

# SUSTAINABLE DEVELOPMENT GOALS



## Sweden's research targeting the Sustainable Development Goals



**STINT**

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## Preface

STINT, the Swedish Foundation for International Collaboration in Research and Higher Education, was set up by the Swedish Government in 1994 with the mission of internationalising Swedish higher education and research. STINT promotes knowledge and competence development in the area of internationalisation and invests in internationalisation projects proposed by researchers, teachers and senior leadership at Swedish universities.

The UN Sustainable Development Goals (SDGs) receive much attention in the Swedish higher education system. These internationally agreed upon goals form an excellent starting point in the development of international collaborations. Moreover, it is often argued that global challenges require broad collaborations.

The purpose of this study is to piggy-back on the work already done by Elsevier and partners to identify publications relating to each SDG and use it to investigate how Swedish SDG-related research compares to that of the world as a whole, focusing on international collaborations. This is a first and rather limited attempt, which is expected to trigger discussions and, potentially, further detailed studies.

The author of this report is Dr Hans Pohl, Programme Director, STINT. We would like to present our sincere thanks to Dr Ylva Hillbur, Pro Vice-Chancellor for International Relations at the Swedish University of Agricultural Sciences, SLU, who has read and provided valuable comments on a draft version of the report.

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*Stockholm, Sweden, September 2020*

## Summary

The UN's Sustainable Development Goals (SDGs) were adopted in 2015 and they constitute a relevant and meaningful starting point for international research collaboration. In this study, STINT used methods developed by Elsevier and partners to identify scientific publications that are related to the SDGs. The purpose was to understand how Sweden and Swedish Higher Education Institutions (HEIs) perform and collaborate in SDG-related research. The results might be of interest to policy makers, funding agencies and researchers addressing and using the SDGs, and when developing funding instruments/calls as well as national and international collaborations.

Scopus, the broadest available database with publication and citation data, forms the basis of the study and the focus is on the period 2015–2019. This means that the consequences of the COVID-19 pandemic are not at all captured.

Sweden contributes to 1.4% of all global publications and the country's participation is higher than the global average in all SDGs, with SDG 13: Climate Action showing the highest share of 3.1%. Almost all SDGs enjoy a higher citation impact than the world average, in Sweden and in the world. The only exception is SDG 4: Quality Education. Globally, SDG publications are not very international with values clearly below the global averages for all publications. However, SDG publications with Swedish participation are approximately as international as Sweden's research is on average. The share of SDG publications including both academic and corporate actors is lower than the average for most SDGs, in Sweden and in the world. The two exceptions with higher shares are SDG 7: Affordable and Clean Energy and SDG 14: Life Below Water.

One of the early users of the SDG queries provided by Elsevier and partners is Times Higher Education, which has used the SDG publication data as one part of its SDG Impact ranking.

Sweden's research collaboration with Kenya, Tanzania and Uganda addresses the SDGs to a large extent. In the SDG with the highest share of Swedish participation, SDG 13: Climate Action, Canada and Russia are among the larger partner countries with high collaboration intensity. Some of the SDGs are more related to challenges in countries with low income per capita, such as SDG 1: No Poverty and SDG 2: Zero Hunger. For Swedish research in these SDGs to be relevant and, not least, used, it is important to involve lower income countries. Sweden's collaboration with India is a good example of this aspect.

At an institutional level, Karolinska Institutet has the highest share of SDG-related publications, whereof almost all in SDG 3: Good Health and Well-being. When SDG 3 publications are excluded, the Swedish University of Agricultural Sciences (SLU) has the highest share of SDG publications followed by Södertörn University and the University of Gävle. Among the large comprehensive HEIs, research conducted at Stockholm University is most SDG active.

In the conclusion, two results of the study are emphasised. The share of international co-publications is low, in particular when looking at data for the world, and the share of academic–corporate co-publications is also low. Given that SDG-related research almost per definition addresses global, needs-driven societal challenges, these results are counterintuitive and potentially problematic.

## Introduction

The UN's Sustainable Development Goals (SDGs) were adopted in 2015, see Figure 1. Given that the SDGs are broadly agreed upon, having been adopted by 193 UN member states, these constitute a relevant and meaningful starting point for international collaboration. Moreover, policy makers are increasingly using mission-oriented instruments when funding research and innovation. Sweden and Swedish higher education institutions (HEIs) have embraced the SDGs and use them to guide initiatives in education and research.



Figure 1: The UN Sustainable Development Goals

The goals and the associated political Agenda 2030 do not cover all issues meriting research but a relatively large share. As is highlighted in this report, approximately 30% of research publications globally and 40% of those produced in Sweden are related to the SDGs. There are overlaps as well as conflicts between the goals, and whereas some cover very broad research areas (particularly SDG 3: Good Health and Well-being), others are more narrowly defined.<sup>1</sup>

A July 2020 editorial in *Nature* notes that, already before the COVID-19 pandemic, some goals were unlikely to be reached. Now, the pandemic has not only stopped but reversed development in several areas, among them SDG 1: No Poverty and SDG 2: Zero Hunger.<sup>2</sup>

<sup>1</sup> More information about the goals is available at <https://sustainabledevelopment.un.org/>

<sup>2</sup> Time to revise the Sustainable Development Goals, July 14, 2020, <https://www.nature.com/articles/d41586-020-02002-3>

In an ongoing project, Elsevier and partners are developing methods to identify scientific publications related to each SDG, except the more generic SDG 17: Partnerships for the Goals. Using the methods developed by Elsevier and partners, STINT conducted a study of the publications to understand how Sweden and Swedish HEIs perform and collaborate in research related to the SDGs. The results might be of interest to policy makers, funding agencies and researchers addressing and using the SDGs, and when developing funding instruments/calls as well as national and international collaborations.

## Data and methods

In 2017, Elsevier and partners started to develop a resource centre covering the SDGs.<sup>3</sup> One part of the work is focused on research, including methods to distinguish publications relating to SDG 1–16. The queries used to find relevant publications are developed in close collaboration with universities and other actors in the higher education system.<sup>4</sup>

A query for each SDG is available in SciVal, a tool provided by Elsevier to analyse publications in the database Scopus. Scopus is the broadest available database with publication and citation data. The queries are based on lists of search terms and if the title, abstract or keywords of the publication match, the publication is included. An example of a query for SDG 1: No Poverty is given in Figure 2.

Updated search string (last update): 10,387 document results

```
TITLE-ABS-KEY ( ( {extreme poverty} OR {poverty alleviation} OR {poverty eradication} OR {poverty reduction} OR {international poverty line} OR ( {financial aid} AND {poverty} ) OR ( {financial aid} AND {poor} ) OR ( {financial aid} AND {north-south divide} ) OR ( {financial development} AND {poverty} ) OR {financial empowerment} OR {distributional effect} OR {distributional effects} OR {child labor} OR {child labour} OR {development aid} OR {social protection} OR {social protection system} OR ( {social protection} AND access ) OR microfinanc* OR micro-financ* OR {resilience of the poor} OR ( {safety net} AND {poor} OR {vulnerable} ) OR ( {economic resource} AND access ) OR ( {economic resources} AND access ) OR {food bank} OR {food banks} ) ) AND PUBYEAR < 2018 AND PUBYEAR > 2012
```

Figure 2: Search query for SDG 1: No Poverty

This study focuses on the last five years, 2015–2019, with (almost) complete data. This means that the consequences of the COVID-19 pandemic are not at all captured. All publications including at least one author with a Swedish affiliation are considered part of Sweden's activity in SDG research and these publications are compared with all SDG publications in the world.

<sup>3</sup> See <https://sdgresources.relx.com/>

<sup>4</sup> The queries and other information about the project are available at <https://data.mendeley.com/datasets/87txkw7khs/1>

Sweden's international collaboration is analysed using the Normalised Collaboration Intensity Index (NCII). This index illustrates how the collaboration differs from a situation when Sweden (or another entity) collaborates with all countries in proportion to their share of all international co-publications globally. For example, authors with an affiliation in the United States participate in 16% of all international co-publications globally. In Sweden's international co-publications, the share of US co-authors is 11%. The NCII is calculated as the actual share divided by the 'expected' share, i.e.  $11/16 = 67\%$ , which indicates that US collaboration is underrepresented in Sweden's portfolio of international co-publications.<sup>5</sup>

Publication data has advantages and disadvantages. Advantages include the fact that publications are considered cornerstones in most academic evaluations. A high degree of standardisation and relatively good data quality in the Scopus database are other advantages. The disadvantages include that not all types of research are covered by publication data and that there is a lag from the discovery until the results are published, and even longer until the publication's citation impact becomes relevant.

One limitation of this study is that it only considers academic publications. Many SDG-related activities and publications, commissioned study reports, policy briefs etc., are not captured in Scopus and are consequently not included in this study.

## Sweden in the SDG world

Is Sweden active in SDG-related research? To answer this question, the share of SDG publications in the total volume of publications with Swedish authors was calculated, see Figure 3. As a comparison, the corresponding calculation was made using all publications in the world during the same period, 2015–2019. SDG 3: Good Health and Well-being is outside the scale, as the number of publications in this category is an order of magnitude greater than that of other publications in Sweden and in the world. SDG 3-related publications comprise 29% of all publications in Sweden and 22% of all publications in the world.

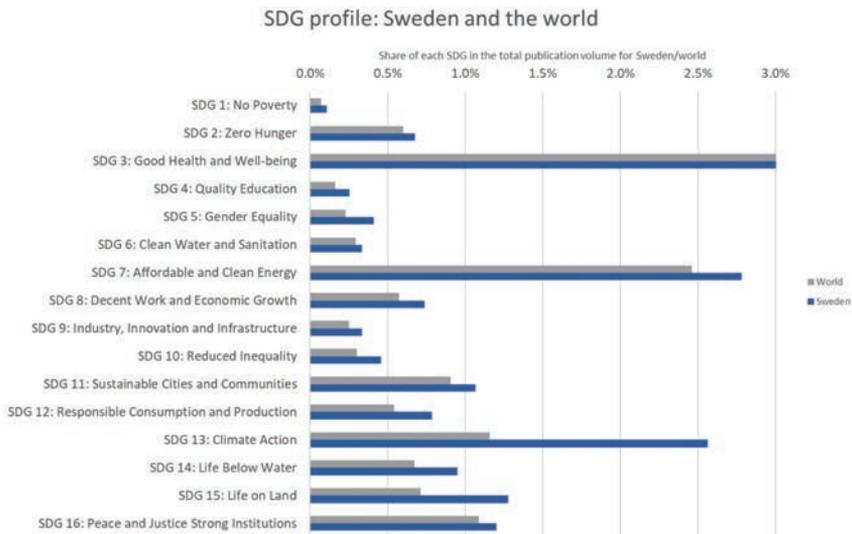


Figure 3: SDG publications in relation to all publications, Sweden and the world

Figure 3 shows that Sweden publishes more than the world average in all 16 SDGs. It also shows that SDG 7: Affordable and Clean Energy is relatively large in terms of publications, whereas SDG 1: No Poverty is very small.

Not indicated in Figure 3 are the total shares of SDG publications. If the publications in each SDG are added together, the global share of SDG publications is approximately 32% and the corresponding figure for Sweden is 43%. However, in both cases, publications which relate to more than one SDG are counted more than once, which means that the actual shares are lower. Due to limitations in the software, it is not possible to merge all publications to remove duplicates. However, when using Sweden and 2019 as a sample, the share decreases from 42.6% to 38.2% when duplicates are removed.

Using the same 2019 sample data for Sweden, the publications include SDGs according to Figure 4 and Figure 5. SDG 3: Good Health and Well-being is excluded from Figure 5 to make it possible to see approximately how the publications include one or several of the other SDGs. For example, in SDG 7: Affordable and Clean Energy, which has the second largest number of publications, most of the publications are only related to SDG 7 but relatively many are also related to SDG 13: Climate Action and SDG 12: Responsible Consumption and Production. Publications including more than two SDGs were fractionalised.

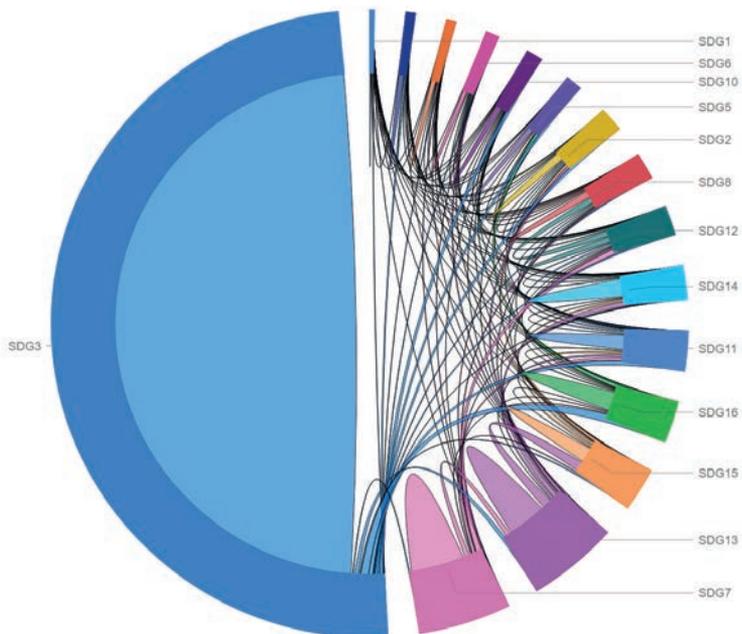


Figure 4: Chord diagram with SDG-related publications for Sweden, 2019

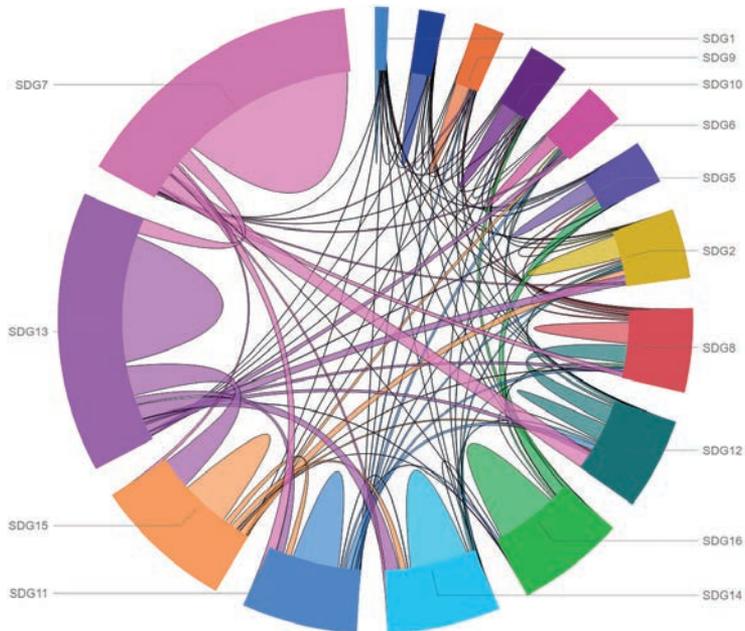


Figure 5: Chord diagram with SDG-related publications for Sweden, 2019 (excl. SDG 3)

To compare Sweden's SDG profile globally, the shares of each SDG in Sweden and globally are divided. The largest relative difference between Sweden and the world is in SDG 13: Climate Action, with 122% more publications in the total Swedish publication volume than in that of the world, see Figure 6. SDG 5: Gender Equality and SDG 15: Life on Land are also prominent in Sweden's profile.

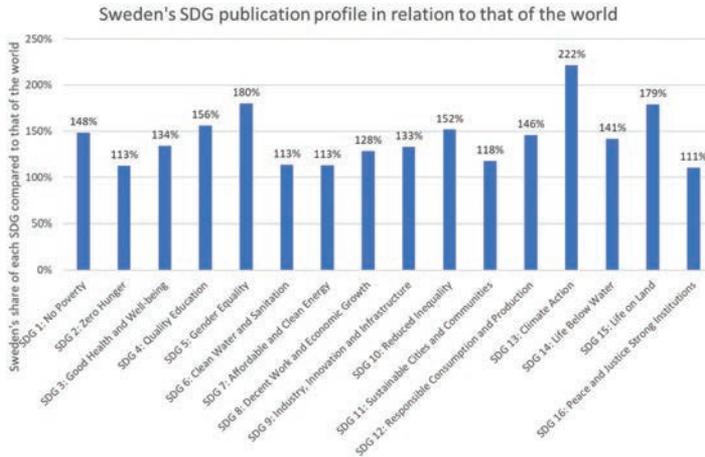


Figure 6: Comparison of the SDG profile of Sweden and the world (a percentage above 100% means that Sweden has a higher share than the world average)

While Swedish research has a stronger focus on the SDGs than the world average, how large is Sweden's contribution to global research? In Figure 7, Sweden's share of all publications in each SDG is indicated, including, at the bottom of the list, Sweden's share of all publications in the world (1.4%). SDG 13: Climate Action shows the highest share with 3.1%.

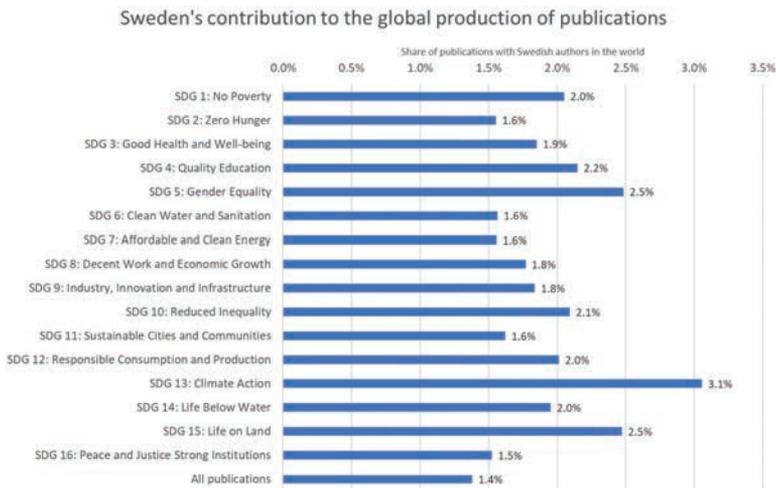


Figure 7: Sweden's share of all SDG publications in the world

In Figure 8, the bars indicate the growth in publication volume for each SDG based on a linear regression of annual data for the period 2015–2019. For the SDGs with blue bars taller than grey ones, Sweden’s share of publications has been increasing. The highest growth is for SDG 5: Gender Equality, which also shows the largest positive difference between the development in Sweden and in the world. Sweden’s growth rate is higher than the world average for five of the 16 SDGs.

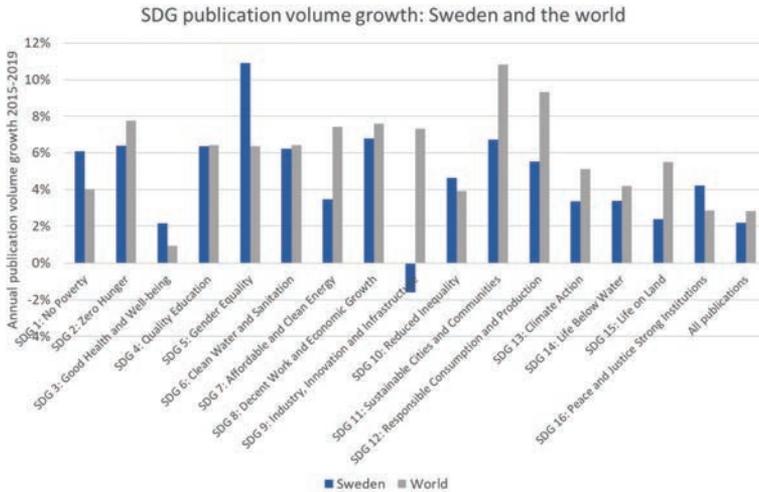


Figure 8: Annual publication volume growth

In Table 1, four indicators are presented for the 16 SDGs and for all publications based on the period 2015–2019. The first columns show the total numbers of publications within each SDG. The large differences in volume are important to remember in the following sections, where collaboration with specific countries or specific HEIs is studied.

The field-weighted citation impact (FWCI) is a normalised indicator comparing the citations a publication receives with other publications in the same scientific field, from the same year and in the same type of publication. The global average is 1.00.<sup>6</sup> As indicated in Table 1, almost all SDGs enjoy a higher citation impact than the world average. The only exception is SDG 4: Quality Education, which has 0.96 in the world and 1.32 in Sweden, which is the lowest FWCI of all SDGs for Sweden. Many SDGs in Sweden enjoy a higher citation impact than the national average (1.68) and several are above 2.00, which means that they are cited more than twice as frequently as average publications in their scientific fields.

<sup>6</sup> For more details, see <https://www.elsevier.com/research-intelligence/resource-library/research-metrics-guidebook>

	Total volume 2015-2019		Citation impact (FWCI)		International collaboration (FWIS)		Academic-corporate collaboration (%)	
	World	Sweden	World	Sweden	World	Sweden	World	Sweden
SDG 1: No Poverty	11,320	232	1.07	1.56	0.72	1.68	1.2%	3.0%
SDG 2: Zero Hunger	93,370	1,451	1.14	2.19	0.64	1.69	1.3%	5.3%
SDG 3: Good Health and Well-being	3,348,103	61,994	1.16	2.17	0.53	1.64	2.5%	8.1%
SDG 4: Quality Education	25,531	549	0.96	1.32	0.53	1.32	0.5%	0.7%
SDG 5: Gender Equality	35,606	884	1.19	1.82	0.54	1.23	0.7%	1.1%
SDG 6: Clean Water and Sanitation	46,064	721	1.31	2.12	0.64	1.63	2.2%	6.4%
SDG 7: Affordable and Clean Energy	383,289	5,975	1.49	1.91	0.60	1.56	3.9%	10.1%
SDG 8: Decent Work and Economic Growth	89,467	1,584	1.14	2.13	0.57	1.45	1.1%	3.6%
SDG 9: Industry, Innovation and Infrastructure	39,103	718	1.20	2.16	0.59	1.53	2.4%	9.6%
SDG 10: Reduced Inequality	47,209	988	1.14	1.58	0.59	1.49	0.8%	1.6%
SDG 11: Sustainable Cities and Communities	141,302	2,293	1.22	2.03	0.58	1.47	1.8%	5.1%
SDG 12: Responsible Consumption and Production	84,096	1,692	1.36	2.31	0.60	1.39	2.0%	7.3%
SDG 13: Climate Action	180,041	5,505	1.37	2.37	0.74	1.57	2.1%	5.5%
SDG 14: Life Below Water	104,503	2,040	1.10	1.89	0.67	1.61	3.5%	10.9%
SDG 15: Life on Land	111,181	2,748	1.30	2.43	0.69	1.59	1.5%	5.6%
SDG 16: Peace and Justice Strong Institutions	169,253	2,582	1.04	1.36	0.46	1.30	0.9%	1.0%
All publications	15,571,793	214,909	1.00	1.68	1.00	1.55	2.6%	8.3%

Table 1: Key indicators for SDG research

In the following two columns in Table 1, another normalised indicator shows how international these publications are. A value above one means that the publications are more international than the average and a value below one that they are less international.<sup>7</sup> Globally, the SDG publications are not very international with values around 0.6. The SDG publications with Swedish participation are approximately as international as Sweden's research on average (1.55). Most international are the SDGs 1, 2 and 3, whereas SDG 5: Gender Equality has the lowest share of international co-publications.

Finally, the share of academic–corporate co-publications is indicated in Table 1. Such a publication includes at least two authors with at least one academic and one corporate affiliation. As SDG research is clearly mission-oriented, it could be expected that it leads to solutions that can be implemented, not least by corporate actors. Collaborative research is one way of facilitating innovations.

Despite this, the share of SDG publications including both academic and corporate actors is lower than the world average (2.6%) for most SDGs. The two exceptions with higher shares are SDG 7: Affordable and Clean Energy and SDG 14: Life Below Water. Publications with Swedish participation follow similar patterns, albeit with higher than global averages. In some SDGs, such as SDG 4: Quality Education, it might be reasonable that corporate actors are not so active as many users of research results are in the public sector, but in other SDGs this appears to be an issue to address.

<sup>7</sup> For more details, see Pohl, H., Warnan, G. and Baas, J. (2014), 'Level the playing field in scientific collaboration with the use of a new indicator: Field-weighted internationalization score', *Research Trends* 39, 3–8.

## Sweden's international SDG collaboration

SDGs are global goals and thus useful to guide international collaboration. Moreover, it is often argued that research targeting global challenges should be based on international collaboration to be impactful.

Globally, SDG research is on average far less international than all research (see Table 1). This is surprising and merits further study. Even though the SDGs involve an interesting mix of global and local challenges, it seems likely that a large share of the knowledge is internationally relevant and would benefit from a joint approach.

Sweden's research is overall fairly international compared to the research done in other countries, and the SDG subset is in line with the national average, as can be seen in Table 1 above. The most international area is SDG 2: Zero Hunger and the least SDG 5: Gender Equality. This section concentrates on Sweden's collaboration network in the different SDGs.

The Normalised Collaboration Intensity Index (NCII) is used, as outlined in the section on Data and methods. This is calculated for all Swedish international co-publications with a maximum of 100 co-authors as well as for the publications within each SDG. All 96 countries with at least 1,000 publications in 2019 are included.

Figure 9 maps Sweden's collaborations. Red indicates high intensity in the collaboration, and blue low intensity. Our neighbouring countries are red, as well as a cluster of countries in Eastern Africa (Tanzania, Uganda and Kenya). It is not surprising that collaboration with countries close to Sweden is intense, even though the NCII for Hungary (215%) and Slovenia (172%) are higher than expected. The cluster in Africa is probably to a large extent explained by the programmes of the Swedish International Development Cooperation Agency (Sida).

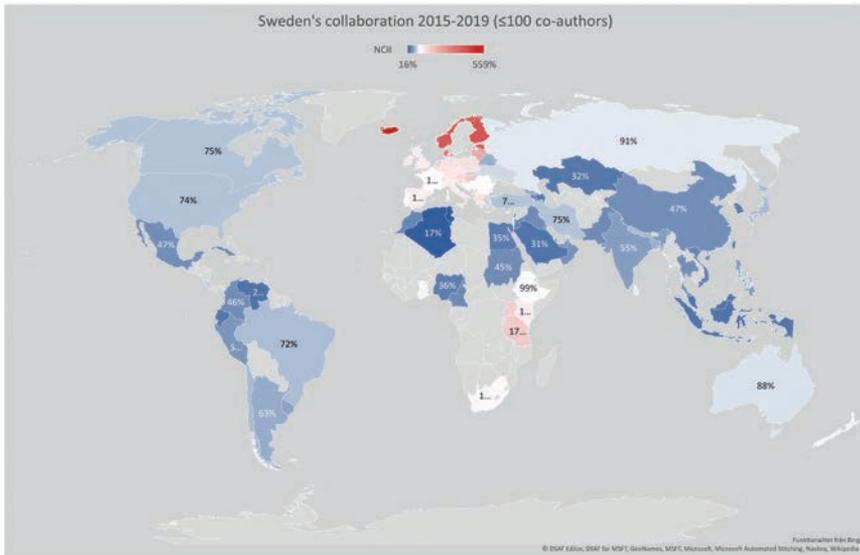


Figure 9: Collaboration intensity map for Sweden

Sweden is very active in SDG 13: Climate Action and the collaboration map in Figure 10 shows how Sweden collaborates in this area. Among the large partner countries, Swedish researchers obviously collaborate significantly with Canada and Russia in climate research. Tanzania and Kenya are clearly involved in climate collaboration, as well as Costa Rica and Peru. As the NCII relates the co-publications within SDG 13 to all co-publications with the country, the absolute numbers differ substantially. For example, out of 8,577 publications including authors from Canada and Sweden, 554 are within SDG 13. Corresponding volumes for Tanzania are 46 out of 481. A couple of countries have zero co-publications with Sweden in this SDG, including Belarus, Kazakhstan, Oman and Kuwait.

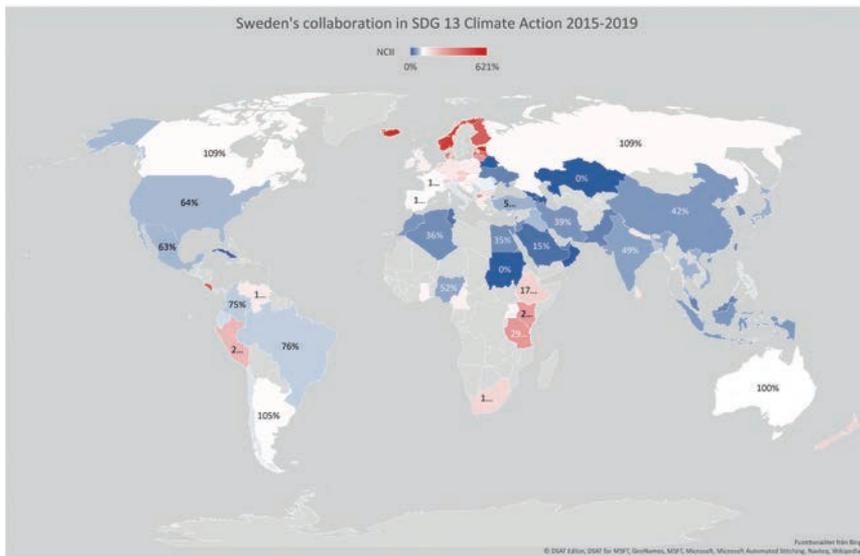


Figure 10: Collaboration intensity map for Sweden, SDG 13: Climate Action

Next, collaboration intensity is presented for smaller groups of countries and all SDGs. Please note that the scale differs substantially between the following figures. The reference value including all co-publications with a maximum of 100 co-authors (“SWE100”) is indicated at 12 o’clock in the spider web.

In Figure 11, Sweden's SDG collaboration with Denmark, Finland and Norway is illustrated. In almost all SDGs, our collaboration with Norway is the most intensive and that with Denmark the least. SDG 16: Peace and Strong Institutions is obviously an area with substantial collaboration between Norway and Sweden. Or, to be more precise, of all the co-publications including authors in Norway and Sweden (and potentially also other countries), a relatively high share is within SDG 16.

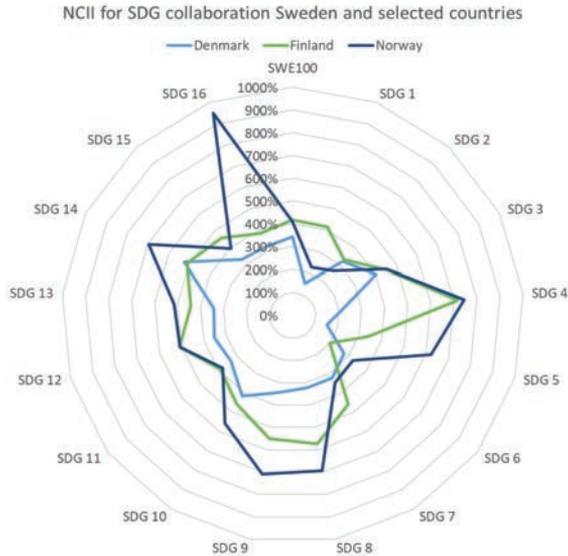


Figure 11: Swedish collaboration intensity per SDG, Scandinavia

The next group comprises Australia, Canada, the United Kingdom and the United States, see Figure 12. With one notable exception, SDG 4: Quality Education, which is very much in focus in the collaboration between Sweden and Australia, the United Kingdom is otherwise the main partner country, followed by Australia, Canada and finally the United States. The reference value SWE100 for Canada and the United States is similar but research collaboration is more intensive with Canada in 14 of 16 SDGs. A closer look at data for all 96 countries reveals that SDG 4 has an interesting pattern with intense collaboration with a few countries and zero collaboration with many. This might be partly explained by the relatively low overall number of publications with Swedish participation (see Table 1).

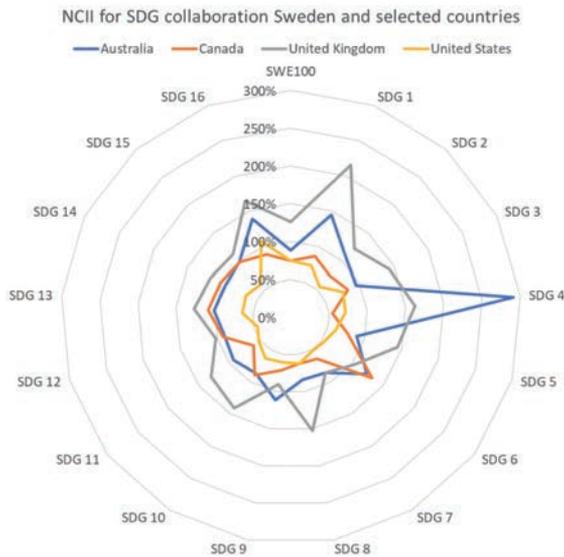


Figure 12: Swedish collaboration intensity per SDG, Anglo-Saxon countries

Moving to Asia, Sweden’s collaboration with China, India, Japan and South Korea is illustrated in Figure 13. Sweden’s SDG collaboration with India is intense, in particular in SDG 1: No Poverty. Interestingly, collaboration with South Korea shows the same pattern regarding SDG 1. Swedish collaboration with China focuses on SDG 7: Affordable and Clean Energy.

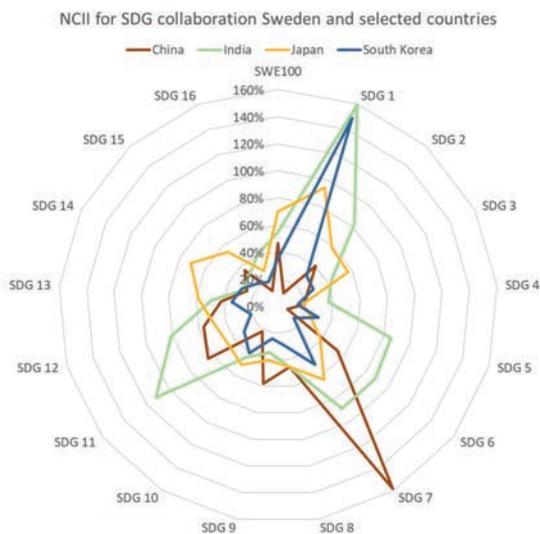


Figure 13: Swedish collaboration intensity per SDG, Asian countries

Finally, a selection of African countries is studied in Figure 14. SDG 1: No Poverty and SDG 5: Gender Equality are prominent in Sweden’s collaboration with Tanzania and Uganda, whereas SDG 2: Zero Hunger is high on the agenda in collaboration with Kenya and Tanzania. The collaboration with Uganda is also intense in SDG 11: Sustainable Cities and Communities and SDG 16: Peace and Justice Strong Institutions. Sweden’s collaboration with South Africa is also intense, even though the scale makes it appear more limited. SDG 4: Quality Education is one of the areas addressed in this collaboration.

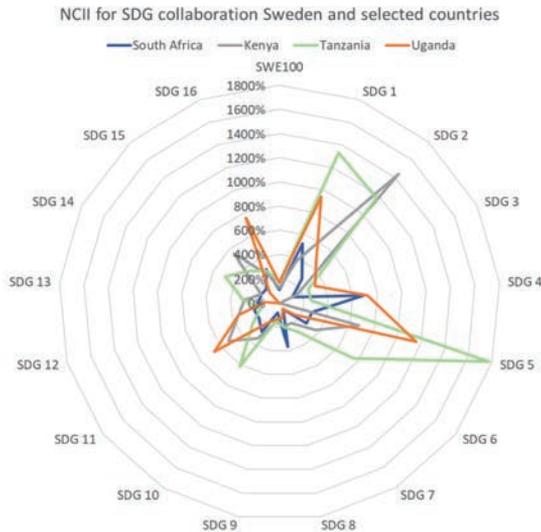


Figure 14: Swedish collaboration intensity per SDG, African countries

## Swedish HEIs

How active are Swedish universities in SDG-related research? Obviously, the profile of the university affects which SDGs it addresses. Data for 28 Swedish HEIs have been analysed. Given the relatively low number of publications per SDG and university, the results focus on the total publication volume and its distribution between the different SDGs.

The overall SDG publication volumes per HEI are presented in Table 2. As explained above, SDG 3: Good Health and Well-being is unique as the number of publications linked to this SDG is an order of magnitude greater than that of the other SDGs. The results clearly illustrate this: 73% of Karolinska Institutet's publications relate to the SDGs and 70% are linked to SDG 3. Other HEIs with a high overall share of SDG-related publications, including SDG 3, are Umeå University and Örebro University.

Based on publications 2015-2019	All publications	All SDG publications	Share SDG	Share SDG (excl SDG 3)
Blekinge Institute of Technology	1,256	257	20%	11%
Chalmers University of Technology	14,664	3,074	21%	15%
Dalarna University	1,029	600	58%	17%
Halmstad University	1,065	371	35%	17%
Jönköping University	2,063	843	41%	12%
Karlstad University	2,001	678	34%	18%
Karolinska Institutet	36,015	26,379	73%	3%
Kristianstad University	589	319	54%	17%
KTH Royal Institute of Technology	22,020	4,287	19%	15%
Linköping University	14,220	6,007	42%	11%
Linnaeus University	3,539	1,404	40%	23%
Luleå University of Technology	5,523	1,323	24%	19%
Lund University	31,566	15,189	48%	13%
Malmö University	2,303	920	40%	14%
Mid Sweden University	1,808	604	33%	15%
Mälardalen University	2,406	866	36%	23%
Stockholm School of Economics	895	191	21%	14%
Stockholm University	18,085	6,328	35%	21%
Swedish U. of Agricultural Sciences	9,091	4,483	49%	39%
Södertörn University	961	404	42%	28%
Umeå University	12,121	7,210	59%	15%
University of Borås	1,017	449	44%	19%
University of Gothenburg	22,702	12,689	56%	12%
University of Gävle	1,237	617	50%	24%
University of Skövde	1,189	381	32%	6%
University West	861	232	27%	7%
Uppsala University	29,523	12,129	41%	9%
Örebro University	4,581	2,686	59%	8%
Sweden	214,909	91,956	43%	14%

Table 2: SDG publication output per Swedish HEI, colour scale from low (blue) to high share (red) in each column

When SDG 3 publications are excluded, the Swedish University of Agricultural Sciences (SLU) has the highest share of SDG publications followed by Södertörn University and the University of Gävle. Of the large comprehensive HEIs, the research conducted at Stockholm University is most SDG active.

A 'heat map' was created to compare how all 28 HEIs address each SDG, by relating the publication volume per HEI and SDG with the corresponding figure for Sweden as a whole, see Figure 15.

	SDG 1: No Poverty	SDG 2: Zero Hunger	SDG 3: Good Health and Well-being	SDG 4: Quality Education	SDG 5: Gender Equality	SDG 6: Clean Water and Sanitation	SDG 7: Affordable and Clean Energy	SDG 8: Decent Work and Economic Growth	SDG 9: Industry, Innovation and Infrastructure	SDG 10: Reduced Inequality	SDG 11: Sustainable Cities and Communities	SDG 12: Responsible Consumption and Production	SDG 13: Climate Action	SDG 14: Life Below Water	SDG 15: Life on Land	SDG 16: Peace and Justice Strong Institutions
Blekinge Institute of Technology	0%	24%	34%	0%	19%	47%	83%	151%	596%	17%	112%	142%	31%	8%	19%	119%
Chalmers University of Technology	19%	51%	20%	8%	13%	96%	236%	74%	192%	13%	139%	219%	65%	92%	80%	20%
Dalarna University	90%	29%	143%	342%	213%	0%	241%	105%	116%	190%	82%	148%	95%	20%	8%	129%
Halmstad University	0%	83%	80%	74%	48%	56%	243%	140%	875%	61%	70%	167%	37%	40%	110%	102%
Jönköping University	359%	101%	100%	398%	212%	14%	24%	204%	479%	264%	91%	105%	17%	15%	19%	109%
Karlstad University	46%	81%	54%	352%	318%	74%	142%	149%	224%	141%	176%	146%	72%	32%	109%	179%
Karolinska Institutet	46%	34%	245%	30%	61%	8%	3%	17%	7%	74%	27%	11%	5%	5%	5%	70%
Kristianstad University	0%	251%	129%	864%	0%	405%	18%	207%	152%	111%	175%	151%	80%	179%	80%	71%
KTH Royal Institute of Technology	42%	43%	16%	9%	18%	119%	254%	91%	205%	24%	156%	147%	52%	33%	43%	30%
Linköping University	52%	56%	109%	105%	97%	21%	121%	102%	91%	106%	83%	78%	52%	28%	35%	98%
Linnaeus University	131%	117%	57%	288%	269%	101%	74%	384%	93%	184%	127%	280%	168%	250%	150%	174%
Luleå University of Technology	67%	72%	17%	64%	70%	162%	264%	150%	336%	26%	188%	232%	90%	50%	55%	38%
Lund University	85%	103%	122%	43%	93%	105%	62%	120%	107%	103%	89%	80%	118%	69%	125%	82%
Malmö University	161%	39%	90%	357%	454%	39%	37%	153%	39%	264%	163%	28%	29%	0%	24%	347%
Mid Sweden University	51%	41%	62%	108%	390%	16%	13%	240%	33%	132%	109%	105%	43%	29%	52%	249%
Mälardalen University	77%	86%	44%	439%	71%	149%	428%	107%	211%	61%	210%	216%	75%	13%	20%	55%
Stockholm School of Economics	518%	33%	26%	44%	353%	33%	12%	485%	468%	170%	21%	270%	39%	24%	0%	130%
Stockholm University	225%	124%	49%	141%	198%	173%	33%	119%	41%	194%	108%	79%	240%	307%	209%	165%
Swedish U. of Agricultural Sciences	112%	811%	36%	13%	67%	482%	96%	93%	63%	74%	191%	238%	402%	308%	770%	31%
Södertörn University	368%	123%	50%	285%	508%	93%	28%	339%	156%	811%	156%	145%	138%	417%	163%	355%
Umeå University	99%	67%	154%	223%	201%	130%	55%	99%	32%	163%	111%	84%	139%	56%	165%	116%
University of Borås	0%	169%	87%	308%	48%	68%	180%	133%	116%	86%	175%	812%	35%	21%	23%	147%
University of Gothenburg	131%	67%	152%	250%	135%	68%	15%	92%	50%	140%	82%	54%	94%	190%	65%	142%
University of Gävle	150%	180%	90%	285%	177%	24%	224%	186%	339%	123%	235%	370%	107%	85%	57%	168%
University of Skövde	0%	25%	90%	99%	20%	25%	39%	137%	178%	55%	63%	32%	16%	9%	20%	70%
University West	0%	0%	69%	136%	169%	0%	50%	79%	139%	51%	11%	69%	23%	49%	0%	135%
Uppsala University	63%	53%	110%	73%	100%	58%	82%	51%	33%	74%	46%	21%	67%	82%	56%	104%
Örebro University	101%	48%	174%	179%	165%	52%	10%	50%	65%	95%	82%	64%	36%	16%	26%	209%
Publication volume per SDG (Sweden)	232	1461	61934	343	894	121	5375	1394	78	988	2,263	3932	5,505	2,040	2,748	2,362

Figure 15: Heat map for 28 Swedish HEIs and their SDG profiles. Figures below 100% (different shades of blue) indicate that the HEI is less active than the Swedish average in this SDG, and a percentage higher than 100 (different shades of red) indicate the opposite.

As explained earlier, the volume of publications within each SDG differs substantially, which partly explains the large variations from 0% (=no publications) to 518% for the Stockholm School of Economics in the SDG 1 column. In the next column, SDG 2, the Swedish University of Agricultural Sciences (SLU) is very active. SLU and Stockholm University are both very active in SDG 13: Climate Action, the SDG that proportionately is given the most attention in Sweden.

## Discussion – Swedish SDG research

This study uses the Elsevier and partners' definitions of the SDGs as reflected in search profiles for publications in the Scopus database. This approach saves time and increases the quality of results, as substantial resources have been invested in its development. It also allows for international comparisons, as the same definitions are available for everyone to use. Still, it should be noted that the work is ongoing, and the methods will probably be adjusted over time.

Among all publications in the world during 2015–2019, the share of publications with Swedish (co-)authors is 1.4%. Sweden produces, in relative terms, more research addressing the SDGs than the world average.<sup>8</sup> Still, even for the SDG with the highest share of Swedish publications, SDG 13: Climate Action, Sweden is only involved in 3.1% of all global publications. And the trends during 2015–2019 were negative – in 11 of 16 SDGs, Sweden's share of the global SDG research was decreasing. This can partly be explained by the fact that Sweden's total publication volume grows more slowly than that of the rest of the world.

Given the need for solutions to the societal challenges represented by the SDGs and the attention devoted to the SDGs, it could be expected that SDG research is more cited than research in general. This is confirmed at a global as well as Swedish level.

Another expectation is that SDG research to a larger extent should stimulate international collaboration, not least because the goals are internationally adopted, and the missions are global. However, this seems not be the case, neither when looking at global data nor data for Sweden. At the time of this study, SDG publications globally are clearly less international than other publications, whereas Swedish SDG publications are on par with all Swedish publications. International co-publications in general have a higher citation impact than national ones. It is therefore notable that the citation impact for the SDG publications is higher than the world average despite their comparatively low share of international co-publications.

The moderate degree of international collaboration might partly be explained by the dominance of national funding schemes. In combination with specific and different priorities in each country, international collaboration is made more difficult. In the Times Higher Impact ranking, differences in the priorities of European and African HEIs are highlighted.

It could also be presumed that SDG publications would be comparatively more applied and solution-oriented, as they to a larger extent target specified societal goals. One publication indicator that relates to the degree of applicability of research is the share of academic–corporate co-publications. Among all publications in the world, only those related to SDGs 7 and 14 have a higher share of academic–corporate co-publications than the world average, see Table 1. For Sweden, in addition to SDGs 7 and 14, SDG 9: Industry and innovation also has a higher share. This pattern could indicate that corporate actors are less involved in SDG research compared to other types of research. More active involvement of corporate actors in SDG research is a potential policy implication that merits closer study.

Related to the impact of the research, one of the early users of the SDG queries provided by Elsevier and partners is Times Higher Education, which has used the SDG publication data as one part of its SDG Impact ranking. Compared to the other world rankings by Times Higher Education, the number of participating universities is relatively low (766), partly as it is a new ranking which requires substantial input from each HEI to be ranked. Two universities in Sweden were ranked in the results presented in April 2020: the University of Gothenburg and KTH Royal Institute of Technology.<sup>9</sup>

Sweden's international collaboration network in SDG research differs from its overall network and, even more so, differs between the various SDGs. As the maps show, Sweden's SDG research collaboration is far from evenly distributed over all countries.

Some of the SDGs are more related to challenges in countries with low income per capita, such as SDG 1: No Poverty and SDG 2: Zero Hunger. For Swedish research in these SDGs to be relevant and, not least, used, it is important to involve lower income countries. Sweden's collaboration with India is a good example in this respect, but it will be important to continuously monitor developments in this area.

In Figure 14, Tanzania and Sweden are shown to have a very high collaboration intensity in SDG 5: Gender Equality. The publications included in this collaboration involve several Swedish universities, among them Uppsala University, Karolinska Institutet and Malmö University. However, it should be noted that the number of publications related to individual SDGs and produced in collaboration with less research-intense countries is low.

<sup>9</sup> See [https://www.timeshighereducation.com/rankings/impact/2020/overall#!/page/0/length/25/sort\\_by/rank/sort\\_order/asc/cols/undefined](https://www.timeshighereducation.com/rankings/impact/2020/overall#!/page/0/length/25/sort_by/rank/sort_order/asc/cols/undefined)

In this case, 13 publications address SDG 5 that include authors from Sweden and Tanzania. This means that if the study is repeated for another period, the results might be different. However, as these co-publications probably to a large extent emanate from Sida's capacity-building efforts in the region, a certain sustainability could be expected in the collaborations as well as in the areas addressed.

At an institutional level, involvement in the SDGs differs substantially between Swedish HEIs depending on the research profile of each university. Universities with faculties of medicine have the highest total numbers of publications, whereas SLU has the highest share of SDG publications when SDG 3: Good Health and Well-being is excluded. This is reflected in the heat map, that shows large variations in SDG research profiles between the HEIs in Sweden.

This study focuses on the national level and only touches upon the institutional one. Several Swedish HEIs have probably developed their own methods to track their involvement in SDGs. One example is SLU, which has scrutinised its publications, partially manually, to relate them to different SDGs. SLU includes other types of data, such as attention in social media, which are clearly interesting in studying research impact.<sup>10</sup>

## Conclusions

To conclude, this publication study provides some perspectives on Sweden's involvement in SDG research, with a focus on the international dimension. Despite general weaknesses of publication studies and the specific limitations of this study, the results serve as a good starting point for further discussions of Swedish research policy at different levels. Such discussions should lead to better interpretations of the results and they could also lead to more elaborate and specific studies of SDG-related research.

At least two results highlighted in this study deserve specific attention: (1) the share of international co-publications is lower than expected, in particular when looking at data for the world, and (2) the share of academic–corporate co-publications is low given that SDG-related research almost per definition is needs-driven and aims to meet urgent societal challenges.

STINT, The Swedish Foundation for International Cooperation in Research and Higher Education, was set up by the Swedish Government in 1994 with the mission to internationalise Swedish higher education and research.

STINT promotes knowledge and competence development within internationalisation and invests in internationalisation projects proposed by researchers, educators and leaderships at Swedish universities.

STINT promotes internationalisation as an instrument to:

- Enhance the quality of research and higher education
- Increase the competitiveness of universities
- Strengthen the attractiveness of Swedish universities

STINT's mission is to encourage renewal within internationalisation through new collaboration forms and new partners. For example, STINT invests in young researchers' and teachers' international collaborations. Moreover, STINT's ambition is to be a pioneer in establishing strategic cooperation with emerging countries in research and higher education.