A systematic review of the **International Assessment Systems** for **urban sustainability**

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AGENDA

I. Introduction

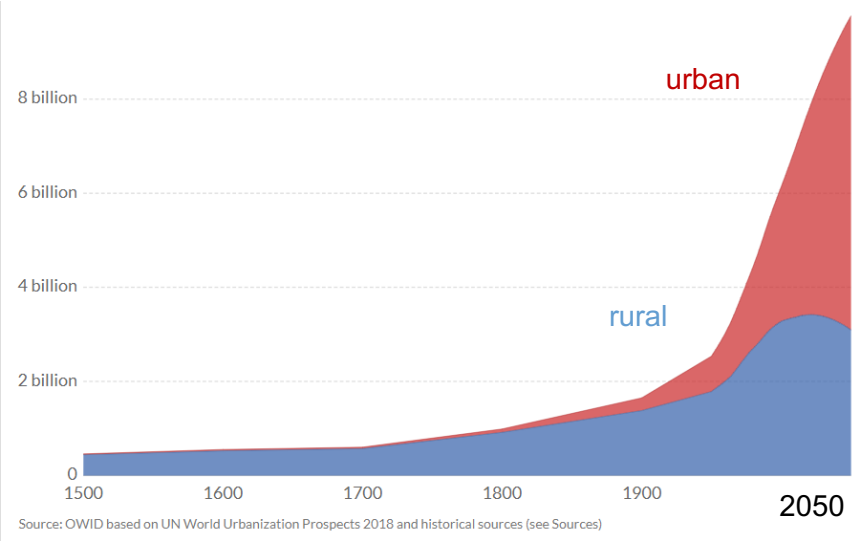
II. Review Methodology

III. Results & Discussion

- Overview of the Systems
- Key criteria and metrics
- Common shortcomings

Introduction

***"The growth of cities* will be the single largest influence on development in the 21st century."** UNFPA's 1996 State of World Population Report



Introduction

The construction sector has an increasing impact on the demand for scarce resources

Building sector Accounts for

40% energy consumption
(WEC, 2016)
(EUROSTAT, 2016)

15% potable water demand
(WRG, 2009)

30% construction and demolition waste
(EUROSTAT, 2014)
(USEPA, 2016).

Need to develop planning and decision support tools for **cities sustainable development**

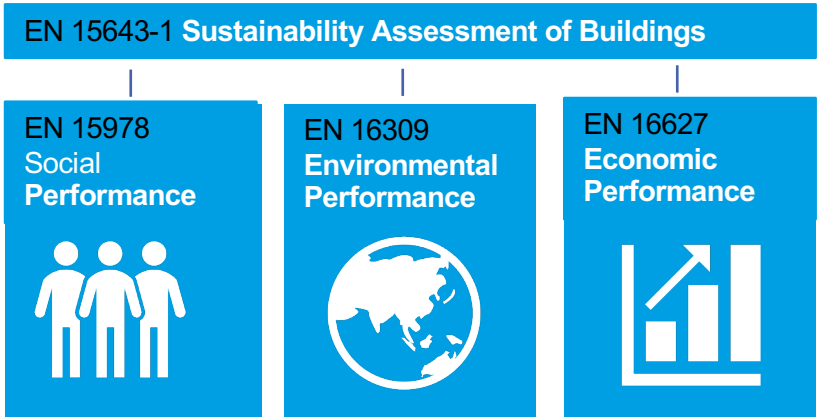
Introduction

Approaching sustainability in the construction sector

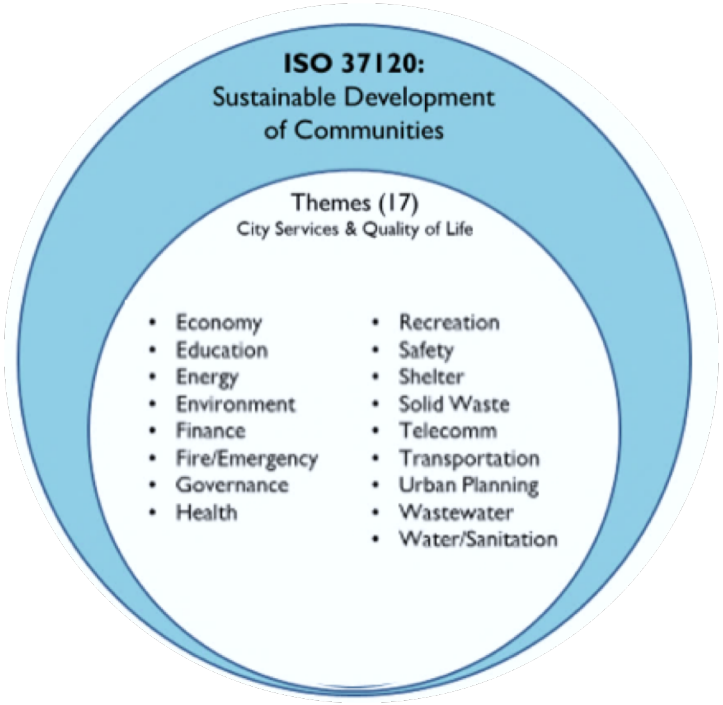
Buildings

ISO 21929:2011 | **CEN/TC 350 | EN** 15643

Provide the general framework for the evaluation of sustainability for the construction sector



Urban areas



Introduction

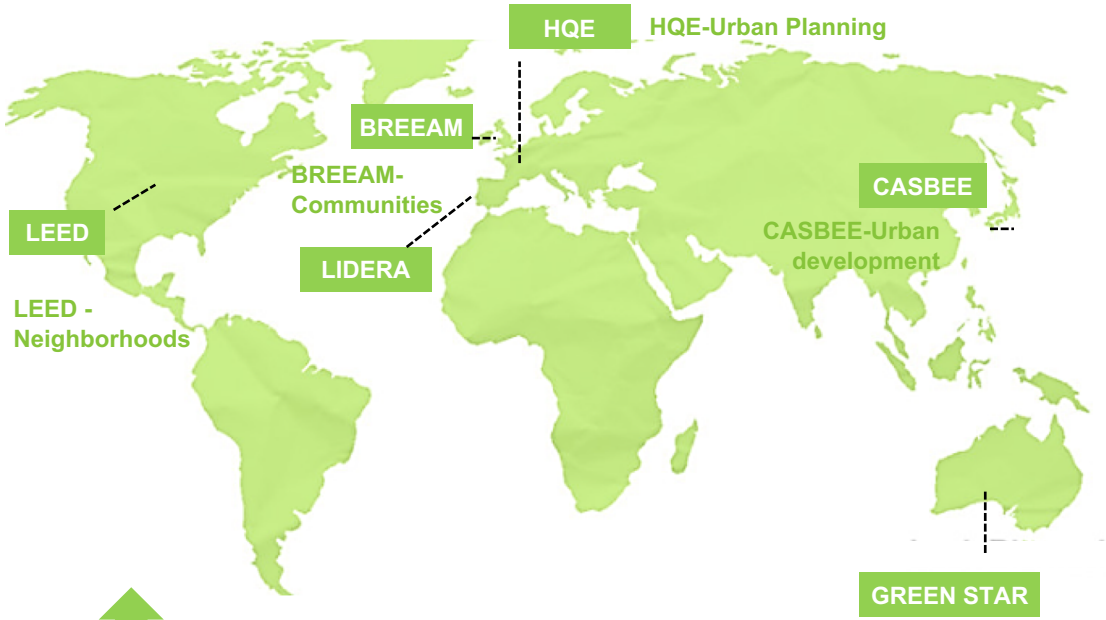
What are the International Sustainability Assessment systems and why do they matter?

International Sustainability Assessment systems

are **Multicriteria** based tools that can be used to **measure and document sustainability** performance of a construction project, which can support and guide an **integrated** and interdisciplinary collaboration in the design of the **buildings and built environments**

This study focus on the **Urban Scale**

By analyzing in detail the following selected tools

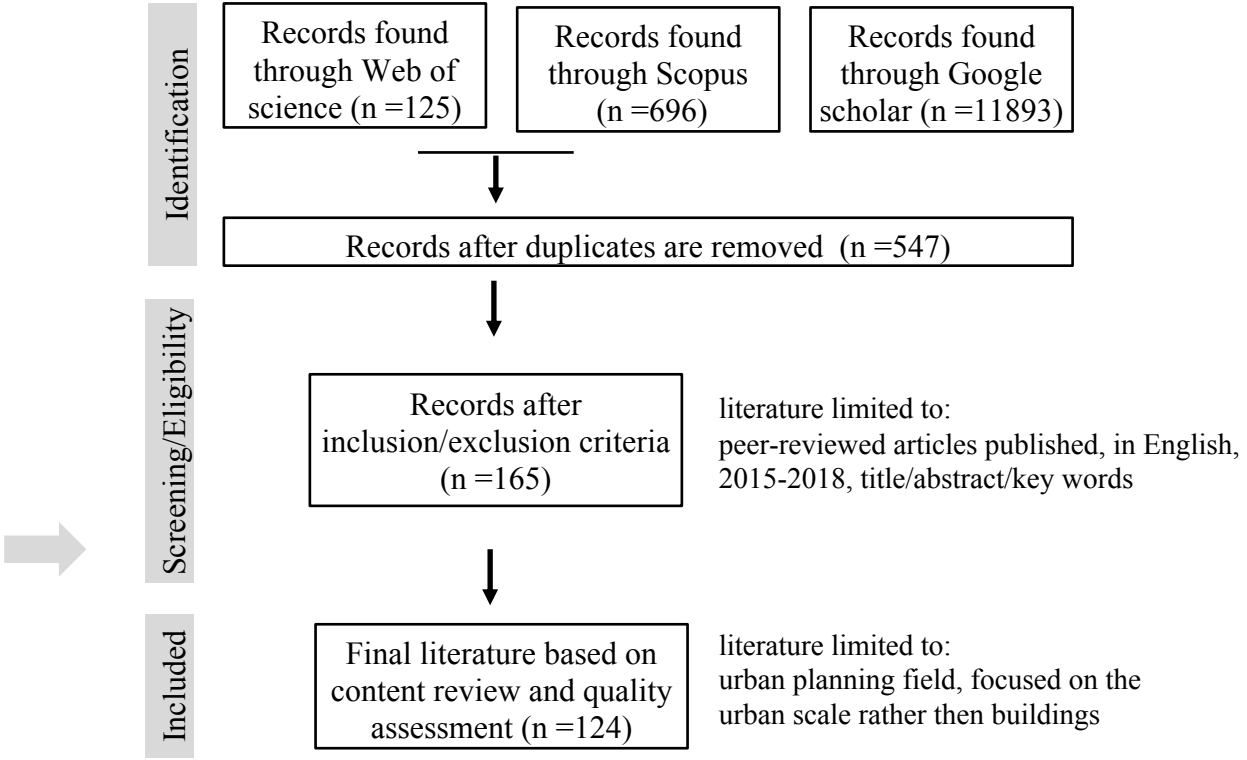


Review Methodology

1 part:
comparison the system (timeline, spatial spread, scoring).

2 part:
review of the main indicators and metric

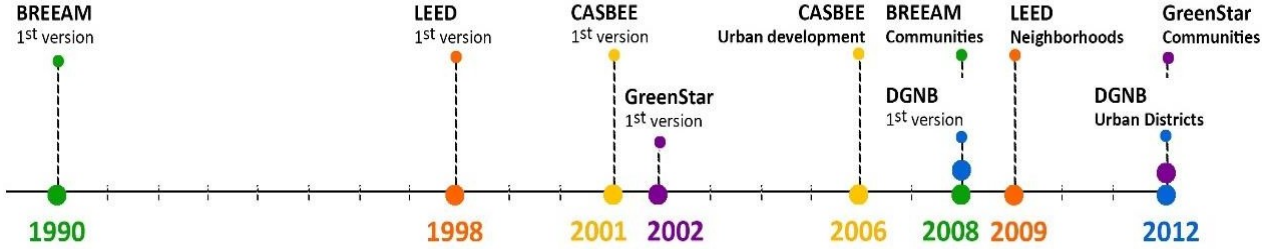
3 part:
Identification of the common shortcoming



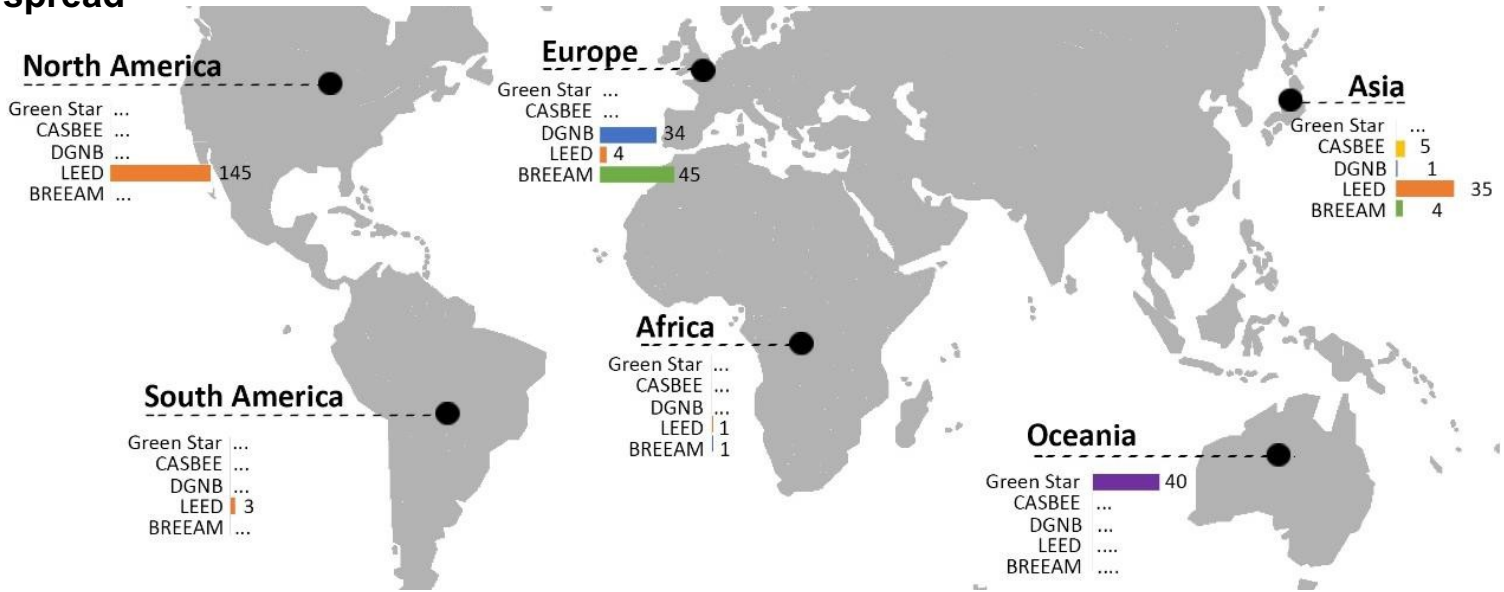
*methodological approach for literature search and selection according to the Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines

Overview of the Systems

Timeline



Spatial spread

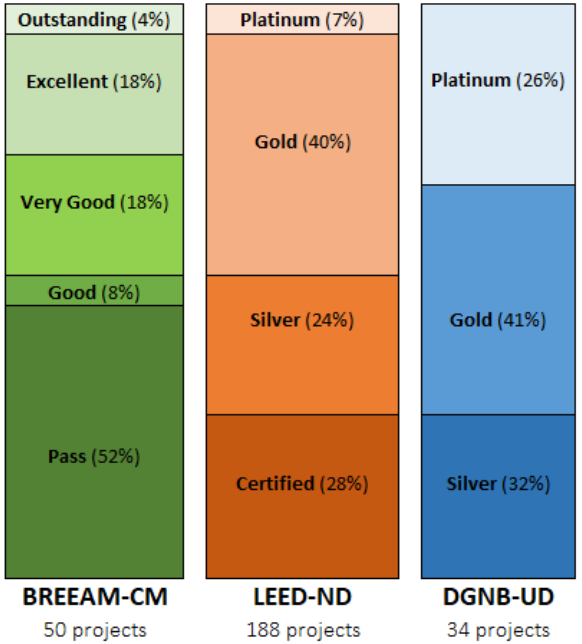


Overview of the Systems

Sustainability levels

Scoring points
Number of points required to achieve each level

Statistics
Number of projects achieving each level



* Insufficient statistical info for CASBEE and Green Star

Key Sustainability criteria and weights: Environmental criteria

Criteria	BREEAM-CM	LEED-ND	DGNB-UD	CASBEE-UD	G.STAR-CM
Energy & Emissions	energy strategy*; transport carbon emissions 7%	minimum building energy performance*; solar orientation; optimize building energy; renewable energy; district heating & cooling; infrastructure energy efficiency 9%	energy infrastructure; LCA -emissions 9%	possibility demand/supply …; adaptability and expandability 6%	greenhouse gas strategy; peak electricity demand 8%
Water	water strategy*; water pollution; rainwater harvesting 5%	indoor water use reduction*; outdoor water use reduction; wastewater management 5%	water cycle 3%	water resource – waterworks; sewerage 6%	integrated water cycle 7%
Waste	low impact materials; resource efficiency; existing buildings*; sustainable buildings 12%	construction activity pollution prev.*; solid waste management; building reuse; certified green building*; recycled and reused infrastructure 8%	lca-resource cons; resilience and adaptability; resource management 10%	resources recycling-construction; operation; environmentally considerate buildings 17%	materials; waste management; sustainable buildings 11%
Land use	ecology strategy*; enhancement of ecological value; green infrastructure; land use*; landscape 12%	smart location*; imperiled species*; wetland & water body conservation*; agricultural land conservation*; site design for habitat or wetland*; restoration of habitat or wetlands; long-term conservation management; minimized site disturbance 4%	biodiversity; land use; smart infrastructure; land use efficiency (Wst: 15%)	greenery - ground greening; building top greening; biodiversity – preservation; regeneration & creation; consistency with upper level; planning; land use 17%	sustainable sites*; ecological value 4%

Key Sustainability criteria and weights: Social criteria

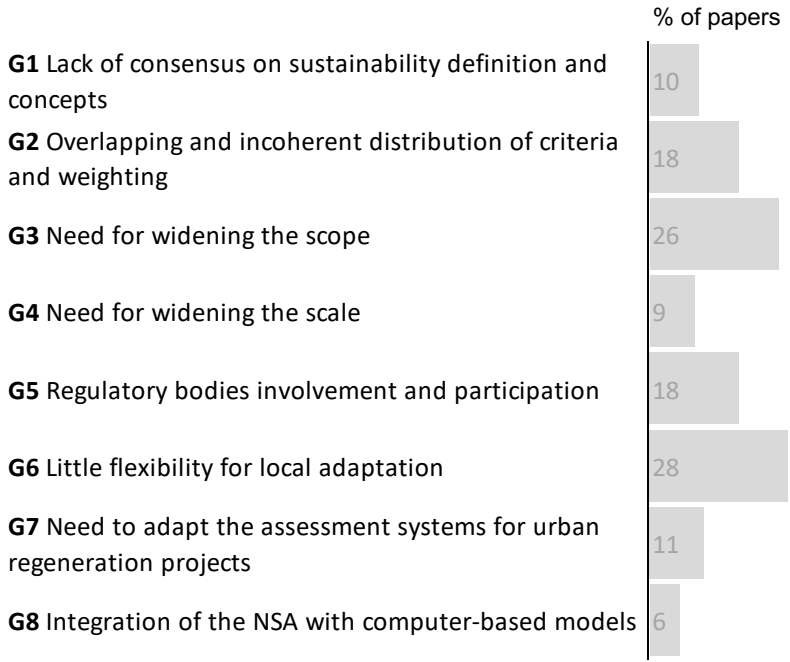
Criteria	BREEAM-CM	LEED-ND	DGNB-UD	CASBEE-UD	G.STAR-CM
Well-being	noise pollution*; light pollution 3%	light pollution reduction 1%	thermal comfort open spaces; open space; noise, exhaust & light emiss 10%	View; inhabitant population; staying population 8%	healthy and active living*; light pollution 6%
Climate adapt & resilience	adapting to climate change; flood risk assessment*; flood risk management; microclimate 8%	rainwater management; floodplain avoidance*; steep slope protection; brownfield remediation; heat island red 8%	urban climate; environmental risks; groundwater and soil protection 7%	basic disaster prevention; disaster response ability; traffic safety; crime prevent 11%	adaptation and resilience; safe places*; heat island effect 7%
Access to services	access to public transport; public transport facilities; transport assessment*; cycling network; cycling facilities; local parking; demographic needs*; delivery of services, facilities; public realm; utilities; inclusive design; safe and appealing streets 26%	preferred locations; access to quality transit; transit facilities; transportation demand…; bicycle facilities; reduced parking …; compact development*; connected & open community*; mixed-use neighbor.; access to civic & public space; access to recreation facilities; neighbor. schools; walkable streets; local food prod.; visibility & universal design; tree-lined & shaded streets ~51%	motorized transportation; pedestrian and cyclists; robust social and functional mix; social & commercial industry; barrier-free design 21%	convenience; health and welfare, education; development of traffic facilities; traffic - logistics management 11%	sustainable transport & movement; walkable access to amenities; access to fresh food; digital infrastructure 9%
Heritage	local vernacular 1%	historic resource preservation 2%	urban design 3%	history and culture 3%	culture, heritage and identity 3%
Participation	consultation plan*; consul. & engagement*; design review; training and skills; community management of facilities 15%	community outreach and involvement 2%	integrated design; consultation; project management); governance; monitoring 10%	compliance; area management; information service performance; information system - block management 17%	Gstar professional; design review; engagement; corporate responsibility; sustainability awareness; community participation; environmental management; community develop* 28%

Key Sustainability criteria and weights: Economic criteria

Criteria	BREEAM-CM	LEED-ND	DGNB-UD	CASBEE-UD	G.STAR-CM
Economic prosperity	Economic impact*; Housing provision 12%	Housing and jobs proximity; Housing types and affordability 10%	Local economic impact; Value stability 6%	Economic development revitalization activity 6%	Community investment; Affordability; Employment& economic resilience; Education & skills 13%
Life cycle costs	Not found any exclusively dedicated criteria, although costs calculation is included in the energy-related criteria 0%	Not found any exclusively dedicated criteria, although costs calculation is included in building reuse and energy criteria 0%	Life cycle cost; partially included in resilience and adaptability 6%	0%	Return on investment; Incentive programs 4%

Shortcomings and pathways for improvement

Identified Gaps



*from the total of 124publications

Pathways for improvement

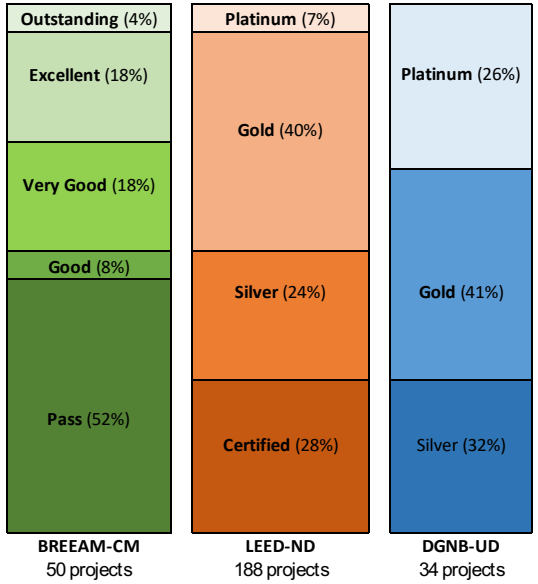
Shortcomings and pathways for improvement

G1 Lack of consensus on sustainability definition and concepts

Sustainability is not a fixed term yet.
They providing a practical pathway to measure sustainability, but they often group and use different metrics and weights to each sustainability issue.

G2 Overlapping and incoherent distribution of criteria and weighting

Because of this lack of consensus on the definition of sustainability, they often face the problem of completeness, and overlapping criteria



which raises the question about what exactly do they measure
“Do green neighborhood ratings cover sustainability?” Reith &Orova,2015

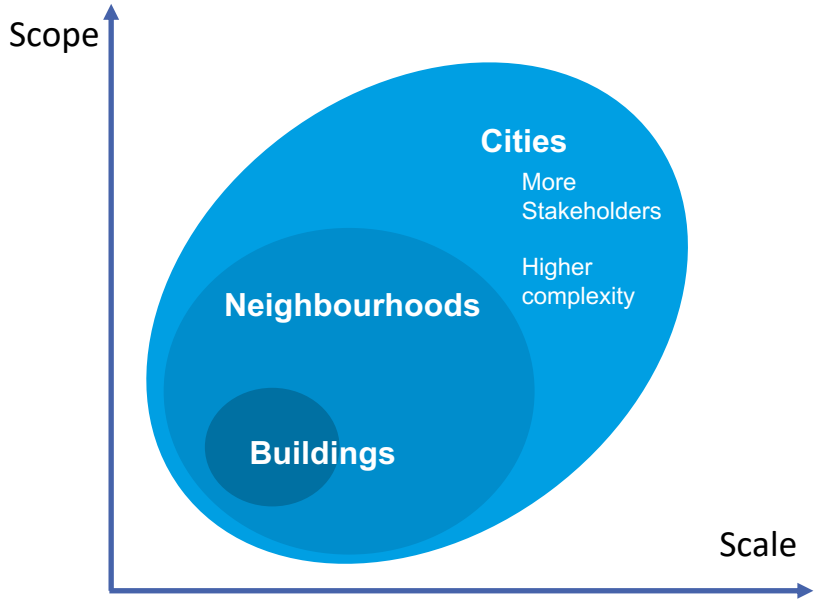
Shortcomings and pathways for improvement

G3 Need for widening the scope

To include socioeconomic factors, mobility and walkability, disaster resilience and climate change, cultural factors

G4 Need for widening the scale

New opportunities - improved efficiency and better management of local resources &
New challenges - increased complexity and interconnectivity



G5 Regulatory bodies involvement and participation

Is a key factor for the successful adoption of green communities.
Also, the improvement of the obligatory minimum standards may push forward the current voluntary standards by establishing a more demanding baseline that incentivizes competitiveness in the market.

Shortcomings and pathways for improvement

G6 Little flexibility for local adaptation

Most of the systems are developed within a certain country but are often used internationally. This opens the debate on the viability of using global standards and the pertinence of their use in actual local conditions. This particularly noticed and needed for developing countries.

G7 Need to adapt the assessment systems for urban regeneration projects

are mostly designed to guide the development of new urban areas, but cities are already built environments, therefore, there is a need to adapt these systems to serve built environments as well

G8 Integration with computer-based models

These systems are typically expert-based rather than computer-based models. Yet, as scale is enlarged and complexity increases, there is a need to couple it with computer-based models (e.g., GIS, BIM)

Thank you for your attention

Any Questions?

Joana Pedro

[1] WHO, “WHO | Urban population growth,” WHO, 2015. [Online]. Available: http://www.who.int/gho/urban_health/situation_trends/urban_population_growth_text/en/. [Accessed: 26-Apr- 2017].
[2] D. Reckien, F. Creutzig, B. Fernandez, S. Lwasa, M. Tovar-restrepo, and D. Satterthwaite, “Climate change , equity and the Sustainable Development Goals : an urban perspective,” Environ. Urban., vol. 29, no. 1, pp. 159–182, 2017.
[3] V. C. Broto, “Urban Governance and the Politics of Climate change,” World Dev., vol. xx, 2017.
[4] D. T. Doan, A. Ghaffarianhoseini, N. Naismith, T. Zhang, A. Ghaffarianhoseini, and J. Tookey, “A critical comparison of green building rating systems,” Build. Environ., vol. 123, pp. 243–260, 2017.
[5] U. Berardi, Sustainability assessments of buildings, communities, and cities. Elsevier Inc., 2015.
[6] A. Haapio and P. Viitaniemi, “A critical review of building environmental assessment tools,” Environ. Impact Assess. Rev., vol. 28, no. 7, pp. 469–482, 2008.
[7] L. Boyle, K. Michell, and F. Viruly, “A Critique of the Application of Neighborhood Sustainability Assessment Tools in Urban Regeneration,” 2018.
[8] A. Sharifi and A. Murayama, “Neighborhood sustainability assessment in action : Cross-evaluation of three assessment systems and their cases from the US , the UK , and Japan,” vol. 72, 2014.
[9] B. Mattoni, C. Guattari, L. Evangelisti, F. Bisegna, P. Gori, and F. Asdrubali, “Critical review and methodological approach to evaluate the di ff erences among international green building rating tools,” Renew. Sustain. Energy Rev., vol. 82, no. September 2017, pp. 950–960, 2018.
[10] T. Dixton, M. Eames, M. Hunt, and S. Lannon, Urban Retrofitting for Sustainability. 2014.
[11] R. F. M. Ameen, M. Mourshed, and H. Li, “A critical review of environmental assessment tools for sustainable urban design,” Environ. Impact Assess. Rev., vol. 55, pp. 110–125, 2015.
[12] BRE Global, “The Digest of BREEAM Assessment Statistics,” vol. 01, p. 54, 2014.
[13] BRE Global, “Certified BREEAM Assessments,” 2018. [Online]. Available: http://www.greenbooklive.com/search/scheme.jsp?id=202. [Accessed: 29-Nov-2018].
[14] USGBC, “LEED Projects,” 2018. [Online]. Available: https://www.usgbc.org/projects. [Accessed: 29-Nov-2018].
[15] F. Ali-Toudert and L. Ji, “Modeling and measuring urban sustainability in multi-criteria based systems — A challenging issue,” Ecol. Indic., vol. 73, 2017.
[16] A. Haapio, “Towards sustainable urban communities,” Environ. Impact Assess. Rev., vol. 32, no. 1, pp. 165–169, 2012.
[17] A. Sharifi and A. Murayama, “A critical review of seven selected neighborhood sustainability assessment tools,” Environ. Impact Assess. Rev., vol. 38, pp. 73–87, 2013.
[18] A. Komeily and R. S. Srinivasan, “A need for balanced approach to neighborhood sustainability assessments: A critical review and analysis,” Sustain. Cities Soc., vol. 18, pp. 32–43, 2015.
[19] V. W. Y. Tam, H. Karimipour, K. N. Le, and J. Wang, “Green neighbourhood : Review on the international assessment systems,” Renew. Sustain. Energy Rev., vol. 82, no. August 2016, pp. 689–699, 2018.
[20] S. Yıldız, “Neighborhood Sustainability Assessment Tools and a Comparative Analysis of Five Different Assessment Tools,” J. Plan., no. October, 2016.
[21] D. Moher, A. Liberati, J. Tetzlaff, and D. G. Altman, “Preferred reporting items for systematic reviews and meta- analyses: The PRISMA statement,” Int. J. Surg., vol. 8, no. 5, pp. 336–341, 2010.

[22]H. Kaur and P. Garg, “Urban Sustainability Assessment Tools: A Review,” J. Clean. Prod., 2018.
[23]M. Cohen, “A Systematic Review of Urban Sustainability Assessment Literature,” no. 1, pp. 1–16, 2017.
[24]BRE Global, BREEAM Communities: Technical Manual SD202-0.1:2012. 2012.
[25]BRE Global, “GreenBook Live: Certified BREEAM Assessments,” 2019. [Online]. Available: http://www.greenbooklive.com/search/scheme.jsp?id=202. [Accessed: 01-Mar-2019].
[26]USGBC, “LEED for Neighborhood Development, ballot version , v4,” 2014.
[27]USGBC, “Projects | U.S. Green Building Council,” 2018. [Online]. Available: https://www.usgbc.org/projects. [Accessed: 01-Mar-2019].
[28]JSBC, CASBEE for Urban Development. IBEC, 2014.
[29]JaGBC, “Dissemination of CASBEE,” 2014. [Online]. Available: http://www.ibec.or.jp/CASBEE/english/statistics.htm. [Accessed: 01-Mar-2019].
[30]DGNB, “DGNB – Urban Districts,” 2018. [Online]. Available: https://www.dgnb-system.de/en/schemes/scheme- overview/urban_districts.php. [Accessed: 26-Nov-2018].
[31]DGNB, “DGNB pre-certified and certified projects,” 2019. [Online]. Available: https://www.dgnb- system.de/en/projects/. [Accessed: 01-Mar-2019].
[32]GBCA, “Green Star - Communities,” 2012.
[33]GBCA, “Green Star – Communities | Green Building Council of Australia,” 2018. [Online]. Available: https://new.gbca.org.au/green-star/rating-system/communities/. [Accessed: 01-Mar-2019].
[34]A. Sharifi, M. Gentile, T. Tammaru, and R. Van Kempen, “From Garden City to Eco-urbanism: The quest for sustainable neighborhood development,” Cities, vol. 29, no. 5, pp. 291–299, 2016.
[35]WCED, “World Commission on Environment and Development: Our Common Future,” 1987.
[36]A. Dawodu, B. Akinwolemiwa, and A. Cheshmehzangi, “A conceptual re-visualization of the adoption and utilization of the Pillars of Sustainability in the development of Neighbourhood Sustainability Assessment Tools,”
Sustain. Cities Soc., vol. 28, pp. 398–410, 2017.
[37]C. Turcu, “Local experiences of urban sustainability: Researching Housing Market Renewal interventions in three English neighbourhoods,” Prog. Plann., vol. 78, no. 3, pp. 101–150, 2012.
[38]U. Berardi, “Sustainability assessment of urban communities through rating systems,” Environ. Dev. Sustain., vol. 15, no. 6, pp. 1573–1591, 2013.
[39]A. Reith and M. Orova, “Do green neighbourhood ratings cover sustainability?,” Ecol. Indic., vol. 48, pp. 660–672, 2015.
[40]M. Wallhagen, T. Malmqvist, and G. Finnveden, “Certification systems for sustainable neighbourhoods: What do they really certify ?,” vol. 56, pp. 200–213, 2016.
[41]G. Wu, K. Duan, J. Zuo, X. Zhao, and D. Tang, “Integrated sustainability assessment of public rental housing community based on a hybrid method of AHP-entropyweight and cloud model,” Sustain., vol. 9, no. 4, 2017.
[42]P. Wu, Y. Song, X. Hu, and X. Wang, “A preliminary investigation of the transition from green building to green community: Insights from LEED ND,” Sustain., vol. 10, no. 6, 2018.

[43]A. A. Gouda and H. E. Masoumi, “Sustainable transportation according to certification systems: A viability analysis based on neighborhood size and context relevance,” Environ. Impact Assess. Rev., vol. 63, pp. 147–159, 2017.
[44]W. Riggs, “Walkability: to quantify or not to quantify,” J. Urban. Int. Res. Placemaking Urban Sustain., vol. 10, no. 1, pp. 125–127, Jan. 2017.
[45]J. G. Sally Naij, “A.Sustainability in Relation to Building Adaptive Capacity to Climate Change,” 2016.
[46]J. M. Diaz-Sarachaga and D. Jato-Espino, “Development and application of a new Resilient, Sustainable, Safe and Inclusive Community Rating System (RESSICOM),” J. Clean. Prod., vol. 207, pp. 971–979, Jan. 2019.
[47]A. Sharifi and A. Murayama, “Viability of using global standards for neighbourhood sustainability assessment: insights from a comparative case study,” J. Environ. Plan. Manag., vol. 58, no. 1, pp. 1–23, 2015.
[48]A. Dawodu, B. Akinwolemiwa, and A. Cheshmehzangi, “A conceptual re-visualization of the adoption and utilization of the Pillars of Sustainability in the development of Neighbourhood Sustainability Assessment Tools,” Sustain. Cities Soc., vol. 28, pp. 398–410, 2017.
[49]A. A. Gouda and H. E. Masoumi, “Certifications systems as independent and rigorous tools for assessing urban sustainability,” Int. J. Urban Sci., vol. 22, no. 3, pp. 308–321, 2018.
[50]A. Dawodu, A. Cheshmehzangi, and B. Akinwolemiwa, “The systematic selection of headline sustainable indicators for the development of future neighbourhood sustainability assessment tools for Africa,” Sustain. Cities Soc., vol. 41, pp. 760–776, 2018.
[51]J. M. Diaz-Sarachaga, D. Jato-Espino, B. Alsulami, and D. Castro-Fresno, “Evaluation of existing sustainable infrastructure rating systems for their application in developing countries,” Ecol. Indic., vol. 71, pp. 491–502, 2016.
[52]H. W. Zheng, G. Q. Shen, Y. Song, B. Sun, and J. Hong, “Neighborhood sustainability in urban renewal: An assessment framework,” Environ. Plan. B Urban Anal. City Sci., vol. 44, no. 5, pp. 903–924, Sep. 2017.
[53]F. Cappai, D. Forgues, and M. Glaus, “Socio-Economic Indicators for the Ex-Post Evaluation of Brownfield Rehabilitation: A Case Study,” Urban Sci., vol. 2, no. 4, p. 100, Sep. 2018.
[54]F. Appendino, “Heritage-related Indicators for Urban Sustainable Development : A Systematic Heritage-related Indicators for Urban Sustainable Development : A Systematic Review,” no. December, 2018.
[55]A. Morris, J. Zuo, Y. Wang, and J. Wang, “Readiness for sustainable community: A case study of Green Star Communities,” J. Clean. Prod., vol. 173, pp. 308–317, 2018.
[56]Z. A. Göçmen and J. A. LaGro, “Assessing local planning capacity to promote environmentally sustainable residential development,” J. Environ. Plan. Manag., vol. 59, no. 8, pp. 1513–1535, 2016.
[57]A. Oliver and D. S. Pearl, “Rethinking sustainability frameworks in neighbourhood projects: a process-based approach,” Build. Res. Inf., vol. 46, no. 5, pp. 513–527, 2018.
[58]F. Encinas, C. Aguirre, and C. Marmolejo-Duarte, “Sustainability attributes in real estate development: Private Perspectives on advancing energy regulation in a liberalized market,” Sustain., vol. 10, no. 1, 2018.
[59]S. Verovsek, M. Juvancic, and T. Zupancic, “Widening the Scope and Scale of Sustainability Assessments in Built Environments: From Passive House to Active Neighbourhood,” Acad. J. Interdiscip. Stud., vol. 7, no. 1, pp. 129– 135, 2018.

[60] C. Skaar, N. Labonnote, and K. Gradeci, “From zero emission buildings (ZEB) to Zero emission neighbourhoods (ZEN): A mapping review of algorithm-based LCA,” Sustain., vol. 10, no. 7, 2018.
[61] R. Aghamolaei, M. H. Shamsi, M. Tahsildoost, and J. O’Donnell, “Review of district-scale energy performance analysis: Outlooks towards holistic urban frameworks,” Sustain. Cities Soc., vol. 41, pp. 252–264, 2018.
[62] S. Koutra, V. Becue, M. A. Gallas, and C. S. Ioakimidis, “Towards the development of a net-zero energy district evaluation approach: A review of sustainable approaches and assessment tools,” Sustain. Cities Soc., vol. 39, pp. 784–800, 2018.
[63] J. Pedro, C. Silva, and M. Pinheiro, “Scaling up LEED-ND sustainability assessment from the neighborhood towards the city scale with the support of GIS modeling: Lisbon case study,” Sustain. Cities Soc., 2017.
[64] C. Kuster, Y. Rezgui, J.-L. Hippolyte, and M. Mourshed, “Total life cycle and near real time environmental assessment approach: An application to district and urban environment?,” eWork Ebus. Archit. Eng. Constr. - Proc. 11th Eur. Conf. Prod. Process Model. ECPPM 2016, no. September, 2016.
[65] X. Oregi, E. Roth, E. Alsema, M. Van Ginkel, and D. Struik, “Use of ICT tools for integration of energy in urban planning projects,” Energy Procedia, vol. 83, pp. 157–166, 2015.
[66] A. Cheshmehzangi, Y. Zhu, and B. Li, “Application of environmental performance analysis for urban design with Computational Fluid Dynamics (CFD) and EcoTect tools: The case of Cao Fei Dian eco-city, China,” Int. J. Sustain. Built Environ., vol. 6, no. 1, pp. 102–112, 2017.
[67] P. H. Chen and T. C. Nguyen, “Integrating web map service and building information modeling for location and transportation analysis in green building certification process,” Autom. Constr., vol. 77, pp. 52–66, 2017.