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The Interactions of Sustainable Development Goals: The Case of Urban Informal Settlements in Ethiopia

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ABSTRACT

Ethiopia is challenged by a strong development progress. Currently the major issues in Ethiopia, as a least developed country with a rapid urbanisation, include a high level of income inequality, lack of formal employment opportunities, deeply rooted poverty, tenure insecurity, poor infrastructure, and limited access to electricity and energy. The Erasmus+ Project "Social Inclusion and Energy Management for Informal Urban Settlements", enables European and Ethiopian universities to develop new university courses integrating the aspects of sustainability for future professionals in the field of architecture, urban planning but also social sciences. The paper investigates the respective situation in Ethiopia, and demonstrates the interactions of six selected Sustainable Development Goals of the United Nations highly linked with this topic. These six Sustainable Development Goals were identified in a participative process, involving different stakeholders like government officials, urban planners or informal settlers by interviews, focus groups, workshops and conferences. The focus is on SDG1 "No Poverty", SDG3 "Good Health and Well-being", SDG7 "Affordable and Clean Energy", SDG11 "Sustainable Cities and Communities", SDG13 "Climate Action" and SDG15 "Life on Land". In the context of Ethiopian cities, energy production and distribution have been highly centralised under state entities and the scope for exploring local/business driven and decentralised energy systems has been limited. Transitions can be implemented towards sustainability and the United Nations Sustainable Development Goals, if collective identification and structuring of issues along with collective envisioning of the future, and the interactions and trade-offs of different goals are taken into consideration.

1. INTRODUCTION

Social and environmental aspects for the sustainable development of informal settlements (slums) are the main focus in the context of the EU Erasmus plus Project "Social Inclusion and Energy Management for Informal Urban Settlements (SES)", running for three years until 2020, with Ethiopia as the African partner [1]. A holistic approach in Ethiopian universities' existing academic programs for future architects, urban developers and energy managers is applied, and responsible personnel at local authorities will be trained. The results will sharpen the profile of universities and their responsiveness to societal needs, improve the employability of graduates as well as the networking between local stakeholders and intensify contacts between Ethiopia and Europe.

The key aspects of the project SES, the current situations of informal settlements and of energy supply and demand in Ethiopia, are the focus of this paper. In this context, six out of the 17 UN Sustainable Development Goals (SDGs) are discussed regarding their mutual interaction demonstrating that on the way to a sustainable development a broad and holistic approach may support the goals best.

2. INFORMAL SETTLEMENTS IN ETHIOPIA

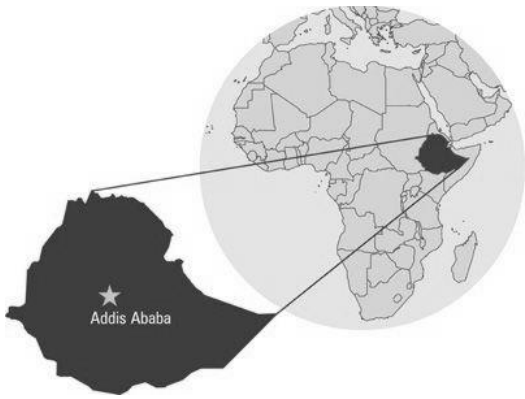


Figure 1. Geographical position of Ethiopia, Africa [2]

Ethiopia is located in the north-east of Africa, in the Horn of Africa (Figure 1). The country with its very rich cultural heritage is classified as a least developed country (LDC) by the United Nations. Challenges of the country are still poverty (40% live in poverty), education, gender, maternal mortality, nutrition etc., but to an increasing extent the consequences of climate change too [2].

Currently the urbanisation rate in Ethiopia is relatively low (20%), but the outlook is expecting a development up to 37% for 2050, nearly double compared to 2015 [3]. In combination with a predicted high increase in population, urbanisation and informal settlements are a hugh challenge in Ethiopia.

Informal settlements show poor quality of infrastructure and housing, often without access to electricity. In Ethiopia 80% of the urban population live in slums with an urbanisation rate of 8% per year. Nearly 25% of the inhabitants of the capital of Ethiopia have no access to sanitary facilities [4-6].

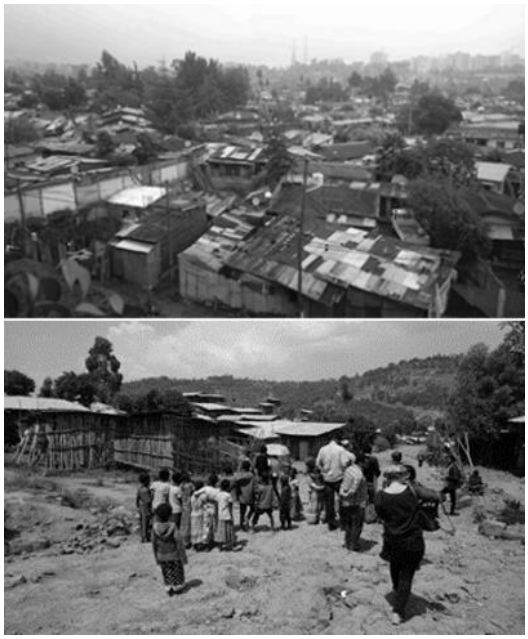


Figure 2. Informal settlements in Addis Ababa and Gondar, © Hoeltl

Figure 2 shows informal settlements in Ethiopia during site visits of European and African members of the project SES in Addis Ababa (with electrification) and in Gondar (without electrification or any infrastructure) in 2017 [7].

3. ENERGY AND CO_2 EMISSIONS IN ETHIOPIA

Economic development of a country can help reducing unemployment and poverty, especially in Least Developed Countries. One of the big challenges in this context is the decoupling of energy production and economic development from the greenhouse gas emissions.

3.1 National and international framework

Ethiopia already shows different international agreements as well as national strategies for supporting a sustainable development of the country. Therefore, the Ethiopian Climate Resilient and Green Economy (CRGE) strategy indicates the intention and the plan for becoming a carbon-neutral and climate change resilient green economy [7].

The Ethiopian's second Growth and Transformation Plan (GTP II) 2015/16–2019/20 includes the CRGE strategy as the important pillar „building a climate resilient green economy", with the effect of corresponding legal, policy and institutional frameworks at the federal, regional and district levels, e.g. a ten-year forest sector development programme. However, Ethiopia faces big challenges from climate change consequences [8].

As a member of the United Nations, Ethiopia has accepted and supports the 2030 Agenda for Sustainable Development and the SDGs with national commitments. In the Voluntary National Review (VNR) 2017, Ethiopia refers to a number of consultations ensuring the involvement of all relevant stakeholders, the government, the private sector, the civil society, NGO, business etc. [9].

The national GTP II of Ethiopia considers the SDGs, shown in Figure 3, as well. One of Ethiopian's main objectives here is "Eradicating Poverty and Promoting Prosperity" with a focus on SDG1, 2, 3, 5, 9, and 14. Among those, the project SES deals with SDG1 "No Poverty" and 3 "Good Health and Well-Being", additionally with SDG7 „Affordable and Clean Energy", SDG11 "Sustainable Cities and Communities", SDG13 "Climate Action", and SDG15 "Life on Land" [10].

Figure 3. The 17 UN SDGs for sustainable development [10]

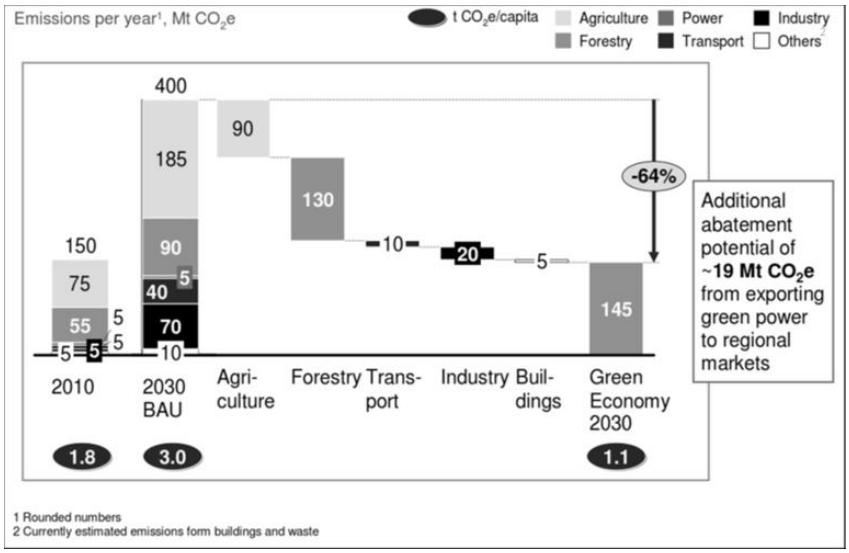


Figure 4. Intended greenhouse gas emissions reduction of Ethiopia until 2030 [12]

Ethiopia also ratified the Paris Climate Agreement in March 2017, the international agreement of the United Nations Framework Convention on Climate Change, aiming to limit global warming to well below 2°C [11]. In the context of the Paris Agreement the countries are requested to provide a Nationally Determined Contribution (NDC) [12]. Ethiopia submitted its NDC in March 2017. The NDC intends to promote modern and energy efficient technologies in transport, industry and in the building sectors, and to develop and implement climate change compliant building/construction codes for buildings. Figure 4 shows that Ethiopia aims to reduce its greenhouse gas emissions based on the protected business-as-usual emissions by 64 % in 2030, and in the long term to become carbon-neutral.

3.2 Energy situation in Ethiopia

The share of renewable resources (mainly hydro, biofuels and waste) for the primary energy production is with 91.6 % very high in Ethiopia. However, the consequences of the current way of using biofuels are often deforestation or health problems, which have to be reduced by modern technologies. Furthermore, it has to be taken into consideration that transport and industry are still on a very low level. Industry had a share of 3% of the total final energy consumption in 2015, compared e.g. to Austria with 34%, or China with 58%. Transport in Ethiopia needed 4% of the total final energy consumption in 2015, for comparison in China 16% or in Austria 31%. Vice versa, residential had a share of 91% of total final energy consumption in 2015 in Ethiopia compared to 22% in Austria or 16% in China. In 2014 in the rural areas of Ethiopia only 12.2% of the inhabitants had access to electricity, in the urban areas 91% [13].

The adaption of the most modern and efficient energy technologies may support a sustainable development of Ethiopia, facing the challenge of a necessary economic growth on the one hand and the country's aim at reducing CO_2 emissions on the other hand.

According to the United Nations SDG report 2018 [14], 45% of the renewables were not derived from modern forms of renewable energy, but e.g. are charcoal or fuelwood in 2015. Used for cooking, such fuels affect the health and well-being especially of women and children.

Figure 5 indicates the electricity consumption for Ethiopia with 0.09 MWh/capita, for Spain with 5.48 MWh/capita, and for Austria with 8.35 MWh/capita. Therefore, in 2015 the electricity consumption per capita was 92 times higher in Austria than in Ethiopia.

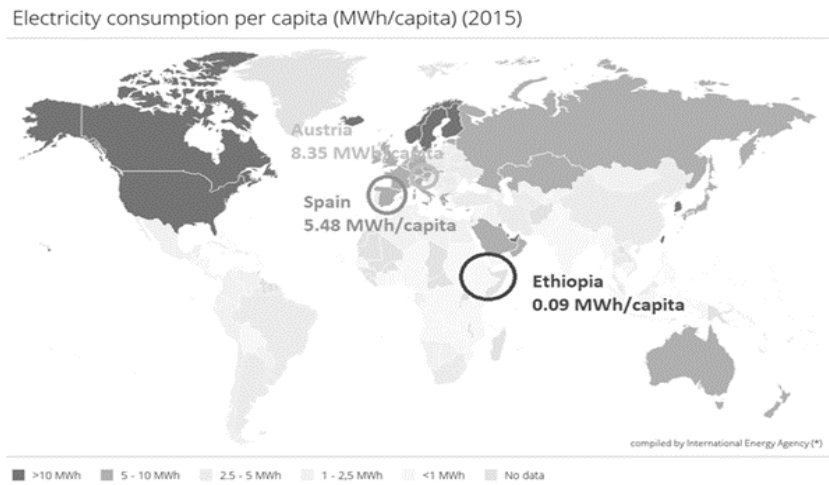


Figure 5. Electricity consumption per capita in MWh of Ethiopia, Spain and Austria in 2015 [15]

3.3 Carbon dioxide emissions in Ethiopia

In 2015, Ethiopia's carbon dioxide emissions were 10.2 Mt, a nearly insignificant share to the global emissions. China, the United States and India emit most with 9,000 Mt, 5,000 Mt and 2,100 Mt CO_2 in 2015, respectively.

The very low level of Ethiopian's CO_2 emissions, and thereby its small contribution to the anthropogenic climate change, becomes much more evident by focusing on the CO_2 emissions per capita (Figure 6). In 2016, on average an American emitted with 15.56 tons approximately twice than an Austrian or a Chinese, an Ethiopian emitted on average 0.1-ton CO_2. Therefore, in 2016 an American emitted on average 155 times more CO_2 than an Ethiopian, an Austrian still 85 times more and an average citizen of our world 48 times more.

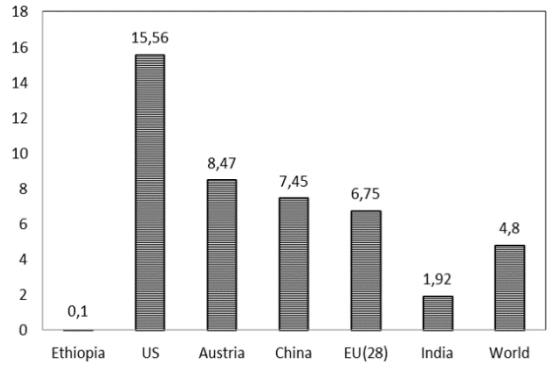


Figure 6. CO_2 emissions in tons/capita in Ethiopia, the US, Austria, China, the EU(28), India, and worldwide in 2016 [16]

4. METHODOLOGY

The current situation regarding informal housing in Ethiopia and specifically in Addis Ababa is evaluated on the one hand by a literature review and on the other hand by interviews with key personnel like government officials, energy planners and suppliers, NGO's and informal settlers. For the field research in-depth neighbourhood and household surveys, mapping and photos are the methods for documenting the living conditions, the source of energy etc. Expert interviews with governmental officials could be organised in the context of the first conference of the project SES in Addis Ababa in 2017, focus groups were held in 2017 and 2018 in Austria and in The Netherlands during the project meetings.

5. SYNERGIES AND TRADE-OFFS OF THE SUSTAINABLE DEVELOPMENT GOALS

Pradhan et al. [16] analysed the synergies and trade-offs of the SDG interactions on the database of 227 countries between the years 1983 and 2016. They ranked these synergies and trade-offs between SDG pairs emphasising the extend of the different interactions.

5.1 Interactions within an SDG

Figure 7 shows the synergies and trade-offs of the indicators within each SDG. For example, improving one indicator of SDG1 "No Poverty" positively influences most of the other indicators of the same SDG, e.g. investing in the indicator 1.4.1 "Proportion of population living in households with access to basic services" shows a positive correlation with indicator 1.2.1 "Proportion of population living below the national poverty line, by sex and age".

Some SDGs like SDG7 and SDG15 show more trade-offs than other SDGs, which means, that improvements in one indicator of the SDG is negative correlated with another indicator, e.g. increasing the "Proportion of population with access to electricity" (indicator 7.1.1) may have a negative impact on the indicator 7.2.1 "Renewable energy share in the total final energy consumption".

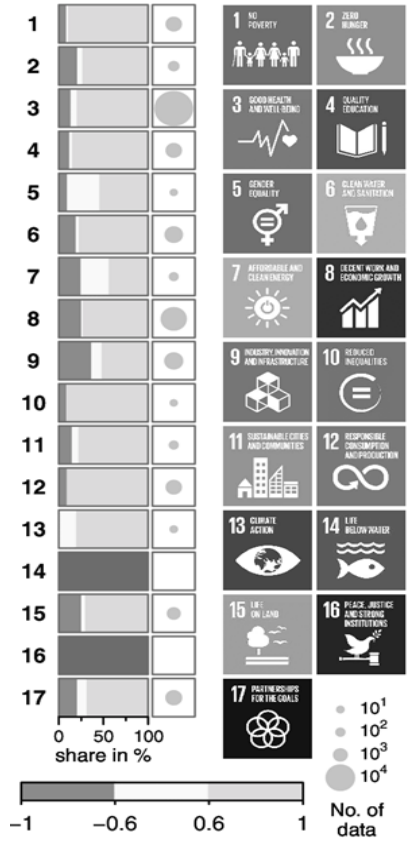


Figure 7. Synergies and trade-offs within each SDG, light grey means synergies, white nonclassifieds, grey trade-offs, and dark grey means insufficient data, see SDG14 and SDG16 [17]

5.2 Interactions between the SDGs

Furthermore, Pradhan et al. [16] analysed the synergies and trade-offs between the different SDGs. The results are e.g. that SDG1 "No Poverty" shows synergies among most other SDGs, compared to SDG12 "Responsible Consumption and Production" or SDG15 "Life on Land" showing different extents of trade-offs among the other SDGs (see Figure 8).

The analysis of Pradhan et al. [17] demonstrates the most synergies between SDG11 "Sustainable Cities and Communities" and SDG13 "Climate Change", followed by SDG1 "No Poverty" and SDG4 "Quality Education". Corresponding to these synergies, the project SES focuses on the implementation of topics like sustainability, energy management, or participatory planning in existing university courses for architects, planners and social scientists regarding urban informal settlements. Several researches were done on the important influence of education for a transformation to a more sustainable society, e.g. Mochizuki & Fadeeva [18], so

investing in university education regarding sustainable cities and communities have the ability to contribute to reducing poverty and improving environmental and social situation in cities.

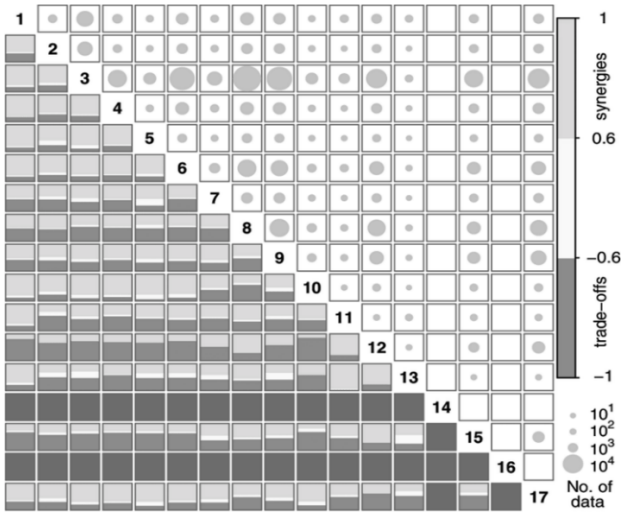


Figure 8. Synergies and trade-offs within the different SDGs, light grey means synergies, white nonclassifieds, grey trade-offs, and dark grey means insufficient data, see especially SDG14 and SDG16 [17]

6. THE INTERLINKAGE BETWEEN SPECIFIC SUSTAINABLE DEVELOPMENT GOALS IN ETHIOPIA

As the grand challenges like climate change, loss of biodiversity or extreme economic inequality cannot be solved by one discipline or solely by the scientific community, the project SES used interdisciplinary and transdisciplinary approaches. So on the academic level, several disciplines like urban planning, architecture or economics brought in their specific approaches, perspectives and expertise and worked on concepts and solutions together with politicians and practitioners e.g. like urban planners or social workers.

It is clear that the SDGs cannot be considered separated from each other. As Pradhan et al. [17] show, there are links between all 17 SDGs as one SDG may support several other SDGs, or, trade-offs between different SDGs are necessary, e.g. between SDG7 (which includes energy production by renewable sources) and SDG15 (a feasible additional biodiversity loss) (Figure 8).

6.1 Interactions between six SDGs

The six most relevant SDGs in relation to the project SES were identified by focus groups, interviews and workshops with different stakeholders like government officials, urban planners or informal settlers. The interactions between these six selected SDGs are demonstrated in the context of the project aims. The 2030 Agenda for Sustainable Development includes 17 SDGs, 169 targets, and 232 individual indicators to enable the evaluation of the progress of the SDGs. The following SDGs were identified:

- **SDG1 No Poverty** – End poverty in all its forms everywhere
- **SDG3 Good Health and Well-being** – Ensure healthy lives and promote well-being for all at all ages
- **SDG7 Affordable and Clean Energy** – Ensure access to affordable, reliable, sustainable and modern energy for all
- **SDG11 Sustainable Cities and Communities** – Make cities and human settlements inclusive, safe, resilient and sustainable
- **SDG13 Climate Action** – Make urgent action to combat climate change and its impacts
- **SDG15 Life on Land** – Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss

Indirectly, all actions and investments in one of the 17 SDGs influence in different extents the progress of the other respective 16 SDGs. Here the focus is still on direct impacts of one SDG on another, and on the selection of six SDGs with a strong interaction in the context of the topics of urbanisation, informal settlements and energy management.

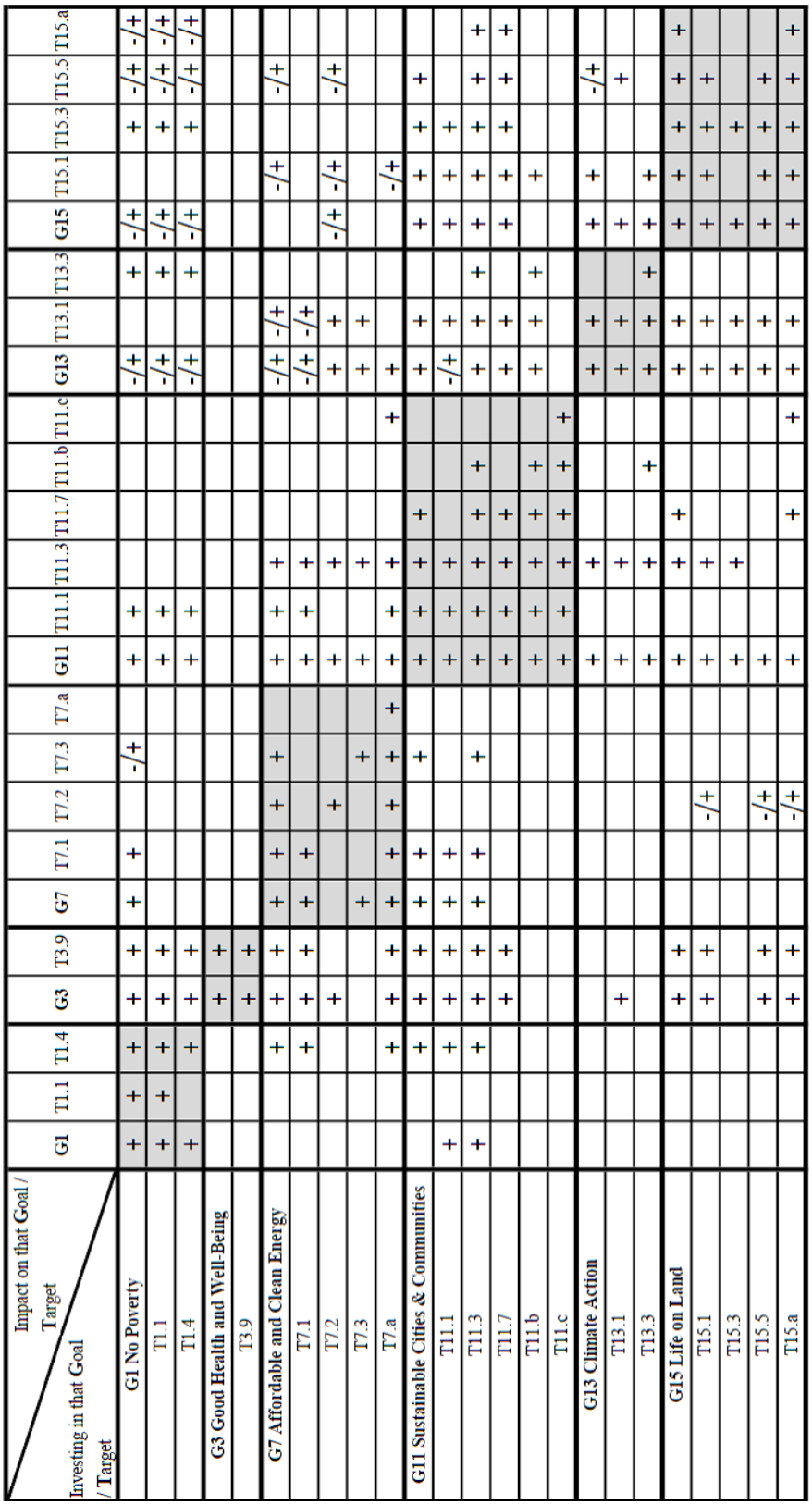
Of course, also further goals and targets are affected, like target 4.7 "…all learners acquire the knowledge and skills needed to promote sustainable development…". As a result of several interviews and focus groups with different experts in Ethiopia, the most relevant 18 targets were selected:

- **SDG1:** T1.1 Eradicate extreme poverty, T1.4 Equal rights to economic resources
- **SDG3:** T3.9 Reduce illnesses from air, water and soil pollution
- **SDG7:** T7.1 Universal access to energy services, T7.2 Increase share of renewable energy, T7.3 Improvement of energy efficiency, T7.a. International cooperation for clean energy research and technology
- **SDG11:** T11.1 Upgrade slums, T11.3 Enhance inclusive and sustainable urbanisation, T11.7 Green and public spaces, T11.b Implementing integrated policies and plans, T11.c Financial and technical assistance for least developed countries
- **SDG13:** T13.1 Strengthen resilience, T13.3 Improve education on climate change
- **SDG15:** T15.1 Ensure sustainable use of ecosystems, T15.3 Restore degraded forests, T15.5 Halt the loss of biodiversity, T15.a. Increase financial resources for biodiversity and ecosystems

An overview of the feasible interactions of the chosen six SDGs and 18 associated targets is given in Table 1. A positive impact is indicated by "+", "–/+" showing the possibility of a negative or positive impact. The latter requires specific attention, e.g. regarding renewable resources for additional energy supply and a feasible loss of biodiversity.

The overview demonstrates that most of the goals and targets are positively correlated, but concerning specific targets, e.g. T7.2 "Increase share of renewable energy", the impact may also be negative in respect to T15.3 "Restore degraded forests" or T15.5 "Halt the loss of biodiversity". Another example is, that T7.1 "Universal access to energy services" may mean a negative impact on the targets of SDG13, the climate, causing an increase of energy consumption on the basis of CO_2 intensive resources like oil. This shows clearly, that in fulfilling specific goals and targets, the impact on other targets, thus trade-offs have to be taken in consideration.

Table 1. Interactions between the SDGs 1, 3, 7, 11, 13, 15



Notes:

- T1.1 Eradicate extreme poverty T1.4 Equal rights to economic resources
- T3.9 Reduce illnesses from air, water and soil pollution
- T7.1 Universal access to energy services T7.2 Increase share of renewable energy T7.3 Improvement of energy efficiency T7.a International cooperation for clean energy research and technology
- T11.1 Upgrade slums T11.3 Enhance inclusive and sustainable urbanisation T11.7 Green and public spaces T11.b Implementing integrated policies and plans T11.c Financial and technical assistance for least developed countries
- T13.1 Strengthen resilience T13.3 Improve education on climate change
- T15.1 Ensure sustainable use of ecosystems T15.3 Restore degraded forests T15.5 Halt the loss of biodiversity T15.a Increase financial resources for biodiversity and ecosystems [11]

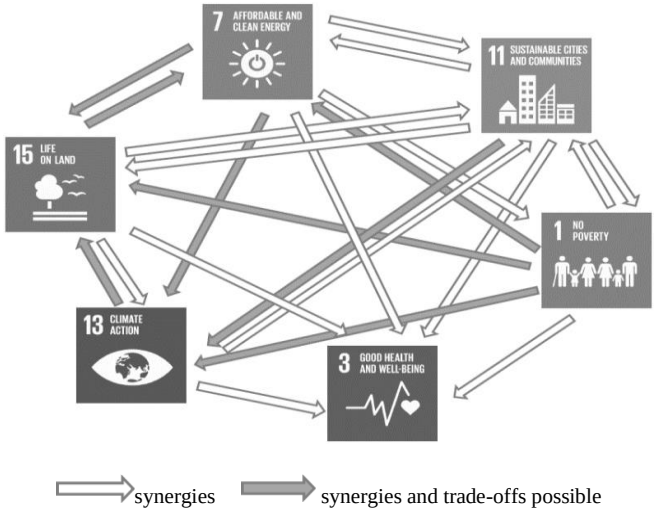


Figure 9. Overview of the interactions between the selected SDGs 1, 3, 7, 11, 13, 15

For a further analysis, also the indicators should be taken into account. Additionally, it has to be mentioned, that each interaction between the different SDGs, targets and indicators depends on the specific context being under consideration and can change according to that.

The interactions of the six selected SDGs in a nutshell as a summary of Table 1 are shown in Figure 9. For a better overview, only the SDGs, and not the targets, are considered. The white arrows indicate a positive impact or synergies from actions in one SDG to the progress in another SDG, the grey arrows mean, that positive as well as negative impacts, synergies and trade-offs, are feasible. By that, trade-offs are easily to be identified. In such cases, the analysis of the trade-offs in more detail can support the process to best decisions for a sustainable development.

6.2 Synergies and trade-offs in comparison

Additionally to the interactions between the different SDGs, also the feasible trade-offs within each SDG have to be taken into account. According to Pradhan et al. [17] and regarding the six chosen SDGs, most trade-offs may occur in SDG7 “Affordable and Clean Energy” and SDG15 “Life on Land”, and the most synergies in SDG1 “No Poverty” and SDG13 “Climate Action” (see Figure 7). In our case, the SES project in Ethiopia, the interactions within the selected targets of SDG1, SDG7, SDG13 as well as SDG15 are all evaluated as synergies. Thus, the experience in the SES project corresponds to the results of the analysis of Pradhan et al. [16] for SDG1 and SDG13, but not for SDG7 and SDG15. This confirms the assumption that the SDG interactions may depend more or less on the specific context, project or country. Regarding the interactions between the SDGs, in the SES projects the greatest trade-offs are related between SDG1 and SDG13, between SDG1 and SDG15, between SDG7 and SDG13, and between SDG7 and SDG15. This corresponds more or less with the trend analysed by Pradhan et al. [17] (see Figure 8).

7. CONCLUSIONS

Ethiopia shows a relatively low degree of urbanisation with 20% and thereby a corresponding high annual growth rate of urbanisation of 8%. Therefore, the country faces various challenges from an economical, ecological and social point of view. Looking at the energy situation, the case of Ethiopia shows that least developed countries face a challenging discrepancy concerning environmental protection, international agreements and sustainable development. Ethiopia, as a least developed country still has on the one hand a rather low rate of access to electrification, on the other hand the country has to reduce CO_2 emissions by international agreements. Because of the fact that Ethiopia will need high energy supply for the development of the country and for increasing quality of life, support by industrialized countries regarding funding and technology transfer, as an obligation of the Paris Agreement, is crucial.

The interactions between the SDGs should be an essential part of each strategic plan of national, regional and local governments, including the decision making about transfer systems in respect to taxes and subsidies, for promoting the 2030 Agenda for Sustainable Development for a single country and worldwide. The focus has to be on the synergies and trade-offs of each relevant SDG as well as between different SDGs. Although there is a general trend regarding these interactions, they may differ more or less according to the specific project or country and thus should be analysed and evaluated for each case separately for enabling the best and most efficient strategies to a sustainable development.

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