Property-level Environmental Assessment Tools for Outdoor Areas

Development, Analysis and Comparison

Ulla Myhr
Faculty of Natural Resources and Agricultural Sciences
Department of Urban and Rural Development
Uppsala

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Abstract

There is an increasing interest for building environmental assessment tools in the society. These tools simultaneously consider differing aspects in the built environment although when the aspects most often are of various environmental significance. The structures of the tools i.e. offer a framework to deal with a lot of aspects at the same time. Many actors regard tools to be valuable support for decision making, marketing purposes, communication, and for gaining information.

This thesis is focussing on tools that assess *outdoor environments* within the structure of building environmental assessment tools.

There are two parts in the study. The first part is dealing with tool development; three tools in various levels were developed. One comprehensive tool, including both building and site; one tool for outdoor area assessment; and one tool for in-depth assessment of a single aspect of the outdoor environment, namely biodiversity. The second part is a comparative analysis of ten building environmental assessment tools.

In the comparison of the tools, many differences were found. For example in scope, structure, metrics and the weighting procedure. All these differences are hindering the transparency of the tools and the comparability between various tools. In addition the concept use among the tools is not standardized.

The fundamental values and presuppositions for tools have to be declared to reach more transparent tools for making comparison possible and reliable assessments that are societal accepted.

Keywords: Outdoor assessment, building environmental assessment tool, method development,

Author's address: Ulla Myhr, Department of Urban and Rural Development, SLU
Box 7012, SE-750 07 Uppsala, Sweden
E-mail: Ulla.Myhr@sol.slu.se

Svensk sammanfattning

Under några decennier har intresset i den industrialiserade delen av världen ökat för att använda verktyg för att bedöma miljöpåverkan som är förknippad med den urbana utvecklingen. Många olika sektorer i samhället har börjat reflektera över sitt ansvar för olika miljöproblem, det har även byggsektorn gjort.

Myndigheter och allmänheten ställer numera högre krav på att byggsektorn ska ta större miljöhänsyn än tidigare. Det finns exempelvis önskemål om miljödeklarationer eller miljömärkning för att det ska vara möjligt att kunna granska byggmaterial, produkter och även hela byggnader utifrån deras miljöbelastningar. Här kan miljövärderingsverktyg vara till hjälp. Även byggsektorn ser möjligheter med att använda värderingsverktyg som beslutsstöd i valsituationer som kan innebära olika miljöpåverkan.

Miljövärderingsverktyg för byggnader (i vissa fall fastigheter) förkortas i fortsättningen med MVB. MVB är ett sätt att förutsäga, beräkna eller bedöma miljöprestanda för byggnader. Syftet med verktygen är att demonstrera hur bra eller hur dålig en byggnad är när det gäller miljöpåverkan. Ett miljövärderingsverktyg består av en systematisk steg-för-steg procedur och en matematisk beräkningsmodell. Värderingen syftar till att ange ett kvantitativt mått på byggnadens miljöpåverkan. I verktygen innefattas många indikatorer som är var och en för sig är karaktäristiska för valda områden av miljöpåverkan och som varierar med graden av miljöpåverkan. Indikatorerna bedöms efter angivna kriterier och poängsätts efter en skala. Detta är ett sätt att samtidigt värdera en mängd olika aspekter av miljöpåverkan på en fastighet och att de olika aspekternas relativa betydelse tas hänsyn till. En sammanräkning av poängen görs, antingen till en slutpoäng eller för delområden. Därefter ger vissa verktyg ett betyg eller en märkning för det värderade objektet.

Idag finns det många verktyg över världen. Utvecklingen startade med att det brittiska verktyget *BREEAM* presenterades. Det är fortfarande idag det mest kända och använda verktyget. I Sverige heter den mest välkända MVB *Miljöstatus,* och har sedan verksamheten startade år 1997 används vid miljövärdering av cirka 2400 byggnader i Sverige .

Olika aktörer har olika perspektiv på MVB. Myndigheter ser möjligheten att använda MVB i kommunikation med byggsektorn om miljöfrågor. Eftersom många nationer har minskat regleringarna inom byggandet kan verktygen vara ett sätt för myndigheterna att ändå styra och kontrollera, men i större samråd med byggsektorn.

Byggherrar å sin sida ser att MVB kan användas i marknadsföring. De vill gärna demonstrera alla sina ansträngningar att bygga miljöanpassat. Verktygen kan också komma till användning i köp-och–sälj situationer, då en köpare vill förvissa sig om att slippa miljömässiga negativa överraskningar. Användarna av husen, boende eller arbetstagare, kan få miljöinformation om byggnaderna, kanske i form av en lättförståelig märkning. Majoriteten av MVB har hittills inte beaktat utemiljön i värderingen. Fokus har istället riktats mot själva byggnaderna eller byggprodukterna. Denna avhandling vill ändra på detta faktum och lyfta fram att utemiljön är en viktig del av boende- och arbetsmiljön. Ytterligare en drivkraft är att fler MVB ska inkludera utemiljö som en självklar del i en värdering.

Syftet med den här avhandlingen är att öka våra kunskaper om strukturella och metodologiska aspekter både av verktygen och av utemiljöindikatorer som används i verktygen, detta genom att klassificera, jämföra och analysera verktyg för utemiljövärdering.

Olika frågor har präglat de olika delstudierna. För att konkretisera arbetet vidareutvecklades ett preliminär utemiljövärderingsverktyg som en del av ett svenskt projekt. *EcoEffect* är ett miljövärderingsverktyg för byggnader och tomt. *EcoEffect* är ett övergripande verktyg som strävar efter att värdera all viktig miljöpåverkan från byggnader och tomt. Det är uppbyggt av fem delar som var och en fokuserar på olika delar av miljöpåverkan, energianvändning, materialanvändning, innemiljö, utemiljö och livscykelkostnader. Utemiljödelen kallas *EcoEffect Ute*. Det konkreta arbetet med utemiljövärderingsverktyget syftade till att klargöra aspekter av verktygsutveckling. Detta skedde genom att praktiska test av verktyget genomfördes på existerande fastigheter. Verktyget diskuterades med experter, landskapsarkitekter, ekologer och boende.

För att få ett bredare perspektiv på miljövärderingsverktyg jämfördes och analyserades tio verktyg från olika länder. Här rörde frågorna sig om skillnader och likheter i struktur och metodologi. Hur de olika verktygen benämnde olika delar och företeelser studerades också eftersom det inte finns någon gemensam terminologi. Denna studie syftade också till att söka gemensamma begrepp för att benämna de olika delarna i värderingsverktyget och i värderingen. Även innehållet i verktygen undersöktes, det vill säga vilka frågor innefattades i verktygen och hur stort inflytande hade dessa på verktygets slutresultat? De indikatorer som verktygen innefattade kategoriserades och verktygen jämfördes sinsemellan. Den sista undersökningen innebar en fördjupning i en enskild indikator i utemiljön. Studien syftade till att utveckla ett verktyg för att mäta biodiversitet på fastighetsnivå. Hur kan detta göras med både de vetenskapliga och de praktiska kraven uppfyllda? Två teoriområden sammanfördes och tillsammans kunde de konstrueras till en modell för värdering av biodiversitet.

Resultaten av undersökningarna fördelar sig på två områden: metodutveckling och den jämförande analysen. I metodutveckling är det själva metoden som är resultatet. I den här avhandlingen presenteras verktyg på tre olika nivåer, den mest övergripande nivån är miljövärderingsverktyget för byggnader och tomt, *EcoEffect*. Nästa nivå är verktyget för att värdera utemiljöer, *EcoEffect Ute*. Det ”smalaste” verktyget, det vill säga för den mest specialiserade användningen, är verktyget för att bedöma den lokala påfrestningen för biodiversitet på en fastighet, det så kallade *HD-verktyget*.

När de olika metodernas struktur jämfördes, visade det sig att metoderna är uppbyggda enligt två olika principer: hierarkisk struktur eller checklistans struktur. En grundläggande svaghet för MVB kunde också urskiljas, nämligen bristen på transparens. Både hierarkin och checklistan är förknippande med respektive fördelar och nackdelar. Den hierarkiska strukturen innebär att alla indikatorer i värderingen vägs samman till en eller flera slutpoäng. Sammanvägningen sker med hjälp av ”vikter” då de olika delarna relateras mot varandra och mot det övergripande målet med värderingen. Själva strukturen hos hierarkin har inneboende möjligheter att klarlägga vilka värderingar som styr utformning och avgränsningar i verktyget. Värderingarna som ligger till grund för verktyget kan därmed visas upp. Nackdelar med hierarkin är att den tenderar att bli svår att förstå om det är många nivåer i hierarkin. Checklistans struktur är enkel. Alla indikatorer värderas i en nivå och poängen summeras. Alla indikatorer kan belönas med olika antal poäng. Nackdelen med checklistan är att logiken för att fördela olika antal poäng för indikatorerna inte redovisas. Det är därmed inte möjligt att förstå sambanden mellan hur de olika indikatorerna värderas.

I utvecklingsarbetet var landskapsarkitekter delaktiga och i diskussioner klargjorde de att metoder som inte var tydliga och lättförståeliga saknar användningsområde. De är inte intresserade av hjälpmedel som de inte har insyn i och som de kan förstå funktionen av. För att MVB ska bli en kraft som kan förändra byggandet och särskilt hur utemiljöer hanteras i byggprocessen, är det nödvändigt att alla aktörer kan känna sig säkra på åt vilket håll värderingsmetoderna styr och på vilka grunder. Detta innebär att verktygsmakarna har en pedagogisk och metodologisk utmaning framför sig i den fortsatta utvecklingen av hjälpmedel i riktning mot det miljövänliga byggandet.

Contents

List of Publications

This thesis is based on the work reported in the following papers. In the text they are referred to by the appointed Roman numerals.

I Assefa, G., M. Glaumann, T. Malmquist, B. Kindembe, M. Hult, U. Myhr and O. Eriksson. 2007. Environmental assessment of building properties - Where natural and social sciences meet: The case of EcoEffect. *Building and Environment* 42:1458-1464.

II Myhr, U. and R. Johansson. 2007. EcoEffect for outdoor environments: The process of tool development. *Environmental Impact Assessment Review*. doi:10.1016/j.eiar.2007.09.001. In press.

III Myhr, U. and R. Johansson. 2008. A comparative analysis of property-level building environmental assessment tools; outdoor assessment. Submitted paper.

IV Forsberg, O. and U. Myhr. 2008. EcoEffect Outdoors – Habitat Depletion: A Novel Tool for the Assessment of locally inflicted strain on biodiversity in Urban Properties. Submitted paper.

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In Paper I Myhr contributed to the development of the overall structure for EcoEffect. She participated in the information exchange processes in dialogue and workshops with the stakeholder group. The author contributed to the test, evaluation and development of the computer software linked to the system EcoEffect. Assefa was the principal writer of the paper.

Paper II is entirely based on data collection and processing by Myhr. The paper was written by Myhr with Johansson as the discussion partner throughout the work.

Paper III is entirely based on data collection and processing by Myhr. The paper was written by Myhr with Johansson as the discussion partner throughout the work.

Paper IV is based on data collected and processed by the author and Forsberg together, equally in merit. They share the responsibility for the development of the tool and for writing of the paper. Myhr took the initiative to the article. She holds a greater responsibility for the accommodation of the ideas to the EcoEffect framework and Forsberg is the biodiversity specialist.

Introduction

Growing concern over resource depletion and environmental pollution associated with urban development both in Sweden and in rest of the industrialized world has emerged in recent years. This has led many individual sectors to reflect on their contribution to various environmental problems. The building sector is one such sector. Increasing awareness in the sector of these issues has precipitated a shift in how buildings are designed, built and operated (Crawley & Aho, 1999). The idea of "green" building has emerged. Green building practice means that environmental issues are taken into consideration, i.e. efforts to increase the efficiency of resource use to bring about a reduction of the impacts of building construction and usage on human health and on the environment. A number of global conferences have taken place on green building practice over the last ten years, starting with Vancouver in 1998, and continuing with Maastricht, Oslo, Tokyo, and Melbourne, 2008.

The growing concern for environmental problems associated with urban development is also reflected in governmental and public expectations of the building sector. Today governments and the general public continually seek to call the building sector to account asking for improvements and "green labelling" in respect of e.g. building techniques and material choices. The building sector in turn, requires researchers to help them to discriminate between different alternatives in the environmental dimension in both the planning and management stages. The sector is also of course interested in obtaining market advantage through the green labelling on their products, the buildings. In this context a plurality of building environmental assessment tools, further abbreviated as beat, have developed.

BEAT is "a technique that predicts, calculates or estimates one or more environmental performance characteristics of a building" (Cole, 2005). It aims to demonstrate how good or how bad a building is environmentally. A tool typically consists of a systematic step-by-step procedure and a mathematical model (Baumann & Cowell, 1999). The tools included in this study, are criterion tools. This means that they include several indicators which represent the environmental problems that are addressed by the overall objective. The indicators are related to each dependent on their significance. These tools aim to illustrate the consequences of decisions and choices made in respect of various designs. BEAT contribute scientifically to the understanding of the relationship between the building and the environment (Cole, 1998).

Great diversity currently exists in respect of BEAT usage across the globe, with a concentration of different tools used within the developed countries. The field concerning environmental assessment tools for buildings started to develop with the launch of the British system, *Building Research Establishment Environmental Assessment Method, BREEAM* (BRE, 2006) in 1990. *BREEAM* began as a simple checklist for the environmental assessment of office buildings and it was something of a success. During *BREEAM*'s first four years, 25 % of all new office buildings in the UK were assessed by *BREEAM* (Boverket, 1998). Today this is the world's leading and most widely used BEAT with over 100 000 buildings certified (BREEAM, Without year). In Sweden the leading tool, *Environmental status of buildings,* has since 1997 inspected and assessed about 2 400 buildings (Miljöstatus, Without year). The success of *BREEAM* has been a model and an inspiration for many tool developers across the world.

This thesis is oriented around tools that assess *outdoor environments* within the structure of BEAT. In relation to the vast number of BEAT currently used, relatively few are found to recognize the outdoor environment in the assessment scope. The BEAT that include outdoor issues have until now not been analysed and compared with a focus on outdoor issues. Knowledge of what they include, how they assess outdoor issues, and how much the outdoor issue may influence the overall assessment, remains therefore limited. This thesis is an effort to change that situation.

1.1 Various perspectives on BEAT

Historically, governmental legislation in developed countries has driven the building sector towards the development of greater environmental awareness. Since the 1990's the focus on legislation has however shifted towards the embracing of voluntary agreements between the sector and government. Even if legal regulations continues to be important, voluntary agreements between government and sector are increasingly required to address environmental problems (Aggeri, 1999). In later years, deregulation of the building sector has seen many countries redirect their building codes and regulations from feature-based to performance-based requirements. This equates to a change from controlling by rules to controlling by goals. Voluntary BEAT are accepted by many governments as an alternative to complying with building regulations (Crawley & Aho, 1999).

Since legislation nearly always represents the consensus on the *minimum* performance improvements, it is therefore unlikely to create sufficient force to mandate a substantial level of improvement (Larsson, 1999). BEAT then provide an option to exhibit a detailed assessment result. The opportunity to advertise the result of an assessment which is *better than average* is then probably driving developments here towards increased environmental concerns being more forcefully addressed than would otherwise be the case through the legislative route.

BEAT are considered potent and effective vehicles in improving the environmental performance of buildings and in promoting higher demands and expectations. BEAT have emerged in the conceptual gap between the academic desire for objective, scientifically relevant and stringent indicators and the sector's desire for practical, transparent and foremost, easily understandable indicators that are easy to communicate. The various actors in a building process each have different definitions of building performance and consequently different expectations and demands in respect of BEAT. BEAT are therefore utilized for multiple purposes, each different for the various actors concerned. The context of decision-making and the stakeholders involved determine what information is required (Olsthoorn *et al.*, 2001). Ding (2008) describes an ideal BEAT as including all the requirements of the different actors involved in the development. Among their purposes, BEAT can promote incentives for building owners, designers and users to develop high-quality sustainable buildings and sites (Larsson, 1999).

A *building owner's* or the *building management's* major focus may be that the building performs well from a financial perspective. A financial return is fundamental for all building projects (Ding, 2008). Few of the studied BEAT however include financial aspects in their evaluation framework. Environmental issues are however now emerging as an important issue. There is a need to communicate environmental improvements in a structured way with stakeholders e.g. to receive market advantages. Building owners striving for a higher environmental standard can use BEAT as a means to demonstrate their efforts to attain higher environmental standards and thus gain market reward (Cole, 1999). Assessment by a BEAT can offer assessment result in various levels of details. At on hand the result can provide easily understandable labels appropriate to present to an external public, and at the other hand present a detailed declaration offering the potential to identify opportunities for internal environmental improvement targets. The building owner may also strategically use environmental information about the building to monitor its development or direct management to formulate the environmental targets for a company's strategic efforts. The BEAT may provide basic data for changeovers and elucidate the consequences of various choices. A learning process is in this way directed at the companies while potential exists to implement a common language.

BEAT can be useful in purchasing situations (Olsthoorn *et al.*, 2001). The *purchaser* can use BEAT to provide information about the environmental condition of the property. The *investors* also need to know whether environmental liabilities, which could potentially affect the financial performance of the property, exist.

The *occupants,* the users of the buildings and outdoor environments, mainly direct their focus at safety and maintenance issues (Myhr & Johansson, 2007). These issues are in the main not even comprised by BEAT as they are not considered to be environmental issues by the toolmakers. The occupants are also concerned with comfort and health issues, which some BEAT do consider. A consumer may request environmental information at a general level, perhaps a simple signal that says if the building is "green" or not (Olsthoorn *et al.*, 2001).

Governments can use voluntary agreements to enhance communication with the building sector. Society is concerned both with development and economic growth and also with the long-term effects of living standards for present and future generations (Ding, 2008). Some tools are used by governments for building approval and as a guideline for enhancing 'green' building. As such, BEAT are adopted both for control and as a positive motivational influence. In the USA, national and local governments use the green building rating system *Leadership in Energy and Environmental Design, LEED,* for public-owned and public-funded buildings (USGBC, 2008). In Japan, local governments in some major cities such as Osaka, Kyoto and Yokohama have adopted the *Comprehensive Assessment System for Building Environmental Efficiency, CASBEE.* Local governments require the building owners to report the result of an assessment by CASBEE when they put up a new building. Just over 2000 buildings have submitted their results to the governments between the 2004 and 2007 (JSBC, 2007).

Environmental issues should be addressed in the earliest phases of a development process to minimise negative environmental impacts (Ding, 2008). The *designers, as architects and engineers,* are helped most by a tool designed for the pre-design stage where tools focus on green practice, where they can be particularly useful in providing structure and priority, such as strategic advice, to the design team (Cole, 2004). BEAT are also used to inform decision makers at all stages of the design development and to provide a common "yardstick" for measuring progress towards sustainability (Cole, 1999). The use of BEAT often includes additional services, such as education and training for the staff members by the companies that provide the BEAT. This can help generate a learning process among the designers.

A primary objective for many of the *toolmakers* of voluntary tools is to stimulate market demand for buildings with improved environmental performance (Cole, 1999). There is however something of a conflict here, on the one hand the tools have to be credible within the environmental community while on the other they must also be attractive to the sector with its desire for recognition in respect of environmental performance (Cole, 1999). They want to provide a basis for making informed design decisions and to assist with guidance during each of a building's life-stages by prioritizing between issues and by suggesting how various options relate to each other (Cole, 2004). The toolmaker wants to evaluate how successful any development is with regard to balancing energy, environment and ecology (Ding, 2008). Many building and design companies around the world have developed tools providing assessments of properties, over various stages of the building's lifetime. Some BEAT are the result of cooperation between three groups, the building sector, academia and government. Others are the result of efforts within one or two of these groups. In addition a few also include non-governmental organisations, NGOs.

1.2 Comparability versus parallel development

Some countries have witnessed the parallel development of more than one tool, e.g. in Sweden, the USA and Canada. These tools focus on various issues; they operate in different scales, and thus the results of the assessments undertaken are not easily comparable. Parallel development can be useful and may in some cases be beneficial. Cole (2006) considers competition to improve the quality of tools both in respect of technical and operational aspects. Competition stimulates refinements to both current aspects and future directions. The existence of several tools enables specialisation ensuring that users can be supplied with a proper 'targeted' tool. Any single tool cannot cover ever conceivable goal, goals which in any case may be contrary. A lack of competition in the market can induce conservative behaviour since the presence of only one tool may help stagnate intellectual debate while also creating 'lock-in' effects for those who wish to extend the scope of the prevailing method (Cole, 2006).

An additional drawback as regards the range and scope of tools is their lack of comparability. Haapio and Viitaniemi (2008) consider it nearly impossible to compare one BEAT and it's result to another, since they are designed to assess different types of buildings, different stages in the building's lifespan and they often rely on different foundations.

2 The research problem and research questions

This thesis is oriented around tools that assess outdoor environments within the structure of BEAT. In relation to the vast number of BEAT which have already been developed around the world, relatively few tools recognize the outdoor environment to be an issue in the assessment scope. Furthermore, since tools which include outdoor issues have not yet been analysed and compared with a focus on the outdoor issues, limited knowledge exists of what aspects of the outdoor issues the tools include. The question of which issues are included, how they are assessed, and how much the outdoor issues may influence the overall assessment, are all important to understand in respect of increasing our knowledge here.

The actors in the building sector are eager to use tools both to gain market advantage and as a means of meeting governmental and public demands. Many governments have removed regulations concerning the building sector. They are increasingly using tools as support to encouraging green buildings and for evaluating building permission applications.

The situation is thus, the building sector is currently facing rising demand for tool usage while it still possesses *insufficient knowledge* about what aspects the tools give priority to and how they relate various aspects to each other.

Both of the *individual elements* in the assessments are important, while the *organization* and the *structure* of the tool are equally important (Cole, 2005). Therefore, the focus is not only on outdoor issues in respect of the tools, but also on the entire tool.

2.1 Aim and research questions

The aim of this thesis is to classify, compare and analyse outdoor environmental assessment tools in order to enhance our understanding of the structural and methodological aspects of the tools, and the outdoor indicators of the tools. And to contribute to the development of the concepts used in outdoor assessment as conducted by building environmental assessment tools.

The questions outlined below have provided a guide throughout the work. They are a support to focusing on the data in various ways and help break up the aim into a number of substantial parts.

- What can the process of test and modification of *EcoEffect Outdoor* teach us about tool development?
- In what structural and methodological aspects do building environmental assessment tools display similarities and in what aspects do they differ?
- What issues are included in the outdoor assessment units for BEAT assessing outdoor issues, and to what extent does the outdoor assessment influence the overall result?
- How can biodiversity at the property-level be assessed with all scientific as well as practical demands fulfilled?
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The purpose of this research is to produce a richer picture and indicate the advantages and shortcomings for tools which assess impacts in outdoor areas. One way of gaining knowledge of tool development is to design and test a tool. As such then a tool designed specifically for the Swedish context was developed, presented to experts and stakeholders, and tested in practice. In addition, the thesis aims to discern how the tools deal with outdoor issues i.e. which issues are included and how are they assessed?

The outdoor environmental assessment area is often part of a comprehensive assessment including many aspects of a building and the property. To increase our knowledge of this relationship, the outdoor issues' importance as compared to the overall assessment was scrutinized in various BEAT.

2.2 Delimitations

This research was delimited to building environmental assessment tools which use the property border as the functional border i.e. the property is the basis of comparison. Therefore, tools with limits such as the town, region or other, were not included in this study. In addition, selected tools include more than one aspect of the outdoor environment, which means that tools that only deal with one issue e.g. storm-water treatment, were also omitted.

The BEAT were scrutinized through an interaction with written material provided by tool administrators and manuals and descriptions that were made available in reports or on websites on the internet etc. The tools were thus not tested in practice, with one exception, *EcoEffect Outdoor*, which was developed in conjunction with the carrying out of this research.

Note also that the weighting process is *not* dealt with in this thesis.

3 Concepts and components in BEAT

When describing BEAT, reference to a set of concepts and components is useful. In this section the central concepts of BEAT are mapped. The concepts are critically reviewed; here the way in which the concepts are used in the tools and in the field of research is presented. In addition, how the concepts are used in this thesis is also specified.

Outdoor environment refers to the physical outdoor conditions at the property. Here the terms *outdoor environment*, *outdoor area* and *outdoors* are used synonymously. Vegetation, playing grounds and other places where people spend time using the environment in conjunction with their home or workplace are found in the outdoor environment. In addition, water surfaces, roads, areas with roof as well as bicycle stores and hard surfaces are included in outdoor areas. The outdoor areas can be described in terms of physical objects but can also be described in characteristic dimensions such as climate, noise, orientation, complexity and beauty. The properties of the outdoor area are changing by natural causes, e.g. trees are growing high.

Various tools are proposed for use at various scales. A significant range of difference exists between tools with a narrow scope and the most widely embracing tools while in this regard Crawley and Aho (1999) identify several levels of inclusiveness. They describe *environmental impact assessment*, EIA, as one endpoint of the scale of inclusiveness. EIA tools operate on a broad scale, on the community level, assessing the allocation of buildings in the community, including supporting infrastructure and amenities in the proximity. An assessment by EIA assesses the site and its context specific environmental impacts.

The other endpoint is depicted as *life cycle assessment*, LCA. These tools have a narrow scope and specialize in assessing e.g. separate building components, individual construction materials or energy use. The assessment handles non site-specific potential impacts on the environment.

Crawley and Aho (1999) consider a building to be identified as both a product of which the performance can be assessed and as a generic industrial product of which the function can be assessed. The building incorporates a variety of characteristics of both aspects and can be considered as being somewhere in between these two endpoints. This is also mirrored in the scope of the various BEAT. Many BEAT use LCA to assess energy and material use while other BEAT include the buildings contextual aspects in the assessment by assessing e.g. proximity to bus stops and shops.

Tools regarding the *property level scale* use the property, both building and site, as the unit of assessment. Environmental impacts that are related to energy and material use, dependent on the construction or management of the property, are included in the assessment, while environmental impacts that are dependent on the context but which occur inside the borders of the property e.g. air pollution, are also included.

There are various terms to denote the individual efforts to assess environmental impacts or concerns. Both the term tool and method is used for the level of assessment that BEAT produce. In summary, Cole considers the difference between a tool and a method to lie in who is executing the assessment and the extent of the assessment. Cole (2005) considers an assessment *tool* to be a technique which deals with one or more of the environmental performance characteristics of a building. A designer who deems it appropriate in their project can use a tool as a decision support. Cole contrasts tool to *method* and concludes this to be a structured framework in which to assign performance credits and deliver a label or a rating. He regards a method to be is executed by an assessor who is certified by the administrator of the method and who, in addition, can deliver *a third-party verification*.

Trusty (without year) presents a typology where he ranks tools in three levels depending on where in the design/assessment process they are used and for what purpose. *Level 1* tools are used in the procurement state and are a product comparison tool. They may include economic issues in addition to environmental data. They are not intended to be used in a complete building assessment. *Level 2* tools are whole building decision support tools and are used as early as possible in the design phase. They focus on a specific area of concern such as lighting or operating energy. Level 2 tools are design-oriented and adhere to formal standards such as ISO or ASHREA. *Level 3* tools are whole building assessment frameworks utilised in relation to new designs or existing buildings. They provide broad coverage of the issues deemed important for sustainability such as economic, environmental, social or other issues. Most of the level 3 tools produce an overall assessment based on a weighting or an additive process of all issues entered into the assessment. Many of the level 3 tools offer a label or a certificate which indicates the building's environmental performance. The level 3 tool may also supply a third-party verification.

In summing-up, Cole's description of *method* and Trusty's description of *level 3 tools* are equivalent. However, neither recognizes the property-level as being significant. In this thesis the property level assessment which includes the outdoor areas, is the focus. Neither Crawley and Aho (1999) nor Todd *et al* (2001) include this when comparing criterion systems with one aspect being the scope of the tool. They rank the tools by their inclusiveness of scope. None regard the building and site as a scope level. Both the analyses go directly from the building level to the building and supporting infrastructure level. *The building and site i.e. the property level is not distinguished.*

The approaches use various terms to categorize themselves. They use *method, system* and *tool*. The concepts are sometimes an effort to advertise the variety of comprehensiveness where the system advertises comprehensiveness in excess of tool and method, but the terminology is not yet established.

In this study, the term *tool* is used to denominate the studied efforts for systematic environmental assessment since all, but one, are viewed as level 3 tools in the nomenclature by Trusty (without year). The exception is designed for assessing outdoor areas. When the indicators of the tools are compared in the study, only the outdoor indicators are topical.

A *property* is the land area with attached buildings and other immovable properties such as vegetation which constitutes a jurisdictional entity. BEAT consider the features of the building and the land – the physical environment at the property. BEAT are normally intended for the assessment of properties with residential purposes or for workplaces such as offices or retail. In general the tools are not designed to detect contaminations at industrial properties or for the evaluation of entirely vegetated areas such as parks or forests.

In order to assemble an assessment tool a certain amount of simplification has to take place. *Indicators* are quantitative, qualitative or descriptive measures which represent the phenomenon being studied. Indicators simplify information which can help to reveal complex phenomena. If they are repeatedly evaluated, they can show the direction of change (SS-ISO, 2004). According to the European Environment Agency (EEA) an environmental indicator is a "parameter or a value derived from parameters that describe the state of the environment and its impact on human beings, ecosystems and materials, the pressures on the environment, the driving forces and the response steering that system". A shorter definition would be: "a variable which helps to measure a state or a progress towards an objective" (CRISP, 2002).

In BEAT the indicators are used to assign numerals to a phenomenon, as approximate values on an explicit environmental problem (Malmquist & Glaumann, 2006). The selection of indicators is a concretization of what the toolmaker considered to be the problem. The indicators are used to construct a simplified picture since they describe the state of a phenomenon with a significance extending beyond what is directly associated with a parameter value. An indicator is quantified to allow comparison. The challenge in terms of tool development is to quantify the variation of a feature, the indicator, according to rules established in the tool.

The terminology differs between tools when quantifying the indicators: e. g. points, credits and loading values are expressions in use. In this research, the term *credit* is used regardless of which term is utilize by the reviewed tools. The assignment of a number of possible credits for each performance issue which can be earned by meeting a given level of performance is referred to as *scoring* (Cole, 2003).

The fundamental value is expressed in the *overall objective* of the tool. It is the apex of a hierarchy and a concretisation of the fundamental value. All issues that are considered by the hierarchy should be related to the overall objective. Overall objectives determine what is regarded as an environmental load feature and therefore what aspects of the outdoor environment are included in the hierarchy. The fundamental values frame the decision made in respect of how to choose between alternatives and how to influence the design of the tool.

Structuring the indicators is useful since it provides a common framework which provides an account of all of the important issues included. The structuring process ensures that all important issues are integrated. The structuring process itself can be a support for revealing the objectives and may also identify indicators. Decision makers and stakeholders can then relate to the framework when evaluating the design or change options. The structure also facilitates communication (Andresen, 2000:58). Various structures are used in the BEAT context. The two most common are checklist and hierarchy described below.

A checklist is here referred to as a straightforward ordering of information where the issues to be considered are listed. One sub-originated level can be used to organize the information. When a checklist is used as a building environmental assessment tool, each indicator is described and target levels are assigned for the indicators. Dependent on the attained target, various numbers of credits are distributed, without consideration for the significance of one indicator relative to the others (Cole, 1999). No weighting is executed in a checklist. To reach a final score an additive process that summarises all of the credits into one single score is carried out.

A *hierarchy* is a theoretical construction that allows us to examine the interaction between the parts of the system and the impact on the system as a whole (Saaty, 1990). Hierarchies are preferable when there are subordinated levels of data, or when data has different levels of detail. A hierarchy contains all the problems included in the assessment and the structure permits a focus on one issue at a time without loss of overview (Andresen, 2000). At the top is the sometimes abstract overall objective but each level down the hierarchy becomes more concrete with an increasing level of detail. At the very bottom of the hierarchy are the measurable variables, the parameters that are classified using criteria limits for the score intervals. Andresen (2000) takes the view that one advantage of the hierarchical structure is that it generates an overview in which different aspects of the same problem are brought together step-by-step by use of weights. In a hierarchy a common scale is used to assign credits to the various indicators (Cole, 1999). This means that the various steps in the scale increment are related to each other in a coherent system.

Assessment tools, as they are a type of measurement, try to convert empirical observations into values which are possible to assess, evaluate or to compare to other observations (Frankfort-Nachmias & Nachmias, 1996). Both *what* to measure – the selection of indicators, and *how* to measure it – e.g. the rules are significant in tool development.

Weighting, as it is an expression of the fundamental values and consequently the overall objective of a tool, is a way to model the relationship between the significance of different criteria or problems (Andresen, 2000), it is i.e. a way to relate the significance of various impacts to each other and in relation to the selected overall objective.

The user of a BEAT is given assistance in setting priorities between alternatives by means of a systematic weighting system. It is used to gain a better foundation for decisions. The impacts at lowers level are merged, aggregated into higher levels with use of weights. In this way the relationship between different impacts are established. The weighting reflects the significance or danger dependent on what is chosen as a weighting aspect. Different types of data are assigned weights – the same or different levels of significance – dependent upon the overall objective. Aggregation and weighting are two sides of the same process, and as such are tightly intertwined. However it is complicated to realize all important links and relationships between a property and potential impacts, as such, considerable research and data collection will be needed before these relationships can be established (Cole, 1999).

The alternative to aggregation and weighting is to present all of the data generated in the survey without processing it. Without this type of aid, the extensive quantity of information would however preclude an efficient use of the assessment to support comparisons or decisions.

One of the main objectives in improving building environmental performance is to minimise the amount of energy and material used in the construction and management processes. When the quantities are reduced, impacts caused by energy and material use, such as emissions and resource depletion, are also reduced. Another objective in improving building environmental performance is to quantify the direct impacts experienced by humans in the building or at the site, e.g. indoor and outdoor environment. Different tools usually handle these two areas of impacts; Life Cycle Assessment methods, LCA, are mostly used for assessment of external impacts and *criterion systems* for internal impacts.

Various tools use different delimitations for the assessment and in addition issues that are taken into account do vary. There is no consensus either among the toolmakers or the users of such tools, about how environmental assessment for the built environment should be conducted or in respect of what issues to include (Sundkvist *et al.*, 2006). Perhaps there will never be an agreement in this matter since it ultimately depends on what values we want to protect and safeguard (Finnveden, 1997).

There are a number of comparisons between various BEAT. The LCA tools have hitherto received most attention and interest from researchers. LCA was initially developed to assess *products* or *services* and, as such, is not adequate to assess either indoor or outdoor environments. Therefore these tools do not normally include impacts in outdoor areas in their scope. Consequently, the prevailing comparisons between LCA tools do not tell us much about outdoor issues. When comparing LCA tools, Forsberg and Malmborg (2004) conclude that land-use is difficult to assess via LCA tools since the majority of the tools are not site-specific. It is a typical characteristic for BEAT to be site specific in contrast to LCA tools.

3.1 EcoEffect, an overview

EcoEffect is a BEAT developed for the national context in Sweden. *EcoEffect* is comprehensive and assesses many environmental aspects of the built environment. In this thesis *EcoEffect* had a two-fold role. It formed both the background and the framework for the outdoor environmental assessment tool. It was also itself subject to elaboration in the process since the development of the outdoor sub-area, as with the other sub-areas, implied changes in the *EcoEffect* system. The development and changes in the sub-areas and in the system as a whole were mutually dependent and parallel.

EcoEffect consists of five sub-areas, respectively aiming to assess one separate sub-area using various methods for the assessment.

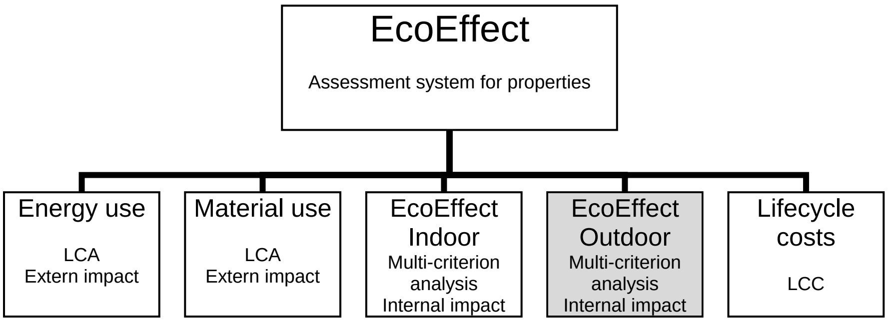

Figure 1. Overview of the EcoEffect system with its various sub-areas (Glaumann, 1999)

Here, only a short brief about the framework and the approach of *EcoEffect*, is presented. Paper I describes the relationship between the main system and the sub-areas in detail. The subordinate position of the outdoor part implies that certain confinements and rules are determined by the relation to the whole assessment system of *EcoEffect*. The description of *EcoEffect* is mainly based on Glaumann (1999) and Glaumann and Malmquist (2005).

EcoEffect assesses negative environmental performance or environmental loadings. The system is problem-based with ambitions to cover all important negative impacts on *human health and comfort* caused by the construction and maintenance of a building and site in a conceived lifetime. Human health, as defined by WHO (1948) is the overall objective in the *EcoEffect* system. The full range of environmental issues are addressed by considering five assessment areas, energy use, materials use, indoor, outdoor and lifecycle costs. The two first assessment areas are evaluating impacts that derive at another place then the property. This is termed *external impacts* in the *EcoEffect* system. Impacts that are recognizable at the property are referred to as *internal impacts*. By assessing various environmental impacts the system proposes to preclude sub-optimization.

The outdoor assessment deals with internal impacts: how people are influenced by the outdoor environment while in the outdoor areas of the property. The boundary for the outdoor assessment is the property border. Some impacts in the outdoor areas emanate from places outside the property, such as wind, air pollution and noise. The impacts are mostly dependent on the localisation of the property but arrangements inside the property may mitigate the impacts. Since these impacts influence people while outdoors at the property, this is included in the outdoor assessment.

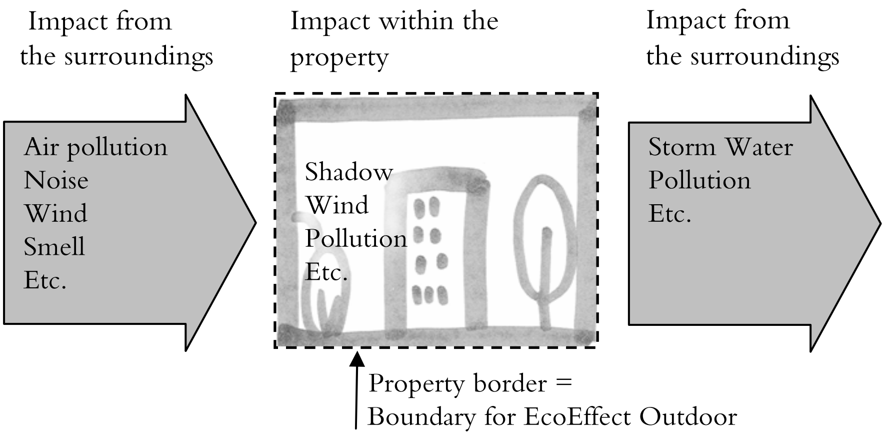

Figure 2. Conceptual picture of the impact of the outdoor environment and the boundary for assessment, using EcoEffect Outdoor.

The user of a property that spends time outdoors is affected by conditions that arise due to the design of the property e.g. how buildings are interrelated. The property's situation in the landscape affects the windiness, noise and the distribution of sun and shade. Other environmental factors originating with the property include soil contamination, magnetic flux densities and allergens. In addition, some outdoor issues such as biological diversity, previous land use and quantity of storm water, do not influence people's health in an obvious and self-evident manner. These issues impact in a secondary manner and in the longer term.

Material and energy use in the outdoor areas also trigger environmental impacts. For example, lawn moving cause fuel consumption and impacts rise as both exhaust gas at the property and as well as depletion of natural resources and impact on the climate. Such events are assessed as external impacts in the material and energy use sub-areas.

3.2 Other tools

This thesis is oriented around BEAT which assess environmental issues related to outdoor areas at e.g. workplaces or residential buildings. Over the years, differing ways to assess the built environment have been used. The assessment may be executed at various levels and with various focuses. The following section includes some examples of tools where the property at various levels and also with a different focus is assessed.

Life cycle assessment, LCA

The most detailed level of assessment focuses on the *building elements* or *products* that are used in the construction of the building as in *Life Cycle Assessment,* LCA. LCA is defined in ISO 14040 as the "compilation and evaluation of the inputs, outputs and potential environmental impacts of a product system throughout its life cycle". The product system is the total system of unit processes that are involved in the life cycle of a product or a service.

Popularly, LCA is described as a way to analyse all of the environmental burdens of a product "from the cradle to the grave". This means that *all stages* are analysed, from the extraction of resources, through the production of materials, the product parts and the product itself to, finally, the use of the product. The analysis also includes the management after the product is used, when it is re-used, recycled or put to final disposal. The impacts that are considered in an analysis consist of all types; extraction of different types of resources, emission of hazardous substances and land use.

The effort to analyse a product from cradle to grave implies a holistic approach, which brings all environmental impacts into one framework. All impacts, regardless of where and when they occur, are taken into account.

LCA defines the term "product" broadly; it corresponds to physical objects as well as to services. When LCA is used to compare different products, it is the function that the product provides that is compared, not the object itself.

The LCA can be used for a number of reasons. The main applications in relation to products are (Guinee, 2002:7):

- to analyse the origins of problems in relation to a particular product
- to compare the improvement variants of a product
- when designing new products
- to choose between a number of analogous products

A LCA can also be used in a wider role; such as dealing with complex business strategies or government policies that are related to lifestyle choices in diverse sectors of society. Here the assessed function is often complex, embraces more aspects, and relates to strategic decisions. Examples of this wider use of LCA includes the development of a waste management strategy for a municipality; a comparison of alternatives for the transportation of goods as a basis for new infrastructure investment; and to quantify and assess energy and material use in buildings to make buildings "greener"(Guinee, 2002:7).

LCA does however suffer from inbuilt limitations in respect of its holistic approach. When analysing with a broad scope simplifications have to be made. An LCA cannot provide a local assessment risk study since it is not possible to scale down the impacts to that level. Another limit with LCAs is the need for extensive data to conduct the analysis.

LCA is aimed at decision support and cannot replace the decision making process itself. It is most often beneficial to combine the LCA with other analytical instruments such as risk assessment, substance flow analysis or public health and welfare (Guinee, 2002:9). In building environmental assessments, LCA is often one part of a comprehensive assessment and is used to assess energy and material use in building construction and management. Other methods complement the assessment.

LCA conforms to an ISO standard (the ISO 14040 series) which concerns both the technical and organisational aspects of an LCA project. This international standard has enhanced the acceptance of LCA as a support to decision making both by the industry and by government.

Comprehensive BEAT often combines many methods to assess the various aspects of the building and the property in question. LCA is a suitable method when assessing material and energy use. The LCA assesses the non-site specific potential impacts of a product, regardless of where, when and by whom it is used (Crawley & Aho, 1999). However the method is not appropriate to assessing impacts in the outdoor areas such as the property level as outdoor issues such as impacts on health and comfort for the user, impacts in respect of biodiversity, land-use and so on, as such impacts are not within the scope of LCA.

Environmental impact assessment, EIA

EIA is an *ex-ante* assessment, e.g. an assessment that is carried out before a change is made. The object of EIA's are projects and plans. It aims to predict the future environmental impacts of a planned activity. More than 120 countries have regulations or similar in respect of EIA (Hedlund &

Kjellander, 2007:9). Most countries' EIA systems differ particularly in respect of who is responsible and in which cases EIA should be undertaken.

EIA is often used in cases of judicial leave to appeal various activities and actions when it is used to predict the environmental impacts of projects such as planned industrial sites, road or other development. The aim of EIA is to integrate environmental aspects into the plan or programme so that sustainable development will be promoted. The EIA is meant to provide a better foundation for decisions in respect of governments issuing permission on actions. The EIA shall identify the short- and long-term environmental consequences that a planned activity can imply for humans, animals, plants, soil, water, air, climate, landscape and the cultural environment. In addition, consequences that deal with economizing with materials, natural resources and energy shall also be described.

The European Union has adopted a directive to provide for a high level of protection for the environment (EU, 2001). The directive regulates that plans and programmes, which are likely to have significant effects on the environment, have to be assessed by use of EIA.

Other areas of application where EIA is frequently used and considered valuable include development cooperation work. For example, the Swedish International Development Cooperation Agency, Sida, have used EIA to review the environmental aspects of all their development projects since 2001(Sida, 2002). This is an important instrument enabling Sida to live up to societal demands to contribute to sustainable development.

The *World Bank* considers EIA to be one of the ten environmental and social safeguard policies to examine environmental risks and benefits associated with the lending operations of the bank (The World (The World Bank, 2008). Therefore the Bank requires environmental assessment of projects proposed for financing to ensure that they are environmentally sound and sustainable, and thus to improve decision-making. The Bank aims for poverty reduction and the use of EIA is expected to prevent and mitigate undue harm to people and their environments in light of the ongoing development process.

The United Nations Environment Programme, UNEP, has assisted countries to apply project-level EIA's over the last three decades. Since the late 1990's they have expanded and elevated EIA to examine not only the environmental but also the social and economic impacts of development policies including plans and programmes (UNEP, electronic source).

EIA focuses assessment on the actual environmental impacts of an object at a specified site and in a given context (Crawley & Aho, 1999). Assessment of a building and site, a property, has a relationship with the assessment via an EIA. But since the building and outdoor environment can also be regarded as a generic industrial product serving a defined function, the scopes diverge. A BEAT may be considered as an assessment in-between the scope of LCA and EIA displaying features in common with each.

Post occupancy evaluation, POE

*Post occupancy evaluatio*n, POE is an evaluation of the built environment, conducted in the phase of usage. The assessment may by property level based but focusing on issues other than environmental concerns such as *design and function*. POE underwent a rapid developed in the 1960's and was directed to buildings containing student halls of residence, mental hospitals and prisons. The aim of POE is to provide experience of what is already built to produce better knowledge about how buildings should now be designed, to provide a foundation for new targets for various activities such as design, building and maintenance, and to create better pre-requisites for choosing management control measurements. This type of evaluation is executed after the occupants have moved in and have taken the buildings into use. The post occupancy evaluation focuses on the feedback in respect of knowledge about design and function in a project from the occupants who are considered to be an important source of information for the design team.

Preiser *et al.* (1988) describe the three levels of a POE as *indicative*, *investigative* and *diagnostic* assessments. The *indicative* POE is used to collate the advantages and disadvantages in the environment. The *investigative* POE implies an in-depth evaluation against explicit criteria that may be predefined by use of an indicative POE or in other way. The *diagnostic* POE can be equated to a case-study and often many complementary methods are used to evaluate the building.

A specific type of indicative POE is the *walk-through evaluation*. In Sweden this method is used for assessment of outdoor environments by de Laval (1994). The method implies that invited persons, administers, residents, users, consultants, caretakers and persons otherwise connected to the project, take a walk together in the area in question. The route is determined beforehand and stops along the way are prepared. At the various stops, the participants record their impressions of the place, both god and bad. After the walk, a dialogue about the walk and the stops is carried out. The documentation collected often builds on and contains photos from the stops, the participants' notes and a compilation of the discussion standpoints. The walk-through evaluation is a fast and easy way of getting an indication on what is good and what is not in a specific environment (de Laval, 1994). It is also a way of mediating knowledge about a project in use to the planners, consultants and building managers.

A walk-through evaluation could act as part of an outdoor environmental assessment since some issues may deal with comfort in outdoor areas. The users have knowledge about e.g. the local climate, noise levels and whether noxious or off-putting odours can be experienced at the property outdoors. Some BEAT are interested in the occupants' standpoints and use a questionnaire to collate them. A walk-through evaluation would certainly help provide a better level of insight into the outdoor conditions pertaining at a site, but since it is such a time-consuming process (de Laval, 1994:107), it is not likely to be a popular alterative to the questionnaire.

4 The design and methods of the study

This thesis contains four papers. Each paper concerns the assessment of outdoor issues as executed by BEAT. The study was designed to examine various major topics such as the development of a tool, the comparison and analysis of many tools which assess outdoor areas and to provide an in-depth examination of one of the major outdoor issues, namely, the assessment of biodiversity on a property.

This research effort began with the development of a comprehensive BEAT for the Swedish context, *EcoEffect* in 1999 (Glaumann, 1999). *Paper I* provided an overview of *EcoEffect* introducing the tool and the five assessment sub-areas. Since knowledge of and perspective on the main system is the starting point for the development of each of the sub-areas, the relationship between the main system and the sub-areas needed to be elucidated.

A preliminary tool designed to assess outdoor environment within *EcoEffect* was introduced a year after the main system (Florgård, 2000). The preliminary tool was put through a process of testing and development. *Paper II* describes and discusses the various issues that emerged during this phase. The paper also describes how these issues were resolved through the redevelopment and extension of the tool. The revised tool, *EcoEffect Outdoor,* is then briefly introduced. The process of test and modification revealed vital aspects about tool development in addition to increasing our knowledge of tool design more generally.

In *Paper III* ten BEAT, including *EcoEffect Outdoor,* were analysed on two levels to improve our knowledge and understanding of outdoor assessment tools and to outline similarities and differences in structure, methodology and content. The structural and methodological properties of the tools were categorized in the first step, i.e. defined, described and compared. In the second step the content of the tools were analysed i.e. the issues that the tools embraced in their outdoor assessments. Paper III, also presents an effort to elaborate the concepts used in the research field and the practice of BEAT since the use of concepts and terms remains inconsistent and often cause inconvenience.

In *Paper IV*, the final paper, a single aspect of the assessment of outdoor environment, the *assessment of biodiversity*, was selected for in-depth examination. The aim here was to design a sub-tool that as far as possible assessed the local strain on biodiversity at the property level. No attempt here was however made to relate the importance of biodiversity to other aspects of an outdoor environment. The paper presented the development of the *Habitat Depletion tool, HD-tool*.

The methods used in the research are presented below. Figure 3 illustrates the main areas of focus of the study as well as the methods used.

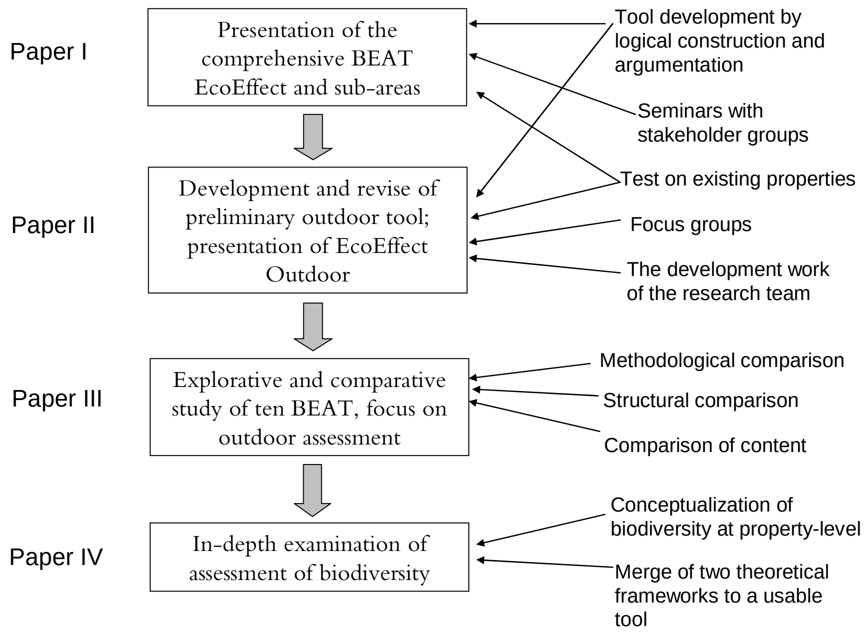

Figure 3 The connection between the focus in the study, methods used and respective paper

4.1 Paper I, Environmental assessment of building properties

Paper I introduces and describes the building environmental assessment system *EcoEffect* and its sub-areas. In parallel to the development of the methodological aspects of the overarching *EcoEffect* system, sub-areas of the system were developed. A research group which included persons with differing and complementary expertise was conducted for this purpose. Each sub-area was elaborated by one or several members of the group. The development of the system and the development of the sub-areas were mutually enriching since the development of the system influenced each of the separate sub-areas, and *vice versa*, the development of the sub-areas influenced the entire system.

In Paper I, two of the methods used in an *EcoEffect* assessment were presented, LCA and the criterion system. In addition, the respective weighting procedure was presented. The third method utilised by the system, *Life cost assessment,* was not the issue of this paper.

The *EcoEffect* research group cooperated with a various actors in the building sector, developers, managers, architects and the producers of building materials. This collaboration took place in seminars, training courses and in respect of practical tests. In this context various matters were discussed such as weighting, fundamental values and the definition of criteria for the credit scale (in this paper and by *EcoEffect,* termed the loading value scale). This cooperation with the building sector provided an important source of information representing a useful source of knowledge on various business aspects, legislation issues and, to some extent also, the needs of the occupants. When developing the tool, the points of views of the stakeholders were important; this was also the case when designing the data programme that accompanied the system.

4.2 Paper II, EcoEffect for outdoor environments

Paper II describes the testing of the preliminary outdoor tool and the development of *EcoEffect Outdoor.* The aim here was to produce a tool for the Swedish context and to reveal insights in respect of the design of criterion tools in general. This implied that both the *theoretical* aspects such as structure, methodological aspects, scale increment and *practical* aspects such as access to data and investigation methods at the property were scrutinized.

The starting point here was a preliminary outdoor assessment tool (Florgård, 2000). Expectations existed of the potential for simplification and also in respect of making the assessments more reliable by including better instructions for data collection and ensuring that the development colligated with the criteria laid down in Swedish legislation in a systematic manner. In addition, this was also seen as an opportunity to extend the outdoor assessment to comprise the phase of planned properties, i.e. non-existing but the design phase is almost ended and documents are ready. The preliminary tool only covered existing outdoor environments. The preliminary tool was examined in order to identify the practical and methodological difficulties associated with exercising an assessment and thus identifying potential solutions. The revision process sought also to better integrate the building sector for two reasons: to integrate opinions and ideas from the sector, and to provide a better starting point for the implementation of the tool.

The preliminary outdoor assessment tool was scrutinised in various ways: it was tested in *pilot tests on outdoor environments;* the tool and its potentials were discussed in *focus groups*. In addition, the work of *the research group* with the over-arching system *EcoEffect* influenced the outdoor area as well as each sub-area.

The pilot test on the four existing outdoor environments was carried out as the instructions of the preliminary tool specified. The purpose of the pilot test was to gain experience, e.g. to carry through the assessment and to reflect upon all parts of the assessment task and subsequently produce a foundation for the revision. How did the preliminary tool work and when did difficulties rise? This necessitated the diversification of the test objects. As such then, the four selected properties were of various sizes, ages, purposes and were also situated in different urban types. The pilot test aimed at an evaluation of how the tool was geared to different situations such as various types of properties. Practical aspects, including data collection, measurement and estimation were also scrutinized.

The preliminary tool was discussed in focus groups assembled by one group respectively of landscape architects, ecological experts and residents. Each group was included five to seven persons. The focus group approach is a research method where data is collected by group interactions about a subject determined by the researcher (Morgan, 1996). Focus groups are thought to be useful in revealing the fundamental values upon which the basic subject arguments rest (Wibeck, 2000). The purpose here, namely, to discuss the *EcoEffect Outdoor* tool was to understand the participants' arguments for and against the tool; and to clarify what difficulties, obstacles, benefits and relevance the tool had in the eyes of the participants. Additionally, the aim was also to learn about those aspects of the tool not previously raised or identified by the creator but subsequently uncovered by the groups.

The group of landscape architects was chosen because they are an important target-user group for the tool. If landscape architects find the tool useful, it can be rather quickly adopted in the building process. Therefore, their opinions were valuable. The participants were landscape architects with experience of, and interest in, utilizing some type of environmental impact assessment method.

Ecologists were chosen because biodiversity in urban areas is an issue which is attracting more and more attention in Sweden as it also is in the rest of the urbanized world. Since the preliminary tool included biodiversity, use of a focus group provided an opportunity to discuss how the tool assessed biodiversity in general and in the matter of retained natural land and planned vegetation areas in particular.

The last focus group assembled together a group of parents with small children. Since this group of residents use the outdoor environments at the property more than the other groups studied (Berglund & Jergeby, 1992), they were taken to represent the residents. The aim with this group was to investigate whether the disturbances experienced by residents in the outdoor environment coincided with the scope of the preliminary outdoor assessment tool.

The work of the research group on general issues for the *EcoEffect* system affected the outdoor assessment. This development saw one important change in data collection in existing properties since a questionnaire to the users of a property was developed. The questionnaire provided a method for determining the level of inconvenience in the indoor and outdoor areas studied.

The tool was extended from only assessing the stage of existing properties to also comprising the stage of planned outdoor areas. This implied that the indicators often had to be assessed in two ways, one for the existing stage and one for the planned stage. The planned stage is a situation where the design is practically complete and since all documents are available, the performance is feasible to forecast. Assessing a planned outdoor environment is not to be mixed up with a design tool used as a support in the design process. The existing stage denotes a complete construction and with people using the environments available to answer a questionnaire.

One of the goals of the revision was to adapt the criteria to limit-values issued by the government since one level in the credit scale was considered to correspond to national recommendations or legislation such as the Swedish environmental quality targets or international recommendations issued by e.g. the UN. An example of the former is the assessment of noise, while an example of the latter is the assessment of odour.

4.3 Paper III, A comparative analysis of property-level building environmental assessment tools

Paper III reports on a comparative analysis where methodological aspects and outdoor issues considered by the tools were contrasted and categorized. The analyses were conducted on two levels, an over-arching level and a detailed level. The overarching level focused on structural and methodological aspects. In the detailed level, the outdoor issues in the respective tool were reviewed and the manner in which they were quantified. In addition, the outdoor impact on the overall result of the tools was calculated. A judgement of which tool was most readily able to assess outdoor environments was then made.

Ten BEAT with a focus on outdoor assessment were included in the analysis. The selected tools were of two types; including nine tools which addressed both the building and the outdoor environment, and one tool which only assessed outdoor areas. All of the tools assess more than one aspect of the outdoor issues. The information about the tools, the manuals or data sheet used in the assessment, were provided by the respective administration at homepages, or otherwise.

There are many in which ways to gain knowledge of how a tool works. One is to perform an assessment by using the tool at a particular 'case study' property. This would likely provide good insight into the respective tool and its working process. The focus of the overarching level of the study here was however to examine the methodology and structure of the tools and therefore a framework developed by Todd *et al* (2001) was used as a starting point to examine similarities and differences. The framework was a support when reviewing the tools and to elaborate the concepts used in the framework and in other literatures to describe various characteristics in respect of the criteria systems.

The framework (Todd *et al.*, 2001) was originally developed to examine tools which are used in assessing buildings. Here the framework was modified for a richer categorization with exhaustive categories. The aspects used by Todd *et al* were descriptive but not distinct categories. When trying to put across differences between the tools as clearly as possible, clearer categorization was needed. Therefore, the framework was partly redefined. Each tool was defined by all aspects and then categorized.

In the detailed level analysis, all of the outdoor indicators reviewed by the tool were compiled and arranged by issue and categorized by type. For example, under the issue *Water* all indicators assessing aspects of water were arranged, e.g. storm water and irrigation. Both the choice of indicator and how to assess it – the rules that were applied to the indicators – were displayed. Additionally, the type of indicator was determined and applied. The category types used were measurements, estimations and calculations as described in Paper II.

The outdoor impact on the final score was calculated. All indicators were presumed to score full credits and the calculation procedure to reach the final score was performed as stated by the respective tool, aggregation with weighting or summarizing. The percentile rate of the outdoor credits of the total amount of credits was considered as was the relative impact of the outdoor issues on the overall result.

Finally the tools were appraised in respect of how well suited they were to the outdoor assessment task. Three aspects were taken into consideration: the content of outdoor issues i.e., the number of issues that the respective tool assessed, the organization of the tool i.e. whether the outdoor issues were assembled in one unit and were easy to distinguish from the rest of the assessment; and the outdoor assessment potential relative impact of the overall assessment.

4.4 Paper IV, EcoEffect Outdoor – Habitat Depletion

Paper IV describes an effort to design a tool to assess biodiversity at the property-level using the framework and constraints of the *EcoEffect* system. Consequently the assessment of biodiversity concerned negative performance, i.e. pressure on biodiversity or lack in biodiversity. The tool was termed the Habitat Depletion tool, the *HD-tool*.

Vegetation was taken to represent biodiversity. Many other groups of species are dependent on the vegetation since it is a primary source of food and shelter. In addition, the vegetation is often manipulated and managed through human intervention.

The tool was developed to assess locally inflicted strain on vegetation in urban properties. The process included the merger of two approaches: Noss' recognition of three primal attributes for biodiversity (1990), and a framework developed by Thackway and Leslie (2006) to report vegetation condition.

Noss considers the three attributes: *composition*, *structure* and *function* to constitute biodiversity at a property and to be useful in various levels of organization such as from the regional landscape to the genome level. The property level was used in the *HD-tool*. It was deemed here to be similar to the community-ecosystem level described by Noss.

Thackway and Leslie illustrate how changes in the vegetation condition can be described and mapped as various states. Their framework builds on *vegetation*, *assets* and *transitions*, and is termed the VAST framework. The framework can be used to classify vegetation in a series of states and transitions. The benefits of the system include that it describes and accounts for changes, it makes explicit links between land management and vegetation modification, and it provides a way in which to describe the consequences of land management on vegetation.

Noss' three attributes were taken to represent the indicators in the tool. A further indicator, *abiotic conditions,* was added since this is a prerequisite for the vegetation. The VAST framework was taken as the foundation for the scale to quantify the impact. The states that were identified in VAST: residual, modified, replaced and removed, were designated to denote levels in a scale reaching from 0 to 100. Criteria for the various states were retrieved from VAST. The states were also taken to denote the levels in the scale. These two frameworks were thus merged into a new tool for assessment of the locally inflicted strain on biodiversity.

5 Main findings

The aim of this thesis is to enhance our understanding of outdoor environmental assessment tools. The main findings are presented in this chapter. For a detailed account of the results, the respective paper should be addressed. The main findings focus on three areas of results, *tool development, a comparative analysis of BEAT* and *the content of outdoor issues in the various BEAT*.

5.1 Tool development

Papers I, II and IV all focused on various aspects of tool design, development and elaboration. The result of tool development is of course the development of the tool itself. Along the way however additional aspects of interest were uncovered. In what follows below some of the results are presented.

5.1.1 Stakeholder participation

A general conclusion about tool development and stakeholder participation was communicated in Papers I and II. *When the intended users are invited to participate in the knowledge production process, to define and to solve problems, the result can be the generation of greater social accountability in terms of knowledge and thus, consequently, the production of a more reliable tool.* In the development of the Swedish BEAT *EcoEffect*, reported in Paper I, stakeholders from the building sector such as building owners and managers, were represented in the steering group for the project. Stakeholders also participated in seminars and workshops which functioned as discussion forums between the researchers and the stakeholders. The stakeholders provided case-study properties and took part in practical tests in respect of *EcoEffect*. Their points of view convinced the research group to elucidate the aim of, and the values that, governed *EcoEffect*. In addition, the research group was encouraged to display how a tool could support the tool users in various decision situations.

In Paper II, in the development of *EcoEffect Outdoor*, other groups of stakeholders similarly participated. Landscape architects, ecologists and residents discussed the tool in focus-groups and reviewed and scrutinized the tool in cooperation with the researcher. One of the conclusions of Paper II emanating from this cooperation process with the stakeholders is that, in order to gain credibility with the stakeholders, *a tool must provide an open account of its own functioning logic*. The landscape architects stated firmly that they would not utilise a tool without all suppositions and objectives coupled with the tool being declared. They stated a general distrust in weighting procedures and they stated that they need to be convinced by easily accessed information and the existence of an open process. Consequently, the challenge for the tool maker is to overcome this suspicion by being both explicit and pedagogical in displaying and reporting the fundamental values which govern the tool. To secure methodological transparency, all presumptions and choices made during the development of a tool, have to be supplied in a manner that enables even a non-expert to review the information. As an example the selection of indicators and how the indicators are weighted to each other are vital for a user to be able to properly review a tool.

In spite of effort to promote transparency it probably remains impractical to explicitly reveal all of the aspects and presumptions which contribute to the design of the tool simply because of the sheer abundance of details. The tool maker will then always possess greater knowledge of the 'inner workings' of the tool than the user.

5.1.2 Consistency in assessment

For enhanced transparency and for logical and pedagogical reasons the assessment should be reported in the same manner throughout the assessment area. In Paper II, the testing of the preliminary tool indicated that the use of two methods in the assessment gave rise to confusion among users. The preliminary version of the *EcoEffect* outdoor assessment tool made use of both a checklist and a hierarchy and thus reported two separate results. The checklist considered qualities, in the main, but also indicators beyond the scope of the hierarchy. The hierarchy, on the other hand, considered a set of negative environmental performance indicators, or 'loadings'. This caused confusion in respect of which of the results was to be counted as the definitive assessment result.

5.1.3 Development of an assessment tool for biodiversity

When developing a sub-tool specialising in the assessment of biodiversity to adhere to *EcoEffect* a number of constraints became apparent such as the tool had to assess negative performance since *EcoEffect* is oriented around loadings. Therefore locally inflicted strain on biodiversity was chosen. The scale had to be negative which implies that zero is the best scoring, and thus the more loading credit – the worse the result in the assessment. The tool had to be able to perform in various sizes of properties and to be useable throughout most of the year. Vegetation is optionally assessed year round and thus provides a good indicator of the on site biodiversity. As such then vegetation was chosen to represent the biodiversity measure. The tool was expected to be able to recognize the often trivial vegetation that is found in urban areas. In addition the tool was expected to provide easily recognizable guidance to designers and managers such that more vegetation areas could be retained and more vegetated areas are in future produced in urban areas. The tool was termed the Habitat Depletion tool, *HD-tool. Paper IV proposed that the merger of the VAST framework by Thackway & Leslie and the main attributes for biodiversity recognized by Noss produces a useful tool for the assessment of locally inflicted strain on biodiversity.* The HD-tool combined two theoretical approaches considering vegetation states and biodiversity. The vegetation, asset, states and transition – VAST – framework by Thackway & Leslie, describes how transitions between vegetation states are induced either by natural or anthropological driving forces. These transitions may be either positive or negative in respect of biodiversity. Noss presents the three main attributes of biodiversity, composition, structure and function. The prerequisite for vegetation at a site was also added here, namely, the abiotic condition. Simulations of tool use indicated that the tool is able to assess biodiversity at the property level. *The HD-tool is a way to conceptualize urban and trivial biodiversity at the property-level.* With the support of the *HD-tool* discriminating between various, often trivial, biotopes of the common surroundings in built-up areas was made possible. The tool was made area-weighted, so the relationship between the size of the vegetation area, retained and/or newly-planted, and the assessment result by the tool should be obvious to the user.

5.2 Comparative analysis of BEAT

In the comparative analysis of BEAT found in Paper III, various tool properties were elucidated. Paper III categorizes compares and analyses ten BEAT to reveal intrinsic similarities and differences, benefits and disadvantages in their structure, methodology and content. Many of the similarities and differences between them relate to the various structures: hierarchy or checklist. Among the BEAT reviewed in the context of the current study, there were six hierarchies: *CASBEE*, *EcoEffect, SBTool, Ecoprofile, BREEAM* and four checklists: *Environmental Status Model, Green Globes*, *Green Star,* and *LEED*. The benefits and disadvantages of the properties outlined are set out below.

5.2.1 The structures of hierarchy and checklist

A hierarchy is typically structured in levels with the overall objective in the apex of the hierarchy. The hierarchy's overall objective is a concretisation of the fundamental values governing the tool thus it is the foundation for weighting. *One benefit of the hierarchical structure is the obvious opportunity to present the values of the tool.* In Paper III it was revealed that this opportunity was seized by half of the group of hierarchies, namely, *BAF*, *CASBEE* and *EcoEffect*.

The numbers of levels in the various tools differ. The measurable indicators are positioned at the bottom of the hierarchy. The indicators are stepwise aggregated, from the bottom upwards with the support of weights. The weights express the relative importance of the respective indicator in relation to the overall objective. When the weights are expressed openly, they can be reviewed by a user of the tool. This is termed *explicit weighting*. A variation exists in the number of levels structuring the hierarchies. In *CASBEE* and *SBTool* aggregation and weighting are iterated four times in increasingly higher levels. The other hierarchies aggregate once or twice, e.g. they use two or three levels. When the tool is structured into many levels, many rounds of 'weighting' are required. This implies a loss of transparency. *One disadvantage with the hierarchical structure is the complicated relationship between the lowest level and the apex level. It is difficult to understand how a change in an indicator value is transmitted to the final result when there are many levels in the hierarchy.*

A checklist is typically composed of one and on occasion sometimes two levels. The indicators are lined up in one level, the second level, if there is one it is not a true disposition of level but rather a grouping of indicators by issue. Credits earned in the assessment are summarized in the final score without weighting. *One benefit of the checklist structure is the ease it affords to understanding the structure and to following the calculation of the tool. One credit earned in the assessment transmits to one credit in the final results.*

5.2.2 The target-related scale and the consistent scale

The transparency in the checklist structure is ostensible because of the scale. The checklist credit scale is target-related. This means that the indicators are levelled in various steps denoting various targets. Instead each credit level is defined by a target and when the target is satisfied the credit amount for the level is earned.The targets are typically of differing character, but they may be continuous, i.e. denoting an increased amount of an indicator. The intervals between the levels are often irregular. One target level may qualify for one credit while the next may be rewarded by five credits. The respective scale is valid only for a separate indictor thus there is no comparability between indicators. The allocation of credits may seem *ad-hoc* when there are no rules that exist in respect of how the credits relate to the targets or to each other. *One disadvantage with the target-related scale is the concealed reasons for the allocation of credits in various target levels. It is difficult to form an opinion about the relevance of the credit levels when no declaration is made about how the credits are distributed.* None of the checklists studied in Paper III expressed how and why the credits were allocated in a certain pattern. Furthermore, since one earned credit transmits to one credit in the result, the number of indicators which review a special indicator becomes crucial. When a particular indicator receives significant attention and is scrutinized by many indicators, the performance of this indicator exercises a significant impact on the final result. *An issue that is examined by many indicators will be able to influence the final result more forcefully than one examined by only a few indicators. The fact that the credits are allocated irregularly and that issues are assessed by differing numbers of indicators; both facts provide ways in which to model the importance of an issue or an indicator. This is termed implicit weighting in Paper III.*

The hierarchical scale is typically consistent and common for all indicators. A consistent scale means that the levels of the scale are subsequent and the credits denote a stepwise increase or decrease of the indicator. One level or more in the scale is anchored to some feature outside the tool. An example of this is when "acceptable practice" or national legislation is taken to calibrate the scale. *The consistent scale is anchored to an exterior aspect which provides internal comparability for the indicators in the tool as well as increased transparency.* In the context of an ever changeable world a number of inherent problems exist with the notions of "practice", "normal" and "legislation". When societal demands change or increase each of these three levels change at the same time. The old numerals will become out of date. As such, a tool needs to be continuously upgraded to keep pace with the process of societal change.

5.2.3 Mixed metrics

Paper III revealed that *a mix between two metrics constrains transparency*. Two of the BEAT studied, namely, *CASBEE* and *Green Star* were found to be respectively mixing two approaches in the credit scale. *CASBEE* used a combination of, at the lowest level, a checklist and then a hierarchy. This made the transmission of credit from the single indicator to the final result difficult to follow. *Green Star* used an automatic device, called a "calculator" which performs a concealed calculation after being fed with data for various types of areas, before and after a change. Neither of these combined calculations can be considered transparent.

5.3 Content of outdoor issues

Various BEAT have differing scopes. The selection of BEAT in Paper III only included those that dealt with more than one outdoor issue. The comparison of the issues included by the respective BEAT in the outdoor assessment reveals that they use different delimitations in outdoor assessment. For example neither the *BAF, BREEAM* nor *LEED* tools included the "impact on people" in their scope while *EcoEffect* examined the same issue by means of five indicators and *CASBEE* and *Environmental Status Model* used three indicators.

Table 1 reveals a simplified overview of the major issues assessed by the various beat. Issues assessed by four or fewer tools, e.g. Pest management and Previous land use (see paper III for a detailed account) were omitted here. None of the issues in the table were assessed by all ten BEAT. The most frequently assessed issue was *Water* which was assessed by nine tools. Next most popular was *Vegetation*, assessed by eight tools. *EcoEffect*, *SBTool* and *Green Globes* emerged as the most comprehensive BEAT in terms of the comparison conducted in Paper III, the least comprehensive was found to be BAF which assesses two issues.

The structure of the BEAT, in terms of hierarchy or checklist, did not impact significantly on the scope of the tool realized by the selection of outdoor issues, save for one issue, namely, the *occurrence of pollution*. Each of the checklists considered this issue but only half of the hierarchies did so. *There is currently no consensus among tool makers on what issues a BEAT should include in terms of the outdoor environment assessment area.*

Table 1. *The outdoor indicators assembled by issue*

	BAF	BREEAM	CASBEE	EcoEffect	Ecoprofile	Environmental Status Model	SBTool	Green Globes	Green Star	LEED	Total
Impact on people			X	X	X	X	X	X	X		7
Occurrence of pollution				X	X	X	X	X	X		6
Vegetation	X	X	X	X		X	X	X	X		8
Water	X	X	X	X	X		X	X	X	X	9
Total	2	2	3	4	3	3	4	4	4	1	

Table 1 illustrates the potential impact of the outdoor issues on the final result. The figures were calculated by the ratio between the potential outdoor credits and the sum of the potential credits for the entire assessment. Among the BEAT that presented the assessment by a single score, *BREEAM* revealed the highest figure, 15 %. The comparability between the BEAT was not straight-forward since *EcoEffect* and *Ecoprofile* did not present a final single score. In *EcoEffect* all outdoor issues were merged in one separate sub-area, therefore 100 % in that unit. *Ecoprofile* use two units for assessment of outdoor issues. The relative impact of outdoor issues in BAF was 100% since that tool is designed for assessing outdoor areas.

Table 2. *The relative impact of outdoor issues on the overall assessment*

Tool	The relative impact
BAF	100 % impact. The tool only assesses outdoor issues.
BREEAM	15 % impact.
CASBEE	18 % impact in section *Qualities* and by 21 % in section *Loadings*.
EcoEffect	No aggregation to a single score. 100 % in assessment unit *Outdoor*.
Ecoprofile	No aggregation to a single score. 37 % in assessment unit *External environment* and by 5 % in *Resources*.
Environmental Status Model	6 % impact in basic assessment. 21 % impact if the optional *Ground examination* unit is included.
Green Globes	11 % impact.
Green Star	6 % impact.
LEED	27 % impact.
SBTool	13 % impact.

The results indicate that *BAF, EcoEffect, Ecoprofile, SBTool, Green Globes* and LEED perform interesting assessments in various respects. The combination of table 1 and table 2 provides us with an image of the adequacy, or otherwise, of the outdoor assessment of the BEAT in this study. The combination provides an account of the outdoor assessments' impact on the final assessment and displays the inclusiveness of the assessment. In addition, the structure of a separate assessment section for outdoor issues is also an interesting aspect to consider here since this may recognize and indeed advertise the importance of outdoor issues.

A list of advantages and disadvantages in respect of these tools is reproduced below.

- BAF is a special tool for outdoor assessments, but with a very narrow scope since it only assesses vegetation and water. Hierarchy (ground cover index).
- *EcoEffect* is comprehensive. Assessing a separate outdoor unit but with no final score. Hierarchy with fundamental values declared.
- *Ecoprofile* lacks one major issue. Most outdoor issues are contained in a special section. Hierarchy.
- *SBTool* assesses all of the major issues. No special unit for outdoor areas. Hierarchy with foundation for weighting expressed.
- *Green Globes* assesses all of the major issues. Most outdoor issues are contained in a special unit. Checklist with implicit weighting.
- LEED allocates outdoor areas as being most important in the final result, but lacks three of the major issues. Checklist with implicit weighting.

In total, *EcoEffect* and *SBTOOL* were the only comprehensive tools, assessing all major issues. Both declared the foundation for the weighting; the weights were also possible to review. *SBTool* presented a final score of which outdoor issues may impact by 13%. *EcoEffect* did aggregate to a final score, but the outdoor assessment was presented as a separate unit in the results presentation. The separate outdoor unit did however make *EcoEffect* the most readily available tool to use in assessing outdoor areas.

6 Discussion

One issue permeates this study, namely that of tool transparency. "Transparent" is in everyday language understood as something which it is possible to see through. In the realm of environmental management, transparency is defined as the "open, comprehensive and understandable presentation of information" (SS-ISO, 2004). As regards building environmental assessment tools, ideal transparency would imply that all of the actors who make use of BEAT have access to all the necessary background information and that the information is presented in an understandable manner. As this thesis has exhibited, many of the choices which occur during the process of tool design and development are related to the *fundamental values* of the tool. Transparency in respect of BEAT also includes comparability. Comparability is dependent on concordance over e.g. delimitation and concept use.

In the case of BEAT many of the transparency problems could be solved if the fundamental values of a tool could be recognized and declared. This is however not as easy as it appears as many BEAT are developed during a long time, in a stepwise manner, often by several people from various groups of actors. Fundamental values are not so easy to detect under these conditions.

These transparency claims may also provoke a clash of interests between the owners of the various brands of voluntary tools. As such, proprietary interests may hinder dissemination and the free flow of information.

No consensus currently exists among tool makers as to which issues a BEAT should include in terms of the outdoor environment assessment area. One explanation is that the tools are developed in various contexts and under various conditions. Moreover, parallel developments around the world have not revealed a rising unity in respect of e.g. principles concerning scope, the use of concepts, or the presentation of results and so on. In addition, tool makers are often not explicit enough about the overall values or principles that govern the selection process when, for example, deciding over delimitations and inclusiveness.

It seems then that tool makers in the domain of BEAT have up to now been preoccupied with problem solving in respect of traditional natural science problems. Namely, tracing impacts and cause-and-effect chains and determining measurement methods. As such they may have inadvertently downplayed the view that a tool is also an embodiment of values.

Finnveden describes how a distinction is made between two phases in the assessment by LCA tools, separating them from each other by acknowledging that they are different types of processes, namely, *classification and characterisation* on the one hand and *valuation* on the other (Finnveden, 1997). This separation makes it obvious that they are of differing character. The first is solved by use of natural scientific methods. The second requires the deployment of political, ideological and ethical values. Finnveden concludes that within LCA values are seldom discussed. The mere division into this two separate parts, *classification and characterisation* and *valuation* nevertheless however is recognition of the fact that values are present. Among BEAT, such as those reviewed in this study, fundamental values and are not yet recognized as an important presupposition for tool design.

A desirable development as regards the creation of criteria tools such as the BEAT in this study would thus be the implementation of the same kind of standardization process that LCA-tools have undergone in recent years. The result of that process was a higher level of conformity in respect of e.g. the comparability of the outcomes of the tools. Today, by choosing one particular BEAT, the user is forced into a certain model including e.g. definitions, weighting and scoring system. This is not easily compared to another tool.

The designers as a user group, request tools which are transparent, otherwise they do not want to use them. They are sceptical of making use of processes which they can neither follow nor understand. They do not want somebody else to make decisions for them, in that sense a non-transparent tool can easily lead them in an unknown direction; ruled by values concealed from the gaze of the users.

Crawley and Aho (1999) state that methodological transparency is one of the most fundamental requirements of an environmental assessment method. Companies operating in this market and consumers, the users of the built environment, must be able to access and understand the assumptions, data and other methodological issues that influence the outcome of an assessment.

The various BEAT reviewed in this study were representative of both hierarchies and checklists. Hierarchies are organized in structures that while they have the potential to elucidate the values of the tool at the same time, potentially also impede transparency. There are two aspects of the hierarchy that could promote comparability and transparency. The overall objective is the apex in the hierarchy and the ultimate starting point for the weighting procedure. If the overall objective is declared openly both the fundamental values for the tool will be revealed for a user to review and to take a standpoint on, while at the same time the logic of the relationship between the various indicators is also expressed. The other aspect of a hierarchy that may promote transparency is the option to scrutinize at various levels, from an aggregated position down to the measurable indicators. The structure enables a reviewer both to gain an overview of the tool and the detailed information simultaneously. This provides transparency.

The existence of many levels in the hierarchy may be a threat to transparency, since many levels need many rounds of weighting. Even if the weighting values are rendered transparent, the level of complexity increases with every step of the aggregation and weighting process. The relationship between the assessment of the single indicator and the final result will hence be difficult to follow.

Checklists have the advantage of having an easy structure to understand while no complicated calculations, which often obscure the relationship between the indicator level and the result, are needed. But for a checklist to be considered transparent the allocation of credits has to be discussed and the logic behind the various levels has to be declared. This was not the case for the checklists reviewed in this study. None of the checklists declared which overall values they wanted to safeguard with the use of the tool.

The delimitation of the tool is an aspect which lies ahead of the relationship inside the tool, and concerns all types of BEAT. The delimitation issue handles the inclusion and exclusion of the tool, or the scope. To attain transparency and a subsequent level of comparability, the simplifications and selection of issues and indicators has to be declared. Transparency has to be implemented in every step from the design of the tool to the presentation and interpretation of the result. Transparency is then a prerequisite for comparability.

Finally, some remarks are required in respect of the terming of the type of tool that this thesis is oriented around. The concept *"Building Environmental Assessment Tool"* is an unfortunate term. It is derived from a narrow approach to assessing a property. Even if the tool actually considers outdoor areas, the toolmakers often neglect to mention this when describing the tool. BEAT implies that the assessment is restricted solely to the buildings, when in fact as displayed earlier; BEAT can state various scopes. However, some tools indicate the inclusion of outdoor areas by using the term *property-level* assessment. Hopefully, the assessment of outdoor environments will be a topic for many more assessment tools in the light of the findings contained within this thesis. If BEAT that include outdoor aspects were termed *"Property Environmental Assessment Tools"*, this new label would help emphasise the wider scope of the tool.

7 Future research

This thesis only records the initiation of the study of outdoor issues and indicators at a property by tool makers, designers and builders. In tool development more generally however there remain a number of interesting issues to examine, issues such as how do the various scales in different tools relate to each other? How do the various tools measure the various outdoor indicators and how do they allocate criteria limits? And, is the "normal" impact value the same throughout all tools using this anchor?

Other questions here include, how the users perceive the outdoor areas and what problems do they relate to the outdoor environments? How can the outdoor problems be concretized in a tool assessing outdoor environments? Outdoor issues then remain in need of profound and continuing examination.

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