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Urban Daylight Study for Alsike

Alsike Nord Etapp 2

As an effort for providing and promoting social cohesion and equality within the urban landscape, the development of Alsike Nord Stage 2, contemplates a comprehensive analysis of the use of the outdoor urban shared space. Known as the “Third place”, these public outdoor environments are important for civil society, democracy, civic engagement and for establishing a sense of place and belonging. The importance to provide, within the natural and built limitations, new urban spaces with the understanding of the local daylight conditions is crucial to identify into what extent such activities could be supported and promoted.

It is part of this Urban Daylight Study for Alsike to contemplate the Available Daylight Provision on the facades, Annual Sunlight Hours (ASH) calculation, Universal Thermal Climate Index based on ASH, Insolation Analysis, definition and categorization of the usable outdoor areas and finalizing with alternative solutions based on the thorough analysis of the afore mentioned daylight investigations with the aim to provide a better sustainable urban life when it comes to daylight availability.

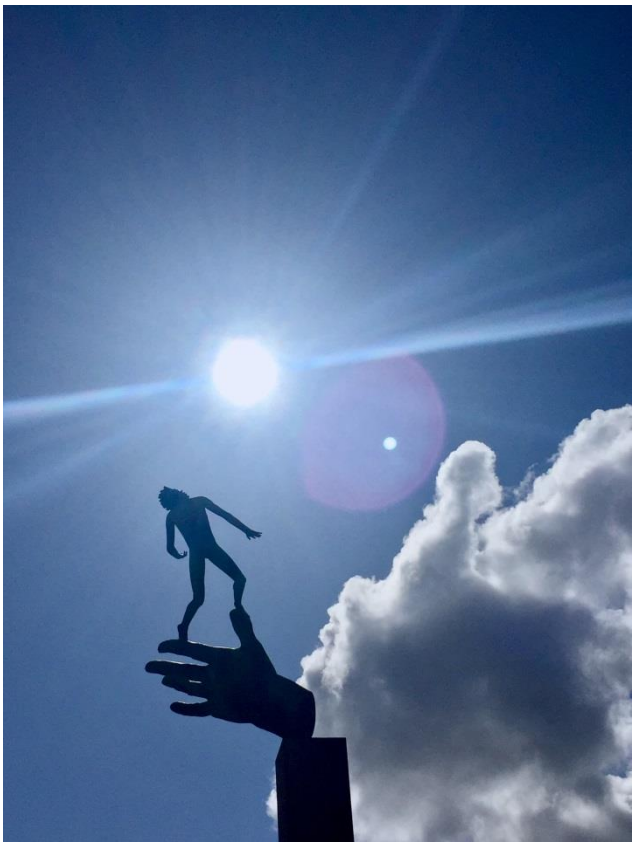


Figure 1: God's Hand, sculpture by Carl Milles
On permanent display at Millesgården.
Source: KTH Lighting Lab archive

Content

1 Presentation

The Urban Daylight Study for Alsike at Knivsta kommun is a joint collaboration between KTH Arkitekturskolan and Alsike Fastighets AB.

Alsike Fastighets AB represented through Jan Rydén as Head of Design & Research is asking KTH Arkitekturskolan for consultancy in the area of expertise of Light and Lighting, specifically Daylight as a design tool for the urban space.

The project has been developed by KTH Arkitekturskolan; Per Franson as Head of the department of Ljus Design, Rodrigo Muro as project leader of "Urban Daylight Study for Alsike" together with lighting specialists Isabel Dominguez, Majid Miri and Federico Favero.

This daylight study will be the initiation of a future research collaboration between KTH and Alsike Fastighets AB on the quality of light in public space and housing where the new city district of Alsike will be used as a test-bed. This project is the first on a mutual application for research financing for the future stages of this collaboration.

This Urban Daylight Study takes into consideration a variety of different resources for the investigation of the daylight situation available at this specific location such as; urban theories, different daylight calculation and standards and daylight models. Different general guidelines as BBR (Boverkets byggregler) establishes, different research sources that create a basis for implementation and discussion of the quality of the urban day lit environment and a unique methodology and perspective for the understanding of the daylight situation used by the research team.

It is important to notice that there is no standard, common practice procedure/methodology when it comes to daylight planning/study in the urban environment. The current Study has structured a procedure and is using different existing parameters as well as introducing new parameters for the daylight analysis of Alsike Stage 2.

2 Objectives

Scope of the investigation of the Urban Daylight Study for Alsike is the area of the new plan for the growth of Alsike limited to Stage 2.

The intentions are to analyse views, daylight, sunlight and health aspects and its conditions at the area based on the volumetric expression of the "Detaljplan" for Alsike Stage 2. Being these previous points the main subject of this study, the general focus of the Study is placed on a User´s Perspective, where the quality of space and enhancement of a varied experience of the different scales in urban and residential spatial environments will be in the centre of the investigation.

The main goal of this study is to provide parameters and guidelines for urban outdoor spaces of high quality regarding natural daylight in the residential and street/public spaces context. The study will go beyond the quantitative data that can be inferred from digital calculations and from

the compliance with standards. New methods of qualitative evaluation of daylight in the city context will be developed through the investigation.

It is the ambition of the Urban Daylight Study for Alsike at Knivsta kommun to be able to provide qualitative and quantitative criteria that will lead to the success of a better day lit environment and be able to influence decisions in the design process with the goal of providing liveable urban spaces. The main intention is to provide good quality day lit environments for the people.

These provided parameters and guidelines will be the basis for the creation of layouts of each of the blocks (kvarter) where the potential of the spaces in terms of the relation use-daylight is maximized and be the basis for the future architectural project of each building/courtyard. A similar approach will be taken for the definition of the use and zoning of the streets, parks and in general all public outdoor spaces.

A long term objective of the study would be to continue as an independent research project connected to the development of the area. The magnitude and implication of the possibilities that Daylight considers is capable to create a framework to be able to create a new infrastructure system at the same category level as roads, tracks, energy, water, waste and telecommunication. Regardless the fact that Daylight as such has not tangible physicality as the rest of the infrastructures, it is certainly part of an infrastructural system, meaning the build environment; architectural elements, buildings. Its impact on the quality of the space, the cost involved on the shaping and control of it and its direct connection and influence over health and energy makes it worth considering.

3 Work process

3.1 Methodology & structure

In order to provide a structured, coherent and communicative document this Urban Daylight Study for Alsike follows a specific methodology. Such methodology includes a procedure and will make use of certain tools (See

Figure 2).

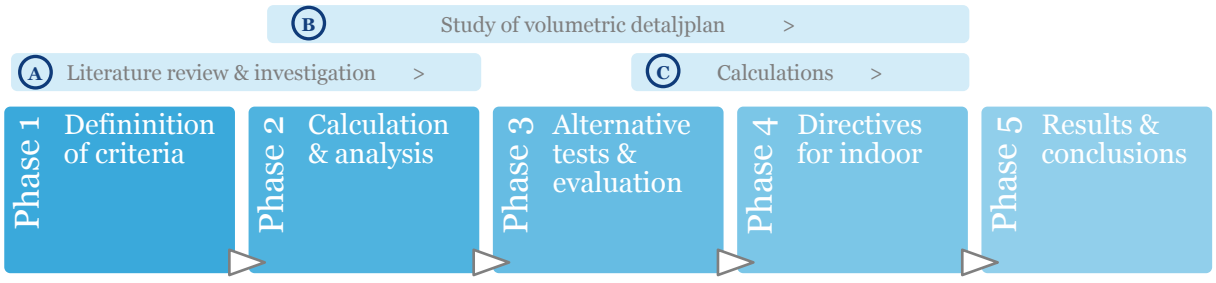


Figure 2: Scheme: Methodology & process

A. Literature review of standards, recommendations, research papers, and specialized literature on the topic together with the documents of “Projekt Gestaltning for Alsike Nord Stage 2” and the ”Detaljplan for Alsike Nord Stage 2” (see “Chapter 4.2” for detailed and full comprehension).

B. Study of the urban plan delivered by Erséus Arkitekter. Based on the volumetric expression of the block/buildings, planning of the areas designated for circulation (streets, boulevards, pedestrian areas, etc.) and distribution of green areas and different use of the public space a strategy for the daylight analysis is set (Figure 3). Calculation of the daylight conditions on the current proposal for Alsike Stage 2 using different analytical metrics.

C. Calculation includes: Available Daylight Provision on the facades, Annual Sunlight Hours (ASH) calculation, Universal Thermal Climate Index based on ASH and Insolation Analysis for calculations. For a complete definition and comprehension of these calculation methods see chapter 6.

Figure 3: 3d volumetric representation of Alsike Stage 2
Source: Erséus Arkitekter

3.2 Procedure

The Urban Daylight Study for Alsike has been structured in five phases or steps. This sequence of steps built on top of each other in other to reach a final outcome in this investigation.

Phase 1: Definition of criteria: Set up criteria for “good daylight” and “positive multisensory experience“ in the urban space.

At the beginning of the project criteria for “well day lit urban space” in the Scandinavian context will be set up. An evaluation scheme will be developed that helps to communicate aims and criteria for the daylight design to professionals and the general public.

Phase 2: Calculation & analysis: First analysis, understanding of the daylight conditions in the given area.

The tri-dimensional volumetric design Urban Daylight Study for Alsike at Knivsta will be the basis for a first analysis and understanding of the daylight conditions in the given area. The daylight study includes both skylight and sunlight analysis providing information on daylight irradiation over the facades. The calculations include: annual sunlight hours calculations, seasonal comparisons together with the analysis of patterns, behaviour and influence the built environment has over urban fabric in terms of daylight, shadowing, luminance, illuminance and ratios.

Phase 3: Alternative tests & evaluation: Evaluation and suggestions for modifications + possibilities based on the previous phase.

Phase 2 will draw substantial amount of information that will be analysed and evaluated and classified according the urban planning theories, own proposal and parameters that the Gestalning plan for Alsike Nord Stage 2 proposes, in order to arrive to conclusions about the quality of the urban space according to the objectives defined in Phase 1. The aforementioned quantitative framework (Phase 2) will help us to deliver a comprehensive image of what are the actual daylight conditions. By presenting the pros and cons a qualitative oriented plan of usability of areas will be given as an interpretation of the possibilities that daylight conditions on site allow.

Phase 4: Directives for indoor: Impact Daylight Outdoor City Planning on Interior Spaces.

General schemes for the quality of the interior day lit space will be provided in order to set up the basis for minimum requirements in search for user's satisfaction. Ratios of window (WWR) in relation to area of the room based on the daylight intake subtracted from the influence that daylight has over the façade.

Phase 5: Results & conclusion.

Generating conclusions and shaping the format of the studio results into a document and presentation.

4 Context

4.1 Location

Located in Knivsta Kommun, Alsike has a unique position between two important bigger cities, Uppsala and Stockholm (Figure 4). With the future development of Alsike and its infrastructure, this new settlement at the northern of part Alsike will have a privilege attractive position in this geographical zone.

Alsike Nord is the most recent area in Knivsta that is currently under construction. It lies as the north of the former area and joins the old Alsike with the new to a whole. Overall, Alsike is a young and modern residential area under constant expansion. Here are new villas, chain houses and apartments built for people who appreciate comfortable accommodation, social environment and proximity to nature.[1] (Figure 5)

Currently Alsike Fastighetsaktiebolag is working on the "detaljplan" of Alsike Nord Stage 2, object of this Urban Daylight Study. As part of the development and planning for this future expansion various investigations have been carried out and are ongoing; archaeology, geotechnics, tidal water, nature, water and sewerage, traffic, noise and a future location for the commuter train station [2]. From a sustainable and economic perspective many aspects have been considered, being the Urban Daylight Study one of these investigations to support and promote the wellbeing and a liveable city in Alsike.

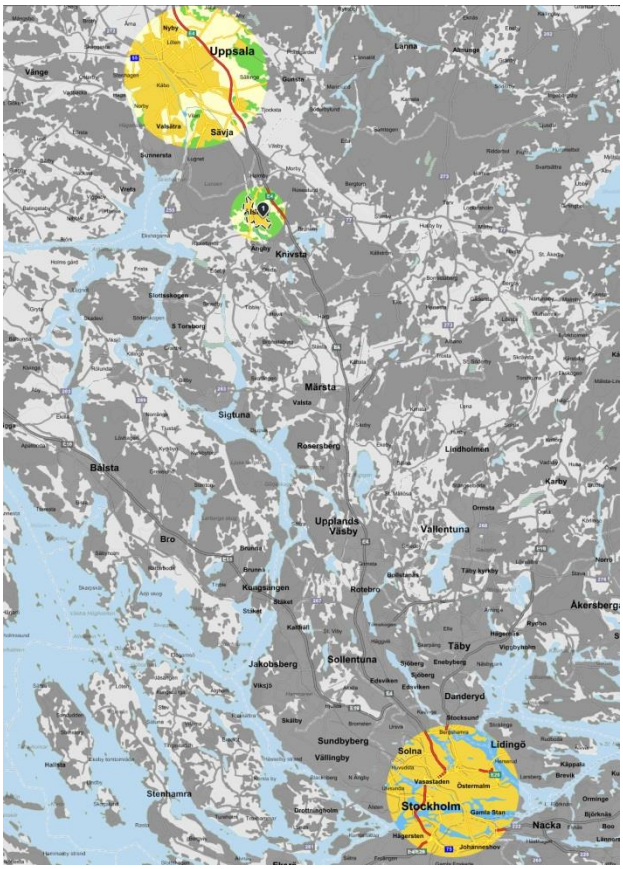


Figure 4: Location of Alsike in proximity to Stockholm and Uppsala.
Source: Screenshot https://kartor.eniro.se

Figure 5: Alsike delimitation.
Source: Screenshot https://kartor.eniro.se

[1] http://toofab.se/2016/03/23/pendlarlaget-mellan-uppsala-och-sthlm-alsike-nord/

[2] http://alsikebolaget.knivsta.se/~/link.aspx?_id=383AE243BCE2452F8768DF6745C2C90D&_z=z

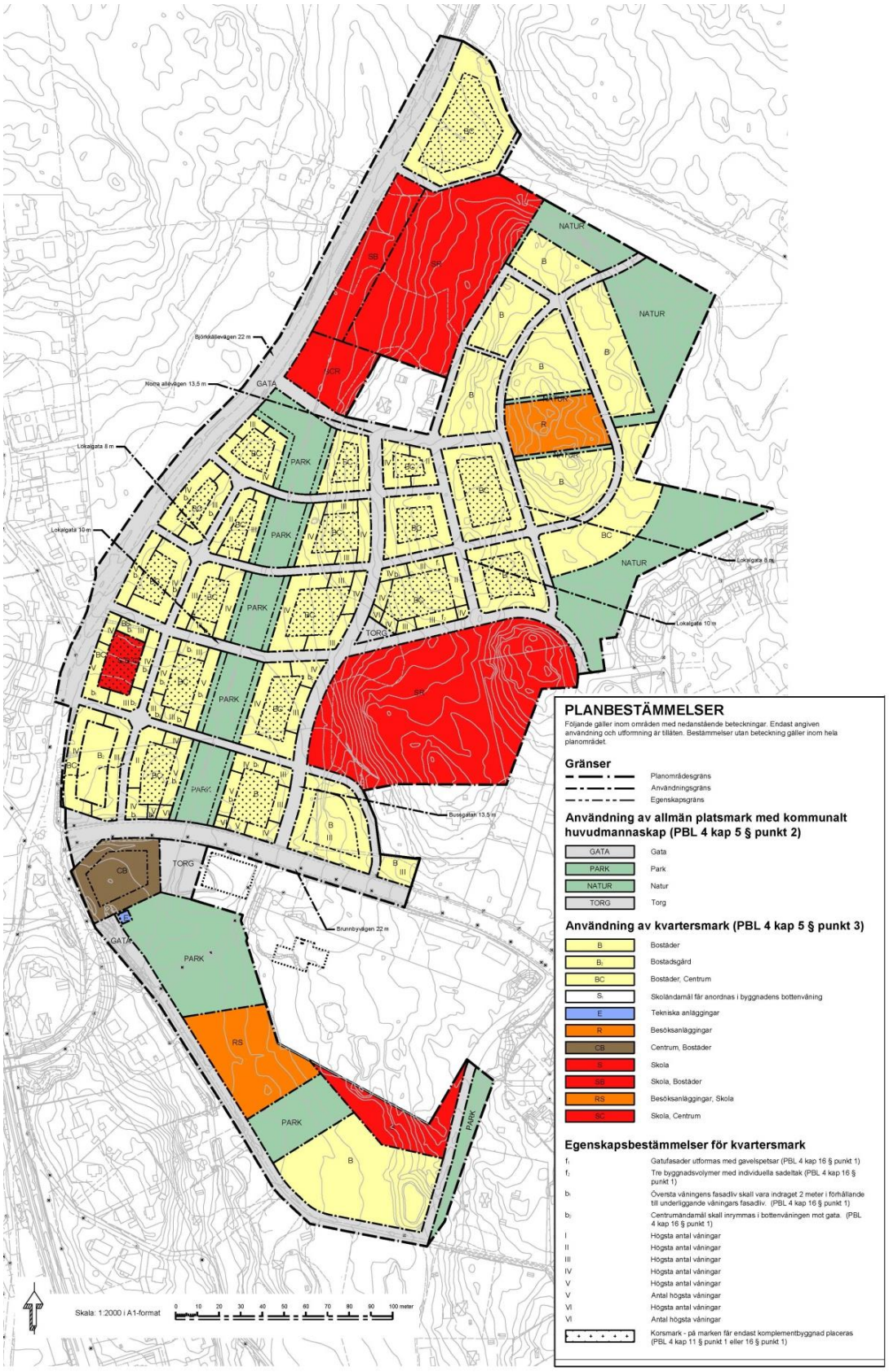


Figure 6: ”Detaljplan” for Alsike Nord Stage 2
Source: Alsike Fastihetsbolag

4.2 Daylight in the urban context

The benefit that offers the present Urban Daylight Study of Alsike is to provide a comprehensive daylight situation for the exploration and exploitation of the different areas and its potential within the urban realm when it comes to daylight strategies (

Figure 7).

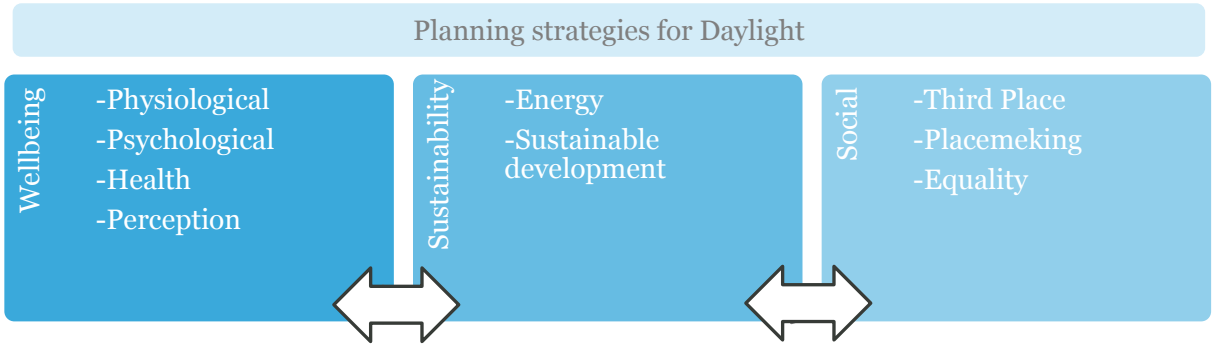


Figure 7: Main drivers for Urban Planing with Daylight as a deigb generator.

The planning of Daylight is of crucial importance in the build environment as it has qualities that shape our perception of the space :

- Continuous spectral power distribution and excellent colour rendering (Ra100).
- Variation Correlated Colour Temperature (CCT) and intensity throughout the day and different seasons around the year (ranging from 2000K up to over 20,000K)[3].
- High light levels of light intensity available (12100 lux as a median external illuminance at 59,65° N Latitude)[4].

Being the definition of Daylight the visible part of global solar radiation[5] it is clear that Daylight has influence on a multisensory level and its influence on us goes beyond its physical properties and connects to our perceptual world. Being our perception much more than the visual aspects of our human condition, our psyche and health are also influenced by the presence and absence of light, as well as different qualities of light, both in the urban and indoor environment.

Health effects Sunlight is important to indoor environments hygiene for many reasons especially in hospitality and housing. It provides significant physiological and psychological benefits to health and wellbeing. It can provide thermal comfort or discomfort depending on the season and location. It also directly influences natural daylighting conditions inside rooms as well as the character of exterior views. In terms of urban planning, Sunlight is very significant; for example, recreation areas may need to be sunny while car parking areas need to be cool. Sunlight provisions

3 DiLaura, David et al (2011) *IES The Lighting Handbook*.
4 (2015) *European Standard CEN/TC* 169 working document
5 EN 12665:2011 - 3.4.7

have to be considered in relation to density requirements, orientation of buildings and spacing between apartment blocks[6].

Daylight has certain implication over our health and psychology which are of crucial importance for our wellbeing:

- Light processed through the eye can influence human physiology, mood and behaviour[7].
- Influence on all human systems, processes and functions[8]
- Circadian regulation, adjusting our biological body clock
- Human wellbeing, increased alertness, productivity and visual performance
- Importance of view and contact with outside world[9]
- Knowledge of weather and time of day
- Relief from feelings of monotony or boredom
- A change of visual focus
- Satisfaction (home/job) and decreased intention to quit.

Lighting Design has become of crucial interest for the promotion of the wellbeing in the built environment, being Daylight part of it. Certification standards such as WELL Building Standard provide guidelines to promote health and in general quality for the wellbeing. This is aimed to minimize disruption to the body's circadian system, enhance productivity, support good sleep quality and provide appropriate visual acuity where needed[10]. These principles can be translated into the outdoor environment in order to address similar questions, pushing Alsike in the forefront of Urban Planning and turning it into a desired place to live in.

The increased use of outdoor open spaces and good day lit indoor space will support the idea of sustainable development and build up an awareness of the use of Natural Resources such as daylight. They need not only to be protected but harvested and used in an intelligible way. Being the topic of Sustainable Development[11] a multidimensional and multidisciplinary concept, creates a basis for outdoor and indoor spaces where Daylight is a driving tool for decisions regarding the built environment.

In international context the theories and ideas that are shaping the contemporary urban design discourse may differ in approach but they all share ideas and concerns regarding the quality of the space. For example; the liveability of the outdoor context and places the health aspect into play at

6 Guidelines for Healthy Housing (1998), World Health Organization Regional Office For Europe

7 Veitch J A (2003) *Visual, Principles of healthy lighting: a role for daylight*.

8 Veitch J A. (2011) *The physiological and psychological effects of windows, daylight, and view at home. Velux symposium, Lausanne.*

9 Cetegen D, Veitch J A, Newsham G R, (2008) *View size and office luminance effects on employee satisfaction.*

10 WELL Building Standard® V1 (2015), *Light.*

11 "Sustainable development: development that meets the needs of the present without compromising the ability of future generation to meet their own needs" (1987) *Brundtland Report, Wolrd Commision on Environment and Development*.

the same level as variation, interest, familiarity and interaction.[12] In all these urban approaches Daylight has not a core role in the planning and definition of the quality and liveability of the urban life, being quality of the air, water and energy saving the key elements. It is the ambition of this Urban Daylight Study of Alsike to set up the basis for future Urban Programmes to incorporate this kind of studies at an early stage to be able to shape the Urban Context and support other disciplines.

Beside the already stated perception, psychology and health, daylight has also an impact in two other main aspects; energy consumption and social aspect. The first one directly connected to a sustainable development strategy. Where, by proving sufficient daylight not only in indoor spaces but outside as well, the use of energy can be minimized. An urban planning approach where buildings/facades towards the street are designed with a variations of heights and building/blocks include openings and separation between them energy consumption could be reduced. By providing sufficient daylight in this urban context leads to repercussions into the street lighting, hence energy savings can also be achieved in this front13. From an energy perspective Daylight is a free source of energy, wireless and if well-planned daylighting can significantly reduce energy consumption in electric lighting in a building.

The Social aspect is a key element that needs special attention in the analysis of the Daylight analysis. By creating a good daylight “Third Place” in the public realm is certainly affected in a positive way. The good life requires balanced participation in "three realms of experience": the home, the work place, and this concept of the “third place”, being in this case the outdoor spaces such as; urban atriums, winter gardens, courtyards, streets, boulevards, pedestrian zones and urban plazas. These “third places” are defined as core settings for informal public life[14].

The idea above is connected directly to current ideas of what is the future for Urban Planning, synthesized in the idea and movement of Placemaking. Placemaking helps to inspire people to collectively reimagine and reinvent public spaces. The idea resides on strengthening connections between people and the place they share. The idea goes beyond just promoting a good or better urban design, the ambition is to facilitate creative patterns of use, understanding the influence that the physical, cultural and social identities have to support activities in the open public space[15]. The current analysis makes us understand what influence Daylight has on Alsike to promote this kind of symbiosis of people/space.

Designing public spaces which provide comfort and support socialization with the aid of daylight will promote the use of a mixed diversity. The use of this “Third room” where age, gender, occupation, and socioeconomic status of its regulars is balanced into equality should be on the goals of urban planning[16] [17]. For the daylight considerations and analysis, the study takes into account the provided information contained in the document “Gestaltning, Alsike Nord Etapp 2” from 20180327. Such document presents a clear description of what are the important factors when it comes to shape the urban/public environment for the benefits of its citizens.

[12] Metzger, Jonathan (2013) *Sustainable Stockholm, Exploring sustainability in Europe´s greenest city.*

[13] Sundborg, Bengt (2016) *Energy Savings by Using Daylight for Basic Urban Shapes.*

[14] Oldenburg, Ray (1989) *The Great Good Place.*

[15] Kent, Ethan (2018) *A thiving Future through Place: Placemaking as the New Urban Agenda*. Published in “*Ten Years of Urban Research*” Edited by Peter Elmlund.

[16] *Social Forces,* Vol. 69, No. 3 (Mar., 1991), pp. 931-932 Published by: Oxford University Press.

[17] *Contemporary Sociology,* Vol. 20, No. 1 (Jan., 1991), pp. 78-79 Published by: American Sociological Association

As part of the Urban Daylight Study for Alsike an investigation on the impact that Daylight has in the urban context has been made. Different ideas from experts in the field of lighting, urban planning and architecture have been integrated for the developing of the current analysis. By combining the afore mentioned document and the gathered information on the field, can be concluded that the following points are crucial in the planning when Daylight is part of the design process (Figure 8).

Human factors	Built environment	Daylight character
Ambience[18]: Towards a dynamic multisensory approach. User satisfaction Urban life for people[19]: experience, expression, movement, people meeting. Prioritize people before vehicles[20] Social aspects; cohesion, socialization, activation. Quality of the "Third place" Health, psychology and perception	Scale[22]: Urban, building, detail Division of spaces: transitional/temporal usage (low, mid and long term use) Variation in the heights of the buildings[21] Façade Material[22] Hybrid zone 0.5-2m from the façade [22] Variation between narrow streets, open spaces.[22] Facade painting and cityscape (Material, colour, common architectural grammar, higher floors at the bottom, lower floors higher up in the house. Smooth window setting.) [22]	Environmental diversity: Regarding brightness, contrast, thermal aspects. Daylight availability/location based Free use the natural resources such as daylight Daylight has the unique potential of promoting biodiversity, which according to some urban theorists is essential not only for the urban landscape[23] and quality but for the functioning and sustainability of an ecosystem. To support this biodiversity, green areas should offer suitable conditions[24], greatly understood by using the information drawn by this Daylight Study.

Figure 8 : Influential points for daylight in urban planing

5 Definition of Urban Spaces

Potentially an element of the city in public urban space has the possibility to offer good quality experiences, depending on what it has to offer. One of the elements that attracts people to a space, such as a park, is Sun[25]. Direct sunlight has the potential to activate an area, its location and morphology is not only directly connected to capacity to allocate people but to attract them as it can allow or block direct sun.

[18] Demers, Claude (2013) *Daylight design for the existent. Velux Daylight Conference.*

[19] Saabi, Tina (2013) *Planning for people and urban life. Velux Daylight Conference.*

[20] Rydén, Jan (2016) *The Right to the City as a Swedish Tradition - Allborgarrätten*

[21] Henning Larsen Architects (?) *What about daylight?-Design manual with suggestions for overall renovation.*

[22] Arbetsmaterial kvalitetsprogram (171107) Färgfabriken Projekt"*Gestaltning" for Alsike Nord Stage 2*

[23] Alberti, M. (2005) "*The effects of urban patterns on ecosystem function" International Regional Science Review, 28(2): 168-192*

[24] Elmqvist, T, et al. (2003)*" Response diversity, ecosystem change, and resilience" Frontiers in Ecology and the Environment,1: 488-494.*

[25] Grichting, Anna (2015) *Design of Spaces by William W Whyte.* Department of Architecture & Urban Planning

The elements of the city[26] in Alsike urban space are listed here with some considerations to take into account in relation to Daylight availability:

Urban Element	Characteristics		Daylight	
	Category use*	Activity	Typology[27]	Value**
Urban Atriums	A, B, D	Sitting, circulation, medium intensity use.	Skylight/Sunlight	1
Winter gardens	A, D	Sitting extended periods of time	Skylight	1
Courtyards	A, B, C, D	View, ventilation & illumination for residential area, play, circulation, medium intensity use.	Skylight/Sunlight	1
Lokalgata	B	Walking, short continued use (hrs)	Skylight	3
Street	A, B, D	Walking, commercial use, utteplats servering, medium continued use (hrs)	Skylight/Sunlight	2
Boulevard	A, B, C, D	Main green area, view, character of the area, medium continued use (hrs)	Skylight/Sunlight	1
Pedestrian zones	A, B, D	Walking, medium continued use (hrs) short continued use (hrs)	Skylight/Sunlight	2
Urban plazas	A, B, C, D	Meeting, socialising, medium continued use (hrs)	Skylight/Sunlight	1
Shared outdoor space	A, B, C, D		Skylight/Sunlight	1
Play areas	A, C	Playground for children, meeting point for adults, play, 1-3 hours of continuous use.	Skylight/Sunlight	1
Green areas	Socializing		Skylight/Sunlight	2

Figure 9: Table Urban elements, use and daylight conditions

* Main activity of the urban element[28]:

A: Socializing NODE

B: Circulation/communication PATH

C: Playing NODE

** Level of importance/amount of hours[29]:

1: High

2: Medium

3: Low

[26] Watson, Donald et al (2003) *Time-Saver Standards for Urban Design*, 6 Elements of the City.

[27] Assigned criteria for daylight availability by author based on the urban element´s use and activity.

[28] Consideration of the Urban Elements created by Kevin Lynch

[29] Assigned criteria for daylight availability by author based on the urban element´s use and activity.

D: Meeting NODE/PATH

6 Evaluation

6.1 Criteria

Based on the definition of Urban Spaces in Chapter 5 (page 10)a comprehensive evaluation of the Alsike Stage 2 has been done after the calculation of important parameters to consider in Daylight analysis.

For the understanding and evaluation of all what been described before and be able to reach conclusions and have material for analysis software calculations are needed.

Available Daylight Provision on the facades (See 6.2.1)

Window-to-Wall Ratio (See 6.2.2)

Annual Sunlight Hours calculation (See 6.2.3)

Universal Thermal Climate Index based on ASH (See 6.2.4)

Insolation Analysis (See 6.2.5)

In order to have an accurate reading and a simple and straight forward communication tool the area of Alvsike Stage 2 has been divided in 5 different Zones (A, B, C, D & D) creating quadrants of investigation where all the different block building belong to either of them, being in total 28 block buildings.

Streets without a name are referred al “Lokalgata” with an ID number after it, using letters (A to D in the North-South directions and numbers (1 to 3) in the West-East direction (Figure 10).

On Figure 11 con be read the location of the points where the calculation for “Available Daylight Provision on the facades (See 6.2.1) and “Window-to-Wall Ratio” (See 6.2.2). Each of the points represents the observer perspective as seen through a “fisheye lens” in order to visualize as much as possible from the selected area. For both calculation a “false colour scale” is used to present the different valus to which each of the two measured parameters refer to.

An important note to be considered and to keep in mind while reading the results, the reflectance factor for the facades in the calculation has been set up at 0,3 REFF and for the ground at the courtyards and streets has been set up at 0,25 REFF. Any change on the selection of the material that has a different reflectance factor will affect the delivered results. If a higher reflectance factor the change will be towards the positive side of the scheme, meaning brighter areas.

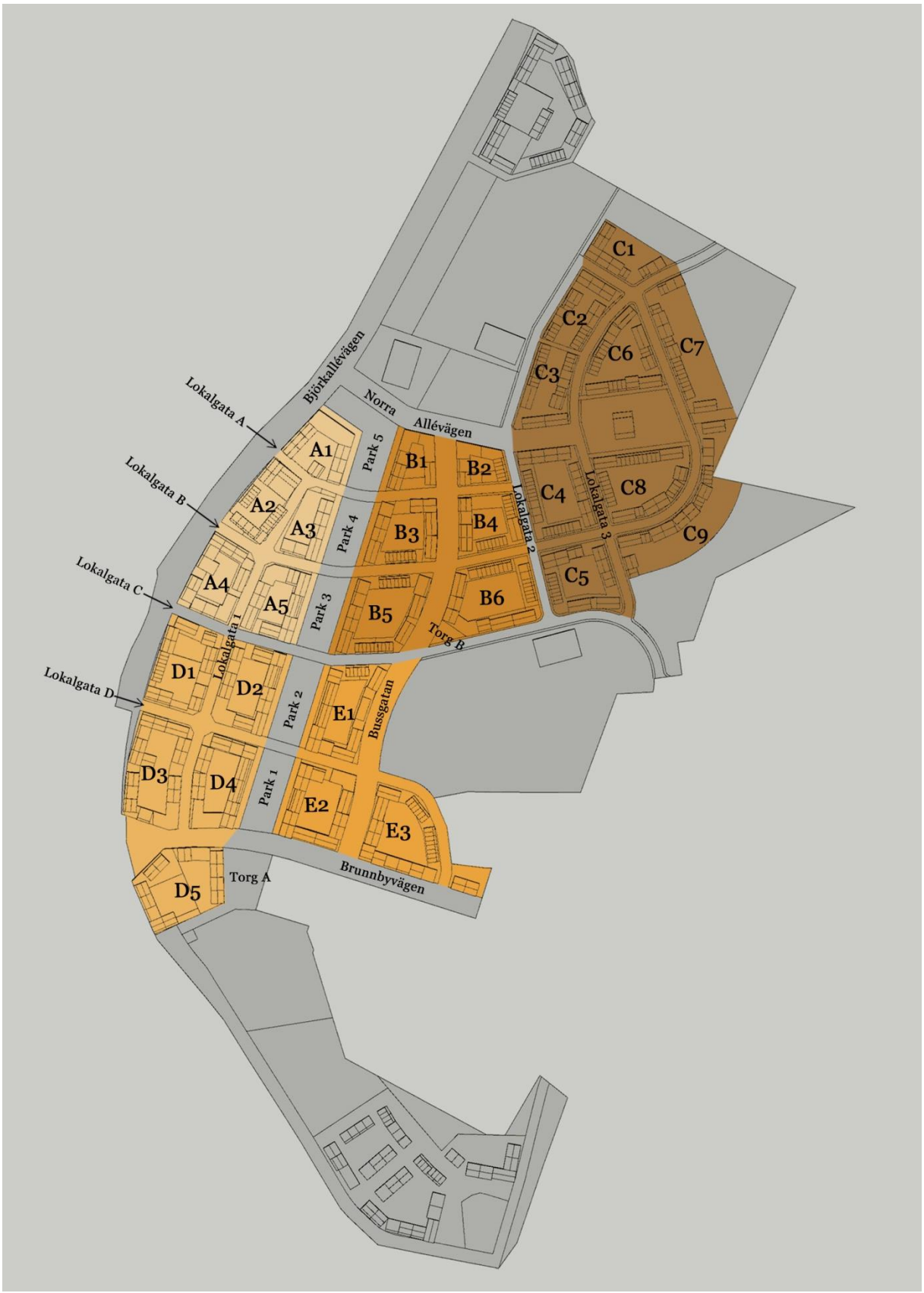


Figure 10 :Identificacion labeling of blocks (kvarter)

Figure 11 : Location of points where camera is placed for calculations marked with "X")

6.2 Calculations

6.2.1 Available Daylight Provision on the facades (Figure 12)

Calculation of daylight provision on the vertical surfaces/façade of the building. A logarithmic expression of a "Daylight Factor" calculation over the facades of the buildings blocks where the availability and daylight distribution can be drawn. This calculation allows to spot the range of available daylight, from the most beneficial case to the most critical daylight access conditions. Note that this calculation is based on the specific condition of an overcast sky using CIE Overcast sky model, therefore is named "Daylight Factor"[30].

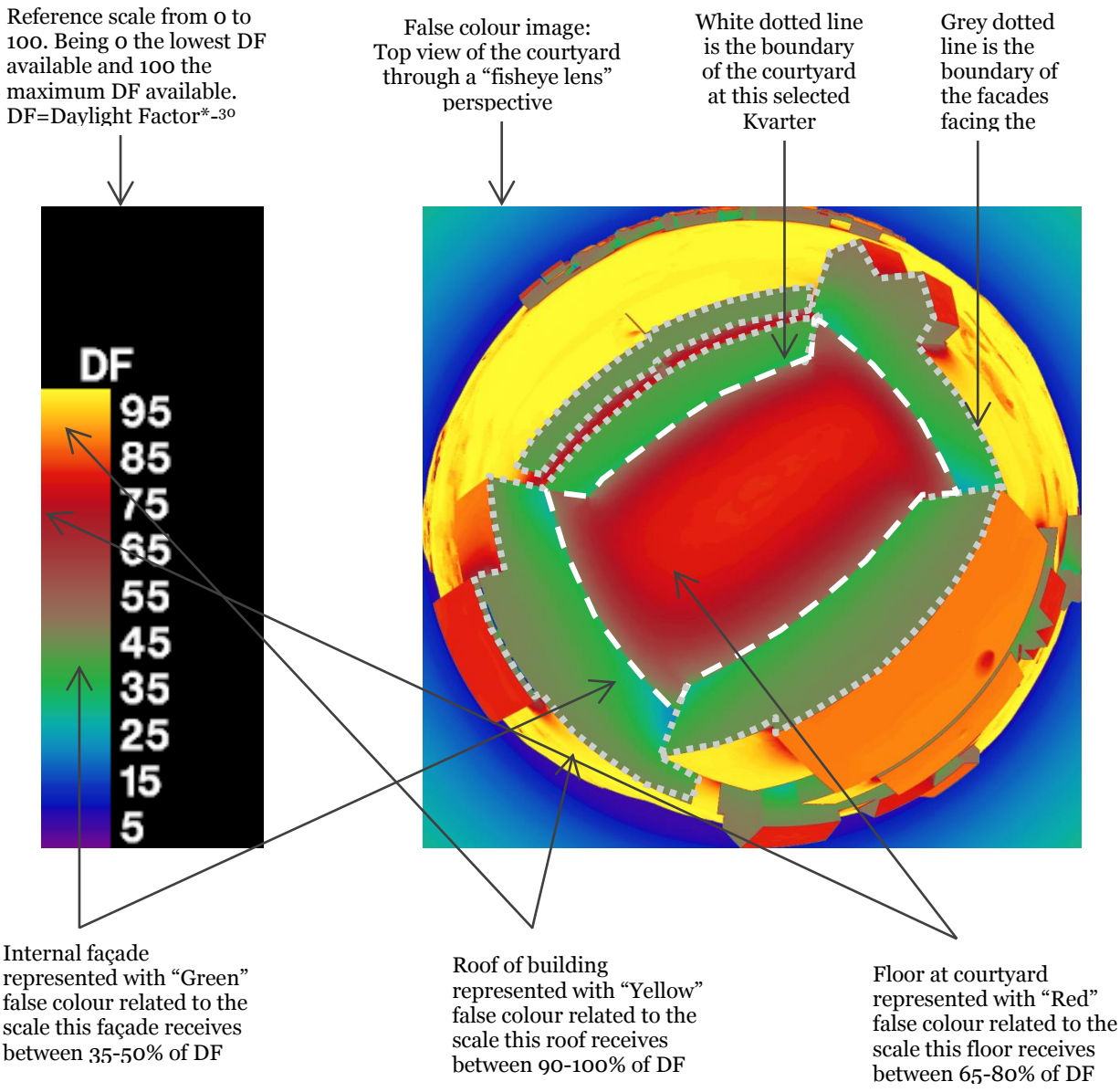
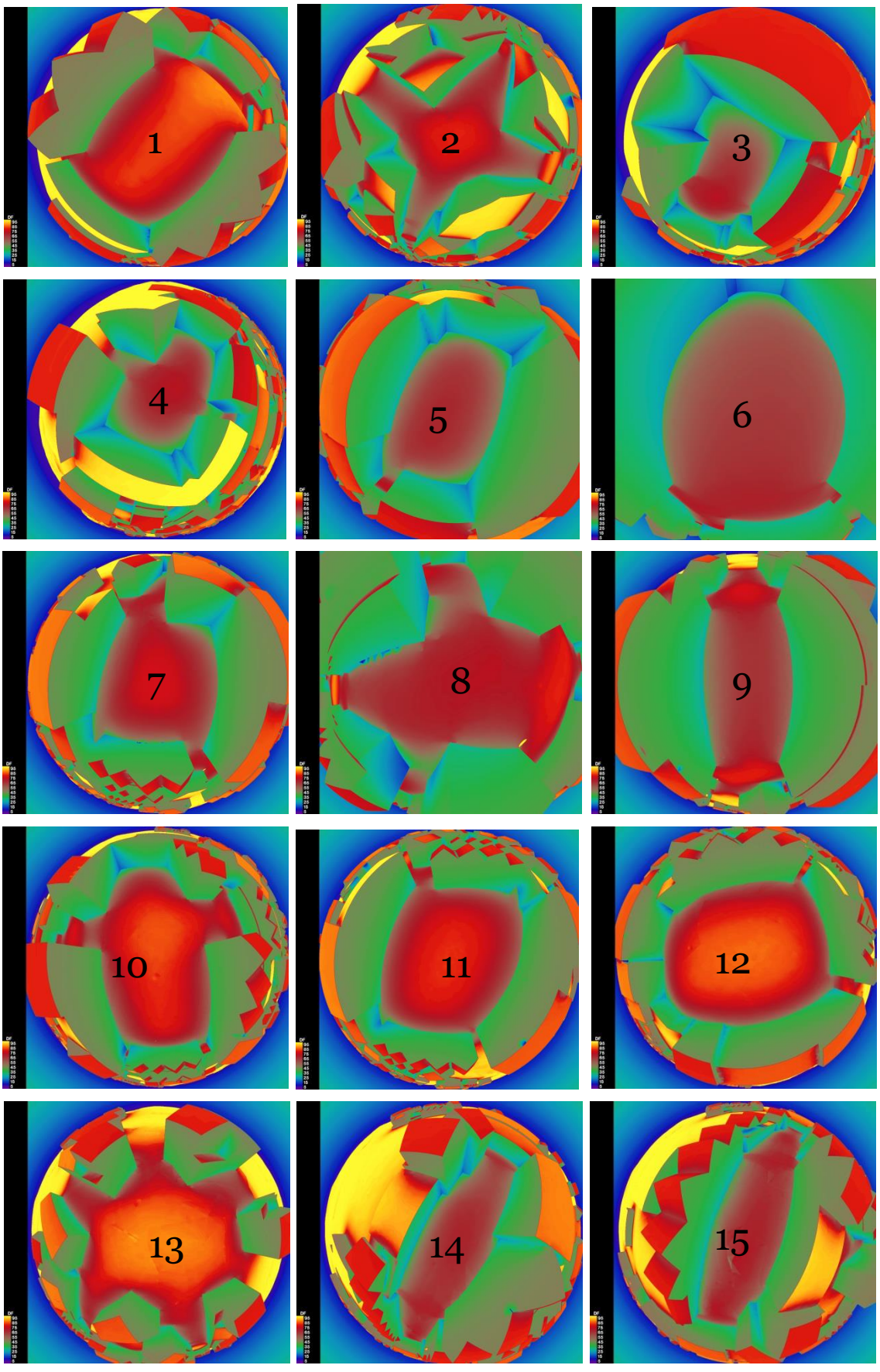


Figure 12 : Description of calculation visualization for Available Daylight Provision on the courtyards based on a DF scheme.

[30] DF=Daylight Factor. Is not the traditional DF value measured on an indoor space. This is the result of generation of a logarithmic expression created for this type of calculation in the the outdoor environment.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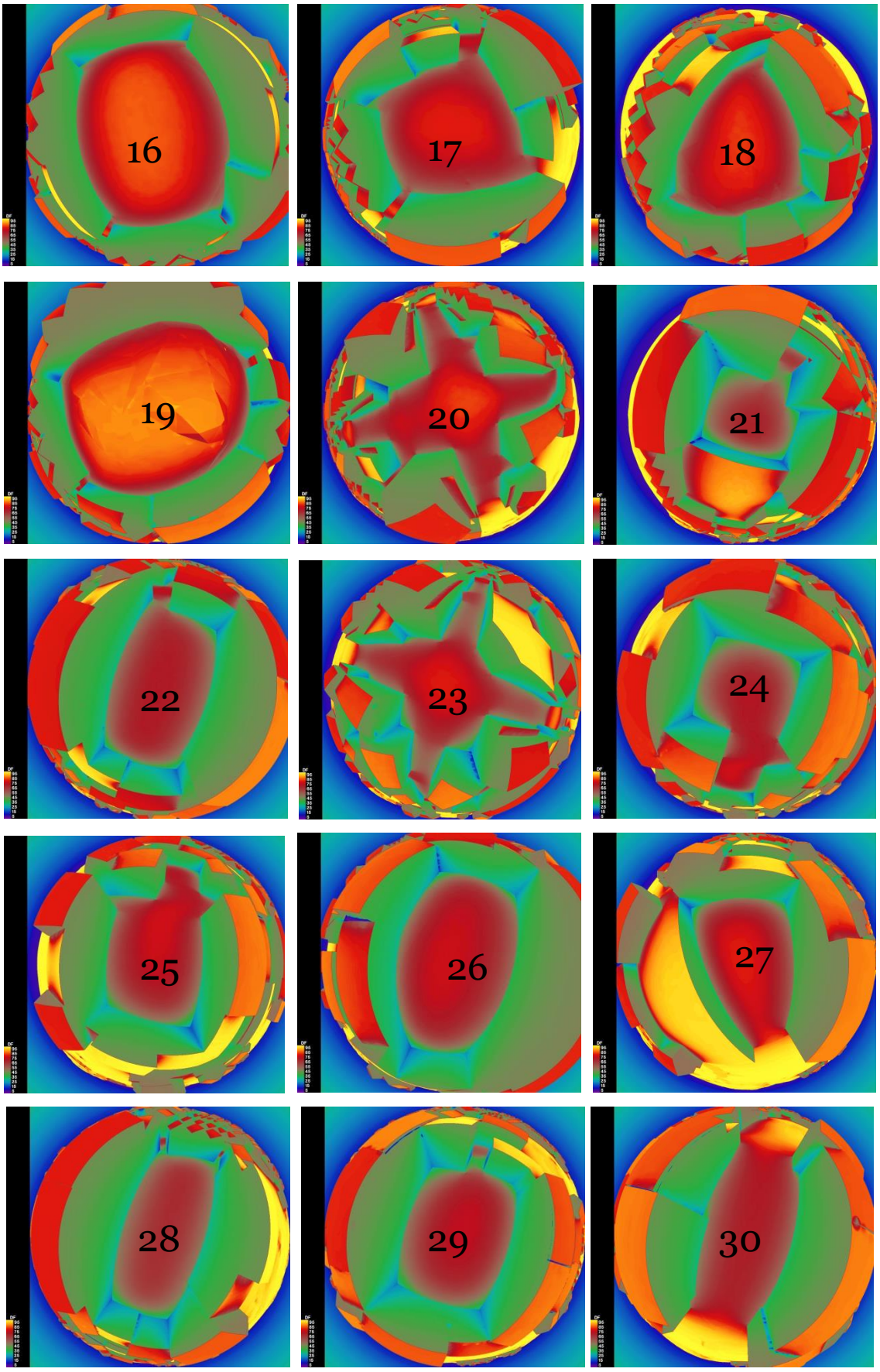
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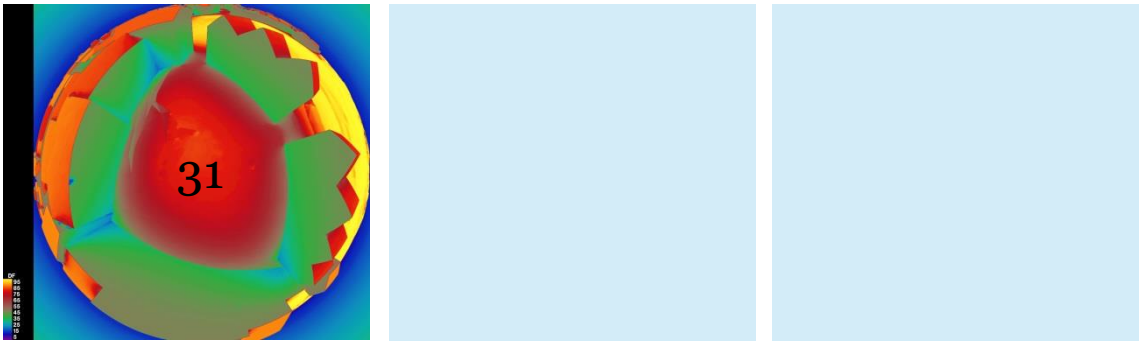
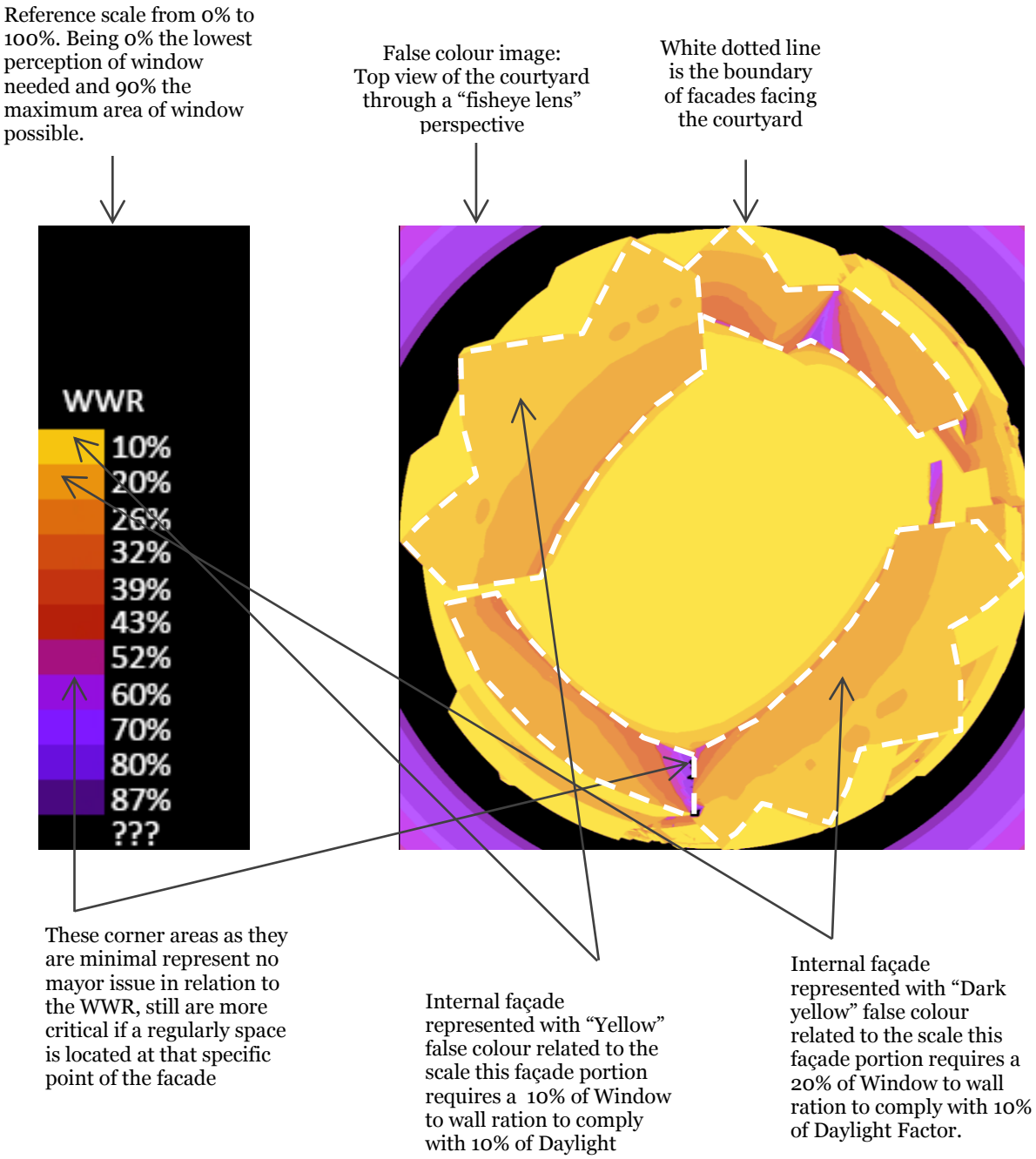


Figure 13 : Images 1-31 False colour ”Available Daylight Provision on the facades”

6.2.2 Window-to-Wall Ratio

(WWR) is the fraction of surface within a wall area that is covered by fenestration, calculated as the ratio of the wall fenestration area to the whole wall area. The setting of a Window-to-Wall ratio will influence the architectural expression on the level of number of windows, window dimensions, and the wall dimensions. A maximum WWR of 95% should not be considered.



In order to have a clear idea of the reuslts that WWR is based on and to have a clear reading of the calculations is important to consider that a target of 1% Daylight factor on the representing point (based on BBR) of that standard office room (being a starting point even these blocks will host housing), the amount of daylight factor that is needed on the façade (depending of WWR ratios) are as follows:

WWR	DF on façade
10	57,71
20	46,17
26	40,14
32	37,43
39	32,59
43	32,21
52	29,78
60	26,89
70	25,65
80	20,67
87	19,37

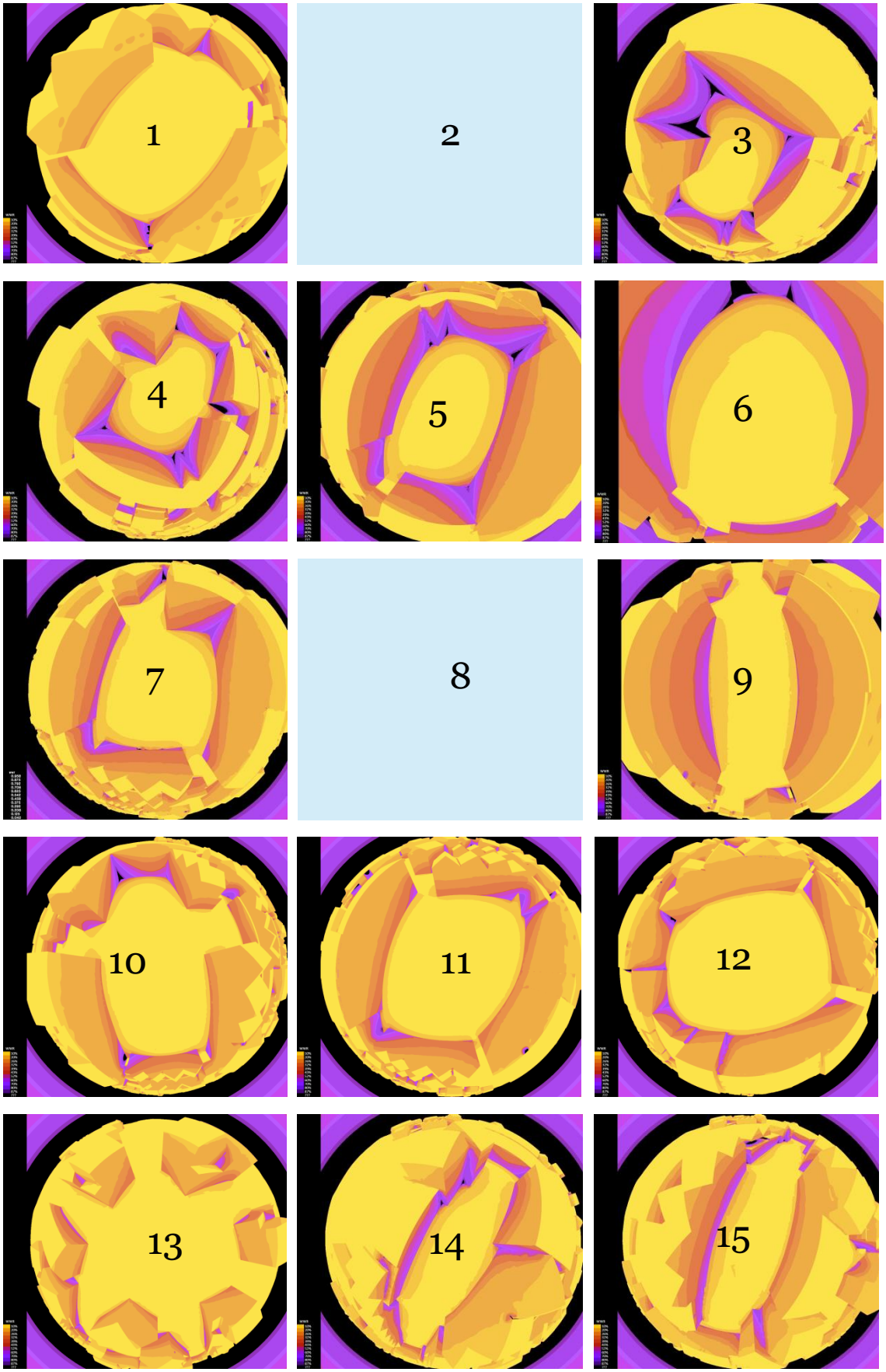
Here it is just worth to say that since the depth of rooms are usually less than 8m, (these calculations refer to a 8m depth room as a reference room[31]) these values are kind of worst case scenario, so if we follow this recommendation, final results should be slightly better.

ORIENTATION:

Based on daylight utilization alone and no considering climate, architectural layout and detailed materials the results indicate an optimal WWR ranging between 20% and 40%, with a North orientation requiring a larger WWR (40%), a South orientation a smaller WWR (20%) and an East/West orientation an intermediate WWR (30%).
The reflectance of inner surfaces has a significant effect on daylight autonomy and the use of low transmittance glazing demands a larger WWR (60%).

[31] Reinhart C.F., Jakubiec J.A. and Ibarra D. (2013)

Reference room:
Dimensions: W=3.60m L=8.20m H=2,80m
Materials of the reference room:
Walls reflection = 60%
Floors reflection = 30%
Ceilings reflection = 80%
Window glass Transmission = 70%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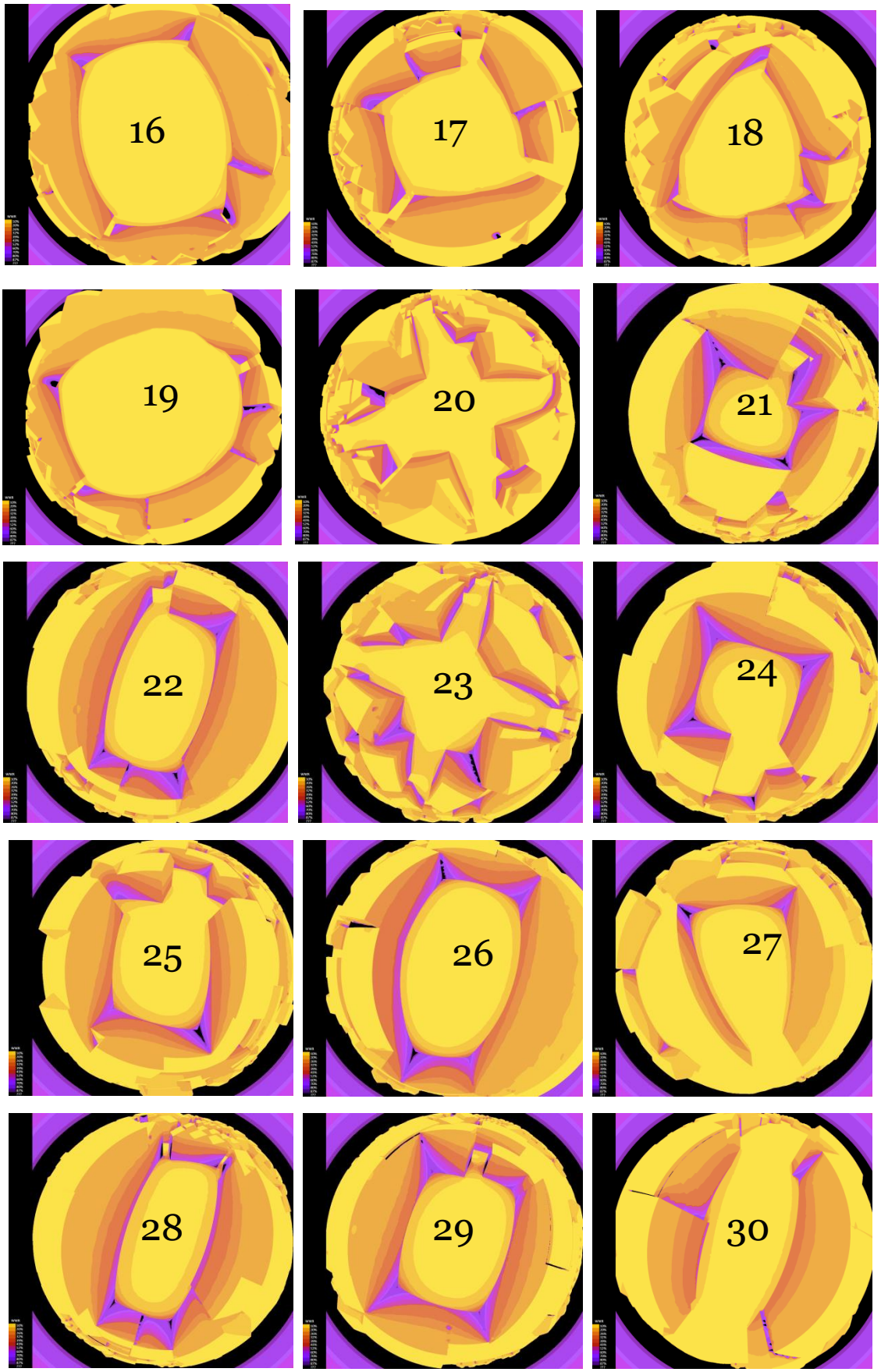
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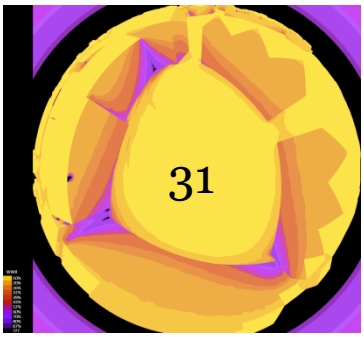


Figure 14 : Images 1-31: False colour images; Window-to-Wall Ratio

In conclusion the areas that are shown within a circle as a Kvater and the areas in a dotter line, as a street, are the areas that present a lower value on the daylight calculations Available Daylight Provision on the facades and Window-to-Wall Ratio (Figure 15).

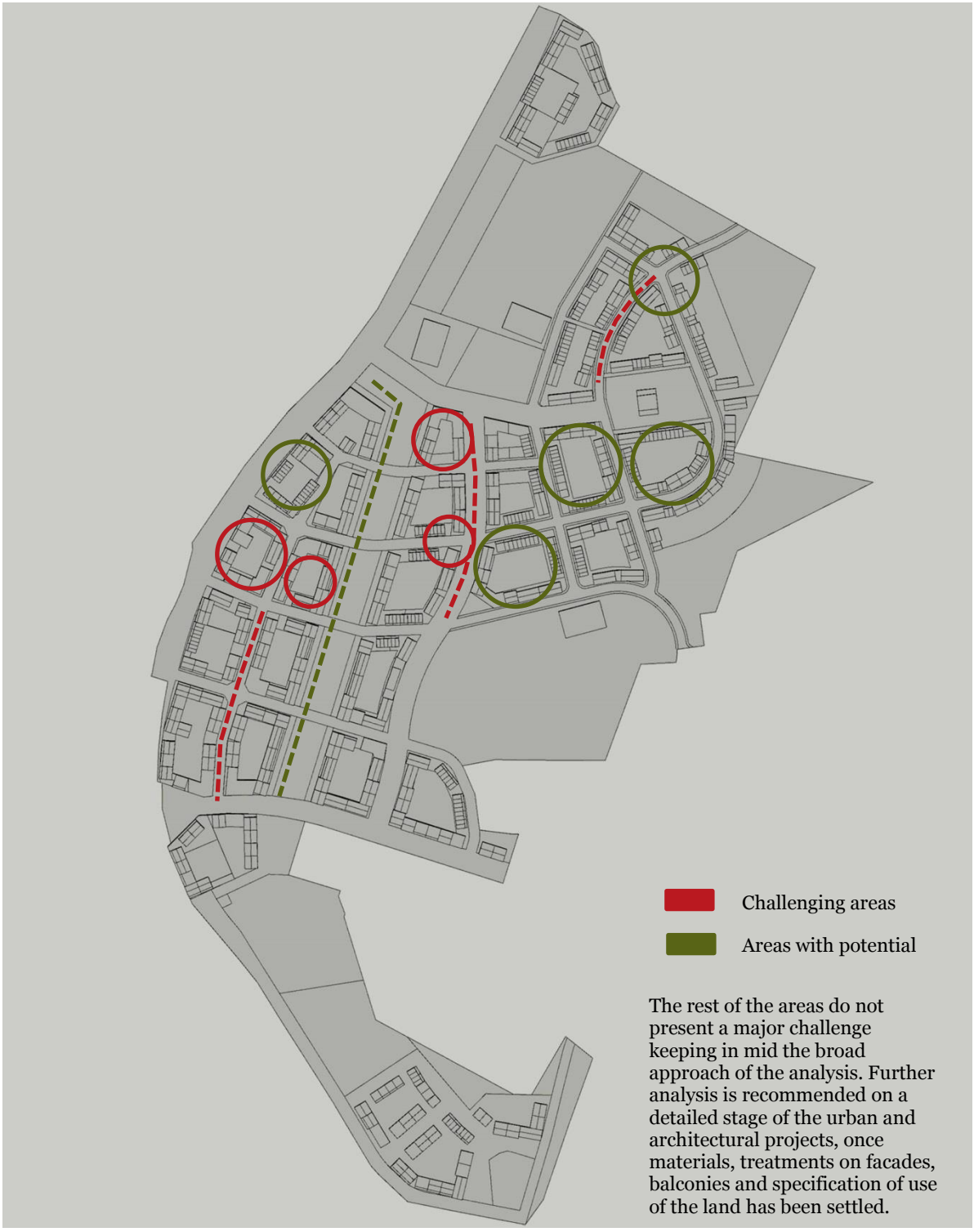
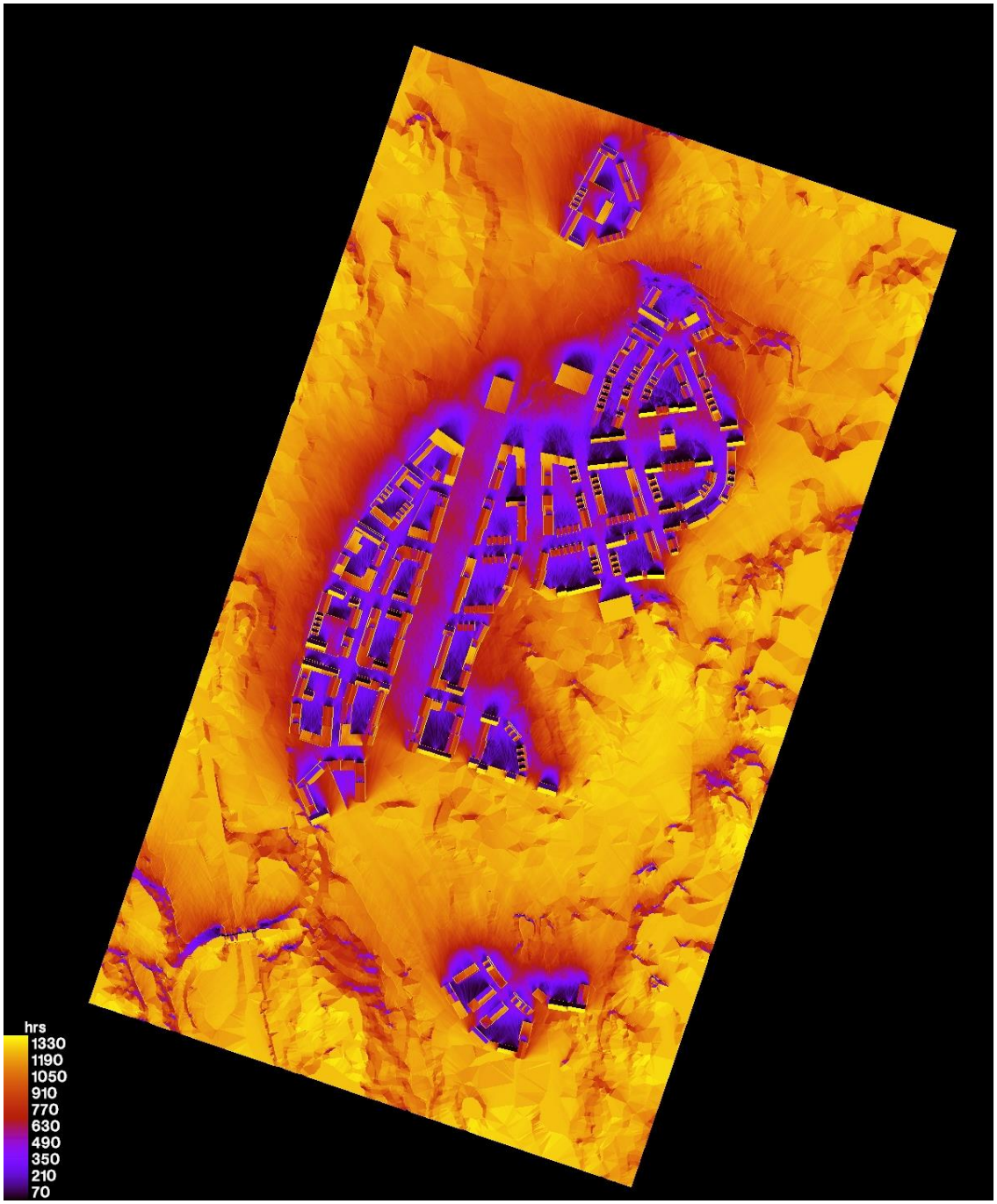


Figure 15 : Identification of areas with potential and challenging areas in relation to Available Daylight Provision on the facades and Window-to-Wall Ratio performance

6.2.3 Annual Sunlight Hours (ASH) calculation

This type of analysis calculates total sunlight hours (considering the whole year with a clear sky condition/direct sun light) that each analyzed point of interest is supposed to get during a specific time or in a yearly period (in comparison with 4380 daytime hours in a normal year).The drawn information of this calculation is to detect the most problematic areas regarding glare or excess heat. At the same time it provides information on the potentially good areas for placing a desired space that requires sufficient daylighting such as; play grounds, pedestrian walkways, parking lots, to name a few.

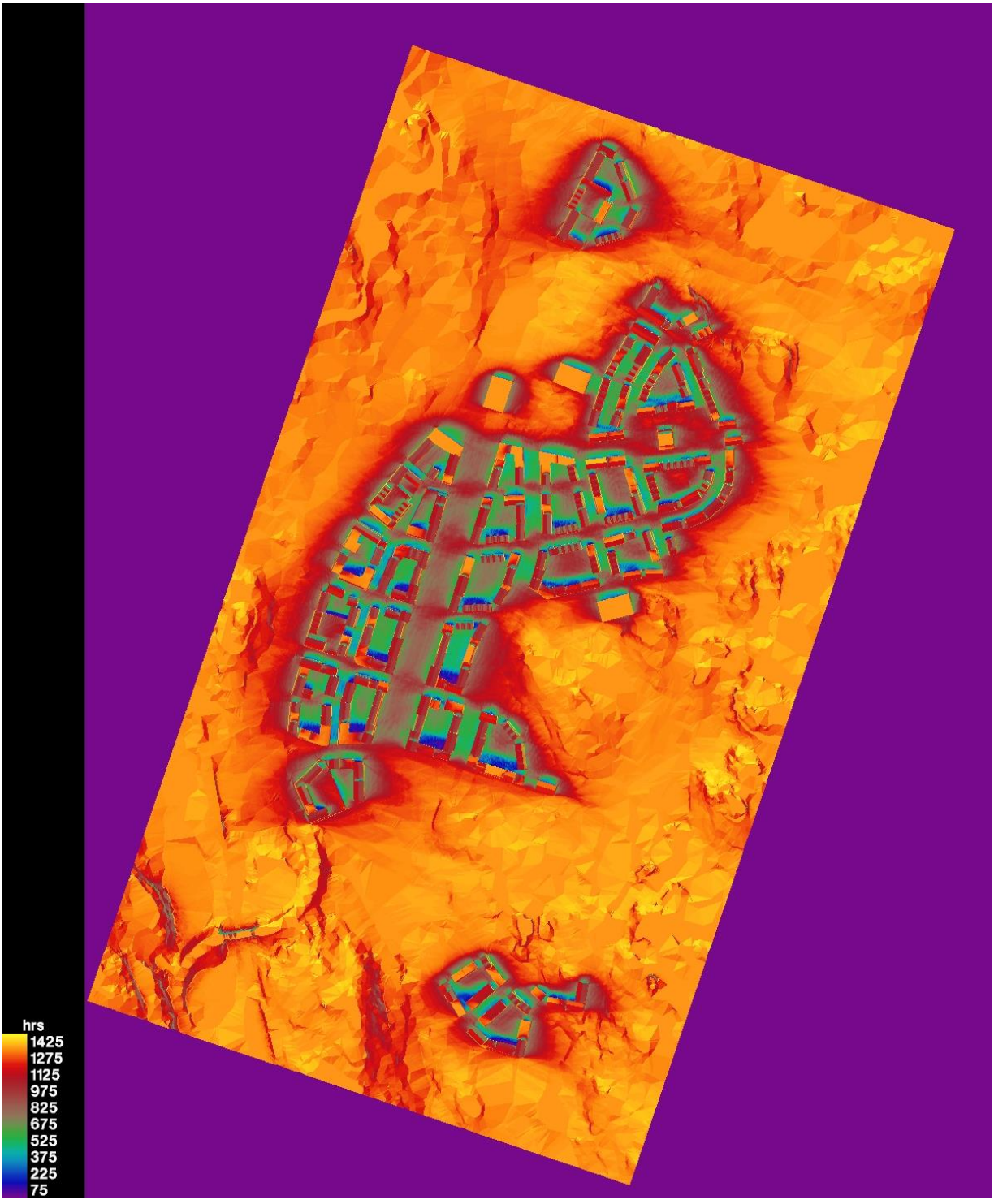


Annual sunlight hours 50%

Annual sunlight hours 40%

6.2.4 Universal Thermal Climate Index based

Known as UTCI is based on the Annual Sunlight Hours (ASH). It relates to the Apparent Temperature (AT). This calculation takes into account firstly; finding the comfortable outdoor temperature (from a simplified version of UTCI calculation formula) for the whole year and subsequently a sunlight hours calculation the period of time (hours) people enjoy to be outdoor.The weather data used is a simplified version of the UTCI formula from Arlanda airport.



Based sunlight hours cut of 50%

Based sunlight hours cut down to 40%

6.2.5 Insolation Analysis

The insolation analysis is a way to calculate Incident Solar Radiation falling onto a surface. Its calculation is based on a standard weather data file representing the prevailing conditions of the place and is created based on on-site measurement over a period of years. At an urban scale, it shows where it is best to locate photovoltaic panels, solar collectors or the potentially good locations for green areas (plants, vegetation and trees) to receive the right amount of light that is needed for them to grow.

7 Further consideration

Glare probability

Wind analysis

Sound Analysis

Analysis of mobility

Urban modelling interface (UMI)

Urban Daylight Study for Alsike

Project developed by
KTH Ljus Design department
KTH Architecture School
Project leader: Rodrigo Muro
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