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1 **Systems Approaches for Localising the SDGs: Co-Production of Place-based Case Studies**

2 **In: Globalization and Health**

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10

11 Abstract

12 *Introduction/Background*

13 Localisation is a pervasive challenge in achieving sustainable development. Contextual particularities
14 may render generalized strategies to achieve the Sustainable Development Goals (SDGs) unfeasible,
15 impractical, or ineffective. Furthermore, many localities are resource- and data-poor, limiting
16 applicability of the global SDG indicator framework. Tools to enable local actors to make sense of
17 complex problems, communicate this understanding, and act accordingly would improve results.

18 *Aim*

19 Systems approaches can help characterise local causal systems, identify useful leverage points, and foster
20 participation needed to localise and catalyse development action. Critically, such efforts must be deeply
21 rooted in place, involving local actors in mapping decision-processes and causation within local physical,
22 social and policy environments. Given that each place has a unique geographical or spatial extent and
23 therein lies its unique characters and problems, we term these activities “placially-explicit.” We describe
24 here a process used to develop placially-explicit, systems-based (PESB) case studies on issues that impact
25 urban health and wellbeing, producing place-based models and insights that are useful for SDG
26 localisation.

27 *Methods*

28 Seven case studies were co-produced by one or more Partners with place-based knowledge of the case
29 study issue and a Systems Thinker. In each case, joint delineation of an appropriate framing was followed
30 by iterative dialogue cycles to uncover key contextual factors, with attention to institutional and societal
31 structures and paradigms and the motivations and constraints of other actors. Casual loop diagrams were
32 iteratively developed to capture complex narratives in a simple visual way.

33 *Results*

34 Case study development facilitated transfer of local knowledge and development of systems thinking
35 capacity. Partners reported new insights, including a shifting of problem frames and corresponding
36 solution spaces to higher systems levels. Such changes led partners to re-evaluate their roles and goals,
37 and thence to new actions and strategies. CLD-based narratives also proved useful in ongoing
38 communications.

39 *Conclusion*

40 Co-production of placially-explicit, systems-based case studies are a useful component of
41 transdisciplinary toolsets for local SDG implementation, building the capacity of local actors to explore
42 complex problems, identify new solutions and indicators, and understand the systemic linkages inherent
43 in SDG actions across sectors and scales.

44 Keywords

45 Systems approaches, systems thinking, place-based approaches, placially-explicit, localisation, decision-
46 making, co-production

47 Background

48 *Translating SDGs into local contexts*

49 The United Nations Sustainable Development Goals (SDGs) were adopted in 2015 as a globally-agreed
50 vision for advancing the conditions of people and planet while ensuring that no one is left behind.

51 Because health is central to and deeply interlinked with sustainable development (1), progress toward

52 these goals is essential for creating physical, social and policy environments that will sustain and enhance
53 health and wellbeing. Realising such progress will require action at local scales, yet localisation involves
54 more than just local application of high-level agendas. Rather, SDG localisation encompasses local
55 agenda setting, decision-making, and process monitoring with locally-adapted indicators, which together
56 generate the ownership necessary for successful SDG implementation at local scale. It is thus critical that
57 the apparatus of sustainable development become more responsive and relevant to local needs and
58 aspirations.

59 Substantial difficulties exist in translating high-level SDG goals for local contexts, as evidenced by the
60 literature on gaps between global indicators and local needs and understandings. Global indicators enable
61 comparison between contexts but may sacrifice local validity (2,3) and the ability to motivate action by
62 reflecting local values (4,5). Furthermore, global indicators may be unusable at local scales where data, or
63 the resources and capacity to obtain such data, are unavailable (2,3). Necessary development of SDG
64 indicators that match locally available needs, values, and capacity is hampered by the same resource and
65 capacity deficits that limit local application of global indicators. Furthermore, responsibilities and
66 expertise are vertically and horizontally fragmented. This fragmentation frequently isolates local actors,
67 depriving them of support and empowerment and thereby limiting meaningful participation and
68 ownership. This is problematic given that participation, rooted in place as an organising principle, is
69 critical for connecting domains such as planning and health (6) that are critical for SDG action.

70

71 *Systems approaches for localisation*

72 Despite shared emphases on contextual understanding and holistic approaches, systems thinking and
73 place-based approaches have rarely, and only recently, been mentioned together in scientific literature (7–
74 9). They intersect in systems approaches (10–13), which are strategies for problem exploration, framing
75 and solving that make use of systems thinking tools and methodologies in tandem with participatory
76 engagement beyond the academy.

77 Systems thinking has been defined in various ways, with key elements including a consideration of
78 interconnections, holistic rather than reductionist approaches, and exploration of dynamic and emergent
79 behaviour arising from the action of feedback relationships (14). Systems thinking provides tools for
80 managing complexity by shifting problem frameworks from linear cause-effect interpretations toward an
81 understanding of the larger context in which interventions might occur, how other actors might respond,
82 and unintended consequences that might affect not only outcomes but also interventions themselves (15).

83 Place-based approaches are motivated by the idea that sustainability problems are often best understood
84 by analysing human–environment interactions in specific locations and at relatively small scales. This is
85 generally justified in terms of analytical tractability, or on the grounds that macro-scale approaches
86 involve the sacrifice of process detail, or in the belief that human–environment interactions are strongly
87 context-sensitive (16,17). An important critique of the local approach to sustainability issues is that action
88 which is locally optimal may shift externalities to other scales, sectors, or locations. Systems thinking,
89 with its emphasis on interconnectedness, can be a useful corrective to this.

90 Systems approaches make use of causal loop diagrams (CLDs) and other systems thinking tools to enable
91 participatory exploration of problems. In addressing local problems, a place-specific approach is critical,
92 because problems manifest in unique ways in particular contexts. Although common contextual features
93 are often shared across different settings, the interconnections and interdependencies between parts of
94 systems (especially between people and environments) are often diverse, dynamic, and, most importantly,
95 place-specific. Pre-existing social, cultural, economic, and environmental conditions in different places
96 also play a significant role in determining the structure of causal chains (Cartwright, 2013). Thus, lessons
97 are not easily translated across contexts. Rather, efforts to address local problems—such as in SDG
98 localisation—require a placially-explicit understanding of the relationships and interconnections in that
99 place.

100 In systems approaches, placially-explicit understanding is achieved by engaging actors and stakeholders
101 with systems tools for model- and narrative-building. These methodologies provide a common language
102 that is a necessary part of any solution for overcoming disciplinary and organisational fragmentation and

103 enabling diverse stakeholders to create shared narratives about important development issues (18). A
104 common language is critical to transdisciplinary work that integrates both academic researchers from
105 different unrelated disciplines and non-academic participants to research a common goal and create new
106 knowledge and theory. Narratives developed in transdisciplinary projects can advance localisation of the
107 SDGs in various ways:

- 108 • By facilitating the creation and communication of holistic understandings of complex socio-
109 ecological issues (19).
- 110 • By creating systems frameworks that are useful for evaluating likely leverage points and
111 consequences of actions (20,21), thus suggesting local SDG solutions and ways to parlay the
112 SDGs into broader local development.
- 113 • By fostering the development of relationships among actors, thus providing a pathway for
114 developing the local, intersubjective, value-based indicators advocated by Burford et al. (2013,
115 2016) and enabling the integrated multi-level partnerships that have been identified as one of the
116 key drivers for SDGs localisation (22,23).

117 Transdisciplinary systems thinking workshops have been a typical vehicle for building systems thinking
118 capacity and applying systems methodologies to local problem exploration (24,25). Such workshops
119 facilitate transdisciplinary action, often by training participants to overcome disciplinary barriers, and can
120 thereby serve as a vehicle for systems approaches. However, while valuable, such workshops are often
121 resource-intensive, and may require the convening of large groups of stakeholders. Here, we describe a
122 complementary capacity-building process: co-development of placially-explicit, systems-based (PESB)
123 case studies. Such studies are well-suited to meet the challenges of SDG localisation in ways that improve
124 health and wellbeing, especially in low-resource and low-capacity settings.

125

126 Methods

127 While the urban environment, including the built environment, is a key determinant of health (26), the
128 fields of urban planning and public health are limited in their interactions, the result of a long-standing

129 divergence (6). Under the Systems Thinking and Place Based Methods for Healthier Malaysian Cities
 130 (SCHEMA) project, an effort to improve decision-making for urban health, PESB case studies were
 131 developed to demonstrate the value of systems approaches for improving understanding and developing
 132 narratives to address this and other such gaps, with the end goal of improved decision making. Simple
 133 CLDs were used to visually communicate the complex relationships among urban planning, public health,
 134 and other fields (18,20). These were combined with other written and visual elements to produce seven
 135 case studies (Table 1) aimed at policy-makers, and were launched at the 9th World Urban Forum (WUF9)
 136 in Kuala Lumpur, Malaysia.

137 Case studies were co-produced by one or more partners with place-specific knowledge of the case study
 138 issue (“Partners”) and an expert in systems thinking (“Systems Thinker”). Partners were recruited via an
 139 open call and through professional networks. Partners included representatives from civil society
 140 organisations, policy researchers, academics, and the private sector. With one exception, Partners had no
 141 or minimal prior exposure to systems thinking.

Table 1: List of Case Studies

| Case Study Description | Partners | Key Insights |
|--|---|--|
| Analysis of how policies and practices around school canteens interact based on observations of schools in a small township. | Anthropology researcher | Policies and practices surrounding school canteens with different goals (i.e. student nutrition, promotion of small businesses, and school finances) have been set independently of each other. While they make sense independently, they are incoherent together, undermining nutritional value of school canteen food. |
| Challenges in changing diets in Malaysia to combat rise in diabetes. | Health policy researchers | Health promotion through informational campaigns needs to be accompanied by strategies that address societal and environmental drivers of food consumption and physical activity. |
| Sustaining urban rejuvenation efforts in a financially-limited locality. | Officers from an organisation funding and facilitating urban rejuvenation efforts | When urban rejuvenation efforts are coupled with a locally-appropriate strategy for engaging communities and developing cross-sector partnerships, resources can be unlocked for maintaining improvements and initiating new efforts. |

| | | |
|--|--|---|
| A university botanic garden’s challenge in maintaining conservation and education missions as university institutional priorities and funding shift. | University researcher and living laboratory programme officer | To maintain its mission, the botanic garden needs to re-evaluate who it considers as its key stakeholders, and reorient its activities and focus to cultivate those relationships. |
| Competing paradigms within a university of the value of its undeveloped land, and the challenge of maintaining green spaces in urban centres. | University administration leader and living laboratory programme officer | To secure university green spaces, institutional paradigms and sustainable land use must be strengthened. To achieve this, linkages must be made between conservation and other core values and priorities the university holds. |
| Technological and community approaches to river clean-up and maintenance. | Civil society advocates and university researcher | Technology appears to offer predictable and easily-implementable solutions to state and local authorities dealing with pollution issues. However, when this is the sole solution, communities are disempowered and become disengaged, feeding paradigms that lead to increased pollution. |
| Bike-sharing as part of an integrated public-transit solution. | Private sector bike-sharing company | Barriers to cycling are lowered when there is a critical mass of cyclists such that driver-awareness and road infrastructure change to accommodate cycling. Bike-sharing companies can play a role in overcoming initial barriers such that this critical mass can be reached. |

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Co-production of PESB case studies was designed to fully engage Partners in holistic problem definition and representation so that Partners retained control over the transfer of knowledge, often implicit or tacit, into the case study format (27). The process began with selection of an appropriate framework for understanding the issue in question. Partners were provided with a short primer on CLDs, a sample case study, and a short set of guidelines, and developed a 200-word abstract describing the problem and highlighting attempted or proposed solutions. The Systems Thinker followed up, via e-mail or a face-to-face meeting, with an iterative series of questions, based on principles in systems approaches, to map out the larger context in which the case study was embedded. Attention was given to institutional and societal structures and paradigms, as well as the motivations and constraints of other actors involved in the problem and/or solution.

154 Based on responses to initial questions, the Systems Thinker developed three to four candidate CLDs that
155 attempted to create a conceptual model of causal linkages surrounding the problem and solution in a
156 manner consistent with the Partner’s narrative. Partners were asked to identify what was correctly
157 captured and what was left out, concluding with the selection of a preliminary CLD and corresponding
158 problem frame that accurately represented the Partner’s understandings. The selected CLD went through
159 several further iterations, informed by ongoing engagement. The CLDs were broken down into 3-4 stages
160 of complexity. The simplest stage involved one or two key feedback loops, with further contextual detail
161 added in subsequent stages. Potential systems-based interventions were usually added in the last stage.
162 When the CLDs were finalised, Partners wrote the case study text, using the CLD stages as an outline.
163 The Systems Thinker played an editorial role to ensure the text was consistent with and adequately
164 explained the narrative portrayed in the CLDs. Contact time between the Systems Thinker and the
165 Partners varied widely; the Systems Thinker spent an average of ten hours per case study on face-to-face
166 time and written correspondence, with an additional ten hours in developing CLDs and the editorial role.

167

168 Results

169 Development of the PESB case studies facilitated a transfer of local knowledge from Partners to the
170 Systems Thinker, and development of systems thinking capacity in the former. In five of the seven case
171 studies, Partners engaged deeply with CLD development, giving substantive comments about CLD
172 structure and variable naming; in the remaining two, Partners were more invested with developing a case
173 study product than with the reflective process and were largely uncritical about the CLD representation.
174 Engaged Partners reported new insights that changed the way they understood the highlighted issue.
175 The PESB case study methodology adopted here provided Partners with tools for describing a place in
176 terms of feedback relationships and for understanding the origins of various consequences—desirable and
177 undesirable. Initial case study abstracts by Partners were usually framed narrowly, with solutions
178 presented as direct, linear responses to the problem. Through the process here described, Partners
179 reframed their conceptualization of local challenges away from immediate problems, goals, and roles,

180 instead mapping out the incentives, constraints, and goals of other actors within the system. In each case,
181 the final problem frame was at a higher systems level—engaging with broader institutional and societal
182 rules, values, and paradigms—than the original problem described in the abstract. The resulting
183 conceptual models in the CLDs were useful for hypothesizing about leverage points, causal pathways and
184 theories of change, and for prioritising among evidence to be collected or generated. This resulted in
185 proposed solutions at higher problem levels, understood in connection with larger causal pathways for
186 change.

187 Improved understanding among Partners of the complex nature of their case studies has had real-world
188 relevance as they continue to work and advocate on these issues. For example, one Partner who had
189 conducted an observational, anthropological study of the nutritional value of meals in school canteens
190 developed an analytical framework for integrating the motivations and actions of various actors (28). The
191 analysis revealed how important but diverse priorities—school funding, enterprise as welfare-promotion,
192 and student health—underlying the different policies affecting school canteen operators undermined
193 nutritional standards in student meals. The interactions of these policies were clear through the combined
194 experiences of the different actors at the local level, but not through the viewpoints of any single actor or
195 policy. The integrated approach in the case study enabled identification of key feedback loops that could
196 be strengthened to increase the capacity and motivation of school canteen operators to provide healthy
197 food options.

198 The PESB case studies had benefits beyond improved problem understanding. Several Partners requested
199 further capacity building and engagement, having found the exercise valuable to their work. For example,
200 one Partner initiated and funded a transdisciplinary workshop on campus sustainability, to extend insights
201 from their case studies to other university actors. Additionally, the case studies provided compelling
202 narratives which proved useful for Partners' organisations, both internally to improve understanding, and
203 externally to communicate effectively.

204

205 *Example: Illustration of Localisation, Capacity-Building, and Values-as-Indicators*

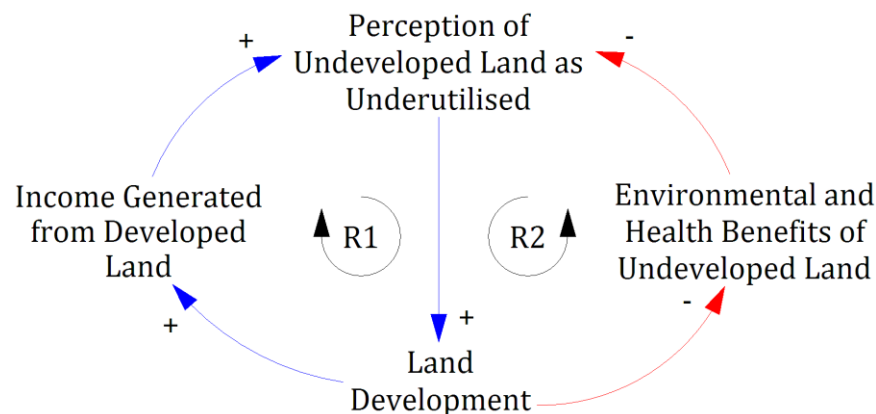
206 A pair of case studies examined campus sustainability in the setting of a major Malaysian public
207 university, unpacking how place-specific institutional structures and paradigms support or threaten
208 educational and outreach efforts and sustainable land-use choices (29,30). Partners originated from a
209 botanic garden facility with a broad mission of conservation and education and from a closely-associated
210 grassroots initiative (alumni and student) for ecological engagement and volunteerism adopted by the
211 university. The first case study examined drift in university support for the broad botanic garden mission,
212 while the latter examined a project conducted by the grassroots initiative that contributed to the
213 preservation of a rewilded parcel of land in the face of development pressures.

214 A wide body of literature establishes the positive contributions that green space and biodiversity make to
215 health, especially mental health (31,32). However, drivers that promote appreciation, preservation, and
216 cultivation of green space are strongly place-based and heavily subject to local context, including
217 socioeconomic conditions, developmental legacy and climate (33,34). Malaysia is a developing economy,
218 in which income generation is a high priority. Land is a priceless resource in the city and the neoliberal
219 developmental paradigm adopted worldwide over recent decades has resulted in the side-lining of green
220 space conservation (35). The intrinsic assumption in this paradigm is that undeveloped land constitutes an
221 underutilised resource. Yet the modern-day reframing of development in terms of sustainability
222 recognizes the value of green space. This is contained not only in SDG 15.9, calling for the integration of
223 ecosystem and biodiversity values into national and local planning, but also in SDG 11.7 which affirms
224 the need to provide universal access to safe, inclusive and accessible, green and public spaces. University
225 campuses and botanic gardens can contribute substantial institutional green space to a city (36), but most
226 relevant examples come from well-resourced institutions in highly-developed contexts.

227 These case studies explored the value to the university of maintaining or converting green spaces and the
228 institutional values required to sustain urban green space efforts more broadly. The Partners' initial
229 framing of the problem was in terms of individual decision-makers and their values, and of institutional
230 resource constraints. While the Partners have a degree of agency in addressing the issues at hand, the
231 primary locus of decision-making authority lies elsewhere, contributing to a sense of disempowerment

232 and uncertainty over the long-term viability of their efforts. Their engagement with the case studies was,
 233 in part, an attempt to advocate for their positions on these issues.

234 A systems-level analysis shifted focus from personalities as guardians of values toward the influence of
 235 institutional structures and incentives in shaping institutional values. Partners attributed this to rigorous
 236 and repeated probing via the systems thinking process, which interrogated many underlying assumptions.
 237 For example, funding cuts to the botanic garden were originally ascribed to budgetary constraints
 238 stemming from reduction of public funding for the university. Further reflection revealed shifts in the
 239 university institutional priorities as the fundamental driver, as university budgetary constraints had merely
 240 accelerated funding cuts to the botanic garden, a trend that had begun long before. This revised
 241 conceptual model of events created a better appreciation of the various constraints faced by decision-
 242 makers face and pointed toward institutional paradigms of undeveloped land as a core issue undermining
 243 support for biodiversity and greenspace initiatives (Figure 1).

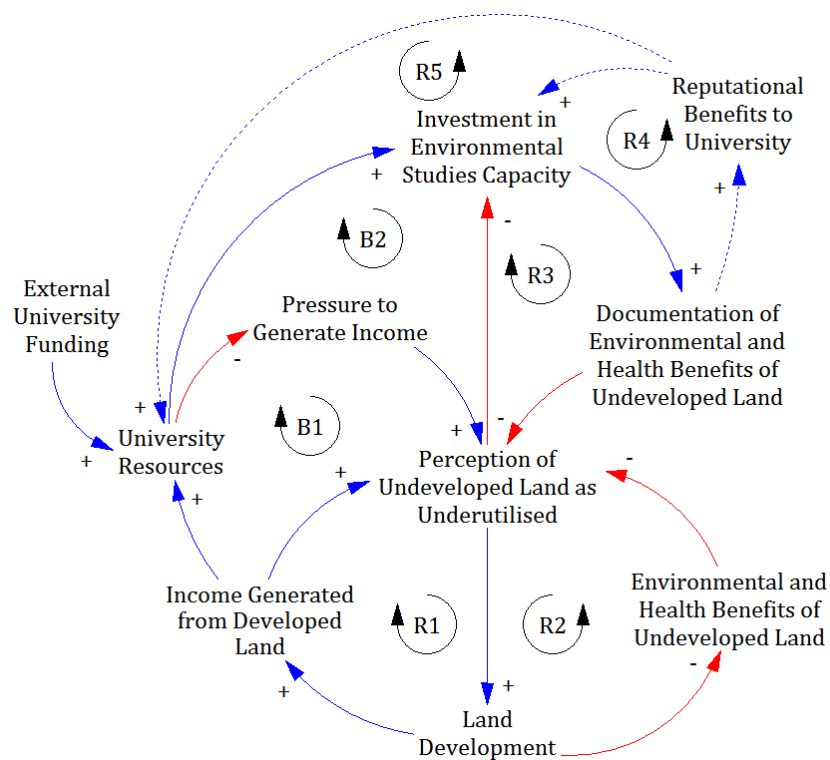


245

246 **Figure 1:** Partners discovered competing institutional narratives surrounding undeveloped university
 247 land, each driven by reinforcing feedback loops. The perception that undeveloped land is underutilised
 248 drives new development, which in turn generates income, reinforcing the perception that undeveloped
 249 land should be developed (R1). Conversely, when undeveloped land is perceived as valuable, low rates of
 250 development will preserve environmental and health benefits, and the experience of these benefits
 251 undermines the belief that undeveloped land is underutilised (R2). Figure is reproduced from Ong and
 252 Adikan (2018). (29)

253 Whereas a general analysis of the issue of green space on campuses might focus on profit-vs-loss
 254 calculations, situating the issue within a unique place allowed for deeper consideration of the local socio-

255 geographic context. The university's land bank is a significant green space in a locality where nature is
 256 otherwise scarce. The engagement of student volunteers in this project provided low-cost capacity
 257 building through fieldwork training at a time when classroom-based practical sessions were threatened by
 258 severe funding cuts across the university. Choosing to maintain green space fostered good will with
 259 neighbourhood residents who would have been affected by the proposed development. These insights
 260 suggested that Partners need not only advocate ecological and sustainability causes, but also seek out the
 261 systemic feedbacks that shape institutional perspectives and values related to land-use (Figure 2).

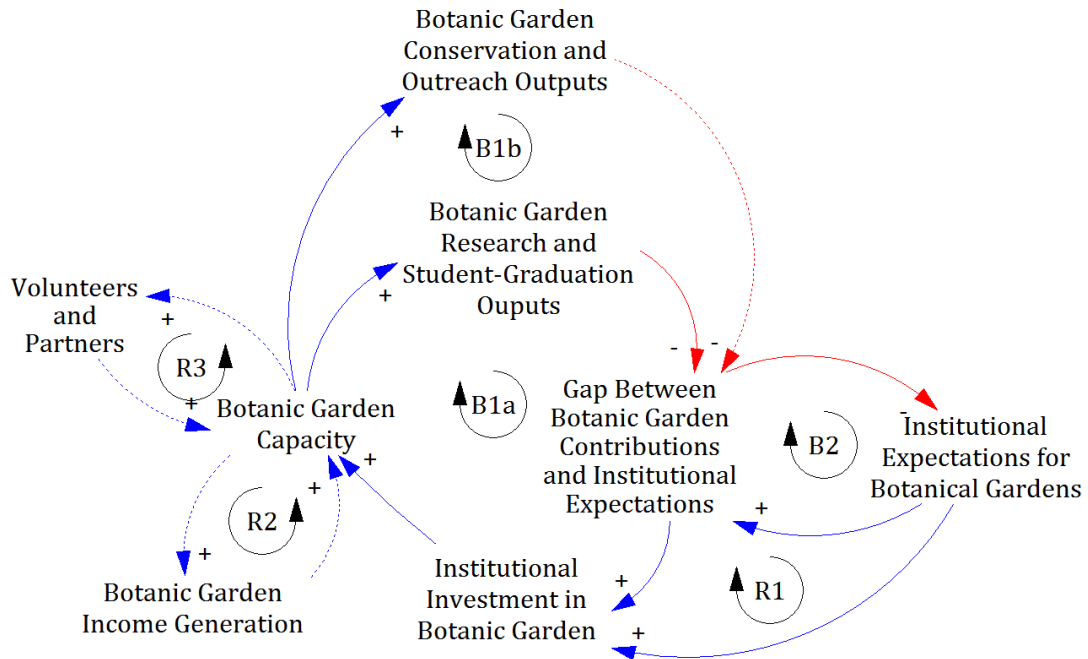


262
 263 **Figure 2:** Partners identified several systemic relationships that strengthen or weaken the competing
 264 narratives. Availability of university resources, driven largely by external public funding, determines the
 265 level of pressure for income generation, which in turn can lead to development to alleviate financial
 266 pressure (B1 loop). University efforts to document environmental and health benefits of undeveloped land
 267 have shaped perceptions of the land and encourage further investment in such studies (R3 loop); however,
 268 such efforts are also threatened by university funding limitations, which are further constrained by
 269 decisions to forego income generation to preserve undeveloped land (B2 loop). Partners identified
 270 reputational benefits to the university as useful leverage point if certain pathways (dotted arrows) could
 271 be developed and strengthened. Translation of documented environmental and health benefits of
 272 undeveloped university land into reputational benefits could reinforce university decisions to invest in

273 environmental studies (R4). Reputational benefits could also be leveraged for income generation through
274 edu-tourism and other means (R5). Figure is adapted from Ong and Adikan (29).

275 The case study process provided Partners a space to reflect on the importance of underlying variables,
276 causes, consequences, and feedbacks. In developing their conceptual models and narratives with the
277 Systems Thinker, the Partners revisited everyday experiences. This reflection catalysed discovery of the
278 interconnectedness of the issues and more importantly, their linkages to wider narratives of sustainability.
279 Partners re-evaluated the value of various key performance indicators in directing focus to the actions
280 necessary to advance the overarching mission. One such example was the identification of land-use
281 paradigms as a central issue. This led the grassroots initiative to invest effort in engaging the university in
282 dialogue on how land is valued. A prior focus on green space and biodiversity indicators, which remain
283 important outcomes, did not draw attention to the importance of engaging institutional values driving
284 university decision-making processes. This illustrates the role that values-as-indicators in SDG
285 localisation can play in drawing actors attention to critical processes that must be engaged to achieve
286 desired outcomes (4,5).

287 The Partners also recognised that the previous strategy of treating the university as the botanic garden's
288 sole primary stakeholder limited their capacity to influence the feedback loops shaping institutional
289 perspectives (Figure 3). This became the basis of a theory-of-change exercise that underpinned a major
290 restructuring of the relationship between the grassroots initiative and the botanic garden for better
291 medium-term sustainability. The respective roles played by the botanic garden facility and the grassroots
292 initiative were re-evaluated, with a pivot toward recognizing the external support community (volunteers,
293 alumni, etc.) as a primary stakeholder, and the creation of an entity outside the university institutional
294 system to support this.



295

296 **Figure 3:** Although the botanic garden had, since its foundation in the 1970s, developed a mission for
 297 conservation and public education/outreach, university institutional priorities and performance indicators
 298 since the mid-2000s shifted toward research and student-graduation outputs, severely weakening the B1b
 299 loop (indicated by dotted arrow). As the university was viewed as the sole primary stakeholder, the
 300 botanic garden felt pressure to shift its mission toward research (B1a loop). The alternative was to face
 301 diminished capacity as repeated failure to meet expectations would lead the institute to expect less from
 302 botanic garden in the long term (B2 loop) and thus invest less (R1 loop). The case study Partners
 303 identified that a pivot toward the external support community as another primary stakeholder could enable
 304 the botanical garden to maintain both its mission and its capacity. This requires investment to establish
 305 and strengthen new feedback loops (R2 and R3 loops).

306 Meanwhile, the botanic garden is bolstering its endorsement of and infrastructural support for the
 307 grassroots initiative through greater access to its space and legacy resources. This represents a shift in the
 308 way the botanic garden operates: its relationship to volunteer and grassroots movements in the past was
 309 more casual, as such partnerships were deemed peripheral to day-to-day operations at best, and
 310 burdensome and a liability at worst. This expanded capacity for risk-taking was made possible through a
 311 better understanding of systems, in which such actions are not just public service, but are critical to
 312 building the botanic garden's own support and capacity in the long-term. By anchoring some educational
 313 and outreach efforts outside the university, the Partners aim to increase resilience, improve

314 responsiveness to community values and priorities, and extend the utility of the botanic garden
315 infrastructure and facilities.

Box 1: Example of SDG Localisation Problem that Can be Addressed with Case Study Methodology

Efforts in Malaysia for family planning (FP) and sexual and reproductive health (SRH) have been guided by various international movements and documents, national plans and policies, and accompanied by significant advocacy efforts over the several decades. The Malaysia Sustainable Development Goals Voluntary National Review Report 2017 (Economic Planning Unit, Prime Minister's Department, 2017) showed that Malaysia has made substantial overall progress toward SDG 3: Good Health and Well Being. Nonetheless, SRH remains a concern, with issues such as contraceptives use and adolescents sexual and reproductive health remaining controversial, contested, and difficult to operationalise 'downstream' in policies, programmes and services due to diverse local gendered realities, culture and religion, and ways of allying and working creatively with influential actors.

In Malaysia, the National Family Planning and SRH Programme and services are mainly targeted at married couples. These are provided free of charge at Ministry of Health clinics or at a subsidised rate from the National Population and Family Development Board (NPFDB) facilities and the non-government organisation - Federation of Reproductive Health Associations, Malaysia (FRHAM) clinics. Unsubsidised FP and SRH services are also available from private pharmacies and clinics. Nevertheless, these services have been insufficient to address low use of contraceptives and deficiencies in adolescent sexual and reproductive health. Much of the shortcomings stem from problems in local implementation:

There are no clear mechanisms to coordinate and track progress of SRH programmes and services across the NFPDB, MOH and FRHAM clinics at the ground level. Common indicators and frameworks are necessary to coordinate action and leverage resources. An Advisory and Coordinating Committee on Reproductive Health (ACCRH) was established in 2001 at both national and state levels for SRH programmes and services, consisting of these three and other relevant organisations. However, the ACCRH has often been inactive and the decisions that are made do not translate into local, coordinated, action.

Meaningful engagement with local communities has not been established particularly with the marginalised and underserved populations, including young people. Community members are perceived as recipients of FP and SRH programmes and services instead of being empowered and engaged in generating ideas, making informed decisions, and sharing responsibility.

There is a lack of understanding and buy-in from other crucial partners at the local level including the Youth and Sports Ministry, Ministry of Education, Department for Islamic Development, and local community leaders. Addressing SRH needs of unmarried, young people and adolescents remains controversial for most of the key partners.

Here, we see the need for (1) systemic understanding to overcome fragmentation of efforts; (2) for sense-making tools to enable bottom-up approaches to generate contextually-appropriate solutions; and (3) for powerful narratives that can challenge and shift deeply-held paradigms. These needs in localisation are not unique to the challenges of FP and SRH, and the case study approach described herein attempts to address all three.

316

317 Discussion

318 *Utility for SDG Localisation*

319 Systems thinking has often been used as a tool for scaling-up local interventions for improved health
320 outcomes (44,45). Here, a different approach has been taken, using systems approaches for down-scaling
321 and localisation, recognising that complexity and interconnections exist at all problem scales. Indeed, the
322 PESB case study methodology was conceptualised to enhance decision-making, especially in the face of
323 cross-sectoral issues that impact health and wellbeing, by improving capacity for systemic understanding
324 and transdisciplinary communication. As a bottom-up process, it features minimal resource requirements.
325 These design parameters make this approach uniquely suited for SDG localisation, in which complex and
326 interconnected challenges particular to a specific place need to be addressed with locally-available
327 resources.

328 In local SDG implementation, local indicators are important not only for measuring impacts, but for
329 highlighting important processes that generate the desired outcomes. Indeed, systems thinking recognises
330 that indicators are not just a measurement, but that the choice of indicators also changes system behaviour
331 as indicators become targets and actors take actions accordingly (37). This can be beneficial if indicators
332 are well-aligned with actual goals, but can be detrimental if there are pathways to achieve indicators that
333 are not relevant—or even detrimental—to desired outcomes. The case study methodology enables actors
334 to develop conceptual models of systems processes, enabling them to choose supportive indicators in a
335 holistic manner that acknowledges critical relationships and system leverage points (21). Key processes
336 often include the inculcation and nurturing of values that support the SDG goals—enabling factors that
337 are often neglected in indicator selection because of the difficulties in quantifying and standardising such
338 subjective and place-specific variables (4,5). Systems approaches can enable and inform the process of re-
339 examining accepted narratives, mitigating against path dependency so that indicators are not adopted
340 merely because of prior usage (38).

341 The same improved conceptual models that enables better selection of local indicators also increases
342 capacity to act. Systemic understanding is useful not only for identifying pathways and leverage points for

343 achieving specific SDG targets, but also for identifying the potential unintended consequences of
344 simultaneous SDG actions across different sectors and scales, as where efforts to achieve one SDG target
345 reinforce or constrain efforts to achieve another (39). Benefits are most apparent where multiple actors in
346 sustainable development can be brought together in the development of a case study, with a simple
347 systems model such as a CLD serving as an organizing principle for communication and relationship-
348 building needed to achieve sustainable development.

349 Case studies are effective tools for advocating positions to policy-makers (Sallis et al., 2016). However,
350 the complex messages and relationships frequently inherent in local operationalisation of the SDGs are
351 often difficult to communicate in an accessible narrative. The CLDs used in the PESB case studies
352 address this challenge, acting as metaphors that communicate complex ideas and relationships that are not
353 easily communicated through words alone (18,40). The input of the System Thinker was important to
354 effectively use CLDs in this manner. In general, Partners tended to push for greater detail and complexity
355 in CLDs, to represent all the particularities of their case study. While additional complexity was useful in
356 exploration and achieving a comprehensive understanding of the issue, the Systems Thinker generally
357 advocated for simplification to make key relationships visually observable and comprehensible.

358 *Strengths and Limitations*

359 The PESB case study methodology is one of several ways in which systems thinking and place-based
360 research can be brought together in systems approaches, and comes with particular strengths and
361 weaknesses. The development of the case studies involved extended engagement, which allowed the
362 Partners to use, practice, and develop the skills of creating and interpreting causal loop diagrams to a
363 higher level than can be done in a short course or workshop. It is a flexible methodology with low costs,
364 enabling its utilisation in a wide variety of challenges. As it relies heavily on Partners implicit knowledge,
365 it does not require the extensive data that certain systems methodologies rely on—which is typically
366 unavailable at local scales.

367 There are a number of limitations in the PESB case study methodology. It is an involved and potentially
368 time-intensive process, and several prospective Partners declined to participate for this reason.

369 Interpersonal connections are important in cross-disciplinary work (41), especially in small co-located
370 projects (42), and were important in sustaining a multi-month collaborative process. The opportunity to
371 showcase work or highlight issues at WUF9 was a key incentive for Partners. Finding or creating such
372 opportunities may be important for obtaining Partner interest when there is not prior interpersonal
373 connection or interest in systems methodologies. A second major limitation was the lack of representation
374 from different stakeholder groups in most of the case studies, limiting the scope of perspectives that could
375 have been otherwise achieved. It can be difficult to obtain the buy-in needed from different groups, a
376 factor that implies significant interpersonal management challenges for the Systems Thinker. The
377 problem of limited perspective was partially addressed by asking the Partners to reflect deeply on the
378 motivations and paradigms of the other actors involved in their challenges.

379 The PESB case study methodology can complement other systems tools. It can serve as a catalyst for
380 transdisciplinary systems thinking workshops by creating outputs that draw interest, and can also be a
381 way of sustaining learning and engagement with systems methodologies following an introductory
382 workshop. The CLDs developed through the case studies are also a good starting point for low-order
383 systems dynamics modelling that can further aid local decision-making (43). The PESB case study
384 methodology is not dependent upon other systems methodologies to achieve impact, however: improved
385 understanding of causal linkages can in itself improve local decision-making for the SDGs, generating
386 benefits for population health and wellbeing. The extent of impact in this methodology depends on the
387 same conditions that other transdisciplinary engagement tools depend upon: long-term follow-up and
388 commitment of resources to act upon insights generated via transdisciplinary understanding.

389

390 Conclusion

391 A Systems Thinker engaged several local Partners to co-produce placially-explicit, systems-based case
392 studies, using systems approaches to develop conceptual models and narratives that describe and analyse
393 local urban challenges that impact health. In addition to producing documents that visually communicated
394 complex challenges, this provided a method, suitable for resource-poor contexts, for drawing out

395 Partners' implicit and tacit knowledge and placing it in a systems framework. This process improved
396 Partners' understanding of the challenges they faced, improving analysis and action.

397 Local decision-making is critical to operationalising the SDGs. This affects urban planning, delivery of
398 health services, education, environmental management, and many other factors that shape population
399 level health. While the complexities of interlinkages coupled with lack of resources makes localisation of
400 the SDGs a daunting task, local actors have vast implicit and tacit knowledge that they can draw upon.
401 The PESB case study methodology is a powerful way of enabling these actors to articulate this knowledge
402 through conceptual models for synthesis, evaluation, and action. Such placially-explicit models can be
403 powerful tools to inform local decision-making and communication, increasing the likelihood of
404 achieving desired outcomes in local actions toward the SDGs.

405

406 Declaration

407 *Ethics approval and consent to participate*

408 Not applicable.

409 *Consent for publication*

410 Not applicable.

411 *Availability of data and material*

412 Data sharing is not applicable to this article as no datasets were generated or analysed during the current
413 study. The co-produced case studies can be accessed at [http://www.thriveurban.info/wp-](http://www.thriveurban.info/wp-content/uploads/2018/02/SCHEMA-Case-Studies.pdf)
414 [content/uploads/2018/02/SCHEMA-Case-Studies.pdf](http://www.thriveurban.info/wp-content/uploads/2018/02/SCHEMA-Case-Studies.pdf)

415 *Competing interests*

416 The authors declare that they have no competing interests

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420 *Authors' contributions*

421 DTT led the study design, carried it out, and led the preparation of this manuscript. JGS contributed to the
422 study design and supported the development of the PESB case studies. BO was a Partner in two of the
423 case studies and led the section, “Example: Illustration of Localisation, Capacity-Building, and Values-as-
424 Indicators.” DTT, JGS, YG, BMG, and TM developed the conceptual discussion of systems approaches,
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433 References

- 434 1. WHO. Health as the pulse of the new urban agenda: United Nations conference on housing and
435 sustainable urban development, Quito, October 2016. Geneva, Switzerland: World Health
436 Organization; 2016.
- 437 2. Klopp JM, Petretta DL. The urban sustainable development goal: Indicators, complexity and the
438 politics of measuring cities. *Cities*. 2017 Mar 1;63:92–7.
- 439 3. Patel Z, Greyling S, Simon D, Arfvidsson H, Moodley N, Primo N, et al. Local responses to global
440 sustainability agendas: learning from experimenting with the urban sustainable development goal in
441 Cape Town. *Sustain Sci*. 2017 Sep 1;12(5):785–97.

- 442 4. Burford G, Hoover E, Velasco I, Janoušková S, Jimenez A, Piggot G, et al. Bringing the “Missing
443 Pillar” into Sustainable Development Goals: Towards Intersubjective Values-Based Indicators.
444 Sustainability. 2013 Jul 12;5(7):3035–59.
- 445 5. Burford G, Tamás P, Harder M, Burford G, Tamás P, Harder MK. Can We Improve Indicator
446 Design for Complex Sustainable Development Goals? A Comparison of a Values-Based and
447 Conventional Approach. Sustainability. 2016 Aug 30;8(9):861.
- 448 6. Corburn J. Confronting the Challenges in Reconnecting Urban Planning and Public Health. *Am J*
449 *Public Health*. 2004 Apr;94(4):541–6.
- 450 7. Allington G, Fernandez-Gimenez M, Chen J, Brown D. Combining participatory scenario planning
451 and systems modeling to identify drivers of future sustainability on the Mongolian Plateau. *Ecol Soc*
452 [Internet]. 2018 Apr 17 [cited 2018 Jul 20];23(2). Available from:
453 <https://www.ecologyandsociety.org/vol23/iss2/art9/>
- 454 8. Ens EJ, Pert P, Clarke PA, Budden M, Clubb L, Doran B, et al. Indigenous biocultural knowledge in
455 ecosystem science and management: Review and insight from Australia. *Biol Conserv*. 2015 Jan
456 1;181:133–49.
- 457 9. Keynan A, Ben-Zvi Assaraf O, Goldman D. The repertory grid as a tool for evaluating the
458 development of students’ ecological system thinking abilities. *Stud Educ Eval*. 2014 Jun 1;41:90–
459 105.
- 460 10. Bai X, Surveyer A, Elmqvist T, Gatzweiler FW, Güneralp B, Parnell S, et al. Defining and
461 advancing a systems approach for sustainable cities. *Curr Opin Environ Sustain*. 2016 Dec 1;23:69–
462 78.
- 463 11. Oliveira JAP de, Doll CNH, Siri J, Dreyfus M, Farzaneh H, Capon A. Urban governance and the
464 systems approaches to health-environment co-benefits in cities. *Cad Saude Publica*. 2015 Nov;31
465 Suppl 1:25–38.
- 466 12. Rietveld LC, Siri JG, Chakravarty I, Arsénio AM, Biswas R, Chatterjee A. Improving health in
467 cities through systems approaches for urban water management. *Environ Health*. 2016;15(1):151–
468 60.
- 469 13. Siri JG, Newell B, Proust K, Capon A. Urbanization, Extreme Events, and Health: The Case for
470 Systems Approaches in Mitigation, Management, and Response. *Asia Pac J Public Health*
471 [Internet]. 2015 Jul 28 [cited 2015 Jul 31]; Available from:
472 <http://aph.sagepub.com/cgi/doi/10.1177/1010539515595694>
- 473 14. Arnold RD, Wade JP. A Definition of Systems Thinking: A Systems Approach. *Procedia Comput*
474 *Sci*. 2015 Jan 1;44:669–78.
- 475 15. Sterman JD. Learning from Evidence in a Complex World. *Am J Public Health*. 2006
476 Mar;96(3):505–14.
- 477 16. Clifford N, Richards K. Earth System Science: an oxymoron? *Earth Surf Process Landf*.
478 2005;30(3):379–83.

- 479 17. Wilbanks TJ. Putting “Place” in a multiscale context: Perspectives from the sustainability sciences.
480 Environ Sci Policy. 2015 Nov 1;53:70–9.
- 481 18. Newell B. Simple models, powerful ideas: Towards effective integrative practice. Glob Environ
482 Change. 2012 Aug 1;22(3):776–83.
- 483 19. Moskwa E, Bardsley DK, Robinson GM, Weber D. Generating narratives on bushfire risk and
484 biodiversity values to inform environmental policy. Environ Sci Policy. 2018 Nov 1;89:30–40.
- 485 20. Proust K, Newell B, Brown H, Capon A, Browne C, Burton A, et al. Human Health and Climate
486 Change: Leverage Points for Adaptation in Urban Environments. Int J Environ Res Public Health.
487 2012 Jun;9(6):2134–58.
- 488 21. Zhang Q, Prouty C, Zimmerman JB, Mihelcic JR. More than Target 6.3: A Systems Approach to
489 Rethinking Sustainable Development Goals in a Resource-Scarce World. Engineering. 2016 Dec
490 1;2(4):481–9.
- 491 22. Global Taskforce of Local and Regional Governments. towards_the_localization_of_the_sdgs.pdf
492 [Internet]. Barcelona: United Cities and Local Governments; 2018 [cited 2018 Oct 25] p. 110.
493 Available from: https://www.uclg.org/sites/default/files/towards_the_localization_of_the_sdgs.pdf
- 494 23. Global Taskforce of Local and Regional Governments, UN Habitat, UNDP. Roadmap For
495 Localizing the SDGs: Implementation and Monitoring at Subnational Level [Internet]. 2016 [cited
496 2018 Oct 25] p. 44. Available from:
497 https://www.uclg.org/sites/default/files/roadmap_for_localizing_the_sdgs_0.pdf
- 498 24. Guimarães MH, Ballé-Béganton J, Bailly D, Newton A, Boski T, Dentinho T. Transdisciplinary
499 conceptual modeling of a social-ecological system—A case study application in Terceira Island,
500 Azores. Ecosyst Serv. 2013 Mar;3:e22–31.
- 501 25. Schweizer S, Stavrou V, van Breda J, Alder C. Transdisciplinary-Training-Program-
502 Report_3June20161.pdf [Internet]. 2016 [cited 2018 Oct 25]. Available from: [https://start.org/wp-](https://start.org/wp-content/uploads/Transdisciplinary-Training-Program-Report_3June20161.pdf)
503 [content/uploads/Transdisciplinary-Training-Program-Report_3June20161.pdf](https://start.org/wp-content/uploads/Transdisciplinary-Training-Program-Report_3June20161.pdf)
- 504 26. Capon AG. Health impacts of urban development: key considerations. New South Wales Public
505 Health Bull. 2007;18(10):155.
- 506 27. Delvaux B, Schoenaers F. Knowledge, local actors and public action. Policy Soc. 2012 Jun
507 1;31(2):105–17.
- 508 28. Li FF, Tan D. School Canteens and Student Nutrition SCHEMA Case Study #1 [Internet]. United
509 Nations University International Institute for Global Health; 2018. Available from:
510 [http://www.thriveurban.info/wp-](http://www.thriveurban.info/wp-content/uploads/2018/02/SCHEMA-Case-Studies.pdf)
[content/uploads/2018/02/SCHEMA-Case-Studies.pdf](http://www.thriveurban.info/wp-content/uploads/2018/02/SCHEMA-Case-Studies.pdf)
- 511 29. Ong B, Adikan FRM. Challenging Land Use Paradigms in a University Context. 2018.
- 512 30. Sugumaran M, Tan D, Ong B. Holding onto a Mission for Conservation and Education, SCHEMA
513 Case Study #4 [Internet]. 2018. Available from: [http://www.thriveurban.info/wp-](http://www.thriveurban.info/wp-content/uploads/2018/02/SCHEMA-Case-Studies.pdf)
514 [content/uploads/2018/02/SCHEMA-Case-Studies.pdf](http://www.thriveurban.info/wp-content/uploads/2018/02/SCHEMA-Case-Studies.pdf)

- 515 31. Clayton S, Brook A. Can psychology help save the world? A model for conservation psychology.
516 Anal Soc Issues Public Policy ASAP. 2005;5(1):87–102.
- 517 32. Fuller RA, Irvine KN, Devine-Wright P, Warren PH, Gaston KJ. Psychological benefits of
518 greenspace increase with biodiversity. Biol Lett. 2007 Aug 22;3(4):390–4.
- 519 33. Lachmund J. Greening Berlin: the co-production of science, politics, and urban nature [Internet].
520 Cambridge, Mass.: MIT Press; 2013 [cited 2019 Mar 5]. Available from:
521 <http://public.eblib.com/choice/publicfullrecord.aspx?p=3339559>
- 522 34. Wulf A. The invention of nature: the adventures of Alexander von Humboldt, the lost hero of
523 science. 2016.
- 524 35. Apostolopoulou E, Adams WM. Cutting nature to fit: Urbanization, neoliberalism and biodiversity
525 offsetting in England. Geoforum. 2019 Jan 1;98:214–25.
- 526 36. Smith P, Harvey-Brown Y. The economic, social and environmental impacts of botanic gardens
527 [Internet]. Richmond: Botanic Gardens Conservation International; 2018 Aug p. 24. (BGCI
528 Technical Review). Available from:
529 <https://www.bgci.org/files/IAC/IAC%202018/TechReportLowRes.pdf>
- 530 37. Mair S, Jones A, Ward J, Christie I, Druckman A, Lyon F. A Critical Review of the Role of
531 Indicators in Implementing the Sustainable Development Goals. In: Leal Filho W, editor. Handbook
532 of Sustainability Science and Research [Internet]. Cham: Springer International Publishing; 2018
533 [cited 2019 Mar 1]. p. 41–56. (World Sustainability Series). Available from:
534 https://doi.org/10.1007/978-3-319-63007-6_3
- 535 38. Zinkernagel R, Evans J, Neij L, Zinkernagel R, Evans J, Neij L. Applying the SDGs to Cities:
536 Business as Usual or a New Dawn? Sustainability. 2018 Sep 7;10(9):3201.
- 537 39. ICSU. A Guide to SDG Interactions: From Science to Implementation [Internet]. Paris, France:
538 International Council for Science; 2017 [cited 2018 Jul 24]. Available from:
539 <https://council.science/cms/2017/05/SDGs-Guide-to-Interactions.pdf>
- 540 40. Newell B, Proust K. Escaping the complexity dilemma. In: Sustainability Science [Internet].
541 London: Routledge; 2017 [cited 2018 Oct 24]. p. 396. Available from:
542 <https://www.taylorfrancis.com/>
- 543 41. Harris F, Lyon F. Transdisciplinary environmental research: Building trust across professional
544 cultures. Environ Sci Policy. 2013 Aug;31:109–19.
- 545 42. Gray B. Enhancing Transdisciplinary Research Through Collaborative Leadership. Am J Prev Med.
546 2008 Aug;35(2 Suppl):S124–32.
- 547 43. Newell B, Siri J. A role for low-order system dynamics models in urban health policy making.
548 Environ Int. 2016 Oct 1;95:93–7.
- 549 44. Windisch R, Waiswa P, Neuhann F, Scheibe F, de Savigny D. Scaling up antiretroviral therapy in
550 Uganda: using supply chain management to appraise health systems strengthening. Glob Health.
551 2011 Aug 1;7(1):25.

552 45. MacGregor H, McKenzie A, Jacobs T, Ullauri A. Scaling up ART adherence clubs in the public
553 sector health system in the Western Cape, South Africa: a study of the institutionalisation of a pilot
554 innovation. *Glob Health* [Internet]. 2018 Apr 25 [cited 2019 Mar 7];14. Available from:
555 <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5918532/>

556