Identifying synergies and trade-offs for regional sustainability in Jämtland Härjedalen

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Abstract

Agenda 2030 unifies ecological, social, and economic sustainability, with the Sustainable Development Goals (SDGs) at its heart. The integrated nature of the SDGs leads to complex relationships that can be divided into synergies (progress in one goal favour progress in another) and trade-offs (progress in one goal hinders progress in another). These interlinkages are important to consider in policy planning and implementation of the SDGs to enhance progress across all the 17 goals. The Swedish government has declared the regional level as being especially important in the fulfilment of Agenda 2030 on a national level, as many of the basic welfare assignments lie within their responsibility. This paper uses the Swedish region Jämtland Härjedalen as an example of how knowledge of synergies and trade-offs can be used in the work with Agenda 2030 by identifying interactions between 15 targets relevant for the region. The assessment of interlinkages between targets are supported by a literature review aimed at finding relevant information based on the geographic context and the specific targets chosen. Synergies and trade-offs were identified using a seven-point typology for scoring. The results are presented in a cross-impact matrix that visualizes interaction between targets and identifies which targets have the most and the least positive influence on the network. The analysis shows that most of the interactions are synergistic which means that progress in one area often makes it easier to fulfil other targets simultaneously. The results also highlight a few important trade-offs, related to land-use and the use of natural resources, that are important to consider to avoid irreversible effects. Displaying interactions between targets alone does not offer any guidance on how to enhance synergies or manage trade-offs but it is an important first step to enhance progress across all SDGs. Knowledge of how different targets relate to each other can offer guidance for where specific attention is needed and where cross-sectorial collaboration is merited. Overall, it can lead to better informed decision-making.

Keywords: Sustainable Development Goals, Agenda 2030, SDG interactions framework, Policy priorities

1. **Introduction**

Achieving sustainability can be found as a policy goal in all levels of society; internationally as well as nationally, regionally, and locally. The Sustainable Development Goals (SDGs) are described by the UN as inseparable, meaning that none of the goals can be achieved at the expense of another and that success is required within all areas to achieve sustainable development (Sveriges Kommuner och Regioner [SKR], 2020). But while advocates describe it as an 'indivisible whole', studies aimed at examining the interlinkages of the SDGs, provides a more complex image with the occurrence of both synergies and trade-offs (Allen et al., 2018; ICSU, 2017; Lyytimäki et al., 2020; McCollum et al., 2018; Nilsson et al., 2016; Pradhan et al., 2017; Weitz et al., 2018). Generally speaking, synergies arise when progress in one goal favours progress in another while trade-offs are signified by progress in one goal that hinders progress in another (Pradhan et al., 2017). The inability to overcome persistent trade-offs have been found to seriously threaten the achievement of the Agenda 2030 (Kroll et al., 2019), but there are several attempts of using the knowledge on synergies and trade-offs as a means for policy support to enhance progress across all 17 SDGs (Allen et al., 2018; Weitz et al., 2018). Disentangling interactions amongst the SDGs can support effective and coherent implementation of policies across sectors (Weitz et al., 2018).

Sweden's decentralized model of society means that many of the basic welfare assignments lies on regions and municipalities which means that a great deal of the responsibility for achieving Agenda 2030 falls on them (Swedish Government, 2019c). There are some studies investigating the topic in a Swedish context, such as Engström et al. (2019) that looks at interactions between water-and-land related SDGs (goal 2, 6, 7, 11, 13, 15) and Weitz et al. (2018) that examines interactions between 34 targets relevant for Sweden. Exactly how targets interact with each other will be different in different contexts (Nilsson et al., 2016) which implies the need for an investigation from a regional perspective.

There are examples of how regions and municipalities have taken on the work with the Agenda (SKR, 2019) but information regarding what conflicts might exist within the Agenda and how this affects regional actors is limited. There is a risk that the challenge of fulfilling the Agenda is simplified and that local actors fail to consider trade-offs, which might lead to the fulfilment of some goals at the expense of others, threatening the achievement of the Agenda on a global level (Sternad-Fackel, 2018). This study address this research gap by investigating interlinkages of Agenda 2030 in a case study from the region Jämtland Härjedalen, located in the middle of Sweden.

The purpose of the study is to identify interactions between relevant SDG-targets and to contribute with an understanding of how knowledge of synergies and trade-offs within Agenda 2030 can be used to assess and prioritise targets in the work with sustainable development on a regional level. The objectives are:

- To assess where synergies and trade-offs can be found between the selected SDG-targets.
- To identify which targets require specific attention from a policy perspective based on identified synergies and trade-offs.

2. Background

The work with Agenda 2030 has had a breakthrough in Swedish municipalities and regions. A report conducted by the State Office (Statskontoret, 2019) showed that 70 percent of municipalities and almost all regions are using the agenda as a tool in their work with sustainable development. Despite this, their investigation shows that the work with Agenda 2030 so far has had little effect on the overall work with sustainability. The actor's way of working and their priorities has not shifted in any significant way within most of the regions or municipalities. Further on they describe how the implementation of Agenda 2030 in steering and action has proven difficult for regions and municipalities. Insecurities in how the work should be performed in order to fulfil the national commitment of the agenda has resulted in requests for further support on how to work with the goals. The Swedish Government might need to clarify the connection between the SDGs and other national goals (such as the environmental objectives) and offer guidance on how authorities should prioritize between goals (Statskontoret, 2019). The joint organisation for Sweden's municipalities and regions (SKR, 2020), emphasizes the importance of integrating Agenda 2030 and the goals into the steering-and-management of municipalities and regions to achieve the goals on a national level.

Being responsible for regional development and growth (Kullander, 2020) Region Jämtland Härejdalen is obliged to develop a Regional Development Strategy (RDS) according to Swedish law (Swedish Parliament, 2017). This is an important steering tool that is the foundation for other regional strategies and programmes and sustainability should be an integral part of this (ibid.). In the process of revising their old RDS, Region Jämtland Härjedalen commissioned Oxford Research AB to perform an analysis of the old RDS to clarify how it was connected to the SDGs (Oxford Research, 2019). They assessed that a majority of the goals found in the RDS had bearing against the SDGs. Goals concerning education, work and economic growth, sustainable industry, infrastructure, and sustainable cities along with health and wellbeing was the focus of the RDS. They also concluded that goals concerning equality and environment- and climate needed to be more directly implemented. Goals concerning equality were completely missing from the strategy.

Table 1. The 15 targets chosen for Region Jämtland Härjedalen with official descriptions.

Target	Short description	Official description
1.2	Poverty	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
2.4	Food production/ agriculture	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
3.4	Non-communicable diseases	By 2030, reduce by one third premature mortality from non-communicable diseases through prevention and treatment and promote mental health and well-being
4.4	Technical/vocational skills	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
5.5	Women's participation	Ensure women's full and effective participation and equal opportunities for leadership at all levels of decision-making in political, economic and public life
6.6	Water-related ecosystems	6.6 By 2020, protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes
7.2	Renewable energy	By 2030, increase substantially the share of renewable energy in the global energy mix
8.9	Sustainable tourism	By 2030, devise and implement policies to promote sustainable tourism that creates jobs and promotes local culture and products
9.1	Infrastructure	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
10.1	Economic equality	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
11.2	Transport	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
12.5	Waste	By 2030, substantially reduce waste generation through prevention, reduction, recycling and reuse
13.2	Climate change/ policy planning	Integrate climate change measures into national policies, strategies and planning
15.2	Biodiversity	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
16.7	Decision-making	16.7 Ensure responsive, inclusive, participatory and representative decision-making at all levels

3. Methods

The interactions between the SDG-targets were assessed in a cross-impact matrix based on two systematically selected literature sources per target. In addition, a screening for relevant policy documents in Region Jämtland Härjedalen with regards to the chosen targets was performed. 15 SDG-targets based on Weitz et al. (2018) and RKA (2020) were included in the analysis, resulting in a total of 210 interactions to be analysed, see Table 1. Based on the SDG interactions framework developed by Nilsson et al. (2016, 2018), with an adaption by Boman (2018) used in this study, the targets were organised into a cross-impact matrix of 15x14 interactions with the SDG-targets as headings along all rows and columns. The framework characterizes relationships with a seven point scale. Horizontally the question is: If progress is made on target x (rows), how does this influence progress on target y (columns)? The seven possible types of scores ranges between (+3) and (-3), where positive scores represent synergies, while negative scores represent trade-offs, see Table 2.
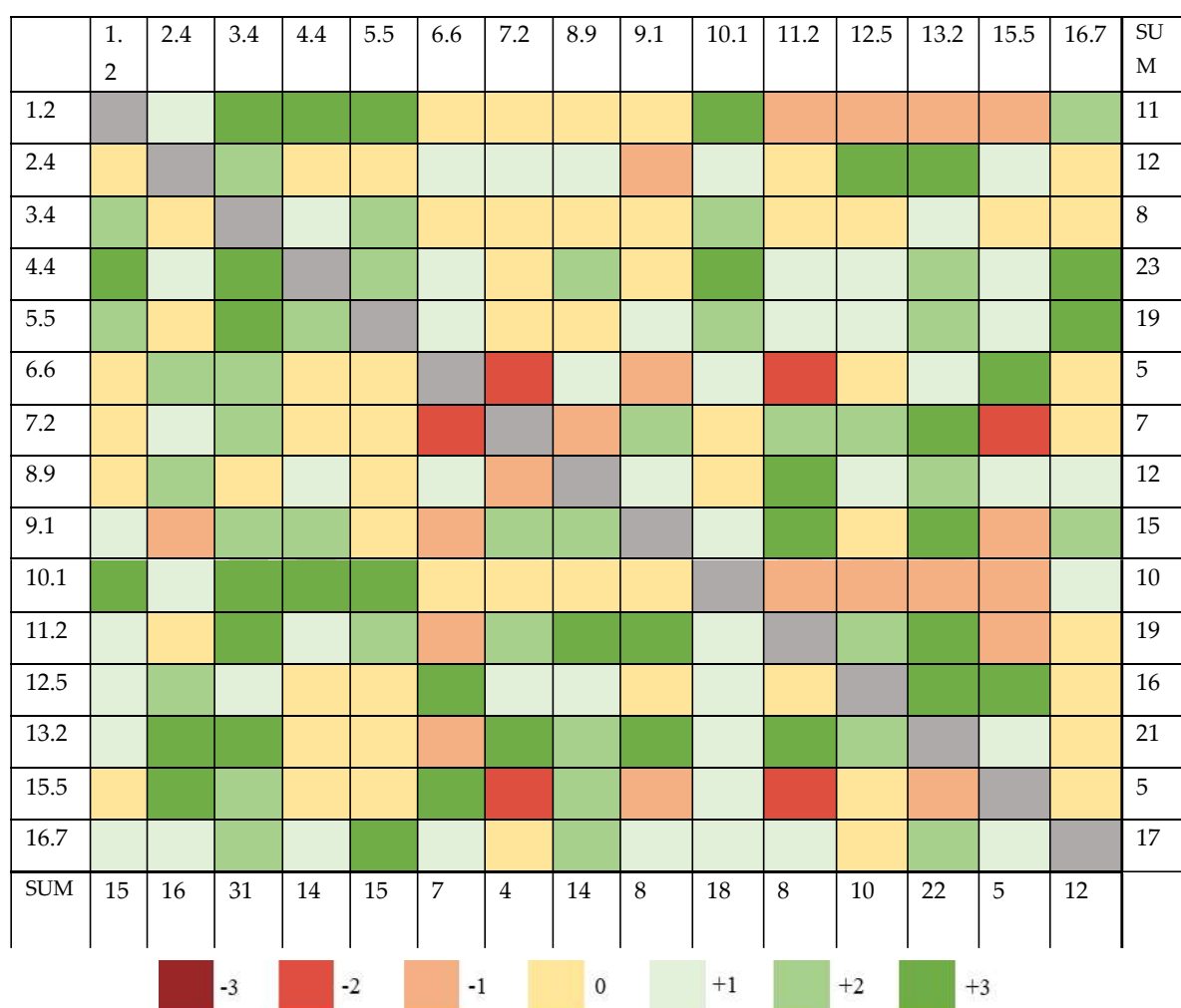
Table 2. *Criteria for scoring. Adapted from Nilsson et al. (2016) and Boman (2018).*

Score	Meaning
+3	Progress on one target creates very good conditions for achieving progress on another target. The literature describes a positive connection between progress of the analysed target and target X and explains the connection
+2	Progress on one target leads to a synergy between that and another target. The literature describes a positive connection between progress of the analysed target and target X and explains the connection.
+1	Progress on one target leads to a possible synergy between that and another target. The literature is limited or contradictory
+/- 0	There is no significant link between two targets' progress found in the literature
-1	Progress on one target leads to a possible trade-off between that and another target but the literature is limited or contradictory
-2	Progress on one target leads to a trade-off between that and another target. The literature describes a negative connection between progress of the analysed target and target X and explains the connection.
-3	Progress on one target makes it very difficult to achieve progress on another target. The literature describes a negative connection between progress of the analysed target and target X and explains the connection

4. Results

The cross-impact matrix is the result of the analysis of 210 interactions and shows the influence that targets exert on each other, see Fig. 1. The analysis will give further examples on what information can be drawn from the cross-impact matrix and how this can be used for policy-making. Mainly positive or neutral connections have been identified, which means that targets in general exert more positive than negative influence on each other. This also means that progress in one area often makes it easier to fulfil other targets simultaneously. Only eight percent of the connections are red, but they mark important exceptions as this indicates conflicts of aims. The matrix can be examined from different perspectives, where the numerical row-sum indicates the net influence of a target on other targets. A target with a

high row-sum can be seen as a synergetic one as this implies that successful implementation of a target makes the realization of other targets easier. A negative or low row-sum suggests that implementation of a target generally makes it more difficult to achieve other targets. The column-sum shows us how a target is influenced by the progress of other targets. Here, a high number suggests a predominant positive influence by other targets, while a negative or low column-sum implies that successful implementation of other targets makes it more difficult to reach the target. However, the numerical sums (row and column) in isolation does not show if the net influence is due to a large number of weak or contradictory influences on several targets or a few strong ones, nor does it show the distribution between positive and negative connections.

	1.2	2.4	3.4	4.4	5.5	6.6	7.2	8.9	9.1	10.1	11.2	12.5	13.2	15.5	16.7	SUM
1.2																11
2.4																12
3.4																8
4.4																23
5.5																19
6.6																5
7.2																7
8.9																12
9.1																15
10.1																10
11.2																19
12.5																16
13.2																21
15.5																5
16.7																17
SUM	15	16	31	14	15	7	4	14	8	18	8	10	22	5	12	

Legend: -3 | -2 | -1 | 0 | +1 | +2 | +3

Figure 1. Cross-impact matrix of 15 targets and their interaction. Colour according to scale where dark red is -3/very difficult and dark green is +3/very good conditions. The row sum represents the net influence form a target on all other targets and the column sum represents how the target is influenced.

4.1 Summary of row-and column sums

Several targets only exert positive influence, such as 4.4 *(Technical/vocational skills)*, 5.5 (*Women's participation*), 16.7 (*Decision-making*), 12.5 (*Waste*) and 3.4 (*Non-communicable diseases*). Some of these targets also have the highest row-sum. In the top we find target 4.4 (sum 23) followed by target 13.2 (*Climate change policy/planning*) (sum 21) and thereafter target 5.5 and 11.2 (*Transport)* (sum 19). Both target 13.2 and 11.2 exerts negative influence on other targets despite the high row-sum.

The other end of the spectrum shows targets with the least amount of positive net influence of other targets. The lowest row-sum is held by target 6.6 (*Water-related ecosystems)* and 15.5 (*Biodiversity)*, which both have a sum of five. Following that is target 7.2 (*Renewable energy*) (sum 7) and 3.4 (*Non-communicable diseases*) (sum 8). There are however important differences behind these results. Target 15.5 exerts a negative influence of -6, leading it to be the target with the least positive influence on other targets. Target 6.6 and 7.2 both have a negative influence of -5, while target 3.4 has no negative influence but is given a low number due to its many neutral connections.

Looking at the column sums, which indicates how a specific target is influenced by other targets, we find target 3.4 (*Non-communicable diseases*) (sum 31), 13.2 (*Climate change policy/planning*) (sum 22), and 10.1 (*Economic equality)* (sum 18) in the top. Out of these, only target 13.2 are negatively influenced by other targets (-3 in total). On the bottom end we find target 7.2 (*Renewable energy*) (sum 4), followed by target 15.5 (*Biodiversity)* (sum 5) and target 6.6 (*Water-related ecosystems*) (sum 7). However, looking specifically at the negative influence from other targets, it shows that both target 15.5 and 11.2 (*Transport*) receive the same amount of negative influence from other targets (-6), followed by target 6.6 and 7.2 that both receive a negative influence of -5.

4.2 Policy implications

The analysis performed by Oxford Research on the old version of the RDS can be used to demonstrate the implications of using the SDG-interaction framework for policy implications. Target 10.1 on economic equality is not found in the former RDS. Taking a closer look at the analysis of how this target is connected to the network, we find that targets that they are already prioritizing such as health, education, infrastructure and sustainable transport will have a positive influence. This indicates that progress will be made in this target even if it is not a priority, but it also suggests that the potential negative influence might take place as well whether measures are aimed at making progress in target 10.1 or not. It also shows the potential of positive reinforcement that target 10.1 can have on other areas of the SDGs which might be lost if measures aimed specifically at this target are not pursued.

An analysis of this kind can also provide useful information when it comes to policies in terms of which departments would benefit from deeper cooperation. Figure 2a shows which other targets affect the ability to make progress on target 10.1 and whom they need to foster good collaboration with. Figure

2b shows how target 10.1 affect other targets and where it might meet resistance or where the need for negotiation might be greater.
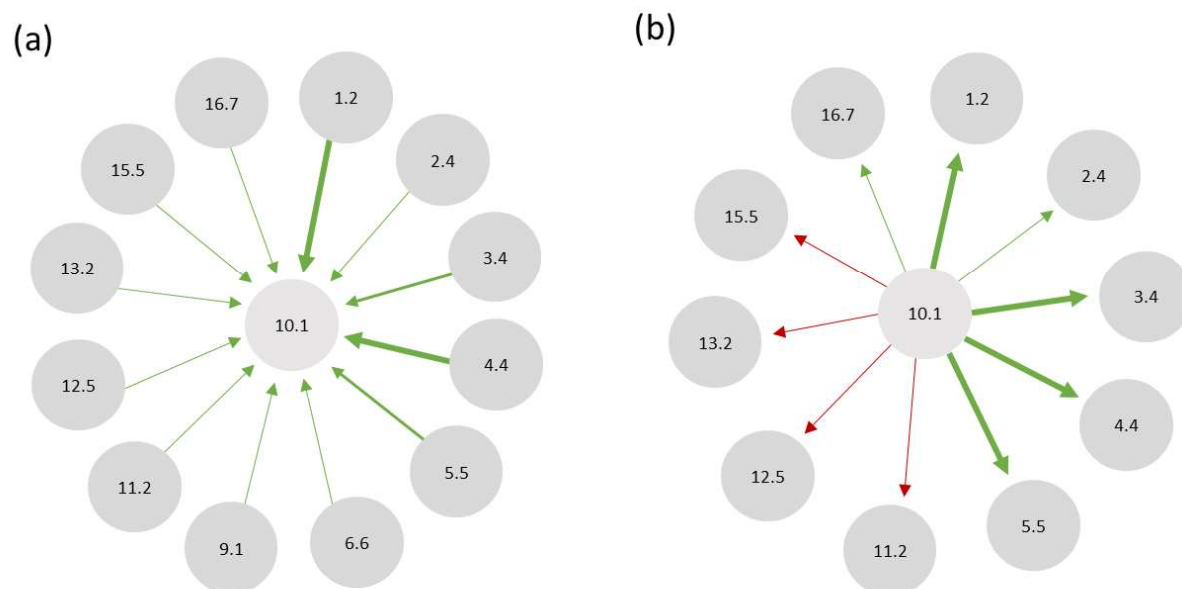
Figure 1. a) Network of interactions based on target 10.1: influence from other targets. The thickness of arrows represents the level of influence (-3 to +3). Negative influence in red, positive in green. b) Network of interactions based on target 10.1: influence on other targets. The thickness of arrows represents the level of influence (-3 to +3). Negative influence in red, positive in green.

5. Discussion

5.1 Method discussion

Using the SDG interaction framework as a method to analyse synergies and trade-offs between the SDGs entail both stronger and weaker aspects. The framework has since it was created been used in a number of studies and is therefore a proven concept (Allen et al., 2018; ICSU, 2017; Lyytimäki et al., 2020; McCollum et al., 2018; Nilsson et al., 2016; Weitz et al., 2018). However, the scoring process in previous studies has been based on the judgement of different expert groups. As this was not possible within this thesis due to practical limitations and time restrictions, the adaptation to the original typology was seen as necessary. The ambiguity of the goals resulted in sometimes contradictory statements in the literature which made it difficult to assess the connections according to the original seven-point scale. The degree of insecurity is therefore a part of the evaluation in this study. Because of this the method gives an indication both of the strength of interaction but also of how certain the scoring is. This has different consequences for the result. It can be argued that the results are not as clearly conveyed as in the previous mentioned studies or that the results are not as reliable. It can however be

noted that the results are in line with previous findings from Sweden (Weitz et al. 2018) which implies that the change did not have serious implications. That the results are not as clearly conveyed cannot be overlooked but presenting the insecurities this way gives a fair picture of reality since many of the goals are complex. It is important to be able to view the targets and their interactions from different perspectives when working with them. The choice of not using a judgement-based scoring was primarily due to limited options. This has however had some positive effects on the methodology, as one potential weakness with the judgement-based exercise is that the identification of connections is highly dependent on the assumptions made by the evaluator (Lyytimäki et al. 2020). This was partly avoided by using a literature base for the scoring which can be seen as a strength in the study.

5.2 Discussion of results

The findings are in line with earlier studies performed in the same contextual area, which suggests that most of the relationships within the SDGs are synergistic ones (Lyytimäki et al., 2020; Weitz et al., 2018). This means that activities aimed at reaching one goal or target generally improves opportunities to reach other goals or targets as well. None of the interactions were seen to make it very difficult to make progress in another target. The analysis shows that progress in targets 4.4 (*Technical/vocational skills*), 13.2 (*Climate change policy/planning*), 5.5 (*Women's participation*) and 11.2 (*Transportation)* generates the most positive influence on other targets which suggests that efforts to make progress here should be prioritized as it will have positive ripple effects that drive progress on the 15 SDGs overall. These can be good starting points to achieve maximum synergistic effects.

Targets with the least positive influence on other targets are target 15.5 (*Biodiversity*) and target 6.6 (*Water-related ecosystems*), followed by 7.2 (*Renewable energy*). This means that making progress in these targets will make it more difficult to achieve other targets and therefore special attention needs to be directed here to mitigate the problem. This result highlights the ongoing debate about how we should use the forest which is related to its differing benefits for climate (Bergström et al., 2020).

Targets 3.4 (*Non-communicable diseases*), 13.2 (*Climate change policy/planning*) and 10.1 (*Economic equality*), receive the most positive influence from progress in other targets. At first hand it might look like these targets would not need as much targeted support or that they might not need to be made priorities in strategies such as the RDS. However, Weitz et al. (2018) points out that progress in other goals should not be assumed. If anything, this result indicates a high dependency on other targets which may make these targets progress more uncertain as they are highly influenced on what happens in other areas. It indicates that close collaboration is needed with the actors that holds the key to their development. It should however be noted that several of the scores on target 10.1 are +1 scores and that additional information is needed to confirm the total score. Target 15.5 (*Biodiversity*) receives the most negative influence by other targets followed by target 6.6 (*Water-related ecosystems*) and 7.2. (*Renewable energy*). This means that progress in other areas will make it harder to achieve these goals.

For the people in charge of these goals it could be of special interest to collaborate with actors that have the potential of making progress in their areas more difficult.

Both low and high row- and column sums suggest that special attention should be directed to the implementation of the target in question (Lyytimäki et al., 2020). It is, however, important to note that synergies or trade-offs between targets may exist despite of the total sum being high or low. It is therefore important to use figure 3 as a starting point for further analysis and discussions on policy implications. Looking in detail at the connections in figure 4 and 5 can be a useful way to move further and to highlight where cooperation is most needed. Although only eight percent of the interactions indicate trade-offs, they call for careful consideration. Especially since some of these trade-off's risk leading to irreversible problems. Both target 13.2 and target 11.2 are a good examples of this, where the net influence is positive but without careful consideration the use of more biofuels could have a negative effect on restoration and protection of forests as well as biodiversity connected to forest.

Many of the identified connections are paired with an uncertainty (scores -1 and +1) that stems from limited or contradicting information from the literature. One example is the effect of protection of biodiversity (15.5) on climate measures (13.2). There are several synergetic effects, such as how protection of natural environments can help increase carbon storage and mitigate climate change. On the other hand, this can interfere with climate measures aimed at replacing fossil energy with bioenergy. These types of uncertainties are not just a result of a lack of literature, rather it is connected to the complexity of many of the targets and shows how important it is to have a systems perspective when implementing measures. The risk is otherwise that certain efforts will backfire in another part of the system that is unexpected. Some targets are paired with more insecurities than others. Target 16.7 stands out as having the most uncertain scoring (nine connections are marked +1). This is related to limited information on the connections rather than any contradictions. Higher participation seems to have an overall positive effect on other targets, but more information is needed on the matter before any definite conclusions can be drawn.

One of the main principles of Agenda 2030 is that of indivisibility, meaning that none of the goals can be achieved at the expense of another (Statskontoret, 2019). As mentioned earlier, the Agenda has undergone critique for entailing inconsistencies, particularly between the socio-economic development and the environmental sustainability goals (ICSU and ISSC, 2015). The fact that trade-offs exist within the SDGs is established and this study is yet another proof of that. The result and analysis show that there is a risk of losing the principle of indivisibility if careful consideration is not given to the impact on other goals. This leads to dilemmas when it comes to simultaneously fulfilling all targets.

5.3 Measures to reduce trade-offs and enhance synergies

The seven-point typology is useful for detecting potential synergies and trade-off's, but it does not offer any guidance on how to deal with these findings. This must be dealt with on a case-to-case basis. Looking elsewhere there are different views on how trade-offs can be mitigated. Ekener et al. (2019b) describes how the negative connections in many cases can be avoided if there is a sustainability-creating policy framework in place that can reduce the risks of progress in one area of society taking place at the expense of progress in another. One example from this investigation is how development of tourism is seen as a way to increase the possibilities of local food production (target 2.4), although this can only be seen as a synergy if increased agriculture is performed in a sustainable matter. What measures are put in place is important for the overall turnout.

Bergström et al. (2020) instead finds it unrealistic to expect full goal fulfilment for different competing goals. They conclude that synergetic effects are not something that will come automatically, it needs to be planned. Going back to the discussion about forests, climate adaptation can lead to both synergies and trade-offs between goals. There are however suggestions on how to overcome this particular conflict. A report published by a number of authorities representing different sectors shows great potential to extract sustainable bioenergy that does not have negative effects on the forests carbon storage and that can even lead to positive effects on biodiversity. The key is using clear instructions, appropriate incentives and special consideration when felling (Black-Samuelsson et al., 2017). This shows that the correct use of technique in combination with planning can avoid trade-offs and enhance synergies.

Investing in interdisciplinary research, strengthening knowledge and competence regarding Agenda 2030 and its connections and providing support to all actors on all levels of society to absorb this information is another key part in reaching the goals (Ekener et al., 2019a). Another important factor to avoid trade-offs and enhance synergies is cooperation. In the final report from the Swedish Agenda 2030-delegation (Swedish Government, 2019a), they present suggestions for the continued implementation of Agenda 2030. The need for cooperation between different sectors and authorities as well as between different levels (local, regional, national) is emphasized as keys for being able to achieve the targets. The need for leadership that acts long-term is also highlighted.

Regardless of one's belief concerning the possibilities to reach full goal fulfilment there is agreement on the importance that awareness is needed of how different goals relate to each other to be able to manage conflicts and to enhance synergies (Bergström et al., 2020; Ekener et al., 2019b).

5.4 Implications for Region Jämtland Härjedalen

Oxford Research (2019) concluded that goals concerning equality and the environment needed to be more directly implemented in the new RDS. Apart from the added value of making these goals a priority it can also be wise from a policy perspective since target 5.5 on women's participation and target 13.2 on climate policy is found as highly synergetic. Among the environmental targets (6.6 and 15.5) there are some important trade-offs to handle, and these might be given more attention if the goals are prioritised in the new RDS.

When it comes to using the seven-point typology specifically to work with Agenda 2030, there are both positive and negative aspects. The target level-analysis is beneficial because it is more precise, but with the SDG framework being so extensive it could lead to obstacles on where to start and which ones to focus on. The goal of the framework could be to provide decision makers with an understanding of where there are arguments for focusing specific attention on implementing certain goals or targets and where there are risks of significant harmful effects that need to be taken into account. The negative aspects can be summarized with time and money. The framework is time consuming and to achieve the best effect officials from different departments would have to be involved which would also result in high costs. The time spent could however result in great possibilities. Using the framework would give a better overview of the regions work with sustainability and could increase cooperation between different sectors, which in itself is seen as an important factor for achieving the goals. It would also increase the chances of using the possible synergies and be a way of acknowledging trade-offs which is a first step towards dealing with them. Overall, it is likely to lead to better informed decision-making.

This report has focused on what a potential progress across the investigated SDGs would lead to and less on what would happen if progress is not achieved. This scenario could bring even bigger conflicts and lead to increased costs for society as a whole. One example of this is lack of education which can cause a downward spiral leading to unemployment (Kvist, 2020), premature death (SKL, 2013) and poverty (Mood & Jonsson, 2019). The consequences of climate change risk far-reaching negative consequences for ecosystems around the world, as well as for human societies and livelihoods (IPCC, 2014). The risks for serious and irreversible effects are expected to increase the longer we wait to take action, and so are the costs for society (ibid.). Another example relates to inequality, where it has been shown that economic inequality tends to lead to increased social tension and anxiety, increased criminality as well as growing intolerance and extremism (Swedish Government, 2019b). This needs to be taken into account when working with the SDGs and is a reminder to not let potential conflicts slow down the work towards the goals, all while the risk of conflicting aims cannot be overlooked.

6. Conclusions

The interactions found reveal mostly synergetic effects between the SDG targets, only eight percent of the connections are associated with trade-offs. Several targets only exert positive and neutral influence on others (target 3.4, 4.4, 5.5, 12.5, 16.7). Out of these, target 4.4 (*Technical/vocational skills)* and 5.5 (*Women's participation*) stands out as having the most positive influence on other targets, which implies that efforts to make progress here will maximise synergistic effects. In this category we also find target 13.2 (*Climate change policy/planning*) and 11.2 (*Transportation)*, although they have some negative influence that needs to be considered. Target 13.2 also stands out as being highly dependent on other targets which means that close collaboration with actors in charge of the targets that holds the key for its progress should be developed. The positive ripple effects that come with progress in these targets can however provide guidance on where to focus specific attention. Target 15.5 (*Biodiversity)* has the least positive influence on other targets followed by target 6.6 (*Water-related ecosystems*), and target 7.2 (*Renewable energy)*. Progress in these targets is associated with difficulties to make progress in other areas and the risk for harmful effects calls for careful consideration from a policy perspective. Having knowledge on potential trade-offs does not make the obstacles of solving them any easier and there is no blueprint on how to achieve full goal fulfilment in all areas of the SDGs. It can however be concluded that awareness of how different targets relate to each other is an important first step to be able to manage conflicts and to enhance synergies and can lead to better informed decision-making.

References

Allen, C., Metternicht, G., & Wiedmann, T. (2018). Prioritising SDG targets: assessing baselines, gaps and interlinkages. *Sustainability Science*, *14* (2), 421–438.

Bergström, L., Borgström, P., Smith, H. G., Bergek, S., Caplat, P., Casini, M., Ekroos, J., Gårdmark, A., Halling, C., Huss, M., Jönsson, A. M., Limburg, K., Miller, P., Nilsson, L., & Sandin, L. (2020). *Klimatförändringar och biologisk mångfald – Slutsatser från IPCC och IPBES i ett svenskt perspektiv [Climate change and biodiversity – Conclusions from IPCC and IPBES in a Swedish perspective]*. Klimatologi Nr 56. SMHI and Naturvårdsverket, Norrköping and Stockholm, Sweden.

Black-Samuelsson, S., Eriksson, H., Henning, D., Janse, G., Kaneryd, L., Lundborg, A., & Niemi Hjulfors, L. (2017). *Bioenergi på rätt sätt: Om hållbar bioenergi i Sverige och andra länder [Bioenergy in the right way: About sustainable bioenergy in Sweden and other countries]*. Report 2017/10 in collaboration with Energimyndigheten, Jordbruksverket and Naturvårdsverket. Skogsstyrelsen, Jönköping, Sweden.

Boman, I. (2018). *Synergier och målkonflikter mellan klimatmålet om noll nettoutsläpp av växthusgaser år 2045 och Sveriges Nationella Miljömål [Synergies and trade-offs between the climate goal of zero net-emissions of GHG emissions year 2045 and the Swedish national environmental objectives]*. [Master thesis], Department of physical geography, Stockholm University, Stockholm.

Ekener, E., Katzeff, C., Gunnarsson-Östling, U., & Skånberg, K. (2019a). *Ömsesidiga beroenden mellan olika hållbarhetsperspektiv: Möjligheter att genom kunskaper om synergier och trade-offs mellan olika globala hållbarhetsmål förbättra förutsättningarna att nå Agenda 2030 i sin helhet [Mutual dependencies between different sustainability perspectives: Opportunities to improve the conditions for achieving Agenda 2030 in its entirety through knowledge of synergies and trade-offs between different global sustainability goals]*. Report 6903. Naturvårdsverket, Stockholm.

Ekener, E., Katzeff, C., Gunnarsson-Östling, U., & Skånberg, K. (2019b). *Så hänger jämställdhet och jämlikhet ihop med miljömålen: En analys av ömsesidiga beroenden mellan olika hållbarhetsmål [How gender equality and equality are linked to environmental goals: An analysis of interdependencies between different sustainability goals]*. Report 6856. Naturvårdsverket, Stockholm.

Engström, R., Destouni, G., Howells, M., Ramaswamy, V., Rogner, H., & Bazilian, M. (2019). Cross-Scale Water and Land Impacts of Local Climate and Energy Policy—A Local Swedish Analysis of Selected SDG Interactions. *Sustainability*, 11 (7), 1847.

ICSU. (2017). *A Guide To SDG Interactions: From Science to implementation*. International Council for Science, Paris.

ICSU and ISSC. (2015). *Review of Targets for The Sustainable Development goals: The Science Perspective*. International Council for Science & International Social Science Council, Paris.

IPCC. (2014). *Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. IPCC, Geneva.

Kroll, C., Warchold, A., & Pradhan, P. (2019). Sustainable Development Goals (SDGs): Are we successful in turning trade-offs into synergies? *Palgrave Communications*, 5 (1), 1–11.

Kullander, B. (2020). *Regionernas åtaganden [Committments of the regions]*. Sveriges Kommuner Och Regioner. https://skr.se/tjanster/kommunerochregioner/faktakommunerochregioner/regionernasataganden.27748.html (Accessed 2021-01-31).

Kvist, M. (2020). *Varken resurs eller problem, om lågutbildade ungas etablerings-och försörjnings-möjligheter [Neither a resource nor a problem, about the establishment and support opportunities of low-educated young people]*. [Doctoral dissertation], Malmö University, Malmö, Sweden.

Lyytimäki, J., Lonkila, K. M., Furman, E., Korhonen-Kurki, K., & Lähteenoja, S. (2020). Untangling the interactions of sustainability targets: synergies and trade-offs in the Northern European context. *Environment, Development and Sustainability*, 23 (3), 3458–3473.

McCollum, D. L., Gomez Echeverri, L., Busch, S., Pachauri, S., Parkinson, S., Rogelj, J., Krey, V., Minx, J. C., Nilsson, M., Stevance, A.-S., & Riahi, K. (2018). Connecting the sustainable

development goals by their energy inter-linkages. *Environmental Research Letters*, 13 (3), 033006.

Mood, C., & Jonsson, J. . (2019). Välfärden - den nya fattigdomen [Welfare - the new poverty]. In J. Björkman & P. Hadenius (Eds.), *Det nya Sverige - Riksbankens Jubileumsfonds årsbok 2019* (pp. 9–50). Makadam förlag, Göteborg, Sweden.

Nilsson, M., Chisholm, E., Griggs, D., Howden-Chapman, P., McCollum, D., Messerli, P., Neumann, B., Stevance, A.-S., Visbeck, M., & Stafford-Smith, M. (2018). Mapping interactions between the sustainable development goals: lessons learned and ways forward. *Sustainability Science*, 13 (6), 1489–1503.

Nilsson, M., Griggs, D., Visbeck, M., & Ringler, C. (2016). *A draft framework for understanding SDG interactions*. International Council for Science, Paris.

Oxford Research. (2019). *Processtöd för att implementera hållbarhets-aspekter och Agenda 2030 i strategiarbetet [Process support for implementing sustainability aspects and Agenda 2030 in the strategy work]*. Oxford Research, Stockholm.

Pradhan, P., Costa, L., Rybski, D., Lucht, W., & Kropp, J. P. (2017). A Systematic Study of Sustainable Development Goal (SDG) Interactions. *Earth's Future*, 5 (11), 1169–1179.

RKA. (2020). *Agenda 2030- Nyckeltal för kommuner och regioner [Agenda 2030- Key figures for municipalities and regions]*. Rådet för främjande av kommunala analyser, Stockholm.

SKL. (2013). *Gör jämlikt-gör skillnad! Samling för social hållbarhet minskar skillnader i hälsa [Go equal - make a difference! Collection for social sustainability reduces differences in health]*. Sveriges Kommuner och Landsting, Stockholm.

SKR. (2019). *Regionala initiativ inom Agenda 2030 i Sverige [Regional initiatives within Agenda 2030 in Sweden]*. Sveriges Kommuner och Regioner, Stockholm.

SKR. (2020). *Öppna Jämförelser - Agenda 2030 [Open Comparisons - Agenda 2030]*. Sveriges Kommuner och Regioner, Stockholm.

Swedish Government. (2019a). *Agenda 2030 och Sverige: Världens utmaning – världens möjlighet [Agenda 2030 and Sweden: The world's challenge - the world's opportunity]*. SOU 2019:13. [Swedish Government Official Reports, reports by Government commissions of inquiry (SOU series)]. Stockholm.

Swedish Government. (2019b). *Låt fler forma framtiden [Allow more people to shape the future]*. SOU 2016:5. [Swedish Government Official Reports, reports by Government commissions of inquiry (SOU series)]. Stockholm.

Swedish Government. (2019c). *Sveriges genomförande av Agenda 2030 [Sweden's implementation of Agenda 2030]*. Prop. 2019/20:188. [Government bill to the Swedish Parliament]. Stockholm.

Swedish Parliament. (2017). *Förordning om reginalt tillväxtarbete [Ordinance on regional growth work]*. SFS 2017:583. [Ordinance from the Minestry of Economic Affairs], Stockholm.

Statskontoret. (2019). *Agenda 2030 i myndigheter, kommuner och regioner [Agenda 2030 in authorities, municipalities and regions]*. Sub-report 2019:15. Statskontoret, Stockholm.

Sternad-Fackel, S. (2018). *Att våga se komplexa samband [To dare to see complex connections]*. [Bachelor thesis] Gothenburg University, department of global studies, Göteborg, Sweden.

Weitz, N., Carlsen, H., Nilsson, M., & Skånberg, K. (2018). Towards systemic and contextual priority setting for implementing the 2030 Agenda. *Sustainability Science*, *13*(2), 531–548.