ASSESSING THE OUTDOOR ENVIRONMENT CLOSE TO BUILDINGS WITH FOCUS ON WEIGHTING

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Summary

A new Swedish method for assessing the outdoor environment close to buildings, EcoEffect Outdoors, is presented in the paper. The aim of the method is to help planners and managers to create and maintain outdoor environments that are healthy and environmentally friendly by taking advantage of the qualities on the site and minimising the negative environmental impacts inside and outside the property. The paper describes how comprehensive assessments of environmental impact can be made through weighting different environmental impacts. Weighting, which simplifies summarising assessments and comparisons, is made from an anthropocentric perspective. The weighting procedure is inspired by the DALY system and the EQ 5D+ classification method, both developed within social medicine. In the paper Eco Effect Outdoors is applied in the assessment categories of microclimate and biodiversity in the outdoor housing environment.

1. Introduction to EcoEffect Outdoors

The Swedish environment assessment method EcoEffect, (the EE method in the following), measures quantifiable problems within five areas: Energy, Materials, Indoor environment, Outdoor environment and Life cycle costs. An anthropocentric perspective and a precautionary principle are chosen in the processes of assessments and weighting. The assessments deal with the present and future quality of life, i.e. people living today must not destroy the opportunities for future generations by over-consumption of the natural resources or poisoning the environment. These are problems that in the end affect human health and well-being.

The EE method has two major components:

a) A methodology for calculating environmental *load values* for a property. Quantifiable problems have been identified and a method to measure them determined.

b) A methodology for calculating the significance of these problems as *damage values*. The damage values are used as weights in the aggregation of load values.

Environmental *load values* for a certain property are determined for different kinds of problems - internal impact on the property detrimental to those who use it, and external impact, which might occur somewhere else and some other time. These environmental *load values* are multiplied by weights, *damage values*, that are relative to the significance of the problems. In this way they become comparable and possible to summarise to a comprehensive environmental judgement for a group of problems.

EE Outdoors, a module for assessing the outdoor environment, refers to the physical conditions on the ground that belong to a real estate - car parks, playgrounds, water surfaces, paths, resting areas with benches. The internal impact on the users to a great extent comes from the surroundings, such as air pollution, allergens, noise and electromagnetic fields. Internal impact may also come from a polluted ground or from polluted building materials on the property, e.g. PCB leaking from joints. External impact from the property is caused by storm water and use of fuel for mowing and other maintenance work. Material flows and energy consumption, however, are accounted for within the assessment areas Materials and Energy.

This paper deals with assessment of the natural elements in the outdoor environment, the microclimate and the biodiversity, which are principally positive for the users. They are modified by construction and landscaping. The microclimate may improve or deteriorate. Exploitation of a site, however, almost always means deterioration or even extinction of biodiversity. Biodiversity is built by single pieces which are more or less interdependent within a lager area, mostly much larger than the single property. It is difficult to forecast when and where negative effects will turn up. Biodiversity in this respect is an external impact. Here microclimate and biodiversity are treated only as internal impacts, i.e. impacts that affect the users of the outdoor environment. It is the lack of sunshine and wind shelter, that could have been there, and degree of deterioration of biodiversity, which are assessed.

2. Load values

2.1 Impoverished biodiversity

Biodiversity is a natural resource that we have undertaken to protect and preserve in the Convention of Biodiversity, (CBD). Sweden and 175 other countries have agreed to retain and make sustainable use of the biodiversity, (Secretariat of the Convention of Biological Diversity - UNEP). Biodiversity forms a web of organisms, processes and interactions. We all depend on the services that the ecosystems provide - nitrogen retention in the ground, cleaning of water, oxygen production. Biodiversity is like a jigsaw where every piece is connected with another one. To maintain a characteristic flora and fauna and to maintain the functions of the ecosystem one has to take care of the overall situation. Only to protect the core areas for threatened species is not enough for a long-term sustainability. The work to preserve and promote the biological diversity in urban areas has to take place at a local level and with detailed knowledge about the different areas, (Gothnier et al 1999). The habitats in the urban surroundings are dependent on the ability for species to disseminate, i.e. to find food and nesting places. In the town there are lots of obstacles for the organisms; streets, houses and hard surfaces. The flow between natural habitats is dependent of short distances between the different biotopes.

Access to green areas in the densely populated areas is underlined in the Swedish goal for *A Good Built Environment,* (Prop. 1997/97:145. An interim target, *Planning documentation,* stresses the importance of planning strategies for preserving and enhancing green areas and water in urban and suburban areas, (Prop. 2000/01:130). The nature in densely populated areas is probably of minor importance for the *total* biological diversity in the country, (Boverket 1996). Its main importance in urban areas presumably is to give the urban people recreation, nature experiences and to mediate knowledge about essential values of nature. A green environment brings out the seasonal changes of the year. Nature has a restorative power, and it helps people to achieve a fairly quick and strong recovery from fatigue according to psychological research, (e.g. Kaplan 1983). People living close to green areas use them more. People with a garden, private or common, adjacent to their home are reporting lower levels of stress, (Grahn & Stigsdotter 2003).

Verdure has an additional value as seen from the indoors. A green view from the window has been proved to result in lower stress, (Ulrich 2001). Views from the windows, however, will not be assessed here. Impoverishment of biological diversity is assessed as an internal problem for those being in the outdoor environment.

2.1.1 Load values from observations

The assessment of biodiversity deals with existing, natural plant communities on the property. Existing biotopes are assessed with regard to size and degree of disturbance. The term biotope refers to an area characterised by certain conditions and populated by a characteristic biota. An undisturbed biotope is resilient against exterior disturbances. A biotope is regarded as disturbed if it is lacking one or more layers in the vegetation, if it is tidied e.g. dead wood has been removed, or if the ground is drained. Has the biotope left its natural boarders or has there been fragmentation? The size is important because a large biotope can house a higher stock of species than a small. A large biotope is also less affected by the edge effects, i. e. less influenced by the surrounding areas. Classification principles for biotopes and load values for biodiversity are presented in Tables 1 and 2.

Table 1. Classification principles for biotopes

Size	i	Severity of disturbance	ii
Typical size, natural boarders	0	Undisturbed biotope	0
75% of typical size, natural boarders at tree sides	1	Somewhat disturbed, tidied biotope	1
50 % of typical size, natural boarders at two sides	2	Disturbed biotope	2
25 % of typical size, no natural boarders	3	Much disturbed	3
Less than 25 % of typical size	4	Destroyed	4

Table 2. Load values

Size + Severity (i + ii) * 0,125	= Load value
0	no problems
0,25	slight problems
0,50	some problems
0,75	big problems
1	very big problems/ extermination

The load value classes have to be established regionally. Initially the biotope in question on the site is classified as to type. It is compared with an undisturbed reference biotope that is typical for the region. The difference is a measure of the disturbance caused by human interference. Since the size is closely connected to the type of biotope and may vary from less than ten square meters to woods that cover thousands of square meters it is not practicable to indicate exact sizes.

2.2 Problems related to urban microclimate

Sunshine and winds are influenced by construction and landscaping, and they are the most important climatic elements to control with regard to comfort and outdoor staying. In Sweden the winter is long, cold and dark. From April to September, however, it is possible to sit outside in sunny and sheltered places without feeling cold. It may occasionally even be too hot during the summer, but this is rarely a problem. Shade can always be found or arranged.

In the EE method environmental assessments of solar access and wind shelter in the outdoor environment are made for private balconies or patios as well as spaces for common use, e.g. benches or playgrounds. The former Swedish building code contained detailed recommendations for solar access in dwellings and playgrounds. Wind shelter was recommended for the outdoor environment in general. These recommendations have been used as an inspiration for the design of load values for solar access and windiness. Results from investigations made to verify these norms and recommendations have been used in the methodology as explained below, (Westerberg 1989).

2.2.1 Load values from layout plans

Solar access on clear days depends on the geometry - i.e. the latitude, the orientation and the shadows from the surroundings. The geometrically determined solar access can be calculated as the theoretical number of hours of sunshine for representative points in the outdoor environment, e.g. a patio, a bench or a sand-pit for toddlers. It is geometrically easy to make the calculations for the equinoxes. The conditions may then represent an average for the whole year. The assessment of solar access is therefore calculated as the theoretical hours of sunshine at the equinoxes - after 9 in the morning, since most people value the afternoon sun much more. This number van be obtained from a simple overlay on the plan, (Westerberg 1990). A sunpath diagram, however, that gives information for one point for the whole year is much more informative, as shown in the example, Figure 3.

Wind conditions at pedestrian level depend on the local wind conditions and the shape of the surrounding buildings. The general wind conditions in a built up area can be roughly estimated by a method that is based on the analysis of surface roughness in different wind directions, (Glaumann and Westerberg, 1988). The result is yearly median wind speeds at ground level in an open space for various wind directions and a summary value for all directions. These wind speeds are finally modified with respect to the height of the surrounding buildings. The estimated median wind speed corresponds to the average windiness at the windiest corner and it is an indicator of a general windiness, which might be experienced when moving about. The result can be presented in a wind rose showing the effect of the windiness in various directions and indicating strategies for improvement. Wind conditions on balconies, entrances and common outdoor spaces, however, very much depend on shelter from the immediate surroundings, and the interpretation must be modified according to this.

2.2.2 Load values derived from questionnaires made on existing properties

Solar access and wind conditions in the outdoor environment were investigated in five housing estates in different parts of Sweden, from 56 - 66°N, (Westerberg 1989). Here the results have been used to determine the relation between calculated load values and the risk of disturbance. 350 residents responded to questions about solar access and windiness on balconies and outdoor spaces. Solar access at the equinoxes was calculated for every balcony and outdoor space and compared with the residents' assessments. Windiness was measured continuously at several points in two of the areas, and median wind velocities for the whole area were calculated according to the method described above.

Figure 1 shows the relation between calculated hours of sunshine at the equinoxes and subjective assessments of solar access on balconies in general. Figure 2 shows the relation between calculated median wind velocities and subjective assessments of windiness in the outdoor environment, i.e. entrances and benches.

The regression lines in Figures 1 - 2 can be extrapolated and used to transform calculated load values to risks for disturbance. In existing housing estates questionnaires can be used to assess this risk, i.e. the load value. The risk is a dimensionless relation that does not need to be normalised before it is weighted.

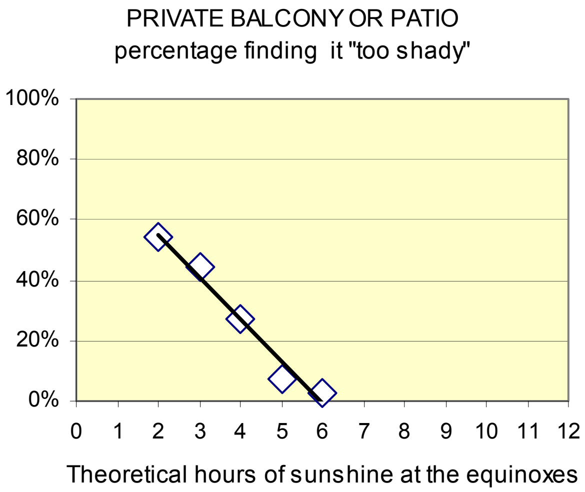

Figure 1. Percentage of users assessing their balcony or private patio as "too shady" with respect to solar access. Each square represents balconies with the same solar access. The answers include 300 residents in ***three*** *housing estates, 7-storey slabs similar in shape (Westerberg, 1989).*

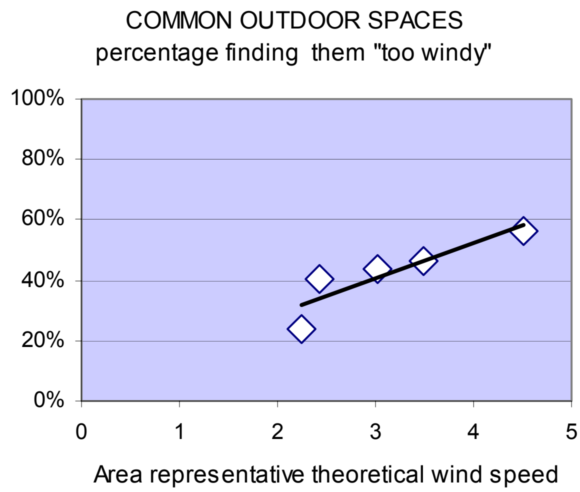

Figure 2. Percentage of residents who assesses their balcony or private patio as "too windy". Each square represents the average assessment from one housing estate. The answers include 350 residents in ***five*** *housing estates. (Westerberg, 1989.)*

3 Damage values

The *damage value* describes the general significance of one problem compared to another, which is the basis for determining the relative importance of problems. It represents averages for a problem or a group of problems at a certain level of disturbance, e.g. traffic noise that is clearly perceivable or windiness that prevents one from "normal" use of the balcony. This means that the effects of the disturbance can be described on a uniform dimensionless scale, so that the damage values are directly comparable.

A method to assess health problems, the DALY method, (Murray and Lopez 1996), has been developed within social medicine in order to be able to make priorities. Different health problems are characterised in terms of Disability Adjusted Life Years. The DALY method has inspired the weighting in the EE method. The weighting of environmental impact in the EE method is accordingly based on the intensity and the duration of the impact. The experienced intensity of the impact is expressed by a *disability weight*. The *duration* is calculated over a life time, i.e. 80 years. This means that a slight problem during a long time is equal to a serious problem during a short time. The *damage value* is the product of *disability weight* and *duration*.

A *disability weight* and *a duration* can be defined for any quantifiable problem that strikes a human being. If it is a disease the question is how disabling it is experienced to be by the average person. Another question is how long time the effect normally lasts once you have been taken ill. Many health problems caused by environmental deficiencies, such as cancer, persist after the exposure to the environmental deficiency. Most comfort problems, like the ones we deal with here, cease when the exposure ceases.

Table 3. EQ 5D+ and modified assessment scales used in the EE method

Aspects of quality of life	EE assessment scale	
Mobility	0	no problem
Self-care	1	small problem
Usual activities	2	some problem
Pain, discomfort	3	big problems
Anxiety, depression	4	very big problem
Cognition		

The EE method has a standardised way to derive disability weights based on the EQ 5D+ method developed to assess quality of life, LQ, (Stouthard et al 1997). The grading in the EQ 5D+ method is made with respect to the impact on 6 different aspects of the quality of life. The assessor can assess all kinds of experienced problems on these scales in a way that is open for scrutiny and modification. The LQ aspect *usual activities* contains the practical and recreational everyday activities that buildings and outdoor environment are normally meant for, and is consequently the most relevant for many internal problems concerning comfort and well-being. The *disability weight* is calculated from weighted assessments on 5-graded scales in the EE method. (3 -graded scales are used in EQ 5D+).

If all the 6 LQ aspects are considered to be of equal importance the following algorithm can be used to calculate the *disability weight*, dw_{VAS}. (VAS is short for answers given along a Visual Analogue Scale.)

$$dw_{VAS} = (\Sigma x_i) /27 \qquad (1)$$

The *duration* is the time that a person would be exposed to the environmental impact if she lived on the premises all her life, i.e. 80 years.

3.1 Disability weights for impoverished biodiversity and problems related to the microclimate

The restorative power of nature is important for relaxation and recreation. Relaxing in the sun, playing with children, reading, walking the dog etc. are everyday activities belonging to the LQ aspect *Usual activities,* table 3. All these activities are influenced by the surroundings and are more pleasant and likely to take place if the environment is green and natural. A nature-like and green surrounding mitigates *anxiety* and *depression*. People are recovering from fatigue and can relax and recover from stress faster when they have access to a garden or a yard. Natural elements also have a pedagogic value, e.g. a value for humans. It is a *cognitive* aspect of nature's restorative effects as explained by environmental psychologists, (e.g. Hartig et al 1991; Kaplan 1983).

It is a big disadvantage not to be able to use the outdoor spaces because they are shady when the sun is out or windy because their position is too exposed. The disadvantage refers to *usual activities*. Sunlight is considered to have a psychological value, and blocked sunlight causes *irritation, depression or anxiety* to an extent that equals 1 on the scale. Windiness is not considered to have the same psychologically depressing effect. Very strong winds, however, could affect mobility negatively. We include this aspect in the *usual activities*.

The above discussion is concluded in table 4, where the *disability weights* are calculated from (1).

Table 4. Disability weights derived from the EQ 5D+ classes with a modified assessment scale.

	Mobility	Self-care	Usual activities	Pain, dis-comfort	Anxiety, depression	Cognition	Disability weight (1)
Biodiversity	0	0	2	0	2	1	0,19
Solar access	0	0	3	0	1	0	0,15
Windiness	0	0	3	0	0	0	0,11

3.2 Duration

5 % of the time is spent outdoors according to a figure that is often mentioned, (source unknown). Recent diary investigations by Statistics Sweden (2000/01) indicate that it is even less, around 3 % as an average for Swedish adults. Outdoor staying, however, varies much depending on area and environment, and it varies individually. Children spend more time outdoors. Season and weather have a very big impact. All weather data in the following comes from Taesler (1971) and they concern Swedish weather conditions, or rather an average, since the climate varies much from north to south, from coast to inland.)

The *duration* represents the time that a person would normally want to use the outdoor environment provided the environmental qualities were optimal. Only a small share of this time is spent on necessary activities in the outdoor housing environment, such as going to and from home. Apart from this necessary outdoor staying it is assumed that weather and season are decisive for outdoor staying, and that biodiversity and microclimate make a big difference when weather and season are favourable.

We assume the necessary passing in and out of the building takes 3 minutes a day, which is all the time spent outdoors on the premises when the weather is nasty. During roughly 50 days of the year in average it is raining or snowing at the same time as the wind speed exceeds 3 m/s. This is what is defined as nasty weather.

A day with more than 5 hours of sunshine is defined as a sunny day, corresponding to 1/3 of the days in winter - October through April, and 2/3 of the days in summer - May through September. We assume that common outdoor spaces are used half an hour a day during winter and one hour a day during summer. This may be true in good environments where people feel safe and like their neighbours, and where many children and holydays at home are included. Such good housing environments, however, are what must be aimed at and therefore used as a reference.

The overcast days in between may be partly rainy and sunny. It is assumed that the daily outdoor staying in the common outdoor spaces is 10 minutes in the summer and 5 minutes during winter including the necessary passages in and out.

All the time spent outdoors in the common spaces must be included in the *duration* calculated for the environmental deficiencies caused by impoverished biodiversity.

When the wind speed exceeds 2 - 3 m/s the urban morphology, e.g. in terms of building height, begins to make a perceptible difference, (Glaumann, M. and Westerberg, U. 1988). The wind speed exceeds 2,5 m/s during 75 % of the time. The duration calculated for windiness is therefore reduced by 25 % compared to the duration calculated for impoverished biodiversity. In the *duration* calculated for lacking solar access only sunny days are included.

The use of balconies is assumed to be concentrated to the sunny summer days. The *duration* calculated for lacking solar access on balconies is estimated to 2 hours a day, calculated for windiness it is reduced by 25 % to 1,5 hours a day.

Tables 5 and 6 summarize the above discussion on *duration* with respect to biodiversity and microclimate. *Duration,* as it is used in the damage value, is calculated for a life-time, 80 years.

Table 5. Estimated duration for use of common spaces and balconies in housing areas.
Italics indicate duration calculated as hours during a life-time

Season	Summer: May - September (153 days)			Winter: October - April (212 days)			Duration
Weather	Nasty, wind and rain	In between	Sunny > 5 hrs sun	Nasty, wind and rain	In between	Sunny > 5 hrs sun	
Nr of days	13 days	35 days	105 days	37 days	114 days	61 days	365 days
Time common spaces	3 min/day *53 hrs*	10 min/day *467 hrs*	1 hrs/day *8 400 hrs*	3 min/day *148 hrs*	5 min/day *760 hrs*	30 min/day *2 440 hrs*	*12 268 hrs*
Time on balconies			2 hrs/day *16 800 hrs*				*16 800 hrs*

Table 6. Estimated damage weights calculated as the product of duration and the disability weight.

Assessment area	Comments on time included in the duration	Duration during 80 years	Disability weight	Damage weight
Biodiversity in common spaces	*All the time is included*	12 268 hrs	0,19	2 432 hrs
Solar access, common spaces	*Only the sunny time is included*	10 840 hrs	0,15	1 632 hrs
Solar access balconies	*Only the sunny summer time is included*	16 800 hrs	0,15	2 400 hrs
Windiness, common spaces	*All the time is included and reduced by 25 %*	9 201 hrs	0,11	1 045 hrs
Windiness balconies	*Only sunny summer time included, red. by 25 %*	12 600 hrs	0,11	1320 hrs

4. Example - Weighted load values for biodiversity and microclimate in a housing estate

The housing estate in this example is situated in Luleå in the north of Sweden, 66°N, Figure 3. The assessment of the outdoor environment basically concerns the area between and around the two 7-storey slabs and private balconies on the west facades.

There is a small birch grove on the site. The biotope is rather small. It is half the size compared with the regional reference type and has natural boarders on two sides. In the grove dead wood is removed and the branches at the stems are pruned.

The solar access, 4 hours of sunshine at the equinoxes, is calculated for a point situated between the houses and representing common outdoor spaces, Figure 3. 4 hours is also the average solar access on the balconies.

The calculated yearly median wind speed, modified for 7-storey buildings, is 3,5 m/s. This corresponds to a probability that 45 % will find the outdoor environment in general too windy according to Figure 2. Walls on three sides shelter the balconies, and the median wind speed has been reduced by 30 %.

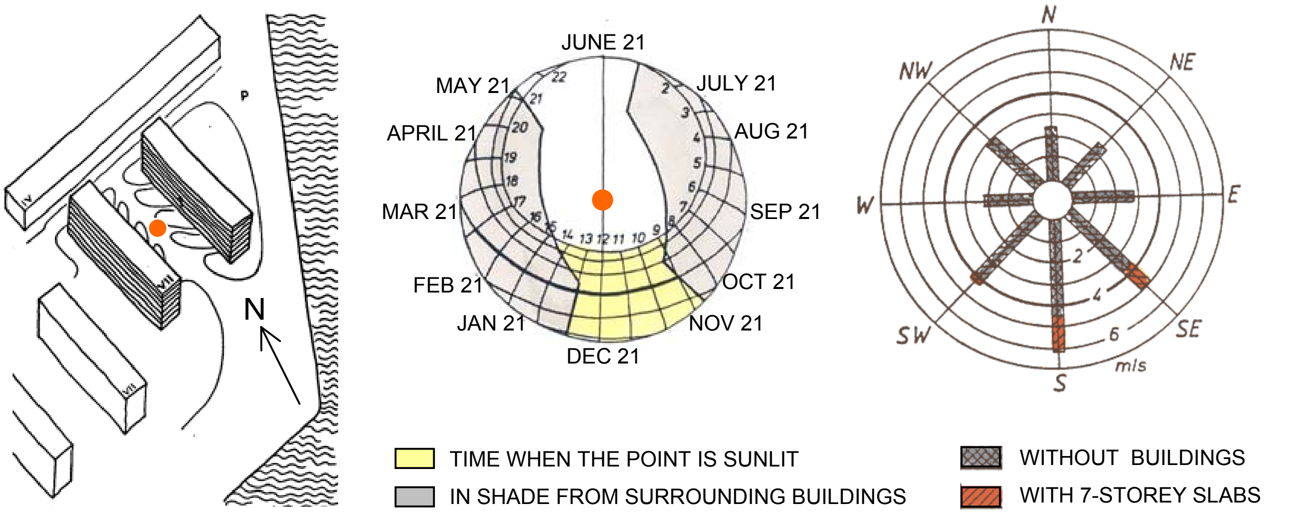

Figure 3. Housing estate with 7-storey slabs in Luleå, 66°N. The sun path diagram in the middle shows solar access in the common outdoor space represented by a point between the slabs. The wind rose indicates estimated yearly median wind speeds for each wind direction and the additional wind speed that is created by the buildings.

Table 7. Calculation of weighted load values for the microclimate of the housing estate in Figure 3.

	Estimated load value	Risk for harm disturbance	Weighted load value	
Assessed parameters	*Estimated from plans or observations*	*From table 1 or Figures 1 - 2 (questionnaire)*	*Damage value (table 6) * Risk for disturbance*	
Biodiversity Size compared with typical size	50 % of typical size, natural boarders at three sides	2 } 0,38		886
Biodiversity Degree of disturbance	Somewhat disturbed, tidied	1		
Solar access in common spaces	4 hours at the equinoxes	0,25	408	} 1037
Solar access on balconies	4 hours at the equinoxes	0,25	600	
Windiness in common spaces	3,5 m/s yearly median speed	0,45	470	} 871
Windiness on balconies	reduced to 2,0 m/s (sheltered)	0,30	396	

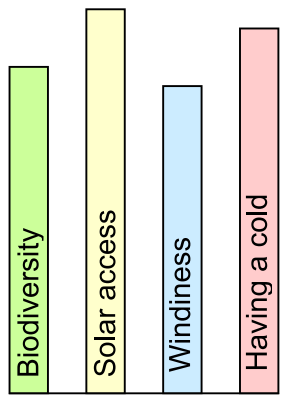

Figure 4. Weighted load values from Table 7 compared with having a cold during 4 days a year.

In Figure 4 the weighted load values in Table 7 are compared with suffering from a cold during four days a year throughout a lifetime, which is an average. The disability weight is estimated to 0,13. The duration is 80 years * 5 days * 24 hours = 7 680 hours. The weighted load value for such a cold is 998 equivalent hours. Is that an adequate comparison? Do you agree with the result?

4 Discussion

The assessments concerning solar access and windiness are based on systematic investigations and experience from the former building code and planning practice. The investigations were made 16 years ago in a kind of multi- family housing environments, which are frequently found in Swedish cities. People's values have changed when it comes to climate and comfort. Today people are more comfort demanding, and outdoor staying depends more on weather and season. And architects' values have changed when it comes to urban design. Today the dominant trends points at increased urbanity, i.e. higher density and higher buildings. These trends are clearly a threat to biodiversity and solar access. They are values that are still important in people's everyday outdoor life. They are values brought out and defended by Eco Effect Outdoors.

Biodiversity and microclimate mainly affect everyday activities, and the residents are the most experienced persons to assess their own outdoor environment in these respects. Questionnaire responses, provided there are enough respondents, are therefore in a sense more valid than calculated load values. The big differences in weather and season make it difficult to undertake assessments in the field and on a single occasion. Weather and season, however, also influence the respondents when they answer the questions in the questionnaire, even though the questions refer to average conditions. The calculations of load values and damage values may seem mechanical, but this is also the strength of the method. The advantage of calculated assessments based on quantifiable properties in the environment is that they reflect a dimension that may be invisible on occasional visits, and they reflect qualities that in many cases can be influenced and improved. Basic values and data included in assessments and weighting, however, are open for scrutiny and they may be changed when new information is available.

More quantitative and updated information on how people perceive climate and biodiversity is needed in the weighting process. Ongoing research on people's relation to biodiversity and "nature" and its importance for health and restoration will hopefully give results that are useful in elaborating the load values and damage values for lacking biodiversity. The use of questionnaires in parallel with calculated load values will make it possible to validate and improve the methodology, e.g. by differentiating it with respect to type of buildings and outdoor environment and with respect to place specific cultural and geographical conditions. The data that is gathered by the method in use is a valuable source of information.

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References

Boverket.1996. Aktionsplan för biologisk mångfald vid byggd miljö.

Glaumann M. and Westerberg U. 1988. Klimatplanering - Vind. Svensk byggtjänst.

Grahn, P. and Stigsdotter, U.A., 2003. Landscape planning and stress. Urban Forestry and Urban Greening 2:001-018

Gothnier. M., Hjort. G. and Östergård. S. (1999). *Rapport från ArtArken, Stockholms artdata-arkiv.* Miljöförvaltningen, Stockholm

Hartig, T., Mang, M. and Evans, G.W., Restorative effects of natural environment experiences. Environment and Behavior, 23:3-26

Kaplan, R. 1983. The role of nature in the urban context. Altman, Wohlwill (red) Behavior and Environment, Vol IV, Behavior and the natural environment, Plenum press.

Murray, J.L.and Lopez, A.D. 1996. The global burden of disease. World health organisation.

Prop. 1997/98:145. Svenska miljömål. Miljöpolitik för ett hållbart Sverige

Prop. 2000/01:130. Svenska miljömål – delmål och åtgärdsstrategier

Secretariat of the Convention on Biological Diversity – UNEP. URL: http://www.biodiv.org/convention/default.shtml

Statistics Sweden. Tidsundersökningen 2000/01. http://www.scb.se/templates/Product____12223.asp

Stouthard et al. 1997. Disability weights for diseases in the Netherlands. Dept of public health, Erasmus University Rotterdam.

Taesler, R. 1972. Klimatdata för Sverige. Statens institut för byggnadsforskning.

Ulrich, R.S., 2001. Effects of health-care environmental design on medical outcomes. In : Design and health (Ed. Dilani A): Svensk Byggtjänst, Stockholm

Westerberg, U. 1989. Klimatstudier i bostadsområden. Underlag för planeringskriterier för sol och vind. SB:19, Statens institut för byggnadsforskning.

Westerberg, U. 1990. Solplaneringsdiagram. Informationsblad från Statens institut för byggnadsforskning.