8 Conclusions

§ 8.1 Answering the research questions

This thesis answers the overall question if the use of satellite imagery could help analysing the UHI in the Netherlands and suggests mitigation actions that can be implemented in the existing urban contexts of the cities, regions and provinces assessed. In order to answer this main research question a number of sub questions were formulated and studied from a theoretical perspective in part A: method. The investigation carried out in part A was used as a basis for the assessment of the urban heat in three specific case studies in the Netherlands in part B: results (Figure 8.1).

Subquestion 1: SCALE

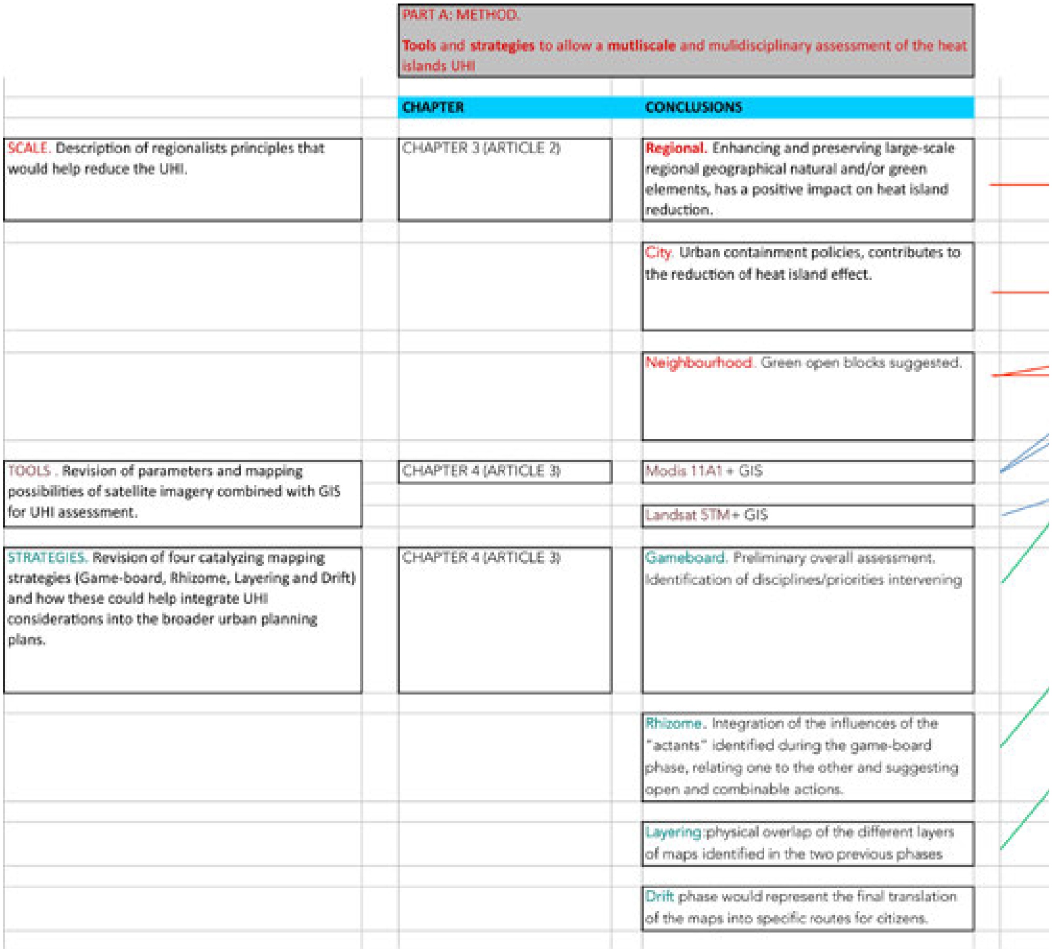
How would the implementation of the 1920´s regionalist premises of Geddes and Mumford affect the UHI phenomenom?

Subquestions 2: TOOLS

What satellite imagery and remote sensing processing techniques could be used for the heat island assessment at supra-urban scale?

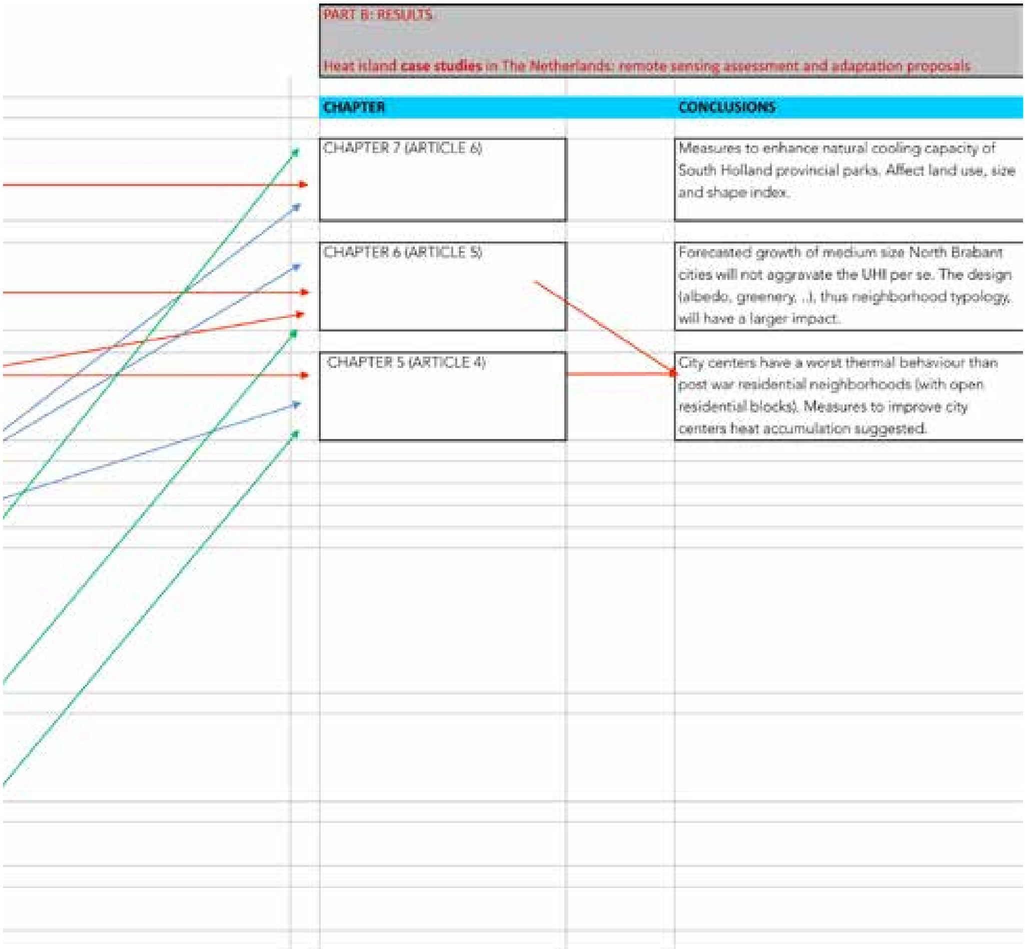
Subquestion 3: STRATEGIES

What representation and mapping strategies could we use to ensure the proposed measures are accurate enough to actually make a difference and open enough to be compatible with the rest of elements?



	PART A: METHOD. Tools and strategies to allow a mutliscale and mulidisciplinary assessment of the heat islands UHI	
	CHAPTER	CONCLUSIONS
SCALE. Description of regionalists principles that would help reduce the UHI.	CHAPTER 3 (ARTICLE 2)	Regional. Enhancing and preserving large-scale regional geographical natural and/or green elements, has a positive impact on heat island reduction.
		City. Urban containment policies, contributes to the reduction of heat island effect.
		Neighbourhood. Green open blocks suggested.
TOOLS . Revision of parameters and mapping possibilities of satellite imagery combined with GIS for UHI assessment.	CHAPTER 4 (ARTICLE 3)	Modis 11A1 + GIS
		Landsat STM+ GIS
STRATEGIES. Revision of four catalyzing mapping strategies (Game-board, Rhizome, Layering and Drift) and how these could help integrate UHI considerations into the broader urban planning plans.	CHAPTER 4 (ARTICLE 3)	Gameboard. Preliminary overall assessment. Identification of disciplines/priorities intervening
		Rhizome. Integration of the influences of the "actants" identified during the game-board phase, relating one to the other and suggesting open and combinable actions.
		Layering:physical overlap of the different layers of maps identified in the two previous phases
		Drift phase would represent the final translation of the maps into specific routes for citizens.

FIGURE 8.1 Overall thesis structure


PART B: RESULTS
Heat island case studies in The Netherlands: remote sensing assessment and adaptation proposals
CHAPTER
CONCLUSIONS
CHAPTER 7 (ARTICLE 6)
Measures to enhance natural cooling capacity of South Holland provincial parks. Affect land use, size and shape index.
CHAPTER 6 (ARTICLE 5)
Forecasted growth of medium size North Brabant cities will not aggravate the UHI per se. The design (albedo, greenery, ...), thus neighborhood typology, will have a larger impact.
CHAPTER 5 (ARTICLE 4)
City centers have a worst thermal behaviour than post war residential neighborhoods (with open residential blocks). Measures to improve city centers heat accumulation suggested.

§ 8.1.1 SCALE. How would the implementation of the 1920´s regionalist premises of Geddes and Mumford affect the UHI phenomenom?

Contemporary urban planners are generally not empowered to act at a regional scale, and thus are often not concerned by that larger supra-metropolitan scale, which seems critical to address the global challenges faced by existing urbanisation patterns, and for which remote sensing is best suited. Geddes and Mumford 1920´s regionalist principles can be divided in two main categories: territorial design principles and urban containment principles.

At the territorial scale, enhancing and preserving large-scale regional geographical natural and/or green elements (thus reinforcing the "sense of place and concept of nature" suggested by the 1920's´ regionalists) is still a very appropriate and much used approach to maintain quality of life at a regional scale. Reaching a regional balance between population, resources, vegetation, and animal life represents the greatest challenge. From an UHI perspective, the measures that are part of "sense of place and the concept of nature" are often prescribed to mitigate the UHI effect. In chapter 7, the cooling capacity of the different land uses found in South Holland provincial parks was studied, in order to promote enhancement measures that would increase the natural cooling capacity of the areas of the park adjacent to hotspots.

The urban containment concept set forward by the regionalists includes elements such as garden cities, limiting the size of the cities, implementing density thresholds and greenery standards, and suggesting interventions at neighbourhood scale. Attempts to limit the growth of the cities' actual footprint are still relevant in present times. In chapter 6, the relationship between the surface temperature and the size of the cities was analysed for several medium-size cities in North Brabant. For the analysed cities, the size was not a determining factor, instead, high albedo did contribute to the reduction of the surface temperature.

The greenery standards applied in garden cities are far from what is realistic in current cities. However, the materialisation of residential blocks interspersed with greenery did find a broad acceptance. From a UHI perspective, in The Netherlands postwar neighbourhoods with green open residential blocks present lower surface temperatures than city centers, as highlighted in chapters 5 and 6.

Overall most key elements of the regionalist concept are still very much relevant today and would indeed help to reduce the impact of the Urban Heat Island. The garden city idea requires a revision.

§ 8.1.2 TOOLS. What satellite imagery and remote sensing processing techniques could be used for the heat island assessment at supra-urban scale?

Remote sensing retrieves mainly land surface information and thus allows mapping surface urban heat islands (SUHI). There are two main categories of urban heat islands: the air temperature urban heat island (UHI) which concentrates in the air temperature difference and the surface urban heat islands (SUHI) which measures the surface temperature difference. They have different behaviours and patterns. The SUHI hits its peak during daytime, when the sun is still shining, reaches up to 15°C difference (EPA, 2015), whereas UHI reaches its peak after sunset, when warm urban surfaces start radiating the heat absorbed during the day towards the atmosphere, registering air temperature differences of up to 12°C.

Air temperature seems a more relevant indicator of human comfort than surface urban heat island. However, retrieving consistent air temperature data in the urban environment is a challenge. In the particular case of the Netherlands, the KNMI meteorological stations are all located in the rural environment, precisely to erase the influence of urban heat in the temperature retrieval. Consistent surface temperature data can be mapped using satellite imagery. Even though the spatial pattern of UHI and SUHI differs (Dousset and Gourmelon, 2003), many climatologists use land surface temperature to assess the urban heat accumulation behaviour (Price, 1979; Roth et al., 1989; Parlow, 2003; Van Hove et al., 2011; Yuan and Bauer, 2007; Cao et al., 2010; Li et al., 2011; Zhou et al., 2011; Choi et al., 2012). Moreover, remote sensing also allows mapping parameters that influence the urban thermal behaviour, such as albedo, vegetation index, imperviousness, storage heat flux, latent heat flux and sensible heat flux.

For urban planners the principal limitation of remote sensing lies in the fact that even though aerial view provides a very comprehensive overview of cityscapes and landscapes, these must be complemented by the analysis of other tangible (street level views, pedestrian flows...) and intangible parameters (economic activity, social cohesion...). However, the most important challenge for urban planners is to be able to turn these accurate and precise images into maps. Satellite imagery per se cannot be taken as true record of reality. First, the selection of scale and frame are critical and then the way in which the information is filtered and represented also plays an important role. Mastering the use of software to treat satellite imagery becomes critical for urban planners to be able to integrate these into design.

ENVI is a geospatial software designed by Exelisvis (Exelis Visual Information Solutions, 2016) to process and analyse any kind of satellite imagery. The combination of ENVI and GIS allows for the greatest integration between the available raster and vector

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information. There is a third type of software consistently needed to work with satellite information. These are the programs that atmospherically and geometrically correct the raw satellite imagery. The geometrical correction is needed in order to be able to transpose the information retrieved from the curved surface of the earth into a two-dimensional image. The atmospheric correction is needed because the satellites retrieve the radiation emitted by the surface of the earth through the atmosphere. The radiance retrieved is somehow distorted due to the composition of the atmosphere (humidity, chemical content). Atmospheric correction software "erase" the effect of the atmosphere from the retrieved radiance through the use of certain atmosphere composition models which vary, depending on the latitude and longitude, on the season and on whether the image captures a rural or an urban environment.

The satellite images themselves, can be downloaded through the US Geological Survey Global EarthExplorer (USGS EarthExplorer, 2016), such as Landsat or Modis. Landsat 5TM and Modis 11A1 satellite imagery were used for the case studies developed in chapter 5, 6 and 7. Landsat has a resolution of 100 m and Modis of 1 km. Land surface temperature, heat fluxes and albedo can be mapped using Landsat imagery (100 m resolution) and processing it in ATCOR (Atmospheric & Topographic Correction, 2016), which allows not only completing the geometric and atmospheric correction of the images but also calculates the before mentioned parameters. Albedo, NDVI and imperviousness are physical characteristics of the built environment which can be addressed and improved. Measures to improve albedo, NDVI and imperviousness can be simulated and quantified. Satellite imagery product Modis 11A1 (1 km resolution) contains a layer where land surface temperature (day and night averages) and albedo are already processed and calculated. In this study the authors have only focused in the use of open source satellite imagery which have enough resolution to assess the SUHI at a city and regional scale. There are high-resolution satellite imagery which provide a more accurate analysis, however these are not open-source.

Studies carried out in Basel by Parlow reveal that heat fluxes might be more relevant indicators of the UHI phenomenon than day-time surface temperature patterns (Parlow, 2003). Remote sensing imagery can be used as a basis for mapping heat fluxes. The energy balance equation for radiant energy absorbed by heat fluxes can be written as (Asrar, 1989): $Rn = G + H + LE$, where Rn is the net radiant energy absorbed by the surface; G is the storage heat flux, i.e. the energy dissipated by conduction into the ground or into the building materials; H is the sensible heat flux, that is the energy dissipated by convection into the atmosphere (its behaviour varies depending on whether the surface is warmer or colder than the surrounding air); and LE is the latent heat flux, that is the energy available of evapotranspiration.

Albedo is an index that represents surface reflectance. It is strongly related to urban heat. Increasing the albedo of roofs and pavement reduces their surface temperatures. When a surface has an albedo of 0, it means that it does not reflect any radiation whereas an albedo of 1 means that all the incoming radiation is reflected by the surface to the atmosphere. In European cities the average albedo is around 0.20 (Taha, 1997). Increasing the surface albedo from 0.25 to 0.40 could lower the air temperature as much as 4°C (Taha et al. 1988).

Normalised difference vegetation index is typically used to calculate vegetation index. It can be mapped after calculating NDVI. If Landsat is used, both NIR and VIS are bands of the satellite imagery. If Modis is used, NDVI is included as one of the satellite products.

The vegetation index can be considered as a relevant indicator for urban heat studies. Several studies show that minimum air temperatures and vegetation indexes (more specifically the Normalised Difference Vegetation Index – NDVI) are correlated: there is a linear relationship between the difference of urban and rural NDVI and the difference of the urban and rural minimum air temperatures (Gallo et al. 1993). In rural environments, heat fluxes can be expressed as a function of the vegetation index (Choudhury et al., 1994; Carlson et al., 1995).

Imperviousness makes a strong contribution to urban heat. Imperviousness seals the surface, it prevents water from evaporating, and hinders the growth of vegetation, in this way it prevents solar radiation from being converted into latent energy. Impervious surfaces have in addition, the capacity to store heat during the daytime. The heat that is stored in this process is then released at night.

The influence of other factors such as sky view factor (SVF) does not seem to be clear. Some studies find a clear correlation between SVF and nocturnal UHI (Svensson, 2004; Unger, 2004), while in other cases the correlation is not so clear (Blankenstein and Kuttler, 2004). In any case the 3-dimensional analysis of the areas is often critical to ensure that the effect of the building radiation is also taken into consideration.

§ 8.1.3 STRATEGY. What representation and mapping strategies could we use to ensure the proposed measures are accurate enough to actually make a difference and open enough to be compatible with the rest of urban planning priorities?

Since urban heat is often not the only priority to be addressed during the planning process, the need to find integrative and catalysing mapping strategies becomes even more crucial. The incorporation of these parameters and tools into open and integrative large scale urban plans can be done through the use of game-board, rhizome, layering and drift. Game-board is the strategical analysis to be carried out in order to understand which are the "driving forces" affecting the process – game-board mapping strategy has been used to set forward the driving forces influencing the design of South Holland provincial parks in chapter 7 – rhizome is used to define the representation of all aspects (including abstract considerations) that condition the process -this mapping strategy was used to connect the existing neighbourhood categories and the surface thermal clusters in chapter 6-, layering describes the mapping phase which displays the overlap of the different strategies that could be used to reduce urban heat – it was applied in chapter 5 to provide an overview of the parameters influencing urban heat in the six Dutch cities analysed – and finally drift is used as a tool to guide citizens to fresher areas during heat waves. These catalysing mapping categories would allow integrating among others critical climatologic parameters such as urban heat. Heat related parameters (such as heat fluxes, land surface temperature, albedo, NDVI and imperviousness) are mapped at supra-regional scale through the use of satellite imagery.

The catalysing mapping strategies allow reinterpreting the information unfolded by these powerful tools ensuring they to not lead to static prescriptions, but instead they reveal inspiring connections and information, which triggers interactions between actants, parameters and systems.

§ 8.1.4 Could the use of satellite imagery help analyse specifically the urban heat in the Netherlands and suggest mitigation actions implementable in the existing urban contexts of the cities, regions and provinces assessed?

In this PhD thesis remote sensing has been used in three different studies: firstly for the UHI assessment in the city centers of The Hague, Delft, Leiden, Gouda, Utrecht and Den Bosch, secondly for the analysis of factors influencing the formation of UHI at neighbourhood and city scale in medium-size cities in North Brabant and third to study how to increase the cooling capacity of Midden-Delfland South Holland provincial park.

UHI assessment in the cities of The Hague, Delft, Leiden, Gouda, Utrecht and Den Bosch

- Remote sensing was effectively used to identify urban heat hotspots in areas where there is a lack of micro-measurements. Storage heat flux was used as an indicator for the identification of urban areas with a high tendency to accumulate heat. Storage heat flux can be mapped using Landsat 5 TM imagery and processing it in ATCOR 2/3 and ENVI 4.7.
- Landsat 5TM processed in ATCOR 2/3 and ENVI 4.7 allowed defining mitigation strategies to reduce urban heat in the identified hotspots. The mapping of vegetation indexes, land surface temperature, coolspots and albedo, allowed identifying areas where to implement more vegetation, areas where wind corridors (connecting hotspots to coolspots) could be created and areas where to increase the reflectance of the materials (to improve the albedo) in the six analysed city centers.
- The layering mapping strategy was used to display the analysis of the different parameters and strategies in the 6 case studies.
- The same satellite imagery was used to estimate the surface of bituminous flat roofs and of clay sloped roofs within the hotspots, in order to calculate a high level estimation of the mitigation effect of the increase of albedo of those surfaces.
- Ultimately remote sensing was used to provide a customised UHI assessment for the cities of The Hague, Delft, Leiden, Gouda, Utrecht and Den Bosch:

UHI assessment of North Brabant medium-size cities

- Remote sensing and GIS were used to map and calculate average night LST, albedo, NDVI, imperviousness and surface of 21 medium-size cities in the region of North Brabant. Further a regression analysis was carried out to understand how these parameters affect the night-time LST. The purpose was to incorporate UHI-related aspects into the design guidelines for the identified future growth areas of medium-sized cities in North Brabant, as these aim to contribute to sustainable development, but do not incorporate yet any urban heat considerations.
- GIS was also used to carry out an “unsupervised cluster classification” of the three most relevant parameters affecting UHI (albedo, NDVI and imperviousness) in order to map and identify the main 6 thermal clusters in the cities of the region. The combined classification of the surface thermal clusters with the existing “urban living environment” categories, has allowed us to come up with a new classification for the development of design guidelines for existing and growth areas which take into consideration the UHI phenomenom.

UHI assessment for South Holland Provincial parks

- First remote sensing and GIS was used to map and calculate the average night LST, day LST, NDVI, imperviousness, size of the patch and shape index for the six most relevant land use categories present in South Holland provincial parks. Then a regression analysis was carried out to understand which factors had a greater influence on day LST.
- GIS was used to carry out an unsupervised classification of day LST, NDVI and imperviousness and obtained 5 surface thermal clusters in South Holland provincial parks (that can be assimilated to water surfaces, trees & bush areas, green grassland patches, warm grassland patches and finally urban and bare soil zones).
- In the second part of the study the authors identified the urban hotspots surrounding the Midden-Delfland park (areas with surfaces larger than 10 ha and average LST above 42°C, and areas with average LST above 36°C with connecting lengths above 1,500 m) and they identified Park Adaptation Areas (PAA) within the park (areas with less than 10°C difference with the hotspots) in order to suggest measures to improve the cooling capacity of those PAAs, based on the conclusions of the first part of the study (measures consisting mainly in a change of land use within the park, or in the increase of NDVI, reduction of imperviousness).

§ 8.2 Interpretation of the results and conclusions in a wider context

The three main characteristics of this research are the scale, the tool, and the mapping strategy.

The scale is the regional one which is key for the urban/rural balance, so critical to ensure sustainable urbanisation patterns at all levels (thus not only to prevent the formation of the UHI effect).

The tool is remote sensing combined with GIS which is key not only for the UHI assessment, but which provides real time accurate information on existing urban environments, unfolding information of any part of the globe and capturing “invisible” wavelengths, allowing also to look back in time (and thus to trace and map) changes since the 1980s (when consistent satellite imagery became available), and finally enabling the treatment of these images (to allow calculation of indexes, surface cluster classifications, completion of regression analysis…). Remote sensing combined with GIS is a very powerful tool not only for the UHI assessment, but also for the overall urban planning purposes. Aerial imagery can be obtained through satellite imagery or through images retrieved on board of airplanes, or drones. The use of drones for many different disciplines is proliferating, and even though its operation is not yet legally regulated in any country, they can potentially revolve the urban data collection mechanism, offering infinite possibilities. In such context, the present research gains particular relevance.

The mapping strategies suggested (game board, rhizome, layering or drift) are also key for integrative urban plans, as the risk of overspecialisation is precisely to forget the integration, the priorisation, the cross connections.

§ 8.3 Discussion

§ 8.3.1 Climatologist tools for the urban planning practice

Even though urban planners should aim for producing integrating plans, the urban planner cannot be an expert in all disciplines of mobility, sociology, economy, climatology… The urban planner needs to be able to retrieve input from different experts, and build up integrating proposals from there. In principle, the urban planner should not necessarily have a specific command of the tools used by climatologists, sociologists, transportation engineers… However, some of the instruments used for the assessment of those specific disciplines, have proven to have wider applications, which can be used for a more general assessment by urban planners. This is the case of remote sensing, which is often used by climatologists, to study (for example) in depth the Urban Heat Island phenomenon, but which can also be used by urban planners for a more superficial assessment of the phenomenon, more oriented towards the development of design adaptation guidelines, rather than focusing on the accuracy of the retrieved measurements. The depth and accuracy of the climatological assessment produced by urban planners is inevitably not comparable to the ones issued by climatological experts. In that sense it is important to remind the different purposes of these two disciplines. Climatologists aim at having the most accurate insight of the phenomena themselves, while the focus of urban planners is on developing spatial planning guidelines to reduce the effect of the phenomena and which are flexible and compatible with other urban planning priorities. The use that those two disciplines make of certain tools is therefore not the same.

§ 8.3.2 Resolution limitations

Landsat 5TM is an appropriate tool to assess urban heat accumulation at city scale due to the resolution of its spectral bands: 30 m for bands 1 to 7, and 120 m for band 6 which is resampled to 30 m. However, in this study Landsat 5 TM was also used to quantify and assess on the phenomenom at neighbourhood scale. The resolution of Landsat 5TM for material discrimination is a little rough. Nonetheless, the purpose of the surface estimations is to provide a high-level quantification of the mitigation effect of the proposed measures, therefore a certain degree of inaccuracy in the surface quantification and qualifications should be acceptable. Furthermore, the objective of these studies is not only to quantify the mitigation effect of the measures, but also to suggest a methodology that could also be replicated with finer resolution satellite imagery, allowing more accurate surface classification results.

MOD11A1is the other satellite imagery used in the studies included in this research is a satellite imagery product issued by MODIS and has a resolution of 1,000 m, which is considerably coarser than Landsat 5TM, and thus only used for large surface assessments (whole city assessments).

§ 8.3.3 Remote sensing limitations for UHI assessment

In principle, satellite imagery provides surface temperature assessment only (even though there are some algorithms that allow the calculation of air temperature based on LST, and some software that calculate the sky view factor based on Landsat satellite imagery), which can be considered as a limitation. Overall parameters related to the neighbourhood structure (sky view factor, wind, shadow…) as well as factors such as anthropogenic heat emissions should be the object of another study to determine to what extent they influence the formation of the UHI. The present research focuses on suggesting measures to improve the surface cover behaviour. The same urban structures can considerably improve their thermal behaviour only modifying their surface covers.

§ 8.3.4 Replicability of the study

The studies presented in this PhD research can be replicated with a basic remote sensing and climatological knowledge and only require a certain command of the two main software utilised (ENVI 4.7 and ATCOR 2.3). One critical item is the selection of the satellite imagery, which should preferably be retrieved during a heat wave, and on a cloudless and windless day.

The satellite imageries used for this research are Landsat 5 TM and Modis 11A1 (open source), however the same exercise can be performed with finer resolution satellite imagery, thus obtaining more accurate results.

§ 8.3.5 The challenge of redefining the regional scale balance nowadays

Even though revisiting the regionalist principles is inspiring for the creation of spatial planning guidelines for reducing the heat island in new urban developments, it is important to highlight that these are precisely only applicable in certain contemporary scenarios. Thus Mumford's concept of "reversal" is often no longer valid in the current context, since in the last 100 years automobile technology has in most cases only accentuated the ravages caused by the 19th century city that Mumford described in the 1920's, and thus in that sense the recovery of the garden city principles in an existing metropolis no longer seems feasible. He referred to that "reversion phase" as "neotechnics". Thus a new contemporary form of regional balance should be explored by urban planners, one that is compatible with existing metropolis. That is, on the one hand, one that is compatible with the minimum infrastructure required to operate and supply (food, material and human transportation) these megalopolises, which rely up to a certain point on intensive road and air traffic – with their corresponding CO_2 and heat emissions – and one that on the other hand is also compatible with (or that mitigates) existing unbalanced urbanisation and growth patterns (high density, sprawl...).

§ 8.4 Outlook

Existing urbanisation patterns seem unsustainable, both from a global metabolism perspective and from a local liveability angle. 54% of the world's population resides in urban environments (UN, 2014), cities occupy 3% of the Earth's land and account for 60-80% of total energy consumption and 75% of carbon emissions (UN, 2016). The world´s urban population will experience an increase of 2.45 billion inhabitants by 2050. Urban planners need to come up with measures to retrofit existing urban structures, and to plan urban growth to accommodate the new dwellers. The magnitude of the UHI is such that during the heat wave of 2003 it generated over 30,000 excess deaths in Europe, and still it is only one example of an urban climate phenomenon resulting from unbalanced design arrangements. New development patterns need to be investigated to ensure a natural balance at local and global scales, which will be reached through the reinforcement of the cohesion at the intermediate scale that is the regional scale.

§ 8.5 Societal Impact

Innovative solutions at a large scale require on the one hand urban planners to assume responsibility and control over the interventions at an infrastructural and regional scale to ensure a coherence between the interventions suggested at neighbourhood, city and regional scales; on the other hand the incorporation of appropriate technology (here remote sensing) and mapping strategies (game board, rhizome, layering and drift) is critical to be able to assess with coherence at this larger scale.

§ 8.5.1 Reinterpretation of technology

In a world ruled by technology, urban planners are often tempted to specialise in one of the disciplines they are supposed to integrate and adopt the tools and instruments specific to that specific field for a greater specialisation, forgetting their main original mission which consists in developing "a holistic urban vision". This research study aims at suggesting the incorporation of a cutting edge technology – remote sensing analysed and processed with ENVI 3.4, Atcor and GIS – combined with catalysing mapping strategies into the urban planners field in order to use technology as an integrator of fields, parameters, inputs, processes and actants. Scientific input is as relevant as the sociological, cultural, economic and political context, thus urban planners maps need to reflect any on-going debates, contradictions and/or challenges and scientific input should not be treated as compulsory, irrefutable truth. Somehow the regionalists already anticipated the importance of the debate of the integration of the scientific input into the urban planning discipline when Mumford denounced the use of science to narrow the depth of the urban planning discussion (Luccarelli M, 1995) for the defence of his Regional Plan of New York and Its Environs (RPNY) (GLP, 1932).

§ 8.5.2 Connection with existing realities

Beside analysing and assessing on the impact of urban heat, and potential mitigation actions, the three studies that were carried out within the framework of this dissertation, establish a connection with the existing realities of the neighbourhoods, cities or regions analysed, in order to try to obtain the maximum impact and relevance for the affected municipalities and provinces analysed.

In the article "The Urban Heat Island Effect in Dutch City Centers: Identifying relevant indicators and first explorations" (Echevarria Icaza et al, 2016c), the study carries out a comparative analysis of several Dutch cities, which have similar city centre structures, and for which it could be interesting to share knowledge, actions and experiences. The purpose of the comparative study is to increase the societal impact, to promote a dialogue between the different municipalities, and to help them benefit from each other experiences.

In the article "Surface thermal analysis of North Brabant cities and neighbourhoods during heat waves" (Echevarria Icaza et al., 2016b), the analysis carried out aimed at estimating the impact of planned future urban developments for the Province of North Brabant (Provincie Noord-Brabant, 2010) in the formation of urban heat. The purpose was thus to assess whether the location of the future growth areas, which are all adjacent to existing small and midsize cities, would per se worsen the UHI effect in those cities or not. The Province of North Brabant had used the "ladder for sustainable urbanisation" developed by the Dutch Ministry of Infrastructure and Environment to compare the urban development needs with the options to restructure nearby derelict areas prior to delimiting the "growth areas", however this tool does not include UHI considerations. The intention of this article was to take into consideration the existing spatial planning context, so to consider existing plans of the province and existing considerations taken into consideration so far ("ladder for sustainable urbanisation"), in order to generate a study connected to the reality of the analysed area.

Finally in the article "Using satellite imagery analysis to redesign provincial parks for a better cooling effect on cities. The case study of South Holland" (Echevarria Icaza et al., 2016a) also picked up the fact that the spatial vision of the province of South Holland ("Structuurvisie Zuid-Holland") – to which the six analysed provincial parks belong – does not specifically take into consideration the UHI phenomenon, which is surprising since South Holland is the densest province of the Netherlands, and thus the most affected by the UHI in absolute terms (CBS, 2006). The article on the South Holland provincial park aims at providing tools to the province, to ensure the parks preserve and enhance their natural cooling properties.

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