

SDG Interlinkages and Social Network Analysis: Finance in SDGs

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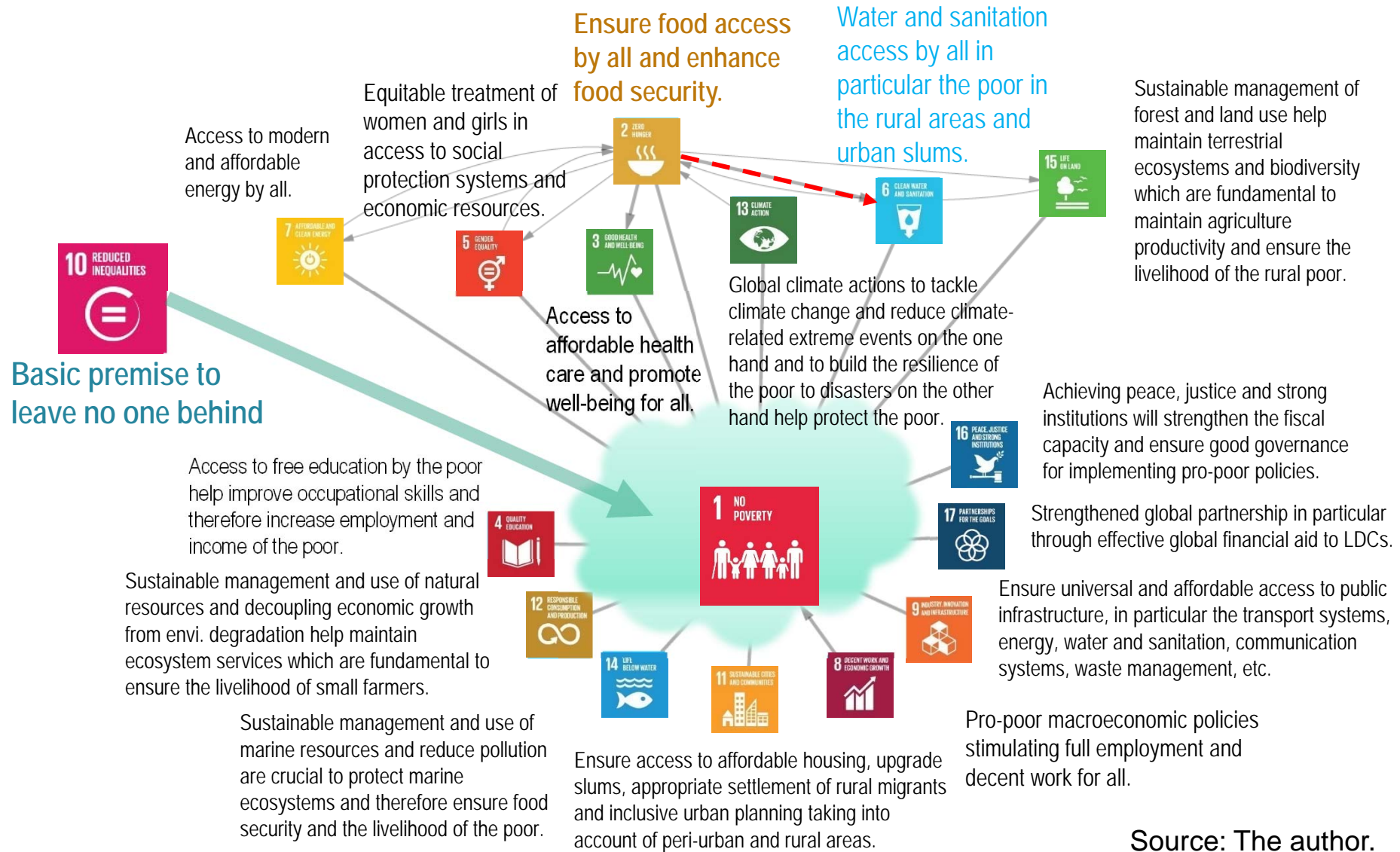
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IGES
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The SDGs: 17 Goals, 169 Targets and 232 Indicators forming an integrated and indivisible framework for delivering sustainability from a systemic perspective.



Multi-dimensional and interwoven SDG interlinkages in a complicated network



Source: The author.

The interconnections between SDGs are diversified.

GOALS SCORING

INDIVISIBLE

The strongest form of positive interaction in which one objective is inextricably linked to the achievement of another. Reduction of air pollution (12.4) is indivisible from improved health and reducing non-communicable diseases (3.4).

+3

Outdoor and indoor air pollution is responsible for 7 million deaths annually, as well as respiratory and cardiovascular disease but also increases in perinatal deaths. In 2012, ambient (outdoor) air pollution was responsible for 3 million deaths, representing 5.4% of the total deaths. Worldwide, ambient air pollution is estimated to cause about 25% of the lung cancer deaths. Major urban centers in low and middle-income countries are the most exposed to this burden. (WHO, 2016).

REINFORCING

One objective directly creates conditions that lead to the achievement of another objective. Increasing economic benefits from sustainable marine resources use (14.7) reinforces the creation of decent jobs and small enterprise in e.g. tourism (8.5 and 8.9)

+2

Sustainable and diversified strategies for using the marine resource base open up opportunities for small enterprises in fisheries or other harvesting and associated value-addition activities, as well as activities related to tourism. Many SIDS and LDCs that are rich in these resources also have poor, vulnerable and marginalized coastal communities.

ENABLING

The pursuit of one objective enables the achievement of another objective. Developing infrastructure for transport (9.1) enables participation of women in the work force and in political life (5.5)

+1

Affordable public transport promotes social inclusion, more equal access to different parts of the city, and enabling employment for marginalized groups. In many places, women do not have access to a car and depend on public transport, walking or bicycling to get around, to work places and to social or political activities (NCE, 2016; GSDR, 2016)

CONSISTENT

A neutral relationship where one objective does not significantly interact with another or where interactions are deemed to be neither positive nor negative. By 2025, prevent and significantly reduce marine pollution of all kinds, in particular from land-based activities, including marine debris and nutrient pollution (14.1) is consistent with target 3.5 Strengthen the prevention and treatment of substance abuse, including narcotic drug abuse and harmful use of alcohol.

0

There is no significant interaction between the two targets.

CONSTRAINING

A mild form of negative interaction when the pursuit of one objective sets a condition or a constraint on the achievement of another. Conserving coastal areas (14.5) and development of safe affordable housing and basic services (11.1) may constrain each other

-1

Establishing protection areas in the coastal zone and expanding urbanization, infrastructure or transport risks spatial competition especially in densely populated areas. Integrated coastal zone management and marine spatial planning tools are readily available to mitigate spatial competition.

COUNTERACTING

The pursuit of one objective counteracts another objective. Ensuring access to safe, nutritious and sufficient food can counteract sustainable water withdrawals (6.4) and reduction of chemicals releases (12.4)

-2

Increasing productivity in agriculture is a necessary (but not sufficient) condition to improve food security. In many places, this might entail increased and/or better irrigation as well as increased use of agro-chemical inputs.

CANCELLING

The most negative interaction is where progress in one goal makes it impossible to reach another goal and possibly leads to a deteriorating state of the second. A choice has to be made between the two. Developing infrastructure (9.1) could be cancelling the reduction of degradation of natural habitats in terrestrial ecosystems (15.1)

-3

In underdeveloped regions, developing roads, dams, and power grids might be a high priority, although it will cause some unavoidable fragmentation of habitats and compromising the integrity of the natural ecosystem, leading to risks to biodiversity as well as social risks.

Source: Nilsson, et al., 2016

Importance of understanding the interlinkages between SDGs to ensure policy coherence

- Policies made to achieve the targets in one sector may have both positive or negative spillovers in other sectors.
- The existence of potential synergies and trade-offs between SDG targets requires integrated institutional arrangements and policy coherence.
- The Synthesis of Voluntary National Reviews (VNR) 2017 indicated that some countries (Columbia, Finland, Germany, etc.) have established SDG coordination committee at the prime minister level. SDG interlinkages analysis can help inter-agency cooperation, set national priorities based on both the leverage and trade-off areas, and efficiently allocate resources.

Available and ongoing studies on interlinkages

➤ The significance of interlinkages is recognised

- Interlinkages in the OWG proposal for SDGs (2014)
- Growing interest among scholars and policymakers
- A Working Group on Interlinkages created under IAEG-SDGs

➤ Various approaches, various methodologies

- Some focused on understanding the interlinkages
- Some attempted for clustering the SDGs

Open Working Group on Sustainable Development Goals
ANNEX 1.
INTERLINKAGES

Focus area 1. Poverty eradication
Since poverty is multidimensional, progress is linked to action in all other focus areas.

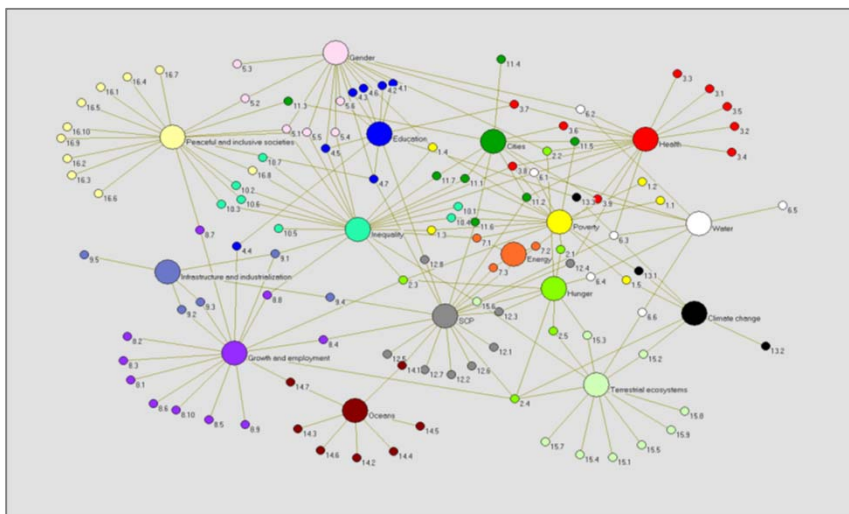
Focus area 2. Sustainable agriculture, food security and nutrition
Interlinkages with other focus areas include poverty eradication, health and population dynamics, gender equality and women's empowerment, water and sanitation, energy, climate, conservation and sustainable use of marine resources, oceans and seas, and ecosystems and biodiversity.

Focus area 3. Health and population dynamics
Interlinkages with other focus areas include: sustainable agriculture, food security and nutrition, gender equality and women's empowerment, water and sanitation, economic growth, productivity, and innovation.

FOCUS AREAS (FA)	FA 1	FA 2	FA 3	FA 4	FA 5	FA 6	FA 7	FA 8	FA 9	FA 10	FA 11	FA 12	FA 13	FA 14	FA 15	FA 16	FA 17	FA 18	FA 19
Focus Inter eradi	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
nutri	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
women	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
work	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
produ	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Focus Inter eradi	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
nutri	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
women	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
work	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
produ	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Focus Inter eradi	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
nutri	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
women	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
work	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
produ	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•

Interlinkages among the focus areas considered by the OWG on SDGs (Based on OWG, 2015)

Some studies focused on understanding the interlinkages



Rank	Sustainable development goal	Number of other goals to which the goal is connected
1	12 – Ensure sustainable consumption and production patterns	14
2	10 - Reduce inequality within and among countries	12
3	1. End poverty in all its forms everywhere	10
4	8 - Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all	10
5	2 - End hunger, achieve food security and improved nutrition and promote sustainable agriculture	8
6	3 - Ensure healthy lives and promote well-being for all at all ages	8
7	5 - Achieve gender equality and empower all women and girls	8
8	4 - Ensure inclusive and equitable quality education and promote lifelong learning	7

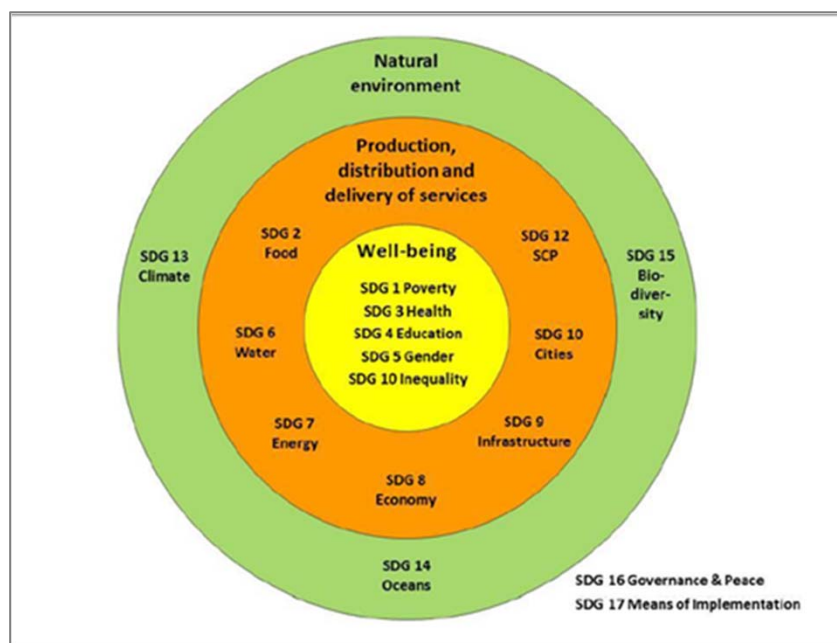
SDGs as a network of targets (Le Blanc, 2015)



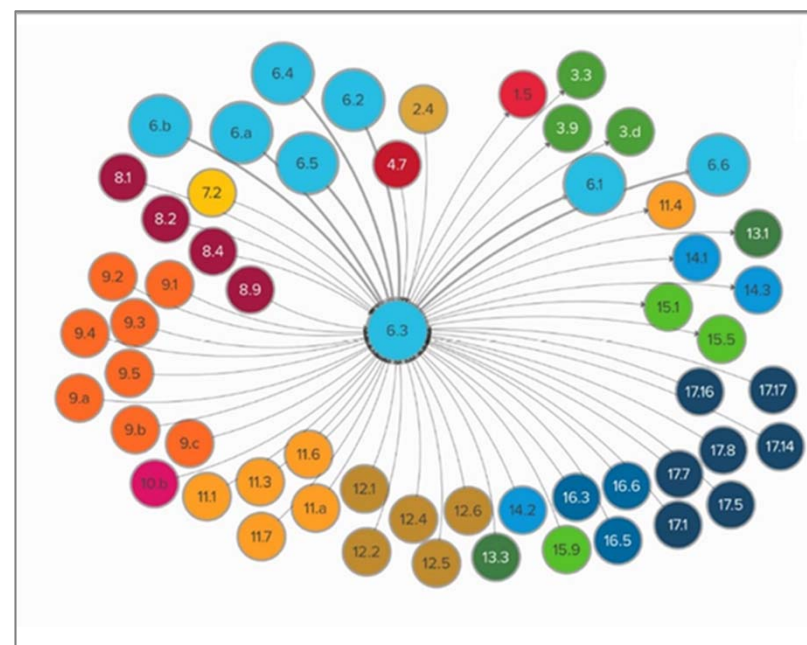
	KEY INTERACTIONS AT THE GOAL LEVEL	KEY INTERACTIONS AT THE TARGET LEVEL
Goal 2	Goal 1, Goal 3, Goal 5, Goal 6, Goal 7, Goal 13, and Goal 15	75 target-level interactions: 50 (positive), 1 (neutral) and 24 (negative)
Goal 3	Goal 1, Goal 2, Goal 8, Goal 11, and Goal 13	86 target-level interactions: 81 (positive) and 5 (negative)
Goal 7	Goal 1, Goal 2, Goal 6, Goal 8, and Goal 13	58 target-level interactions: 46 (positive), 10 (neutral) and 2 (negative)
Goal 14	Goal 1, Goal 2, Goal 8, Goal 11, Goal 12, and Goal 13	96 target-level interactions: 61 (positive), 1 (neutral) and 35 (negative)

Key interactions at the goal and target level (ICSU, 2017)

Others took a nexus approach (clustering of linked issues)



Framework for clustering the SDGs (Niestroy, 2016)

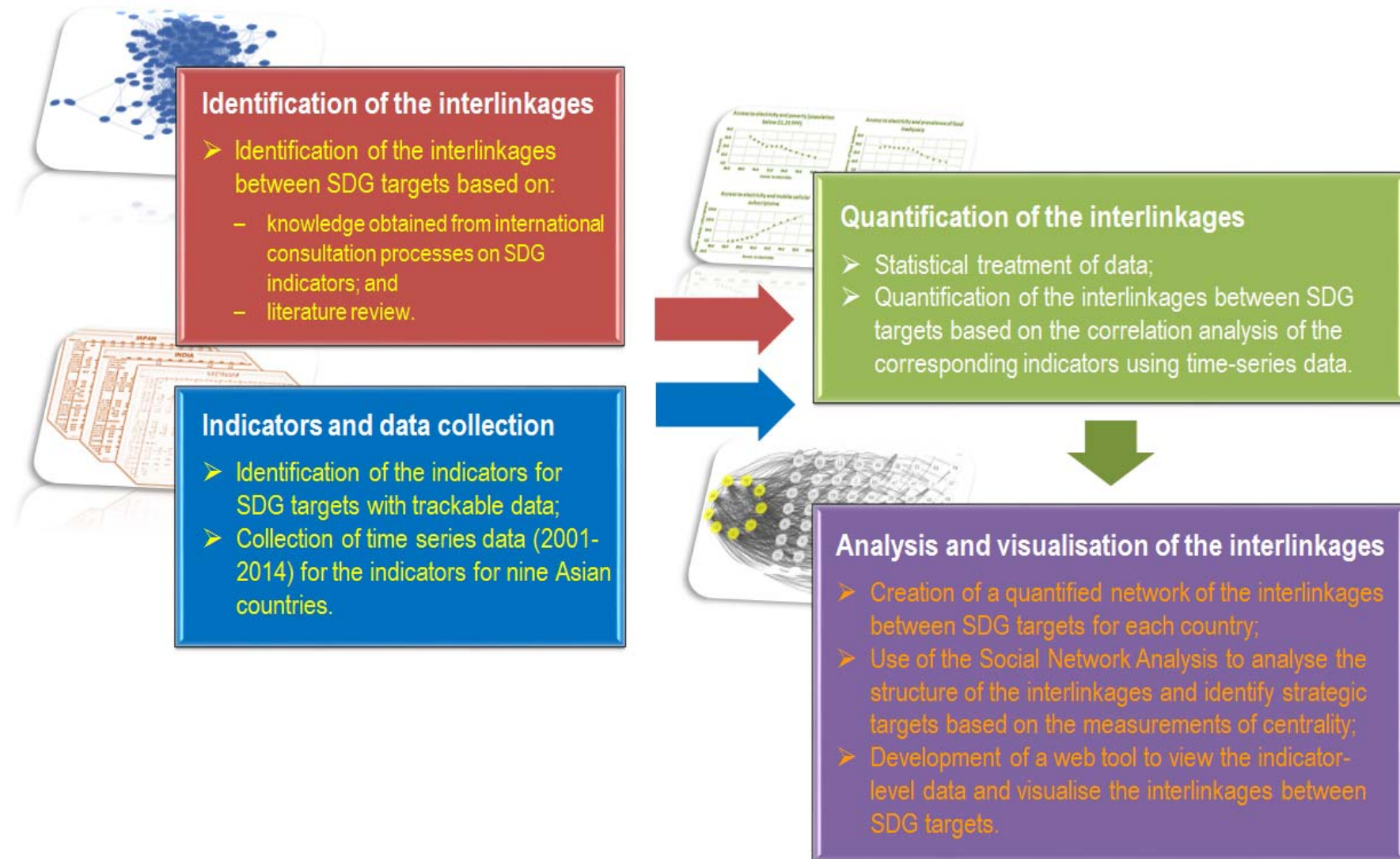


Interlinkages of water-related Target 6.3 as identified by the ESCAP study (ESCAP, 2017)

Substantial gaps in existing knowledge

- **Comprehensive study on the interlinkages** between SDG targets which covers all the 169 targets is lacking. There are, however, some on-going efforts on this (e.g. ICSU's guide to SDG interactions (2017) covering SDGs 2, 3, 7 and 14).
- **Quantification of the SDG interlinkages** is limited in the existing literature though there are few works on categorizing different types of interlinkages with pre-defined weights (Nilsson, et al., 2016; ICSU, 2017, etc.)
- Most of the existing works are limited to the study on the general structure of the SDG interlinkages through identification of the interlinkages in general. **Identification and quantification of the SDG interlinkages** at national level is still missing.
- The focus of most existing works is placed on the identification of the interlinkages. There is little literature which provides **comprehensive analysis on the structure of the network of SDG interlinkages**.

IGES' SDG Interlinkages Analysis and Visualization Tool (Version 1)



Identification of the causal links between SDG targets

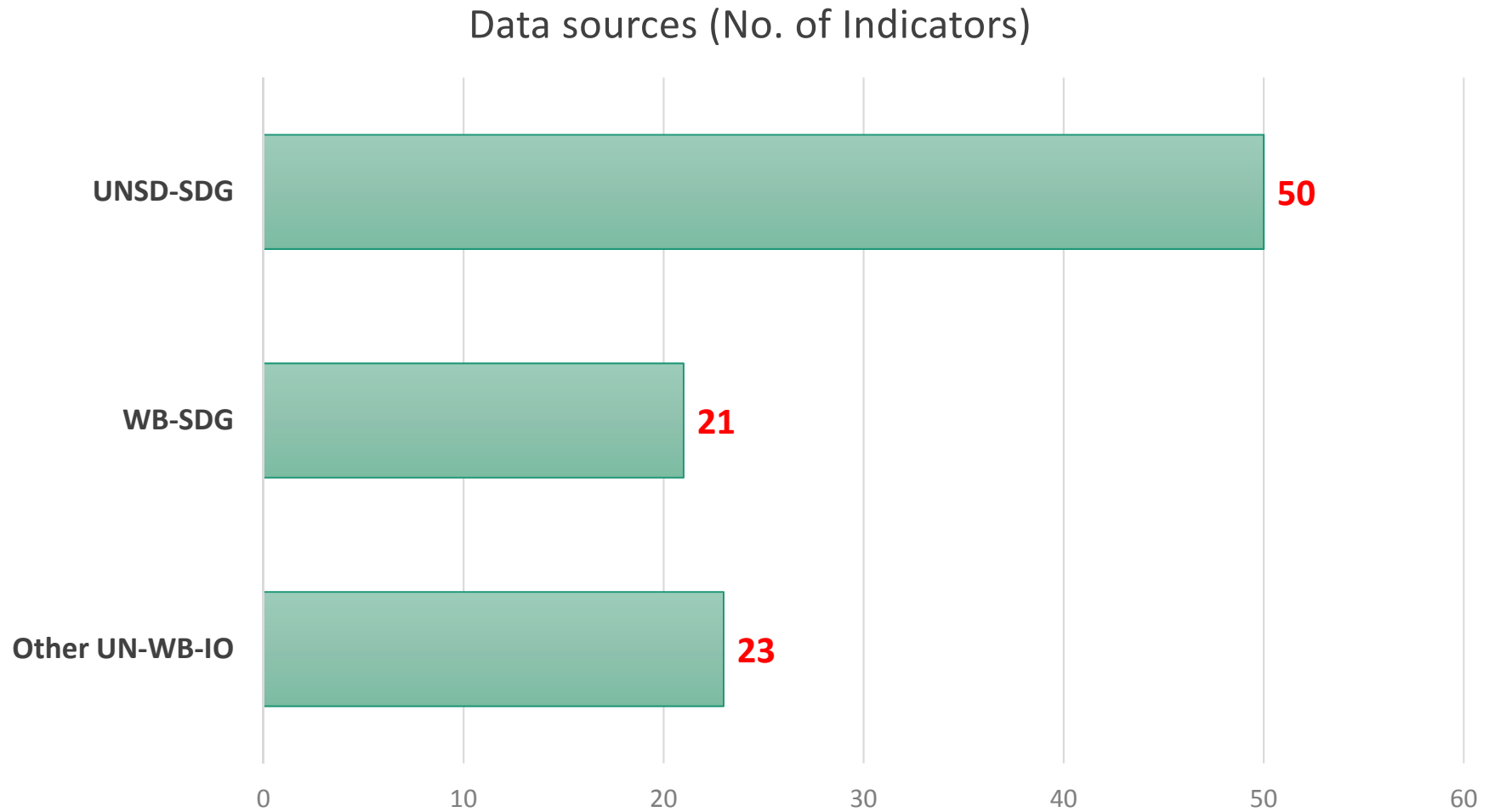
The binary causal links (0,1) between SDG targets, with 1 indicating the existence of the causal relation between the pair of SDG targets and 0 indicating no obvious causal relations between two targets, are identified based on literature review.

No.	Reference code	SDG coverage	Type of interlinkages/G-G, G-T, T-G, T-T
1	IAEG-SDGs	All	T-T
2	SDSN-1	All	T-T through shared indicators.
3	SDSN-Shared indicators	All	T-T through shared indicators.
4	ESCAP-SDG6	SDG6	T-T
5	WEF-Nexus	SDG2, SDG6 and SDG7.	T-T
6	UNECOSOC	All	G-T (for all SDGs except SDG17), G-G (SDG17)
7	UNCTAD-Trade	Trade-related SDGs	T-T (trade-related targets link with each other)
8	IOM-Migration	Migration-related SDGs	T-T (migration-related targets link with each other)
9	Stakeholder Forum_1	All except for SDG17	G-G, T-G, T-T
10	Stakeholder Forum_SDG12	SDG12	T-T

SDG targets, indicators and data

- The Global Indicators Framework adopted by the UN General Assembly in July 2017 contains 232 Indicators.
- SDSN 100 indicators for global monitoring was used in Version 1 of the Web Tool (2015-2016). Time-series data (2000-2014) for 51 indicators for nine Asian countries were collected.
- Now Version 2 is under construction using global indicators and the following steps are used to identify the indicators for corresponding targets
 - Check major data sources for data availability
 - UNSD SDG indicators database
 - World Bank SDG database
 - Other UN/World Bank databases
 - Other sources
 - Identification of the best representative indicator (only one) for each of the targets
 - Indicators with data for at least two time points (years) have been considered.

94 SDG indicators and data sources are identified



Statistical treatment for the missing data

- Data for many of the indicators are infrequent, sometimes available for only 2 or 3 data points.
- To fill in the data gaps for particular indicators in making the full time series, statistical method based on Compound Annual Growth Rate (CAGR) was applied to populate the missing data.

An example of data treatment using statistical method for two poverty indicators

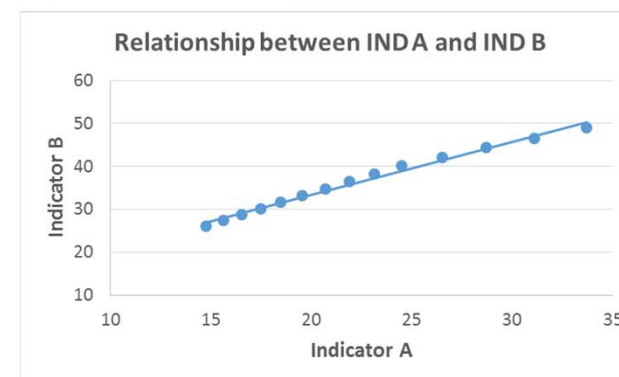
Indicators/ short name	Original data		Modified data by CAGR	
	Population below \$1.90 (2011 PPP) per day	Population below national poverty line	Population below \$1.90 (2011 PPP) per day	Population below national poverty line
Unit	percent	percent	percent	percent
2001			20.39	55.79
2002			19.77	53.86
2003			19.18	52.00
2004	18.60	50.20	18.60	50.20
2005			18.02	48.40
2006			17.46	46.67
2007	16.92	45.00	16.92	45.00
2008	10.13	34.00	10.13	34.00
2009	4.95	23.90	4.95	23.90
2010	4.60	22.10	4.60	22.10
2011	3.37	20.50	3.37	20.50
2012	2.17	17.70	2.17	17.70
2013			1.44	14.69
2014			0.95	12.19

Note: Values in red are the data generated using CAGR.

Quantification of the SDG interlinkages

- Quantification of the causal links that are identified as 1 in the binary links identification was conducted based on the correlation analysis of the time-series data of the indicators corresponding to relevant targets.
- The correlation coefficients, ranging between $[-1, 1]$, indicate the linear relationship between each pair of targets.
 - Positive coefficients (e.g. 0.9) represent positive linear relations and negative ones (e.g. -0.2) represent negative linear relations.
 - Coefficients with larger absolute value (e.g. 0.9 with absolute value of 0.9) indicate stronger linear relationships between the two targets and those with smaller absolute value (e.g. -0.2 with absolute value of 0.2) indicate weaker linear relationships.

Year	IND A	IND B
2001	33.74	48.90
2002	31.15	46.50
2003	28.76	44.23
2004	26.55	42.06
2005	24.51	40.00
2006	23.17	38.14
2007	21.91	36.36
2008	20.72	34.67
2009	19.59	33.05
2010	18.52	31.51
2011	17.51	30.04
2012	16.56	28.64
2013	15.65	27.31
2014	14.80	26.04
Correlation coefficients	0.9951	



IGES SDG Interlinkages and Data Visualisation Web Tool (free online at <https://sdginterlinkages.iges.jp/>)

1 Select One Country

User can select a country from here.

2 Select Sustainable Development Goals (SDGs)

User can select Goals from here.

3 Select SDG Targets & Indicators (See more)

User can select Targets from here.

4 For example, here we selected Japan, Goal 13 on climate action and Target 13.2 on integrating climate change measures into national policies. Target 13.2 has potential synergies with many targets of Goal 7 (energy) and other targets under Goal 13 but possible trade-offs with some targets of Goal 8 (jobs and growth), Goal 9 (Industry and infrastructure) and Goal 6 (water and sanitation).

5

6 Visualisation of interlinkages in a network

Economic targets

Social targets

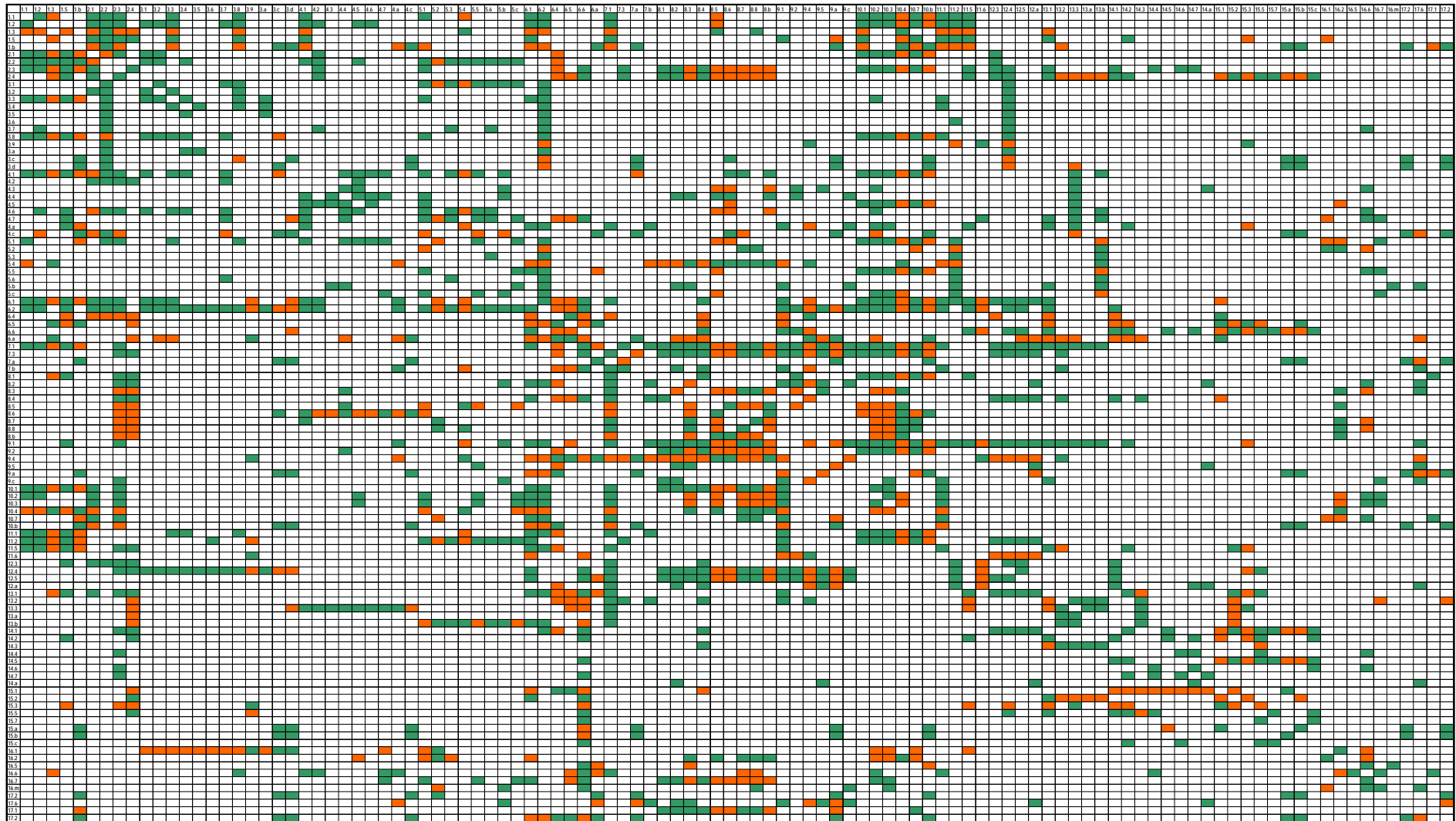
Means of implementation

Other environmental targets

Note: i) Each node represents one SDG Target, e.g. Target 1.1, with yellow ones indicating the selected target.
 ii) Each line with an arrow linking two nodes represents a directional/causal link between two Targets, e.g. from Target 1.1 to Target 1.2. The value over the line (by putting the cursor on the line) indicates the strength of the linear relationship between the pair of targets.
 iii) A line in black represents a positive link and a line in red represents a negative link.

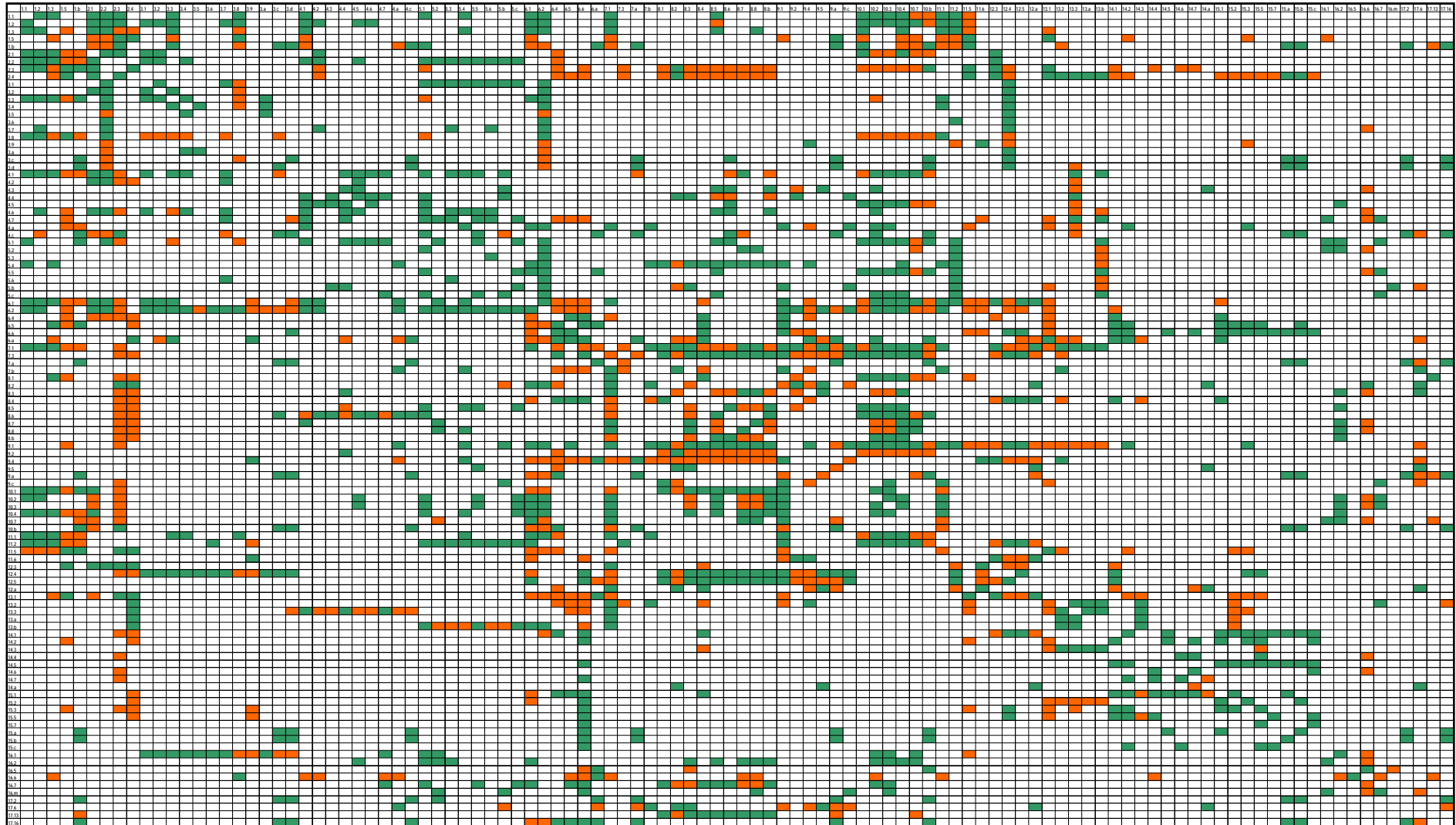
Source: A snapshot taken from IGES SDG Interlinkages and Data Visualisation Web Tool for Japan.

The dashboards for Bangladesh indicating potential reinforcing (green) and conflicting (red) interlinkages



Bangladesh

The dashboards for Japan indicating potential reinforcing (green) and conflicting (red) interlinkages



Japan

Network analysis of SDG interlinkages





Using centrality metrics, based on the Social Network Analysis (SNA) techniques, to analyse the structure of the network of SDG interlinkages in terms of different central roles played by specific targets.

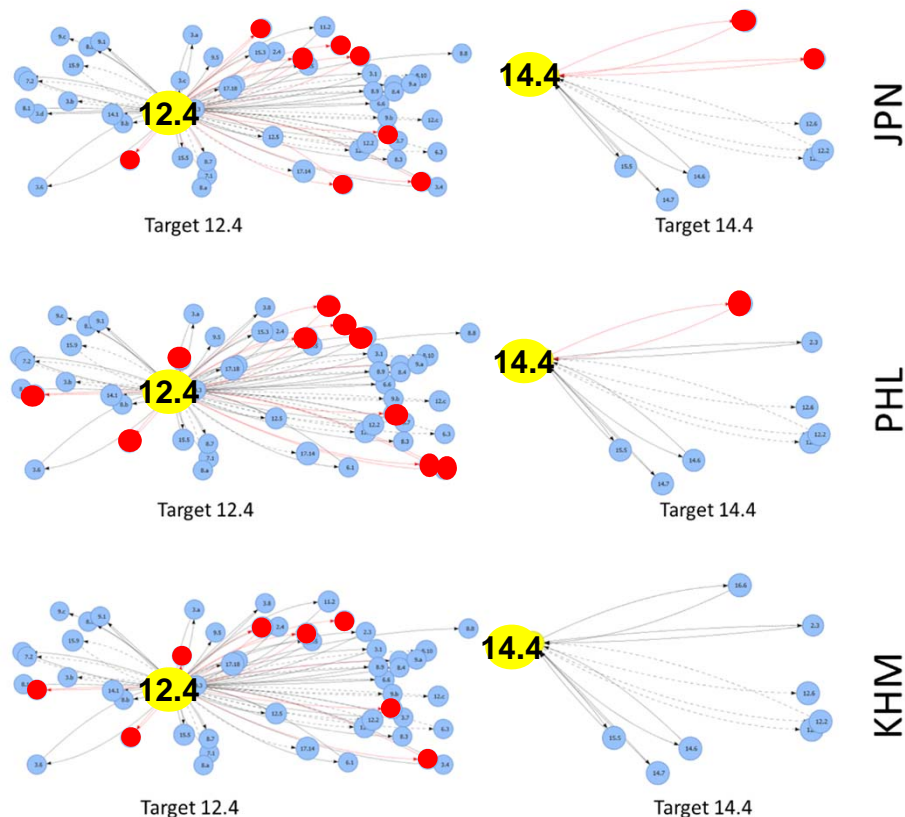
- **Degree centrality**: No. of links to a node. High value indicating the central role of a SDG target in connecting widely with others.
 - ✓ *In-degree centrality*: Receiving influences from others with positive value for reinforcing effects and negative value for conflicting effects.
 - ✓ *Out-degree centrality*: Exerting influences to others with positive value for reinforcing effects and negative value for conflicting effects.
- **Eigenvector centrality**: High eigenvector value indicating the central role of a SDG target in both connecting widely with others and strategically connecting with the influential targets.
- **Betweenness centrality**: High value indicating the central intermediate role of a SDG target in bridging unconnected targets.
- **Closeness centrality**: Low value indicating the central role of a SDG target in connecting closely (vs. remotely) with others and therefore exerting more direct influence on others.

By ranking various centrality metrics strategic targets are identified

Rank	In-degree	Out-degree	Degree	Closeness	Eigenvector	Betweenness
1	6.2	6.2	6.2	15.7	2.3	6.2
2	2.3	9.1	7.1	15.c	7.1	12.4
3	6.1	7.1	6.1	14.a	6.1	2.3
4	7.1	6.1	2.3	14.5	10.2	6.6
5	10.2	12.4	9.1	14.6	10.4	2.4
6	6.6	2.4	12.4	14.4	6.2	7.1
7	10.3	2.3	2.4	14.7	10.3	6.1
8	10.4	4.1	6.6	14.3	9.1	9.1
9	8.5	6.a	10.2	5.3	8.5	16.6
10	10.b	7.3	1.b	9.5	10.7	1.b
11	2.4	9.4	5.1	5.6	1.5	13.3
12	9.1	1.b	10.4	15.b	8.3	11.2
13	12.4	5.1	10.3	13.a	2.1	2.2
14	8.3	11.2	4.1	3.a	8.7	5.1
15	10.7	1.2	9.4	3.5	8.8	8.6
16	1.b	6.6	8.5	3.6	2.4	6.a
17	6.4	12.5	11.2	3.2	10.b	8.2
18	2.2	4.c	2.2	14.2	6.4	5.b
19	5.1	4.6	1.5	3.4	8.b	10.b
20	1.5	10.2	10.b	15.5	11.1	13.b

Country specific leverage points identified which help priority setting and efficient resource allocation

-  In the network of SDG interlinkages, different targets have varying degrees of **leverage—the extent to which they influence other targets**
-  For example, **Target 12.4** (Chemicals and wastes management) is connected with more targets than **Target 14.4** (End overfishing), suggesting it will influence more SDGs.
-  Preliminary results indicate that Targets **9.1** on resilient infrastructure, **6.6** on protecting water ecosystems, **15.a** on financial resources for sustainable ecosystems in **JPN**, Targets **2.3** on doubling agriculture productivity, **7.1** on energy accessibility, **12.4** on chemicals and wastes management in **PHL**, and Targets **10.2** on social, economic and political inclusion, **10.3** on discrimination, and **12.4** on chemicals and wastes management in **KHM** are strategic targets.
-  Setting strategic targets as priorities helps maximize synergies, minimize trade-offs and in particular optimize limited resources in developing countries.



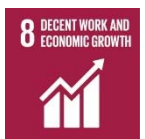
Source: Snapshots taken from IGES SDG Interlinkages and Data Visualisation Web Tool (<https://sdginterlinkages.iges.jp/>).

Finance under Goal 17: 10 targets and 11 indicators











Targets	Indicators
17.1 Capacity building for tax collection in developing countries	17.1.1 Total government revenue as share of GDP 17.1.2 Proportion of domestic budget funded by domestic taxes
17.2 Implement ODA commitments	17.2.1 Net ODA as a proportion of OECD countries' GNI
17.3 Mobilize financial resources for developing countries	17.3.1 FDI, ODA and South-South cooperation as share of domestic budget
17.4 Attain long-term debt sustainability for developing countries	17.4.1 Debt service as share of exports of goods and services
17.5 Promote investment in LDCs	17.5.1 Countries implement investment promotion regimes for LDCs
17.7 Promote environmental technology transfer to developing countries	17.7.1 Funding for developing countries to promote transfer of environmental technologies
17.9 International support for sustainable development capacity building in developing countries	17.9.1 Financial and technical assistance to developing countries
17.16 Enhance global and multistakeholder partnership to share technologies and mobilise financial resources	17.16.1 Countries reporting progress in multistakeholder
17.17 Promote multistakeholder partnerships	17.17.1 Amount committed to PPP and civil society partnerships
17.19 Measure sustainable development	17.19.1 Resources available to strengthen statistical capacity in developing countries

Finance in other SDGs: 28 targets and 30 indicators

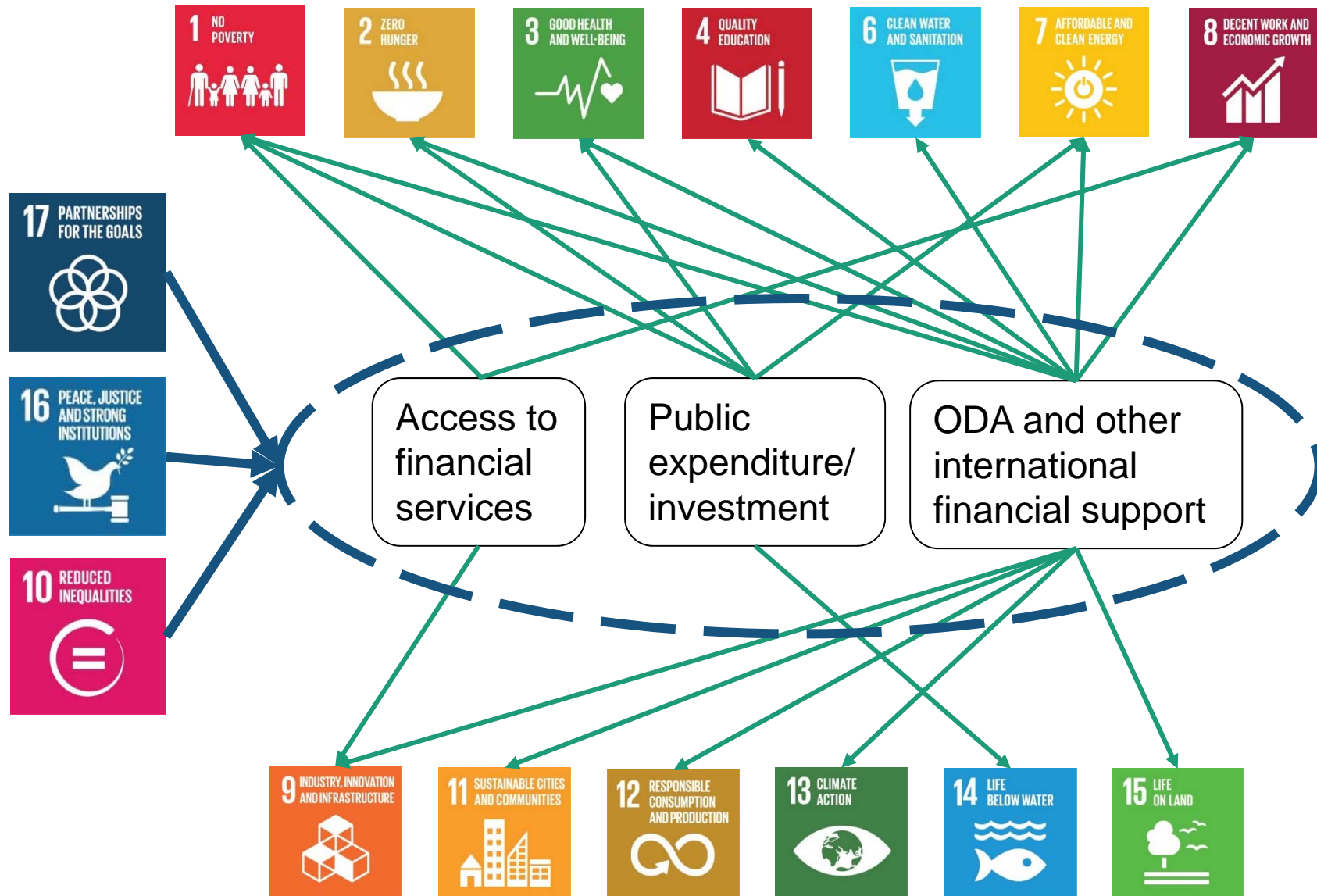


Targets	Indicators
1.4 Full access to economic resources and basic services including financial services	1.4.1 Population with access to basic services
1.a Mobilize resources for ending poverty	1.a.1 Proportion of governmental expenditure on poverty reduction 1.a.2 Proportion of governmental spending on education, health and social protection 1.a.3 ODA on poverty reduction for recipient countries (% of GDP)
2.a Investment in agriculture extension programs	2.a.1 Agriculture orientation index for governmental expenditure 2.a.2 ODA and other official flows to agriculture sector
3.8 Universal health coverage	3.8.2 Population with large health expenditures in total household income
3.b Access to essential medicines	3.b.2 Total ODA to medical research and basic health sectors
3.c Increase health financing and workforce	3.c.1 Health worker density and distribution
4.b Expand scholarships for developing countries	4.b.1 ODA for scholarships
6.a Enhance international cooperation on water and sanitation	6.a.1 Amount of ODA on water and sanitation
7.a Enhance international cooperation on clean energy R&D	7.a.1 International financial flows to developing countries on clean energy R&D
7.b Expand energy infrastructure	7.b.1 Investment in energy efficiency as share in GDP
8.3 Support productive activities through access to financial access	8.3.1 Proportion of informal employment
8.10 Strengthen domestic financial institutions and expand access for all	8.10.1 No. of commercial bank branches/ATMs per 100,000 adults
8.a Increase Aid for Trade	8.a.1 Aid for trade commitments and disbursements

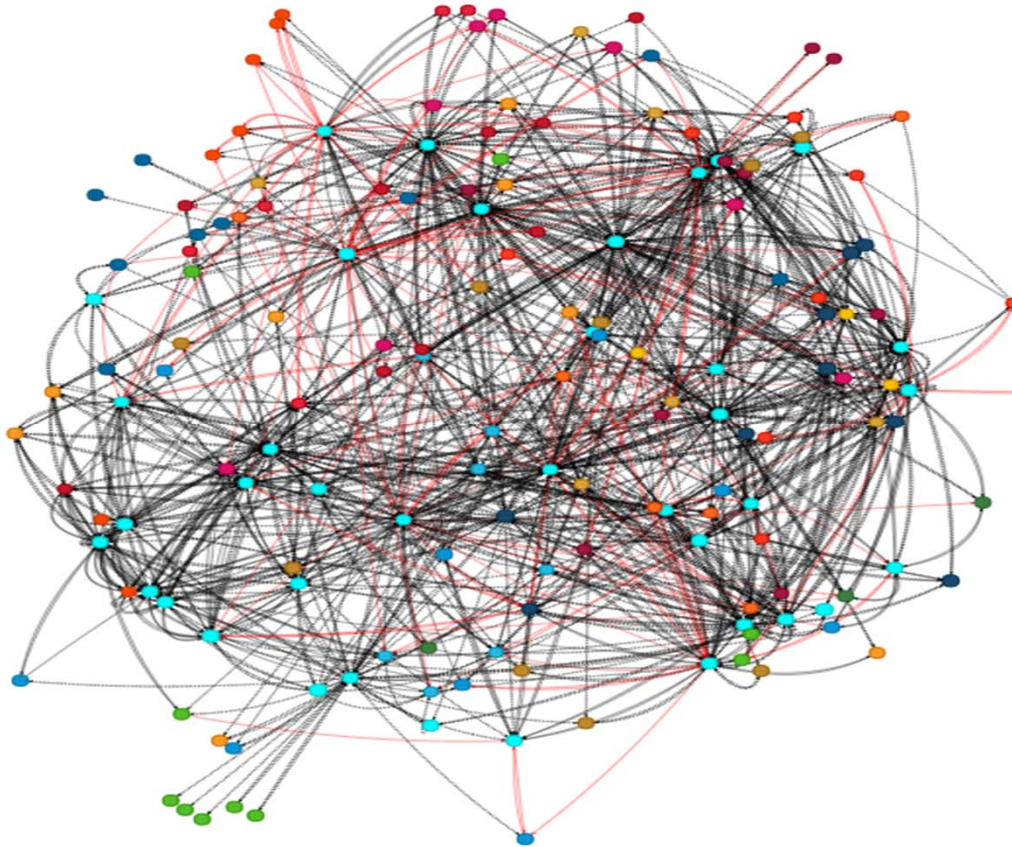
Finance in other SDGs: 28 targets and 30 indicators

	Targets	Indicators
	9.3 Increase access to financial services for small-and-medium enterprises	9.3.2 Proportion of small-scale industries with a loan
	9.a Enhance international aid to build resilient infrastructure	9.a.1 ODA and other international support to infrastructure
	10.5 Improve the regulation of global financial markets and institutions	10.5. Financial Soundness Indicators
	10.6 Representation of developing countries in international economic and financial institutions	10.6.1 Proportion of members of developing countries in international organisations
	11.4 Protect cultural and natural heritage	11.4.1 Total expenditure per capita spent on cultural and heritage protection
	11.c Support building resilient buildings in LDCs	11.c.1 Proportion of financial support to LDCs on buildings
	12.a Support R&D capacity of developing countries for SCP	12.a.1 Amount of support to developing countries on R&D for SCP
	12.c Remove market distortions	12.c.1 Amount of fossil-fuel subsidies as share of GDP
	13.a Finance developing countries for mitigation	13.a.1 Mobilise amount of USD/yr (2020-2050) for \$100 billion commitment
	13.b Enhance capacity for climate change planning for LDCs	13.b.1 No. of LDCs received various support including finance
	14.a Increase R&D on marine technology	Proportion of total R&D budget allocated to marine technology
	15.a Mobilize financial resources for sustainable use of ecosystems	15.a.1 ODA and public expenditure on natural conservation
	15.b Finance sustainable forest management	15.b.1 ODA and public expenditure on natural conservation
	16.4 Reduce illicit financial and arms flows	16.4.1 Total value of illicit financial flows
	16.6 Develop accountable institutions	16.6.1 Government expenditure as a proportion of original approved budget

Framework of finance in SDGs



38 finance targets and interlinkages with SDGs



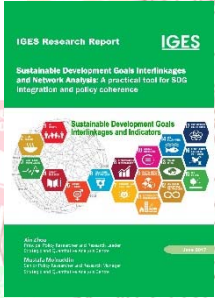
- 38 finance targets and 1772 links with other targets.
- There are some common areas linked with multiple finance targets. For these areas, coordination and collaboration between financial resources can help efficient resource use and allocation.
- There are specific areas related to single finance target. Also achieving some finance targets may generate negative impacts on other SDGs. Sustainability oriented financial assessment is necessary to avoid trade-offs.

Policy implications

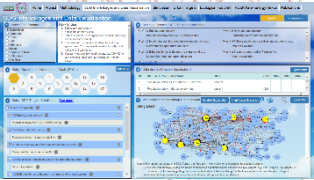
- Finance through expanded access to financial services, governmental investment/expenditure, and international aid in various sectors, in particular poverty reduction, food security, health care, education, infrastructure, urban development, and environmental conservation may generate both positive and negative impacts on other areas. SDG interlinkages analysis help conduct financial impact assessment and inform decision-making.
- The common leverage areas for generating positive spillover effects can be set as priority areas for investment and making use of effective financial mechanisms.
- Finance through FDI and ODA, etc. has profound impacts on cross-border SDG interlinkages which requires further study. This can be set as future research agenda.

Thank you!

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