Analysing Living Labs as enablers of sustainability transitions: could regenerative development nurture their impact?

This literature review has been written, according to Utrecht University Graduate School of Life Sciences guidelines, as part of the curriculum of the MSc programme Bio-Inspired Innovation.

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ABSTRACT

Humanity is not on track to achieve either the human or the environmental dimension of the 2030 Agenda for Sustainable Development and sustainability transitions, radical transformations towards a sustainable society, seem to be extremely necessary. Systemic integrated approaches such as Living Labs (LLs), the UN Sustainable Development Goals (SDGs), and regenerative development (RD) are currently getting considerable attention as potential strategies enabling global sustainability transitions and each one might hold the potential to better inform the others to enable greater sustainable impact. This review aims at engaging conversations around such potential. Recent literature on the contribution of LLs within sustainability transitions is analysed, using the UN SDGs as the benchmark to define such contribution. Overall, all LLs analysed in this article contribute to SDG target 11.4 which concerns strengthening "efforts to protect and safeguard the world's cultural and natural heritage" and out of 169 SDGs targets, 46 were found to be addressed directly by LLs agendas. Despite LLs action acknowledge the interconnectedness of sustainability issues, some subjects proved to be more common than others within LLs projects. RD is defined and characterised, according to recent literature, and it is discussed whether aspects of this approach could prove to be useful to inform LLs contribution to meeting the SDGs and sustainability transitions. Interestingly, RD and LLs seem to share many common elements and such result may prove the compatibility of the two approaches to positively inform one another. LLs and RD are addressing the same challenge of redesigning the human impact on the planet, and RD takes the challenge to a deeper level: changing the impact of humanity on the planet cannot happen without also redesigning the presence of humanity on the planet. Perhaps, RD may prove to be helpful to LLs by providing insights on (how to) asking the right questions, making sure that LLs are also addressing symptoms, and not only causes, of unsustainable development whilst LLs may provide RD with the ideal physical environment in which put into practice its concepts.

LAYMAN'S SUMMARY

Sustainability transitions are, in a nutshell, radical transformations for a sustainable society. In a world in which we are daily challenged by the consequences of unsustainable practices and worrying future projections, they are needed to respond to the many persistent problems that our societies are facing. Recently, many realities and approaches have been developing and contributing to sustainability transitions, such as the Sustainable Development Goals (SDGs) put in place by the United Nations to provide individuals, businesses, organisations and governments with a guide of actions to be carried out, within different sectors, before 2030 to try and avoid the collapse of societies and the planet. Other contributing realities are the so called Living Labs (LLs) and regenerative development (RD) approaches. LLs could be described as a community of practices which put the citizens at the centre of their activities through an open and cooperative approach. LLs activities bring research and innovation, usually combining different disciplines, together and test them in real-life settings, customising them to the specific characteristics and needs of such local contexts. An example of LL used in this work is the LL UULabs from Utrecht University, in the Netherlands. RD could be described as a set of theoretical principles which are applied to (un)sustainable issues, allowing us to address them in such a way that would "heal" our planet, make it a better place for us and for nature itself, and help us learn from and cooperate with it - instead of "exploiting" it. Since these approaches have the goal of making the world a better place in common, perhaps they could inform and learn from each other to achieve it. This literature review analyses the most recent scientific literature on LLs contributions to sustainability transitions and the main characteristics of RD as an approach enabling sustainability transitions. The SDGs are used as a point of reference against which the findings of LLs contributions to sustainability transitions are analysed, together with specific examples of UULabs contributions, in order to evaluate them. Analysing such contributions will allow to gather a first overview of what is currently being done by LLs regarding sustainability issues and what needs to be done in the future to further enable sustainability transitions. Moreover, analysing RD main characteristics might help understanding whether this approach could help the growth and coverage of LLs positive impact. Perhaps, RD might be able to join forces with LLs projects to make sure that sustainability transitions will continue to evolve and to be carried out in a way that respects the needs and characteristics of all the different local realities of our planet, and allows it to thrive rather than just surviving.

I. INTRODUCTION

In 2021, the symptoms of unsustainable action are evident every day. Following the current business-as-usual trajectory, the planet is likely to crash through the 1.5°C ceiling by around 2040 - or before - and the 2°C by around 2050 - or soon thereafter (Masson-Delmotte et al., 2018; 2021). As stated by the Intergovernmental Panel on Climate Change (IPCC), humanity is not on track to achieve either the human or the environmental dimension of the 2030 Agenda for Sustainable Development, and the solutions of today might become the problems of tomorrow (Masson-Delmotte et al., 2018; IPCC, 2019). In the document *"World Scientists' Warning to Humanity: A Second Notice"*, 15,364 scientists stated that, despite having learnt many important lessons, current international environmental policies are far from enough, and changes in those and human behaviours are more urgent than ever (Ripple et al., 2017). Sustainability transitions, which are *"radical transformations towards a sustainable society as a response to a number of persistent problems confronting contemporary modern societies"* (Grin et al. 2010), seem to be extremely necessary. Enabling global sustainability transitions might require re-thinking and reorganising the entire economic, natural management and social systems. Sustainability problems are complex, and systemic and integrated approaches must be adopted taking all the dimensions of sustainability (e.g., economic, ecological, social, cultural, and political) into consideration. To respond to the need to solve such complex challenges, new approaches and perspectives are gaining momentum. Systemic integrated approaches that are currently getting considerable attention as potential strategies enabling global sustainability transitions are, for instance, represented by Living Labs (LLs), the United Nations (UN) Sustainable Development Goals (SDGs), and regenerative development (RD).

LLs are defined by the European Commission as *"user-centred, open innovation ecosystems based on a systematic user co-creation approach integrating research and innovation processes in real-life communities and settings. In practice, LLs place the citizen at the centre of innovation, and have thus shown the ability to better mould the opportunities offered by new ICT concepts and solutions to the specific needs and aspirations of local contexts, cultures, and creativity potentials"*. LLs are an ideal approach to address and tackle complex problems since time, change of attitude, and prolonged attention, required by LL, are also required to succeed to achieve a long-term greater reach rather than quick fixes (Verhoef et al., 2020).

The UN SDGs are a great example of readily available and easily implementable tools to raise awareness while helping develop systemic and practical action enabling sustainability transitions. The SDGs are at the core of the 2030 Agenda for Sustainable Development which, in 2015, had been adopted by all United Nations Member States. The goals are 17, covering a wide range of global (un)sustainable issues and are defined as the "blueprint" for a better sustainable future for all (United Nations, 2017). Each SDG represents one of the main challenges we are currently facing. To make the SDGs more "actionable" and "measurable" specific targets and indicators were identified for each goal (United Nations, 2017). Moreover, tools, like the online publication *"SDG Tracker"*, facilitate the monitoring and tracking of the progress made. More and more organisations choose to integrate the SDGs within their vision and use them as a benchmark to guide, inform and evaluate their sustainable impact. Utrecht University (UU), for instance, as stated in its 2025 strategic plan, strives to contribute to the SDGs by using them as a central framework for its action. This approach led to the development of UULabs, the most recent addition to the sustainable efforts for the sustainable development of UU.

Regenerative development can be described as a problem-solving and innovation framework for the development of a better sustainable world. It is considered as an approach that builds on and broadens the connotations of sustainability since it allows to shift from the neutral rule of "not doing any more damage" to a *"co-evolution of human and natural systems in a partnered relationship"* which supplies health and wellbeing for both humans and the environment (Cole, 2012).

These three approaches, equally, seem to strive to abandon a "damage control" approach in favour of an "integrated" one in which sustainable action takes into consideration present and future wellbeing for all forms of life and dimensions of sustainability. Each one of them might hold the potential to better inform the others (and vice versa) to enable greater impact for successful global sustainability transitions. This review aims at engaging the conversation around such potential. Specifically, the focus will be set on analysing existing recent literature on the contribution of LLs, and UULabs, within sustainability transitions, using the SDGs as the benchmark to define such contribution. Moreover, RD will be defined and characterised, according to the most recent literature, and it will be analysed whether aspects of this approach could prove to be useful to inform LLs, including UULabs, contribution to meeting the SDGs, and to sustainability transitions.

II. MATERIALS & METHODS

II. A. Scoping & research questions

In this review, a summary of the role and contributions of LLs to sustainability transitions, and the main elements of RD, will be given, as found in the most recent literature, together with an overview of the work carried out by UULabs. Overall, the following research questions will be answered:

a. *What are the role and contributions, overall, of living labs to sustainability transitions?*

   a.a. *Specifically, what are the role and contribution of UULabs to sustainable transitions and some examples?*

b. *What are the main characteristics of regenerative development as an approach for the achievement of sustainability transitions?*

By answering these research questions, this work will evaluate whether and how elements resulting from this analysis could be relevant for the improvement of the development of LLs, including UULabs, as enablers of sustainability transitions. Particularly, this work aims to lay a base for future conversation to assess whether the sustainable impact of LLs, including UULabs, could become more effective, in terms of meeting the SDGs, by adhering to regenerative practices.

II. B. State of the art review

The research questions are answered through a state-of-the-art literature review, which illustrates the current situation of a research topic and may highlight new points of view on the matter and, or future research paths (Grant & Booth, 2009). It aims at being a narrative, qualitative review that may identify potential opportunities for current research (Grant & Booth, 2009). Limitations were set when collecting data for the review: articles were sought by using the words "living" and "lab" and "sustainab*", for what concerns living labs, whilst the words "regenerative" and "sustainab*" were used when researching for the characteristics of regeneration as a sustainable approach. Mendeley and Google Scholar were used as search databases and the results were filtered by excluding patents, references and by considering only entrances from the last five years, thus from 2016 until 2022, to keep the review as current as possible - as indicated by UU guidelines. Findings were sorted according to relevance. After omitting the articles to which access was not granted and having read through the first pages of the remaining findings, the number of articles appearing suitable for the research dropped noticeably. Therefore, the final number of articles selected resulted to be 18 for the living labs research and 9 for regenerative development. Next, the analysis continued to careful reading of articles. A summary was conducted and then reported and compared and combined for the relevant parts as findings in the section "*Results*".

II. C. Benchmark: the UN SDGs

Out of the three approaches mentioned in the Introduction, the SDGs is the better defined and globally agreed-upon approach. Moreover, lately, an interest in LLs as an approach contributing towards the achievement of the SDGs has been documented (Compagnucci et al., 2021). Therefore, in this

state-of-the-art review, the SDGs and their targets are used as the benchmark to qualitatively quantify and report the contribution of LLs to sustainable transitions.

The SDGs, also known as the Global Goals, were adopted by the UN in 2015 as a global call to action designed to ensure that by 2030 all people enjoy peace, prosperity and protect the planet. The SDGs are an integrated approach since each recognises that action in one area will affect outcomes in others and that development must balance social, economic, and environmental sustainability. Thus, the SDGs acknowledge that tackling climate change, preserving ocean and land must happen together ending poverty, building economic growth, and addressing social needs such as education, health, equality and job opportunities. The 17 SDGs are presented in table 2, in the Appendix, together with their respective targets. Across the globe, the UN Development Program is implementing integrated solutions to accelerate progress towards the SDGs by responding to complex development challenges. The same integrated approach to address complex challenges is adopted by LLs. Due to these further reasons, and the fact that the goals and their targets provide us with a "guide" to shape and implement tangible strategies and action for a better future, as stated above, they represent the perfect tool to be used to analyse the contribution and role of LLs within sustainable transitions.

III. RESULTS

III. A. LLs role & contribution to sustainability transitions

Overall, the LLs approach can be looked at as a basis to address a variety of themes and issues to improve or develop elements leading to the creation of value for all dimensions of sustainability (Compagnucci et al., 2021; Engez, H. Driessen, et al., 2021). For each case found in the literature, the role of LLs in fostering sustainable transitions was different and, obviously, not all LLs directly addressed sustainability in their projects. Specifically, regarding sustainable transitions, the most common themes found in the literature that underlie projects of LLs seem to be climate change, resource scarcity and efficiency, waste, water, energy, ecosystems protection, environmental threats, and social issues such as social responsibility, to name a few. LLs seem to approach sustainable transitions by being fertile grounds in which sustainable living solutions are conceived, prototyped, and tested, and in which collaboration within diverse sectors is facilitated to achieve the latter (Leal Filho, 2020). For example, with cooperative integrated projects involving users and stakeholders, LLs may work on built design, green infrastructure, and low carbon technologies contributing towards progress in sustainable transitions (Mandai & Brando, 2019). In the next, and each, bulleted sections:

a. Roles that LLs are taking up within sustainable transitions will be presented more in detail, as found in the selected literature. Roles are highlighted in bold at the beginning of each paragraph;

b. Examples of LLs contributions to sustainable transitions, as found in the selected literature, will also be analysed;

c. Lastly, the SDGs and their targets, as presented in section II. C will be used as a benchmark to analyse such contributions.

• **LLs seem to foster transdisciplinary education, partnerships, conversations, and policymaking around sustainability transitions**

LLs act as a platform for action that brings together several actors which, jointly, help LLs contribute to the development of a specific area (Engez, H. Driessen, et al., 2021). Specifically, many articles report that one of the biggest advantages of LLs involvement in sustainability projects is the ability to foster long-term partnerships between those actors, and, particularly, stakeholders which are proven to increase the likelihood of success for the projects themselves since they are often responsible for funding contributions (Cohen et al., 2021; Compagnucci et al., 2021; Engez, H. Driessen, et al., 2021). In fact, LLs often provide the means for the visualisation of potential sustainable futures which are seductive, leading to engagement of stakeholders and catalysation of sustainable conversations (Compagnucci et al., 2021; Engez, H. Driessen, et al., 2021).

LLs, through images and stories of future scenarios and, or successful projects, provide a vision that is more powerful than solely written words leaving less space for personal interpretation and more for concrete hypotheses. Such an approach helps spread impactful narratives about sustainable futures, also highlighting the importance of "strategic storytelling" for the development of the vision and impacts of LLs (von Wirth et al., 2019). For instance, "*BlueCity Lab*" (Rotterdam, The Netherlands) includes as part of its strategy the initiation and cultivation of such discursive elements, as they play an important role for sustainable and circular solutions to reach beyond the LL borders. Such storytelling is enriched through examples of successful implementation of sustainable and circular strategies and solutions within the lab itself, providing future investors, policymakers and, or stakeholders with a solid ground for further acceleration and scaling of the projects (von Wirth et al., 2019).

Concrete hypotheses - often delivered by LLs in the form of applicable relevant sets of data – and perspectives offer the opportunity to envision positive, tangible goals for the present and the future, potentially providing the initial information necessary to write effective sustainability policies such as "to offset y it is needed to do a, b and c, in x way" (Evans et al., 2015). For instance, hypothesising an LLs project able to provide a geographically relevant set of data regarding surface

water runoff, in a specific setting, together with the demonstration of the amount of green infrastructure needed in such setting to offset x amount of surface water runoff, it would be possible to take tangible and effective action by developing a policy that says "green infrastructure needs to be increased in that setting by x amount". (Evans et al., 2015).

Moreover, LLs transparency and communication contribute to nurturing an open vision towards change and innovative processes. For instance, it has been reported that communicating LLs activities and outcomes with city administrations intensified the uptake of such activities by the municipalities. Thus, giving birth to a spread of the projects through the creation of new partnerships with additional stakeholders and the further expansion of the projects into other settings, using the initial LLs experiments as an example (von Wirth et al., 2019).

By fostering transdisciplinary education, partnerships, conversations, and policymaking around sustainability transitions, LLs seem to have the potential to contribute towards the achievement of SDG target 12.8 (by 2030) of ensuring "*that people everywhere have the relevant information and awareness for sustainable development and lifestyles in harmony with nature*". Moreover, LLs have proven to be able to provide useful tools, data and information that could facilitate the Integration of "*climate change measures into national policies, strategies and planning*", as stated in SDG target 13.2, and the improvement of "*education, awareness-raising and human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning*", as stated by SDG target 13.3. Furthermore, specifically through stakeholder engagement and funding, they have the potential of contributing to SDG target 15. a, of mobilising "*and significantly increase financial resources from all sources to conserve and sustainably use biodiversity and ecosystems*" and SDG target 17.3, of mobilising "*additional financial resources for developing countries from multiple sources*". Lastly, LLs offer the opportunity to contribute to SDG target 17.16 for enhancing "*the Global Partnership for Sustainable Development, complemented by multi-stakeholder partnerships that mobilise and share knowledge, expertise, technology and financial resources, to support the achievement of the Sustainable Development Goals in all countries, in particular developing countries*" and 17.17 for encouraging and promoting "*effective public, public-private and civil society partnerships, building on the experience and resourcing strategies of partnerships*".

• **LLs seem to promote innovations and knowledge co-creation for sustainability transitions**

To collectively enable and participate in sustainable transitions, a series of explorative, research and development activities for sustainable innovations needs to be carried out. LLs are the testbeds allowing the performance of such

activities (Engez, H. Driessen, et al., 2021). Exploring, and co-creating knowledge and innovations around sustainability is fundamental not only to accelerate the rates of development of sustainable innovations but also the rates of their implementation. LLs offer the potential to produce the knowledge that could help, for instance, reducing the environmental impacts and consumption of resources of cities, and generating new economic growth (Evans et al., 2015). For example, such developing activities are carried out by "*The Green Village*" at TU Delft, KTH "*Live-In Lab*" for the construction and real estate sectors, and MIT "*Office of Sustainability*" (MITOS).

MITOS is employing the university campus as a testbed, and a considerable number of other universities are doing the same, transforming campuses into actual LLs venues for testing, validating, and replicating solutions (Verhoef & Bossert, 2019). Universities are great assets as LLs since they share the same transdisciplinary, transformative, and community-based approaches. Universities are consolidating their relations with their communities (students, professors, researchers, municipalities, stakeholders), developing LLs projects for the co-creation of innovations, and becoming collaborative vehicles that enact transformative knowledge (von Wirth et al., 2019). Thus, becoming seeding grounds for the advancement of sustainability transitions (Verhoef & Bossert, 2019).

Lastly, LLs seem to also be the perfect setting for knowledge creation regarding nature-based solutions, which have proven to be an asset for climate change adaptation and mitigation (United Nations, 2021). For instance, many urban areas will experience higher amounts of rainwater which, when coupled with a decrease of greenfield lands in such settings due to population growth, will likely pose risks for water run-off and a decrease in greenery will also lead to a loss of biodiversity (Engez, Leminen, et al., 2021). These issues highlight the importance of nature-based solutions, and many LLs are focusing on their creation and implementation to address such and many more challenges. The goal of these projects is to develop and monitor impactful nature-based solutions to promote and engage more and more communities in further co-create multi-functional nature-based solutions. For example, an LL developed a retention pond to retain and purify stormwater and monitor the yearly water quality and flow (Engez, Leminen, et al., 2021). The local community informed the project and helped test and design it, promoting innovation and knowledge co-creation within the residents (Engez, Leminen, et al., 2021). Additionally, to promote the latter, the LL developed so-called "innovation vouchers" for the realisation of a horse paddock and community gardens in buildings to attract more people to develop solutions together (Engez, Leminen, et al., 2021). This example also embeds within itself another way in which LLs contribute towards

sustainable transitions, presented in the next bullet-point section.

Overall, in this context, SDG 9, specifically promoting and fostering sustainable innovation and promoting inclusive and sustainable industrialisation, seems to be fostered by LLs action, which, more specifically, seem to prove to have the potential to contribute to SDG target 9.5, by setting the base for indirectly the enhancing of "*scientific research, upgrade the technological capabilities of industrial sectors in all countries, in particular developing countries, including, by 2030, encouraging innovation and substantially increasing the number of research and development workers per 1 million people and public and private research and development spending*".

- **LLs seem to act as change catalysts for the co-adoption of new behaviour, lifestyles, and beliefs attuned with sustainability transitions**

Many LLs projects lead to results that often act to convince authorities, stakeholders, specific industries and sectors of the validity and functionality of innovations for sustainability transitions (Voytenko et al. 2016). The community-scale at which the LL approach happens seems to be the most applicable to directly influence the behaviour of individuals. Interestingly, effective change requires both technological transformations and a shift in cultures, lifestyles, and practices (Voytenko et al., 2016). Thus, also sustainable transitions cannot be accomplished only through technological development (Liedtke et al., 2015). Consequentially, the LL integrated user-centred approach seems to be the ideal strategy to successfully promote and nurture rapid social, economic, and technological transformations, enabling behavioural change (Liedtke et al., 2015) (Voytenko et al. 2016) (Engez, H. Driessen, et al., 2021). For instance, LL "*NutriCity*" aims to recover nutrients from human wastes, such as urine, through the usage of dry and vacuum toilet systems, to produce fertilisers and reduce the amount of nutrients leakage into water bodies. The low acceptance within the food industry towards products grown with fertilisers made from wastewater, due to the risks and fears of contamination, led to the becoming of the LL as a means to change the attitude towards the use of urine fertilisers themselves (Engez, Leminen, et al., 2021). Thus, promoting a shift in the current culture and practices. Similarly, another LL, "*Hierakka*", tried to achieve the same change in attitude within the food industry, and the LL "*Kivireki*" worked on promoting urban farming, specifically addressing the potential of making use of local nutrient cycles in cities through bio-wastes (e.g., separately collected urine) (Engez, H. Driessen, et al., 2021). Many other examples are found in the literature, such as the one from LL "*Sustainable decisions*" (Riimäki, Finland) which aims at raising awareness on sustainable energy for decision-makers, and from the City of Malmö

(Sweden) which is exploring new practices of urban governance and city development.

In this context, LLs efforts seem to be contributing, for instance, towards SDG target 12.6 of encouraging "*companies, especially large and transnational companies, to adopt sustainable practices and to integrate sustainability information into their reporting cycle*". Acting as catalysts for the co-adoption of new attitudes towards more sustainable lifestyles, LLs, for instance, are indirectly contributing to SDG target 6. b, by supporting and strengthening "*the participation of local communities in improving water and sanitation management*", but also to SDG target 11. b, which aimed at (by 2020) "*substantially increase the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change, resilience to disasters, and develop and implement, in line with the Sendai Framework for Disaster Risk Reduction 2015–2030, holistic disaster risk management at all levels*".

• **LLs seem to contribute to sustainability transitions within the sectors of land, water and waste use and management**

Many LLs projects presented in the paragraphs above aim to tackle problems related to water and waste issues and many more are found in the literature (von Wirth et al., 2019). For instance, several LLs projects focus on waste treatment, preventing nutrient leakage into land and water bodies, making use of resources otherwise labelled as waste - such as human bio-wastes (e.g., to be transformed into fertilisers) and side streams of business operations -, and water treatment and conservation (Voytenko et al., 2016). Moreover, many address future climate scenarios such as an increase in rainfall in the northern areas of the planet and associated reduction in the water infiltration capacity due to higher urbanisation, thus addressing the management of urban rain and stormwater. Several are the projects which are researching and testing the use of green and blue infrastructures (e.g., trees and ponds), such as "*New Kiruna City*" which is committed to using the latter to manage stormwater instead of relying on conventional piped networks (Voytenko et al., 2016). In this context, "*UNaLab*", an EU-funded project, was specifically founded to tackle climate and water-related challenges in urban areas. For instance, within one of its action areas, it aims at retaining and purifying stormwater (e.g., through the use of bio-filters that treat nutrient-rich seepage waters from an old landfill) and monitoring water quality and flows throughout the year (Engez, Leminen, et al., 2021). The LL "*Lev sieppary*" also focused on recycling nutrients from wastewater, in this case using algae, and on reducing water pollution, using algae-bound nutrients (Engez, Leminen, et al., 2021) and the "*IJburg*" project (Amsterdam, The Netherlands) addresses water-land planning whilst considering a near protected ecosystem (Voytenko et al., 2016). Furthermore, for example,

the University of Copenhagen addresses monitoring water consumption within its sustainability strategy plan (Mandai & Brando, 2019), and the project "*i-trees*" collected data on water runoff and vegetation and run experiments to demonstrate the potential role of green infrastructure to tackle the issue of surface water runoff in urban settings (Evans et al., 2015).

In this context, LLs seem to contribute to SDG target 6.3, which aims (by 2030) to "*improve water quality by reducing pollution, eliminating dumping and minimising release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally*", SDG target 6.6, which aimed at protecting and restoring "*water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes*" (by 2020), and SDG target 6. b, which aims at supporting and strengthening "*the participation of local communities in improving water and sanitation management*". Also, SDG target 11.6, which wants to "*reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management*" (by 2030), seems to be addressed by LLs projects. Moreover, LLs seem to contribute to SDG target 12.3 of halving (by 2030) the "*per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains, including post-harvest losses*", SDG target 12.4, which aimed to achieve (by 2020) "*the environmentally sound management of chemicals and all wastes throughout their life cycle, in accordance with agreed international frameworks, and significantly reduce their release to air, water and soil in order to minimise their adverse impacts on human health and the environment*", and SDG target 12.5 of reducing substantially (by 2030) waste generation through prevention, reduction, recycling and reuse. Lastly, they seem to be contributing to SDG target 14.1, which aims at preventing (by 2025) and reducing significantly "*marine pollution of all kinds, in particular from land-based activities, including marine debris and nutrient pollution*" and SDG target 15.3, which aims to (by 2030) "*combat desertification, restore degraded land and soil, including land affected by desertification, drought and floods, and strive to achieve a land degradation-neutral world*".

• **LLs seem to contribute to climate change mitigation and adaptation and preservation and planning for (future) ecosystems**

Climate change asks for planning for future climate and living scenarios. LLs addressing this topic are mainly focusing on the loss of biodiversity, the role of greenery and vegetation, renewable resources, implementing nature-based solutions, and the concepts of carbon-neutrality and circularity, to mitigate and adapt to climate change (Scholl & de Kraker, 2021). This is especially the case for many universities

worldwide, acting as LLs and undergoing transformative processes towards climate neutrality and circularity, on top of becoming "*UN-SDG responsible campuses*" (Verhoef & Bossert, 2019). In this context, the literature warns that, despite these environmental challenges being considered by many LLs projects, in several cases, they are not looked at as the main issue, being often "add on" problems to other challenges (Voytenko et al., 2016).

In this theme, LLs projects seem to contribute to SDG target 11.7, which aims to (by 2030) "*provide universal access to safe, inclusive and accessible, green and public spaces, in particular for women and children, older persons and persons with disabilities*", SDG target 11. b, which aimed (by 2020) to "*substantially increase the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change, resilience to disasters, and develop and implement, in line with the Sendai Framework for Disaster Risk Reduction 2015–2030, holistic disaster risk management at all levels*", SDG target 12.2 which aims to (by 2030) "*achieve the sustainable management and efficient use of natural resources*", and SDG target 13.1 by strengthening "*resilience and adaptive capacity to climate-related hazards and natural disasters in all countries*". Moreover, projects have also addressed SDG targets 15.5 and 15.9, which aimed (by 2020) at, respectively, taking "*urgent and significant action to reduce the degradation of natural habitats, halt the loss of biodiversity and protect and prevent the expansion of threatened species*", and integrating "*ecosystem and biodiversity values into national and local planning, development processes, poverty reduction strategies and accounts*".

- **LLs seem to contribute to sustainability transitions within the sectors of emissions, energy, infrastructure and transportation**

Especially in urban settings, LLs projects focus on increasing urban sustainability through optimisation of resource use for mitigating carbon emissions, energy use and low-carbon infrastructure and transportation (Voytenko et al., 2016; Von Wirth et al., 2019; Engez, H. Driessen, et al., 2021; Scholl & de Kraker, 2021). The University of Copenhagen, with "*The Green Lighthouse*" project attempted to test such changes, specifically investigating, through the first Danish public carbon-neutral building, the reduction of emissions related to climate change. Moreover, the university also focuses on other projects such as automatic energy control, energy production from solar panels (e.g., to be used to heat water), buildings with low-carbon production, as done with The Green Lighthouse, and investment in low-carbon equipment (Mandai & Brando, 2019). Many universities all over the globe are especially working on improving their carbon footprint, planning, and testing to become carbon-neutral campuses.

Together with several Urban LLs (ULLs - i.e., spaces that bring together policymakers, city governments, residents, and (research) institutions to cooperate to address urban problems (von Wirth et al., 2019)), the goal is to contribute to a low carbon economy. The Vienna (Austria) and the Stockholm (Sweden) Neighbourhood LLs are developing innovative ideas and scenarios for sustainable urban transportation, mobility and housing. The "*Kiruna international ULL*" (Sweden), the "*National ULL Netherlands*", and the "*National ULL Austria*" are bringing together communities, decision-makers, and specialists to cooperatively develop innovations for green and blue infrastructure. Moreover, the "*ULL Energetic Cooperation*" (Riimäki, Finland) is providing smart meters to its residents to decrease electricity consumption, and the "*Maastricht-LAB*" (Maastricht, The Netherlands) is addressing complex urban challenges such as that of vacant properties within the city. The same issue was addressed by the "*Concept House Village Lab*" (CHV) (Rotterdam, The Netherlands) which itself occupies an old shipyard that had been vacant since the 1980s (von Wirth et al., 2019). The CHV allows for innovative houses, products, and systems to be tested together with and by their occupants, focusing on usability, the feasibility of demolition and (re)construction, and participating in shared education and research (von Wirth et al., 2019). Although all these projects aim at doing good and contributing to a low carbon economy, the literature warns that not all of them are designed with a low carbon rationale in mind (Voytenko et al., 2016).

In this context, LLs projects contribute to SDG targets 7.2, 7. a, and 7. b, which (by 2030) aim, respectively, at increasing "*substantially the share of renewable energy in the global energy mix*", enhancing "*international cooperation to facilitate access to clean energy research and technology, including renewable energy, energy efficiency and advanced and cleaner fossil-fuel technology, and promote investment in energy infrastructure and clean energy technology*", and expanding "*infrastructure and upgrade technology for supplying modern and sustainable energy services for all in developing countries, in particular least developed countries, small island developing States and landlocked developing countries, in accordance with their respective programmes of support*". Moreover, they seem to contribute to SDG targets 9.1 and 9.4, which, respectively, work towards developing "*quality, reliable, sustainable and resilient infrastructure, including regional and trans-border infrastructure, to support economic development and human well-being, with a focus on affordable and equitable access for all*", and (by 2030) upgrading "*infrastructure and retrofit industries to make them sustainable, with increased resource-use efficiency and greater adoption of clean and environmentally sound technologies and industrial processes, with all countries taking action in accordance with their respective capabilities*". Lastly, they seem to take action towards SDG targets 11.2 and 11.3, which (by 2030), respectively, want to "*provide access to safe,*

affordable, accessible and sustainable transport systems for all, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, women, children, persons with disabilities and older persons", and "*enhance inclusive and sustainable urbanisation and capacity for participatory, integrated and sustainable human settlement planning and management in all countries*".

- **LLs seem to contribute to the social dimension of sustainability transitions**

Unsurprisingly, the results of this research show that the general effort is focused on operational areas concerning the environmental aspects of sustainability, despite social sustainability transitions being an urgent matter, especially in less valued suburbs which need both modernisation and social uplift (Buhr et al., 2016). There seems to be a lower engagement on the social dimension of sustainability and, therefore, in addressing issues such as civic engagement, social behaviour, diversity and inclusion, physical and mental health, and wellbeing, to name a few. Nonetheless, LLs can contribute to social sustainability issues by bringing together stakeholders and residents and making sure that outcomes of projects not only address social sustainability issues but also resonate with the needs and culture of the residents (Buhr et al., 2016). A few initiatives seem to be appearing, such as the "*Harvard Living Lab*" project, which aims to use the campus of the university as a testbed to enhance both the health of the planet and human beings (Verhoef & Bossert, 2019). Furthermore, many LLs in cities are starting to address social sustainability issues as well, with several Dutch cities being a European case (Scholl & de Kraker, 2021). An example of a LL project involved in the social dimension of sustainability is the one carried out by the nursing students at the Otago Polytechnic. Through the LL approach, they were able to successfully identify health needs within groups of the local rural communities and to generate, therefore, valuable, and apposite resources for better outcomes for the healthcare of such vulnerable people (Mahoney & Ross, 2019). Moreover, the ULL "*Shape Your World*" (Botkyrka, Sweden) is focusing on youth involvement, modernisation and social uplifting of suburbs, similarly to the city of Graz (Austria) which is involving citizens in its urban planning to make urban areas more suitable to their needs and prevent social problems (Voytenko et al., 2016). The project "*APRILab*" is also focusing on social development, addressing issues such as segregation, unemployment, and low level of education (Voytenko et al., 2016). The "*New Light on Alby Hill*" project transformed an insecure walkway with LED technology installations and artistic decorations, thus being energy-efficient, inexpensive, increasing the sense of security, and collaborating with the residents by allowing them to participate in the project: the drawings used for the artistic decorations were realised by locals and elementary school students (Buhr et al., 2016).

In this context, LLs projects seem to contribute to SDG targets 1.5, 4.6, and 4.7, which aim, respectively, (by 2030) to "*build the resilience of the poor and those in vulnerable situations and reduce their exposure and vulnerability to climate-related extreme events and other economic, social and environmental shocks and disasters*", "*ensure that all youth and a substantial proportion of adults, both men and women, achieve literacy and numeracy*", and "*ensure that all learners acquire the knowledge and skills needed to promote sustainable development, including, among others, through education for sustainable development and sustainable lifestyles, human rights, gender equality, promotion of a culture of peace and non-violence, global citizenship and appreciation of cultural diversity and of culture's contribution to sustainable development*". Moreover, LLs seem to be working towards the achievement of SDG target 8.5 to "*achieve full and productive employment and decent work for all women and men, including for young people and persons with disabilities, and equal pay for work of equal value*", and SDG target 10.2, to "*empower and promote the social, economic and political inclusion of all, irrespective of age, sex, disability, race, ethnicity, origin, religion or economic or other status*". Lastly, they seem to contribute to SDG target 11.1, to ensure (by 2030) "*access for all to adequate, safe and affordable housing and basic services and upgrade slums*", and 11. c, to "*support least developed countries, including through financial and technical assistance, in building sustainable and resilient buildings utilising local materials*".

- **LLs seem to contribute to sustainability transitions within the food sector**

In the literature, it was also reported the contribution of LLs towards sustainable food transitions for healthier lifestyles and practices through the implementation of, for instance, organic agriculture and shorter supply chains. For example, a project from the School for Organic Agriculture (Witzenhausen, Germany) tried to develop a methodological framework, using an LL approach, to accelerate the shift towards greener food services in public universities by developing and testing a model of local, organic, and sustainable meal planning and service (Kretschmer & Dehm, 2021). For instance, dietary requirements such as low percentages of animal products, thus an investment in more in fresh, regional, organic, and plant-based products, were investigated by the project, resulting in high financial and health benefits (Kretschmer & Dehm, 2021).

In this context, LLs projects seem to be contributing to SDG target 2.4, which (by 2030) aims at ensuring "*sustainable food production systems and implement resilient agricultural practices that increase productivity and production, that help maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather, drought, flooding and other disasters and that progressively improve land and soil*

quality". Moreover, LLs contribution seems to go towards SDG target 2.5, which aimed (by 2020) to "*maintain the genetic diversity of seeds, cultivated plants and farmed and domesticated animals and their related wild species, including through soundly managed and diversified seed and plant banks at the national, regional and international levels, and promote access to and fair and equitable sharing of benefits arising from the utilisation of genetic resources and associated traditional knowledge, as internationally agreed*". Lastly, SDG target 2. a, increasing "*investment, including through enhanced international cooperation, in rural infrastructure, agricultural research and extension services, technology development and plant and livestock gene banks in order to enhance agricultural productive capacity in developing countries, in particular least developed countries*", seems to also be addressed by LLs projects.

- **LLs seem to foster circular practices for sustainability transitions**

Through the literature, LLs are further represented as contributors and enablers of circularity. The most cited example is "*BlueCity Lab*" (Rotterdam, The Netherlands). The LL is located in a former indoor swimming pool building, transformed into a symbol of sustainable living, with the main goal to be a platform for the circular economy (von Wirth et al., 2019). This is reflected in the organisational structure of the LL itself, which, supposedly, is an example of the future circular city operating at zero waste and recycling all the materials used within the settings. Mostly, the LL acts as the head office for many circular start-ups. However, it also offers a series of integrated services, starting from the provision of spaces for co-creation, co-working and experimentation, to hosting waste-free events, lectures, hack parties, a bar and a restaurant, overall facilitating trials and demonstration of successful closed-loop circular business models and drawing attention to circular activities (von Wirth et al., 2019). Moreover, the LL has become the topic of training sessions and courses, offered by the LL itself, as a model for "how to" replicate and develop similar initiatives within different social and spatial contexts (von Wirth et al., 2019).

Many SDG targets addressed by LLs projects related to circularity have already been mentioned in the previous sections since several goals of circular approaches are common to other sustainability practices. On top of contributing to such SDG targets, LLs seem to aim at achieving also SDG targets 8.4 and 17.14, which, respectively, aim to "*improve progressively, through 2030, global resource efficiency in consumption and production and endeavour to decouple economic growth from environmental degradation, by the 10-Year Framework of Programmes on Sustainable Consumption and Production, with developed countries taking the lead*", and "*enhance policy coherence for sustainable development*".

III. A. I. UULabs role & contribution to sustainability transitions

UULabs is a relatively young project born at Utrecht University, in the Netherlands. UULabs emerge from the 2025 Strategic Plan of Utrecht University, which, amongst several goals, also aims to create sustainability through testing grounds on the university campus that combine teaching, research, and operational management (UULabs, 2022). Thus, UULabs, bring together and facilitate the development of several UU projects by mobilising individuals and ideas through a LL approach: "real-life" experiments for the co-creation of solutions for complex sustainability challenges (UULabs, 2022). UU campus is therefore transformed into a living testbed for sustainable practices through transdisciplinary collaborations and experiments on the themes of biodiversity, circularity, climate action and creative space (UULabs, 2022). The current portfolio of UULabs, developing throughout the themes of biodiversity, climate action, creative space, and circularity, presents 20 active projects both on and off-campus and involving both internal and external actors. Despite UULabs recognise the importance and interconnectedness of all sustainable topics, to align with UU strategic plan and sustainability strategy only four "main topics" were chosen as central to UULabs work on the university campus but still leaving space for other sustainability topics to be addressed due to the natural transdisciplinary of both UULabs and sustainability. For each theme, UULabs has developed a series of focus areas that have been largely based on SDGs targets. For what concerns climate action, the aim is to take steps to combat climate change and its impacts whilst ensuring that affordable, reliable, sustainable, and modern energy is accessible for all. Specifically, in this context, UULabs is focusing on addressing carbon dioxide reduction, renewable and efficient energy, climate mitigation and adaptation. For what concerns biodiversity, LLs projects vary from real estate to urban space, and agriculture. For what concerns circularity, the goal is to achieve a condition in which systems are regenerative, thus, exist through minimisation of resource input and waste, emission, and energy leakage thanks to processes of slowing, closing, and narrowing material and energy loops. To do so, the circularity focus areas addressed by UULabs are resources, buildings, food, IT, and procurement. The fourth and last theme, creative space, is meant to be an open category that allows for space for research ideas that are identified as "ambiguous" about sustainability such as arts, history, science communication, sociology, commons, etcetera. Overall, according to UULabs reports, the action themes climate action, biodiversity, and circularity, seem to be mostly related to SDGs 13, 15 and 12, with "climate action" also having the potential to additionally expand on SDGs 7 and 11, "biodiversity" on SDGs 2 and 13, and "circularity" on SDG 11.

A few examples of currently active LLs, within the UULabs network, are the following:

• The project "*Denver House*", a prize-winning sustainable housing concept, is located on the UU campus. The project, operating under the circularity and biodiversity themes, is being finalised to act as an ecosystem services testbed, to inform the sustainable development of other buildings on campus. Specifically, the project is currently focusing on using Denver House to test innovations related to the food, water and energy dimensions. Ultimately, by answering the question "*how do various ecological and technological functions together convert Denver House into a living system?*" the challenge is for Denver House to become a building that creates life.

• The LL "*Solar Ecology Meadow*", is being set up to explore the opportunities of generating renewable energy, through innovative solar panel technology, in one of the meadows of the UU campus, whilst increasing and preserving ecosystem functions (respectively, strengthening biodiversity and allowing for the area of the meadow to remain available for sheep grazing) and gaining societal support. The project also aims to be a pilot for larger on and off-campus upscaling and contributes to the university goal of generating renewable energy towards 100% local renewables in 2030 and regenerating biodiversity. Ultimately, the outcome will be the realisation of a 0.5 h solar ecology meadow, where livestock grazing is combined with renewable energy generation and biodiversity research.

• The LL "*Bio-receptivity P-Olympos*", is a LL developed within a bigger project. The latter is the construction of a modular, circular and energy-saving parking garage on the UU campus. As part of the LL, gabions with recycled materials were filled by students and members of the Faculty of Science together with colleagues of the Sustainability and Real Estate & Campus Programme, the latter responsible for the construction of the parking itself. The gabions were filled with a mixture of local, second-hand stones, roof tiles and concrete debris, including debris from Utrecht Dom tower, highlighting the connection between the city and the university. The gabions are supposed to form a wall surrounding the ground level of parking for mosses and greenery growth, capturing fine dust and contributing to a better and greener environment. Specifically, this LL brings together research and education to investigate how new (local) constructions can be integrated into the existing scenery and contribute to local biodiversity.

Overall, it seems that, through these projects illustrated as examples of the LLs fostered by UULabs, the latter is contributing to the achievement of SDG targets 2.4, 2.5, 6.6, 7.2, 9.1, 9.5, 11.3, 11.4, 11. a, 12.2, 12.8, 13.3, 15.5, 15.9, 15. a, 17.7, and 17.17.

III. B. Regenerative development

Within the field of sustainability, RD has been gaining importance as a concept that builds on and broadens the connotations of the former. RD does not negate nor replace the valuable efforts and insights made and provided by sustainable development, instead, it adds to such knowledge, providing a diverse perspective and framework of action. According to Cole (2012), RD is an approach that eases the "*co-evolution of human and natural systems in a partnered relationship*" that supplies health and wellbeing for both humans and the environment. This definition is expanded in the work of Reed & Mang (2012) who further define RD as a system of strategies and technologies which enable a "*patterned whole system understanding of a place*", development of "*strategic systemic thinking capacities*", and "*stakeholder engagement/commitment*" needed for regenerative design processes to achieve "*maximum systemic leverage and support*" that is salutogenic. These perspectives, shift the focus from the (un)sustainable paradigm of "limiting the damage" to a new one that also enables the emergence of health and wellbeing (Cole, 2012). For example, if we apply this perspective to the agricultural sector, rather than just avoiding degradation of the ecosystems involved in agricultural processes, RD would seek to use soil for food production whilst leaving the land in a better-than-before condition that allows improving the quality and, or quantity of the harvestable soil itself. Therefore, when talking about RD for the health of humans and the environment, social and natural systems are facilitated to maintain a healthy status, grow, and improve. A holistic and systemic perspective is adopted by RD which advocates a co-evolution of human designs with the designs embedded in nature itself, and humans participating and collaborating with and as nature - as opposed to humans "doing things" to nature, as Wahl (2016) argues in the book "*Designing Regenerative Cultures*". Wahl explains how it is necessary to adopt a forma mentis that allows individuals to become change agents who notice destruction and inequalities, question them, and then ask how to act on them to co-create with nature, allowing for a regenerative effect on the functions and productivity of the local ecosystems. Figure 1 illustrates the trajectory to follow to reach such regenerative systemic change according to Wahl and RD: from a degenerating system, in which the vitality, of our planet, decreases, and more energy is required due to conventional, relatively green and, or, (un)sustainable neutral practices, it is needed to shift to a system that is regenerating, in which less energy is needed, and the systemic vitality increases (Wahl, 2016). This can be achieved by adopting reconciliatory and regenerative practices.

Based on these perspectives, RD aims at accomplishing positive outcomes - improving the health and vitality of human and natural communities (physical, psychological, economic, and ecological) - with a whole-system integrated

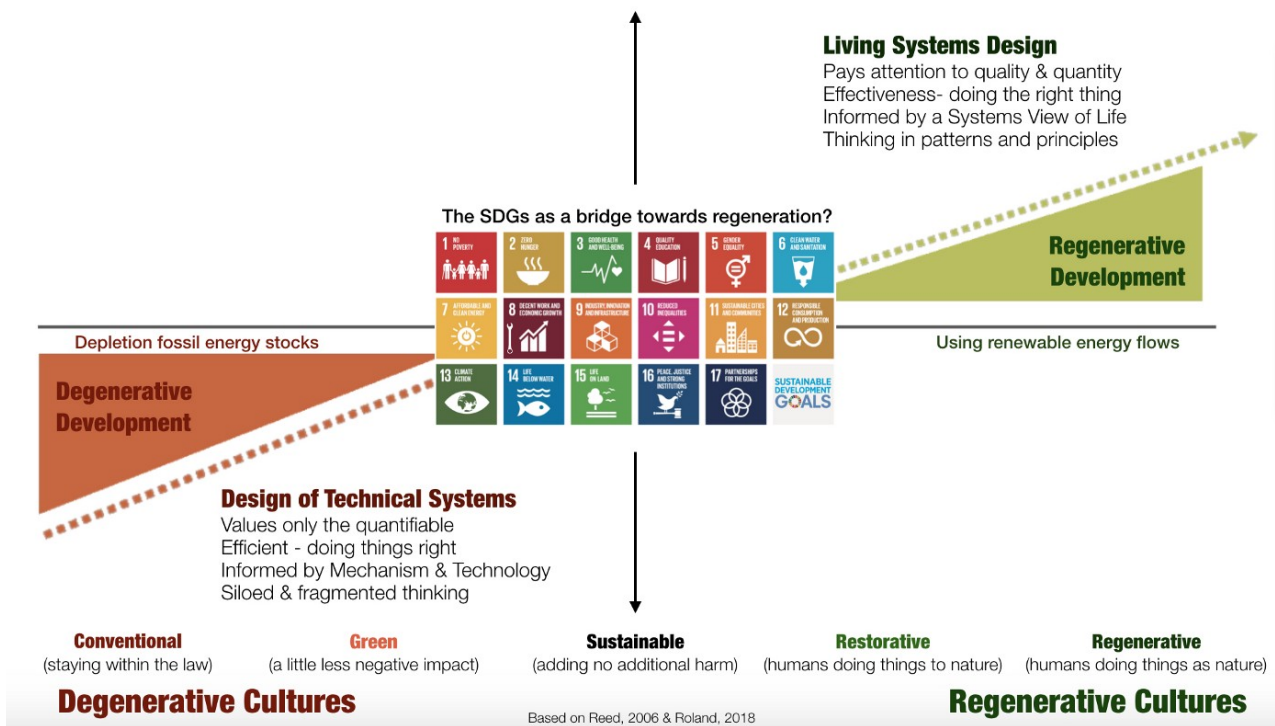# Beyond Sustainability: Designing Regenerative Cultures

Figure 1. The trajectory to follow to reach regenerative systemic change according to regenerative development consultant and educator D. C. Wahl.

approach of which the key elements can be elaborated, by summarising literature findings, as follow (Cole, 2012; du Plessis, 2012; du Plessis & Brandon, 2015; Gibbons, 2020; Mang & Reed, 2012; Reed, 2007; Wahl, 2016):

1. RD focuses on building capacity, in opposition to conventional sustainability practices which only aim at maintaining it. It could be said that regenerative development aims at providing and developing products, services, and systems for human needs whilst both preserving and enabling the emergence of healthy ecosystem metabolisms and services.

2. Building on the previous principle, goals need to be set based on the capacity necessary for the support of ongoing co-evolution of the built, cultural, and natural environments, and of the humans who make use of and tend to them. Thus, regenerative approaches should facilitate a context in which human and natural systems co-evolve, adapt, and transform whilst increasing their reciprocal health.

3. Since RD is associated with strategies that support systemic and collaborative co-evolution, instead of building systems and controlling them, it is needed to work in partnership with a place and its processes. Nature does not need protection but collaboration.

4. To achieve this, a systemic approach should be adopted for problem-solving. Problems are no longer only something that needs to be solved, but symptoms of something bigger: solutions are found in the whole, not only in its parts.

5. A local and attuned response is necessary globally, as the planet thrives operating through a global network of local phenomena. Regenerative approaches are to be developed based on a deep understanding of the unique social and ecological principles and patterns belonging to the systems within which they will be implemented, (re)enabling their natural flows and interactions. Thus, it is necessary to understand the evolutionary dynamics of a place to identify the potential for realising greater health and viability as a consequence of the human presence in such a place. For instance, landowners must commit to deeply understanding how "their" land works and what is its potential as a catalyst to enable its ecological, economic, and social health, and community leaders must replace their import mindset with the development of strategies that re-invest in the ecological systems that make each community special. Thus, when shifting from a society and economy based on degenerative industrial growth to regenerative life-sustaining ones, it is necessary to meet human needs in ways that fit into nature patterns. Also in this context, according to RD, it is necessary to

adopt a locally attuned response: switching from a global economy to local economies, with underlying patterns and principles that might as well be the same for all, but with place-sourced adaptations unique as and attuned to their bio-regional context.

6. Regenerative approaches adopt a transdisciplinary co-operative perspective: several figures, from specialists and technicians to stakeholders, institutions, citizens, and the individual need to be involved in a project to reach the maximum potential of capacity building.

7. Regenerative approaches, at all scales, seek to constantly catalyse dynamic harmony between the always evolving human and natural systems. To practice regeneration is to work on the individual and collective capacity to keep reinventing and transforming individually, as a community and society, in an adaptable response to the inevitable change and transformation of the systems and processes humans and the planet are embedded in. This also entails developing markers and systems of measurement that can track dynamic, holistic, and evolving processes.

8. The world is to be seen as a living system. This helps shift from a mechanistic worldview to one that re-integrates humans within nature. Moreover, it allows seeing biological models, from organisms to ecosystems, as a learning opportunity, thus, giving back value to natural resources.

To give an example of how regenerative principles could be put into action when try finding answers for sustainability transitions, the industrial system can be taken into consideration. If the industrial system is to be transformed regeneratively, the transformation should result in a system that, in the long term, co-evolves, adapts, and transforms with other existing systems whilst increasing their reciprocal health. How to do so? It is known that for a more sustainable industrial system, the volume of industrial materials cycled in the system should decrease in favour of an increase in the volume of biological material cycled in the system, thus, moving away from fossil materials and energy in favour of renewable energy use, towards a biomaterials transition. To effectively and successfully achieve this, it would be necessary to re-regionalise both production and consumption, co-developing them with local systems based on the understanding and potential of bio-regional principles and patterns, ensuring the growth of reciprocal wellbeing (Wahl, 2019). RD will ask and address questions such as, for instance: what do humans produce and why? If the motive is good, then could such production happen more locally? Could the primary needs of humanity be met in ways that differ from the consumption of products, materials, and energy? Which materials are being cycled from local, to regional, and global scale? What renewable energy sources that are regionally "personalised" can enable such flows to be circular? How is it

possible to transition from a global materialistic system, dependent on depleting non-renewable sources of material and energy to a regenerative bio-materials system that is tailored to the regionally bio-available sources of renewable energy and materials? How can water and life sheds and bioregions be inhabited in fashions that nurture humans, ecosystems, and planetary health? (Wahl, 2016; 2019).

Overall, the RD approach could be summarised by saying that regeneration builds on current sustainability and circularity methods and acknowledges that life is a regenerative community: as Janine Benyus, biomimicry expert, puts it,"'life creates conditions conducive to life". Therefore, mankind, as a constituent of the life community, should not compromise it, but rather locally nurture and learn from it, adopting a systemic and salutogenic transformative approach.

IV. DISCUSSION & CONCLUSIONS

In this section, the results will be analysed to evaluate whether and how elements resulting from this analysis could be relevant for the improvement of the development of LLs, including UULabs. Then, this section will elaborate on such analysis to address whether the sustainable impact of LLs and UULabs may become more effective in contributing to the UN SDGs, and, thus, to sustainability transitions, by adhering to certain regenerative practices.

From the presented results, LLs have emerged to address a range of challenges such as, for instance, new technologies, climate, infrastructure retrofit, food production, urban landscape, sustainability, circularity, low carbon practices, and social-uplifting, to name a few. Therefore, it can be stated that, overall, all LLs analysed in this study contribute to SDG target 11.4, which aims at strengthening *"efforts to protect and safeguard the world's cultural and natural heritage"*. When considering sustainability transitions, in the literature, climate change and, thus, topics such as, for instance, circularity and low carbon development, seem to stand out as first drivers for LLs action. However, the results analysed in this literature review also show another trend. Topics such as economic growth, social cohesion and uplifting seem to occupy an important role within LLs agendas, with projects ranging from subjects such as regeneration and modernisation of specific areas to social security, health, and economic development. Moreover, less established environmental issues such as, for instance, the conservation of biodiversity and planning for (future) ecosystems are considered. At the same time, positive narratives regarding sustainability transitions are promoted and favoured by LLs, enhancing the investment and interest of stakeholders and communities and, therefore, the chances of success of LLs projects. These results are encouraging since they are representative of an integrated and wider approach of LLs towards all the dimensions of

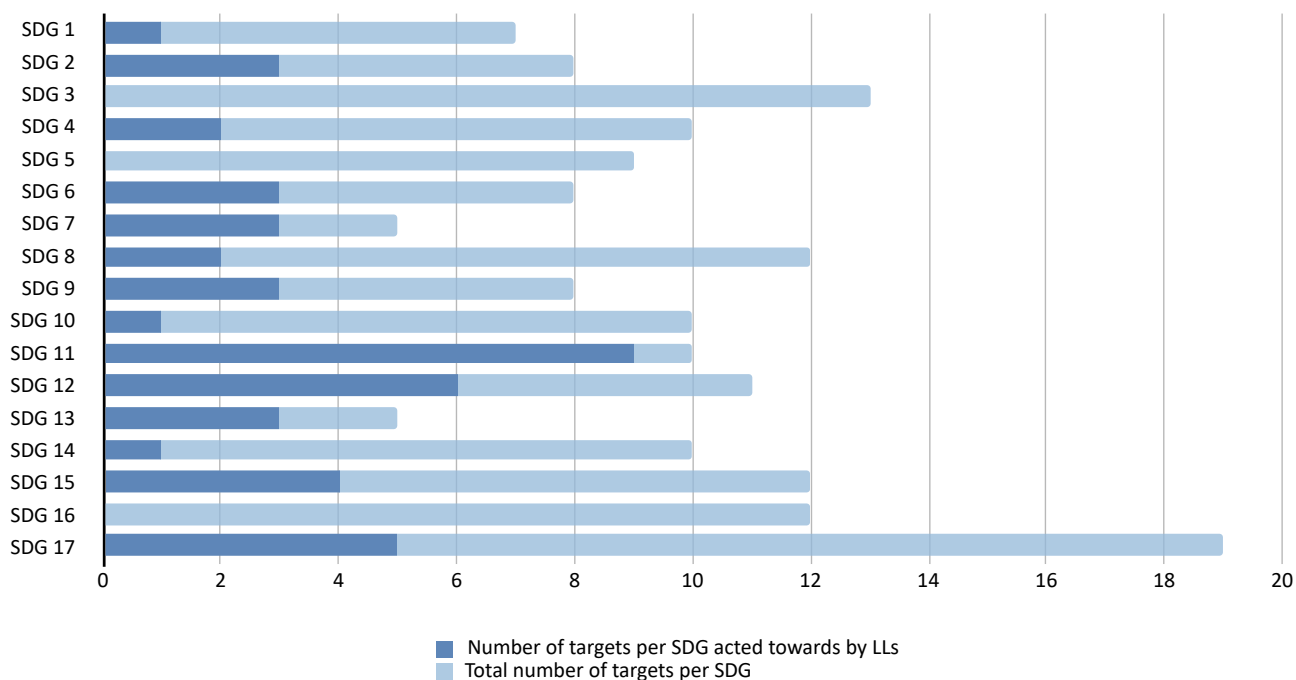## LLs contribution to SDGs targets for sustainability transitions

Table 1. LLs contribution to SDGs targets for sustainability transitions. Overall, out of a total of 169 SDGs targets, 46 targets have been receiving contribution by LLs, with SDG 11 being the goal with the highest number of targets addressed by LLs projects and SDG 3, 5, and 16 being the goals the lowest number of targets addressed by LLs projects.

sustainability. This means that LLs seem not to limit their action towards the most popular "sustainability issues" but, instead, to acknowledge that all of them are deeply interconnected and that, thus, it is necessary to adopt a 360° agenda, addressing, together, the environmental, social, and economic dimensions of sustainability, as proposed by the SDGs. The SDGs and their related targets proved to be an effective tool, in this review, to analyse the contributions of LLs approaches to sustainability transitions. With goals that range from environmental, natural, and ecological health, to social, economic, political, and financial change, the SDGs also advocate positive change happening through integration rather than through compartmentalisation of problems, essential for successful sustainability transitions. Of course, when using the SDGs as a benchmark for the analysis of the impact of LLs contributions towards sustainability transitions, some subjects and issues proved to be more common than others within LLs agendas, as represented in Table 1. For instance, none of the targets from SDG 3, "*ensure healthy lives and promote wellbeing for all at all ages*", SDG 5, "*achieve gender equality and empower all women and girls*", and SDG 16, "*promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels*", were addressed by the LLs projects found in the literature within the topic of sustainability transitions. The absence of contribution towards such goals revealed through the results of this review might mean that, overall, such issues may still need to be addressed by LLs agendas and, or that, perhaps,

such issues may not be considered as part of the topics related to sustainability transitions and, thus, not represented in the samples of studies chosen for this review. In both cases, this result demonstrates that much still needs to be done to advocate the importance of a healthy, equal, decent, peaceful, inclusive, just, educated society for the achievement and maintenance of sustainable futures, which accomplishment is not guaranteed only by environmental and economic wellbeing. Moreover, as also shown in Table 1, only one out of seven targets of SDG 1, "*end poverty in all its forms everywhere*", two targets out of ten of SDG 4, "*ensure inclusive and equitable quality education and promote lifelong learning opportunities for all*", two targets out of 12 of SDG 8, "*promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all*", and one target out of 10 of SDG 10, "*reduce inequality within and among countries*", were addressed by the analysed LLs projects. These results highlight and reinforce what has been hypothesised above. Furthermore, only three out of eight targets of SDG 2, "*end hunger, achieve food security and improved nutrition and promote sustainable agriculture*", of SDG 6, "*ensure availability and sustainable management of water and sanitation for all*", and of SDG 9, "*build resilient infrastructure, promote inclusive and sustainable industrialisation and foster innovation*", were found to be addressed by LLs agendas in this study. Again, this result is showing a detachment of sustainable action, within LLs agenda and, or within the sustainability sector, from social action. Additionally, most of the non-addressed targets of such

SDGs tackle sustainability transitions for and within developing countries, highlighting a need for LLs projects to focus their efforts also towards underdeveloped realities which, alone, may not have the means and knowledge to give birth and nurture LLs approaches. LLs contributions to SDGs 2, 3, 6, and SDGs 14 and 15 (of which, respectively, only one out of ten and four out of twelve targets were found to be addressed by LLs agendas), reveal that many of the non-addressed SDGs targets, which are strictly directly and, or indirectly, environment-related, concern regional and or local issues whose details and situation, as well as potential action, vary according to the specific location. In this context, the non-addressed targets are, for example, SDG target 2.3 regarding small-scale agricultural productivity, SDG target 3.9 regarding the reduction in "t*he number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination*", SDG targets 6.1, 6.4, 6.5, 6. a, regarding safe drinkable water and sustainable water use and management, SDGs targets from 14.2 to 14.5, and 14. a and b, regarding the conservation and sustainable use of oceans, seas and marine resources, and SDG targets 15.1, 12.2, 15.4, 15.8, 15. b and 15. c, regarding protection, restoration, and promotion of sustainable use of the terrestrial ecosystems. For instance, in fact, air, soil and water pollution and contamination have diverse characteristics depending on the specific geographical and regional location, as well as agricultural resources and practices, marine and coastal ecosystems, fishing practices, marine biodiversity and resources, terrestrial freshwater ecosystems, forest management, mountain ecosystems, and alien and protected species. On the other hand, from the results, it is possible to understand that action within urban and industrial contexts instead seems to be more common within LLs agendas, especially regarding energy issues, infrastructure, transportation, cities pollution, urban greenery, waste, and chemicals, as indicated by LLs contribution to SDGs 7, 9 and 11. These results might suggest that more specific and locally attuned actions are more complex and difficult to undertake, perhaps due to them having a smaller reach in terms of funding and collaboration and scalability potential, compared to "urban projects". The latter, instead, might be more popular since they are easily replicable, adaptable and scalable, due to cities having been developed, all over the world, according to many similar and shared patterns, on top of having a wider funding and cooperation reach-potential. Lastly, many of the remaining SDGs targets that have not been addressed by the LLs agendas analysed in this review, concern the promotion and implementation of sustainable policies, legislations, reforms and laws at an institutional level and of economic benefits, the elimination and, or rationalisation of subsidies and costs regarding unsustainable practices, the mobilisation of financial resources and investments, the promotion of sustainable public procurement practices, the regulation of international economic and financial institutions and markets, trading systems, capacity-building, national social protection and health systems and services, tobacco control, institutional international collaboration, economic productivity and labour rights. A direct contribution of LLs towards such sustainability topics was not found within the analysed literature. However, LLs indirectly contribute to such topics, as explained in the sections "*LLs seem to foster transdisciplinary education, partnerships, conversations, and policymaking around sustainability transitions*", "*LLs seem to promote innovation and knowledge co-creation around sustainability transitions*", "*LLs seem to act as change catalysts for the co-adoption of new behaviour, lifestyles, and beliefs attuned with sustainability transitions*" and "LLs seem to foster circular practices for sustainability transitions". In fact, through their actions, storytelling, projects, and cooperative involvement of communities, institutions and stakeholders, LLs seem to be able to influence and, or provide examples for institutional decision-making and action. Overall, out of 169 SDGs targets, 46 were found to be addressed directly by LLs agendas.

For what concern RD, an interesting result is that regenerative development and LLs seem to share, as approaches towards sustainable transitions, many common elements, such as:

• Building on top of traditional processes and perspectives.

• Bringing together people with diverse values and worldviews to collaborate and co-create.

• Co-creating research focuses that are problem-oriented.

• Integrating research across scales, thus working with a systemic perspective which allows a better understanding of the several intricacies and interdependences of sustainability issues.

• Starting with small-scale pilot projects for institutional, economic, and behavioural changes fostering sustainability transitions leading to solutions that are both tailored to and dependent on the local, regional, and national natural, cultural, and economic contexts.

• Testing in real-life. Allowing for real-life problems to arise and be tested in non-confined environments, for actions and judgements to be made in a real context, and for more valid results and impacts to be achieved.

Such results may prove the compatibility of the two approaches to positively inform one another. Perhaps, RD may prove to be helpful to LLs to better and fully address the SDGs and thus, contribute to sustainable transitions and LLs may provide RD with the ideal physical environment in which put into practice its concepts. RD may help LL projects with insights on (how to) asking the right questions thanks to a framework of principles that inform in what way LL projects are (and will be) contributing to sustainable transitions and how such contribution is carried out. For instance, RD may

better inform LLs approach by being the "Nature" representative within the organisation of LL projects, making sure that the environment and its cultures are informing LLs work itself and how they are informing it. LLs and RD are addressing the same challenge, which, fundamentally is to redesign the impact of humanity on the planet. RD, through its principles, takes this challenge to a slightly deeper level by believing that changing the impact of humanity on the planet cannot happen without also redesigning the presence of humanity on the planet. For instance, RD does not necessarily focus on the creation of new and greener products, but on asking questions such as, for example, *"how could we live using fewer things, how could we change consumption and production patterns?"*. In a society that tends to be obsessed with quick fixes, theory and practice, LLs and RD, could be joining forces to, as RD argues, address symptoms, (e.g., how humanity is present on the planet) rather than causes, of unsustainable development. Local collaboration, community and adaptation, re-inhabitation of bioregions, coming back to the place and creating conditions conducive to life are long-term strategies of RD that align with LLs integrated and collaborative approach. For instance, RD promotes the relocation of activities to a local scale, to reduce the energy required for the functioning of the ecosystem and improve the resilience of the territory. LLs might have the potential to be the practice, the testbed, in which such principles are tested and advanced enabling cooperation towards the creation of shared abundance and local and regional capacity building: the more (local) know-how will be available, the better the capacity to respond to disturbances (resilience).

Overall, considering:

a. the reflections made in this section, such as the potential problem of many SDGs social targets often not being addressed under the collective name of "sustainable action";

b. the limitations posed to this review by time restrictions and filters used for data gathering;

c. the fact that LLs and SDGs are approached that only relatively recently have been picked up as conventional by the literature;

the contribution of LLs to 46, out of 169, SDG targets seems to be a positive and encouraging number. It suggests that LLs agendas should indeed keep influencing, collaborating, engaging with, and providing examples for institutional decision-making and action contributing towards sustainable transitions. However, at the same time, it suggests that LLs should improve and re-consider their contribution towards social and local environmental sustainability issues – that specifically go further and beyond urbanised areas. Specifically, LLs projects should consider focusing more on the development of tailor-made and locally attuned approaches,

which match and consider the uniqueness of each issue in relation to its specific (spatial and social) context.

These conclusions seem to suggest that LLs are contributing to and meeting the SDGs agenda, showing a promising involvement within sustainable transitions. Nonetheless, it seems that further attention may need to be set on some of the "means" in which such contribution is carried out, since, from the results and discussion, it appears that such means should, in some instances, become even more diversified, attuned, and specific approaches. This seems to be valid for all LLs approaches, regardless of the issue that is being tackled. Perhaps, RD may be the approach to help the contribution of LLs towards sustainability transitions to develop further and enable a greater and fuller potential. This hypothesis, raised in this work, will need to be further investigated.

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APPENDIX

Sustainable Development Goals and targets of the 2030 Agenda for Sustainable Development

Goal 1. End poverty in all its forms everywhere

1.1 By 2030, eradicate extreme poverty for all people everywhere, currently measured as people living on less than $1.25 a day

1.2 By 2030, reduce at least by half the proportion of men, women and children of all ages living in poverty in all its dimensions according to national definitions

1.3 Implement nationally appropriate social protection systems and measures for all, including floors, and by 2030 achieve substantial coverage of the poor and the vulnerable

1.4 By 2030, ensure that all men and women, in particular the poor and the vulnerable, have equal rights to economic resources, as well as access to basic services, ownership and control over land and other forms of property, inheritance, natural resources, appropriate new technology and financial services, including microfinance

1.5 By 2030, build the resilience of the poor and those in vulnerable situations and reduce their exposure and vulnerability to climate-related extreme events and other economic, social and environmental shocks and disasters

1.a Ensure significant mobilization of resources from a variety of sources, including through enhanced development cooperation, in order to provide adequate and predictable means for developing countries, in particular least developed countries, to implement programmes and policies to end poverty in all its dimensions

1.b Create sound policy frameworks at the national, regional and international levels, based on pro-poor and gender-sensitive development strategies, to support accelerated investment in poverty eradication actions

Goal 2. End hunger, achieve food security and improved nutrition and promote sustainable agriculture

2.1 By 2030, end hunger and ensure access by all people, in particular the poor and people in vulnerable situations, including infants, to safe, nutritious and sufficient food all year round

2.2 By 2030, end all forms of malnutrition, including achieving, by 2025, the internationally agreed targets on stunting and wasting in children under 5 years of age, and address the nutritional needs of adolescent girls, pregnant and lactating women and older persons

2.3 By 2030, double the agricultural productivity and incomes of small-scale food producers, in particular women, indigenous peoples, family farmers, pastoralists and fishers, including through secure and equal access to land, other productive resources and inputs, knowledge, financial services, markets and opportunities for value addition and non-farm employment

2.4 By 2030, ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production, that help maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather, drought, flooding and other disasters and that progressively improve land and soil quality

2.5 By 2020, maintain the genetic diversity of seeds, cultivated plants and farmed and domesticated animals and their related wild species, including through soundly managed and diversified seed and plant banks at the national, regional and international levels, and promote access to and fair and equitable sharing of benefits arising from the utilization of genetic resources and associated traditional knowledge, as internationally agreed

2.a Increase investment, including through enhanced international cooperation, in rural infrastructure, agricultural research and extension services, technology development and plant and livestock gene banks in order to enhance agricultural productive capacity in developing countries, in particular least developed countries

2.b Correct and prevent trade restrictions and distortions in world agricultural markets, including through the parallel elimination of all forms of agricultural export subsidies and all export measures with equivalent effect, in accordance with the mandate of the Doha Development Round

2.c Adopt measures to ensure the proper functioning of food commodity markets and their derivatives and facilitate timely access to market information, including on food reserves, in order to help limit extreme food price volatility

Goal 3. Ensure healthy lives and promote well-being for all at all ages

3.1 By 2030, reduce the global maternal mortality ratio to less than 70 per 100,000 live births

3.2 By 2030, end preventable deaths of newborns and children under 5 years of age, with all countries aiming to reduce neonatal mortality to at least as low as 12 per 1,000 live births and under-5 mortality to at least as low as 25 per 1,000 live births

3.3 By 2030, end the epidemics of AIDS, tuberculosis, malaria and neglected tropical diseases and combat hepatitis, water-borne diseases and other communicable diseases

3.4 By 2030, reduce by one third premature mortality from non-communicable diseases through prevention and treatment and promote mental health and well-being

3.5 Strengthen the prevention and treatment of substance abuse, including narcotic drug abuse and harmful use of alcohol

3.6 By 2020, halve the number of global deaths and injuries from road traffic accidents

3.7 By 2030, ensure universal access to sexual and reproductive health-care services, including for family planning, information and education, and the integration of reproductive health into national strategies and programmes

3.8 Achieve universal health coverage, including financial risk protection, access to quality essential health-care services and access to safe, effective, quality and affordable essential medicines and vaccines for all

3.9 By 2030, substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination

3.a Strengthen the implementation of the World Health Organization Framework Convention on Tobacco Control in all countries, as appropriate

3.b Support the research and development of vaccines and medicines for the communicable and non-communicable diseases that primarily affect developing countries, provide access to affordable essential medicines and vaccines, in accordance with the Doha Declaration on the TRIPS Agreement and Public Health, which affirms the right of developing countries to use to the full the provisions in the Agreement on Trade-Related Aspects of Intellectual Property Rights regarding flexibilities to protect public health, and, in particular, provide access to medicines for all

3.c Substantially increase health financing and the recruitment, development, training and retention of the health workforce in developing countries, especially in least developed countries and small island developing States

3.d Strengthen the capacity of all countries, in particular developing countries, for early warning, risk reduction and management of national and global health risks

Goal 4. Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all

4.1 By 2030, ensure that all girls and boys complete free, equitable and quality primary and secondary education leading to relevant and effective learning outcomes

4.2 By 2030, ensure that all girls and boys have access to quality early childhood development, care and pre-primary education so that they are ready for primary education

4.3 By 2030, ensure equal access for all women and men to affordable and quality technical, vocational and tertiary education, including university

4.4 By 2030, substantially increase the number of youth and adults who have relevant skills, including technical and vocational skills, for employment, decent jobs and entrepreneurship

4.5 By 2030, eliminate gender disparities in education and ensure equal access to all levels of education and vocational training for the vulnerable, including persons with disabilities, indigenous peoples and children in vulnerable situations

4.6 By 2030, ensure that all youth and a substantial proportion of adults, both men and women, achieve literacy and numeracy

4.7 By 2030, ensure that all learners acquire the knowledge and skills needed to promote sustainable development, including, among others, through education for sustainable development and sustainable lifestyles, human rights, gender equality, promotion of a culture of peace and non-violence, global citizenship and appreciation of cultural diversity and of culture's contribution to sustainable development

4.a Build and upgrade education facilities that are child, disability and gender sensitive and provide safe, non-violent, inclusive and effective learning environments for all

4.b By 2020, substantially expand globally the number of scholarships available to developing countries, in particular least developed countries, small island developing States and African countries, for enrolment in higher education, including vocational training and information and communications technology, technical, engineering and scientific programmes, in developed countries and other developing countries

4.c By 2030, substantially increase the supply of qualified teachers, including through international cooperation for teacher training in developing countries, especially least developed countries and small island developing States

Goal 5. Achieve gender equality and empower all women and girls

5.1 End all forms of discrimination against all women and girls everywhere

5.2 Eliminate all forms of violence against all women and girls in the public and private spheres, including trafficking and sexual and other types of exploitation

5.3 Eliminate all harmful practices, such as child, early and forced marriage and female genital mutilation

5.4 Recognize and value unpaid care and domestic work through the provision of public services, infrastructure and social protection policies and the promotion of shared responsibility within the household and the family as nationally appropriate

5.5 Ensure women's full and effective participation and equal opportunities for leadership at all levels of decision-making in political, economic and public life

5.6 Ensure universal access to sexual and reproductive health and reproductive rights as agreed in accordance with the Programme of Action of the International Conference on Population and Development and the Beijing Platform for Action and the outcome documents of their review conferences

5.a Undertake reforms to give women equal rights to economic resources, as well as access to ownership and control over land and other forms of property, financial services, inheritance and natural resources, in accordance with national laws

5.b Enhance the use of enabling technology, in particular information and communications technology, to promote the empowerment of women

5.c Adopt and strengthen sound policies and enforceable legislation for the promotion of gender equality and the empowerment of all women and girls at all levels

Goal 6. Ensure availability and sustainable management of water and sanitation for all

6.1 By 2030, achieve universal and equitable access to safe and affordable drinking water for all

6.2 By 2030, achieve access to adequate and equitable sanitation and hygiene for all and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations

6.3 By 2030, improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally

6.4 By 2030, substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity

6.5 By 2030, implement integrated water resources management at all levels, including through transboundary cooperation as appropriate

6.6 By 2020, protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes

6.a By 2030, expand international cooperation and capacity-building support to developing countries in water- and sanitation-related activities and programmes, including water harvesting, desalination, water efficiency, wastewater treatment, recycling and reuse technologies

6.b Support and strengthen the participation of local communities in improving water and sanitation management

Goal 7. Ensure access to affordable, reliable, sustainable and modern energy for all

7.1 By 2030, ensure universal access to affordable, reliable and modern energy services

7.2 By 2030, increase substantially the share of renewable energy in the global energy mix

7.3 By 2030, double the global rate of improvement in energy efficiency

7.a By 2030, enhance international cooperation to facilitate access to clean energy research and technology, including renewable energy, energy efficiency and advanced and cleaner fossil-fuel technology, and promote investment in energy infrastructure and clean energy technology

7.b By 2030, expand infrastructure and upgrade technology for supplying modern and sustainable energy services for all in developing countries, in particular least developed countries, small island developing States and landlocked developing countries, in accordance with their respective programmes of support

Goal 8. Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all

8.1 Sustain per capita economic growth in accordance with national circumstances and, in particular, at least 7 per cent gross domestic product growth per annum in the least developed countries

8.2 Achieve higher levels of economic productivity through diversification, technological upgrading and innovation, including through a focus on high-value added and labour-intensive sectors

8.3 Promote development-oriented policies that support productive activities, decent job creation, entrepreneurship, creativity and innovation, and encourage the formalization and growth of micro-, small- and medium-sized enterprises, including through access to financial services

8.4 Improve progressively, through 2030, global resource efficiency in consumption and production and endeavour to decouple economic growth from environmental degradation, in accordance with the 10-Year Framework of Programmes on Sustainable Consumption and Production, with developed countries taking the lead

8.5 By 2030, achieve full and productive employment and decent work for all women and men, including for young people and persons with disabilities, and equal pay for work of equal value

8.6 By 2020, substantially reduce the proportion of youth not in employment, education or training

8.7 Take immediate and effective measures to eradicate forced labour, end modern slavery and human trafficking and secure the prohibition and elimination of the worst forms of child labour, including recruitment and use of child soldiers, and by 2025 end child labour in all its forms

8.8 Protect labour rights and promote safe and secure working environments for all workers, including migrant workers, in particular women migrants, and those in precarious employment

8.9 By 2030, devise and implement policies to promote sustainable tourism that creates jobs and promotes local culture and products

8.10 Strengthen the capacity of domestic financial institutions to encourage and expand access to banking, insurance and financial services for all

8.a Increase Aid for Trade support for developing countries, in particular least developed countries, including through the Enhanced Integrated Framework for Trade-related Technical Assistance to Least Developed Countries

8.b By 2020, develop and operationalize a global strategy for youth employment and implement the Global Jobs Pact of the International Labour Organization

Goal 9. Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation

9.1 Develop quality, reliable, sustainable and resilient infrastructure, including regional and transborder infrastructure, to support economic development and human well-being, with a focus on affordable and equitable access for all

9.2 Promote inclusive and sustainable industrialization and, by 2030, significantly raise industry's share of employment and gross domestic product, in line with national circumstances, and double its share in least developed countries

9.3 Increase the access of small-scale industrial and other enterprises, in particular in developing countries, to financial services, including affordable credit, and their integration into value chains and markets

9.4 By 2030, upgrade infrastructure and retrofit industries to make them sustainable, with increased resource-use efficiency and greater adoption of clean and environmentally sound technologies and industrial processes, with all countries taking action in accordance with their respective capabilities

9.5 Enhance scientific research, upgrade the technological capabilities of industrial sectors in all countries, in particular developing countries, including, by 2030, encouraging innovation and substantially increasing the number of research and development workers per 1 million people and public and private research and development spending

9.a Facilitate sustainable and resilient infrastructure development in developing countries through enhanced financial, technological and technical support to African countries, least developed countries, landlocked developing countries and small island developing States

9.b Support domestic technology development, research and innovation in developing countries, including by ensuring a conducive policy environment for, inter alia, industrial diversification and value addition to commodities

9.c Significantly increase access to information and communications technology and strive to provide universal and affordable access to the Internet in least developed countries by 2020

Goal 10. Reduce inequality within and among countries

10.1 By 2030, progressively achieve and sustain income growth of the bottom 40 per cent of the population at a rate higher than the national average

10.2 By 2030, empower and promote the social, economic and political inclusion of all, irrespective of age, sex, disability, race, ethnicity, origin, religion or economic or other status

10.3 Ensure equal opportunity and reduce inequalities of outcome, including by eliminating discriminatory laws, policies and practices and promoting appropriate legislation, policies and action in this regard

10.4 Adopt policies, especially fiscal, wage and social protection policies, and progressively achieve greater equality

10.5 Improve the regulation and monitoring of global financial markets and institutions and strengthen the implementation of such regulations

10.6 Ensure enhanced representation and voice for developing countries in decision-making in global international economic and financial institutions in order to deliver more effective, credible, accountable and legitimate institutions

10.7 Facilitate orderly, safe, regular and responsible migration and mobility of people, including through the implementation of planned and well-managed migration policies

10.a Implement the principle of special and differential treatment for developing countries, in particular least developed countries, in accordance with World Trade Organization agreements

10.b Encourage official development assistance and financial flows, including foreign direct investment, to States where the need is greatest, in particular least developed countries, African countries, small island developing States and landlocked developing countries, in accordance with their national plans and programmes

10.c By 2030, reduce to less than 3 per cent the transaction costs of migrant remittances and eliminate remittance corridors with costs higher than 5 per cent

Goal 11. Make cities and human settlements inclusive, safe, resilient and sustainable

11.1 By 2030, ensure access for all to adequate, safe and affordable housing and basic services and upgrade slums

11.2 By 2030, provide access to safe, affordable, accessible and sustainable transport systems for all, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, women, children, persons with disabilities and older persons

11.3 By 2030, enhance inclusive and sustainable urbanization and capacity for participatory, integrated and sustainable human settlement planning and management in all countries

11.4 Strengthen efforts to protect and safeguard the world's cultural and natural heritage

11.5 By 2030, significantly reduce the number of deaths and the number of people affected and substantially decrease the direct economic losses relative to global gross domestic product caused by disasters, including water-related disasters, with a focus on protecting the poor and people in vulnerable situations

11.6 By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management

11.7 By 2030, provide universal access to safe, inclusive and accessible, green and public spaces, in particular for women and children, older persons and persons with disabilities

11.a Support positive economic, social and environmental links between urban, peri-urban and rural areas by strengthening national and regional development planning

11.b By 2020, substantially increase the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change, resilience to disasters, and develop and implement, in line with the Sendai Framework for Disaster Risk Reduction 2015–2030, holistic disaster risk management at all levels

11.c Support least developed countries, including through financial and technical assistance, in building sustainable and resilient buildings utilizing local materials

Goal 12. Ensure sustainable consumption and production patterns

12.1 Implement the 10-Year Framework of Programmes on Sustainable Consumption and Production Patterns, all countries taking action, with developed countries taking the lead, taking into account the development and capabilities of developing countries

12.2 By 2030, achieve the sustainable management and efficient use of natural resources

12.3 By 2030, halve per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains, including post-harvest losses

12.4 By 2020, achieve the environmentally sound management of chemicals and all wastes throughout their life cycle, in accordance with agreed international frameworks, and significantly reduce their release to air, water and soil in order to minimize their adverse impacts on human health and the environment

12.5 By 2030, substantially reduce waste generation through prevention, reduction, recycling and reuse

12.6 Encourage companies, especially large and transnational companies, to adopt sustainable practices and to integrate sustainability information into their reporting cycle

12.7 Promote public procurement practices that are sustainable, in accordance with national policies and priorities

12.8 By 2030, ensure that people everywhere have the relevant information and awareness for sustainable development and lifestyles in harmony with nature

12.a Support developing countries to strengthen their scientific and technological capacity to move towards more sustainable patterns of consumption and production

12.b Develop and implement tools to monitor sustainable development impacts for sustainable tourism that creates jobs and promotes local culture and products

12.c Rationalize inefficient fossil-fuel subsidies that encourage wasteful consumption by removing market distortions, in accordance with national circumstances, including by restructuring taxation and phasing out those harmful subsidies, where they exist, to reflect their environmental impacts, taking fully into account the specific needs and conditions of developing countries and minimizing the possible adverse impacts on their development in a manner that protects the poor and the affected communities

Goal 13. Take urgent action to combat climate change and its impacts

13.1 Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries

13.2 Integrate climate change measures into national policies, strategies and planning

13.3 Improve education, awareness-raising and human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning

13.a Implement the commitment undertaken by developed-country parties to the United Nations Framework Convention on Climate Change to a goal of mobilizing jointly $100 billion annually by 2020 from all sources to address the needs of developing countries in the context of meaningful mitigation actions and transparency on implementation and fully operationalize the Green Climate Fund through its capitalization as soon as possible

13.b Promote mechanisms for raising capacity for effective climate change-related planning and management in least developed countries and small island developing States, including focusing on women, youth and local and marginalized communities

Goal 14. Conserve and sustainably use the oceans, seas and marine resources for sustainable development

14.1 By 2025, prevent and significantly reduce marine pollution of all kinds, in particular from land-based activities, including marine debris and nutrient pollution

14.2 By 2020, sustainably manage and protect marine and coastal ecosystems to avoid significant adverse impacts, including by strengthening their resilience, and take action for their restoration in order to achieve healthy and productive oceans

14.3 Minimize and address the impacts of ocean acidification, including through enhanced scientific cooperation at all levels

14.4 By 2020, effectively regulate harvesting and end overfishing, illegal, unreported and unregulated fishing and destructive fishing practices and implement science-based management plans, in order to restore fish stocks in the shortest time feasible, at least to levels that can produce maximum sustainable yield as determined by their biological characteristics

14.5 By 2020, conserve at least 10 per cent of coastal and marine areas, consistent with national and international law and based on the best available scientific information

14.6 By 2020, prohibit certain forms of fisheries subsidies which contribute to overcapacity and overfishing, eliminate subsidies that contribute to illegal, unreported and unregulated fishing and refrain from introducing new such subsidies, recognizing that appropriate and effective special and differential treatment for developing and least developed countries should be an integral part of the World Trade Organization fisheries subsidies negotiation[4]

14.7 By 2030, increase the economic benefits to small island developing States and least developed countries from the sustainable use of marine resources, including through sustainable management of fisheries, aquaculture and tourism

14.a Increase scientific knowledge, develop research capacity and transfer marine technology, taking into account the Intergovernmental Oceanographic Commission Criteria and Guidelines on the Transfer of Marine Technology, in order to improve ocean health and to enhance the contribution of marine biodiversity to the development of developing countries, in particular small island developing States and least developed countries

14.b Provide access for small-scale artisanal fishers to marine resources and markets

14.c Enhance the conservation and sustainable use of oceans and their resources by implementing international law as reflected in the United Nations Convention on the Law of the Sea, which provides the legal framework for the conservation and sustainable use of oceans and their resources, as recalled in paragraph 158 of "The future we want"

Goal 15. Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss

15.1 By 2020, ensure the conservation, restoration and sustainable use of terrestrial and inland freshwater ecosystems and their services, in particular forests, wetlands, mountains and drylands, in line with obligations under international agreements

15.2 By 2020, promote the implementation of sustainable management of all types of forests, halt deforestation, restore degraded forests and substantially increase afforestation and reforestation globally

15.3 By 2030, combat desertification, restore degraded land and soil, including land affected by desertification, drought and floods, and strive to achieve a land degradation-neutral world

15.4 By 2030, ensure the conservation of mountain ecosystems, including their biodiversity, in order to enhance their capacity to provide benefits that are essential for sustainable development

15.5 Take urgent and significant action to reduce the degradation of natural habitats, halt the loss of biodiversity and, by 2020, protect and prevent the extinction of threatened species

15.6 Promote fair and equitable sharing of the benefits arising from the utilization of genetic resources and promote appropriate access to such resources, as internationally agreed

15.7 Take urgent action to end poaching and trafficking of protected species of flora and fauna and address both demand and supply of illegal wildlife products

15.8 By 2020, introduce measures to prevent the introduction and significantly reduce the impact of invasive alien species on land and water ecosystems and control or eradicate the priority species

15.9 By 2020, integrate ecosystem and biodiversity values into national and local planning, development processes, poverty reduction strategies and accounts

15.a Mobilize and significantly increase financial resources from all sources to conserve and sustainably use biodiversity and ecosystems

15.b Mobilize significant resources from all sources and at all levels to finance sustainable forest management and provide adequate incentives to developing countries to advance such management, including for conservation and reforestation

15.c Enhance global support for efforts to combat poaching and trafficking of protected species, including by increasing the capacity of local communities to pursue sustainable livelihood opportunities

Goal 16. Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels

16.1 Significantly reduce all forms of violence and related death rates everywhere

16.2 End abuse, exploitation, trafficking and all forms of violence against and torture of children

16.3 Promote the rule of law at the national and international levels and ensure equal access to justice for all

16.4 By 2030, significantly reduce illicit financial and arms flows, strengthen the recovery and return of stolen assets and combat all forms of organized crime

16.5 Substantially reduce corruption and bribery in all their forms

16.6 Develop effective, accountable and transparent institutions at all levels

16.7 Ensure responsive, inclusive, participatory and representative decision-making at all levels

16.8 Broaden and strengthen the participation of developing countries in the institutions of global governance

16.9 By 2030, provide legal identity for all, including birth registration

16.10 Ensure public access to information and protect fundamental freedoms, in accordance with national legislation and international agreements

16.a Strengthen relevant national institutions, including through international cooperation, for building capacity at all levels, in particular in developing countries, to prevent violence and combat terrorism and crime

16.b Promote and enforce non-discriminatory laws and policies for sustainable development

Goal 17. Strengthen the means of implementation and revitalize the Global Partnership for Sustainable Development	**Finance** 17.1 Strengthen domestic resource mobilization, including through international support to developing countries, to improve domestic capacity for tax and other revenue collection 17.2 Developed countries to implement fully their official development assistance commitments, including the commitment by many developed countries to achieve the target of 0.7 per cent of gross national income for official development assistance (ODA/GNI) to developing countries and 0.15 to 0.20 per cent of ODA/GNI to least developed countries; ODA providers are encouraged to consider setting a target to provide at least 0.20 per cent of ODA/GNI to least developed countries 17.3 Mobilize additional financial resources for developing countries from multiple sources 17.4 Assist developing countries in attaining long-term debt sustainability through coordinated policies aimed at fostering debt financing, debt relief and debt restructuring, as appropriate, and address the external debt of highly indebted poor countries to reduce debt distress 17.5 Adopt and implement investment promotion regimes for least developed countries **Technology** 17.6 Enhance North-South, South-South and triangular regional and international cooperation on and access to science, technology and innovation and enhance knowledge-sharing on mutually agreed terms, including through improved coordination among existing mechanisms, in particular at the United Nations level, and through a global technology facilitation mechanism 17.7 Promote the development, transfer, dissemination and diffusion of environmentally sound technologies to developing countries on favourable terms, including on concessional and preferential terms, as mutually agreed 17.8 Fully operationalize the technology bank and science, technology and innovation capacity-building mechanism for least developed countries by 2017 and enhance the use of enabling technology, in particular information and communications technology **Capacity-building** 17.9 Enhance international support for implementing effective and targeted capacity-building in developing countries to support national plans to implement all the Sustainable Development Goals, including through North-South, South-South and triangular cooperation **Trade** 17.10 Promote a universal, rules-based, open, non-discriminatory and equitable multilateral trading system under the World Trade Organization, including through the conclusion of negotiations under its Doha Development Agenda 17.11 Significantly increase the exports of developing countries, in particular with a view to doubling the least developed countries' share of global exports by 2020 17.12 Realize timely implementation of duty-free and quota-free market access on a lasting basis for all least developed countries, consistent with World Trade Organization decisions, including by ensuring that preferential rules of origin applicable to imports from least developed countries are transparent and simple, and contribute to facilitating market access **Systemic issues** *Policy and institutional coherence* 17.13 Enhance global macroeconomic stability, including through policy coordination and policy coherence 17.14 Enhance policy coherence for sustainable development 17.15 Respect each country's policy space and leadership to establish and implement policies for poverty eradication and sustainable development *Multi-stakeholder partnerships* 17.16 Enhance the Global Partnership for Sustainable Development, complemented by multi-stakeholder partnerships that mobilize and share knowledge, expertise, technology and financial resources, to support the achievement of the Sustainable Development Goals in all countries, in particular developing countries 17.17 Encourage and promote effective public, public-private and civil society partnerships, building on the experience and resourcing strategies of partnerships *Data, monitoring and accountability* 17.18 By 2020, enhance capacity-building support to developing countries, including for least developed countries and small island developing States, to increase significantly the availability of high-quality, timely and reliable data disaggregated by income, gender, age, race, ethnicity, migratory status, disability, geographic location and other characteristics relevant in national contexts 17.19 By 2030, build on existing initiatives to develop measurements of progress on sustainable development that complement gross domestic product, and support statistical capacity-building in developing countries

** As contained in the **Annex** of the resolution adopted by the General Assembly on 6 July 2017, **Work of the Statistical Commission pertaining to the 2030 Agenda for Sustainable Development (A/RES/71/313)**, annual refinements contained in E/CN.3/2018/2 (Annex II), E/CN.3/2019/2 (Annex II), 2020 Comprehensive Review changes (Annex II) and annual refinements (Annex III) contained in E/CN.3/2020/2, and annual refinements contained in E/CN.3/2021/2 (Annex).*

¹ Indicator codes were developed by UNSD for data transfer, tracking and other statistical purposes.

¹ Resolution 68/261.

² The Gini Coefficient will be reported as a second series in the database, as it is a component of this indicator.

³ Acknowledging that the United Nations Framework Convention on Climate Change is the primary international, intergovernmental forum for negotiating the global response to climate change.

⁴ Taking into account ongoing World Trade Organization negotiations, the Doha Development Agenda and the Hong Kong ministerial mandate.

⁵ The current indicator 17.6.1 was previously listed as 17.6.2.

Table 2. The United Nations Sustainable Development Goals and their respective targets.