to the other groups. Many interviewees perceived the commercial sector as those who had to take responsibility for the excessive lighting. It was also indicated that this group was not very likely to cooperate, as suggested by other interviewees. For example, Nacht van de Nacht contacts the parties involved in the reports of light pollution they receive, yet few companies responded when involved in such reports. The thesis could have been stronger if this sector was taken into account, but with time constraints this was not feasible. It would, for instance, have required a different theoretical framework that pays attention to how polluters, such as the commercial sector, frame their actions and the problem.

For this thesis, there were no differences in how the different sources of light pollution were analyzed. For example, whilst one interviewee faced light pollution originating from greenhouses, another experienced light pollution due to offices being illuminated at night, yet both were handled similarly. A more diverse approach, where every source is approached differently since the sources of light differ in how they are experienced, could have been used to better show the differences in light.

If more people were to be interviewed, more themes logically could have appeared. More data from more urban residents could have been used, but little was found for this group. In that sense, it possibly indicates that there is little awareness among these urban dwellers on light pollution.

Triangulating these interviews with other sources, such as municipal plans or news articles, proved to be a challenge as these were quite scarce. In the end, I managed to find multiple policy plans that could be used. These sources helped strengthen the already existing claims which originated from the interviews.

Finally, the COVID pandemic has fortunately not impacted this study. All of the data collection was done online and was therefore not influenced by the virus. On the one hand, being able to do the interviews online was very time-efficient, as I did not have to travel to the interviewees. On the other hand, being confined to video-calling limited the depth in emotions visible during the interviews. It was not possible to see how interviewees responded in body language to certain questions, which could have been taken into account. This especially with the focus on framing, as even small forms of body language could have emphasized certain answers to questions. Furthermore, interviewing in person can be seen as more personal, and could have led to more private information being given.

7.3 Recommendations for science

This research was mostly reliant on interviews for its data, but other studies could take this further by using surveys as well, similarly to that of Langers, de Boer and Buijs (2005). Their research could be due for an update, as almost 16 years has passed and the general public might have shifted in their perception of lighting.

Furthermore, this study focused solely on the Netherlands. The Netherlands poses a unique case, as it is one of the most light-polluted countries in Europe (Falchi et al., 2016). Adding to this is the highly specialized greenhouse industry in the country. Other countries with fewer greenhouses might experience different frames if this study were to be replicated, but many of the other more general themes will probably appear as well. This study could be replicated elsewhere in a country with different circumstances.

Perhaps interesting to study is how the health of residents of certain regions are affected by light pollution. Breast and prostate cancer are possible effects of excessive lighting at night (Davis, Mirick & Stevens, 2001: Haim & Portnov, 2013:Chepesiuk, 2009:Walker et al., 2020), yet smaller effects like sleep depravedness (Falchi et al., 2011, p.2715: Van Poll & Kantermann, 2013:Walker et al., 2020) could be interesting to study. For example, a cross-case analysis where the sleeping patterns of residents of multiple similar cities are analysed. It could establish which sources of lighting are more problematic for sleep.

A key actor group missing in this thesis is that of the commercial sector. It was a conscious choice to leave this group out of the study, but other studies could solely focus on this group and how they perceive and frame light pollution. Often seen as the perpetrator in the stories of the interviewees, this group could leverage interesting viewpoints. A problem here is that this sector is not always willing to cooperate about these topics, as suggested by some of the interviewees and Nacht van de Nacht. Yet, knowing how they frame light pollution could help implement strategies to address excessive lighting. Currently, the commercial sector's unnecessary lighting at night accounts for around 536 million kWh, which is similar to the energy usage of 150.000 households (Nacht van de Nacht, n.d.).

Another study could be on the shifting baselines syndrome and how it affects the perception of light pollution, especially comparing rural and urban regions to prove the claims that came forward in this thesis about it. As suggested in this study, there are quite some differences in the perceived importance of darkness between rural and urban regions in the Netherlands, those in rural regions appreciate darkness more and will take more drastic steps to preserve it. Not just urban and rural could be compared, population factors like age could also be an interesting discussion point here.

Safety is often seen as a crucial reason to keep lights on, as mentioned in the many interviews. Other literature points to the same question, as seen in Chepesiuk (2009) and Schulte-Römer, Dannemann & Meier (2018). New studies could be done to find out how much light is acceptable in public space so that unnecessary lighting there can be prevented. Experimental light setups could be used to research what the general public deems as sufficient.

With new developments of LED lights and motion sensors, these too could be used to analyse how people perceive them and interact with them so that unnecessary lighting can be prevented. Especially combining that with the notion of designing for visually impaired eyes, like de Vries suggested, to see what the potential of this design could be.

7.4 Recommendations for practice

Light pollution is easy to fix, yet hard to achieve (Gelder, 2004). Simply turning off the lights is often the best solution, even though it clashes with local opinions. A potential recommendation for organisations involved in the topic of light pollution is to create much more awareness on the effects of light: make people experience darkness. Nacht van de Nacht already does so, but the potential in upscaling these events is there. Their plans on getting a citizens initiative to the Dutch national politics could be the event that would garner awareness, but even then bigger campaigns could do much. If residents are to be more aware of the effects of light they too would accept less lighting at night, but it could also highlight some of the existing light-related problems in the Netherlands.

Again, the topic of light pollution is not very tangible for most. Social movements, like Nacht van de Nacht, should aim to frame their claims more within the ordinary citizen's interpretation (Hannigan, 2006). As many are unaware of light pollution, making it more palpable could be useful in garnering support. This, for example, could be done by showing the general public how different light setups work, and what the effects are of wrongly installed lights. Creating awareness is crucial, which was suggested by all three actor groups as a solution. Another idea for Nacht van de Nacht could be to give labels to companies similar to energy labels, indicating whether they carefully consider their offices' light. The general public could then easily see which businesses are doing their best to address light pollution.

A critical look at the current regulations in place concerning light might be necessary. But, the important part is to not emphasise the differences in frames at this point, instead, focussing on the overlapping topics could be useful. If we were to only concentrate on the differences in frames, then discussions could be long and tiresome. More potential lies in the similarities. By focussing on these themes, like increasing awareness and improving regulations that already are supported by multiple groups of actors, the policy could probably be implemented more successfully. It is up to the government to take action and to take steps in addressing this problem of light.

7.5 Conclusion

Looking back on the research question of this thesis: *"How is light pollution framed by different actors in the Netherlands?",* it can be said that several themes are overlapping regarding the frames of different actors on light pollution.

Starting with the first sub-question: "*How do the different actors define and perceive light pollution?".* Here it became clear that there is a clear difference between light pollution and light nuisance, highlighted by the interviews with experts. Whereas one is unnecessary and excessive lighting, the other focuses on the actual nuisance people experience due to this excessive lighting. A key theme that came forward here is the political arena in which many of the actors operate. This so-called arena makes it hard for many civil society and state actors to effectively tackle light pollution in their regions.

Next, the second sub-question: *"What solutions do the different actors mention to solve light pollution?".* A key discussion that appeared here is that regarding the use of LED lights. These new development are to be a solution according to both civil society and state actors, as these are much cheaper and less energy-intensive. In contrast, an expert notices a problem here. Due to the fact it's much more affordable, the possibility arises that light will be used even more extensively as the importance of the costs are decreased. Another overlapping theme is that of updating existing regulations and the way they are enforced, as all three actors are convinced that it is currently lacking.

Thirdly, the last sub-question: *"What are the motivations of the different actors to address light pollution?".* For as to why these actors saw light pollution as a problem to be tackled, nature was often mentioned. Whereas some of the actors focussed more on the effects on humans, like the civil society actors, the other groups reported the many effects light has on animals, insects and ecosystems. Next, the argument of safety and why light is needed was also brought up for a different call to arms by the civil society actors. This argument was prevalent in other discussions as well, but many have the desire of lighting in public spaces to maintain safety, both social and traffic.

In general, civil society actors frame it more as an individual problem, and in that sense suggest more individual solutions, such as moving the problem elsewhere. State actors see it mostly as a sub-theme, with other important matters being given more attention. By seeing it as a sub-theme little action is taken, or only simple solutions like LED lights. It does not solve the issue directly, as more careful consideration of the usage of light is needed. Furthermore, by seeing it as a sub-theme and acting accordingly, it is surprising to see that state actors mention the public desire as a reason to address light pollution. If little consideration is given to light, then there will be likely little awareness under the general public as they get, or are, used to the number of lights. In that sense, not all state actors take responsibility for the issue of light pollution.

Experts focussed mostly on this lack of awareness and the lack of experts at the right places. Instead, often those unaware of how to address light enact policy plans for it. The expert actors suggested more awareness be created, as well as a lack of policy which also could be linked to the lack of awareness. The policy stems from around 1980, and therefore has had ample time to be updated, yet it did not occur.

All in all, there are some differences in the way the different groups frame and perceive light pollution, yet, there are many themes mentioned that are similar. Little conflicts were present in the way light is framed, except for the solution LED lights, which even then are not directly in dispute. In that sense, light pollution is seen as a problem by most, if not all, actor groups which can be solved and is to be addressed. Solutions to this problem are often similar, like updating existing regulations or making these more strict. Recommended is to focus on these overlapping themes, as these exist for every framing task.

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