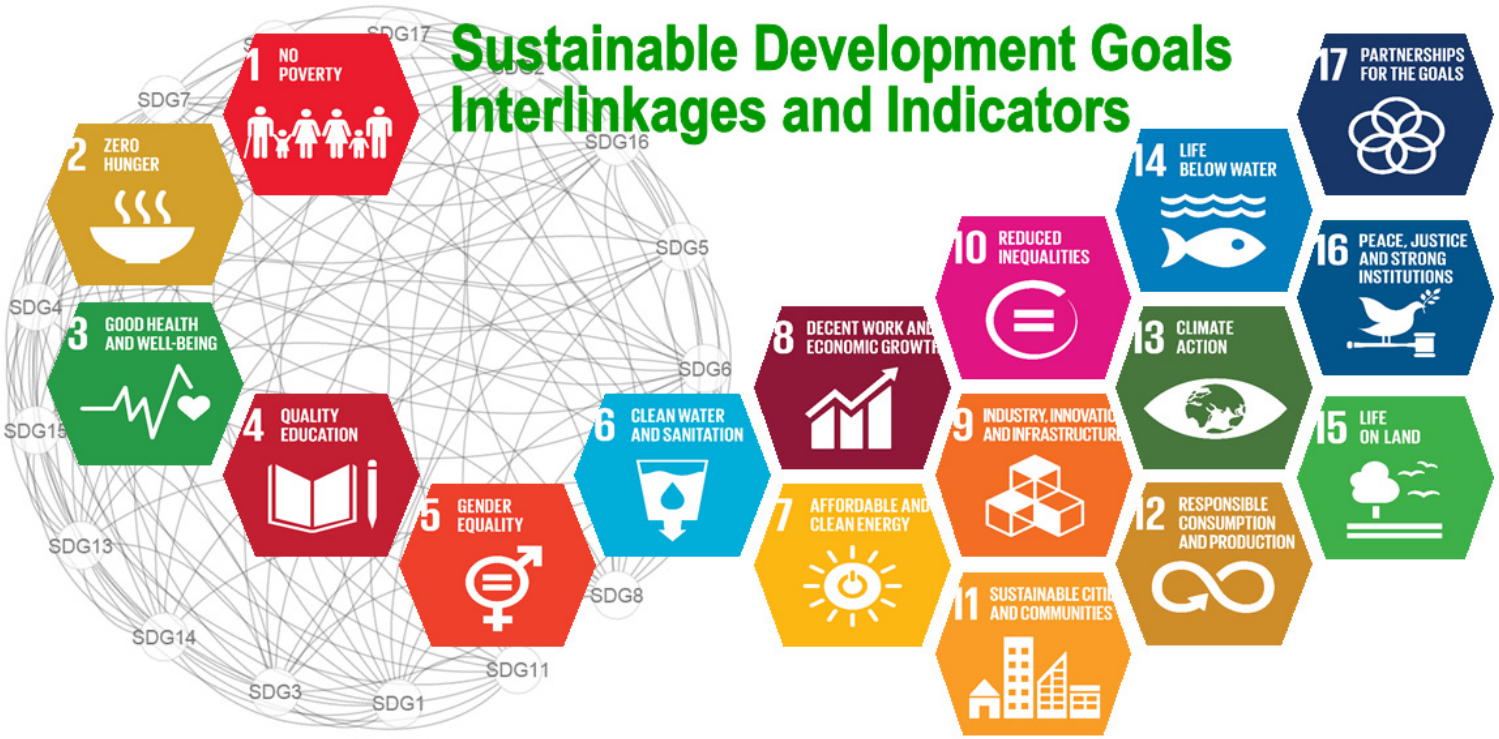
IGES Research Report

Sustainable Development Goals Interlinkages and Network Analysis: A practical tool for SDG integration and policy coherence



Xin Zhou
Principal Policy Researcher and Research Leader
Strategic and Quantitative Analysis Centre

Mustafa Moinuddin
Senior Policy Researcher and Research Manager
Strategic and Quantitative Analysis Centre

June 2017

IGES Research Report No. RR1602

Sustainable Development Goals Interlinkages and Network Analysis: A practical tool for SDG integration and policy coherence

June 2017

Xin Zhou
Principal Policy Researcher and Research Leader
Strategic and Quantitative Analysis Centre

Mustafa Moinuddin
Senior Policy Researcher and Research Manager
Strategic and Quantitative Analysis Centre

Institute for Global Environmental Strategies (IGES)

Sustainable Development Goals Interlinkages and Network Analysis

A practical tool for SDG integration and policy coherence

This report was financially supported by the Strategy Research Fund of the Institute for Global Environmental Strategies (IGES).

Edited by

Xin Zhou and Mustafa Moinuddin

Dr. Xin Zhou
Principal Policy Researcher and Research Leader
Strategic and Quantitative Analysis Centre (QAC)
Institute for Global Environmental Strategies (IGES)
2108-11 Kamiyamaguchi, Hayama, Kanagawa, 240-0115 Japan
Tel: +81 (0)46 855 3863; E-mail: zhou@iges.or.jp
URL: http://www.iges.or.jp

Dr. Mustafa Moinuddin
Senior Policy Researcher and Research Manager
Strategic and Quantitative Analysis Centre (QAC)
Institute for Global Environmental Strategies (IGES)
2108-11 Kamiyamaguchi, Hayama, Kanagawa, 240-0115 Japan
Tel: +81 (0)46 855 3817; E-mail: moinuddin@iges.or.jp
URL: http://www.iges.or.jp

ISBN: 978-4-88788-199-0

Printed on recycled paper.

Cover design by Xin Zhou.

Summary

The 2030 Agenda, adopted by the world leaders in September 2015, charts out a set of 17 Sustainable Development Goals (SDGs) and 169 associated targets to embark on a new path of human development for eradicating poverty everywhere and providing a better life for all over the next fifteen years.

Aiming at integrating and balancing the three dimensions of sustainable development, the 2030 Agenda and the SDGs address a wide scope of issues such as poverty eradication, gender equality, climate change mitigation, quality education and so forth. While being broadly framed as 17 separate and diverse elements, goals and associated targets inherently interlink with one another making up indivisible parts from a systemic perspective. Actions or measures taken for achieving one goal may be mutually reinforcing or contradictory with achieving other goals. The framework of the SDGs with a wide spectrum covering 17 goals and 169 targets offers a good opportunity to take an integrated approach to seek and scale up the synergies, and mitigate and eliminate the trade-offs through horizontal integration across sectors and vertical collaborations across various administrative levels.

SDGs and associated targets through the connections among and between each other form a complicated network of interlinkages. Understanding the interlinkages among the goals and between the targets is crucial for integrated governance and policy coherence in implementing the SDGs. Against this backdrop, however, there are substantial gaps in the existing knowledge on the analysis of SDG interlinkages.

i) Comprehensive studies on the interlinkages between SDG targets which cover all the 169 targets are inadequate and underdeveloped. There are some ongoing works on this issue, such as ICSU's guide to SDG interactions, but complete studies are not yet available.

ii) 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.

iii) 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. But identification and quantification of these interlinkages at national level are still missing.

iv) The focus of most existing works is placed on the identification of the interlinkages. There is hardly any literature which provides comprehensive network analysis on identified SDG interlinkages.

All these limitations constrain the application of SDG interlinkages as practical knowledge supporting SDG integration and policy coherence. To echo these knowledge gaps in the existing literature, the Institute for Global Environmental Strategies (IGES) initiated a project entitled "*Sustainable Development Goals, Targets and Indicators*", supported by the Strategic Research Fund of IGES. The main purpose of this research report focuses on presenting an integrated analytical framework on the network analysis of SDG interlinkages between targets which are then applied to the interlinkages analysis and visualisation for nine selected Asian countries, namely Bangladesh, Cambodia, China, India, Indonesia, Japan, the Philippines, Republic of Korea and Viet Nam.

A novel analytical framework based on social network analysis

The focus of the SDG interlinkages analysis is placed on the interlinkages between SDG targets. The binary linkages between each pair of the 169 SDG targets (with "0" assigned to the pair targets which do not connect with each other and "1" assigned to those pair targets which have potential relationship between them) are identified using a synthesised approach based on extensive review of the existing scientific literature and relevant policy documents provided by major international policy processes working on SDGs and indicators. This enables to construct a directed network of SDG interlinkages assumed to present the causal links between the targets. 51 indicators with trackable data for nine countries are selected and mapped with 108 targets (out of 169 targets due mainly to lacking of trackable data). Identified linkages are then quantified based on the analysis of the indicator-level time-series data corresponding to the associated targets for nine selected countries.

Using Social Network Analysis (SNA) techniques, the general structure of the SDG interlinkages network and the distinguished features of country-specific quantified SDG networks are analysed based on an array of centrality measures including degree centrality (measuring how wide of direct connections), eigenvector centrality (measuring both how wide of direct connections and whether being connected with influential targets), betweenness centrality (measuring the bridging roles between unconnected targets) and closeness centrality (measuring the distance separating from others), etc. Top strategic targets which play various central roles in the network are identified for individual countries by ranking against various centrality measures. Country-specific dashboard matrices indicating potential synergies and trade-offs between SDG targets are provided.

Policy implications

Based on the identification, quantification and analysis of SDG interlinkages between targets, some conclusions and associated policy implications are drawn up as follows.

i) *The structure of the SDG interlinkages network featured by dense and complicated*

interactions between SDG targets implies that an integrated approach for SDG implementation is needed.

From an institutional arrangement point of view, a silo approach which maximises sectoral interests by artificially breaking up the inherent connections between sectors and among various actors has been demonstrated as inappropriate, particularly when dealing with the relations between economic growth and preservation of the environment. The nature of the network of SDG interlinkages with complicated interactions between SDG targets (see an image of a complicated SDG interlinkages network in **Figure s-1**) requires an integrated approach for SDG planning, implementation and governance arrangement.

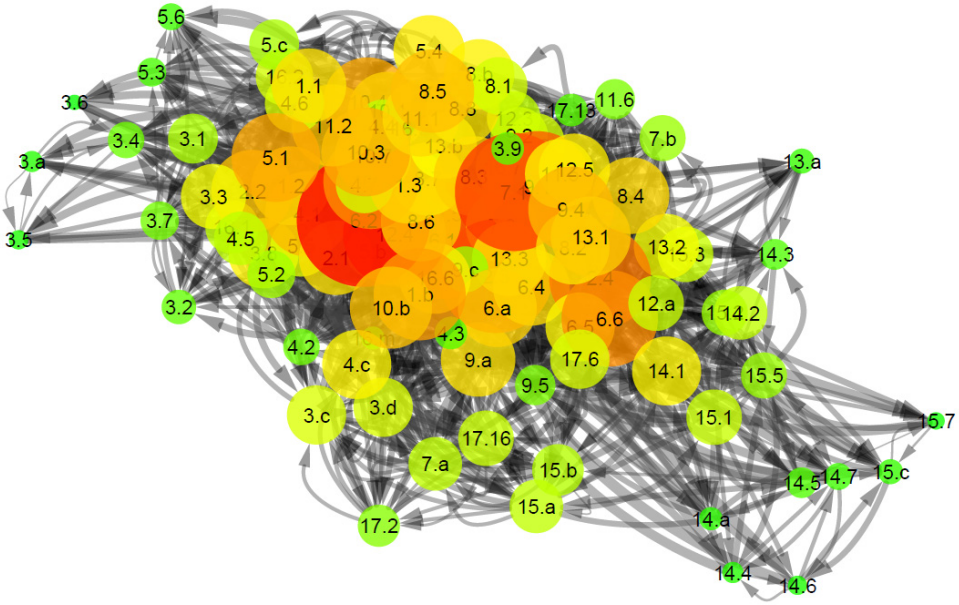


Figure s-1 A complicated network of SDG interlinkages between SDG targets

Note: Each node indicates an SDG target and each directed link indicates the causal relations between a pair of targets. The size and colour of a node indicate how many links a node has with others. The thickness of the connecting lines indicate how strong the links are.

ii) Identification of top central SDG targets in the SDG network ranked by various centrality measures based on Social Network Analysis techniques provides relevant knowledge supporting national priority setting for SDG planning and implementation.

The ranking results of SDG targets against various centrality measures (see **Table s-1** as an example) indicate that Target 2.3 (double agriculture productivity), Target 2.4 (build sustainable food production systems), Target 6.1 (universal access to safe drinking water), Target 6.2 (universal access to sanitation and hygiene), Target 7.1 (universal access to energy) and Target 9.1 (develop resilient infrastructure) are the most influential targets in the

network attributable to their multiple central roles played in terms of having wider connections with other targets (measured by degree centrality) by both exerting influences and receiving influences (measured by in-degree and out-degree centrality), being important intermediates bridging unconnected targets (measured by betweenness centrality) and placing at strategic positions in connecting with other influential targets (measured by eigenvector centrality).

Table s-1 Preliminary results on top 10 central targets ranked by various centrality measures

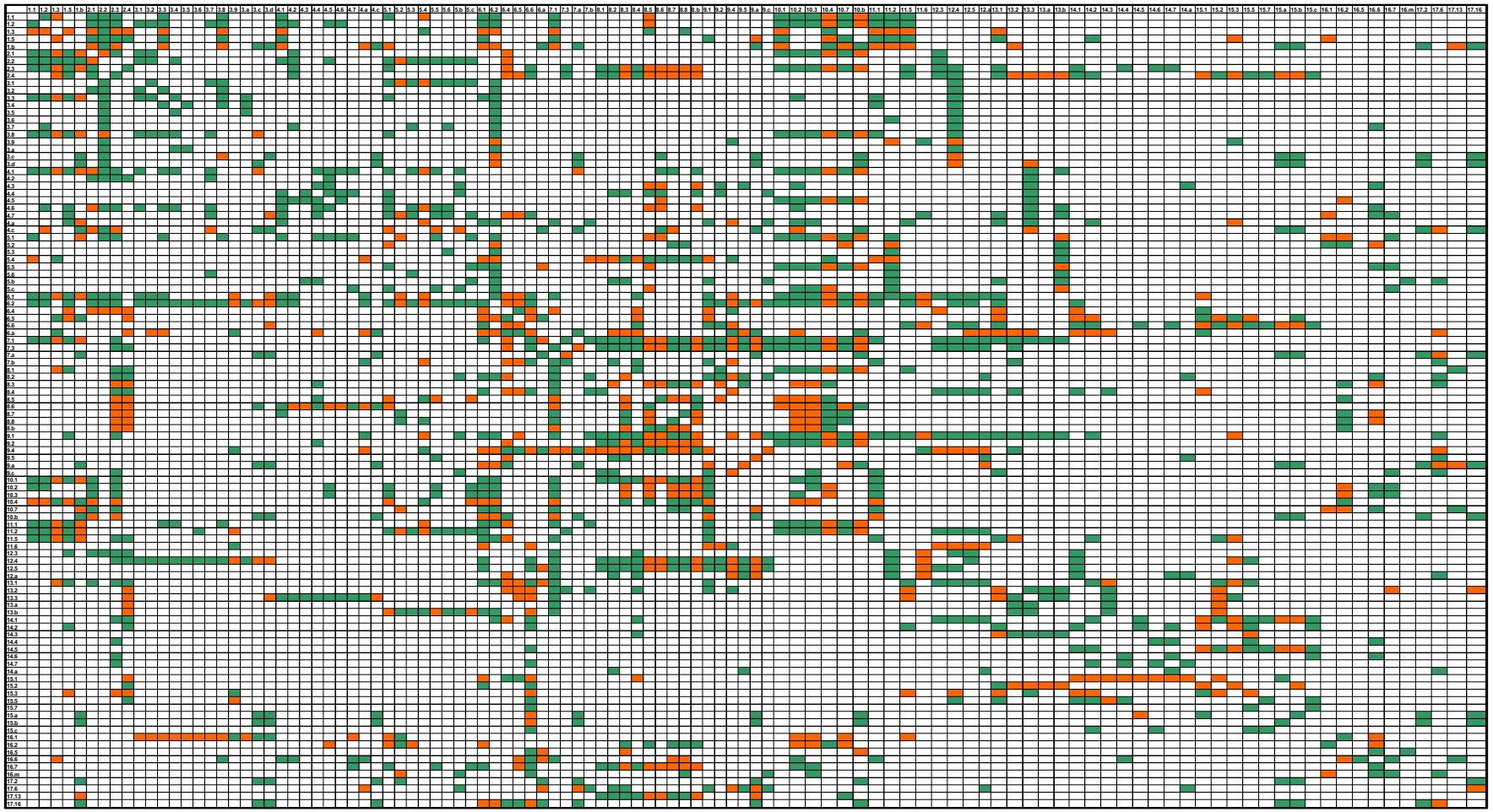
Rank	In-degree	Out-degree	Degree	Closeness	Eigenvector	Betweenness
1	6.2	6.2	6.2	15.7	2.3	6.2
2	2.3	9.1	7.1	15.c	7.1	12.4
3	6.1	7.1	6.1	14.a	6.1	2.3
4	7.1	6.1	2.3	14.5	10.2	6.6
5	10.2	12.4	9.1	14.6	10.4	2.4
6	6.6	2.4	12.4	14.4	6.2	7.1
7	10.3	2.3	2.4	14.7	10.3	6.1
8	10.4	4.1	6.6	14.3	9.1	9.1
9	8.5	6.a	10.2	5.3	8.5	16.6
10	10.b	7.3	1.b	9.5	10.7	1.b

Ranking of top central targets based on the structural analysis of the network of SDG targets can be used as a practical tool by relevant international or regional policy processes working on the SDGs, indicators and interlinkages, such as IAEG-SDGs, SDSN, OECD and ESCAP, etc. as well as national governments in guiding priority setting around central targets which play various influential roles in connecting with other targets in the network.

iii) *Country-specific dashboards indicating potential synergies and trade-offs between SDG targets provide practical knowledge for integrated governance and policy coherence.*

A dashboard matrix indicating potential reinforcing (positive links indicated by green) and conflicting (negative links indicated by red) linkages between 108 targets is developed for individual countries (see an example for Bangladesh in **Figure s-2**). Heterogeneous features of the quantified network of SDG interlinkages at the national level implies the importance of respecting national circumstances and customising the means of implementation for achieving the SDGs to best match with national unique circumstances. The country-specific dashboards can be used as a practical tool guiding national planning, integrated institutional arrangements and joint implementation at the national level by providing relevant knowledge on where synergies and trade-offs between SDG targets will be.

Figure s-2 Dashboard for Bangladesh indicating potential reinforcing (in green) and conflicting (in red) linkages between 108 targets



Notes: This is a square matrix of 108 by 108 targets. Entries without colour indicate there are no potential links between the pair of targets.

iv) *A web tool on **SDG Interlinkages and Data Visualisation**, provided as a handy and practical communication and analytical tool, is expected to support national SDG planning and policy integration across 17 SDG.*

A web tool on SDG Interlinkages and Data Visualisation, accessible for free on-line at http://sdginterlinkages.iges.jp/, was developed to enable users to visualise the interlinkages between SDG targets and explore indicator-level data for the nine selected countries. It is expected to be useful to the policymakers working for the international and regional policy processes on SDGs, indicators and interlinkages(such as IAEG-SDGs, SDSN and ESCAP, etc.), and to the policymakers working on planning and making institutional arrangement across ministries at the national level for the implementation of SDGs.

Limitations and the way forward

There are several limitations which may constrain the effective use of the proposed integrated approach as a practical tool supporting national SDG integration and policy coherence. These limitations includes:

- *Challenges in identification of SDG interlinkages in particular at the national level;*
- *Challenges in well-defined indicators with reliable data;*
- *Challenges in reliable and trackable data for the quantification ;*
- *Limitations in the quantification of causality;*
- *Challenges in defining the functions of the SDG network and selection of appropriate metrics for the structural analysis of the SDG network.*

Except for these technical constrains and recommendations for the solution, moving forward to the applications of the proposed integrated approach to support practical policy-making on SDG planning, implementation and monitoring will be a major task in our future agenda. We plan to initiate an iterative process on the dissemination and the promotion of the applications by sharing and learning from policy practitioners working on SDG implementation at the national level. In the initial stage, we plan to conduct a couple of detailed country studies in close collaboration with national planning agency on SDGs. This forms a major agenda for a follow-up project in July 2017 – June 2018.

Acknowledgements

This research report is an output of the project entitled "Sustainable Development Goals, Targets and Indicators" (July 2016 – June 2017) supported by the Strategic Research Fund of the Institute for Global Environmental Strategies (IGES).

Authors of this research report received various support and encouragement as well as valuable comments from many people at IGES. We are grateful to IGES President Hideyuki Mori, who initiated the project and provided his insights on the design and implementation of the project. Special thanks are given to Professor Hironori Hamanaka, former Chair of IGES Board of Directors for his invaluable comments, suggestions and support.

This research report was reviewed internally by Professor Hironori Hamanaka, Professor Kazuo Matsushita, Dr. Mikiko Kainuma, Dr. Mark Elder and Dr. Eric Zusman and externally by Professor Ming Xu (University of Michigan). Ms. Emma Fushimi at IGES provided assistance in proofreading the Report. Ms. Saeko Kadoshima provided administrative support.

The views expressed in this paper are the authors' own and should not be attributed to the Institute for Global Environmental Strategies (IGES) or any other organisations.

Acronyms and abbreviations

BDG	Bangladesh
CAGR	Compound annual growth rate
CHN	People's Republic of China
CPI	Corruption Perception Index
CO_2	Carbon dioxide
CRED	Centre for Research on the Epidemiology of Disasters
DANE	Departamento Administrativo Nacional de Estadística (Colombian National Statistics Office)
DESA	United Nations Department of Economic and Social Affairs
DIE	Deutsches Institut für Entwicklungspolitik/ German Development Institute
ECOSOC	United Nations Economic and Social Council
EIA	Environmental impact assessment
EIU	Economist Intelligence Unit
EM-DAT	Emergency Events Database
FA	Focus area
FAOSTAT	Food and Agriculture Organization, Statistics Division
GDP	Gross domestic product
G-G	Goal to goal
GHG	Greenhouse gases
GNI	Gross national income
G-T	Goal to target
HIPC	Highly indebted poor countries
IAEG-SDGs	Inter-agency and Expert Group on SDG Indicators
ICSU	International Council for Science
ICT	Information and Communication Technology
IDN	Indonesia
IGES	Institute for Global Environmental Strategies
IISD	International Institute for Sustainable Development
ILO	International Labour Organization
IND	India
INDC	Intended Nationally Determined Contributions
IOM	International Organization for Migration
iSDG	Integrated Model for Sustainable Development Goals Strategies
ISSC	International Social Science Council
IUU	Illegal, unreported and unregulated fishing
JPN	Japan
KHM	Cambodia

km	Kilometre
KOR	Republic of Korea
kWh	Kilowatt-hour
LDC	Least Developed Countries
MDGs	Millennium Development Goals
MSY	Maximum Sustainable Yield
MtCO2e	Megatonnes of carbon dioxide equivalent
MVA	Manufacturing value added
NCD	Non-communicable diseases
ODA	Official Development Assistance
ODC	Ozone-depleting substances
ODP	Ozone depletion potential
OECD	Organisation for Economic Cooperation and Development
OFDA	Office of Foreign Disaster Assistance
OWG	Open Working Group on Sustainable Development Goals
PCD	Policy coherence for development
PCSD	Policy coherence for sustainable development
PHL	The Philippines
PPP	Purchasing power parity
R&D	Research and Development
RDTs	rapid diagnostic tests
SDGs	Sustainable Development Goals
SDSN	United Nations Sustainable Development Solutions Network
SEA	Strategic environmental assessment
SIDS	Small Island Developing States
SNA	Social Network Analysis
SRF	IGES Strategic Research Fund
STI	Science, Technology and Innovation
tCO2e	Tonnes of carbon dioxide equivalent
T-T	Target to target
UHC	Universal health coverage
UN	United Nations
UNCLOS	United Nations Convention on the Law of the Sea
UNCTAD	United Nations Conference on Trade and Development
UNDG	United Nations Development Group
UNEP	United Nations Environment Programme
UNESCAP	United Nations Economic and Social Commission for Asia and the Pacific
UNFCCC	United Nations Framework Convention on Climate Change
UNFPA	United Nations Population Fund
UNGA	United Nations General Assembly
UNSD	United Nations Statistics Division

US$	United States dollar
VNM	Viet Nam
WDI	World Development Indicators
WEF-Nexus	Water-Energy-Food Nexus
WTO	World Trade Organization
℃	Degree Celsius
%	per cent

Table of contents

Tables

Figures

1 Introduction

Mustafa Moinuddin[1] *and Xin Zhou*[2]

The 17 Sustainable Development Goals (SDGs) of the 2030 Agenda for Sustainable Development, adopted by the world leaders in September 2015, came into force on 1 January 2016. The 2030 Agenda charts out a set of 17 Goals and 169 associated targets to embark on a new path of human development for eradicating poverty everywhere and providing a better life for all over the next 15 years. Implementation is central to achieving the SDGs and the effective review of progress and useful indicators will be essential to effective implementation. To facilitate this process, the UN Statistical Commission established an Inter-Agency and Expert Group on SDG Indicators (IAEG-SDGs) to develop a global SDG indicators framework for the follow-up and review of the 2030 Agenda (UNSD, 2016a). In February 2016, the IAEG-SDGs agreed on a global indicators framework with set of 230 indicators "as a practical starting point", which was proposed to the UN Statistical Commission during the Commission's 47th Session (UNSD, 2016b). The Statistical Commission subsequently adopted the framework at its 48th session in March 2017 (ECOSOC, 2017a and ECOSOC, 2017b).

Aiming at integrating and balancing the three dimensions of sustainable development, the 2030 Agenda and the SDGs address a wide scope of issues such as poverty eradication, gender equality, climate change mitigation, quality education and so forth. The issues, however, are very diverse in nature. The UN resolution establishing the 2030 Agenda stipulates that the SDGs and their targets are "integrated and indivisible, global in nature and universally applicable" (UNGA, 2015), but it does not elaborate how the goals/targets are interconnected with each other. Understanding of these interlinkages among the goals and between targets is crucial for policy coherence in implementing the SDGs. This is particularly true because actions or measures taken for one goal may be mutually reinforcing or contradictory with another goal. The interlinkages among the goals and between targets can help identify mutually reinforcing measures and minimise trade-offs. Some preliminary work has already been initiated for defining and mapping these interlinkages among the SDGs, which have been reviewed in the latter part of this paper.

[1] Mustafa Moinuddin, Senior Policy Researcher and Research Manager, Strategic and Quantitative Analysis Centre (QAC), Institute for Global Environmental Strategies (IGES). 2108-11 Kamiyamaguchi, Hayama, Kanagawa, 240-0115 Japan. ✉ moinuddin@iges.or.jp

[2] Xin Zhou, Principal Policy Researcher and Research Leader, Strategic and Quantitative Analysis Centre (QAC), Institute for Global Environmental Strategies (IGES). 2108-11 Kamiyamaguchi, Hayama, Kanagawa, 240-0115 Japan. ✉ zhou@iges.or.jp

The purpose of this research report is to present an interlinkages framework and some analytical options for the SDGs which have been developed by researchers at the Institute for Global Environmental Strategies (IGES). IGES initiated a project on SDG targets and indicators focusing on SDG interlinkages and data analysis. Under this project, the interlinkages between SDG targets have been identified through extensive review of scientific literature and policy documents provided by relevant international processes working on SDG indicators. The interlinkages are then quantified using historical time-series data for a set of selected indicators (for nine countries from East, Southeast and South Asia), they are then presented in a network of interlinkages and analysed using Social Network Analysis techniques. All the steps in targets and indicators selection, data collection, and interlinkages identification, quantification and analysis are explained in this report. The results of the project are made publicly available through an interactive visualisation tool on SDG Interlinkages and Data Visualisation accessible for free on-line at http://sdginterlinkages.iges.jp/ (Zhou, et al., 2017).

Part 2 of the research report provides an overall background of the SDGs, targets, indicators at the global and national levels, and give more details on the significance of SDG interlinkages analysis. Part 3 reviews some of the existing works on SDG interlinkages with gaps identification. Part 4 presents an integrated framework on the network analysis of SDG interlinkages including the analytical framework, selection of SDG indicators and data preparation, and identification and quantification of the interlinkages between SDG targets. In Part 5, the results of interlinkages network analysis using Social Network Analysis (SNA) techniques are presented. Part 6 provides the conclusions with associated policy implications. Part 7 summarises the limitations mainly from technical perspectives with the recommendations for future improvement. It also provides the way forward on the applications of the proposed approach as a practical tool supporting SDG integration for planning, governance arrangements, policy-making and monitoring.

2 SDG interlinkages and Indicators: Need for integration and policy coherence

Mustafa Moinuddin[3]

2.1 SDG indicators framework at the global and national levels

The 2030 Agenda and the SDGs provide, as the former UN Secretary General Ban Ki-moon suggested, "a road map for people and the planet that will build on the success of the Millennium Development Goals and ensure sustainable societal and economic progress worldwide" (UN, 2016). With the official start of the SDGs implementation at the beginning of 2016, the focus is now on the process of reviewing and following up of the progress through indicators. The United Nations Statistical Commission established an Inter-agency and Expert Group on SDG Indicators (IAEG-SDGs) with a mandate to develop a global indicator framework for the goals and targets (UNSD, 2016a). Since June 2015, the IAEG-SDGs has held several rounds of meetings and open consultations to develop a global SDG indicator framework. In February 2016, the Group agreed on a set of 230 indicators "as a practical starting point". The Economic and Social Council (ECOSOC) of the United Nations took note of this framework at its 70th Session in June 2016 (UNSD, 2016b). The global indicators framework with 230 indicators was subsequently adopted by the UN Statistical Commission during its 48th Session (ECOSOC, 2017a and ECOSOC, 2017b). The IAEG-SDGs, however, remains an open-ended process, since new developments relating to the indicators over the years may need to be taken into consideration.

Prior to the IAEG-SDGs, another initiative - the UN Sustainable Development Solutions Network (SDSN) - was launched in 2012 for mobilising "global scientific and technological expertise to promote practical problem solving for sustainable development", including the design and implementation of the SDGs (SDSN, 2016a). SDSN noted the significance of indicators for monitoring the progress in achieving the SDGs. The Network conducted an intensive consultation process with various stakeholders for nearly one year and a half, and then it proposed a set of 100 Global Monitoring Indicators (SDSN, 2015). A number of complementary indicators at the national level was also proposed under the same initiative.

Along with the global level developments, several other approaches at national level were also initiated to support the 2030 Agenda, particularly on data-related issues. Like the SDSN

[3] Mustafa Moinuddin, Senior Policy Researcher and Research Manager, Strategic and Quantitative Analysis Centre (QAC), Institute for Global Environmental Strategies (IGES). 2108-11 Kamiyamaguchi, Hayama, Kanagawa, 240-0115 Japan. ✉ moinuddin@iges.or.jp

initiative, some of these national approaches were launched before the IAEG-SDGs proposed the global indicators framework. The Post-2015 Data Test, for example, focused on assessing data availability of selected potential goals, targets and indicators at the national level for some low, medium and high income countries (Bangladesh, Canada, Ghana, Peru, Sierra Leone, Senegal, Tanzania, and Turkey). Along with assessing data availability, this joint initiative from the Centre for Policy Dialogue and the Norman Paterson School of International Affairs in collaboration with the Southern Voice on Post-MDG International Development Goals and Partnership for African Social and Governance Research also attempted to identify opportunities and challenges relating to the post-2015 framework (Post-2015 Data Test Homepage, 2016).

In some countries, national governments prioritised SDGs for guiding national developments plans and policy measures. Colombia, an "early leader" in embracing SDGs (SDSN, 2016b), established an Inter-Agency Commission for SDG preparation and implementation as early as in 2015 (Espey, 2015). The country started aligning its national priorities of the governmental agencies with SDGs. The Colombian national statistics office (DANE) initiated working on identifying the means for mapping the existing national level datasets with the SDG indicators, and to finding appropriate means to track these indicators (SDSN, 2016b).

2.2 Interlinkages in focus

As noted earlier, although individual SDGs and targets address specific issues pertaining to sustainable development, many of them are directly or indirectly related to each other. Put differently, the goals rely on each other, and can be mutually reinforcing or conflicting. A simple example can illustrate this issue. Measures ensuring inclusive and quality education (Goal 4) can reinforce progress in many - if not all - other SDGs: it can generate employment and foster economic growth (Goal 8), help reduce poverty and increase access to food (Goal 1 and Goal 2), contribute to improving health and well-being (Goal 3), and reduce inequalities (Goal 10), to name a few. On the other hand, measures to promote access to food (Goal 2), water (Goal 6), and energy (Goal 7) for example, if applied in an unsustainable manner, could run counter to the notion of sustainable consumption and production (Goal 12), aggravate climate change (Goal 13), and endanger life below water (Goal 14) as well as life on land (Goal 15). Thinking in a similar line, since the goal areas present strong interlinkages, Elder, et al. (2016) argued that the goals themselves can be seen as part of the means of implementation.

The 2030 Agenda has noted that the goals, which address diverse issues, are "integrated and indivisible", but has not elaborated how they are interconnected. Moreover, planners and policymakers typically work in silos without sufficiently coordinating with each other, and they do not have the means to identify and prioritise reinforcing or trade-off minimising measures (Nilsson et al., 2016a). Lack of integration across various sectors, as a senior UN official observed, may result in incoherent policies and has been one of the major hindrances

sustainable development approaches previously taken (Le Blanc, 2015). To succeed, the 2030 Agenda must avoid this pitfall. In fact, policy coherence is included as one of the targets under Goal 17 (Target 17.4: "Enhance policy coherence for sustainable development"). A recent report of the United Nations Development Group (UNDG) entitled *Mainstreaming the 2030 Agenda for Sustainable Development: Reference Guide to UN Country Teams* has emphasised the importance of integrated policy analysis, coordinated institutional mechanisms and integrated modelling for "breaking the silos" to create horizontal policy coherence (UNDG, 2016).

Recognising the challenges in effectively monitoring the "whole complex web of sustainable development", a Working Group has been created under the IAEG-SDGs with a mandate to identify the interlinkages between the SDGs and targets (UNSD, 2016c), which will be critical in ensuring integration and policy coherence in implementing the SDGs. The tasks of the Working Group include, among others, developing the interlinkages as well as identifying tested national and international integrated analyses and best practices of integrated data collection, identifying frameworks for facilitating monitoring, and proposing strategies for using the interlinkages. As with IAEG-SDGs other activities, this Working Group is also expected to conduct open consultation with relevant stakeholders to deliver its outputs. The Working Group on interlinkages started its activities in April 2016 and will initially work for two years. The significance of identifying the connectivity of the set of SDGs to kick-start the implementation of the 2030 Agenda has been taken into account by other actors (researchers, international as well as national organisations and institutes, the private sector and so forth). Some initial work has already begun on the methodologies and approaches for identifying the interlinkages. The next section reviews some of these methodologies and approaches.

3 Review of existing works on SDG interlinkages

Mustafa Moinuddin[4]

Among the currently-available or in-progress studies on integration of the SDGs, some have focused exclusively on enhancing the knowledge on the nature of the interlinkages. The Open Working Group (OWG) Proposal for Sustainable Development Goals (OWG, 2014a) noted that the SDGs recognise the interlinkages of the three pillars of sustainable development. The OWG also prepared an annex document where the interlinkages among 19 focus areas were listed up (OWG, 2014b). This is probably one of the first works related to the SDGs and their interlinkages. **Table 1** summarises the OWG's SDG interlinkages based on the annex document. As can be seen from the table, while most of the focus areas tend to have varying degrees of interlinkages with other areas, two of them (focus area 1 Poverty eradication and focus area 18 Means of implementation/global partnership for sustainable development) were found to be interlinked with all the other focus areas, indicating their overall significance. Focus area 12 on promoting equality appeared to be least interlinked with other areas, which is somewhat counterintuitive to the whole notion of sustainable development.

A report from the Stakeholder Forum looked into the integration and interlinkages issues even before the SDGs were officially adopted (Cutter, et al., 2015). The report observed that SDG integration can be understood as three different types: (i) a systemic, holistic, system-based approach; (ii) the balancing of the three dimensions of sustainability; and (iii) the use of explicit interlinkages between themes. For the second type, it provided some stakeholder proposals basically for improving the then-draft set of targets. For the third type, the report provided suggestions on the interlinkages among the goals which were derived based on further analysis on the links between goals and targets, allowing for identifying potential synergies and trade-offs. An important observation of the report is that reciprocity, or a two-way relationship between SDG thematic areas proposed at that time was relatively weak, and called for further attention.

[4] Mustafa Moinuddin, Senior Policy Researcher and Research Manager, Strategic and Quantitative Analysis Centre (QAC), Institute for Global Environmental Strategies (IGES). 2108-11 Kamiyamaguchi, Hayama, Kanagawa, 240-0115 Japan. ✉ moinuddin@iges.or.jp

Table 1 Summary of the interlinkages among the focus areas considered by the OWG

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
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	●				●			●				●	●			●	●		

Note: The focus areas considered by the OWG are: Focus area 1: Poverty eradication; Focus area 2: Sustainable agriculture, food security and nutrition; Focus area 3: Health and population dynamics; Focus area 4: Education; Focus area 5: Gender equality and women's empowerment; Focus area 6: Water and sanitation; Focus area 7: Energy; Focus area 8: Economic growth; Focus area 9: Industrialisation; Focus area 10: Infrastructure; Focus area 11: Employment and decent work for all; Focus area 12: Promote equality; Focus area 13: Sustainable cities and human settlements; Focus area 14: Promote sustainable consumption and production; Focus area 15: Climate; Focus area 16: Conservation and sustainable use of marine resources, oceans and seas; Focus area 17: Ecosystems and biodiversity; Focus area 18: Means of implementation/global partnership for sustainable development; and Focus area 19: Peaceful and non-violent societies, rule of law and capable institutions.

Source: Based on OWG (2014b).

The Organisation for Economic Cooperation and Development (OECD), which has been promoting policy coherence for development for over twenty years, has noted that the

"2030 Agenda requires transitioning from policy coherence for development (PCD) to policy coherence for sustainable development (PCSD)" (OECD, 2016). The new OECD report entitled *Better Policies for Sustainable Development 2016: A New Framework for Policy Coherence* incorporates this transitional aspects. The PCSD Framework, the report suggests, introduces the PCSD concept and also explains "how to analyse, apply and track progress". The PCSD Framework replaces the previous PCD Framework and constitutes part of the Organisation's "strategic response to the SDGs". It is flexible and can support both OECD members and partner countries for policy coherence aimed at SDG implementation. The new Framework is a guidance manual as well as a screening tool.

The basic components of the screening tool – namely the analytical framework, the institutional framework, and the monitoring framework – are briefly summarised in **Figure 1**. One of the main purposes of the first component (the analytical framework) is to look into horizontal coherence in terms of interlinkages and different types of interactions between economic, social and environmental policies. Using an illustrative example, a nexus approach of the interactions between water, energy and food in the SDG framework (**Figure 2**), the report demonstrates that while some SDG targets are mutually reinforcing and some are enablers, conflicts and trade-offs among the targets can also occur. The report thus rightfully argues that for coherent decision making, governmental bodies in charge of a specific SDG should consider targets that are also relevant for other SDGs. These types of sectoral interactions need to be considered to take coherent decisions.

The nexus approach – the clustering of linked issues – mentioned earlier is intuitive. It "denotes the observation that different issue areas are intrinsically interconnected and must thus be governed as such" (Boas, et al., 2016). A study from the Stockholm Environment Institute suggests that this approach can be applied for cross-sectoral integration of the SDGs, which can help manage and implement the goals (Weitz, et al., 2016). Another study from the German Development Institute (DIE) provides a conceptual framework for clustering the SDGs (Niestroy, 2016). The framework (see **Figure 3**) places the goals in three layers of concentric circles, with human-centred goals at the core or inner circle, followed by goals relating to production, distribution and delivery of gods and services in the middle circle and finally the goals related to natural resources and ecosystems at the outer circle. The author, however, notes that the classification of the goals in the framework is approximate.

Taking a similar approach, Elder, et al. (2016) attempted to develop a systemic and functional way to classify the SDGs into six goal categories: social objectives, resources, economy, environment, education and governances. A study from IGES focused on Air pollution and provided its broad linkages with SDGs, observing that "air pollution is related in some way to all but one of the SDGs" (Elder and Zusman, 2016). Shaw, et al. (2016) observed that such issue based approaches can strengthen interlinkages between SDGs, disaster risk management, and climate change adaptation, and support better synergies in

implementation. The nexus approach, as noted in a policy brief of the International Institute for Sustainable Development (IISD), can be especially useful "to define a research agenda on specific issue clusters and to develop frameworks for interpreting the evidence and knowledge gathered through that research" (Jungcurt, 2016).

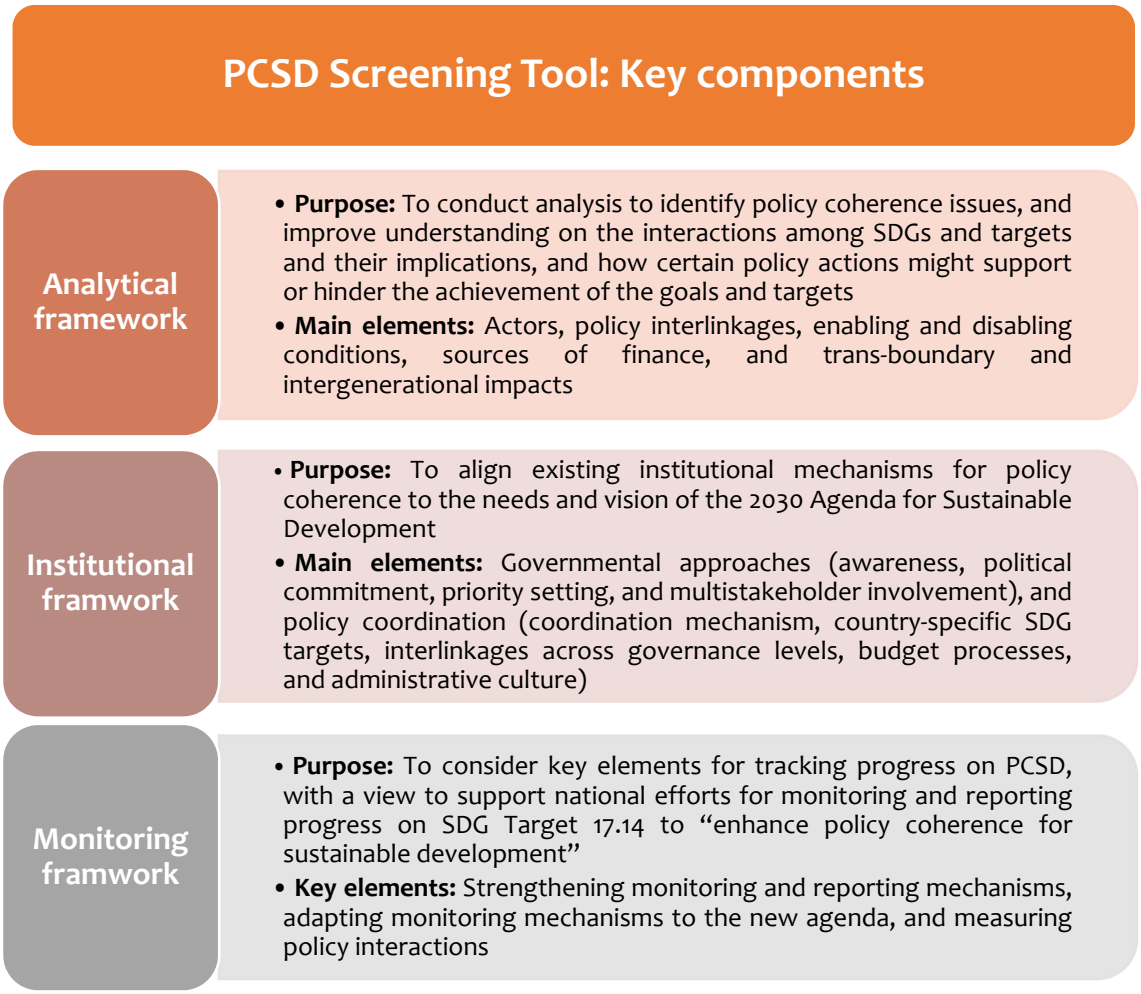


Figure 1 OECD's PCSD screening tool at a glance

Source: Based on OECD (2016).

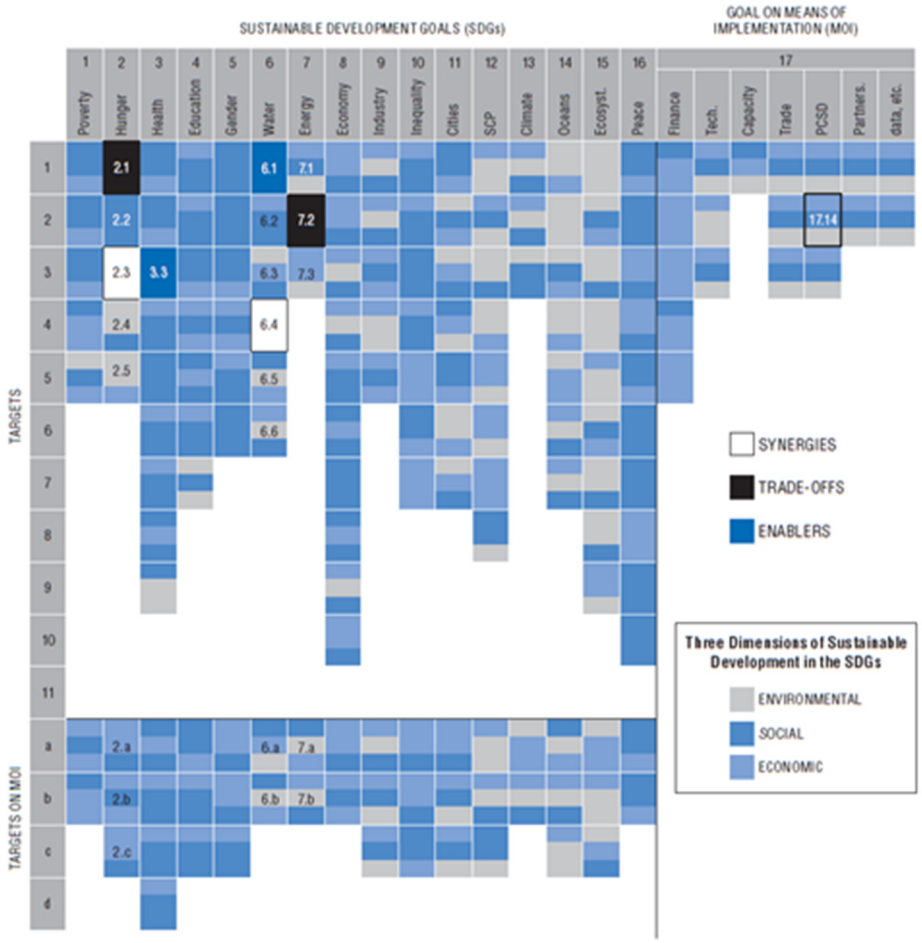


Figure 2 Integrative perspective of the SDGs: Interactions between water, energy and food in the SDG framework (OECD study)

Source: OECD (2016).

Several studies found the water-related Goal 6 to be at the centre of the SDGs. Shivakoti, et al. (2015) and Bengtsson and Shivakoti (2015) called for positioning water at the centre of SDG integrative perspectives. The UN Economic and Social Commission for Asia and the Pacific (ESCAP) developed a methodological framework to assess the interlinkages of the associated targets of Goal 6 (Clean water and sanitation) with the targets under the other 16 Goals (ESCAP, 2017). The ESCAP methodology assessed whether there is a causal relationship between two targets, whether the relationship is direct or indirect, whether the relationship is parallel or invers, whether the related Goal 6 target is a driver or not in a given relationship. Based on this analysis, a visual relationship matrix is then developed. The ESCAP study found Target 6.3 to contain the highest number of direct causal relationship with other targets, and argued it to be "one of the most important leverage points in the systems model of

interlinkages".[5] ESCAP provides an illustration of the interlinkages of Target 6.3 (**Figure 4**).

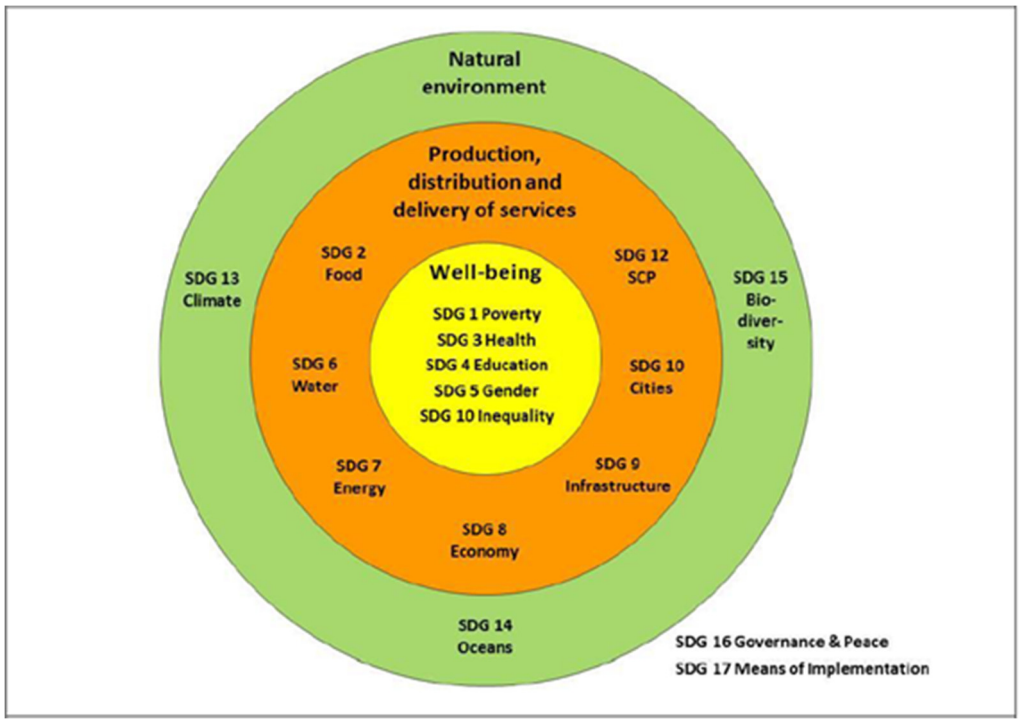


Figure 3 Framework for clustering the SDGs (DIE study)

Source: Niestroy (2016).

[5] Target 6.3 reads as follows: By 2030, improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally

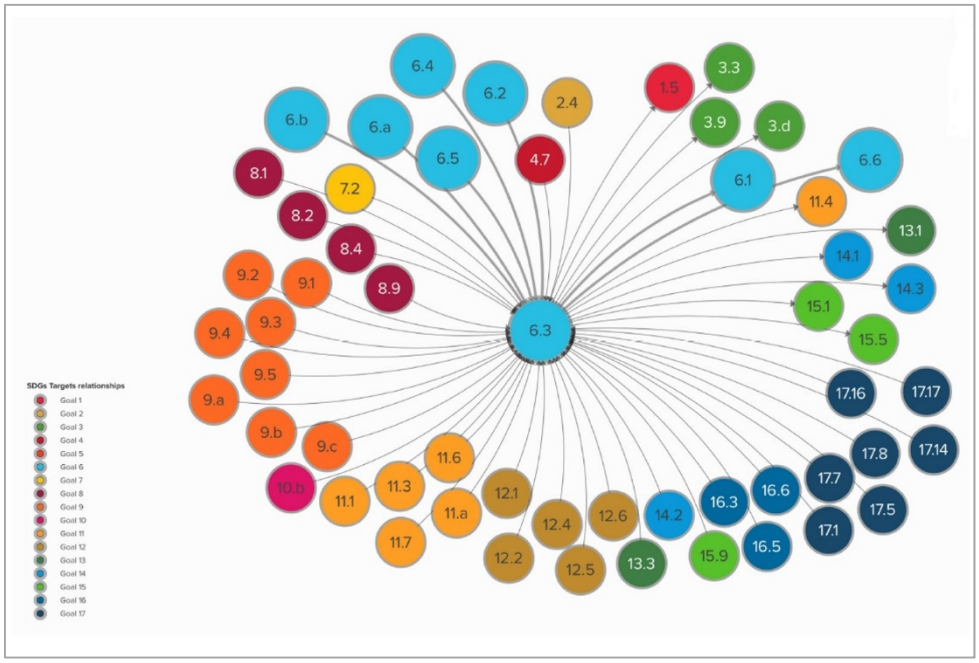


Figure 4 Interlinkages of Target 6.3 as identified by the ESCAP study

Source: ESCAP (2017).

To demonstrate the interlinkages among thematic areas of the SDGs, Le Blanc (2015) offers a systemic approach by using social network analysis techniques to look at the SDGs "as a network of targets". Put differently, based on the wording of the targets, the author mapped each target with its own goal as well as with all other goals, which eventually creates a matrix network (**Figure 5**). Le Blanc's approach shows that SDGs are unequally connected because some goals, such as Goal 12 on Responsible consumption and production, are connected with as many as 14 other goals, whereas some other goals, such as Goal 14 on Life below water, are connected with only two other goals. Le Blanc's study, which was published as a Working Paper of the United Nations Department of Economic and Social Affairs (DESA), suggests that his analysis indicates that compared to the Millennium Development Goals (MDGs), SDGs are more interconnected, which "could enable more integrated policies and easier consideration of synergies and trade-offs across SDG areas".

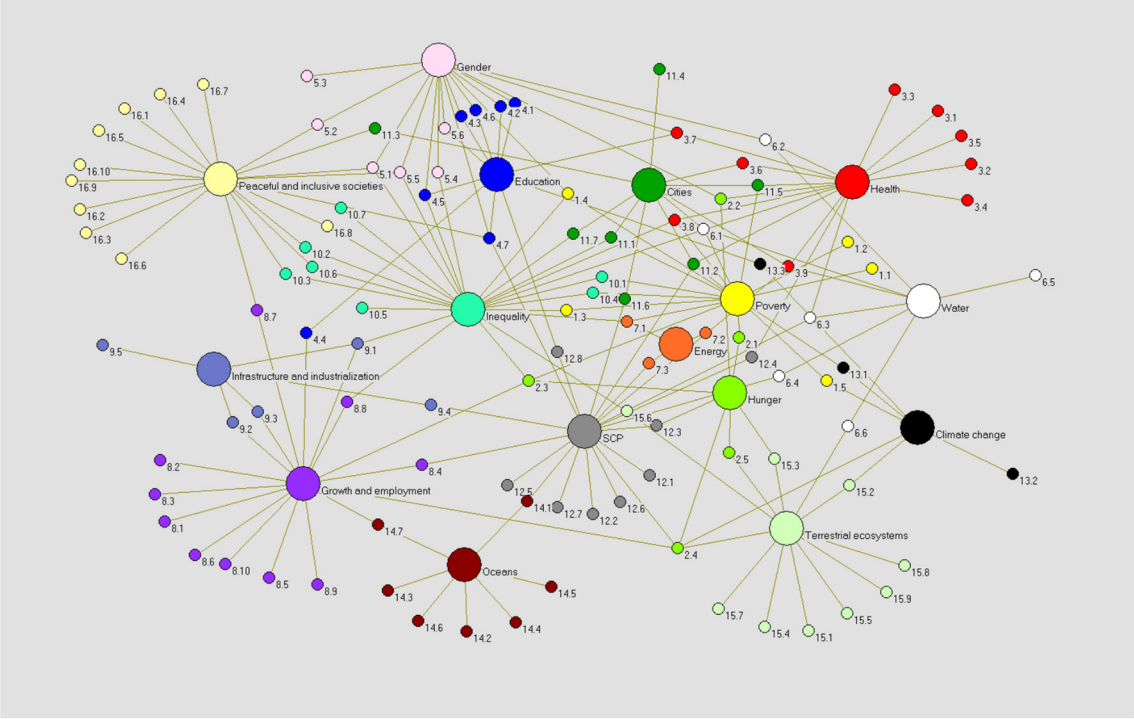


Figure 5 Sustainable Development Goals as a network of targets (DESA study)

Source: Le Blanc (2015).

The Millennium Institute notes that SDG implementation can be affected by how policy interventions are integrated in different areas (Millennium Institute, 2017a). Building on its well-known Threshold 21 system dynamics model, the Institute developed a comprehensive scenario simulation model known as the Integrated Model for Sustainable Development Goals Strategies (iSDG). The iSDG model can generate "country-specific development scenarios to show the implications of policy on a country's progress towards the SDGs" (Millennium Institute, 2017b). The model integrates the three dimensions of sustainability under a single framework to analyse the impact of alternative policy scenarios against a business-as-usual scenario across sectors and over the medium to long term. The iSDG model includes a set of 30 dynamically interacting sectors under the three dimensions, covering all the 17 SDGs. The model also helps understand the interconnections of the goals and targets. It has a tool for assessing synergies, which can be used to analyse the "contribution of each policy to the final result for any indicator; and of synergies among policies" (Millennium Institute, 2017c).

While identifying the existence of trade-offs and synergies among the SDGs is important, experts are also attempting to identify and distinguish various types and degrees of interactions among the SDGs. Coopman et al. (2016), for example, proposes a methodology to categorise SDG interlinkages into eight key types within three broad categories

(supporting, enabling/disenabling, and relying). A numerical value was also assigned for each type of interlinkage to indicate the "strength of the connection". **Table 2**, taken from the Coopman et al. (2016), gives a snapshot of the categories and types of SDG interlinkages as well as the assigned numerical scores. Using a case study application of the methodology on Goal 12 Responsible consumption and production), the authors suggest that their methodology could be a useful tool to analyse the linkages between the SDG targets, and can help develop integrated policy programmes in a systemic way. Working in a similar fashion, a framework developed by Nilsson et al. (2016a), which is now being used by the International Council for Science (ICSU) also emphasises that it may be more useful for implementation activities to consider the "range of different types of interactions" among the SDGs (Nilsson, et al., 2016b). The authors' of the referred studies propose a set of seven possible types of interaction among the SDGs, depending on how positively or how negatively one goal or target influences another. These interactions types are: indivisible, reinforcing, enabling, consistent, constraining, counteracting and cancelling. The authors link these seven interactions to a scale ranging from +3 to -3 (higher score means stronger link) and further explain the meaning of each interaction with related examples (**Table 3**). The interactions scale, the authors believe, can "help policymakers and researchers to identify and test development pathways that minimize negative interactions and enhance positive ones" (Nilsson, et al., 2016a).

Building upon the above-mentioned draft analytical framework developed by Nilsson et al. (2016a; 2016b), ICSU led a consortium of over 20 scientists to develop one of the most detailed, in-depth studies to date on SDG interlinkages. The ICSU report entitled *A Guide to SDG interactions: from Science to Implementation* (ICSU, 2017), quantifies SDG synergies and conflicts and "offers a blueprint to help countries implement and achieve the 17 goals and the 169 targets that sit underneath them". The study analysed four SDGs (Goal 2, Goal 3, Goal 7, and Goal 14), and attempted to identify key interactions at the goal level as well as at the target level (**Table 4**). It found that the SDGs in general are synergistic, although not necessarily at an equal level. At the target level, a total of 316 interactions were identified, of which 238 are positive, 66 negative and the rest neutral. Although the assessment of this study did not find any major incompatibility between the goals, some "potential constraints and conditionality that require coordinated policy interventions" were identified.

Table 2 SDG interlinkages by type and nature (Stakeholders' Forum study)

Category	Category definition	Type	Type definition	Score
Supporting	Targets that support one another tend to do so by fulfilling objectives expressed by each target.	Commonly supporting	Both targets contribute to the same objective	1
		Mutually supporting	Target A's objective is achieved by Target B's means of implementation, and vice versa	2
Enabling	Targets that enable one another satisfy this relationship by having an impact on the achievement of another target.	Disenabling	Implementing target B may hinder or reverse the achievement of Target (eg by competing with it for resources, or more fundamentally because the typical means of implementation of the first target actually worsen the underlying problem which the second target is addressing)	0
		Indirect Enabling	Target B's implementation indirectly enables the achievement of Target A	1
		Direct Enabling	Target B's implementation directly enables the achievement of Target A	2
		Direct Enabling in Both Directions	Target B's implementation directly enables the achievement of Target A, and Target A's implementation directly enables Target B's achievement	3
Relying	Targets that rely on one another derive from a relationship of logical necessity which exists between the two targets.	Partial reliance	Target B is a subcategory of Target A and adds some detail as to how Target A can be achieved	1
		Full reliance	Target B's implementation is necessary for, but not intrinsic to, Target A's achievement	2

Source: Coopman et al. (2016)

Table 3 Scaling the influence of SDGs on each other (ICSU study)

Interaction	Name	Explanation	Example
+3	Indivisible	Inextricably linked to the achievement of another goal.	Ending all forms of discrimination against women and girls is indivisible from ensuring women's full and effective participation and equal opportunities for leadership.
+2	Reinforcing	Aids the achievement of another goal.	Providing access to electricity reinforces water-pumping and irrigation systems. Strengthening the capacity to adapt to climate-related hazards reduces losses caused by disasters.
+1	Enabling	Creates conditions that further another goal.	Providing electricity access in rural homes enables education, because it makes it possible to do homework at night with electric lighting.
0	Consistent	No significant positive or negative interactions.	Ensuring education for all does not interact significantly with infrastructure development or conservation of ocean ecosystems.
–1	Constraining	Limits options on another goal.	Improved water efficiency can constrain agricultural irrigation. Reducing climate change can constrain the options for energy access.
–2	Counteracting	Clashes with another goal.	Boosting consumption for growth can counteract waste reduction and climate mitigation.
–3	Cancelling	Makes it impossible to reach another goal.	Fully ensuring public transparency and democratic accountability cannot be combined with national-security goals. Full protection of natural reserves excludes public access for recreation.

Source: Nilsson et al. (2016a)

Table 4 Key interactions at the goal and target level (ICSU study)

	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)

Source: Based on ICSU (2017).

Since SDGs were only adopted in 2015 and since they cover a very diverse set of issue areas, existing knowledge on SDG interlinkages is also limited. The literature review in this section shows that different organisations and individuals have come up with a wide variety of approaches and methodologies to address this issue, although much more need to be done. While approaches may be different, the review also shows that the significance of understanding the interlinkages between SDGs for efficient management and implementation of the goals as well as for coherent policymaking is increasingly being recognised by scholars and practitioners. However, in order for the SDGs to be successful as an "indivisible whole", existing approaches may need to be further enhanced and new approaches and methodologies need to be developed.

We observe several gaps and limitations that the available approaches have not yet addressed. **First**, the existing studies discuss the overall concept or framework of the interlinkages, either as SDGS as a whole or through the nexus approach, but there is hardly any practical application of these approaches. The ESCAP (2017) and ICSU (2017) studies provided some examples of country-level applications. These are very important, intuitive and provide guidance for interactions assessment. However, since they focused on specific selected goals, the holistic approach incorporating all the 17 goals is missing, which is likely to make policy priority-setting difficult. The importance of identifying the interactions of all the 17 goals have also been noted in the ICSU study's "Looking Ahead: Next Steps" section.

Next, with the exception of Millennium Institute's iSDG model, the existing methodologies

did not really make any quantitative assessment of the interlinkages. Nilsson, et al. (2016b) proposed a scale of interactions and provided values to it based on qualitative judgement of the type of interactions. The same scale is also used in ICSU (2017). But still there is a need for deeper analysis of the interlinkages using real scientific data preferably at the indicator-level.

The current study project on SDG interlinkages and indicators is a modest attempt to contribute to bridging this gap in scientific literature. It uses qualitative information on binary interlinkages (including whether the links are positive or negative) between the targets for all the goals, then quantifies the strength of the interlinkages using selected country-specific indicator-level data. Using an interactive web platform (IGES **SDG Interlinkages and Data Visualisation** web tool), this enables visualising the interlinkages as a whole as well as through clusters of goal areas (similar to the nexus approach). This provides the basis for further analysis using Social Network Analysis (SNA) techniques, from which policy priorities can be identified. Another major advantage of the current study is that it allows for comparison of target-level progress between the covered countries. We expect that this approach will strongly support policy integration for SDG implementation and monitoring. In the subsequent sections of this report, detailed analytical methodology as well as network analysis results are presented before elaborating the implications for policy and recommendations for policy integration.

4 Methodology

Xin Zhou[7] *and Mustafa Moinuddin*[8]

Based on the literature review in Part 3, some research gaps on the analysis of SDG interlinkages are identified.

(a) Comprehensive studies on the interlinkages between SDG targets which covers all the 169 targets are inadequate and underdeveloped. There are some ongoing works on this issue, such as ICSU's guide to SDG interactions (2017), but complete studies are not yet available.

(b) Quantification of the SDG interlinkages is limited in the existing literature though there are a few works on categorizing different types of interlinkages with pre-defined weights.

(c) Most of the existing works are limited to the study on the general structure of SDG interlinkages through identification of the interlinkages in general. But identification and quantification of these interlinkages at national level are still missing.

(d) The focus of most existing works is placed on the identification of the interlinkages. There is hardly any literature which provides comprehensive analysis on the identified SDG interlinkages.

All these limitations constrain the application of SDG interlinkages as practical knowledge to support SDG integration and policy coherence in the real policy world. To echo these knowledge gaps in the existing literature, we presented an integrated analytical framework on the network analysis of SDG interlinkages between targets which is then applied to the interlinkages analysis in nine selected Asian countries, namely Bangladesh, Cambodia, China, India, Indonesia, Japan, the Philippines, Republic of Korea and Viet Nam.

4.1 Analytical framework

To address the knowledge gaps in SDG interlinkages analysis, we developed an analytical framework for identification, quantification and analysis of the interlinkages between SDG

[7] Xin Zhou, Principal Policy Researcher and Research Leader, Strategic and Quantitative Analysis Centre (QAC), Institute for Global Environmental Strategies (IGES). 2108-11 Kamiyamaguchi, Hayama, Kanagawa, 240-0115 Japan. ✉ zhou@iges.or.jp

[8] Mustafa Moinuddin, Senior Policy Researcher and Research Manager, Strategic and Quantitative Analysis Centre (QAC), Institute for Global Environmental Strategies (IGES). 2108-11 Kamiyamaguchi, Hayama, Kanagawa, 240-0115 Japan. ✉ moinuddin@iges.or.jp

targets (see **Figure 6**). First and foremost is the identification of the interlinkages between SDG targets, which is conducted based on the knowledge obtained from international consultation processes on SDG indicators and through literature review. In a parallel process, indicators with trackable data are identified and mapped with SDG targets. Time series data (2001-2014) of the indicators were collected for nine Asian countries (Bangladesh, Cambodia, China, India, Indonesia, Japan, Republic of Korea, the Philippines and Viet Nam). Results from these two processes are then used for the quantification of identified interlinkages based on the correlation analysis of corresponding indicators using their time-series data. A quantified country-specific network of the interlinkages between SDG targets was constructed for each of the nine selected countries. Using Social Network Analysis (SNA), we can analyse the structure of the interlinkages network in each country and identify those targets which play strategic or more influential roles in the interlinkages network using various measurements, such as centrality (e.g. degree centrality, closeness centrality and betweenness centrality, etc.).

A web tool on **SDG Interlinkages and Data Visualisation** (Zhou, et al., 2017) was developed based on the results of this research and is available at http://sdginterlinkages.iges.jp/.

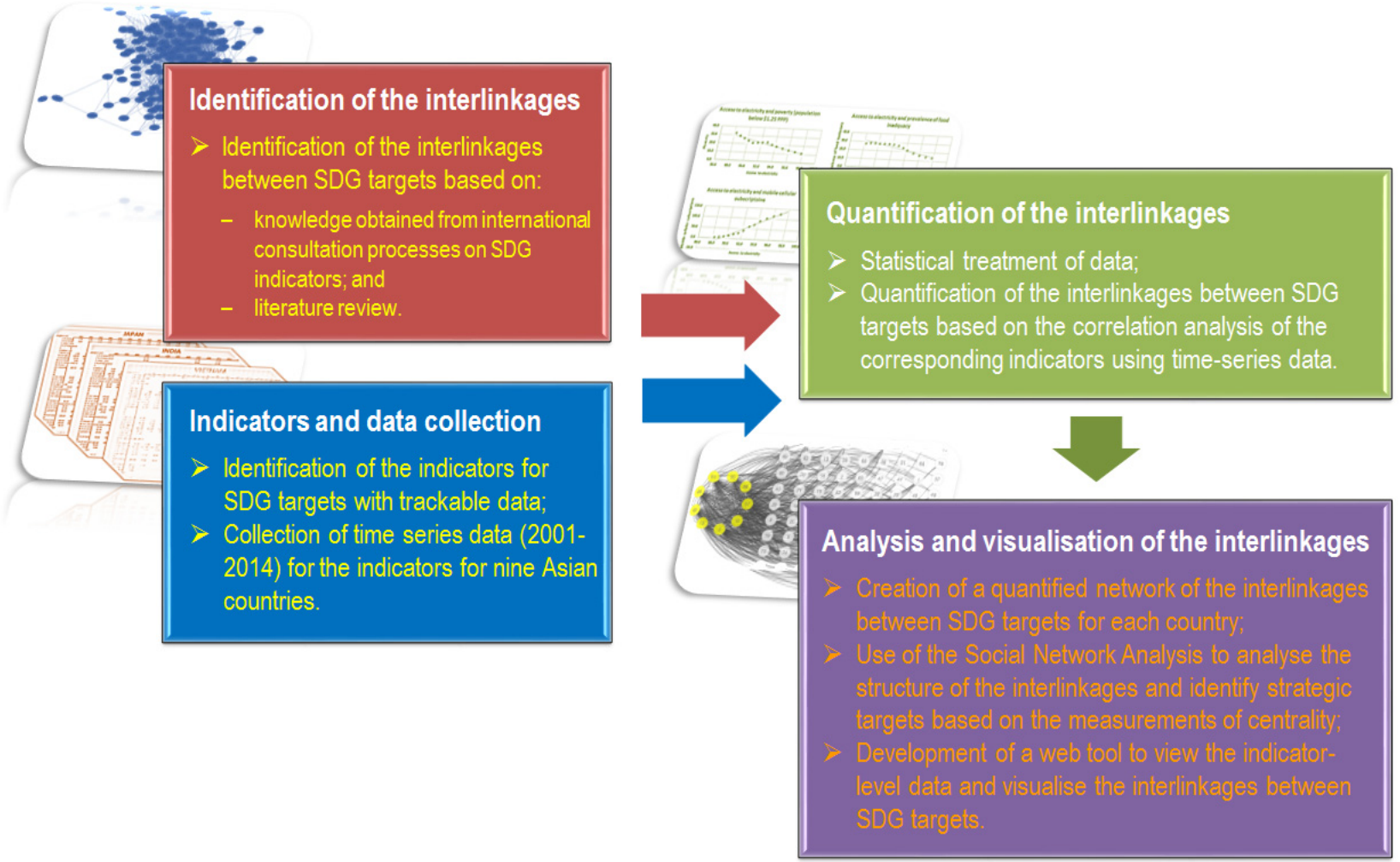


Figure 6 Analytical framework for SDG interlinkages and indicator-level data analysis

4.2 Scope of the study

Interlinkages can refer to those between goals (OWG SDGs, 2014), between a goal and other targets (e.g. ICSU and ISSC, 2015; UNEP, 2015), or between targets (e.g. IAEG-SDGs, 2015; UNESCAP, 2016; Coopman, et al., publishing time unknown), etc. In this study, we focus on the interlinkages between SDG targets. Interlinkages include a direct link between two targets and an indirect link which connects two targets via a third target or more intermediate ones. In addition, interlinkages can be directed links indicating the causality of two targets, or undirected links. In this research, we study direct and causal/directed links between SDG targets. For example, a causal link from Target 1.1 (end extreme poverty) to Target 1.2 (halve national poverty) indicates that achieving Target 1.1 will impact on achieving Target 1.2.

Furthermore, identification of the interlinkages between SDG targets depends on the spatial context which may influence the interactions of the factors related to the corresponding targets. For example, maintaining air quality (Target 11.6 on reducing urban environmental impacts) is influenced by the ways of production and consumption (Goal 12 on sustainable consumption and production) for crowded cities. However, such causal links may not be relevant for rural areas where population is relatively sparse and industrial activities are less dense, which means there is enough atmospheric capacity for the natural purification of air pollutants. In this study, we assume that the interlinkages are identified at the national level, and the indicators and their relevant data are also identified and collected at the national level.

4.3 Identification of the interlinkages between SDG targets

Identifying all possible interlinkages between 169 targets is an extremely difficult task. Existing literature on the interlinkages between SDGs is limited due mainly to the relatively short period after the adoption of the SDGs in 2015. Sufficient knowledge on the interlinkages between SDG targets does not exist because SDGs cover 17 broad areas and relate to multiple disciplines. In this study, the interlinkages between SDG targets are identified based on multiple reference interlinkages provided by various sources, including the working documents provided by relevant international consultation processes on SDG indicators, such as the Inter-agency and Expert Group on Sustainable Development Goal Indicators (IAEG-SDGs, 2015) and the Indicators and a Monitoring Framework for Sustainable Development Goals initiated by the United Nations Sustainable Development Solutions Network (SDSN, 2015), and other literature. **Table 5** provides a list of ten reference interlinkages and their sources.

Table 5 List of ten reference interlinkages

Reference no.	Reference code	SDG coverage	Type of interlinkages/goal to goal (G-G), goal to target (G-T), target to goal (T-G) and target to target (T-T)	Source
1	IAEG-SDGs	All	T-T	IAEG-SDGs, 2015. List of Indicator Proposals (11 August 2015). Available at: https://unstats.un.org/sdgs/files/List%20of%20Indicator%20Proposals%2011-8-2015.pdf
2	SDSN-1	All	T-T through shared indicators.	Leadership Council of the Sustainable Development Solutions Network (SDSN), 2015. Indicators and a Monitoring Framework for the Sustainable Development Goals: Launching a data revolution for the SDGs. A report to the Secretary-General of the United Nations. Available at: http://unsdsn.org/wp-content/uploads/2015/05/FINAL-SDSN-Indicator-Report-WEB.pdf
3	SDSN-Shared indicators	All	T-T through shared indicators.	2015. Indicators for the SDGs: Identifying inter-linkages. SDSN Issue Brief. Available at: http://unsdsn.org/wp-content/uploads/2015/09/150816-Identifying-inter-linkages-SDSN-Briefing-for-IAEG.pdf
4	ESCAP-SDG6	SDG6	T-T	United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP), 2016. Analytical Framework for Integration of Water and Sanitation SDGs and Targets: Using Systems Thinking Approach, Annex I: Full Matrix of Analysis of Direct and Indirect Linkages Between the SDG 6 Targets and the Targets of the Other SDGs. UNESCAP Working Paper. Bangkok: UNESCAP. Available at: https://sustdev.unescap.org/Files/resource/300add205ca64d4ee4b1c4d1116855ce.pdf
5	WEF-Nexus	SDG2, SDG6 and SDG7.	T-T	Weitz, N., Nilsson, M., Davis, M., 2014. A Nexus Approach to the Post-2015 Agenda: Formulating Integrated Water, Energy and Food SDGs. Available at: https://www.oecd.org/pcd/Art%20Nexus%20SAIS%20weitz.pdf
6	UNECOSOC	All	G-T (for all SDGs except SDG17), G-G (SDG17)	Author(s) and publication date unknown. A Nexus Approach for the SDGs: Interlinkages between the goals and targets. Retrieved from the

Reference no.	Reference code	SDG coverage	Type of interlinkages/goal to goal (G-G), goal to target (G-T), target to goal (T-G) and target to target (T-T)	Source
				website of the United Nations Economic and Social Council: https://www.un.org/ecosoc/sites/www.un.org.ecosoc/files/files/en/2016doc/interlinkages-sdgs.pdf
7	UNCTAD-Trade	Trade-related SDGs	T-T (trade-related targets link with each other)	United Nations Conference on Trade and Development (UNCTAD), 2016. Trading into Sustainable Development: Trade, Market Access, and the Sustainable Development Goals. Geneva: United Nations. Available at: http://unctad.org/en/PublicationsLibrary/ditctab2015d3_en.pdf
8	IOM-Migration	Migration-related SDGs	T-T (migration-related targets link with each other)	International Organization for Migration (IOM), publication date not known. 2030 Agenda for Sustainable Development. Available at: https://unofficeny.iom.int/2030-agenda-sustainable-development
9	Stakeholder Forum_1	All except for SDG17	G-G, T-G, T-T	Cutter, A., Osborn, D., Romano, J., Ullah, F., publication date unknown. Sustainable Development Goals and Integration: Achieving a better balance between the economic, social and environmental dimensions. Available at: http://www.stakeholderforum.org/fileadmin/files/Balancing%20the%20dimensions%20in%20the%20SDGs%20FINAL.pdf
10	Stakeholder Forum_SDG12	SDG12	T-T	Coopman, A., Osborn, D., Ullah, F., Auckland, E., Long, G., publication date unknown. See the Whole: Implementing the SDGs in an integrated and coherent way. A Research Pilot by Stakeholder Forum, Biregional and Newcastle University. Available at: http://www.stakeholderforum.org/fileadmin/files/SeeingTheWhole.ResearchPilotReportOnSDGsImplementation.pdf

Each of the ten reference interlinkages is considered as one set of interlinkages. The interlinkages between SDG targets identified by this study is the union of the ten sets of interlinkages (see Eq. (1)).

$$U = \bigcup_i Set_i \quad (1)$$

Taking Target 4.3 on access to technical and tertiary education for all as an example (see **Table 6**), among ten sets of interlinkages, the directed links from Target 4.3 to other targets are identified as {4.3, 1.4}, {4.3, 3.b}, {4.3, 4.4}, {4.3, 5.b}, {4.3, 8.5}, {4.3, 8.6}, {4.3, 8.b}, {4.3, 9.2}, {4.3, 9.5}, {4.3, 10.2} and {4.3, 14.a} by *Set 1* (IAEG-SDGs), {4.3, 4.4}, {4.3, 4.5} and {4.3, 8.6} by *Set 2* (SDSN-1), {4.3, 13.3} by *Set 6* (UNECOSOC), and {4.3, 8.6} and {4.3, 16.6} by *Set 9* (Stakeholder Forum_1). Other reference sets, including *Set 3*, *Set 4*, *Set 5*, *Set 7*, *Set 8* and *Set 10*, are null sets for the directed links from Target 4.3 to other targets. As {4.3, 4.4} appears twice and {4.3, 8.6} appears three times, the directed links from Target 4.3 to others identified by this study, i.e. the union of *Set 1*, *Set 2*, *Set 6* and *Set 9*, therefore includes 14 links in total, including {4.3, 1.4}, {4.3, 3.b}, {4.3, 4.4}, {4.3, 4.5}, {4.3, 5.b}, {4.3, 8.5}, {4.3, 8.6}, {4.3, 8.b}, {4.3, 9.2}, {4.3, 9.5}, {4.3, 10.2}, {4.3, 13.3}, {4.3, 14.a} and {4.3, 16.6}. In the same way, the directed links indicating the causality between two targets are identified for other individual targets.

Table 6 List of ten reference interlinkages

Set no.	Set code	Directed links from Target 4.3[9] to other Targets
1	IAEG-SDGs	{4.3, 1.4}, {4.3, 3.b}, {4.3, 4.4}, {4.3, 5.b}, {4.3, 8.5}, {4.3, 8.6}, {4.3, 8.b}, {4.3, 9.2}, {4.3, 9.5}, {4.3, 10.2}, {4.3, 14.a}, with 11 links in total.
2	SDSN-1	{4.3, 4.4}, {4.3, 4.5}, {4.3, 8.6}, with 3 links in total.
3	SDSN-Shared indicators	Null set.
4	ESCAP-SDG6	Null set.
5	WEF-Nexus	Null set.
6	UNECOSOC	{4.3, 13.3}, with one link in total.
7	UNCTAD-Trade	Null set.
8	IOM-Migration	Null set.
9	Stakeholder Forum_1	{4.3, 8.6}, {4.3, 16.6}, with 2 links in total.
10	Stakeholder Forum_SDG12	Null set.
U**: Interlinkages identified by this study (union of ten sets)**		{4.3, 1.4}, {4.3, 3.b}, {4.3, 4.4}, {4.3, 4.5}, {4.3, 5.b}, {4.3, 8.5}, {4.3, 8.6}, {4.3, 8.b}, {4.3, 9.2}, {4.3, 9.5}, {4.3, 10.2}, {4.3, 13.3}, {4.3, 14.a}, {4.3, 16.6}, with 14 links in total.

There is one caveat to understanding the total number of links that one target has with

[9] Target 4.3 is defined as "by 2030 ensure equal access for all women and men to affordable quality technical, vocational and tertiary education, including university" (UNGA, 2015).

others. Although identification of the interlinkages covers all 169 targets, the levels of details and knowledge on the interlinkages for individual targets vary. Some of the reference interlinkages cover all SDG targets (e.g. References no. 1, 2, 3, 6 and 9) while others with special focus may cover a sub-set of 17 SDGs or a sub-set of 169 targets, e.g. Reference no. 4 focusing solely on Goal 6 (water and sanitation) and Reference no. 5 focusing on Goal 2 (food), Goal 6 (water and sanitation) and Goal 7 (energy), i.e. the water-energy-food (WEF) nexus. A typical example is the reference interlinkages for Goal 6 and its targets (Reference no. 4 in Table 5) provided by the United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP, 2016) based on extensive consultations and in-depth research on water and sanitation targets and their interlinkages with other goals and targets. Therefore, the interlinkages identified for different targets are not provided in an even manner. An outstanding target that has more links with other targets may be attributable to the detailed studies or in-depth knowledge available for this particular target rather than to its extensive interactions with others by nature.

The interlinkages identified in this project can be considered as pioneer work which will be improved with new knowledge and more scientific studies on this issue. The present work can serve as a sub-set of the full picture. In addition, as mentioned above as a caveat, the identified interlinkages for 169 targets may be biased due to asymmetric knowledge on individual targets and their causal links with others.

4.4 SDG indicators and data collection

Each directed link between two targets indicates their causal relationship. The causal links are further quantified to indicate positive or negative relationships and how strong the link is. First, 51 indicators with trackable data are identified for this study based on the SDSN's proposed Global Monitoring Indicators (SDSN, 2015a). Among 51 indicators, some are the same as or similar to the SDSN's indicators, some are indices created based on the SDSN's indicators and some are proxies for the SDSN's indicators due to data availability. The list of 51 indicators with data sources is provided in **Table 7**. 51 indicators are then mapped with 17 goals and 169 targets (see the correspondence table in **Appendix I**) with one target mapping with one indicator at most, and one indicator mapping with one or more targets. Please note that only 108 out of 169 Targets map with corresponding indicators. Due to data availability, the remained 61 Targets do have their corresponding indicators and this is one of the limitations of the existing study which provides partially on a full picture of the quantified interlinkages network.

Table 7 List of 51 indicators

Indicator no.	SDSN's indicator	Indicators identified by this study	Unit	Category	Data source	Notes
1	Proportion of population below $1.25 (PPP) per day (MDG Indicator)	Proportion of population below $1.90 (2011 PPP) per day	percent	A	World Bank World Development Indicators, the World Bank. Available at: http://databank.worldbank.org/data/reports.aspx?source=2&country=&series=SI.POV.DDAY&period=	Similar to the SDSN indicator, but with updated international poverty threshold at $1.90.
2	Proportion of population living below national poverty line, by urban/rural (modified MDG Indicator)	Proportion of population living below national poverty line	percent	A	Millennium Development Goals Indicators - The Official United Nations Site for the MDG Indicators. Available at: https://mdgs.un.org/unsd/mdg/SeriesDetail.aspx?srid=581&crid=	Similar to the SDSN indicator but lacking of urban/rural disaggregation.
3	Losses from natural disasters, by climate and non-climate-related events (in US$ and lives lost)	Total economic damage from top ten natural disasters	billion US$	B	D. Guha-Sapir, R. Below, Ph. Hoyois - EM-DAT: The CRED/OFDA International Disaster Database. Available at: http://emdat.be/country_profile/index.html	A proxy for the SDSN indicator. The major differences include that the proxy indicator: i) lacks of complete data on all events; ii) lacks of disaggregation in climate and non-climate events; and iii) lacks of data on lives lost.
4	Proportion of population below minimum level of dietary energy consumption (MDG Indicator)	Proportion of population below minimum level of dietary energy consumption	percent	A	Millennium Development Goals Indicators - The Official United Nations Site for the MDG Indicators. Available at: https://mdgs.un.org/unsd/mdg/SeriesDetail.aspx?srid=566	Same as the SDSN indicator.
5	Prevalence of stunting and wasting in children under 5 years of age	Prevalence of wasting in children under 5 years of age, weight for height	percent of children under 5	A	World Bank World Development Indicators (Sept 2015 edition), the World Bank. WDI Database archive. Available at: http://data.worldbank.org/products/wdi#archives	Similar to the SDSN indicator but measured in a specific method by the weight for height which is more than two standard deviations below the median for the international reference population ages 0-59.

Indicator no.	SDSN's indicator	Indicators identified by this study	Unit	Category	Data source	Notes
6	Crop yield gap (actual yield as % of attainable yield)	Crop production index (2004-2006 = 100)	index (2004-2006 = 100)	B	World Bank World Development Indicators (Sept 2015 edition), the World Bank. WDI Database archive. Available at: http://data.worldbank.org/products/wdi#archives	A proxy for the SDSN indicator. The major difference is that the SDSN measures the crop yield gap between actual yield and the attainable yield, while the proxy indicator measures the actual crop production against the base year levels (2004 - 2006 = 100)
7	Maternal mortality ratio (MDG indicator) and rate	Maternal mortality ratio per 100,000 live births	woman deaths per 100,000 live births	A	Millennium Development Goals Indicators - The Official United Nations Site for the MDG Indicators. Available at: https://mdgs.un.org/unsd/mdg/SeriesDetail.aspx?srid=553&crid=	Same as the SDSN indicator.
8	Neonatal, infant, and under-5 mortality rates (modified MDG Indicator)	Children under five mortality rate	deaths under 5 per 1,000 live births	A	Millennium Development Goals Indicators - The Official United Nations Site for the MDG Indicators. Available at: https://mdgs.un.org/unsd/mdg/SeriesDetail.aspx?srid=561&crid=	Same as the SDSN indicator.
9	Percent of children receiving full immunization (as recommended by national vaccination schedules)	Percent of children receiving immunisation against measles	percent of children aged 12-23 months	B	World Bank World Development Indicators (Sept 2015 edition), the World Bank. WDI Database archive. Available at: http://data.worldbank.org/products/wdi#archives	Proxy for the SDSN indicator. The major difference is that the SDSN indicator measures the full immunisation while the proxy indicator measures only the immunisation against measles as a representative.
10	Incidence and death rates associated with malaria (MDG Indicator)	Reported confirmed malaria cases (Microscopy slides/RDTs positive)	number of cases	B	Global Health Observatory indicator views, World Health Organisation. Available at: http://apps.who.int/gho/data/node.main.A1364?lang=en	Proxy for the SDSN indicator. The major difference is that the SDSN indicator measures both the incidence and the death rate while the proxy indicator measures only the incidence.
11	Probability of dying between exact ages 30 and 70 from any of cardiovascular disease, cancer, diabetes,	Probability of dying between exact ages 30 and 70 from any of cardiovascular	percent of 30-year-old-people dying before 70	A	Global Health Observatory indicator views, World Health Organisation. Available at: http://apps.who.int/gho/data/view.main.2485?lang=en	Same as the SDSN indicator.

Indicator no.	SDSN's indicator	Indicators identified by this study	Unit	Category	Data source	Notes
	chronic respiratory disease, [or suicide]	disease, cancer, diabetes, or chronic respiratory				
12	Road traffic deaths per 100,000 population	Road traffic death rate per 100,000 population	deaths per 100,000 population	A	Global Health Observatory indicator views, World Health Organisation. Available at: http://apps.who.int/gho/data/node.main.A997?lang=en	Same as the SDSN indicator.
13	[Percentage of population without effective financial protection for health care] – to be developed	Health expenditure, public (% of total health expenditure)	percent of total expenditure on health	B	World Bank World Development Indicators (Sept 2015 edition), the World Bank. WDI Database archive. Available at: http://data.worldbank.org/products/wdi#archives	A proxy for the SDSN indicator. The SDSN indicator measures the percentage of population without effective financial protection for health care, while the proxy indicator measures the percentage of government expenditure on health of total expenditure on health.
14	Contraceptive prevalence rate (MDG Indicator)	Contraceptive prevalence, any methods (% of women aged15-49)	percent of women aged 15-49 who are married or in union	A	World Bank World Development Indicators (Sept 2015 edition), the World Bank. WDI Database archive. Available at: http://data.worldbank.org/products/wdi#archives	Same as the SDSN indicator.
15	Current use of any tobacco product (age-standardized rate)	Current smoking of any tobacco product (age-standardized rate)	percent of male adults aged 15 years and over	A	Global Health Observatory indicator views, World Health Organisation. Available at: http://apps.who.int/gho/data/view.main.1805?lang=en	Same as the SDSN indicator.
16	Percentage of children (36-59 months) receiving at least one year of a quality pre-primary education program	Gross enrolment ratio, pre-primary	percent of relevant age group	A	World Bank World Development Indicators (Sept 2015 edition), the World Bank. WDI Database archive. Available at: http://data.worldbank.org/products/wdi#archives	Similar to the SDSN indicator.

Indicator no.	SDSN's indicator	Indicators identified by this study	Unit	Category	Data source	Notes
17	Primary completion rates for girls and boys	Primary completion rate, total	percent of relevant age group	A	World Bank World Development Indicators (Sept 2015 edition), the World Bank. WDI Database archive. Available at: http://data.worldbank.org/products/wdi#archives	Similar to the SNSN indicator but without disaggregation by sexes.
18	Secondary completion rates for girls and boys	Lower secondary completion rate, total	percent of relevant age group	A	World Bank World Development Indicators (Sept 2015 edition), the World Bank. WDI Database archive. Available at: http://data.worldbank.org/products/wdi#archives	Similar to the SDSN indicator but without disaggregation by sexes.
19	Tertiary enrolment rates for women and men	Gross enrolment ratio, tertiary	percent of relevant age group	A	World Bank World Development Indicators (Sept 2015 edition), the World Bank. WDI Database archive. Available at: http://data.worldbank.org/products/wdi#archives	Similar to the SDSN indicator but without disaggregation by sexes.
20	Prevalence of girls and women 15-49 who have experienced physical or sexual violence [by an intimate partner] in the last 12 months	Prevalence of sexual violence against women aged 15-49 by an intimate partner in the last 12 months	percent of women aged 15-49	A	UN Statistics Division. The World's Women 2015: Chapter 6 Violence against women. Available at: https://unstats.un.org/unsd/gender/chapter6/chapter6.html	Similar to SDSN indicator but only sexual violence taken into consideration. Data frequency is very limited. Physical violence is not included.
21	Percentage of women aged 20-24 who were married or in a union by age 18	Percent of women aged 20-24 who were married or in a union by age 18	percent of women aged 20-24 years	A	United Nations Population Fund (UNFPA) Open Data. Available at: http://unfpaopendata.org/libraries/aspx/home.aspx	Same as the SDSN indicator.
22	Percentage of seats held by women and minorities in national parliament and/or sub-national elected office according to their respective share of the population (modified MDG Indicator)	Proportion of seats held by women in national parliaments	percent of all occupied seats	A	World Bank World Development Indicators (Sept 2015 edition), the World Bank. WDI Database archive. Available at: http://data.worldbank.org/products/wdi#archives	Similar to the SDSN indicator including seats in single or lower chambers of national parliaments but not the seats in the sub-national elected offices.

Indicator no.	SDSN's indicator	Indicators identified by this study	Unit	Category	Data source	Notes
23	Percentage of population using safely managed water services, by urban/rural (modified MDG Indicator)	Percentage of population with access to improved water source	percent	A	World Bank World Development Indicators (Sept 2015 edition), the World Bank. WDI Database archive. Available at: http://data.worldbank.org/products/wdi#archives	Similar to the SDSN indicator but without urban/rural disaggregation.
24	Percentage of population using safely managed sanitation services, by urban/rural (modified MDG Indicator)	Percentage of population with access to improved sanitation facilities	percent	A	World Bank World Development Indicators (Sept 2015 edition), the World Bank. WDI Database archive. Available at: http://data.worldbank.org/products/wdi#archives	Similar to the SDSN indicator but without urban/rural disaggregation.
25	Proportion of total water resources used (MDG Indicator)	Proportion of total water resources used	percent of total renewable water resources withdrawn	A	Millennium Development Goals Indicators - The Official United Nations Site for the MDG Indicators. Available at: https://unstats.un.org/UNSD/MDG/SeriesDetail.aspx?srid=768	Same as the SDSN indicator.
26	Share of population using reliable electricity, by urban/rural	Percentage of people with access to electricity	percent	A	World Bank World Development Indicators (Sept 2015 edition), the World Bank. WDI Database archive. Available at: http://data.worldbank.org/products/wdi#archives	Similar to the SDSN indicator, but does not specify electricity to be "reliable" and is not disaggregated as rural/urban.
27	Rate of primary energy intensity improvement	Energy intensity level of primary energy	MJ/$2011 PPP GDP	B	World Bank World Development Indicators (Sept 2015 edition), the World Bank. WDI Database archive. Available at: http://data.worldbank.org/products/wdi#archives	Proxy for the SDSN indicator. The SDSN indicator captures the rate of improvement of energy intensity but the proxy one captures the intensity level per GDP.
28	GNI per capita (PPP, current US$ Atlas method)	Gross National Income (GNI) per capita, PPP (constant 2011 international $)	constant 2011 international $ PPP	A	World Bank World Development Indicators (Sept 2015 edition), the World Bank. WDI Database archive. Available at: http://data.worldbank.org/products/wdi#archives	Similar to the SDSN indicator.

Indicator no.	SDSN's indicator	Indicators identified by this study	Unit	Category	Data source	Notes
29	Youth employment rate, by formal and informal sector	Youth unemployment rate as percentage of total labour force aged 15-24	percent of total labour force aged 15-24	B	World Bank World Development Indicators (Sept 2015 edition), the World Bank. WDI Database archive. Available at: http://data.worldbank.org/products/wdi#archives	Proxy for the SDSN indicator. The major differences include: i) the SDSN indicator is about employment rate whereas the proxy one is about unemployment rate; and ii) proxy indictor lacks disaggregation based on formal and informal sectors.
30	Ratification and implementation of fundamental ILO labour standards and compliance in law and practice	Ratification of ILO conventions	number of conventions ratified	B	International Labour Organization (ILO) Available at: http://www.ilo.org/dyn/normlex/en/f?p=1000:11001:::NO:::	Proxy for the SDSN indicator. Major difference is that the proxy indicator measures number of conventions ratified by countries and focuses only on ratification (and not on implementation), whereas the SDSN indicator focuses on both ratification and implementation.
31	Access to all-weather road (% access within [x] km distance to road)	Share of paved roads over total road network	percent of total road network	B	Food and Agriculture Organization, Statistics Division (FAOSTAT). Available at: http://www.fao.org/economic/ess/ess-fs/ess-fadata/en/#.WP6mj2dPqt-	Proxy for the SDSN indicator. The SDSN indicator focuses on access to all-weather road including the distance to road, whereas the proxy indicator focuses on improved (paved) road as share of total road network.
32	Mobile broadband subscriptions per 100 inhabitants, by urban/rural	Mobile cellular subscription rate	subscriptions per 100 people	A	World Bank World Development Indicators (Sept 2015 edition), the World Bank. WDI Database archive. Available at: http://data.worldbank.org/products/wdi#archives	Similar to the SDSN indicator but without urban/rural disaggregation.
33	Manufacturing value added (MVA) as percent of GDP	Manufacturing value added as percent of GDP	percent of GDP	A	World Bank World Development Indicators (Sept 2015 edition), the World Bank. WDI Database archive. Available at: http://data.worldbank.org/products/wdi#archives	Same as the SDSN indicator.

Indicator no.	SDSN's indicator	Indicators identified by this study	Unit	Category	Data source	Notes
34	Total energy and industry-related GHG emissions by gas and sector, expressed as production and demand-based emissions (tCO2e)	Total GHG emissions excluding land use change and forestry	$MtCO_2e$	A	World Resources Institute's CAIT Climate Data Explorer, Historical emissions. Available at: http://cait.wri.org/historical/Country%20GHG%20Emissions?indicator[]=Total GHG Emissions Excluding Land-Use Change and Forestry&indicator[]=Total GHG Emissions Including Land-Use Change and Forestry&year[]=2013&sortIdx=NaN&chartType=geo	Similar to the SDSN indicator, but without disaggregation by gas and sector and only focuses on production-based emissions (and not on consumption-based emissions).
35	Personnel in R&D (per million inhabitants)	Researchers in R&D (per million people)	researchers per million people	A	World Bank World Development Indicators (Sept 2015 edition), the World Bank. WDI Database archive. Available at: http://data.worldbank.org/products/wdi#archives	Similar to the SDSN indicator. The SDSN indicator is about "personnel" in R&D whereas the proxy indicator uses the term "researchers" instead of "personnel".
36	[Indicator on inequality at top end of income distribution: GNI share of richest 10% or Palma ratio]	GINI index (World Bank estimate)	index value (range from 0-100, the lower the better in equality)	B	World Bank World Development Indicators (Sept 2015 edition), the World Bank. WDI Database archive. Available at: http://data.worldbank.org/products/wdi#archives	Proxy for the SDSN indicator. Both indicators focus on inequality. The difference is that the SDSN indicator captures inequality by the income share of the richest 10%, while GINI index provides an overall picture of inequality in a country (GINI Index 0 represents perfect equality, and 100 implies perfect inequality).
37	Global Food Loss Indicator [or other indicator to be developed to track the share of food lost or wasted in the value chain after harvest]	Global Food Security Index	index value (range from 0-100, the higher the more favourable)	B	Global Food Security Index 2016. The Economist Intelligence Unit (EIU). Available at: http://foodsecurityindex.eiu.com/Resources	Proxy for the SDSN indicator that provides an overall picture of a country's food security whereas the SDSN indicator is for food loss.
38	Consumption of ozone-depleting substances (MDG Indicator)	Consumption of Ozone-Depleting Substances (ODS)	metric tons measured by ozone	A	Millennium Development Goals Indicators - The Official United Nations Site for the MDG Indicators. Available at:	Same as the SDSN indicator.

Indicator no.	SDSN's indicator	Indicators identified by this study	Unit	Category	Data source	Notes
			depletion potential (ODP)		https://mdgs.un.org/unsd/mdg/SeriesDetail.aspx?srid=649	
39	Availability and implementation of a transparent and detailed deep decarbonisation strategy, consistent with the 2°C - or below - global carbon budget, and with GHG emission targets for 2020, 2030 and 2050	Rating countries ambition based on the consistency between a country's INDC, pledges and current policies and its fair share effort to holding global warming to below 2°C	four levels of consistency (ranges from 1-4 for inadequate, medium, sufficient and role model)	B	Climate Action Tracker: Rating countries. Available at: http://climateactiontracker.org/countries.html	Proxy for the SDSN indicator, based on Climate Action Tracker's rating of countries mitigation ambition in terms of consistency between national INDCs, pledges and current policies and countries' fair share efforts to holding warming to below 2°C.
40	CO_2 intensity of new power generation capacity installed (gCO_2/kWh), and of new cars (gCO_2/person-km) and trucks (gCO_2/ton-km)	CO_2 intensity (kg per kg of oil equivalent energy use)	kg per kg of oil equivalent energy use	B	World Bank World Development Indicators (Sept 2015 edition), the World Bank. WDI Database archive. Available at: http://data.worldbank.org/products/wdi#archives	Proxy for the SDSN indicator. The SDSN indicator measures CO_2 intensity of new power generation capacity installed, new cars and trucks whereas the proxy indicator measures overall CO_2 intensity per energy use.
41	Share of coastal and marine areas that are protected	Share of terrestrial and marine areas protected to total territorial area	percent of total territorial area	B	Millennium Development Goals Indicators - The Official United Nations Site for the MDG Indicators. Available at: https://mdgs.un.org/unsd/mdg/SeriesDetail.aspx?srid=616	Proxy for the SDSN indicator. The main difference is that the proxy indicator is about protected terrestrial and marine areas whereas the SDSN indicator is about protected coastal and marine areas.
42	Percentage of fish tonnage landed within Maximum Sustainable Yield (MSY)	Seafood captured or raised in a sustainable way	index score (ranges from 0-100, the higher the better).	B	Ocean Health Index. Available at: http://www.oceanhealthindex.org/region-scores/annual-scores-and-rankings	Proxy for the SDSN indicator, which measures the amount of seafood captured or raised in a sustainable way by indexing scores.
43	Annual change in forest area and land under cultivation (modified MDG Indicator)	Share of forest area in total land area	percent of total land area	B	World Bank World Development Indicators (Sept 2015 edition), the World Bank. WDI Database archive. Available at: http://data.worldbank.org/products/wdi#archiv	Proxy for the SDSN indicator. The main difference is that the SDSN indicator focuses on annual change in forest/cultivation area, whereas the proxy

Indicator no.	SDSN's indicator	Indicators identified by this study	Unit	Category	Data source	Notes
					es	indicator shows the share of forest area over total land area.
44	Area of forest under sustainable forest management as a percent of forest area	Share of terrestrial areas protected to total surface area	percent of total surface area	B	Millennium Development Goals Indicators - The Official United Nations Site for the MDG Indicators. Available at: https://mdgs.un.org/unsd/mdg/SeriesDetail.aspx?srid=784	Proxy for the SDSN indicator. It measures 'clearly defined geographical spaces, recognized, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values' including terrestrial protected areas as well as marine protected areas in territorial waters(up to 12 nautical miles from the coast).
44	Protected areas overlay with biodiversity	Share of terrestrial areas protected to total surface area	Percent of total surface area	B	Millennium Development Goals Indicators - The Official United Nations Site for the MDG Indicators. Available at: https://mdgs.un.org/unsd/mdg/SeriesDetail.aspx?srid=784	Proxy for the SDSN indicator. The main difference is that the proxy indicator represents the share of protected terrestrial areas but does not look at overlay with biodiversity.
45	Violent injuries and deaths per 100,000 population	Intentional homicides per 100,000 people	homicides per 100,000 people	B	World Bank World Development Indicators (Sept 2015 edition), the World Bank. WDI Database archive. Available at: http://data.worldbank.org/products/wdi#archives	Proxy for the SDSN indicator that captures homicides only, but the SDSN indicator captures both violent injuries and deaths.
46	Number of refugees	Refugee population by country or territory of asylum	thousand people	A	World Bank World Development Indicators (Sept 2015 edition), the World Bank. WDI Database archive. Available at: http://data.worldbank.org/products/wdi#archives	Same as the SDSN indicator. It specifies refugee population in accordance with the asylum country or territory.

Indicator no.	SDSN's indicator	Indicators identified by this study	Unit	Category	Data source	Notes
47	Perception of public sector corruption	Corruption Perception Index (CPI)	index value (ranges between 10, highly clean, and 0, highly corrupt)	A	Transparency International's Corruption Perception Index (various editions). Available at: http://www.transparency.org/research/cpi/overview	Similar to the SDSN indicator. The Corruption Perceptions Index scores countries/territories based on how corrupt a country's public sector is perceived to be.
48	Official development assistance and net private grants as percent of GNI	Net Official Development Assistance (ODA) received (% of GNI)	percent of GNI	A	World Bank World Development Indicators (Sept 2015 edition), the World Bank. WDI Database archive. Available at: http://data.worldbank.org/products/wdi#archives	Similar to the SDSN Indicator, but does not cover private grants.
49		Index for completion rates for all levels of education	index value (ranges from 0-100)	C		Index generated from indicators no. 16-19, based on the arithmetic mean of the values of related indicators.
50		Index for the share of population using public infrastructure	index value (ranges from 0-100)	C		Index generated from indicators no. 23, 24, 26 and 31 based on the arithmetic mean of the values of related indicators.
51		Index for access to basic urban services	index value (ranges from 0-100)	C		Index generated from indicators no. 23, 24 and 26 based on the arithmetic mean of the values of related indicators.

Source: Identified and compiled by the authors based on SDSN's indicators (SDSN, 2015) and various data sources.

Time-series data (2001 – 2014) for each indicator was collected from publicly-available sources, including the World Bank and various United Nations agencies (see **Table 7**), for nine selected Asian countries (Bangladesh, Cambodia, China, India, Indonesia, Japan, Republic of Korea, the Philippines and Viet Nam). Country-specific data can be accessible and downloaded using "Export Table" function provided by the SDG Interlinkages and Data Visualisation web tool developed by IGES (Zhou, et al., 2017) under this research project.

For some indicators or for the same indicator but for different countries, quite often there is incomplete time-series data. To fill in the data gaps for particular indicators in making the full time series, statistical method based on Compound Annual Growth Rate (CAGR[10]) was applied to populate the missing data, based on which a complete time-series data set for all the 51 indicators for all nine selected countries was prepared. An example in **Table 8** shows that complete time-series (2001-2014) data is not available with missing point data for years 2001, 2002, 2003, 2005, 2006, 2013 and 2014 for two poverty indicators on Population Below $1.90 (2011 PPP) Per Day and on Population Below National Poverty Line in Cambodia. To fill in the data gap, CAGR was used and new data was generated for the years in which the original data is missing.

[10] CAGR, also known as smoothed rate of return, assumes that "a random variable grows at a constant rate of return compounded over a sample period of time (Anson, et al., 2011). Put differently, it takes compounding into consideration while reporting average annual growth rate (Chan, 2009). It is a useful technique that can be used, for instance, to estimate future projections based on historical CAGR.

Table 8 An example of data treatment using statistical method for two poverty indicators in Cambodia

	Original data		Modified data by CAGR	
Indicators/ short name	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.

4.5 Quantification of the interlinkages

Quantification of the causal links was conducted based on the correlation analysis of the country-specific 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.

For example, Target 1.1 on ending extreme poverty and Target 1.2 on halving national poverty are identified as having mutual causal links with one another, i.e. achieving either of the targets will contribute to achieving the other target. Two poverty indicators, i.e. Population Below $1.90 (2011 PPP) Per Day and Population below National Poverty Line, are identified as

corresponding to Target 1.1 and Target 1.2, respectively. The time-series data of the two indicators after statistical treatment for nine countries is shown in **Table 9**. The strength of the linear causal link between the two targets for each country, measured by the correlation coefficient of the two indicators, is estimated based on the correlation analysis of the country-specific time-series data (including 14 point data from 2001 to 2014) of the two indicators. For example, the strength of the linear causal link between Target 1.1 and Target 1.2 is 0.9951 for Bangladesh, indicating a positive and strong linear linkage, and -0.42 for the Philippines, indicating a negative and relatively weak linear linkage. It should be mentioned that when the correlation coefficients cannot be estimated due to, e.g. all zeros for the time-series data for the cases of Japan and the Republic of Korea in **Table 9**, regional estimates using the data from the nine countries are used instead.

Based on the identification of the causal links between SDG targets, followed by the quantification of the identified links for individual countries, a directed and weighted network of the interlinkages between SDG targets was constructed for each country (see **Figure 7 - Figure 15**). Due to diversified circumstances for the 17 SDG areas in different countries, each of the interlinkages networks is country-specific with different features in the structure of the interlinkages network.

Table 9 Time-series data for two poverty indicators corresponding to SDG Target 1.1 and Target 1.2 in nine countries

Country	Bangladesh	Cambodia	China	India	Indonesia	Japan	South Korea	Philippines	Viet Nam
Indicators in short name	Population below $1.90 (2011 PPP) per day / percent	Population below national poverty line / percent	Population below $1.90 (2011 PPP) per day / percent	Population below national poverty line / percent	Population below $1.90 (2011 PPP) per day / percent	Population below national poverty line / percent	Population below $1.90 (2011 PPP) per day / percent	Population below national poverty line / percent	Population below $1.90 (2011 PPP) per day / percent
2001	33.74	48.90	20.39	55.79	37.15	4.60	43.02	42.26	35.98
2002	31.15	46.50	19.77	53.86	31.95	4.35	41.36	40.50	23.40
2003	28.76	44.23	19.18	52.00	26.75	4.11	39.75	38.81	23.25
2004	26.55	42.06	18.60	50.20	22.40	3.89	38.21	37.20	24.37
2005	24.51	40.00	18.02	48.40	18.75	3.68	36.67	35.59	21.63
2006	23.17	38.14	17.46	46.67	17.27	3.48	35.19	34.04	27.95
2007	21.91	36.36	16.92	45.00	15.91	3.29	33.77	32.56	22.76
2008	20.72	34.67	10.13	34.00	14.65	3.11	32.41	31.15	21.55
2009	19.59	33.05	4.95	23.90	12.80	2.94	31.10	29.80	18.43
2010	18.52	31.51	4.60	22.10	11.18	2.78	25.70	25.55	15.95
2011	17.51	30.04	3.37	20.50	7.90	2.63	21.23	21.90	13.58
2012	16.56	28.64	2.17	17.70	6.47	2.48	17.54	18.77	11.76
2013	15.65	27.31	1.44	14.69	1.85	2.35	14.49	16.09	9.83
2014	14.80	26.04	0.95	12.19	0.53	2.22	11.97	13.80	8.25
Correlation coefficients	0.9951	0.9970	0.9876	0.9985	0.9766	0.6912	0.6912	-0.4200	0.9891

Note: i) The correlation coefficients for two poverty indicators for individual countries are estimated based on relevant time-series data for respective countries. However, due to the poverty issue being not relevant for Japan and Korea during the specific time period, the correlation coefficients, presented in blue, are estimated based on the time-series data in nine countries. ii) A positive correlation coefficient indicates a positive linear relation between two indicators and a negative correlation coefficient (e.g. for the Philippines) indicates a negative linear relation.

Source: Compiled by the authors.

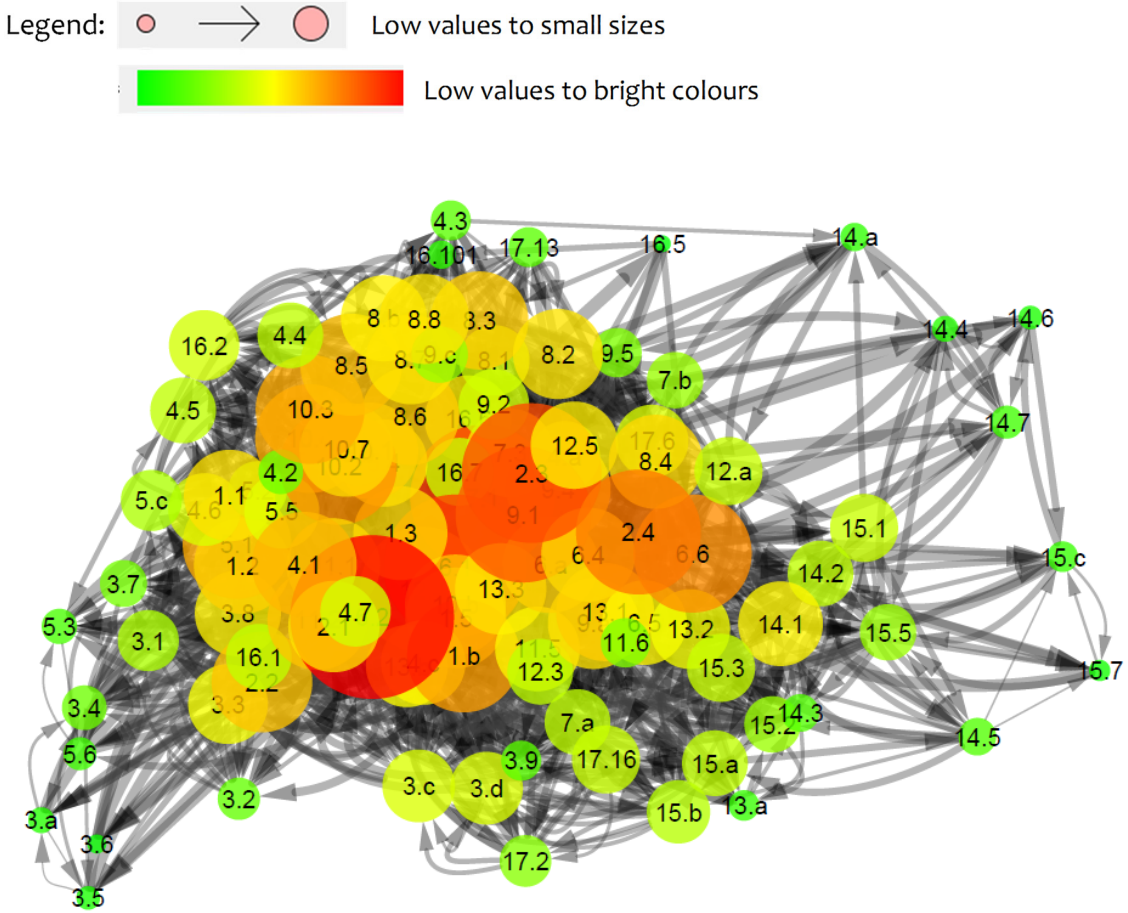


Figure 7 The weighted SDG interlinkages network for Bangladesh

Notes: Notes applied to **Table 8** - **Figure 15**. Each node indicates an SDG target and each directed link connecting two targets indicates the causal relation between the pair of targets. The network is generated using the 'edge-weighted spring embedded layout'[11]. Number in each node represents the code for SDG target. The size and the colour of the nodes is scaled based on the level of degree. The thickness of the edge is scaled based on the level of edge-betweenness.

[11] The 'edge-weighted spring-embedded layout' is based on a 'force-directed' paradigm as implemented by Kamada and Kawai (1988). Network nodes are treated like physical objects that repel each other, such as electrons. The connections between nodes are treated like metal springs attached to the pair of nodes. These springs repel or attract their end points according to a force function. The layout algorithm sets the positions of the nodes in a way that minimizes the sum of forces in the network. (cited from Cytoscape-manual, accessible at: https://github.com/cytoscape/cytoscape-manual/blob/master/docs/Navigation_and_Layout.md).

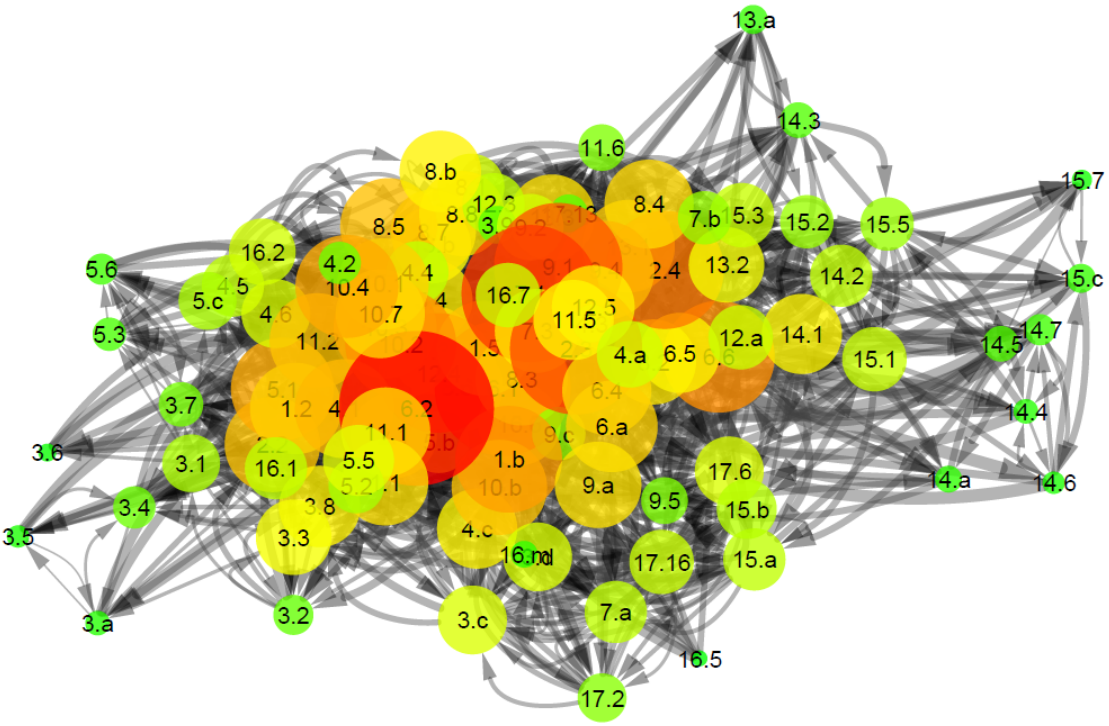


Figure 8 The weighted SDG interlinkages network for Cambodia

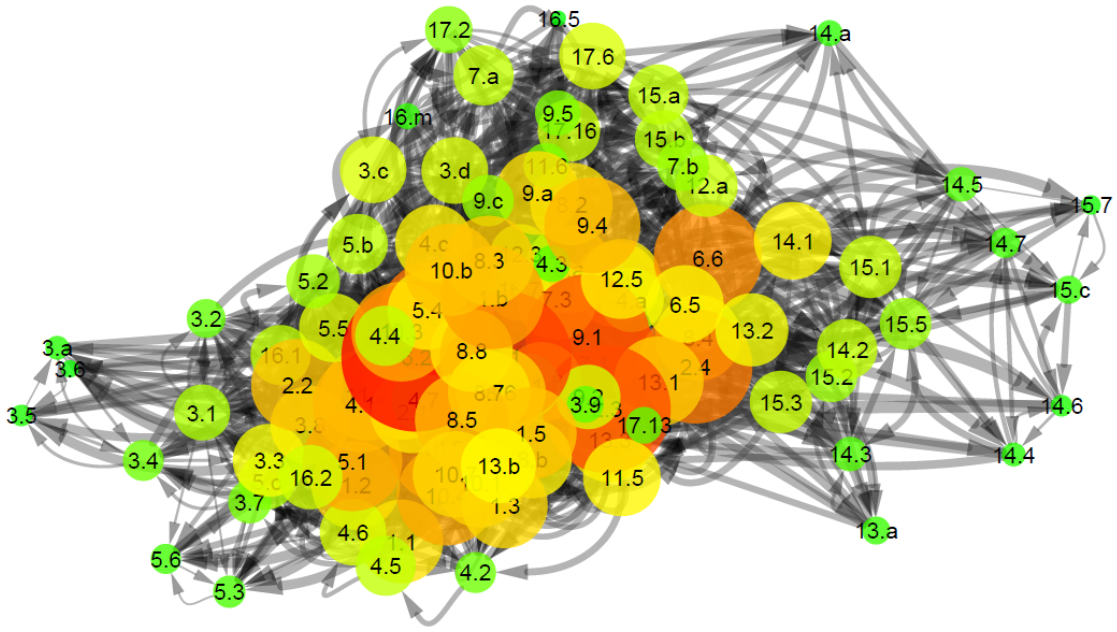


Figure 9 The weighted SDG interlinkages network for China

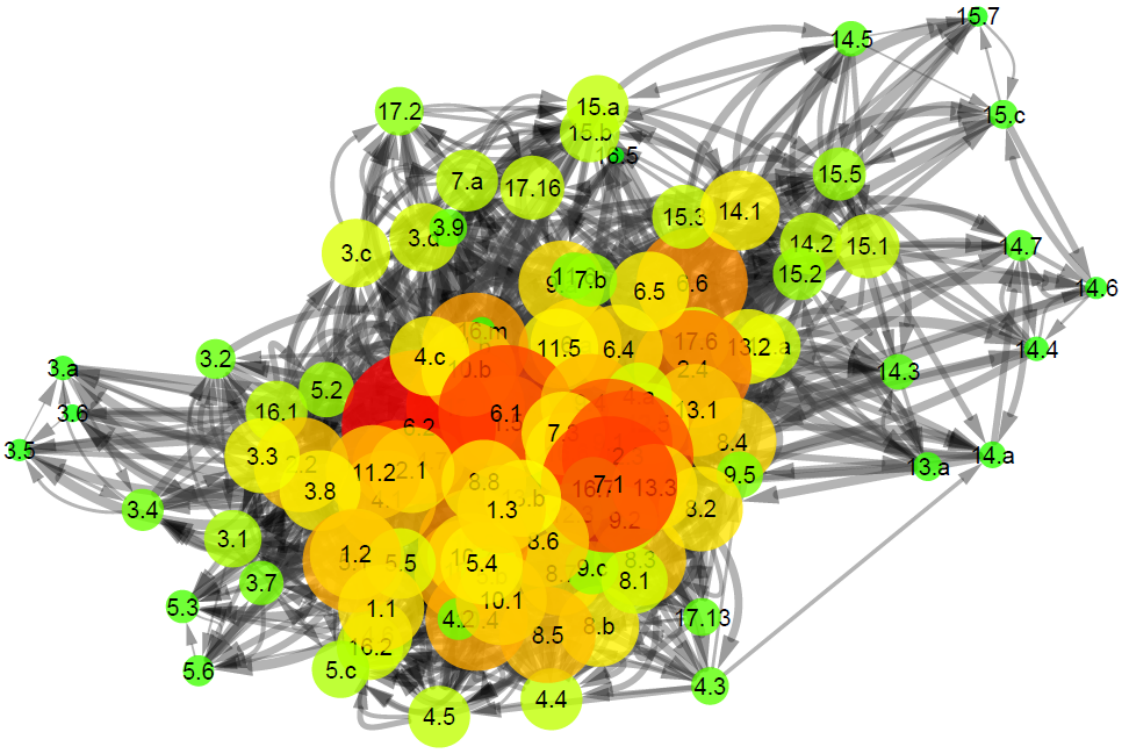


Figure 10 The weighted SDG interlinkages network for India

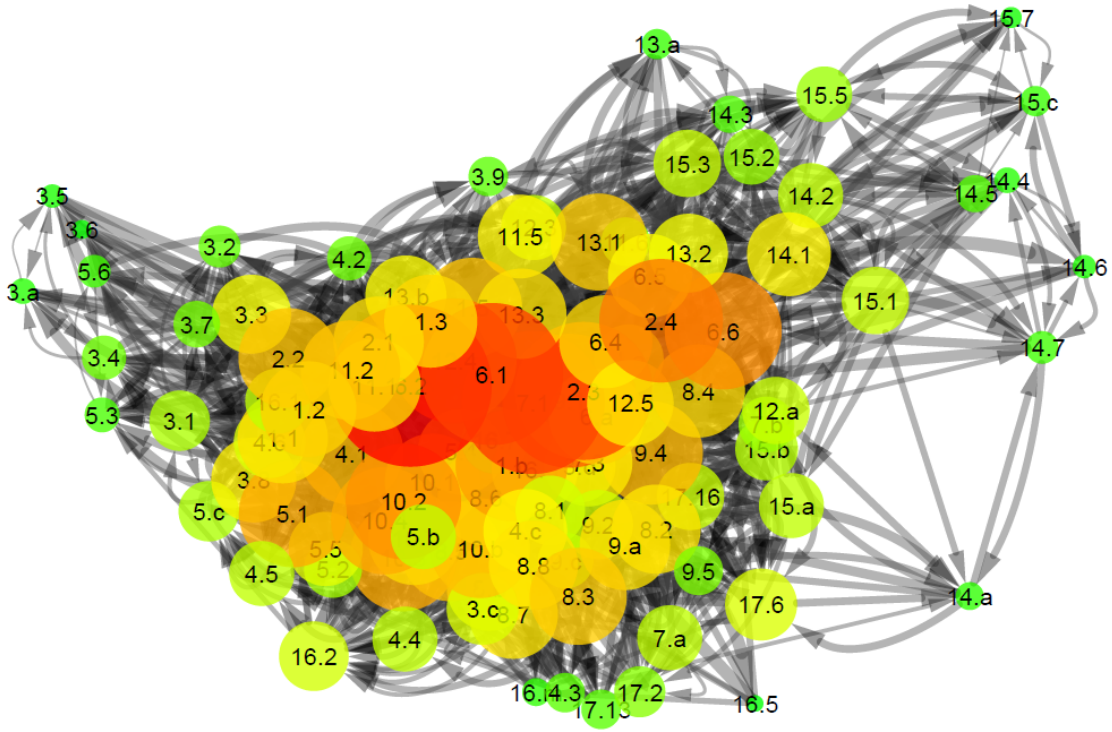


Figure 11 The weighted SDG interlinkages network for Indonesia

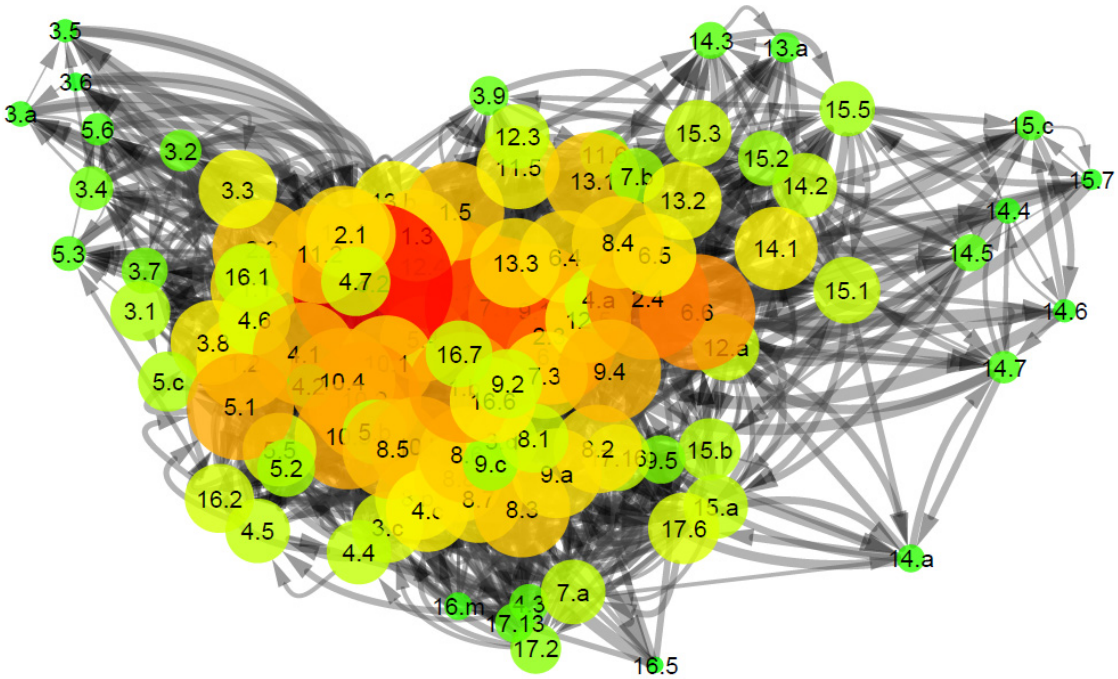


Figure 12 The weighted SDG interlinkages network for Japan

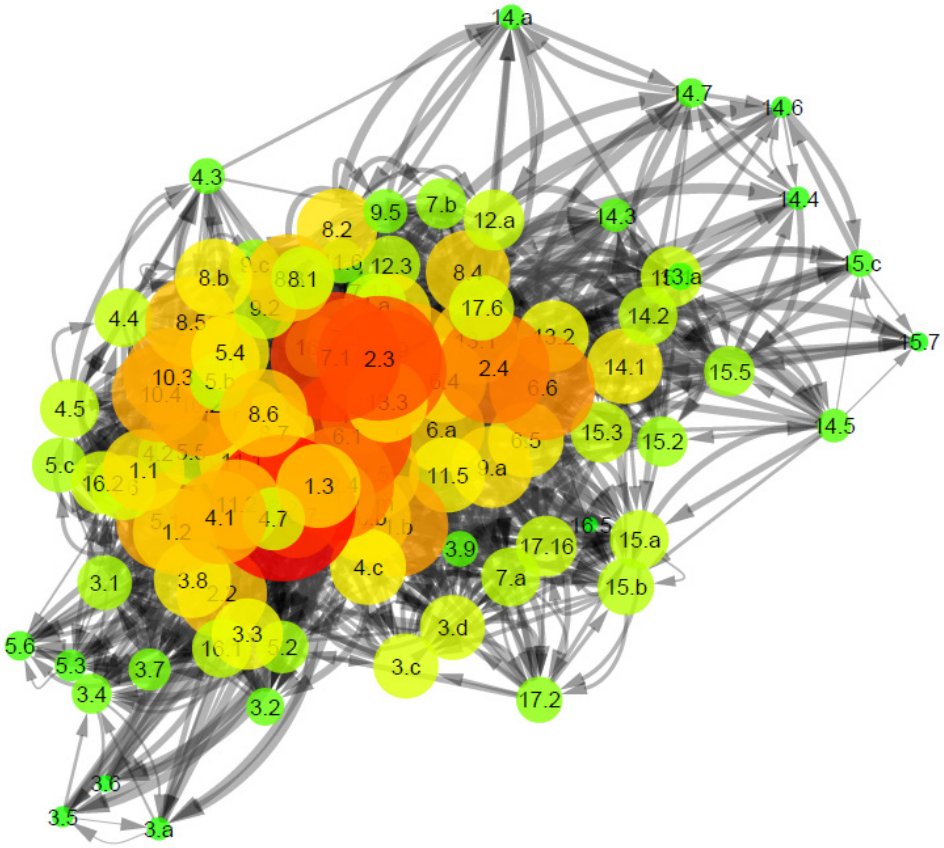


Figure 13 The weighted SDG interlinkages network for the Philippines

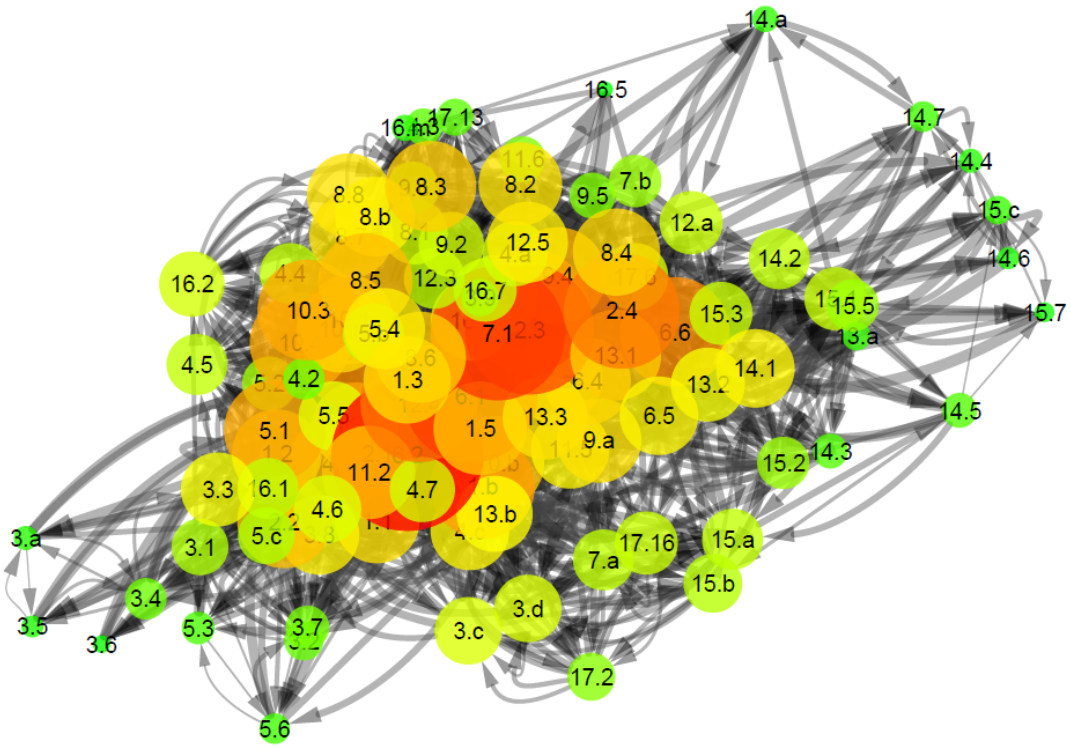


Figure 14 The weighted SDG interlinkages network for Republic for Korea

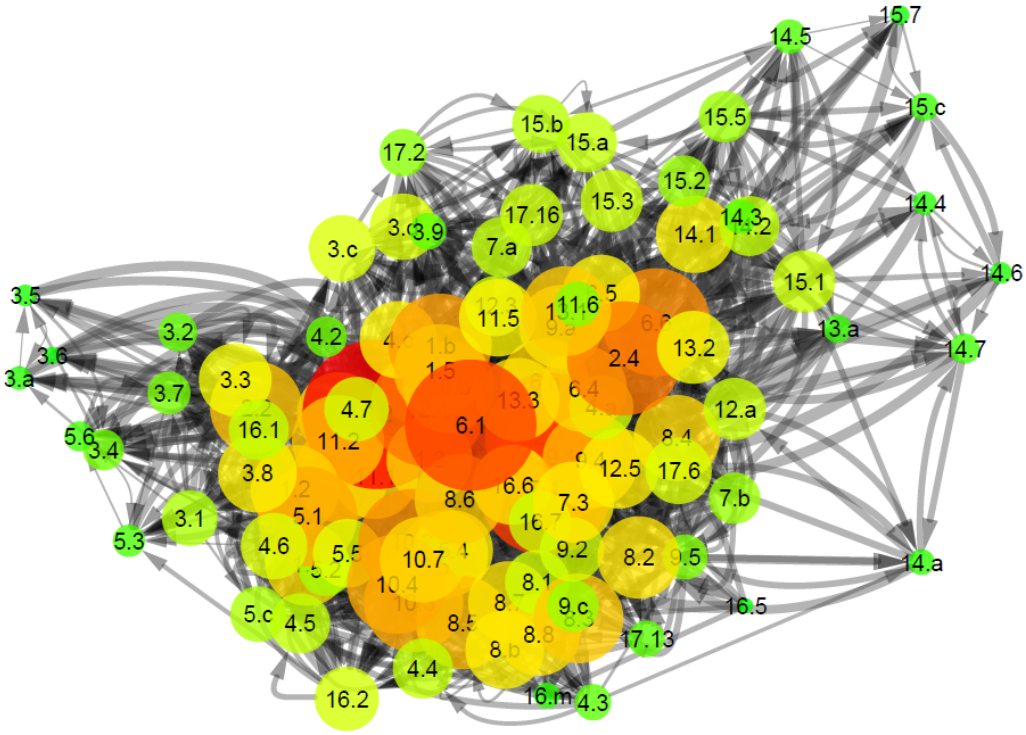


Figure 15 The SDG weighted interlinkages network for Viet Nam

5 Network analysis of SDG interlinkages

Xin Zhou[12] *and Ming Xu*[13]

Using some standard measures and metrics, which originally stemmed from the discipline of Social Network Analysis (SNA), the structure and unique features of the SDG interlinkages networks of individual countries can be analysed. The measures and metrics that are used in this study include degree centrality, eigenvector centrality, betweenness centrality and closeness centrality, among others. Centrality, in the field of SNA, indicates the most important or central roles played by some important nodes (or vertices) in a network.

- **Degree centrality** measures the degree of a node, i.e. the number of edges connected to the node. In directed networks, the degree of a node can be further differentiated by in-degree indicating the direction of the edge from other nodes to the target node, and out-degree indicating the direction of the edge from the target node to other nodes.
  - *In the network of SDG interlinkages, a target with high degree centrality indicates that it has wide interactions with other targets.*
  - *A target with high in-degree centrality indicates that achieving the target will be widely influenced by achieving other targets (receiving influences). A target with higher out-degree centrality indicates that achieving the target will widely influence achieving other targets (exerting influences).*
  - *Furthermore, a target with positive in-degree centrality means that achieving the target will be reinforced by achieving other targets and a target with negative in-degree centrality means achieving the target will be impacted negatively by achieving other targets.*
  - *Similarly, a target with positive out-degree centrality means that achieving the target will reinforce achieving other targets and a target with negative out-degree centrality means achieving the target will impact negatively on achieving other targets.*
- **Eigenvector centrality** takes into account not only how many neighbours a node

[12] Xin Zhou, Principal Policy Researcher and Research Leader, Strategic and Quantitative Analysis Centre (QAC), Institute for Global Environmental Strategies (IGES). 2108-11 Kamiyamaguchi, Hayama, Kanagawa, 240-0115 Japan. ✉ zhou@iges.or.jp

[13] Ming Xu, Associate Professor, School for Environment and Sustainability, and Associate Professor, Department of Civil and Environmental Engineering, University of Michigan. 440 Church St., Ann Arbor, MI 48109-1041. ✉ mingxu@umich.edu

has but also whether it has important neighbours (e.g. the central points in the network).

  - *In the network of SDG interlinkages, a target with high eigenvector centrality indicates that the target both has wide interactions with other targets and places at strategic positions in connecting with other influential targets.*

- **Betweenness centrality** measures the extent to which a node lies on the paths between other nodes. Nodes with high betweenness centrality may have, for example, considerable influence within a network due to their ability of control over the information passing between others (Newman, 2010).

  - *In the network of SDG interlinkages, a target with high betweenness centrality indicates that the target is an important intermediate bridging unconnected targets.*

- **Closeness centrality** measures the mean distance from a node to other nodes. The nodes with low closeness centrality, indicating short geodesic distance separating from others, may have better access to information from other nodes or exert more direct influence on others.

  - *In the network of SDG interlinkages, a target with low closeness centrality indicates that the target is close to other targets and therefore exerts more direct influence on others.*

5.1 General structure of the unweighted network of SDG interlinkages

As introduced in Section 3.3, 3.4 and 3.5, the binary linkage (0 or 1) of each pair of the 169 SDG targets is homogenous for the nine interlinkages networks. This indicates that the structure of the unweighted interlinkages networks for nine countries is homogenous. With a common structure in the network, however, the strength of the link connecting the same pair of SDG targets presented by the weight of edge is heterogeneous, making each of the nine networks of interlinkages country-specific.

In this section, we use unweighted centrality measures, including degree centrality, eigenvector centrality, betweenness centrality and closeness centrality, to analyse the homogeneous structure of the SDG interlinkages network and the features of the structure in terms of identification of the central targets that play various influential roles in the network. The general structure of the SDG interlinkages network homogeneous for nine countries is shown in **Figure 16** using the 'edge-weighted spring embedded layout'. **Figure 17** - **Figure 22** present the landscape of various centrality measures. Detailed data can be found in **Appendix II**. **Table 10** presents the top 20 influential targets in the directed and unweighted SDG interlinkages network ranked by different centrality measures.

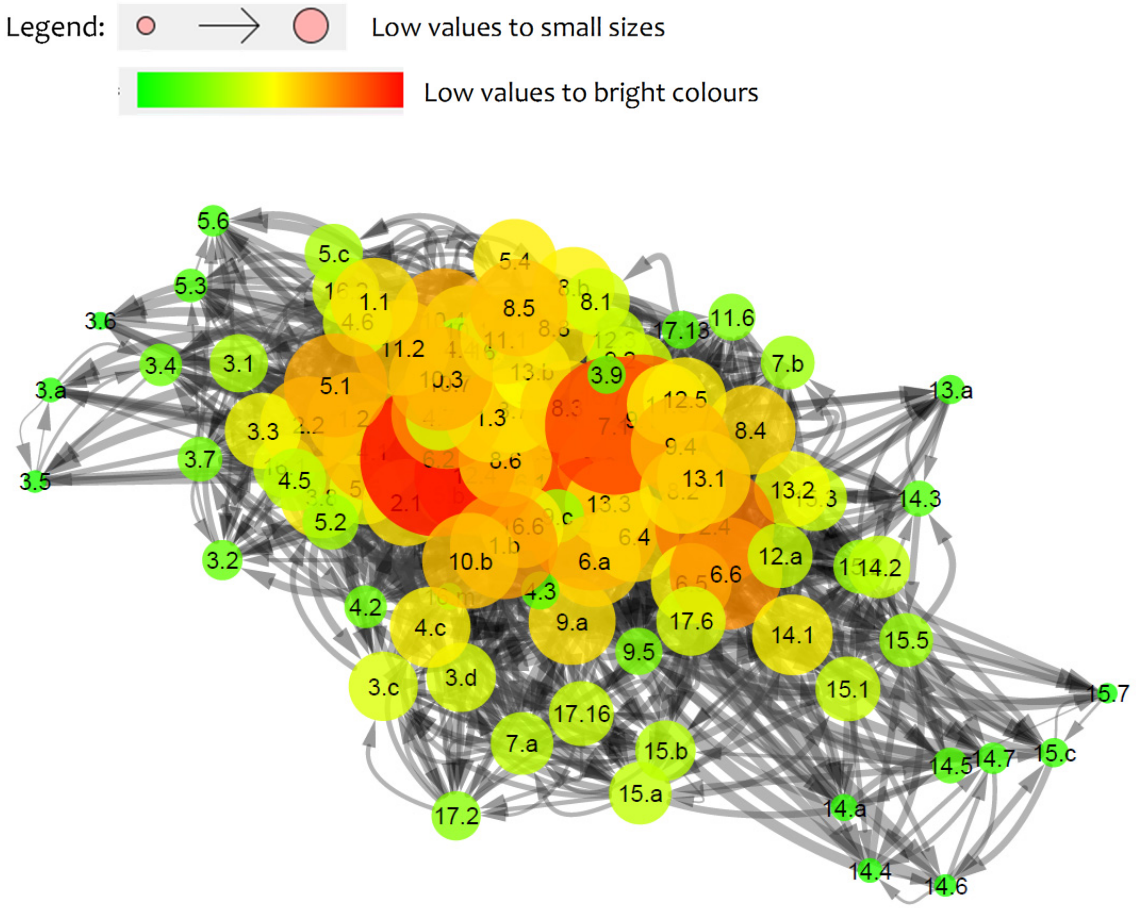


Figure 16 The general structure of the unweighted network of SDG interlinkages

Notes: The network is generated using the 'edge-weighted spring embedded layout'. The size and the colour of the nodes is scaled based on the level of degree. The thickness of the edge is scaled based on the level of edge-betweenness.

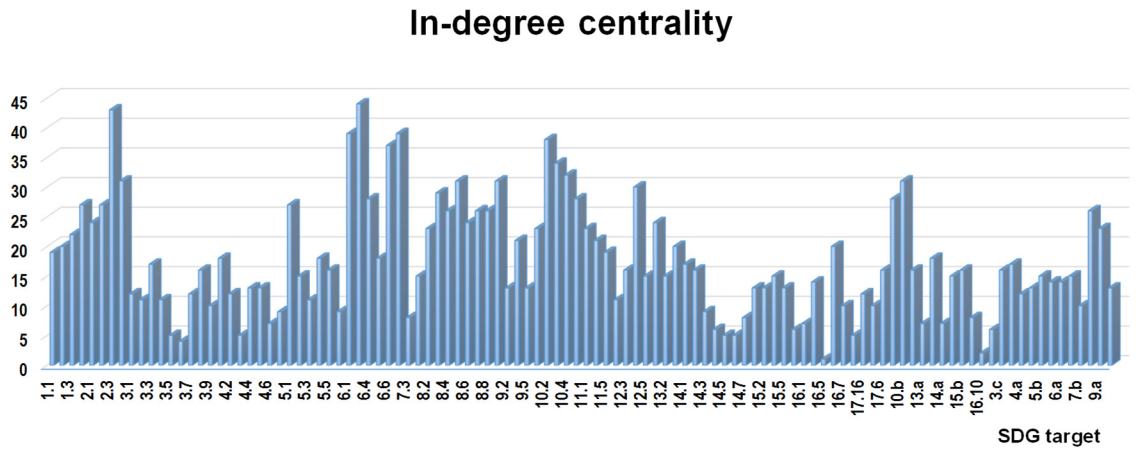


Figure 17 Target-specific central roles measured by in-degree centrality

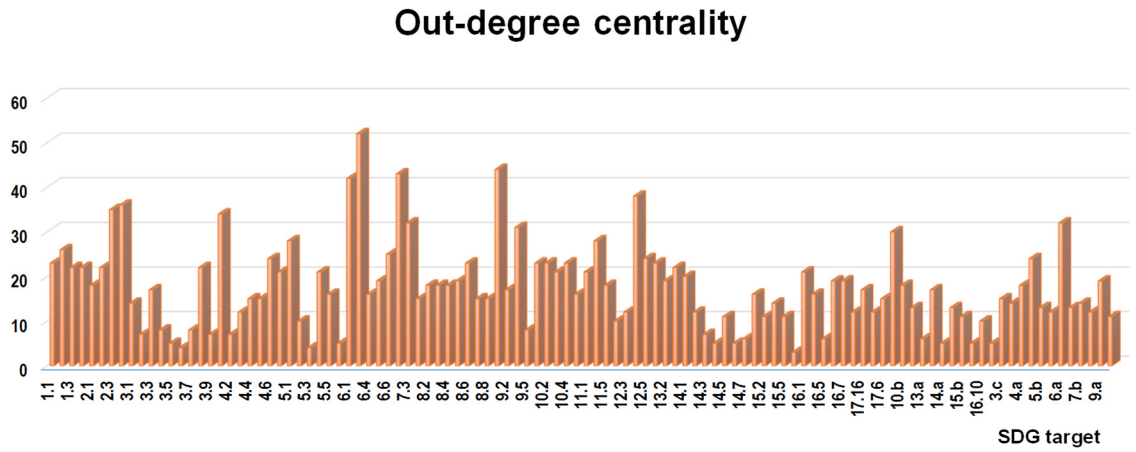


Figure 18 Target-specific central roles measured by out-degree centrality

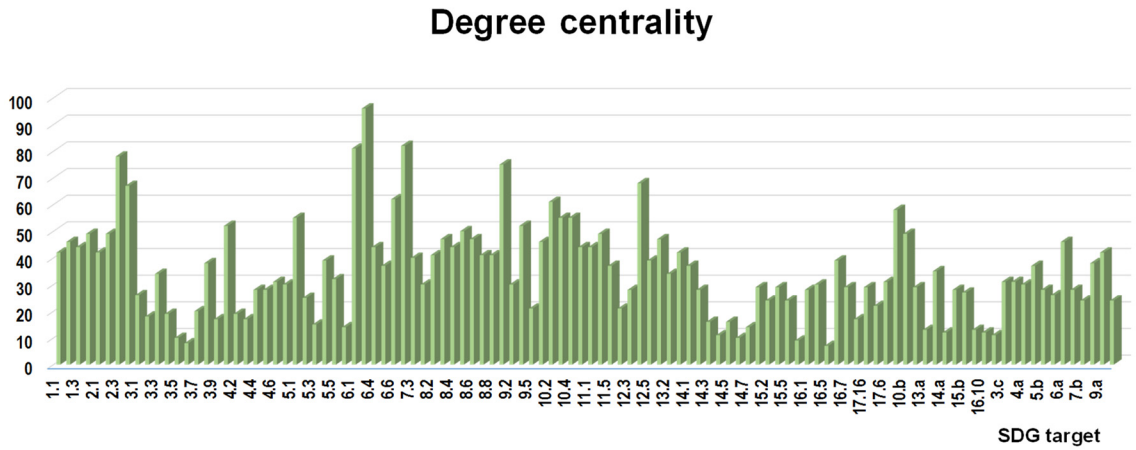


Figure 19 Target-specific central roles measured by degree centrality

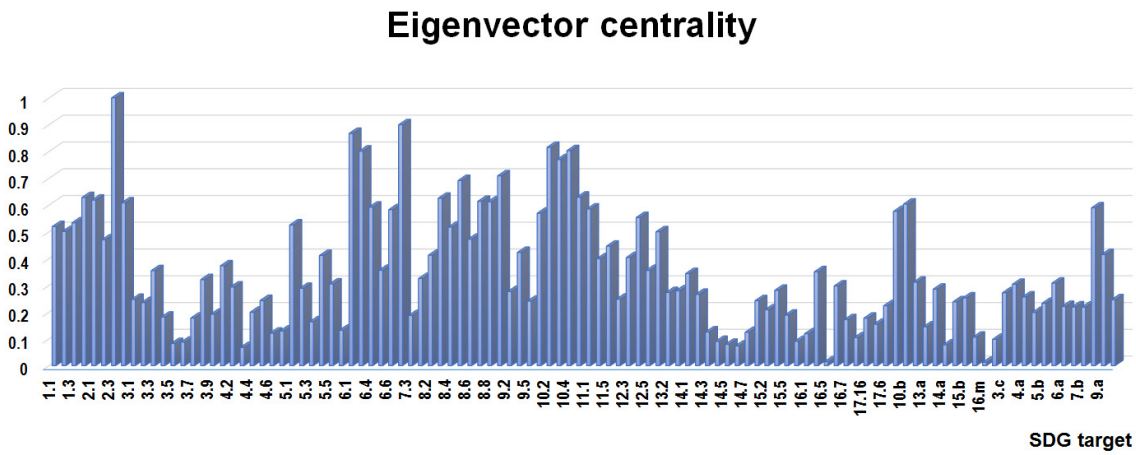


Figure 20 Target-specific central roles measured by eigenvector centrality

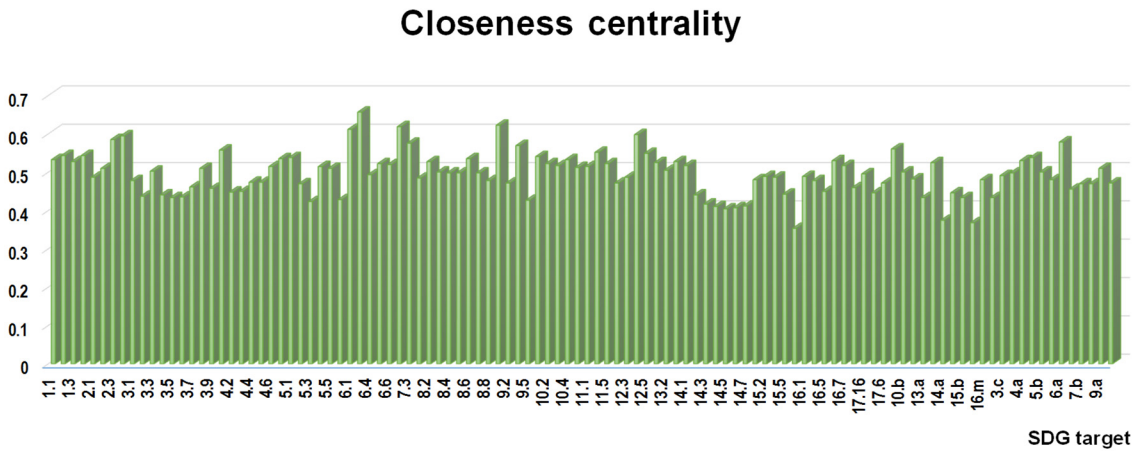


Figure 21 Target-specific central roles measured by closeness centrality

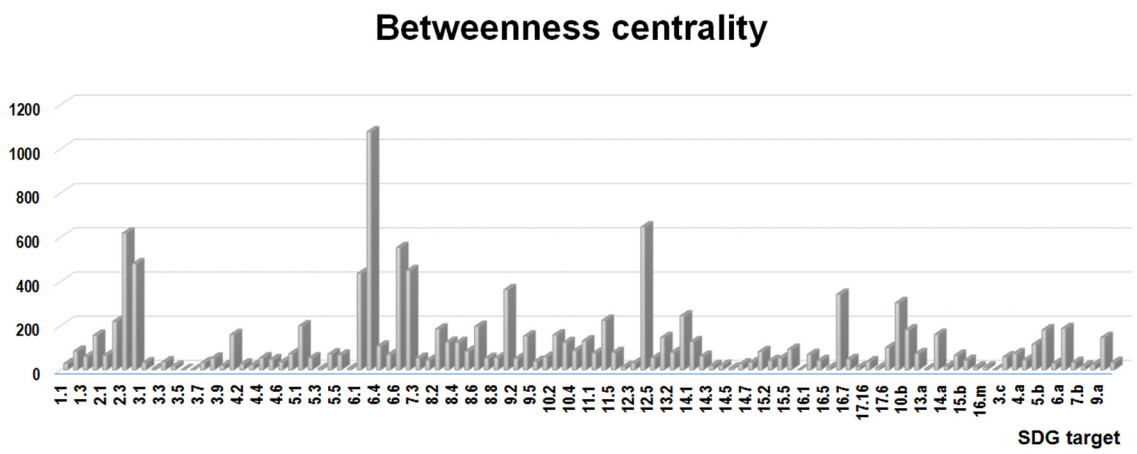


Figure 22 Target-specific central roles measured by betweenness centrality

The interlinkages between 108 SDG targets form one connected network, indicating that there are no separate components. The level of in-degree centrality ranges between [1, 44]. Target 16.5 (reduce corruption) has the in-degree of 1, the lowest in the network and Target 6.2 (universal access to sanitation and hygiene) has the in-degree of 44, the highest in the network. The statistical distribution of in-degree centrality is shown in **Figure 23**. For the interlinkages between SDG targets, in-degree can indicate the impacts that particular targets receive from other targets. Targets with higher level of in-degree imply that to achieve these targets may be potentially impacted by the achievements made in other targets. As shown in **Table 10,** Target 6.2 (universal access to sanitation and hygiene), Target 2.3 (double agriculture productivity), Target 6.1 (universal access to safe drinking water), Target 7.1 (universal access to energy) and Target 10.2 (promote social, economic and political inclusion of all), etc., are such targets with high in-degree levels.

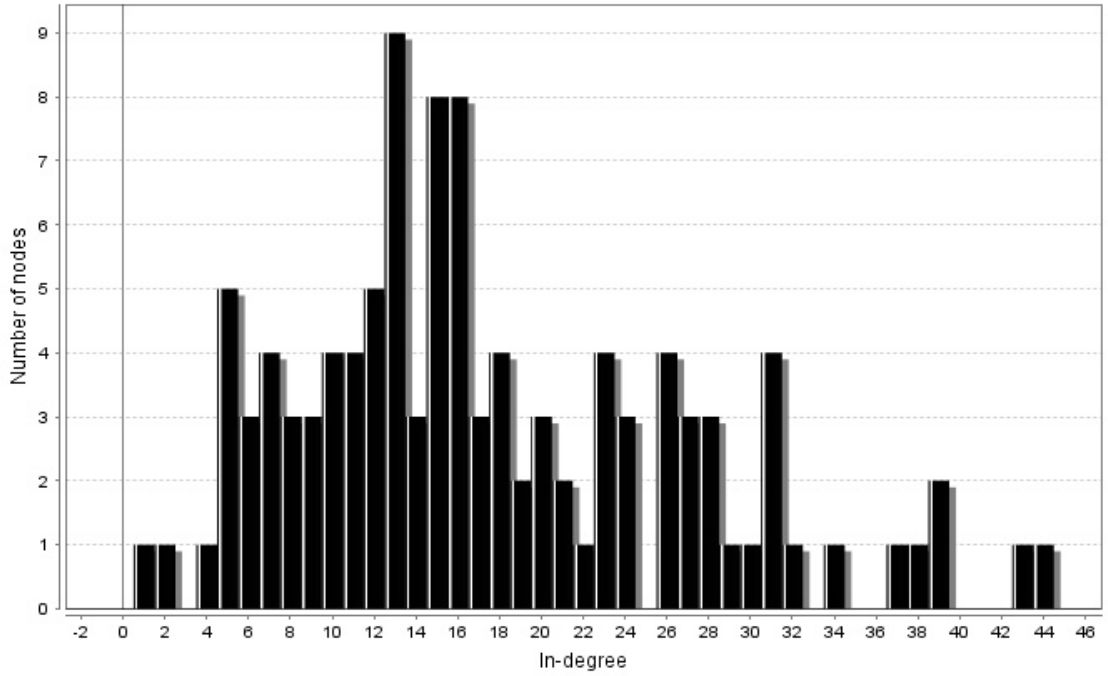


Figure 23 Statistics of in-degree centrality

The level of out-degree centrality ranges between [3, 52] with Target 15.7 (end trafficking of protected species) having the lowest value and Target 6.2 (universal access to sanitation and hygiene) having the highest value. The statistical distribution of out-degree centrality is shown in **Figure 24**. Out-degree can indicate the impacts that particular targets exert on other targets. Targets with higher level of out-degree imply that achieving these targets may potentially influence on achieving other targets. As shown in **Table 10**, Target 6.2 (universal access to sanitation and hygiene), Target 9.1 (develop resilient infrastructure), Target 7.1 (universal access to energy), Target 6.1 (universal access to safe drinking water), and Target 12.4 (sound management of chemicals and wastes), etc., are such targets with high out-degree levels.

Degree centrality measuring the number of linkages that a target has in the SDG interlinkages network is the sum of its in-degree and out-degree. The level of degree centrality ranges between 7 for Target 16.5 (reduce corruption) to 96 for Target 6.2 (universal access to sanitation and hygiene) with an average number of neighbourhoods being 22.2. Targets with a higher degree can be distinguished in terms of their wider connections with other targets. As shown in **Table 10**, Target 6.2 (universal access to sanitation and hygiene), Target 7.1 (universal access to energy), Target 6.1 (universal access to safe drinking water), Target 2.3 (double agriculture productivity) and Target 9.1 (develop resilient infrastructure), etc., are such targets with high degree levels.

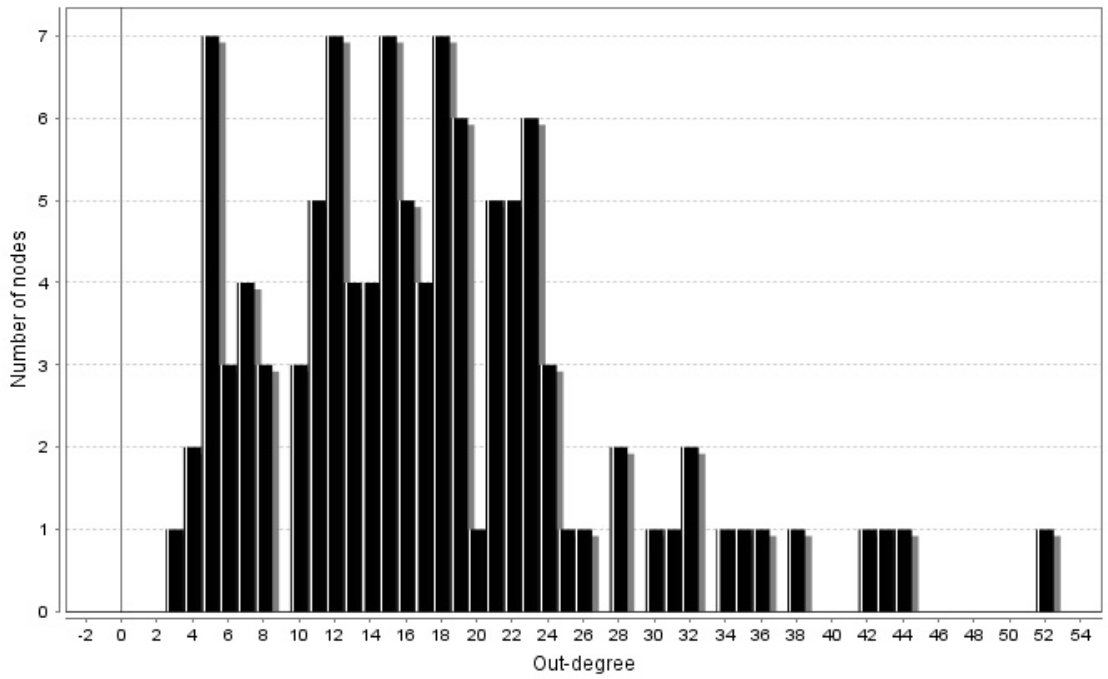


Figure 24 Statistics of out-degree centrality

Closeness centrality ranges from about 0.35 for Target 15.7 to about 0.66 for Target 6.2. The statistical distribution of closeness centrality is shown in **Figure 25**. Targets with lower closeness centrality, indicating short geodesic distance separating from others, imply that achieving these targets may exert more direct influences on others, and vice versa for those with higher closeness centrality. As shown in **Table 10**, Target 15.7 (end trafficking of protected species), Target 15.c (global support to combat trafficking of protected species), Target 14.a (increase R&D on marine technology), Target 14.5 (conserve 10 per cent of coastal areas) and Target 14.6 (eliminate harmful fisheries subsidies), etc., are such targets with low closeness levels.

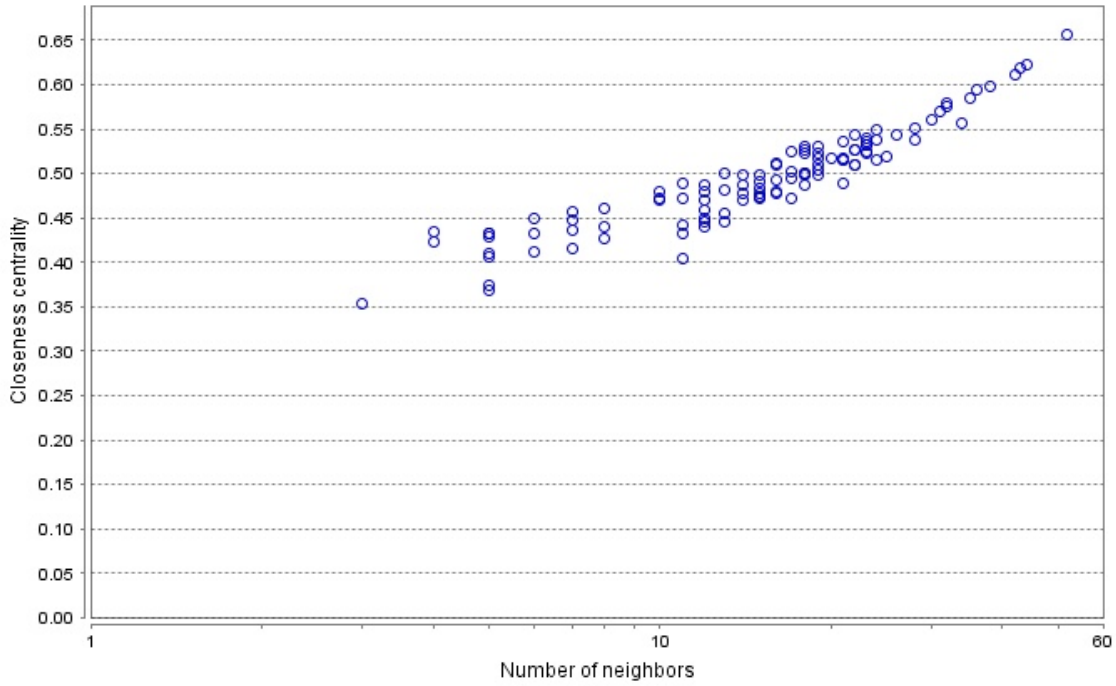


Figure 25 Statistics of closeness centrality

Betweenness centrality ranges from 0 for Target 15.7 to about 1077 for Target 6.2. The statistical distribution of betweenness centrality is shown in **Figure 26**. In the SDG interlinkages network, targets with higher betweenness centrality may play important intermediate roles connecting those targets which do not have direct links. As shown in **Table 10**, Target 6.2 (universal access to sanitation and hygiene), Target 12.4 (sound management of chemicals and wastes), Target 2.3 (double agriculture productivity), Target 6.6 (protect water-related ecosystems) and Target 2.4 (build sustainable food production systems), etc., are such targets with high betweenness levels.

Clustering coefficient measures the average probability that the neighbours of a target connect among themselves. Average clustering coefficients range from 0.71 for Target 17.2 (implement ODA commitments) to 0.17 for Target 16.1 (reduce violence). The statistical distribution of average clustering coefficients is shown in **Figure 27**. A target with lower clustering coefficient imply that the connections between its neighbours are missing, the so-called structural holes. Such a situation gives the target more influential roles in linking its neighbours. Target 16.1 (reduce violence), Target 3.6 (halve traffic deaths), Target 16.6 (develop accountable institutions), Target 6.2 (universal access to sanitation and hygiene) and Target 4.7 (acquire knowledge needed for sustainable development), etc., are such targets with low clustering coefficients.

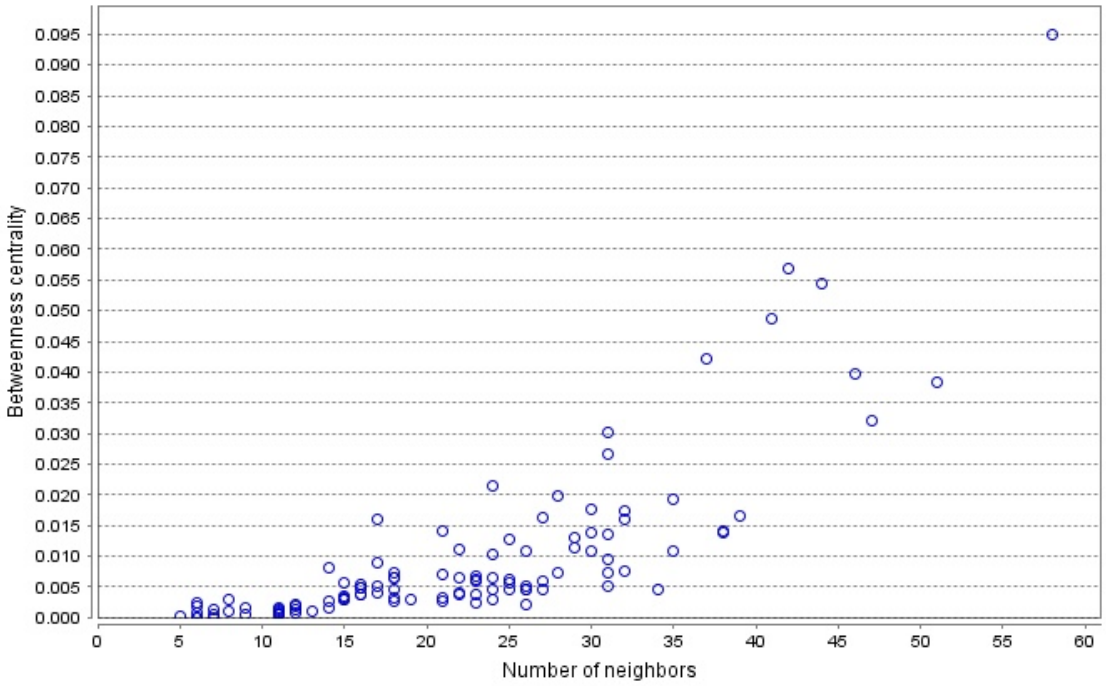


Figure 26 Statistics of betweenness centrality

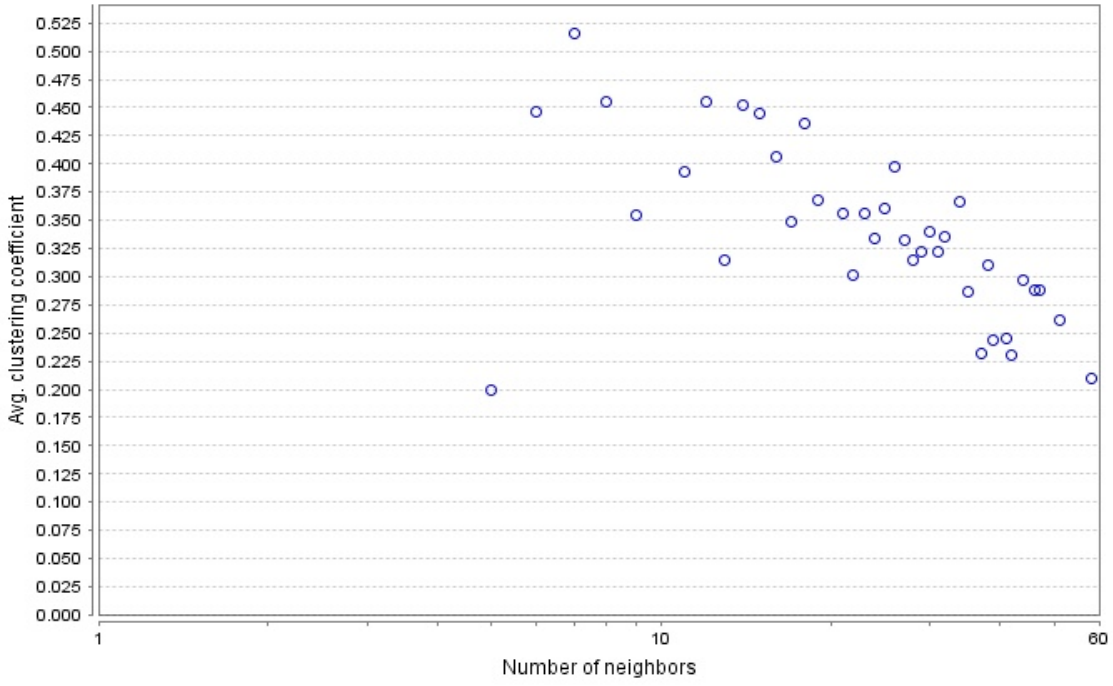


Figure 27 Statistics of average clustering coefficient

Eigenvector centrality measures both how many neighbours a target has in the interlinkages network and whether it has important neighbours, i.e. other influential targets in the network. Eigenvector centrality ranges between 0.01 for Target 16.10 (ensure public access to information) and 1 for Target 2.3 (double agriculture productivity). Targets with higher eigenvector levels imply that these targets have both more and important neighbours. As shown in **Table 10**, Target 2.3 (double agriculture productivity), Target 7.1 (universal access to energy), Target 6.1 (universal access to safe drinking water), Target 10.2 (Promote social, economic and political inclusion of all) and Target 10.4 (policy for greater equality), etc., are such targets with high eigenvector levels.

Table 10 Preliminary results on top 20 central targets ranked by various centrality measures

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

Note: The string indicates the label of targets.

Among top 20 central SDG targets measured by different centrality metrics (see **Table 10**), there are a few common SDG targets which play various central roles simultaneously in the network. These targets include Target 2.3 (double agriculture productivity), Target 2.4 (build

sustainable food production systems), Target 6.1 (universal access to safe drinking water), Target 6.2 (universal access to sanitation and hygiene), Target 7.1 (universal access to energy) and Target 9.1 (develop resilient infrastructure). Except for exerting more direct influences on others that are measured by closeness centrality, these targets are the most influential ones in the interlinkages network and play various roles that can be measured by degree centrality, including both in-degree and out-degree, betweenness centrality and eigenvector centrality.

5.2 Features of country-specific SDG interlinkages networks

Beyond the general structure of the interlinkages network, quantification of the linkages in terms of weighted edge makes each of the nine individual networks distinguished from one another. The features of country-specific SDG interlinkages networks can be described by the measures of weighted degree centrality, including weighted in-degree and weighted out-degree. While in the unweighted networks these metrics are the same for the nine countries, in the weighted networks the weighted degree measures vary for different countries.

Figure 28 - **Figure 30** present country-specific weighted in-degree centrality, weighted out-degree centrality and weighted degree centrality for 108 SDG targets in nine countries. Detailed data for four countries (not for all the nine countries due to the large size of the data for presentation) is shown in **Appendix III**. Different from unweighted degree centrality measures shown in **Figure 17** - **Figure 19**, the value of weighted degree centrality measures can be positive or negative, indicating potential reinforcing or conflicting influences that particular SDG targets may have on achieving other targets.

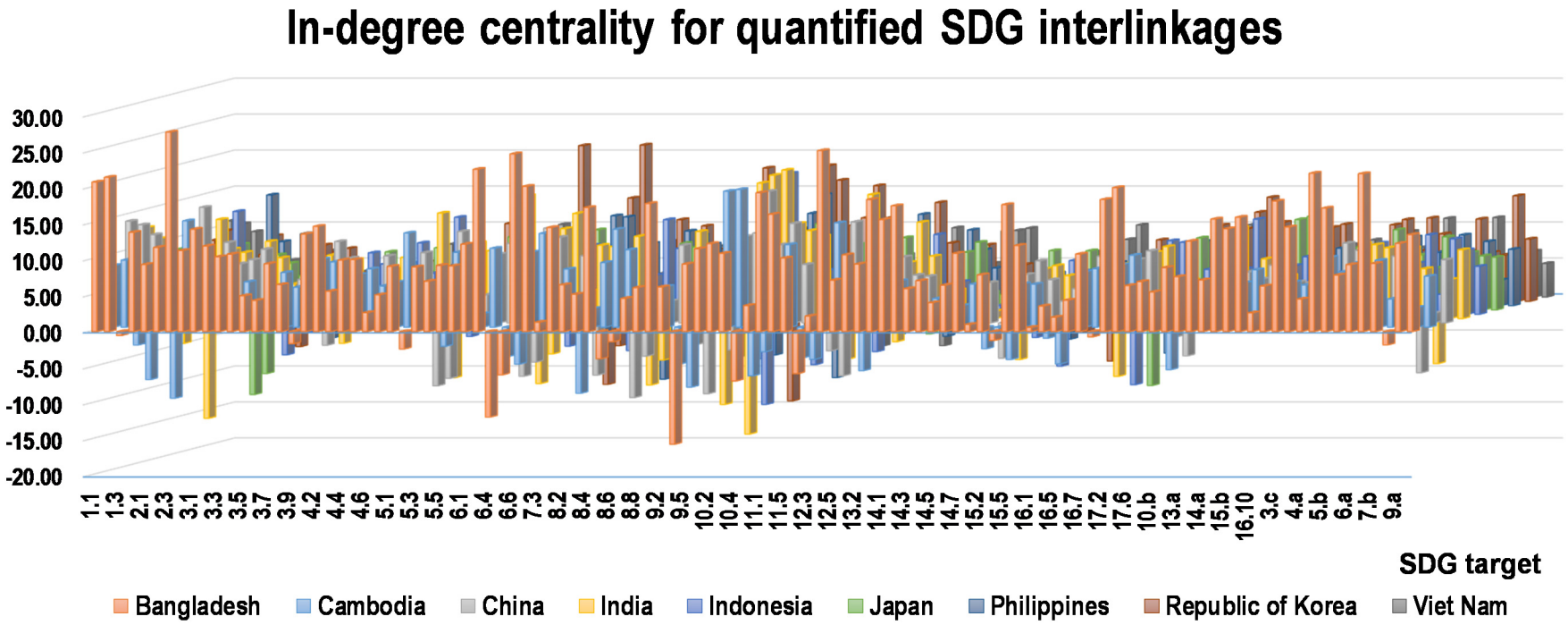


Figure 28 Country-specific in-degree centrality for quantified SDG interlinkages

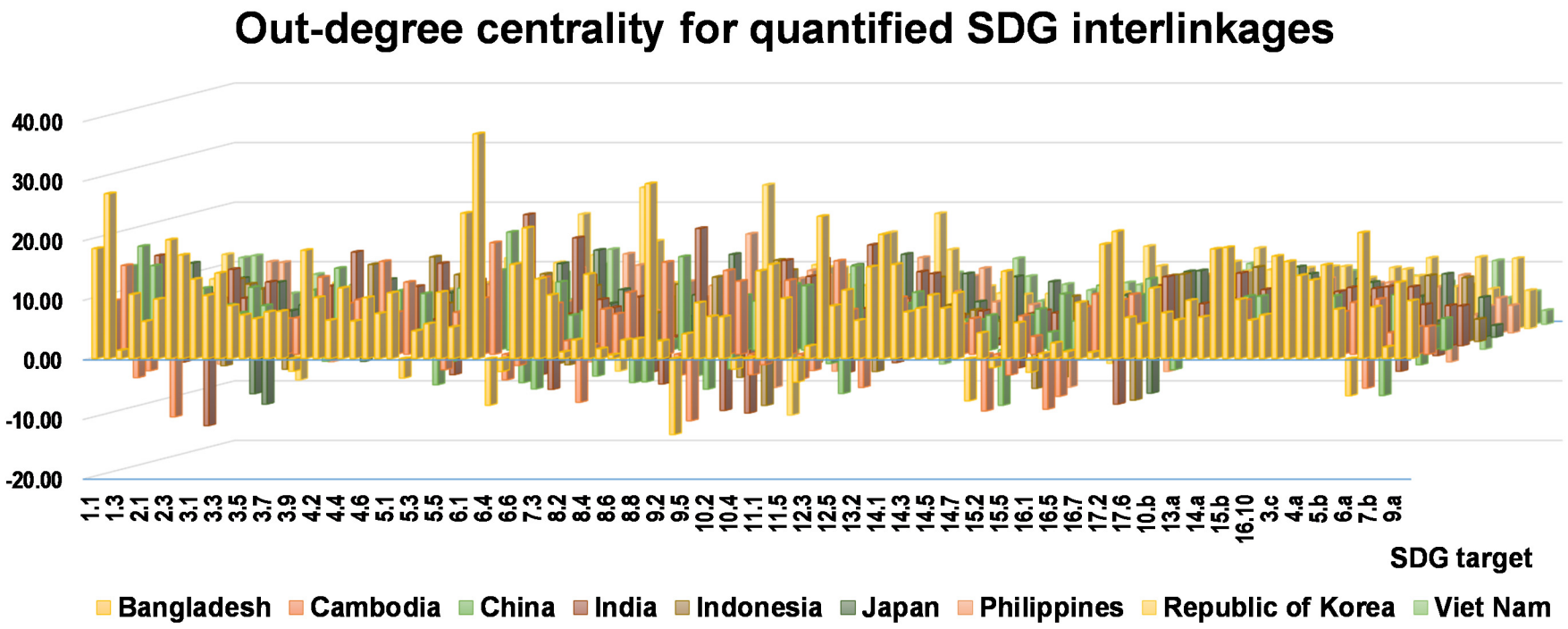


Figure 29 Country-specific out-degree centrality for quantified SDG interlinkages

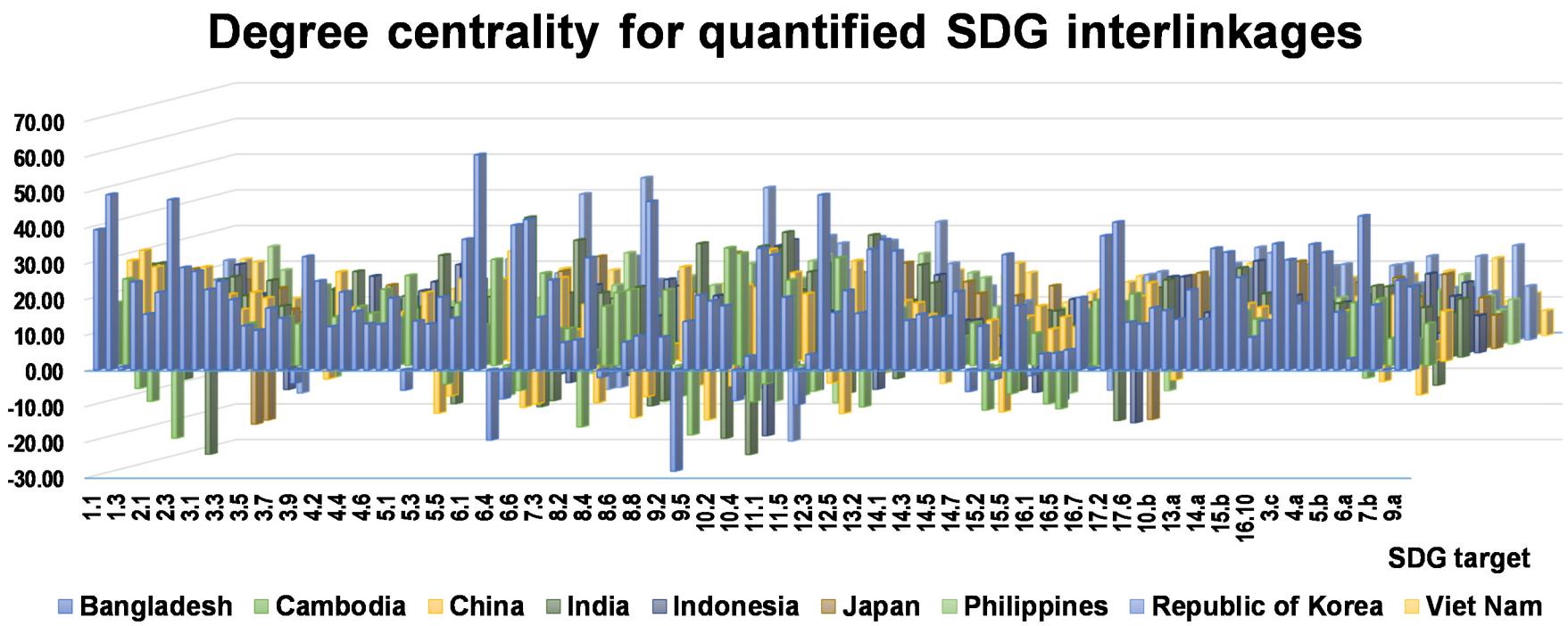


Figure 30 Country-specific degree centrality for quantified SDG interlinkages

Table 11 shows top 20 central targets, measured by weighted in-degree, weighted out-degree and weighted degree for nine countries, which may potentially reinforce the achievements in other targets through the positive links with their neighbours. Brick-red colour indicates those central targets that are the same as identified in the general structure of the unweighted homogeneous interlinkages network. In other words, they can be considered as common central targets both in the unweighted network with the general structure and in nine weighted country-specific networks. Blue colour indicates those SDG targets which are identified as central targets commonly in most of the nine weighted networks. Targets without highlighted colours can be considered as country-specific central targets, which vary from one country to another. **Table 12** shows the bottom 10 central targets, measured by weighted in-degree, weighted out-degree and weighted degree for nine countries, whose achievements may have potential trade-offs with the achievements in other targets through negative links with their neighbours.

Table 11 Country-specific top 20 targets ranked by positive weighted degree centrality measures indicating strong synergies with other targets

Top 20 targets	BDG						KHM					
	Weighted in-degree		Weighted out-degree		Weighted degree		Weighted in-degree		Weighted out-degree		Weighted degree	
	Target	Value	Target	Value	Target	Value	Target	Value	Target	Value	Target	Value
1	2.3	27.72	6.2	37.72	6.2	60.27	10.3	19.14	6.2	18.73	10.2	32.95
2	12.4	25.15	9.1	29.36	1.2	49.12	10.2	18.89	12.4	15.68	10.3	31.40
3	6.6	24.70	1.2	27.68	12.4	49.03	2.3	14.78	4.6	15.58	12.4	30.18
4	6.2	22.55	6.1	24.41	2.3	47.67	12.4	14.51	9.1	15.45	6.2	29.70
5	4.c	22.01	12.4	23.89	9.1	47.16	8.5	13.62	1.2	14.91	7.1	25.88
6	7.a	21.94	7.1	21.92	7.a	43.09	5.1	13.09	10.2	14.06	2.3	25.86
7	1.2	21.44	17.2	21.34	7.1	42.11	7.1	13.04	4.1	12.93	5.1	25.20
8	1.1	20.79	7.a	21.15	17.2	41.34	11.2	11.48	7.1	12.84	1.2	24.23
9	7.1	20.19	14.1	20.84	6.6	40.52	6.2	10.97	11.2	12.42	11.2	23.90
10	17.2	20.00	2.3	19.95	1.1	39.25	8.b	10.93	10.3	12.26	4.1	22.41
11	11.1	19.29	17.16	19.20	17.16	37.55	8.6	10.77	5.1	12.10	4.6	21.31
12	17.16	18.35	15.b	18.65	6.1	36.55	6.6	10.45	2.3	11.09	8.6	21.14
13	13.3	18.34	1.1	18.46	14.1	36.39	5.5	10.40	8.6	10.38	9.1	21.12
14	3.c	18.14	15.a	18.39	3.c	35.34	17.2	10.00	16.7	10.09	8.5	20.39
15	9.1	17.80	4.1	18.17	4.c	35.19	4.c	9.71	3.1	10.05	17.2	20.04
16	15.5	17.64	2.4	17.38	15.a	34.03	4.1	9.47	17.2	10.04	7.a	18.56
17	14.2	17.48	3.c	17.20	11.1	34.02	1.2	9.32	14.1	9.51	16.7	18.22
18	8.4	17.24	3.d	16.30	13.3	33.73	7.a	9.31	6.1	9.35	17.16	17.77
19	5.b	17.16	6.6	15.82	14.2	33.27	13.3	9.17	7.a	9.25	5.c	17.57
20	11.2	16.31	11.2	15.82	15.b	32.93	4.2	9.08	4.4	9.16	1.1	17.55

Note: Colours – Brick-red colour indicates those central targets commonly identified both in the network with general structure (see **Table 10**) and in nine quantified country-specific networks. Blue colour indicates those targets which are identified as central targets commonly in most of the nine quantified networks.

(Continue)

Top 20 targets	CHN						IND					
	Weighted in-degree		Weighted out-degree		Weighted degree		Weighted in-degree		Weighted out-degree		Weighted degree	
	Target	Value	Target	Value	Target	Value	Target	Value	Target	Value	Target	Value
1	10.4	18.28	6.2	19.78	10.4	31.27	10.4	20.63	6.2	22.00	6.2	39.07
2	2.3	16.06	1.2	17.42	1.2	31.05	10.3	19.92	9.1	19.67	10.4	34.94
3	1.1	14.13	9.1	15.67	6.2	30.82	10.2	18.82	7.1	18.10	12.4	34.15
4	12.4	14.03	1.3	14.14	1.1	28.18	12.4	17.24	12.4	16.91	7.1	32.70
5	11.1	13.81	12.4	14.08	12.4	28.11	6.2	17.07	4.1	15.72	9.1	31.78
6	1.2	13.63	1.1	14.05	9.1	26.46	5.1	14.66	1.2	15.13	10.2	30.97
7	6.6	13.15	4.1	13.72	2.3	26.40	7.1	14.60	11.2	14.48	10.3	30.29
8	5.4	12.70	6.1	13.34	1.3	26.40	2.3	13.78	10.4	14.31	5.1	28.47
9	10.3	12.48	10.4	13.00	4.1	25.03	13.3	13.39	5.1	13.82	6.1	26.78
10	1.3	12.26	17.2	11.94	11.1	24.83	10.7	13.21	6.1	13.59	1.2	26.25
11	10.2	12.00	7.1	11.40	7.1	23.29	6.1	13.19	1.1	13.17	11.2	25.95
12	7.1	11.89	11.1	11.02	5.4	23.07	13.b	12.68	2.4	12.81	1.1	25.82
13	4.1	11.31	16.6	10.84	6.1	22.88	1.1	12.65	13.3	12.40	13.3	25.79
14	3.1	11.18	11.2	10.78	17.2	21.94	6.6	12.48	13.b	12.18	13.b	24.86
15	4.c	11.09	3.3	10.52	10.2	21.15	11.1	12.23	10.2	12.15	4.1	23.93
16	6.2	11.04	5.4	10.36	10.3	20.67	9.1	12.11	14.1	12.08	11.1	23.84
17	10.7	10.85	2.3	10.34	16.6	20.08	11.2	11.47	7.3	11.73	2.4	22.47
18	9.1	10.79	3.8	10.05	3.3	19.29	8.4	11.42	11.1	11.62	2.3	21.62
19	3.4	10.23	4.6	9.94	3.8	19.25	1.2	11.12	17.2	11.57	5.4	21.58
20	5.b	10.09	14.1	9.65	5.1	19.22	3.3	10.73	5.4	11.04	17.2	21.56

(Continue)

Top 20 targets	IDN						JPN					
	Weighted in-degree		Weighted out-degree		Weighted degree		Weighted in-degree		Weighted out-degree		Weighted degree	
	Target	Value	Target	Value	Target	Value	Target	Value	Target	Value	Target	Value
1	10.3	19.59	4.6	14.17	10.3	31.49	15.b	12.99	6.6	14.59	9.1	26.76
2	10.2	16.32	10.2	13.61	10.2	29.93	9.1	12.87	12.4	13.90	6.6	25.72
3	2.3	14.28	4.1	12.91	13.b	25.66	15.a	12.55	9.1	13.88	15.a	24.35
4	5.1	13.47	13.b	12.45	2.3	24.67	10.4	11.98	1.2	12.42	12.4	23.94
5	13.b	13.22	10.3	11.90	5.1	24.66	4.c	11.14	6.2	12.34	15.b	23.60
6	8.5	13.14	6.2	11.30	7.a	22.09	6.6	11.13	11.2	12.08	1.2	22.21
7	6.6	11.57	17.2	11.28	13.3	21.73	7.a	10.15	15.a	11.80	10.4	21.82
8	13.3	11.07	5.1	11.20	4.1	21.44	5.4	10.14	17.2	11.15	6.2	21.57
9	7.a	11.05	7.a	11.04	17.2	21.28	12.4	10.04	17.16	10.99	11.2	21.18
10	8.b	10.47	17.16	11.02	17.16	21.24	17.2	10.00	14.1	10.64	17.2	21.15
11	17.16	10.22	9.1	10.79	8.5	20.48	1.2	9.79	15.b	10.61	7.a	20.74
12	17.2	10.00	1.2	10.79	4.6	19.86	14.2	9.40	7.a	10.59	17.16	20.28
13	4.5	9.91	9.a	10.69	9.a	19.65	17.16	9.29	14.5	10.12	5.4	19.81
14	4.c	9.90	13.3	10.66	7.1	18.84	8.5	9.25	2.2	9.85	4.c	19.76
15	7.1	9.58	2.3	10.39	8.6	18.73	6.2	9.23	10.4	9.83	2.2	18.96
16	8.6	9.13	2.4	9.61	5.c	17.78	2.2	9.12	3.c	9.83	14.1	18.65
17	5.c	9.12	8.6	9.60	4.5	17.31	11.2	9.10	5.4	9.67	3.c	18.62
18	9.a	8.96	7.1	9.26	1.2	17.27	3.c	8.79	4.1	9.66	4.1	17.71
19	4.1	8.53	15.a	9.20	6.2	17.10	8.6	8.74	15.1	9.31	15.1	17.55
20	5.5	8.21	15.b	9.19	15.a	16.78	4.5	8.62	6.5	7.66	3.d	16.28

(Continue)

Top 20 targets	PHL						KOR					
	Weighted in-degree		Weighted out-degree		Weighted degree		Weighted in-degree		Weighted out-degree		Weighted degree	
	Target	Value	Target	Value	Target	Value	Target	Value	Target	Value	Target	Value
1	10.3	15.40	9.1	16.59	2.3	27.31	7.1	21.71	9.1	24.10	7.1	45.38
2	2.3	15.37	7.1	13.24	7.1	25.55	6.1	21.63	7.1	23.67	9.1	42.62
3	10.2	12.81	12.4	12.62	12.4	25.30	10.2	18.85	12.4	19.31	6.1	40.81
4	12.4	12.69	2.3	11.93	10.3	24.93	9.1	18.52	6.1	19.18	12.4	33.03
5	6.6	12.48	17.2	11.89	10.2	23.26	10.3	16.83	11.2	16.11	10.2	29.12
6	7.1	12.31	2.4	11.81	9.1	22.52	11.1	16.06	7.3	14.68	11.1	28.77
7	13.3	10.51	7.3	11.35	17.2	21.89	9.a	14.66	16.1	13.80	11.2	27.70
8	8.4	10.36	14.1	10.83	2.4	20.69	10.b	14.46	1.b	13.48	10.3	27.01
9	17.2	10.00	6.2	10.82	13.3	20.00	6.6	14.34	12.5	13.24	9.a	26.43
10	7.a	9.81	10.2	10.46	7.a	19.51	12.4	13.72	11.1	12.71	1.b	25.85
11	8.5	9.76	17.16	9.71	8.4	18.97	1.b	12.37	1.2	12.42	10.b	24.32
12	4.c	9.52	7.a	9.70	17.16	18.65	11.2	11.60	6.2	12.34	4.c	23.42
13	10.1	9.29	13.b	9.58	14.1	18.57	10.7	11.58	7.a	11.98	7.a	23.41
14	17.16	8.93	10.3	9.53	10.1	18.36	4.c	11.57	5.1	11.87	6.6	23.28
15	8.b	8.90	13.3	9.49	13.b	18.33	10.1	11.54	4.c	11.85	5.1	22.67
16	2.4	8.88	15.b	9.09	6.6	16.49	7.a	11.43	9.a	11.77	1.2	22.21
17	15.5	8.85	15.a	9.09	8.6	16.48	3.d	11.35	17.2	11.21	10.1	22.21
18	13.b	8.75	10.1	9.07	15.a	16.32	8.2	11.34	5.5	11.05	6.2	21.57
19	8.1	8.63	8.4	8.61	15.5	16.32	12.a	10.99	17.16	10.88	17.16	21.45
20	8.6	5.68	3.d	6.32	8.5	12.00	5.1	7.87	10.1	8.70	12.5	21.34

(Continue)

Top 20 targets	VNM					
	Weighted in-degree		Weighted out-degree		Weighted degree	
	Target	Value	Target	Value	Target	Value
1	7.a	11.03	6.2	12.57	7.a	21.70
2	4.c	10.92	1.3	11.50	1.2	21.33
3	6.6	10.80	1.2	11.15	1.3	20.58
4	1.1	10.56	14.1	11.03	14.1	20.26
5	1.2	10.18	7.a	10.67	17.2	20.18
6	5.4	10.07	9.1	10.56	5.4	18.73
7	17.2	10.00	17.2	10.18	6.6	18.45
8	15.5	9.99	6.1	9.98	6.2	18.30
9	12.4	9.60	15.b	9.17	12.4	18.26
10	14.2	9.55	15.a	8.92	1.1	18.24
11	14.1	9.23	17.16	8.83	4.c	18.04
12	13.3	9.17	12.4	8.66	17.16	17.64
13	3.c	9.11	5.4	8.65	14.2	17.59
14	1.3	9.08	2.4	8.38	3.c	17.11
15	17.16	8.81	14.2	8.04	13.3	16.86
16	2.3	8.77	3.c	8.01	15.5	16.62
17	15.3	7.98	13.3	7.69	15.a	16.18
18	15.c	7.92	1.1	7.68	15.b	15.61
19	4.2	7.33	6.6	7.65	15.3	14.96
20	15.a	7.27	3.d	7.47	9.1	14.49

Table 12 Country-specific bottom 20 targets ranked by weighted degree centrality which may have trade-offs with the achievements in other targets

Bottom ten	BDG						KHM					
	Weighted in-degree		Weighted out-degree		Weighted degree		Weighted in-degree		Weighted out-degree		Weighted degree	
	Target	Value	Target	Value	Target	Value	Target	Value	Target	Value	Target	Value
1	9.4	-15.66	9.4	-12.75	9.4	-28.41	2.2	-9.86	9.4	-11.16	2.2	-20.36
2	6.4	-11.88	6.4	-7.83	6.4	-19.71	8.2	-9.18	2.2	-10.50	9.4	-19.48
3	10.4	-6.87	15.1	-7.09	11.6	-9.81	9.4	-8.32	15.1	-9.51	8.2	-17.23
4	6.5	-6.01	6.a	-6.24	10.4	-8.64	1.5	-7.27	16.1	-9.22	15.1	-12.49
5	11.6	-5.85	11.6	-3.95	6.5	-8.18	10.4	-6.76	8.2	-8.05	16.2	-12.14
6	8.5	-3.78	5.2	-3.28	15.1	-6.10	13.1	-6.03	16.2	-7.05	13.1	-11.60
7	5.2	-2.43	16.1	-2.30	5.2	-5.71	10.b	-5.90	6.a	-5.68	16.1	-10.74
8	8.b	-1.86	6.5	-2.16	3.9	-3.81	9.2	-5.15	13.1	-5.56	10.4	-10.21
9	3.9	-1.69	3.9	-2.13	15.3	-2.76	6.5	-5.12	6.4	-4.30	1.5	-10.03
10	8.6	-1.41	10.4	-1.78	8.5	-2.14	16.2	-5.09	11.5	-4.16	9.2	-8.75
Bottom ten	**CHN**						**IND**					
	Weighted in-degree		Weighted out-degree		Weighted degree		Weighted in-degree		Weighted out-degree		Weighted degree	
	Target	Value	Target	Value	Target	Value	Target	Value	Target	Value	Target	Value
1	8.5	-10.37	15.1	-9.28	9.4	-16.40	10.1	-16.05	2.2	-13.41	10.1	-27.34
2	9.4	-9.84	6.a	-7.63	8.5	-15.83	2.2	-13.85	10.1	-11.29	2.2	-27.26
3	5.2	-8.74	12.3	-7.30	12.3	-14.64	9.4	-11.93	9.4	-10.87	9.4	-22.80
4	5.3	-7.70	9.4	-6.57	5.2	-14.57	8.5	-9.22	16.6	-9.81	16.6	-17.83
5	6.4	-7.41	6.5	-6.53	15.1	-14.18	6.4	-9.02	6.5	-7.33	6.4	-13.93
6	12.3	-7.34	5.2	-5.83	6.4	-12.89	5.2	-8.23	8.6	-6.43	8.5	-13.70
7	8.2	-7.25	6.4	-5.48	6.5	-11.97	16.6	-8.02	6.4	-4.91	5.2	-13.09
8	8.b	-6.91	8.5	-5.47	8.2	-11.62	8.b	-6.25	5.2	-4.86	6.5	-12.24
9	6.5	-5.44	8.6	-5.34	8.6	-9.95	8.6	-5.77	11.6	-4.50	8.6	-12.20
10	15.1	-4.90	8.2	-4.38	5.3	-9.76	15.1	-5.69	8.5	-4.47	11.6	-10.14

(Continue)

Bottom ten	IDN						JPN					
	Weighted in-degree		Weighted out-degree		Weighted degree		Weighted in-degree		Weighted out-degree		Weighted degree	
	Target	Value	Target	Value	Target	Value	Target	Value	Target	Value	Target	Value
1	10.1	-12.53	10.1	-10.75	10.1	-23.27	2.3	-11.75	2.4	-11.25	9.1	-21.25
2	16.6	-9.78	16.6	-9.86	16.6	-19.65	16.6	-10.50	2.3	-9.50	6.6	-20.08
3	15.3	-7.21	15.1	-7.88	15.3	-13.43	2.4	-8.83	16.6	-9.42	15.a	-19.91
4	10.7	-7.00	15.3	-6.22	9.4	-11.88	13.1	-3.33	3.8	-4.08	12.4	-5.30
5	9.2	-6.95	9.4	-6.03	15.1	-11.10	1.5	-2.53	9.2	-3.82	15.b	-5.13
6	9.4	-5.85	12.3	-5.06	10.7	-10.70	11.6	-2.16	13.1	-1.81	1.2	-4.44
7	3.3	-5.64	3.3	-4.68	3.3	-10.31	3.9	-1.97	1.5	-1.60	10.4	-4.13
8	12.3	-5.19	2.2	-4.08	12.3	-10.25	7.3	-1.69	9.4	-0.88	6.2	-2.70
9	8.2	-5.05	6.5	-3.92	9.2	-10.01	10.7	-1.55	11.5	-0.86	11.2	-2.67
10	6.5	-4.43	6.4	-3.78	6.5	-8.35	11.5	-1.31	3.9	-0.70	17.2	-2.17
Bottom ten	**PHL**						**KOR**					
	Weighted in-degree		Weighted out-degree		Weighted degree		Weighted in-degree		Weighted out-degree		Weighted degree	
	Target	Value	Target	Value	Target	Value	Target	Value	Target	Value	Target	Value
1	8.2	-10.22	9.4	-9.18	10.4	-16.43	9.4	-13.84	9.4	-14.52	9.4	-28.37
2	10.4	-10.00	15.1	-9.11	8.2	-16.15	6.4	-11.54	2.4	-8.62	2.4	-14.92
3	9.2	-7.37	16.6	-6.47	9.4	-16.04	15.3	-8.30	6.5	-7.14	15.3	-14.13
4	9.4	-6.86	10.4	-6.43	15.1	-13.77	2.3	-6.41	15.3	-5.83	6.4	-13.87
5	16.6	-6.59	8.2	-5.92	16.6	-13.07	2.4	-6.30	2.3	-4.19	6.5	-13.31
6	2.2	-4.77	5.4	-5.52	9.2	-12.30	6.5	-6.17	12.3	-3.91	2.3	-10.61
7	15.1	-4.65	1.3	-5.24	3.4	-9.34	15.1	-4.25	15.1	-3.55	15.1	-7.81
8	3.4	-4.48	9.2	-4.94	5.4	-9.05	12.3	-3.79	4.7	-3.48	12.3	-7.71
9	13.1	-4.26	6.4	-4.87	2.2	-8.61	4.7	-0.74	6.4	-2.33	4.7	-4.23
10	11.6	-4.11	6.a	-4.86	6.4	-8.22	14.7	-0.37	4.1	-1.27	14.7	-0.76

(Continue)

Bottom ten	VNM					
	Weighted in-degree		Weighted out-degree		Weighted degree	
	Target	Value	Target	Value	Target	Value
1	9.4	-6.96	8.2	-8.66	8.2	-14.03
2	10.7	-6.81	12.3	-6.66	12.3	-13.42
3	12.3	-6.76	16.6	-5.62	9.4	-11.53
4	8.2	-5.37	9.4	-4.57	10.7	-10.72
5	10.3	-4.78	6.a	-4.19	16.6	-10.08
6	16.6	-4.46	10.7	-3.90	10.3	-6.29
7	10.1	-3.30	10.2	-3.07	10.2	-6.10
8	10.2	-3.03	3.9	-2.56	10.1	-5.45
9	11.6	-2.56	10.1	-2.15	3.9	-4.47
10	17.13	-2.34	5.2	-1.63	17.13	-3.75

6 Conclusions and policy implications

Xin Zhou[14]

Agenda 2030 delineates a global framework on achieving sustainable development with 17 SDGs and 169 associated targets. The 169 SDG targets inherently connect with each other forming an indivisible whole from a systemic perspective. Embedded in an interlinked network of SDGs, achieving one particular target will consequently affect, either positively or negatively, on achieving other goals and targets. The nature of the existence of potential synergies and trade-offs in pursuing individual SDG targets brings about good opportunities for seeking multiple benefits as well as great challenges for maintaining the integrity of the wide-ranging SDGs by not sacrificing in any areas of the SDGs. Knowing well about the interlinkages between SDG targets is fundamental to accessing the keys for materialising the synergies and alleviating the trade-offs successfully.

Against this backdrop, however, there are substantial gaps in the existing knowledge on the analysis of SDG interlinkages.

(a) Comprehensive studies on the interlinkages between SDG targets which covers all the 169 targets are inadequate and underdeveloped. There are some ongoing works on this issue, such as ICSU's guide to SDG interactions (2017), but complete studies are not yet available.

(b) Quantification of the SDG interlinkages is limited in the existing literature though there are a few works on categorizing different types of interlinkages with pre-defined weights.

(c) 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. But identification and quantification of these interlinkages at national level is still missing.

(d) The focus of most existing works is placed on the identification of the interlinkages. There is hardly any literature which provides comprehensive analysis on identified SDG interlinkages.

All these limitations constrain the application of SDG interlinkages as practical knowledge to support SDG integration and policy coherence. To echo these knowledge gaps in the existing

[14] Xin Zhou, Principal Policy Researcher and Research Leader, Strategic and Quantitative Analysis Centre (QAC), Institute for Global Environmental Strategies (IGES). 2108-11 Kamiyamaguchi, Hayama, Kanagawa, 240-0115 Japan. ✉ zhou@iges.or.jp

literature, we presented an integrated analytical framework on the network analysis of SDG interlinkages between targets which is then applied to the interlinkages analysis in nine selected Asian countries, namely Bangladesh, Cambodia, China, India, Indonesia, Japan, the Philippines, Republic of Korea and Viet Nam.

The main purpose of this research report focuses on the presentation of an integrated analytical framework on the network analysis of SDG interlinkages between targets. Potential applications and policy implications are provided.

First, the identification of the binary linkages between 169 SDG targets (with "0" assigned to the pair targets which do not have certain relationship between them and "1" assigned to those pair targets which have potential relationship between them) conducted in this research is based on extensive review of the existing scientific literature and relevant policy documents provided by major international policy processes working on SDGs monitoring and indicators. Different from other existing studies working on the identification of SDG interlinkages itself, we synthesised existing studies by taking the union of multiple sets of the reference interlinkages provided by various existing studies. The advantage of this approach is to provide an upper bound of the interlinkages covering all the 169 targets which helps fill in the knowledge gap related to the above (a) that comprehensive study on the interlinkages between SDG targets which covers all the 169 targets is lacking.

Second, the identified linkages are further quantified based on the correlation analysis of indicator-level data corresponding to the associated targets. Using the time-series data (2001 – 2014) collected for the selected countries for 51 indicators that are mapped with 108 targets (out of 169 targets due mainly to lacking of trackable data) nine country-specific quantified networks of SDG interlinkages are provided. This helps address the limitations related to the above (b) and (C) that quantification of the SDG interlinkages and national-level studies are lagging behind.

Third, using Social Network Analysis (SNA) techniques we first visualised and then analysed both the general structure of the network of SDG interlinkages and country-specific features of the quantified networks of SDG interlinkages in nine countries based on an array of centrality measures including degree centrality, eigenvector centrality, betweenness centrality and closeness centrality, etc. This pioneer work helps address the knowledge gaps related to the above (c) and (d) that quantification and, in particular, analysing the SDG interlinkages rather than staying at the identification and visualisation of the network of SDG interlinkages are missing.

Based on the identification, quantification and analysis of SDG interlinkages between targets, some conclusions and associated policy implications are drawn up as follows.

i) The general structure of the network of SDG interlinkages featured by dense and complicated interactions between targets implies that an integrated approach for SDG implementation is needed.

The interlinked 108 SDG targets (out of 169 targets due mainly to lacking of trackable data for the quantification) form one united network with an average number of neighbourhoods being as 22.2, indicating that all the targets are densely connected with one another either directly or indirectly. The feature of the general structure of SDG interlinkages between targets strongly supports the policy recommendation that taking an integrated approach rather than a silo approach in implementing Agenda 2030 and the SDGs is highly required.

From an institutional arrangement point of view, a silo approach which maximises sectoral interests by artificially breaking up the intrinsic connections between sectors and among various actors has been demonstrated as inappropriate, particularly when dealing with the relations between economic growth and preservation of the environment. A silo approach may deliver a local optimum rather than the system optimum and therefore may deliver only as a sub-optimal solution. The nature of the network of SDG interlinkages with complicated interactions between SDG targets offers a good opportunity for taking an integrated approach to seek and scale up the synergies, or to mitigate and eliminate the trade-offs through horizontal collaborations across ministries and vertical collaborations across various administrative levels.

ii) Network analysis of the general structure of SDG interlinkages and identification of top SDG targets ranked by various centrality measures provides relevant knowledge supporting priority setting for SDG planning and implementation.

Results from the network analysis of the general structure of SDG interlinkages (see more details in Section 5.1 and in particular **Table 10**) provide the knowledge on key targets which play central roles at the strategic positions in the network measured by various centrality metrics based on the Social Network Analysis (SNA) techniques.

Specifically, the ranking results of SDG targets indicates that Target 2.3 (double agriculture productivity), Target 2.4 (build sustainable food production systems), Target 6.1 (universal access to safe drinking water), Target 6.2 (universal access to sanitation and hygiene), Target 7.1 (universal access to energy) and Target 9.1 (develop resilient infrastructure) are the most influential targets in the network attributable to their multiple central roles played in terms of having wider connections with other targets by both exerting influences and receiving influences (measured by in-degree and out-degree centrality), being important intermediates bridging unconnected targets (measured by betweenness centrality) and placing at strategic positions in connecting with influential targets (measured by eigenvector centrality).

Apart from these top-ranked targets which play multiple central roles, there are some individual targets which play specific central role(s) in the network. For example, Target 1.5 (build resilience of the poor to climate and other disasters) and Target 4.1 (all for free primary and secondary education) play specific central roles in terms of being impacted by achieving other targets (measured by in-degree centrality) and exerting impacts on achieving other targets (measured by out-degree centrality), respectively. Another example is Target 16.6 (develop accountable institutions) and Target 13.3 (raise awareness on mitigation and adaptation), which, though not playing eminent roles in terms of having wider connections with other targets (measured by degree centrality), play important intermediate roles in bridging those targets without direct connections (measured by betweenness centrality).

Policy implication derived from these analysis results includes that ranking of top central targets based on the structural analysis of the network of SDG targets can be used as a practical tool by relevant international or regional policy processes working on the SDGs, indicators and interlinkages, such as IAEG-SDGs, SDSN, OECD and ESCAP, etc. in guiding priority setting around central targets which play various influential roles in connecting with other targets in the network.

iii) *Quantification and the structural analysis of the networks of SDG interlinkages at the national level help identify national priority areas based on the identification of country-specific central targets ranked by various centrality measures.*

With quantified networks of SDG interlinkages based on countries' historical time-series data, country-specific features of the network of SDG interlinkages determined by reinforcing vs. conflicting interactions as well as the strength of the interactions can be analysed. Results from the structural analysis of the quantified networks of SDG interlinkages in nine countries (see more details in Section 5.2 and in particular **Table 11** and **Table 12**) and ranking of country-specific top central targets based on various degree centrality measures provide the knowledge on national key SDG targets which play the central roles in country-specific network of interlinkages. For example, Target 6.2 (universal access to sanitation and hygiene) and Target 9.1 (develop resilient infrastructure) are ranked as national top central targets in all the nine countries in terms of having wider connections with other targets (measured by degree centrality) as well as receiving more impacts from and exerting more impacts on achieving other targets (measured by in-degree centrality and out-degree centrality) .

Furthermore, identification of top targets and bottom targets ranked against in-degree centrality (indicating receiving influences from achieving other targets) and out-degree centrality (indicating exerting influences on achieving other targets) help pinpoint national priority targets for which policies and actions need to be prioritised, thereby potentially contributing to maximising the synergies (through positive causal links) and minimising the trade-offs (through negative causal links) at the national level. For example, Target 15.5

(protect natural habitat and biodiversity) is ranked as one of the top central targets which receive more impacts from achieving other targets (measured by in-degree centrality) for the cases in Bangladesh, the Philippines and Viet Nam. Target 15.a (mobilize financial resources for sustainable use of ecosystems) is ranked as one of the top central targets which exert more impacts on achieving other targets (measured by out-degree centrality) for the cases in Bangladesh, Indonesia, Japan, the Philippines and Viet Nam.

The heterogeneous features of the structure of the network of SDG interlinkages at the national level imply the importance of respecting country-specific circumstances and customising the means of implementation for achieving the SDGs at the national level. Knowledge obtained from this research on the structure of the quantified network of SDG interlinkages and ranking of top central targets provides the basis for national priority setting.

iv) Country-specific dashboards provide practical knowledge and visualisation on where SDG targets reinforce/conflict with each other.

A dashboard matrix indicating potential reinforcing (through positive links indicated by green) and conflicting (through negative links indicated by red) linkages between 108 targets is developed for each individual country (see **Figure 31** - **Figure 39**). In particular, the general structure of the interlinkages is the same for all selected countries, described by whether the entries in the square matrix of 108 targets are highlighted with a colour (indicating a certain relations between the pair targets) or not (indicating no potential links between the pair targets). For example, reading by row for Target 1.1, entries at the cross between Target 1.1 and Targets 1.2, 2.1, 2.2, 2.3, 3.3, 3.8, 4.1, 5.1, 5.4, 6.1, 6.2, 7.1, 8.5, 10.1, 10.2, 10.3, 10.7, 10.b, 11.1, 11.2, 11.5 are highlighted with a colour, either in green or red, indicating that achieving Target 1.1 will influence achieving the targets in these areas. On the other hand, different colours indicate potential reinforcing impacts (in green) or contradicting impacts (in red) that Target 1.1 will have on specific target areas, which are heterogeneous for individual countries. Specifically, achieving Target 1.1 will have negative impacts on achieving Targets 1.3, 5.4, 8.5 10.4 and 10.6 in Bangladesh, achieving Targets 1.3, 2.2, 5.4, 10.4, 10.7, 10.b and 11.5 in Cambodia, achieving Targets 8.5, 10.1, 10.b and 11.5 in China, achieving Targets 2.2, 8.5, 10.1, 10.b and 11.5 in India, achieving Targets 2.2, 3.3 10.1, 10.7, 10.b, 11.2 and 11.5 in Indonesia, achieving Targets 10.7, 10.b and 11.5 in Japan, achieving Targets 1.2, 1.3, 2.2, 3.8, 5.4, 10.4, 10.b, 11.2 and 11.5 in the Philippines, achieving Targets 10.7, 10.b and 11.5 in the Republic of Korea, and achieving Targets 5.1, 8.5, 10.1, 10.2, 10.3, 10.7 and 10.b in Viet Nam (shown in **Figure 40** - **Figure 48**).

Country-specific dashboards indicating potential reinforcing and conflicting linkages between 108 targets can be used as a practical tool guiding SDG planning, integrated institutional arrangements and joint implementation at the national level by providing relevant knowledge and the visualisation on where synergies and trade-offs between SDG targets will be.

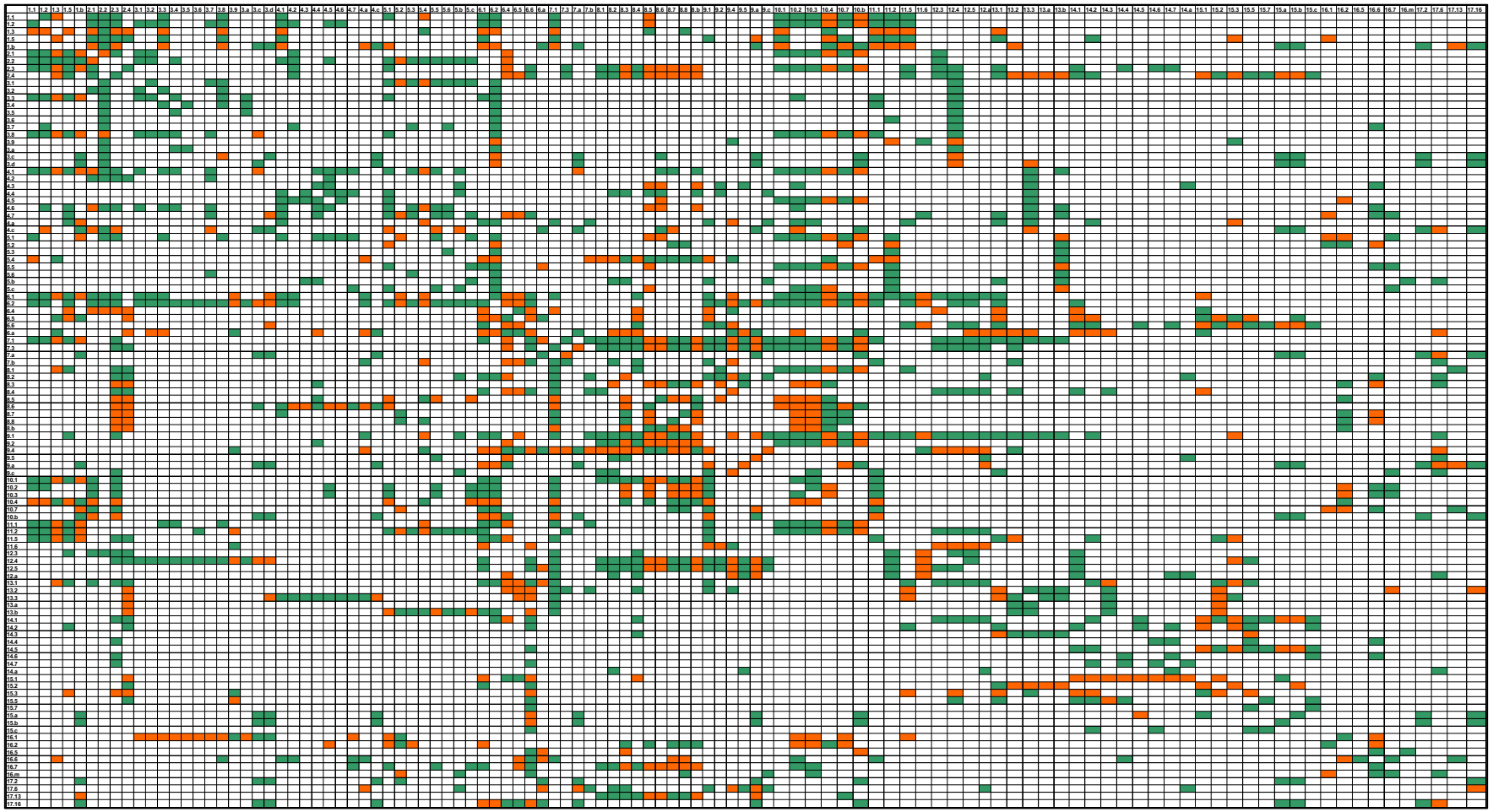
In addition, environmental impact assessment (EIA) and strategic environmental assessment (SEA) at project, programme or strategic planning levels or integrated sustainability assessment are expected to ensure that the three dimensions of sustainable development can be taken into full account to make these assessment tools compatible with the 2030 Agenda and SDGs. By providing specific knowledge on the potential territories of negative impacts, the dashboards can help set the scope and priorities of EIA, SEA or integrated sustainability assessment.

v) *A web tool on **SDG Interlinkages and Data Visualisation**, provided as a handy and practical communication and analytical tool, is expected to support national SDG planning and policy integration across 17 SDG areas in the early stage of implementation.*

A web tool on **SDG Interlinkages and Data Visualisation** (Zhou, et al., 2017), accessible for free on-line at http://sdginterlinkages.iges.jp/, was developed under this project. The web tool enables users to visualise the interlinkages between SDG targets and explore indicator-level data for nine Asian countries (Bangladesh, Cambodia, China, India, Indonesia, Japan, Korea, the Philippines and Viet Nam). Users can select countries, SDG targets and associated indicators to visualise the interlinkages between selected targets and others, and view time-series data for selected indicators. In addition, the web tool enables users to compare indicator-specific data and target-specific interlinkages among countries. Provided for free, users can download the data in Excel tables as well as the visualisation charts in image files.

The web tool is expected to support national SDG planning and policy integration across 17 SDG areas. It is expected to be useful to the policymakers working for the international and regional policy processes on SDGs, indicators and interlinkages(such as IAEG-SDGs, SDSN and ESCAP, etc.), and to the policymakers working on planning and making institutional arrangement across ministries at the national level for the implementation of SDGs. It is also expected that academic researchers and policy researchers will use it to fill in the knowledge gaps for better identification, quantification and analysis of SDG interlinkages.

Figure 31 Dashboard for Bangladesh indicating potential reinforcing (in green) and conflicting (in red) linkages between 108 targets



Notes: Applicable for **Figure 31- Figure 39.** This is a square matrix of 108 by 108 targets. Entries without a colour indicate there are no potential links between the pair of targets. The list of the 108 targets in the same sequence can be found in Appendix I (in orange).

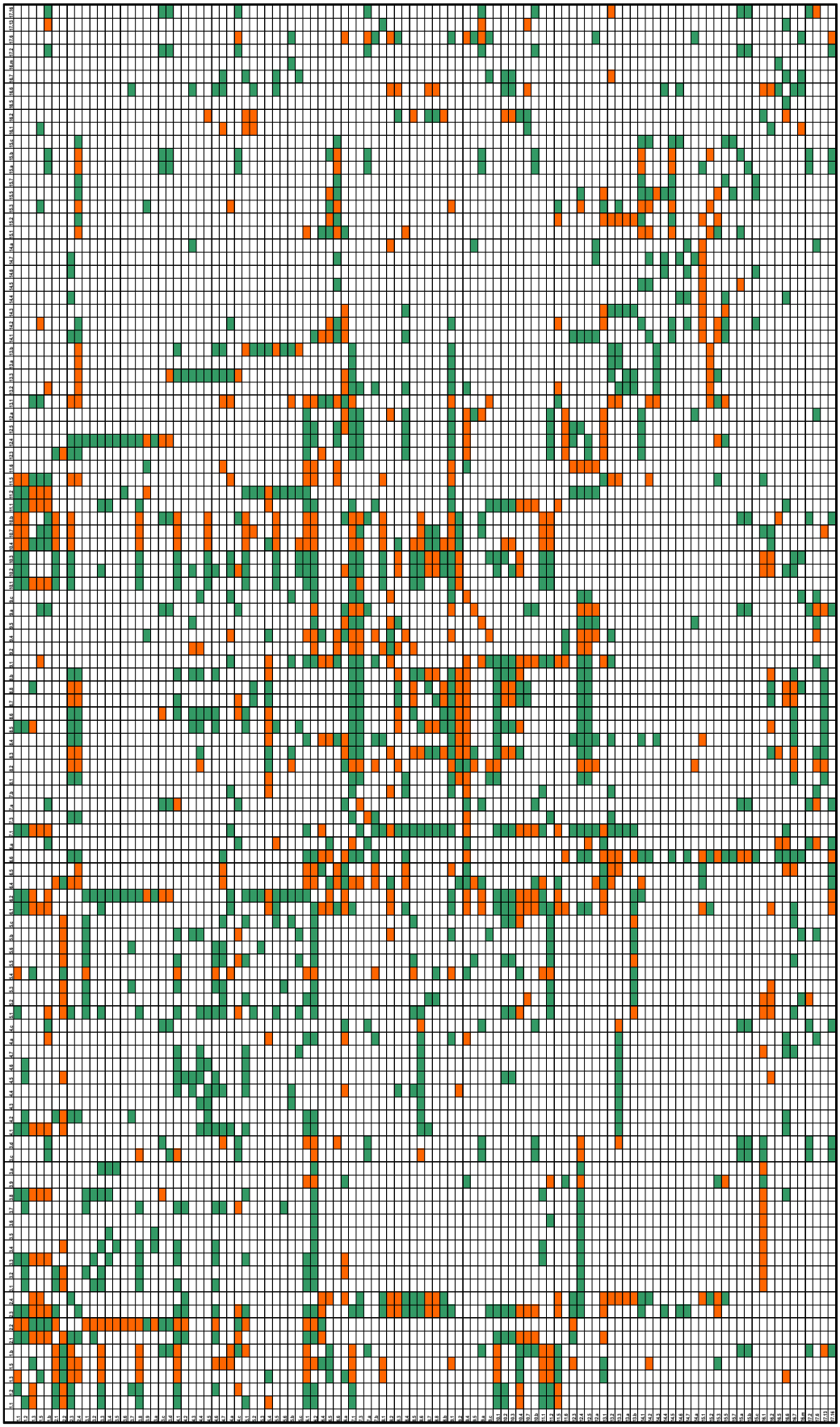
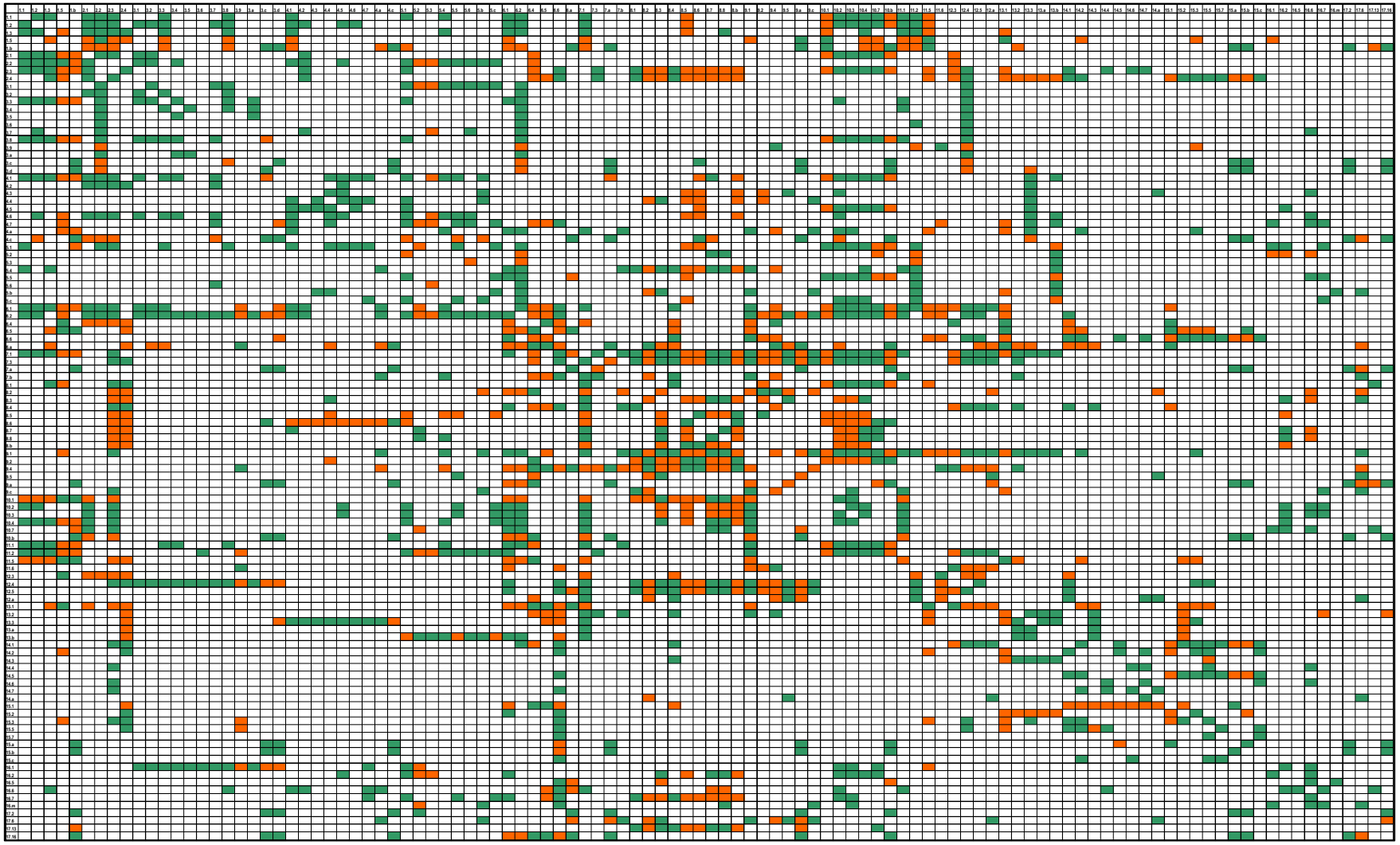


Figure 32 Dashboard for Cambodia indicating potential reinforcing (in green) and conflicting (in red) linkages between 108 targets

Figure 33 Dashboard for China indicating potential reinforcing (in green) and conflicting (in red) linkages between 108 targets



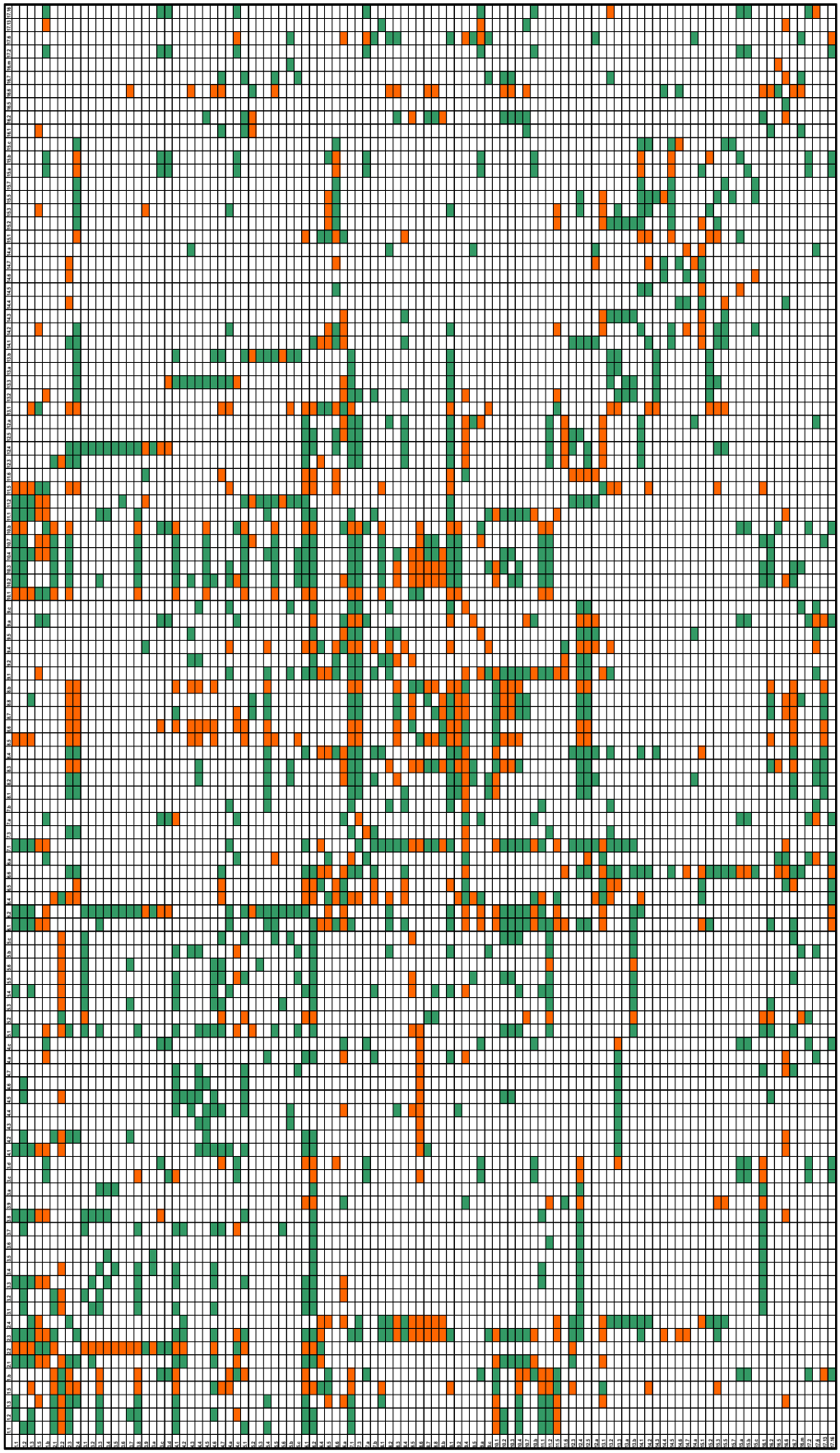
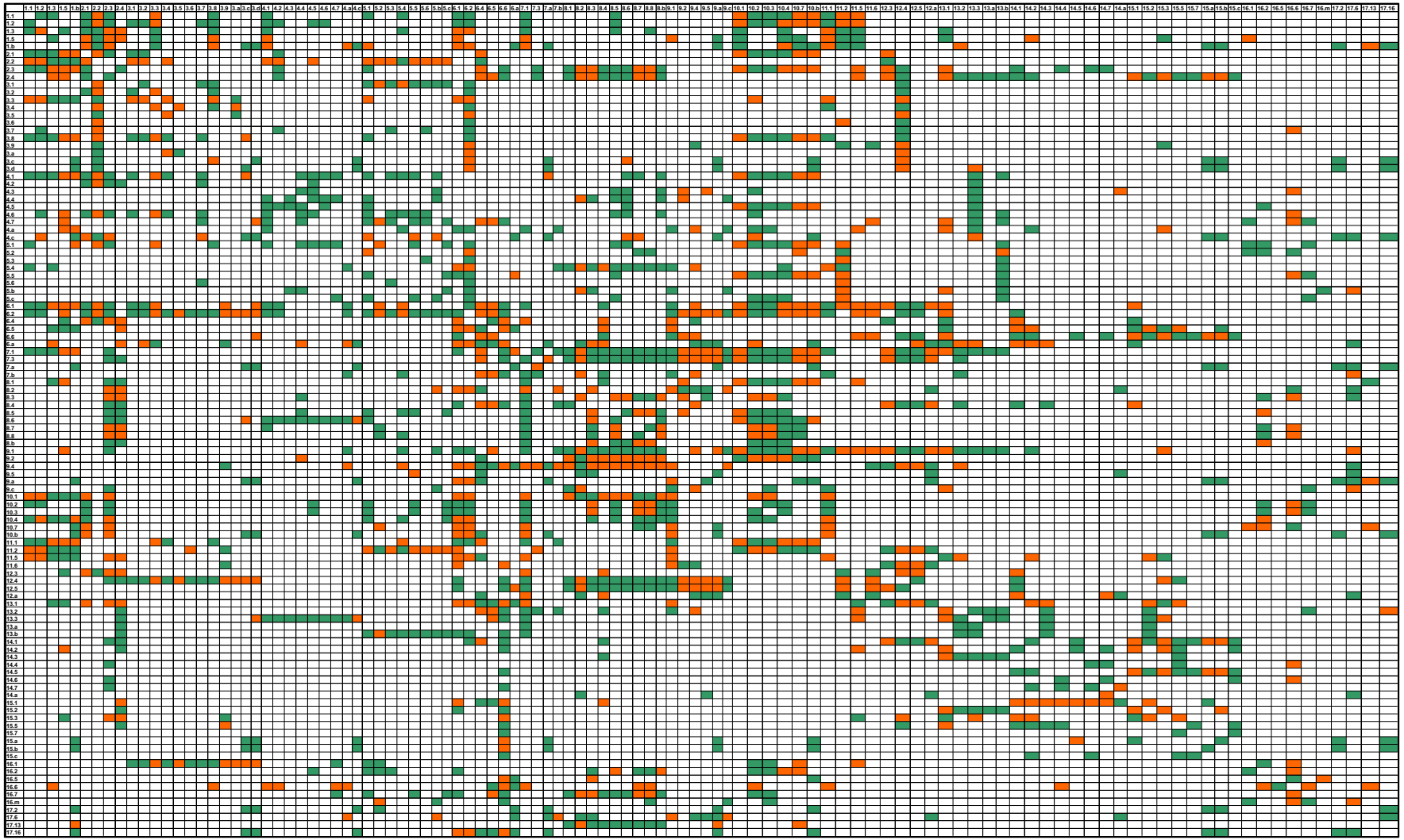


Figure 34 Dashboard for India indicating potential reinforcing (in green) and conflicting (in red) linkages between 108 targets

Figure 35 Dashboard for Indonesia indicating potential reinforcing (in green) and conflicting (in red) linkages between 108 targets



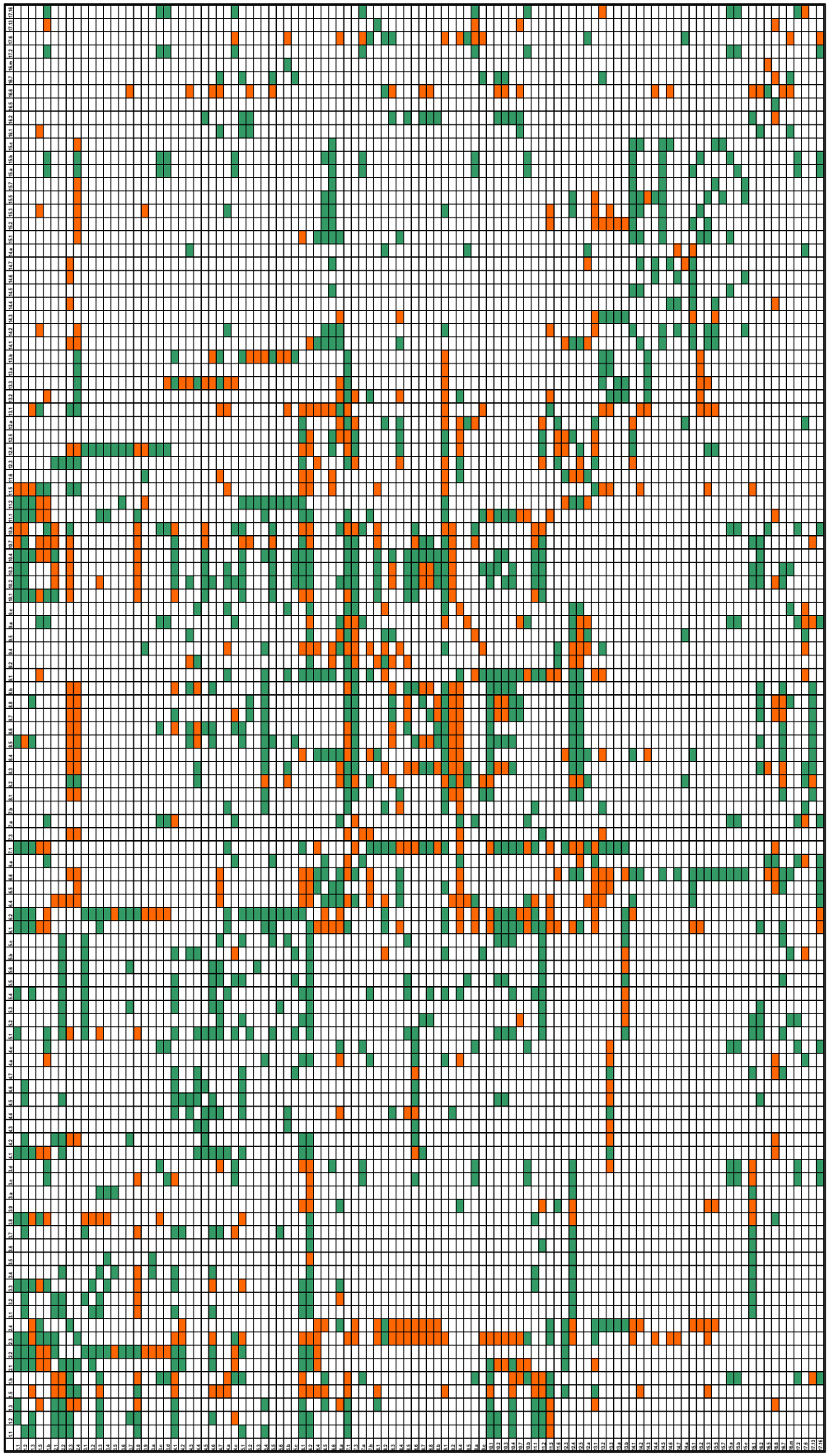
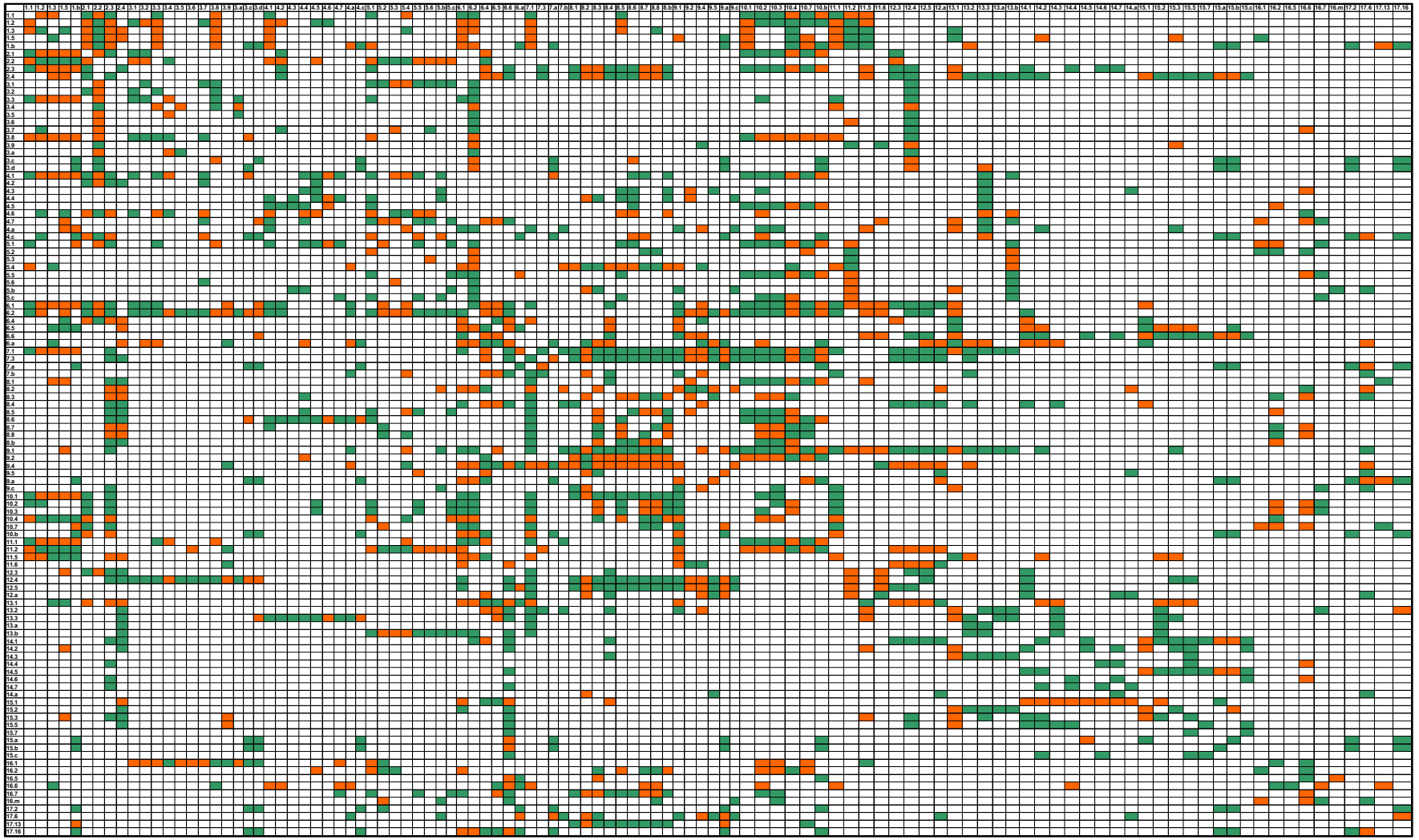


Figure 36 Dashboard for Japan indicating potential reinforcing (in green) and conflicting (in red) linkages between 108 targets

Figure 37 Dashboard for the Philippines indicating potential reinforcing (in green) and conflicting (in red) linkages between 108 targets



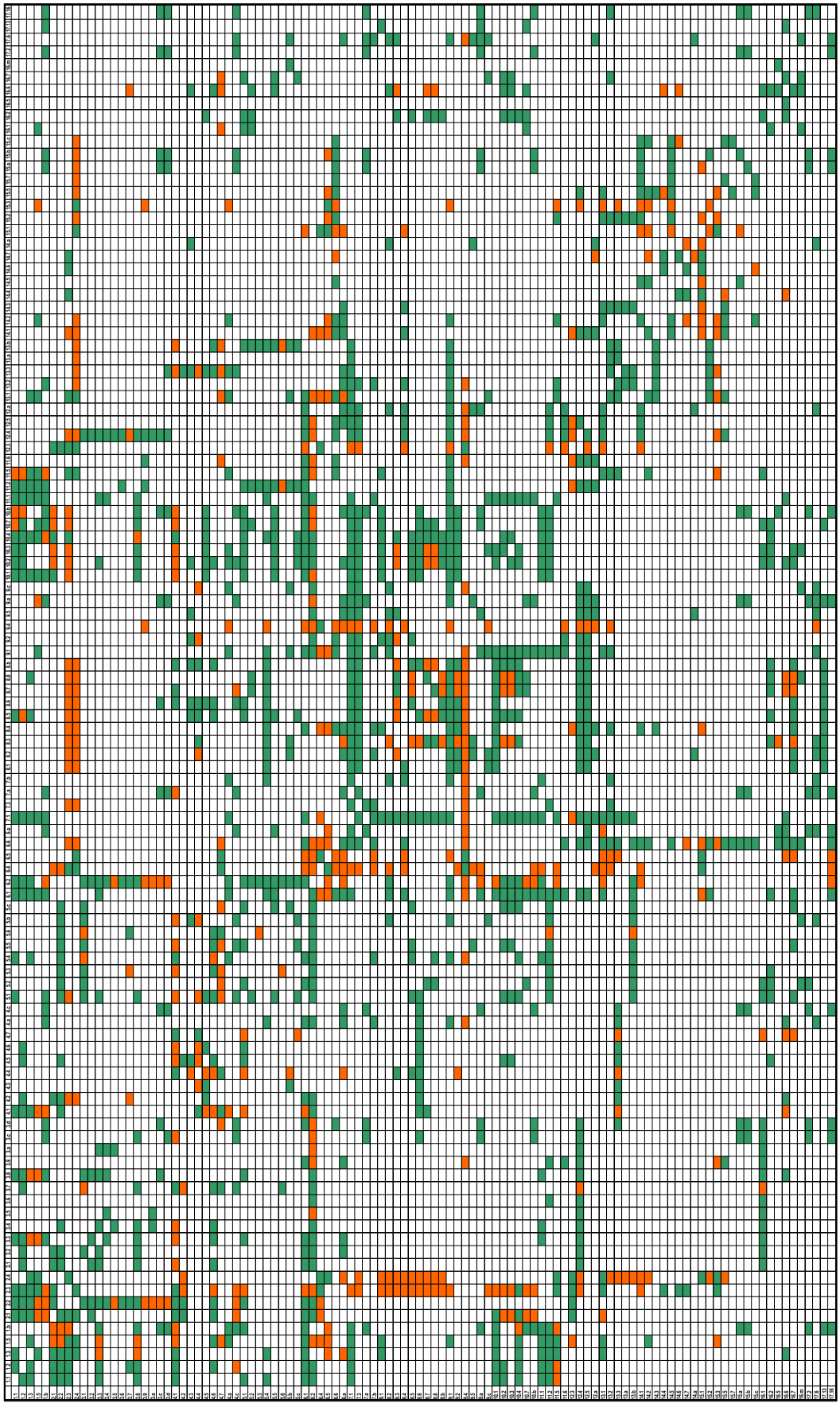
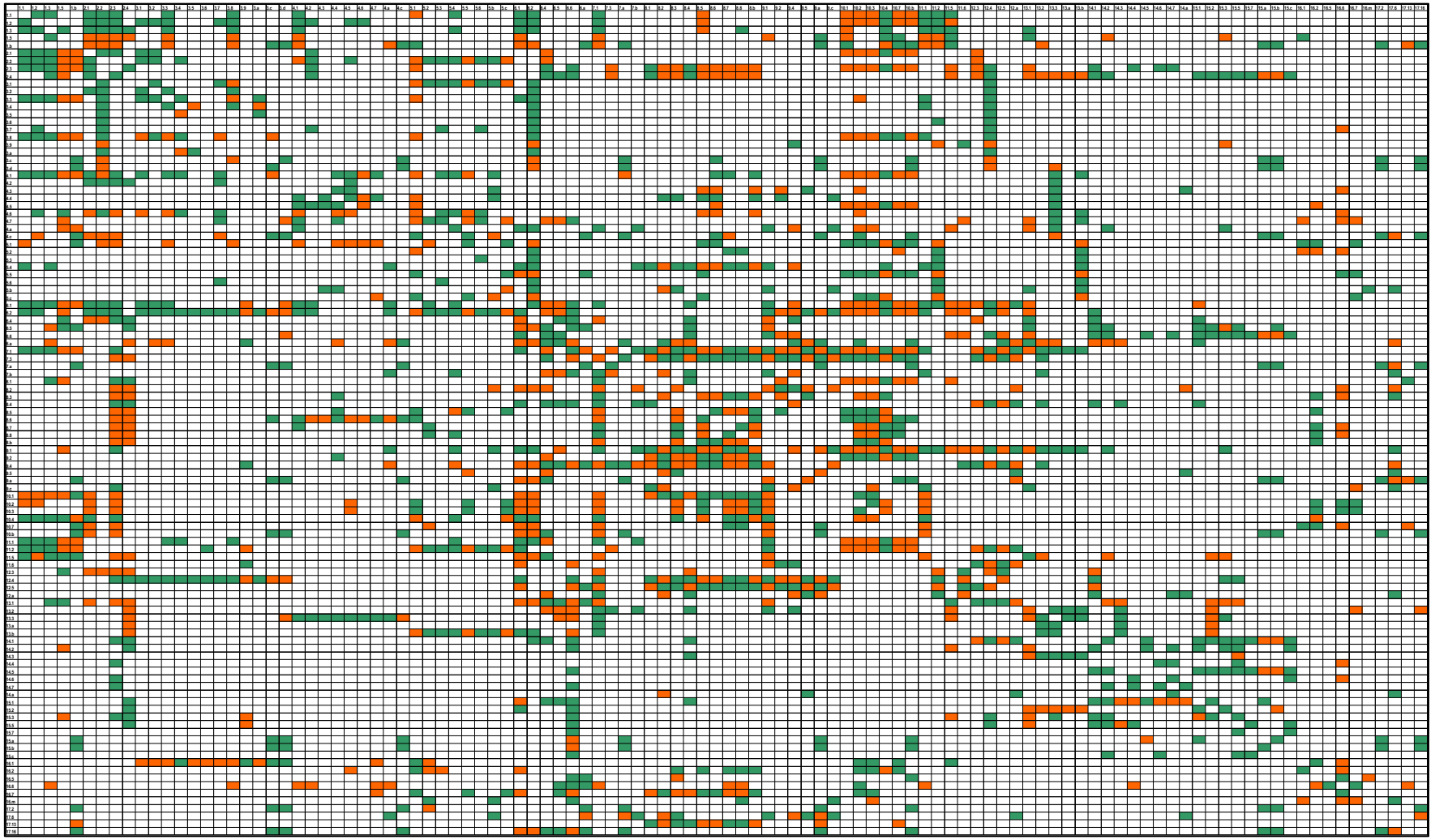


Figure 38 Dashboard for the Republic of Korea indicating potential reinforcing (in green) and conflicting (in red) linkages between 108 targets

Figure 39 Dashboard for Viet Nam indicating potential reinforcing (in green) and conflicting (in red) linkages between 108 targets



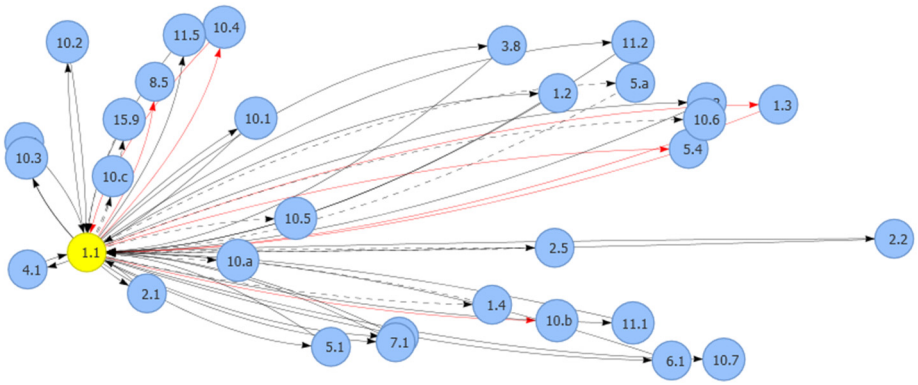


Figure 40 Visualisation of potential reinforcing (in black) and conflicting (in red) interlinkages between Target 1.1 and others in Bangladesh

Note: Applicable for **Figure 40** - **Figure 48**. Target 1.1 is on "end extreme poverty" measured by population below $1.90 (2011 PPP) per day. Solid directed line indicates positive (reinforcing)

Source: Visualisation images generated by IGES SDG Interlinkages and Data Visualisation web tool (Zhou, et al., 2017).

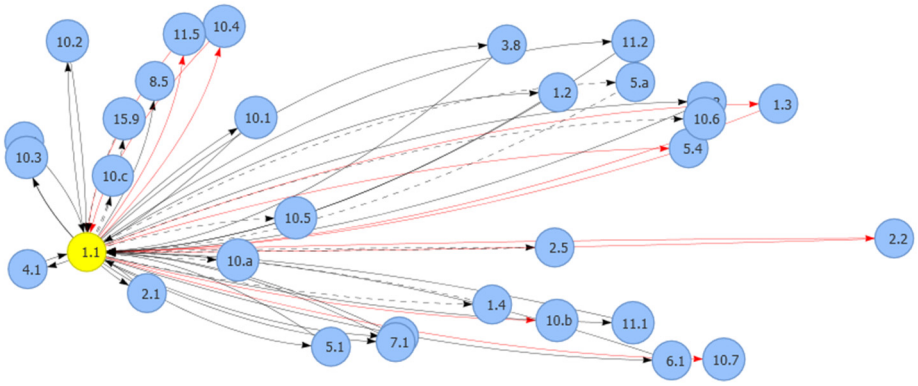


Figure 41 Visualisation of potential reinforcing (in black) and conflicting (in red) interlinkages between Target 1.1 and others in Cambodia

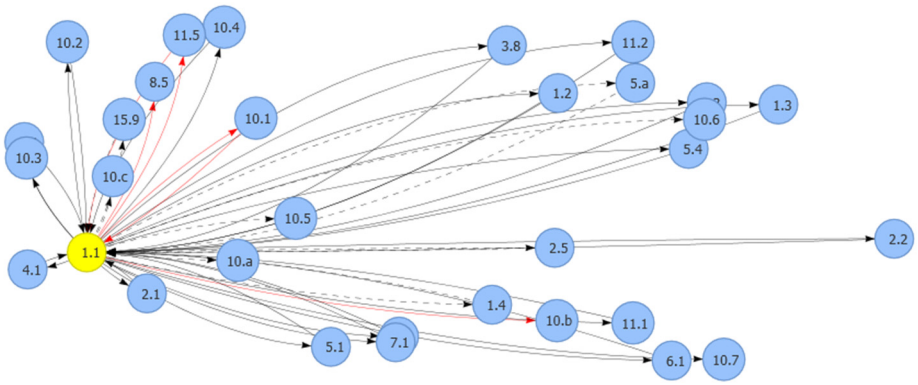


Figure 42 Visualisation of potential reinforcing (in black) and conflicting (in red) interlinkages between Target 1.1 and others in China

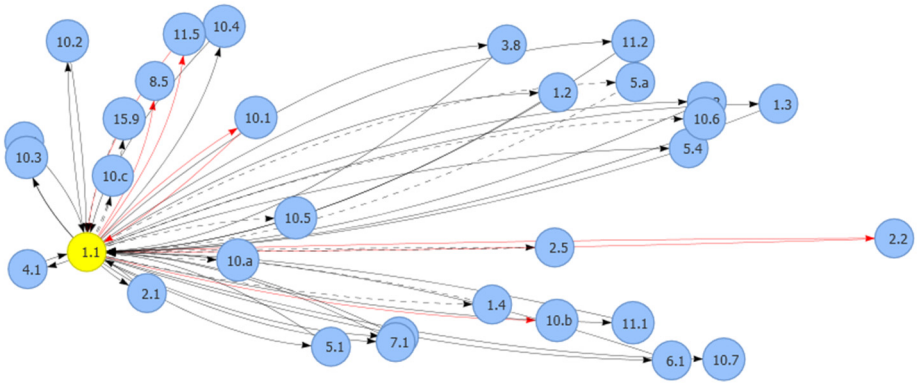


Figure 43 Visualisation of potential reinforcing (in black) and conflicting (in red) interlinkages between Target 1.1 and others in India

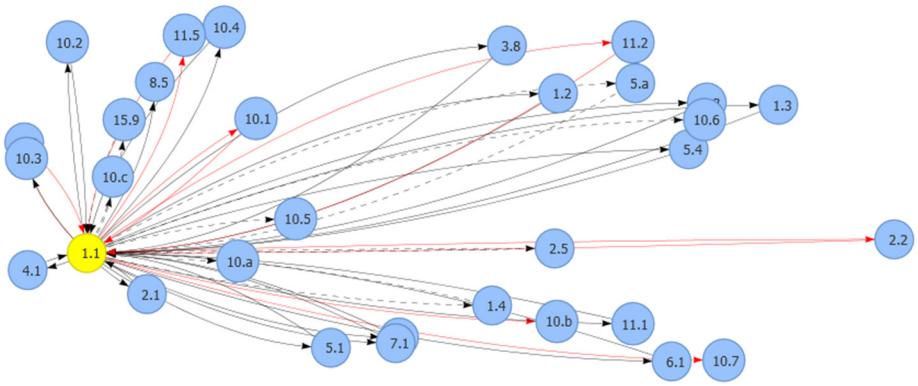


Figure 44 Visualisation of potential reinforcing (in black) and conflicting (in red) interlinkages between Target 1.1 and others in Indonesia

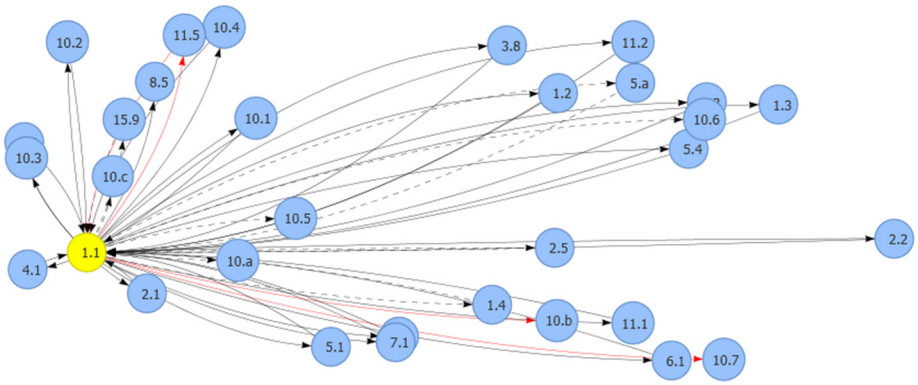


Figure 45 Visualisation of potential reinforcing (in black) and conflicting (in red) interlinkages between Target 1.1 and others in Japan

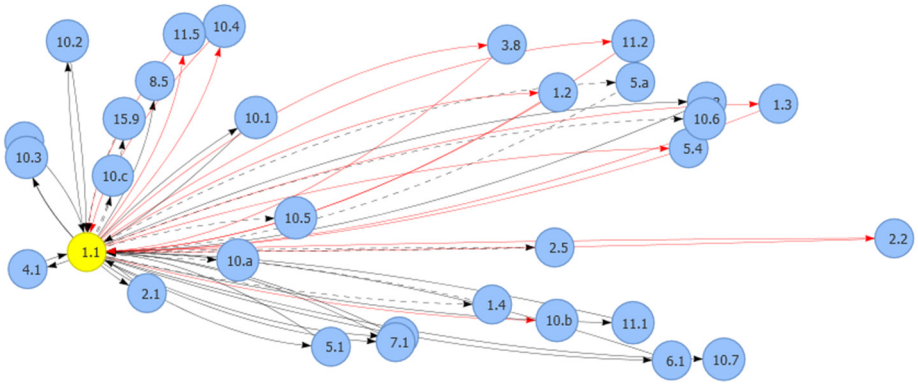


Figure 46 Visualisation of potential reinforcing (in black) and conflicting (in red) interlinkages between Target 1.1 and others in the Philippines

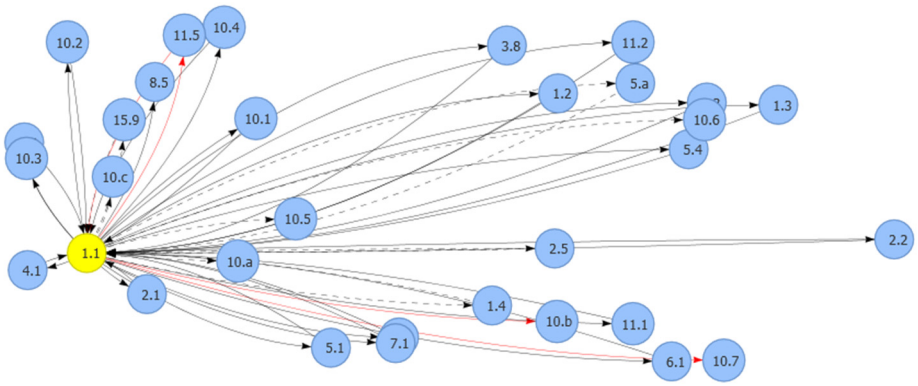


Figure 47 Visualisation of potential reinforcing (in black) and conflicting (in red) interlinkages between Target 1.1 and others in the Republic of Korea

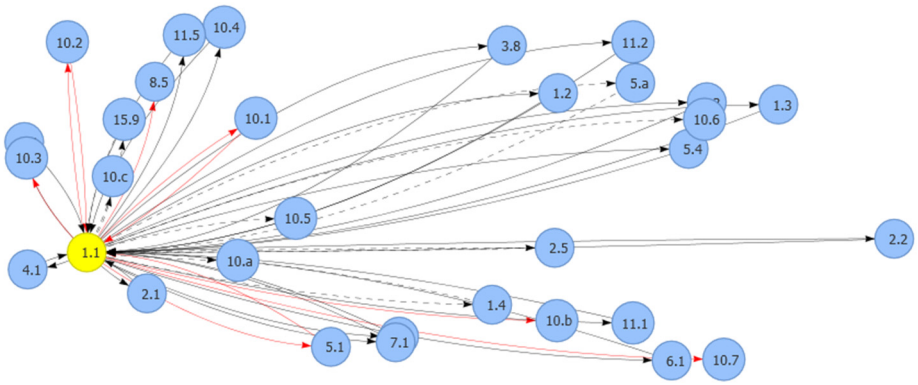


Figure 48 Visualisation of potential reinforcing (in black) and conflicting (in red) interlinkages between Target 1.1 and others in Viet Nam

v) *Review of the results of the identification and quantification of SDG interlinkages by identifying those linkages which contradict to our intuition on possible causal links can contribute to the review of the global SDG indicators in terms of their suitability to match with the defined targets and whether the metrics/methodologies used to measure the indicators are properly defined.*

The global indicator framework for the SDGs and targets, developed by the IAEG-SDGs, was formally agreed upon by the UN Statistical Commission at its 48th session, held in March 2017 (ECOSOC, 2017a and ECOSOC, 2017b). However, improving the SDG indicators is an open-ended process. Review of the results of the identification and quantification of SDG interlinkages can contribute to the review of the global SDG indicators in terms of their suitability to match with the defined targets and whether the metrics/methodologies used to measure the indicators are properly defined.

Identification of SDG interlinkages provides the knowledge on how particular SDG targets connect with others. Quantification of SDG interlinkages provides further knowledge on how strong the linkages are and whether the linkages are positive or negative. This is particular useful to identify those linkages which contradict to our intuition or common knowledge on the possible causal links. In this regard, the country-specific dashboards indicating potential synergies and trade-offs between SDG targets and the *SDG Interlinkages and Data Visualisation* web tool developed under this research project (see Zhou, et al., 2017) can be used as handy tools to help review indicators by visualising the quantified interlinkages.

For example, using the *SDG Interlinkages and Data Visualisation* tool, the interlinkages between Target 13.1 (strengthen resilience to climate change) and other targets can be visualised (see **Figure 49 - Figure 57**) which involves many potential trade-offs (negative links). With a closer look of these negative links, we can see some of them, such as the negative relations with Targets

2.3 (double agriculture productivity), 6.1 (universal access to safe drinking water), 6.2 (universal access to sanitation and hygiene) and 7.1 (universal access to energy), etc. may contradict to our intuitive knowledge. In particular, strengthening resilience to climate change can help improve agriculture productivity and avoid interruptions to access to safe drinking water, sanitation and energy and therefore contributing to achieving Targets 6.1, 6.2 and 7.1. The contradicting results may result from the identified indicator, "economic damage from top ten natural disasters" measured by billion US$, which may not be an appropriate one to measure Target 13.1. Indeed, the occurrence of natural disasters and the ensuing economic damage is highly accidental, which is not necessarily attributable to strengthened resilience to climate change.

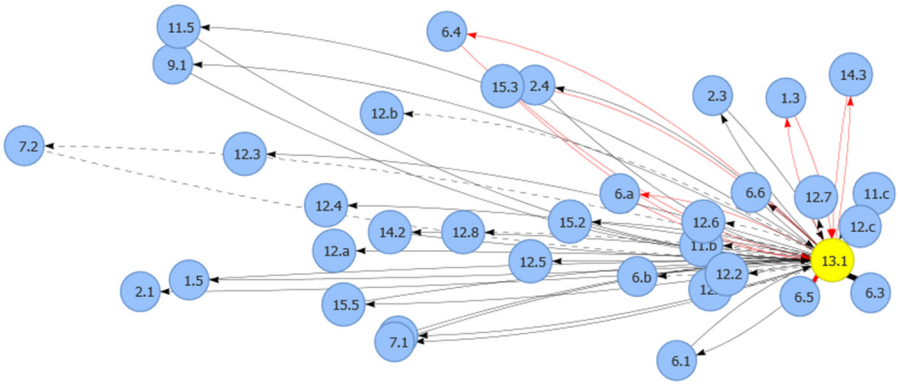


Figure 49 Visualisation of potential reinforcing (in black) and conflicting (in red) interlinkages between Target 13.1 and others in Bangladesh

Note: Applicable for **Figure 49** - **Figure 57.** Target 13.1 is on "strengthen resilience to climate change" with corresponding indicator on the "economic damage from top ten natural disasters" measure by billion US$. Solid directed lines in black indicate positive (reinforcing) impacts and solid directed lines in red indicate negative (conflicting) impacts. Dotted directed lines indicate data is not available.

Source: Visualisation images generated by IGES SDG Interlinkages and Data Visualisation web tool (Zhou, et al., 2017).

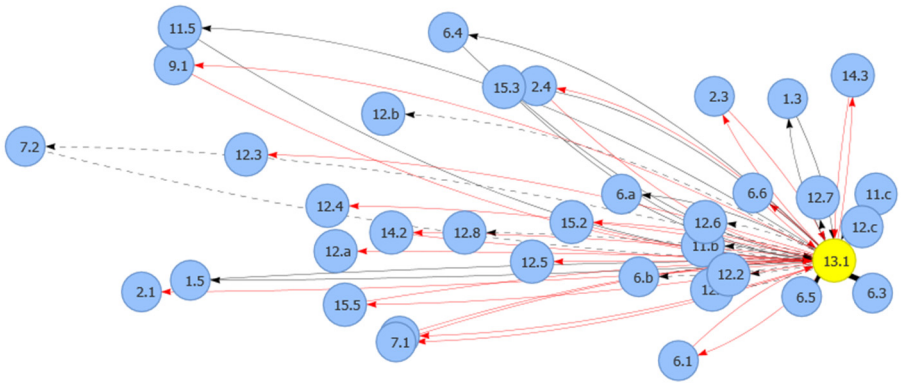


Figure 50 Visualisation of potential reinforcing (in black) and conflicting (in red) interlinkages between Target 13.1 and others in Cambodia

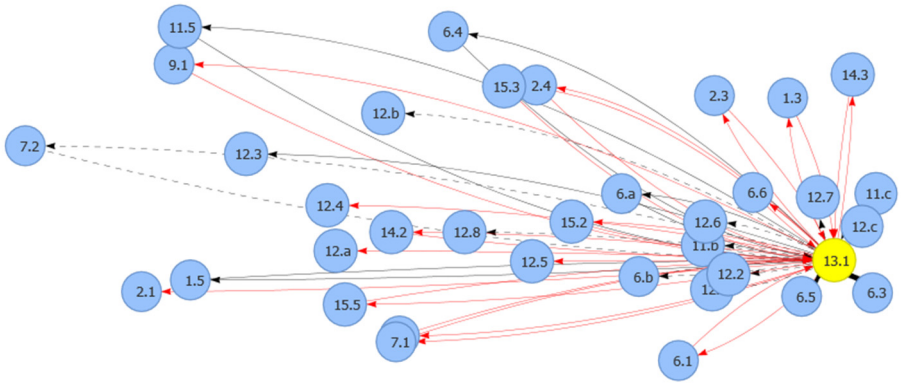


Figure 51 Visualisation of potential reinforcing (in black) and conflicting (in red) interlinkages between Target 13.1 and others in China

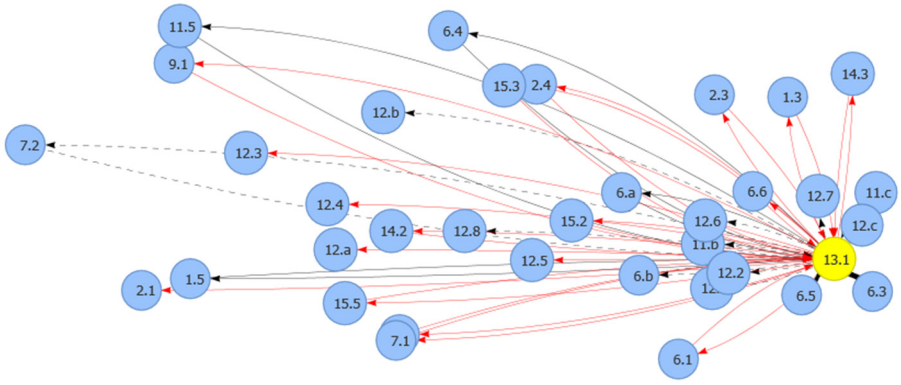


Figure 52 Visualisation of potential reinforcing (in black) and conflicting (in red) interlinkages between Target 13.1 and others in India

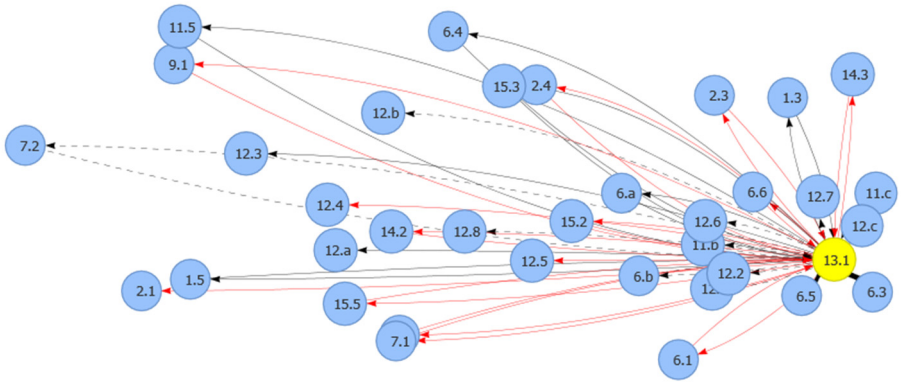


Figure 53 Visualisation of potential reinforcing (in black) and conflicting (in red) interlinkages between Target 13.1 and others in Indonesia

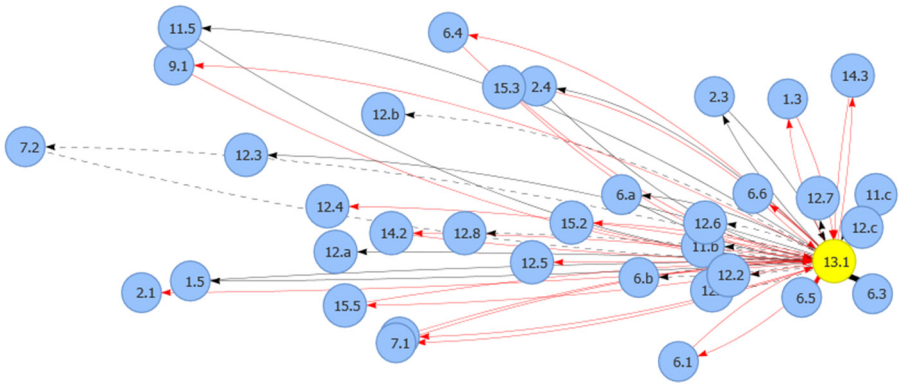


Figure 54 Visualisation of potential reinforcing (in black) and conflicting (in red) interlinkages between Target 13.1 and others in Japan

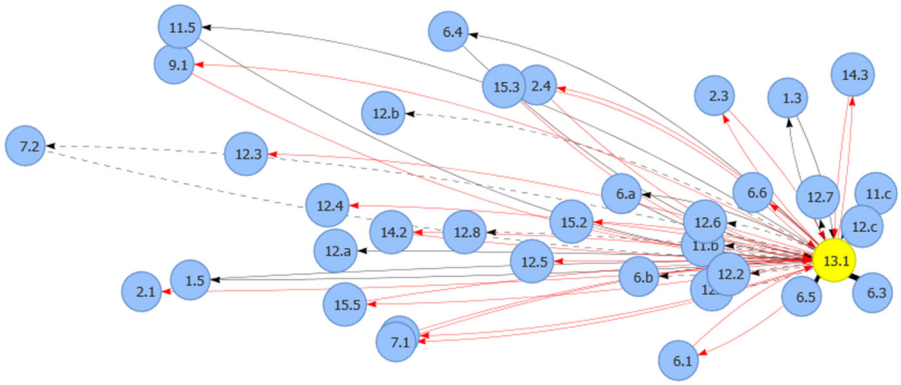


Figure 55 Visualisation of potential reinforcing (in black) and conflicting (in red) interlinkages between Target 13.1 and others in the Philippines

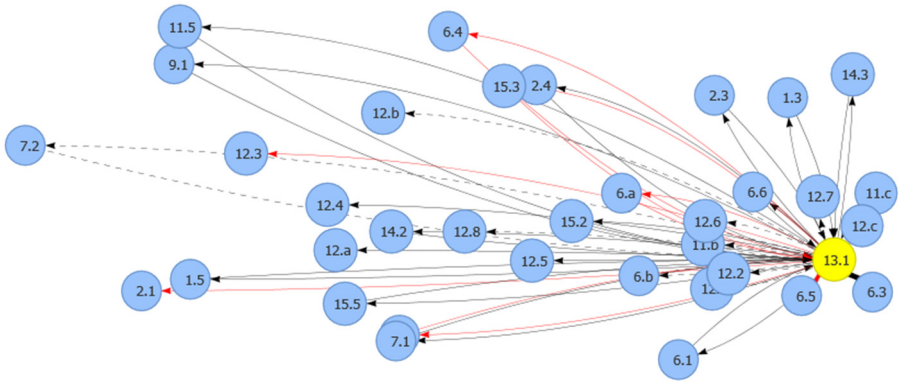


Figure 56 Visualisation of potential reinforcing (in black) and conflicting (in red) interlinkages between Target 13.1 and others in the Republic of Korea

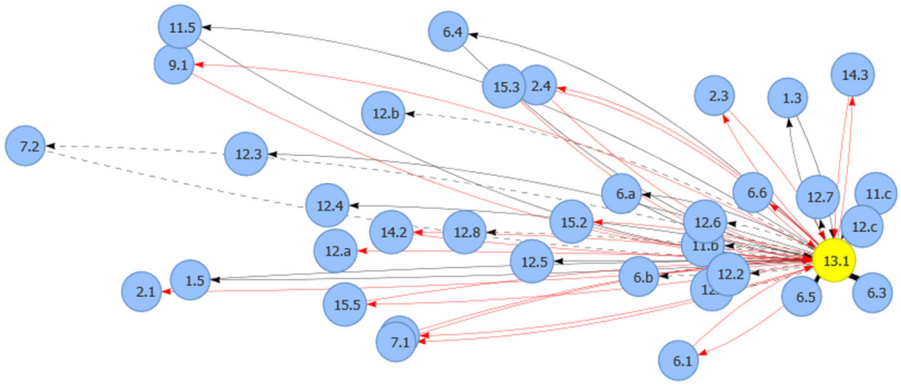


Figure 57 Visualisation of potential reinforcing (in black) and conflicting (in red) interlinkages between Target 13.1 and others in Viet Nam

7 Limitations and the way forward

Xin Zhou[15]

There are several limitations which may constrain the effective use of the proposed integrated approach as a practical tool to support policy integration. These limitations are analysed as follows and relevant recommendations on the solutions are provided.

i) Challenges in the identification of SDG interlinkages

Identification of the interlinkages between SDG targets, which is an extremely difficult task, forms the scientific basis of the proposed methodology on the network analysis of SDG interlinkages. Existing literature or available studies on SDG interlinkages is limited due mainly to the relatively short period after the adoption of the SDGs in 2015. Sufficient knowledge on the interlinkages between SDG targets does not exist because SDGs cover 17 broad areas and relate to multiple disciplines. In this research work, the interlinkages between SDG targets are identified by taking the union of multiple reference interlinkages provided by various sources.

On the one hand, the scope of the SDGs covered by relevant scientific literature or policy documents on SDG interlinkages varies from one to another. Some of the studies cover all SDGs (or at least most of them) while others may give particular focus on a subset of SDGs, e.g. those focusing solely on Goal 6 (water and sanitation) and its interlinkages with other SDGs and targets or those focusing on Goal 2 (food), Goal 6 (water and sanitation) and Goal 7 (energy), the water-energy-food (WEF) nexus issue. Given the different scope of SDGs covered by the reference interlinkages, the SDG interlinkages identified in this research work may not necessarily provide symmetric information on each of the individual targets and may be heavily skewed towards particular elements which due to more focused or in-depth studies on these targets. On the other hand, the level of existing knowledge on particular goals and associated targets and their interlinkages with others varies for 17 SDGs and their targets. In addition, the level of research details differs from one reference to another.

The limitations with the existing reference interlinkages may lead to biased results on SDG interlinkages and constrain the functions of the proposed methodology to be taken full play. To be specific, based on the identification of SDG interlinkages under this research, an

[15] Xin Zhou, Principal Policy Researcher and Research Leader, Strategic and Quantitative Analysis Centre (QAC), Institute for Global Environmental Strategies (IGES). 2108-11 Kamiyamaguchi, Hayama, Kanagawa, 240-0115 Japan. ✉ zhou@iges.or.jp

outstanding target with more links connecting with other targets, such as Target 6.2 (universal access to sanitation and hygiene), may be attributable to more focused and in-depth study on this target based on available reference sources rather than the extensive interactions that the target have with others by nature.

Since good knowledge on SDG interlinkages is fundamental to support informed policymaking on SDG integration and policy coherence, it is urgent to fill in the existing knowledge gaps. To solve this urgent issue, it is expected that relevant international policy processes devoting to SDGs implementation, monitoring and policy integration, such as IAEG-SDGs and SDSN, as well as international scientific communities, such as ICSU, take the leading roles in coordinating and accelerating scientific research and consultations on SDG interlinkages at the international level in close collaborations with relevant UN organizations working on thematic SDG issues, such as UN Environment working on environment-related goals (e.g. Goal 12 on sustainable consumption and projection, Goal 13 on climate change, Goal 14 on life below water and Goal 15 on life on land, etc.), the International Labour Organization working on decent work (Goal 8), and World Health Organization working on health-related goals (e.g. Gal 3 on good health and well-being, etc.).

The interlinkages between SDG targets identified in this research work can be considered as a pioneer work which can be improved with new knowledge and expanded scientific studies on this issue. For example, ICSU led a consortium of over 20 scientists and developed one of the most detailed and in-depth studies to date on SDG interlinkages focusing on four SDGs (Goal 2, Goal 3, Goal 7, and Goal 14) (ICSU, 2017). It is expected that ICSU will continue this work and provide similar knowledge covering all SDGs. Due to the timing of the implementation of this research project, updating the SDG interlinkages using new knowledge and studies to date has not yet been conducted in the current work and should be continued as an open-ended process for future research agenda.

ii) Importance and challenges in the identification of SDG interlinkages at country level

The general structure of the SDG interlinkages network, which is built upon the binary linkage between each pair of 169 targets (with "0" indicating no relations between a pair of targets and "1" indicating certain relations between a pair of targets), is assumed homogeneous to all countries. However, this may not necessarily be true taking into account of diversified national context for sustainability issues. For example, Target 1.1 (end extreme poverty) may not be relevant to developed economies such as Japan and Republic of Korea and therefore the interlinkages between Target 1.1 and others identified for the general structure of the SDG interlinkages network should not be applied equally to the cases of Japan and Republic of Korea. This means that not only the quantification of SDG interlinkages should be country-specific which has been done under the current work, but also identification of the binary linkages between SDG targets should also be country-specific.

Compared to the general knowledge on SDG interlinkages which itself remain big gaps as discussed in the above, country-specific knowledge on SDG interlinkages lags much more behind. It is therefore important to promote building the knowledge on SDG interlinkages at regional (for countries with similar national circumstances) and national levels. For policy processes working on SDG interlinkages at the international level, such as IAEG-SDGs and SDSN, it is expected that the promotion of national studies on SDG interlinkages and relevant capacity building programs can be included in their working agenda. At the national level, it is expected that national governmental organisations working on SDGs and the implementation and monitoring will coordinate and provide relevant resources (including research capacity and financial resources) for the promotion of the national studies on SDG interlinkages.

iii) Challenges in well-defined indicators with reliable data

Well-defined indicators with reliable data that are required for the quantification of the SDG interlinkages is another crucial factor influencing the effectiveness of the proposed methodology to be utilised as a practical tool supporting SDG integration and policy coherence. The global indicator framework for the SDGs and targets was formally agreed upon by the UN Statistical Commission at its 48th session, held in March 2017 (ECOSOC, 2017a and ECOSOC, 2017b). However, improving the SDG indicators is an open-ended process. The global SDG indicators as a voluntary and country-led instrument with the initial set of indicators will be refined annually and reviewed comprehensively by the Commission at its 51st session (2020) and its 56th session (2025). The Commission suggested that the global indicators will be complemented by indicators at the regional and national levels, which will be developed by relevant national governments.

With this open-ended process on improving SDG indicators, the quality of the quantification of SDG interlinkages can be enhanced. In addition, analysis of the sensitivity of various centrality measures to alternative indicators and to the uncertainty of raw data can be conducted to help understand the robustness of the results from network analysis.

iv) Challenges in reliable and trackable data for quantification

Reliable and trackable data for the indicators is decisive to enable effective quantification of SDG interlinkages and ensure the quality of the results. In the current research, we used the indicators based on the SDSN's Global Monitoring Indicators which includes 100 indicators mapping well with 169 targets. Due to lacking of full trackable time-series data for all the indicators which is required for conducting the correlation analysis, the basis for the quantification of the linkages, only 51 indicators (including proxy ones when exact data is not available) out of the 100 SDSN indicators are selected and mapped with 108 targets (out of the 169 targets). As a result, there are many cases that one indicator is used to map with

multiple targets. For example, Targets 13.2 (integrate climate change measures into national policies), 13.3 (raise awareness on mitigation and adaptation), 13.a (finance developing countries for mitigation) and 13.b (enhance capacity for climate change planning) use the same indicator, "rating countries mitigation ambition" measured by 4 levels of consistency. Using one indicator is too limited to match well to four targets with different aspects in terms of means of implementation. The UN Statistical Commission and other international and regional organisations have moved to work on data and established a Global SDG Indicators Database with an initial set of data (ECOSOC, 2017a and ECOSOC, 2017b). With the expected progress made in the Global SDG Indicators Database, the set of global SDG indicators agreed by the UN Statistical Commission with trackable data can be used to substitute the current 51 indicators. This will lead to improved quantification and better results from network analysis.

v) *Improvement in the quantification of causality*

Directed links are assumed to represent the causal relations between SDG targets, i.e. the physical, social and economic mechanisms that change in one indicator due to the changes in others. Ideally, the strength of the directed links in a quantified network shall represent causality. Currently the strength of directed links is estimated based on the correlation analysis of the indicator-level time-series data corresponding to relevant targets. However correlation is not necessarily causality. In the next stage of the study, other options to quantify the strength of the directed links to better reflect causality will be explored.

vi) *Challenges in defining the functions of the SDG network and selection of appropriate metrics for the structural analysis of the SDG interlinkages*

In the field of social science, social networks exist to reduce the cost of information dissemination, i.e. connecting social agents (e.g. people) with less connections. In the specific field of SDG interlinkages network, it is important to define the functions of the SDG network and apply for guiding practical policy-making. Currently the lack of enough knowledge on the functions of the SDG network constrains to derive useful policy implications from various centrality analysis. In particular, what is the policy implications of closeness centrality and clustering for the SDG network? With well-defined functions of the SDG network, it is then important to select appropriate metrics, such as clustering and betweenness centrality, for the structural analysis of the SDG network. Definition of the functions of the SDG network and selection of appropriate metrics for network analysis can be included in the future research agenda.

Except for the above technical constrains related to the current research and recommendations on the solutions to be included in the future research agenda, moving forward to the applications of the proposed integrated approach and social network analysis results to support practical policy-making on SDG integration will be a major task in our future

plan.

In this regard, we plan to initiate an iterative process on the dissemination and the promotion of the applications by sharing and learning from policy practitioners working on SDG policy-making and implementation at the national level. In the initial stage, we plan to conduct a couple of detailed country studies in close collaboration with the national planning agency on SDGs. In the planning stage, we will support informed decision-making on priority setting based on the knowledge of top central targets identified by ranking the targets against various centrality metrics and the country-specific dashboards which indicate potential synergies and trade-offs between SDG tragets. Priority setting is very important for developing countries which face serious constrains by the availability of the required resources. Appropriate priority setting for SDG targets can help improve the cost-effectiveness and cost-efficiency of implementation.

For overall institutional arrangement, though almost all the national governmental organisations are relevant to SDGs, core group of leading agencies will work effectively guiding the overall implementation. The results of ranking top central targets can help recommend corresponding agencies to be included as core group members. For the institutional arrangements related to specific issues, such as Goal 13 on climate change, the dashboards which indicate potential synergies and trade-offs between SDG targets can be useful to the selection of relevant agencies to be included in the special committee established to tackle climate change.

For planning and policy making, various impact assessment, such as EIA, SEA or in general sustainability assessment, will be conducted to inform where and how much the potential impacts are. The dashboards can be useful as a complementary tool for checking whether major synergies and trade-offs and in particular major trade-offs have been taken into full account in the assessment.

References

1. Anson, M.J.P, Fabozzi, F.J., Jones, F.J., 2011. The Handbook of Traditional and Alternative Investment Vehicles: Investment Characteristics and Strategies. New Jersey: John Wiley & Sons.
2. Bengtsson, M., Shivakoti, B.R., 2015. The role of water security in achieving the SDGs: Realising synergies, balancing trade-offs. Chapter 6. In Bengtsson, M., Olsen, S.I., Zusman, E. (eds). Achieving the Sustainable Development Goals: From Agenda to Action. Hayama: Institute for Global Environmental Strategies.
3. Boas, I., Biermann, F., Kanie, N., 2016. Cross-sectoral Strategies in Global Sustainability Governance: Towards a nexus approach. International Environmental Agreements (16) 449-464.
4. Chan, E., 2009. Harvard Business School Confidential: Secrets of Success. Singapore: John Wiley & Sons (Asia) Pte. Ltd.
5. Coopman, A., Osborn, D., Ullah, F., Auckland, E., Long, G., publication date unknown. See the Whole: Implementing the SDGs in an integrated and coherent way. A Research Pilot by Stakeholder Forum, Biregional and Newcastle University. Available at: http://www.stakeholderforum.org/fileadmin/files/SeeingTheWhole.ResearchPilotReportOnSDGsImplementation.pdf.
6. Cutter, A., Osborn, D., Romano, J., Ullah, F., publication date unknown. Sustainable Development Goals and Integration: Achieving a better balance between the economic, social and environmental dimensions. Available at: http://www.stakeholderforum.org/fileadmin/files/Balancing%20the%20dimensions%20in%20the%20SDGs%20FINAL.pdf.
7. Elder, M., Bengtsson, M., Akenji, L. 2016. An Optimistic Analysis of the Means of Implementation for Sustainable Development Goals: Thinking about Goals as Means. Sustainability 8 (9): 962–86. doi:10.3390/su8090962. (Open access).
8. Elder, M., Zusman, E. 2016. Strengthening the Linkages between Air Pollution and the Sustainable Development Goals. IGES Policy Brief No. 35. Hayama: Institute for Global Environmental Strategies. Available at: http://pub.iges.or.jp/modules/envirolib/view.php?docid=6678.
9. Espey, J., 2015. Getting Started with the SDGs: Emerging questions from the first 30 days of SDG implementation in Colombia. Available at: http://unsdsn.org/news/2015/10/30/getting-started-with-the-sdgs-emerging-questions-from-the-first-30-days-of-sdg-implementation-in-colombia/.
10. Inter-agency and Expert Group on Sustainable Development Goal Indicators (IAEG-SDGs), 2015. List of Indicator Proposals (11 August 2015). Available at: https://unstats.un.org/sdgs/files/List%20of%20Indicator%20Proposals%2011-8-2015.pdf.

11. International Council for Science (ICSU), International Social Science Council (ISSC), 2015. Review of the Sustainable Development Goals: The Science Perspective. Paris: ICSU. Available at: https://www.icsu.org/cms/2017/05/SDG-Report.pdf.
12. International Council for Science (ICSU), 2017. A Guide to SDG Interactions: From science to implementation. Paris: ICSU. Available at: https://www.icsu.org/publications/a-guide-to-sdg-interactions-from-science-to-implementation.
13. International Organization for Migration (IOM), publication date unknown. 2030 Agenda for Sustainable Development. Available at: https://unofficeny.iom.int/2030-agenda-sustainable-development.
14. Jungcurt, S., 2016. Towards Integrated Implementation: Tools for understanding linkages and developing strategies for policy coherence. International Institute for Sustainable Development (IISD) Policy Brief. Available at: http://sdg.iisd.org/commentary/policy-briefs/towards-integrated-implementation-tools-for-understanding-linkages-and-developing-strategies-for-policy-coherence/.
15. Le Blanc, D., 2015. Towards Integration at Last? The Sustainable Development Goals as a Network of Targets. New York. United Nations Department of Economic and Social Affairs (UN-DESA) Working Paper No. 141. Available at: http://www.un.org/esa/desa/papers/2015/wp141_2015.pdf.
16. Millennium Institute, 2017a. Homepage of the Integrated Model for Sustainable Development Goals Strategies (iSDG). Available at: http://www.isdgs.org/.
17. Millennium Institute, 2017b. Homepage of the Millennium Institute. Available at: http://www.millennium-institute.org/.
18. Millennium Institute, 2017c. The iSDG Model Documentation. Version of January 15th, 2017. Available at: http://www.isdgs.org/documentation.
19. Niestroy, I., 2016. How Are We Getting Ready? The 2030 Agenda for Sustainable Development in the EU and its Member States: Analysis and action so far. German Development Institute (DIE) Discussion Paper 9/2016. Available at: https://www.die-gdi.de/uploads/media/DP_9.2016.pdf.
20. Nilsson, M., Griggs, D., Visbeck, M., 2016a. Map the Interactions between Sustainable Development Goals. Nature (534) 320-322.
21. Nilsson, M., Griggs, D., Visbeck; M., Riegler, C., 2016b. A Draft Framework for Understanding SDG Interactions. Paris: International Council for Science (ICSU) Working Paper. ICSU: Paris. Available at: https://www.icsu.org/cms/2017/05/SDG-interactions-working-paper.pdf
22. Open Working Group on Sustainable Development Goals (OWG SDGs), 2014a. Open Working Group proposal for Sustainable Development Goals. Available at: https://sustainabledevelopment.un.org/content/documents/1579SDGs%20Proposal.pdf.
23. Open Working Group on Sustainable Development Goals (OWG SDGs), 2014b. Open Working Group on Sustainable Development Goals Annex 1. Interlinkages. Available at: https://sustainabledevelopment.un.org/content/documents/3387Annex_interlinkages_1903.pdf.

24. Organization for Economic Co-operation and Development (OECD), 2016. Better Policies for Sustainable Development 2016: A New Framework for Policy Coherence. OECD Publishing, Paris. Available at: http://www.oecd.org/greengrowth/better-policies-for-sustainable-development-2016-9789264256996-en.htm.
25. Post-2015 Data Test, 2016. Homepage of the Post-2015 Data Test. Available at: http://www.post2015datatest.com/.
26. Shaw, R., Prabhakar, S.V.R.K., Chiba, Y., 2016. SDGs, DRR and CCA: Potential for Strengthening Inter-linkages. IGES Policy Brief No. 34. July. Hayama: Institute for Global Environmental Strategies. Available at: https://pub.iges.or.jp/system/files/publication_documents/pub/policy/5185/PB_34_0705.pdf.
27. Shivakoti, B.R., Bengtsson, M., Zusman, E., Miyazawa, I., Aleksiunaite, I., 2015. Placing Water at the Core of the Sustainable Development Goals (SDGs): Why an Integrated Perspective is Needed. IGES Policy Brief No. 31. March. Hayama: Institute for Global Environmental Strategies. Available at: https://pub.iges.or.jp/system/files/publication_documents/pub/policy/4518/PB_31_E_FINAL.pdf.
28. Sustainable Development Solutions Network (SDSN), 2015. Indicators and a Monitoring Framework for the Sustainable Development Goals: Launching a Data Revolution. A report to the Secretary-General of the United Nations by the Leadership Council of the Sustainable Development Solutions Network. Available at: http://unsdsn.org/wp-content/uploads/2015/05/150612-FINAL-SDSN-Indicator-Report1.pdf.
29. Sustainable Development Solutions Network (SDSN), 2016a. Homepage. Available at: http://unsdsn.org.
30. Sustainable Development Solutions Network (SDSN), 2016b. A Case Study of Colombia: Data driving action on the SDGs. Available at: http://unsdsn.org/news/2016/05/06/a-case-study-of-colombia-data-driving-action-on-the-sdgs/.
31. United Nations (UN), 2016. The Sustainable Development Goals Report 2016. Available at: https://www.unodc.org/documents/commissions/CND_CCPCJ_joint/2030Agenda/The_Sustainable_Development_Goals_Report_2016.pdf.
32. United Nations Development Group (UNDG), 2016. Mainstreaming the 2030 Agenda for Sustainable Development: Reference Guide for UN Country Teams. March 2017 update. Available at: https://undg.org/wp-content/uploads/2017/03/UNDG-Mainstreaming-the-2030-Agenda-Reference-Guide-2017.pdf.
33. United Nations Economic and Social Commission for Asia and the Pacific (ESCAP), 2017. Integrated Approaches for Sustainable Development Goals Planning: The Case of Goal 6 on Water and Sanitation. Bangkok: United Nations. Available at: http://www.unescap.org/sites/default/files/publications/Integrated%20Approaches%20for%20SDG%20Planning_0.pdf
34. United Nations Economic and Social Council (ECOSOC), 2017a. Statistical Commission Report on the Forty-Eighth Session (7-10 March 2017). Economic and Social Council

Official Records, 2017 Supplement No. 4. E/2017/24-E/CN.3/2017/35. New York: United Nations. Available at: https://unstats.un.org/unsd/statcom/48th-session/documents/Report-on-the-48th-session-of-the-statistical-commission-E.pdf.

35. United Nations Economic and Social Council (ECOSOC). 2017b. Progress towards the Sustainable Development Goals: Report of the Secretary-General. E/2017/66*. Available at: https://unstats.un.org/sdgs/files/report/2017/secretary-general-sdg-report-2017--EN.pdf.
36. United Nations General Assembly (UNGA), 2015. Transforming our world: The 2030 Agenda for Sustainable Development. Available at: http://www.un.org/ga/search/view_doc.asp?symbol=A/RES/70/1&Lang=E.
37. United Nations Statistical Division (UNSD), 2016a. Inter-agency Expert Group on SDG Indicators (IAEG-SDGs) Homepage. Available at: http://unstats.un.org/sdgs/iaeg-sdgs/.
38. United Nations Statistical Division (UNSD), 2016b. SDG Indicators: Official List of SDG Indicators. Available at: http://unstats.un.org/sdgs/indicators/indicators-list/.
39. United Nations Statistical Division (UNSD), 2016c. Working Group on Interlinkages of SDG Statistics to Allow for Integrated Analyses in the Monitoring: Terms of Reference. Available at: https://unstats.un.org/sdgs/files/Working-Group-ToR--Interlinkages.pdf.
40. Weitz, N., Nilsson, M., Davis, M., 2014. A Nexus Approach to the Post-2015 Agenda: Formulating Integrated Water, Energy and Food SDGs. Available at: https://www.oecd.org/pcd/Art%20Nexus%20SAIS%20weitz.pdf.
41. Zhou, X., Moinuddin, M., Li, Y., 2017. IGES SDG Interlinkages Visualisation Web Tool. Available for free from internet access at https://sdgindicatorstest.iges.jp/.

Appendix I Correspondence of 17 goals, 169 targets and 51 Indicators

Goals/Full name	Targets/Full name	Indicators/Full name
Goal 1. End poverty in all its forms everywhere	Target 1.1 by 2030, eradicate extreme poverty for all people everywhere, currently measured as people living on less than $1.25 a day	Proportion of population below $1.90 (2011 PPP) per day
	Target 1.2 by 2030, reduce at least by half the proportion of men, women and children of all ages living in poverty in all its dimensions according to national definitions	Proportion of population living below national poverty line
	Target 1.3 implement nationally appropriate social protection systems and measures for all, including floors, and by 2030 achieve substantial coverage of the poor and the vulnerable	Health expenditure, public (% of total health expenditure)
	Target 1.4 by 2030 ensure that all men and women, particularly the poor and the vulnerable, have equal rights to economic resources, as well as access to basic services, ownership, and control over land and other forms of property, inheritance, natural resources, appropriate new technology, and financial services including microfinance	Data not available.
	Target 1.5 by 2030 build the resilience of the poor and those in vulnerable situations, and reduce their exposure and vulnerability to climate-related extreme events and other economic, social and environmental shocks and disasters	Total economic damage from top ten natural disasters
	Target 1.a create sound policy frameworks, at national, regional and international levels, based on pro-poor and gender-sensitive development strategies to support accelerated investments in poverty eradication actions	Data not available.
	Target 1.b ensure significant mobilization of resources from a variety of sources, including through enhanced development cooperation to provide adequate and predictable means for developing countries, in particular LDCs, to implement programs and policies to end poverty in all its dimensions	Net official development assistance (ODA) received (% of GNI)
Goal 2. End hunger, achieve food security and improved nutrition and promote sustainable agriculture	Target 2.1 by 2030 end hunger and ensure access by all	Proportion of population below minimum level of dietary energy consumption
	Target 2.2 by 2030 end all forms of malnutrition, including achieving by 2025 the internationally agreed targets on stunting and wasting in children under 5 years of age, and address the nutritional needs of adolescent girls, pregnant and lactating women, and older persons	Prevalence of wasting in children under 5 years of age, weight for height
	Target 2.3 by 2030 double the agricultural productivity and the incomes of small-scale food producers, particularly women, indigenous peoples, family farmers, pastoralists and fishers, including through secure and equal access to land, other productive resources and inputs, knowledge, financial services, markets and opportunities for value addition and non-farm employment	Crop production index (2004-2006 = 100)

Goals/Full name	Targets/Full name	Indicators/Full name
	Target 2.4 by 2030 ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production, that help maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather, drought, flooding and other disasters, and that progressively improve land and soil quality	Crop production index (2004-2006 = 100)
	Target 2.5 by 2020 maintain genetic diversity of seeds, cultivated plants, farmed and domesticated animals and their related wild species, including through soundly managed and diversified seed and plant banks at national, regional and international levels, and ensure access to and fair and equitable sharing of benefits arising from the utilization of genetic resources and associated traditional knowledge as internationally agreed	Data not available.
	Target 2.a increase investment, including through enhanced international cooperation, in rural infrastructure, agricultural research and extension services, technology development, and plant and livestock gene banks to enhance agricultural productive capacity in developing countries, in particular in least developed countries	Data not available.
	Target 2.b. correct and prevent trade restrictions and distortions in world agricultural markets including by the parallel elimination of all forms of agricultural export subsidies and all export measures with equivalent effect, in accordance with the mandate of the Doha Development Round	Data not available.
	Target 2.c adopt measures to ensure the proper functioning of food commodity markets and their derivatives, and facilitate timely access to market information, including on food reserves, in order to help limit extreme food price volatility	Data not available.
Goal 3. Ensure healthy lives and promote well-being for all at all ages	Target 3.1 by 2030 reduce the global maternal mortality ratio to less than 70 per 100,000 live births	Maternal mortality ratio per 100,000 live births
	Target 3.2 by 2030 end preventable deaths of newborns and under-5 children	Children under five mortality rate
	Target 3.3 by 2030 end the epidemics of AIDS, tuberculosis, malaria, and neglected tropical diseases and combat hepatitis, water-borne diseases, and other communicable diseases	Reported confirmed malaria cases (Microscopy slides/RDTs positive)
	Target 3.4 by 2030 reduce by one-third pre-mature mortality from non-communicable diseases (NCDs) through prevention and treatment, and promote mental health and wellbeing	Probability of dying between exact ages 30 and 70 from any of cardiovascular disease, cancer, diabetes, or chronic respiratory
	Target 3.5 strengthen prevention and treatment of substance abuse, including narcotic drug abuse and harmful use of alcohol	Current smoking of any tobacco product (age-standardized rate)
	Target 3.6. by 2030 halve global deaths from road traffic accidents	Road traffic death rate per 100,000 population
	Target 3.7 by 2030 ensure universal access to sexual and reproductive health care services, including for family planning,	Contraceptive prevalence, any methods (% of women aged 15-49)

Goals/Full name	Targets/Full name	Indicators/Full name
	information and education, and the integration of reproductive health into national strategies and programs	
	Target 3.8 achieve universal health coverage (UHC), including financial risk protection, access to quality essential health care services, and access to safe, effective, quality, and affordable essential medicines and vaccines for all	Percent of children receiving immunisation against measles
	Target 3.9 by 2030 substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water, and soil pollution and contamination	CO2 intensity (kg per kg of oil equivalent energy use)
	Target 3.a strengthen implementation of the Framework Convention on Tobacco Control in all countries as appropriate	Current smoking of any tobacco product (age-standardized rate)
	Target 3.b support research and development of vaccines and medicines for the communicable and non- communicable diseases that primarily affect developing countries, provide access to affordable essential medicines and vaccines, in accordance with the Doha Declaration which affirms the right of developing countries to use to the full the provisions in the TRIPS agreement regarding flexibilities to protect public health and, in particular, provide access to medicines for all	Data not available.
	Target 3.c increase substantially health financing and the recruitment, development and training and retention of the health workforce in developing countries, especially in LDCs and SIDS	Net official development assistance (ODA) received (% of GNI)
	Target 3.d strengthen the capacity of all countries, particularly developing countries, for early warning, risk reduction, and management of national and global health risks	Net official development assistance (ODA) received (% of GNI)
Goal 4. Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all	Target 4.1 by 2030, ensure that all girls and boys complete free, equitable and quality primary and secondary education leading to relevant and effective learning outcomes	Lower secondary completion rate, total
	Target 4.2 by 2030 ensure that all girls and boys have access to quality early childhood development, care and pre-primary education so that they are ready for primary education	Gross enrolment ratio, pre-primary
	Target 4.3 by 2030 ensure equal access for all women and men to affordable quality technical, vocational and tertiary education, including university	Gross enrolment ratio, tertiary
	Target 4.4 by 2030, increase by x% the number of youth and adults who have relevant skills, including technical and vocational skills, for employment, decent jobs and entrepreneurship	Lower secondary completion rate, total
	Target 4.5 by 2030, eliminate gender disparities in education and ensure equal access to all levels of education and vocational training for the vulnerable, including persons with disabilities, indigenous peoples, and children in vulnerable situations	Index for completion rates for all levels of education

Goals/Full name	Targets/Full name	Indicators/Full name
	Target 4.6 by 2030 ensure that all youth and at least x% of adults, both men and women, achieve literacy and numeracy	Primary completion rate, total
	Target 4.7 by 2030 ensure all learners acquire knowledge and skills needed to promote sustainable development, including among others through education for sustainable development and sustainable lifestyles, human rights, gender equality, promotion of a culture of peace and non-violence, global citizenship, and appreciation of cultural diversity and of culture's contribution to sustainable development	Lower secondary completion rate, total
	Target 4.a build and upgrade education facilities that are child, disability and gender sensitive and provide safe, non-violent, inclusive and effective learning environments for all	Index for completion rates for all levels of education
	Target 4.b by 2020 expand by x% globally the number of scholarships for developing countries in particular LDCs, SIDS and African countries to enrol in higher education, including vocational training, ICT, technical, engineering and scientific programs in developed countries and other developing countries	Data not available.
	Target 4.c by 2030 increase by x% the supply of qualified teachers, including through international cooperation for teacher training in developing countries, especially LDCs and SIDS	Net official development assistance (ODA) received (% of GNI)
Goal 5. Achieve gender equality and empower all women and girls	Target 5.1 end all forms of discrimination against women and girls everywhere	Proportion of seats held by women in national parliaments
	Target 5.2 eliminate all forms of violence against all women and girls in public and private spheres, including trafficking and sexual and other types of exploitation	Prevalence of sexual violence against women aged 15-49 by an intimate partner in the last 12 months
	Target 5.3 eliminate all harmful practices, such as child, early and forced marriage and female genital mutilations	Percent of women aged 20-24 who were married or in a union by age 18
	Target 5.4 recognize and value unpaid care and domestic work through the provision of public services, infrastructure and social protection policies, and the promotion of shared responsibility within the household and the family as nationally appropriate	Health expenditure, public (% of total health expenditure)
	Target 5.5 ensure women's full and effective participation and equal opportunities for leadership at all levels of decision-making in political, economic, and public life	Proportion of seats held by women in national parliaments
	Target 5.6 ensure universal access to sexual and reproductive health and reproductive rights as agreed in accordance with the Programme of Action of the ICPD and the Beijing Platform for Action and the outcome documents of their review conferences	Contraceptive prevalence, any methods (% of women aged 15-49)
	Target 5.a undertake reforms to give women equal rights to economic resources, as well as access to ownership and control over land and other forms of property, financial services, inheritance, and natural resources in accordance with national laws	Data not available.

Goals/Full name	Targets/Full name	Indicators/Full name
	Target 5.b enhance the use of enabling technologies, in particular ICT, to promote women's empowerment	Mobile cellular subscription rate
	Target 5.c adopt and strengthen sound policies and enforceable legislation for the promotion of gender equality and the empowerment of all women and girls at all levels	Proportion of seats held by women in national parliaments
Goal 6. Ensure availability and sustainable management of water and sanitation for all	Target 6.1 by 2030, achieve universal and equitable access to safe and affordable drinking water for all	Percentage of population with access to improved water source
	Target 6.2 by 2030, achieve access to adequate and equitable sanitation and hygiene for all, and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations	Percentage of population with access to improved sanitation facilities
	Target 6.3 by 2030, improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater, and increasing recycling and safe reuse by x% globally	Data not available.
	Target 6.4 by 2030, substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity, and substantially reduce the number of people suffering from water scarcity	Proportion of total water resources used
	Target 6.5 by 2030 implement integrated water resources management at all levels, including through transboundary cooperation as appropriate	Proportion of total water resources used
	Target 6.6 by 2020 protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes	Share of terrestrial and marine areas protected to total territorial area
	Target 6.a by 2030, expand international cooperation and capacity-building support to developing countries in water and sanitation related activities and programs, including water harvesting, desalination, water efficiency, wastewater treatment, recycling and reuse technologies	Net official development assistance (ODA) received (% of GNI)
	Target 6.b support and strengthen the participation of local communities for improving water and sanitation management	Data not available.
Goal 7. Ensure access to affordable, reliable, sustainable and modern energy for all	Target 7.1 by 2030 ensure universal access to affordable, reliable, and modern energy services	Percentage of people with access to electricity
	Target 7.2 increase substantially the share of renewable energy in the global energy mix by 2030	Data not available.
	Target 7.3 double the global rate of improvement in energy efficiency by 2030	Energy intensity level of primary energy
	Target 7.a by 2030 enhance international cooperation to facilitate access to clean energy research and technologies, including renewable energy, energy efficiency, and advanced and cleaner fossil fuel technologies, and promote investment in energy infrastructure and clean energy technologies	Net official development assistance (ODA) received (% of GNI)
	Target 7.b by 2030 expand infrastructure and upgrade technology for supplying modern and sustainable energy	Percentage of people with access to electricity

Goals/Full name	Targets/Full name	Indicators/Full name
	services for all in developing countries, particularly LDCs and SIDS	
Goal 8. Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all	Target 8.1 sustain per capita economic growth in accordance with national circumstances, and in particular at least 7% per annum GDP growth in the least-developed countries	Gross National Income (GNI) per capita, PPP (constant 2011 international $)
	Target 8.2 achieve higher levels of productivity of economies through diversification, technological upgrading and innovation, including through a focus on high value added and labour-intensive sectors	Manufacturing value added as percent of GDP
	Target 8.3 promote development-oriented policies that support productive activities, decent job creation, entrepreneurship, creativity and innovation, and encourage formalization and growth of micro-, small- and medium-sized enterprises including through access to financial services	Ratification of ILO conventions
	Target 8.4 improve progressively through 2030 global resource efficiency in consumption and production, and endeavour to decouple economic growth from environmental degradation in accordance with the 10-year framework of programs on sustainable consumption and production with developed countries taking the lead	Consumption of Ozone-Depleting Substances
	Target 8.5 by 2030 achieve full and productive employment and decent work for all women and men, including for young people and persons with disabilities, and equal pay for work of equal value	Youth unemployment rate as percentage of total labour force aged 15-24
	Target 8.6 by 2020 substantially reduce the proportion of youth not in employment, education or training	Youth unemployment rate as percentage of total labour force aged 15-24
	Target 8.7 take immediate and effective measures to secure the prohibition and elimination of the worst forms of child labour, eradicate forced labour, and by 2025 end child labour in all its forms including recruitment and use of child soldiers	Ratification of ILO conventions
	Target 8.8 protect labour rights and promote safe and secure working environments of all workers, including migrant workers, particularly women migrants, and those in precarious employment	Ratification of ILO conventions
	Target 8.9 by 2030 devise and implement policies to promote sustainable tourism which creates jobs, promotes local culture and products	Data not available.
	Target 8.10 Strengthen the capacity of domestic financial institutions to encourage and to expand access to banking, insurance and financial services for all	Data not available.
	Target 8.a increase Aid for Trade support for developing countries, particularly LDCs, including through the Enhanced Integrated Framework for LDCs	Data not available.
	Target 8.b by 2020 develop and operationalize a global strategy for youth employment and implement the ILO Global Jobs Pact	Youth unemployment rate as percentage of total labour force aged 15-24

Goals/Full name	Targets/Full name	Indicators/Full name
Goal 9. Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation	Target 9.1 develop quality, reliable, sustainable and resilient infrastructure, including regional and trans- border infrastructure, to support economic development and human well-being, with a focus on affordable and equitable access for all	Index for the share of population using public infrastructure
	Target 9.2 promote inclusive and sustainable industrialization, and by 2030 raise significantly industry's share of employment and GDP in line with national circumstances, and double its share in LDCs	Manufacturing value added as percent of GDP
	Target 9.3 increase the access of small-scale industrial and other enterprises, particularly in developing countries, to financial services including affordable credit and their integration into value chains and markets	Data not available.
	Target 9.4 by 2030 upgrade infrastructure and retrofit industries to make them sustainable, with increased resource use efficiency and greater adoption of clean and environmentally sound technologies and industrial processes, all countries taking action in accordance with their respective capabilities	Total GHG emissions excluding land use change and forestry
	Target 9.5 enhance scientific research, upgrade the technological capabilities of industrial sectors in all countries, particularly developing countries, including by 2030 encouraging innovation and increasing the number of R&D workers per one million people by x% and public and private R&D spending	Researchers in R&D (per million people)
	Target 9.a facilitate sustainable and resilient infrastructure development in developing countries through enhanced financial, technological and technical support to African countries, LDCs, LLDCs and SIDS	Net official development assistance (ODA) received (% of GNI)
	Target 9.b support domestic technology development, research and innovation in developing countries including by ensuring a conducive policy environment for inter alia industrial diversification and value addition to commodities	Data not available.
	Target 9.c significantly increase access to ICT and strive to provide universal and affordable access to internet in LDCs by 2020	Mobile cellular subscription rate
Goal 10. Reduce inequality within and among countries	Target 10.1 by 2030 progressively achieve and sustain income growth of the bottom 40% of the population at a rate higher than the national average	GINI index (World Bank estimate)
	Target 10.2. by 2030 empower and promote the social, economic and political inclusion of all irrespective of age, sex, disability, race, ethnicity, origin, religion or economic or other status	Proportion of seats held by women in national parliaments
	Target 10.3 ensure equal opportunity and reduce inequalities of outcome, including through eliminating discriminatory laws, policies and practices and promoting appropriate legislation, policies and actions in this regard	Proportion of seats held by women in national parliaments

Goals/Full name	Targets/Full name	Indicators/Full name
	Target 10.4 adopt policies especially fiscal, wage, and social protection policies and progressively achieve greater equality	Health expenditure, public (% of total health expenditure)
	Target 10.5 improve regulation and monitoring of global financial markets and institutions and strengthen implementation of such regulations	Data not available.
	Target 10.6. ensure enhanced representation and voice of developing countries in decision making in global international economic and financial institutions in order to deliver more effective, credible, accountable and legitimate institutions	Data not available.
	Target 10.7 facilitate orderly, safe, and responsible migration and mobility of people, including through implementation of planned and well-managed migration policies	Refugee population by country or territory of asylum
	Target 10.a implement the principle of special and differential treatment for developing countries, in particular least developed countries, in accordance with WTO agreements	Data not available.
	Target 10.b encourage ODA and financial flows, including foreign direct investment, to states where the need is greatest, in particular LDCs, African countries, SIDS, and LLDCs, in accordance with their national plans and programs	Net official development assistance (ODA) received (% of GNI)
	Target 10.c by 2030, reduce to less than 3% the transaction costs of migrant remittances and eliminate remittance corridors with costs higher than 5%	Data not available.
Goal 11. Make cities and human settlements inclusive, safe, resilient and sustainable	Target 11.1 by 2030, ensure access for all to adequate, safe and affordable housing and basic services, and upgrade slums	Index for access to basic urban services
	Target 11.2 by 2030, provide access to safe, affordable, accessible and sustainable transport systems for all, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, women, children, persons with disabilities and older persons	Share of paved roads over total road network
	Target 11.3 by 2030 enhance inclusive and sustainable urbanization and capacities for participatory, integrated and sustainable human settlement planning and management in all countries	Data not available.
	Target 11.4 strengthen efforts to protect and safeguard the world's cultural and natural heritage	Data not available.
	Target 11.5 by 2030 significantly reduce the number of deaths and the number of affected people and decrease by y% the economic losses relative to GDP caused by disasters, including water-related disasters, with the focus on protecting the poor and people in vulnerable situations	Total economic damage from top ten natural disasters
	Target 11.6 by 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality, municipal and other waste management	CO2 intensity (kg per kg of oil equivalent energy use)
	Target 11.7 by 2030, provide universal access to safe, inclusive and accessible, green and public spaces, particularly for women and children, older persons and persons with disabilities	Data not available.

Goals/Full name	Targets/Full name	Indicators/Full name
	Target 11.a support positive economic, social and environmental links between urban, peri-urban and rural areas by strengthening national and regional development planning	Data not available.
	Target 11.b by 2020, increase by x% the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change, resilience to disasters, develop and implement in line with the forthcoming Hyogo Framework holistic disaster risk management at all levels	Data not available.
	Target 11.c support least developed countries, including through financial and technical assistance, for sustainable and resilient buildings utilizing local materials	Data not available.
Goal 12. Ensure sustainable consumption and production patterns	Target 12.1 implement the 10-Year Framework of Programs on sustainable consumption and production (10YFP), all countries taking action, with developed countries taking the lead, taking into account the development and capabilities of developing countries	Data not available.
	Target 12.2 by 2030 achieve sustainable management and efficient use of natural resources	Data not available.
	Target 12.3 by 2030 halve per capita global food waste at the retail and consumer level, and reduce food losses along production and supply chains including post-harvest losses	Global Food Security Index
	Target 12.4 by 2020 achieve environmentally sound management of chemicals and all wastes throughout their life cycle in accordance with agreed international frameworks and significantly reduce their release to air, water and soil to minimize their adverse impacts on human health and the environment	Consumption of Ozone-Depleting Substances
	Target 12.5 by 2030, substantially reduce waste generation through prevention, reduction, recycling, and reuse	Energy intensity level of primary energy
	Target 12.6 encourage companies, especially large and trans-national companies, to adopt sustainable practices and to integrate sustainability information into their reporting cycle	Data not available.
	Target 12.7 promote public procurement practices that are sustainable in accordance with national policies and priorities	Data not available.
	Target 12.8 by 2030 ensure that people everywhere have the relevant information and awareness for sustainable development and lifestyles in harmony with nature	Data not available.
	Target 12.a support developing countries to strengthen their scientific and technological capacities to move towards more sustainable patterns of consumption and production	Researchers in R&D (per million people)
	Target 12.b develop and implement tools to monitor sustainable development impacts for sustainable tourism which creates jobs, promotes local culture and products	Data not available.

Goals/Full name	Targets/Full name	Indicators/Full name
	Target 12.c rationalize inefficient fossil fuel subsidies that encourage wasteful consumption by removing market distortions, in accordance with national circumstances, including by restructuring taxation and phasing out those harmful subsidies, where they exist, to reflect their environmental impacts, taking fully into account the specific needs and conditions of developing countries and minimizing the possible adverse impacts on their development in a manner that protects the poor and the affected communities	Data not available.
Goal 13. Take urgent action to combat climate change and its impacts*	Target 13.1 strengthen resilience and adaptive capacity to climate related hazards and natural disasters in all countries	Total economic damage from top ten natural disasters
	Target 13.2 integrate climate change measures into national policies, strategies, and planning	Rating countries ambition based on the consistency between a country's INDC, pledges and current policies and its fair share effort to holding global warming to below 2°C
	Target 13.3 improve education, awareness raising and human and institutional capacity on climate change mitigation, adaptation, impact reduction, and early warning	Rating countries ambition based on the consistency between a country's INDC, pledges and current policies and its fair share effort to holding global warming to below 2°C
	Target 13.a implement the commitment undertaken by developed country Parties to the UNFCCC to a goal of mobilizing jointly USD100 billion annually by 2020 from all sources to address the needs of developing countries in the context of meaningful mitigation actions and transparency on implementation and fully operationalize the Green Climate Fund through its capitalization as soon as possible	Rating countries ambition based on the consistency between a country's INDC, pledges and current policies and its fair share effort to holding global warming to below 2°C
	Target 13.b Promote mechanisms for raising capacities for effective climate change related planning and management, in LDCs, including focusing on women, youth, local and marginalized communities	Rating countries ambition based on the consistency between a country's INDC, pledges and current policies and its fair share effort to holding global warming to below 2°C
Goal 14. Conserve and sustainably use the oceans, seas and marine resources for sustainable development	Target 14.1 by 2025, prevent and significantly reduce marine pollution of all kinds, particularly from land-based activities, including marine debris and nutrient pollution	Share of terrestrial and marine areas protected to total territorial area
	Target 14.2 by 2020, sustainably manage, and protect marine and coastal ecosystems to avoid significant adverse impacts, including by strengthening their resilience and take action for their restoration, to achieve healthy and productive oceans	Share of terrestrial and marine areas protected to total territorial area
	Target 14.3 minimize and address the impacts of ocean acidification, including through enhanced scientific cooperation at all levels	Rating countries ambition based on the consistency between a country's INDC, pledges and current policies and its fair share effort to holding global warming to below 2°C

Goals/Full name	Targets/Full name	Indicators/Full name
	Target 14.4 by 2020, effectively regulate harvesting, and end overfishing, illegal, unreported and unregulated (IUU) fishing and destructive fishing practices and implement science-based management plans, to restore fish stocks in the shortest time feasible at least to levels that can produce maximum sustainable yield as determined by their biological characteristics	Seafood captured or raised in a sustainable way
	Target 14.5 by 2020, conserve at least 10 per cent of coastal and marine areas, consistent with national and international law and based on best available scientific information	Share of terrestrial and marine areas protected to total territorial area
	Target 14.6 by 2020, prohibit certain forms of fisheries subsidies which contribute to overcapacity and overfishing, and eliminate subsidies that contribute to IUU fishing, and refrain from introducing new such subsidies, recognizing that appropriate and effective special and differential treatment for developing and least developed countries should be an integral part of the WTO fisheries subsidies negotiation	Seafood captured or raised in a sustainable way
	Target 14.7 by 2030 increase the economic benefits to SIDS and LDCs from the sustainable use of marine resources, including through sustainable management of fisheries, aquaculture and tourism	Seafood captured or raised in a sustainable way
	Target 14.a increase scientific knowledge, develop research capacities and transfer marine technology taking into account the Intergovernmental Oceanographic Commission Criteria and Guidelines on the Transfer of Marine Technology, in order to improve ocean health and to enhance the contribution of marine biodiversity to the development of developing countries, in particular SIDS and LDCs	Researchers in R&D (per million people)
	Target 14.b provide access of small-scale artisanal fishers to marine resources and markets	Data not available.
	Target 14.c ensure the full implementation of international law, as reflected in UNCLOS for states parties to it, including, where applicable, existing regional and international regimes for the conservation and sustainable use of oceans and their resources by their parties	Data not available.
Goal 15. Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and	Target 15.1 by 2020 ensure conservation , restoration and sustainable use of terrestrial and inland freshwater ecosystems and their services, in particular forests, wetlands, mountains and drylands, in line with obligations under international agreements	Proportion of total water resources used
	Target 15.2 by 2020, promote the implementation of sustainable management of all types of forests, halt deforestation, restore degraded forests, and increase afforestation and reforestation by x% globally	Share of terrestrial areas protected to total surface area
	Target 15.3 by 2020, combat desertification, and restore degraded land and soil, including land affected by desertification, drought and floods, and strive to achieve a land-degradation neutral world	Share of forest area in total land area

Goals/Full name	Targets/Full name	Indicators/Full name
halt biodiversity loss	Target 15.4 by 2030 ensure the conservation of mountain ecosystems, including their biodiversity, to enhance their capacity to provide benefits which are essential for sustainable development	Data not available.
	Target 15.5 take urgent and significant action to reduce degradation of natural habitat, halt the loss of biodiversity, and by 2020 protect and prevent the extinction of threatened species	Share of terrestrial areas protected to total surface area
	Target 15.6 ensure fair and equitable sharing of the benefits arising from the utilization of genetic resources, and promote appropriate access to genetic resources	Data not available.
	Target 15.7 take urgent action to end poaching and trafficking of protected species of flora and fauna, and address both demand and supply of illegal wildlife products	Share of terrestrial areas protected to total surface area
	Target 15.8 by 2020 introduce measures to prevent the introduction and significantly reduce the impact of invasive alien species on land and water ecosystems, and control or eradicate the priority species	Data not available.
	Target 15.9 by 2020, integrate ecosystems and biodiversity values into national and local planning, development processes and poverty reduction strategies, and accounts	Data not available.
	Target 15.a mobilize and significantly increase from all sources financial resources to conserve and sustainably use biodiversity and ecosystems	Net official development assistance (ODA) received (% of GNI)
	Target 15.b mobilize significantly resources from all sources and at all levels to finance sustainable forest management, and provide adequate incentives to developing countries to advance sustainable forest management, including for conservation and reforestation	Net official development assistance (ODA) received (% of GNI)
	Target 15.c enhance global support to efforts to combat poaching and trafficking of protected species, including by increasing the capacity of local communities to pursue sustainable livelihood opportunities	Share of terrestrial areas protected to total surface area
Goal 16. Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels	Target 16.1 significantly reduce all forms of violence and related death rates everywhere	Intentional homicides per 100,000 people
	Target 16.2 end abuse, exploitation, trafficking and all forms of violence and torture against children	Intentional homicides per 100,000 people
	Target 16.3 promote the rule of law at the national and international levels, and ensure equal access to justice for all	Data not available.
	Target 16.4 by 2030 significantly reduce illicit financial and arms flows, strengthen recovery and return of stolen assets, and combat all forms of organized crime	Data not available.
	Target 16.5 substantially reduce corruption and bribery in all its forms	Corruption Perception Index (CPI)
	Target 16.6 develop effective, accountable and transparent institutions at all levels	Corruption Perception Index (CPI)

Goals/Full name	Targets/Full name	Indicators/Full name
	Target 16.7 ensure responsive, inclusive, participatory and representative decision-making at all levels	Proportion of seats held by women in national parliaments
	Target 16.8 broaden and strengthen the participation of developing countries in the institutions of global governance	Data not available.
	Target 16.9 by 2030 provide legal identity for all including free birth registrations	Data not available.
	Target 16.10 ensure public access to information and protect fundamental freedoms, in accordance with national legislation and international agreements	Mobile cellular subscription rate
	Target 16.a strengthen relevant national institutions, including through international cooperation, for building capacities at all levels, in particular in developing countries, for preventing violence and combating terrorism and crime	Data not available.
	Target 16.b promote and enforce non-discriminatory laws and policies for sustainable development	Data not available.
Goal 17. Strengthen the means of implementation and revitalize the global partnership for sustainable development	Target 17.1 strengthen domestic resource mobilization, including through international support to developing countries to improve domestic capacity for tax and other revenue collection	Data not available.
	Target 17.2 developed countries to implement fully their ODA commitments, including to provide 0.7% of GNI in ODA to developing countries of which 0.15-0.20% to least- developed countries	Net official development assistance (ODA) received (% of GNI)
	Target 17.3 mobilize additional financial resources for developing countries from multiple sources	Data not available.
	Target 17.4 assist developing countries in attaining long-term debt sustainability through coordinated policies aimed at fostering debt financing, debt relief and debt restructuring, as appropriate, and address the external debt of highly indebted poor countries (HIPC) to reduce debt distress	Data not available.
	Target 17.5 adopt and implement investment promotion regimes for LDCs	Data not available.
	Target 17.6 enhance North-South, South-South and triangular regional and international cooperation on and access to science, technology and innovation, and enhance knowledge sharing on mutually agreed terms, including through improved coordination among existing mechanisms, particularly at UN level, and through a global technology facilitation mechanism when agreed	Researchers in R&D (per million people)
	Target 17.7 promote development, transfer, dissemination and diffusion of environmentally sound technologies to developing countries on favourable terms, including on concessional and preferential terms, as mutually agreed	Data not available.
	Target 17.8 fully operationalize the Technology Bank and STI (Science, Technology and Innovation) capacity building mechanism for LDCs by 2017, and enhance the use of enabling technologies in particular ICT	Data not available.

Goals/Full name	Targets/Full name	Indicators/Full name
	Target 17.9 enhance international support for implementing effective and targeted capacity building in developing countries to support national plans to implement all sustainable development goals, including through North-South, South-South, and triangular cooperation	Data not available.
	Target 17.10 promote a universal, rules-based, open, non-discriminatory and equitable multilateral trading system under the WTO including through the conclusion of negotiations within its Doha Development Agenda	Data not available.
	Target 17.11 increase significantly the exports of developing countries, in particular with a view to doubling the LDC share of global exports by 2020	Data not available.
	Target 17.12 realize timely implementation of duty-free, quota-free market access on a lasting basis for all least developed countries consistent with WTO decisions, including through ensuring that preferential rules of origin applicable to imports from LDCs are transparent and simple, and contribute to facilitating market access	Data not available.
	Target 17.13 enhance global macroeconomic stability including through policy coordination and policy coherence	Gross National Income (GNI) per capita, PPP (constant 2011 international $)
	Target 17.14 enhance policy coherence for sustainable development	Data not available.
	Target 17.15 respect each country's policy space and leadership to establish and implement policies for poverty eradication and sustainable development	Data not available.
	Target 17.16 enhance the global partnership for sustainable development complemented by multi-stakeholder partnerships that mobilize and share knowledge, expertise, technologies and financial resources to support the achievement of sustainable development goals in all countries, particularly developing countries	Net official development assistance (ODA) received (% of GNI)
	Target 17.17 encourage and promote effective public, public-private, and civil society partnerships, building on the experience and resourcing strategies of partnerships	Data not available.
	Target 17.18 by 2020, enhance capacity building support to developing countries, including for LDCs and SIDS, to increase significantly the availability of high-quality, timely and reliable data disaggregated by income, gender, age, race, ethnicity, migratory status, disability, geographic location and other characteristics relevant in national contexts	Data not available.
	Target 17.19 by 2030, build on existing initiatives to develop measurements of progress on sustainable development that complement GDP, and support statistical capacity building in developing countries	Data not available.

Note: Cells in grey are those indicators that do not have required data. Among 169 targets, 61 targets are marked in grey and 108 targets are marked in orange indicating indicators identified with trackable data.

Source: Compiled by the authors.

Appendix II Centrality metrics of 108 SDG targets

Target	In-degree	Out-degree	Degree	Eigenvector	Closeness	Betweenness
1.1	19	23	42	0.519	0.532	28.715
1.2	20	26	46	0.501	0.543	84.206
1.3	22	22	44	0.533	0.527	58.433
1.5	27	22	49	0.628	0.543	156.278
2.1	24	18	42	0.618	0.486	64.552
2.2	27	22	49	0.470	0.510	218.888
2.3	43	35	78	1.000	0.585	618.391
2.4	31	36	67	0.608	0.594	479.364
3.1	12	14	26	0.247	0.478	31.580
3.2	11	7	18	0.235	0.437	5.479
3.3	17	17	34	0.355	0.502	35.540
3.4	11	8	19	0.181	0.440	15.804
3.5	5	5	10	0.082	0.433	0.745
3.6	4	4	8	0.087	0.435	1.331
3.7	12	8	20	0.178	0.461	32.288
3.8	16	22	38	0.321	0.510	52.705
3.9	10	7	17	0.192	0.457	19.451
4.1	18	34	52	0.373	0.557	159.334
4.2	12	7	19	0.294	0.448	25.514
4.3	5	12	17	0.068	0.450	20.731
4.4	13	15	28	0.199	0.473	53.946
4.5	13	15	28	0.243	0.473	45.934
4.6	7	24	31	0.121	0.514	34.348
4.7	9	21	30	0.129	0.535	72.715
5.1	27	28	55	0.525	0.538	198.944
5.2	15	10	25	0.289	0.469	53.912
5.3	11	4	15	0.164	0.423	7.094
5.4	18	21	39	0.411	0.514	71.550
5.5	16	16	32	0.305	0.510	66.369
5.6	9	5	14	0.132	0.428	6.079
6.1	39	42	81	0.867	0.611	436.198
6.2	44	52	96	0.801	0.656	1077.136
6.4	28	16	44	0.592	0.493	107.017
6.5	18	19	37	0.356	0.522	67.615
6.6	37	25	62	0.582	0.519	553.056
7.1	39	43	82	0.900	0.618	448.706
7.3	8	32	40	0.187	0.575	52.133
8.1	15	15	30	0.325	0.484	43.261
8.2	23	18	41	0.412	0.527	184.284
8.3	29	18	47	0.625	0.500	124.427

Target	In-degree	Out-degree	Degree	Eigenvector	Closeness	Betweenness
8.4	26	18	44	0.517	0.498	122.995
8.5	31	19	50	0.691	0.498	84.206
8.6	24	23	47	0.472	0.535	196.014
8.7	26	15	41	0.614	0.498	51.578
8.8	26	15	41	0.612	0.478	53.315
9.1	31	44	75	0.709	0.622	362.632
9.2	13	17	30	0.277	0.471	50.501
9.4	21	31	52	0.423	0.569	152.495
9.5	13	8	21	0.241	0.426	37.336
10.1	23	23	46	0.569	0.540	57.756
10.2	38	23	61	0.815	0.522	157.400
10.3	34	21	55	0.770	0.517	123.214
10.4	32	23	55	0.803	0.532	86.392
10.7	28	16	44	0.629	0.512	130.617
11.1	23	21	44	0.585	0.514	74.988
11.2	21	28	49	0.399	0.552	223.846
11.5	19	18	37	0.446	0.522	78.033
11.6	11	10	21	0.248	0.471	13.535
12.3	16	12	28	0.404	0.486	29.780
12.4	30	38	68	0.553	0.598	646.208
12.5	15	24	39	0.356	0.549	52.993
13.1	24	23	47	0.500	0.525	146.125
13.2	15	19	34	0.273	0.505	78.303
13.3	20	22	42	0.279	0.527	243.703
14.1	17	20	37	0.344	0.517	126.262
14.2	16	12	28	0.266	0.440	60.833
14.3	9	7	16	0.125	0.416	19.178
14.4	6	5	11	0.090	0.410	20.168
14.5	5	11	16	0.079	0.404	7.544
14.6	5	5	10	0.073	0.407	26.415
14.7	8	6	14	0.124	0.412	32.993
15.1	13	16	29	0.242	0.480	82.278
15.2	13	11	24	0.208	0.489	41.088
15.3	15	14	29	0.281	0.486	52.309
15.5	13	11	24	0.188	0.442	92.260
15.7	6	3	9	0.090	0.353	0.000
16.1	7	21	28	0.119	0.489	69.441
16.2	14	16	30	0.351	0.478	41.874
16.5	1	6	7	0.014	0.450	10.192
16.6	20	19	39	0.297	0.530	341.154
16.7	10	19	29	0.171	0.517	46.559
17.13	5	12	17	0.104	0.459	12.510
17.16	12	17	29	0.177	0.495	36.073
17.2	10	12	22	0.155	0.446	10.005

Target	In-degree	Out-degree	Degree	Eigenvector	Closeness	Betweenness
17.6	16	15	31	0.223	0.471	100.997
1.b	28	30	58	0.576	0.560	303.369
10.b	31	18	49	0.603	0.500	180.740
12.a	16	13	29	0.311	0.482	73.125
13.a	7	6	13	0.145	0.433	4.652
13.b	18	17	35	0.285	0.525	160.137
14.a	7	5	12	0.077	0.374	15.887
15.a	15	13	28	0.238	0.446	65.585
15.b	16	11	27	0.253	0.433	42.463
15.c	8	5	13	0.106	0.368	12.130
16.m	2	10	12	0.012	0.480	12.026
3.a	6	5	11	0.098	0.433	0.995
3.c	16	15	31	0.272	0.491	58.172
3.d	17	14	31	0.304	0.498	72.435
4.a	12	18	30	0.256	0.530	43.700
4.c	13	24	37	0.198	0.538	115.413
5.b	15	13	28	0.233	0.500	180.792
5.c	14	12	26	0.308	0.480	28.855
6.a	14	32	46	0.221	0.578	186.853
7.a	15	13	28	0.219	0.455	33.247
7.b	10	14	24	0.218	0.469	17.283
8.b	26	12	38	0.589	0.469	23.427
9.a	23	19	42	0.415	0.510	145.866
9.c	13	11	24	0.246	0.471	32.697

Appendix III Degree centrality metrics for quantified SDG interlinkages

	Bangladesh			China			India			Indonesia			Japan		
Target	In-degree	Out-degree	Degree	In-degree	Out-degree	Degree	In-degree	Out-degree	Degree	In-degree	Out-degree	Degree	In-degree	Out-degree	Degree
1.1	20.79	18.46	39.25	14.13	14.05	28.18	12.65	13.17	25.82	7.02	7.04	14.05	8.45	8.29	16.75
1.2	21.44	27.68	49.12	13.63	17.42	31.05	11.12	15.13	26.25	6.48	10.79	17.27	9.79	12.42	22.21
1.3	-0.55	1.38	0.84	12.26	14.14	26.40	8.03	10.92	18.94	5.40	6.53	11.92	5.78	8.19	13.97
1.5	13.79	10.79	24.58	-1.14	-0.78	-1.92	-3.44	-2.75	-6.19	3.11	3.59	6.70	-2.53	-1.60	-4.13
1.b	6.96	5.78	12.74	-1.97	-3.30	-5.27	5.39	4.86	10.25	6.24	4.97	11.21	4.84	4.35	9.18
2.1	9.32	6.25	15.56	9.07	6.59	15.67	9.89	7.33	17.22	5.68	2.94	8.62	6.49	4.99	11.49
2.2	11.70	9.96	21.66	9.18	8.13	17.31	-13.85	-13.41	-27.26	-0.84	-4.08	-4.92	9.12	9.85	18.96
2.3	27.72	19.95	47.67	16.06	10.34	26.40	13.78	7.84	21.62	14.28	10.39	24.67	-11.75	-9.50	-21.25
2.4	11.27	17.38	28.65	2.69	5.68	8.38	9.65	12.81	22.47	6.56	9.61	16.17	-8.83	-11.25	-20.08
3.1	14.23	13.32	27.55	11.18	7.53	18.71	9.19	7.97	17.16	7.60	8.79	16.39	7.66	9.19	16.86
3.2	11.89	10.58	22.47	8.21	6.22	14.43	6.79	4.55	11.34	5.01	3.21	8.23	6.50	4.41	10.92
3.3	10.40	14.36	24.76	8.77	10.52	19.29	10.73	10.68	21.41	-5.64	-4.68	-10.31	4.75	5.42	10.17
3.4	10.77	8.88	19.65	10.23	7.45	17.68	8.45	5.80	14.25	2.82	0.42	3.24	6.55	4.75	11.30
3.5	4.98	7.31	12.28	4.88	4.72	9.60	4.82	2.93	7.74	-2.44	-1.27	-3.71	3.80	2.70	6.49
3.6	4.33	6.70	11.03	3.83	3.68	7.51	3.69	1.83	5.52	2.08	0.85	2.92	3.28	2.59	5.88
3.7	9.42	7.84	17.26	6.05	3.41	9.45	3.92	1.93	5.85	7.66	3.50	11.16	5.79	3.82	9.61
3.8	6.53	7.92	14.45	9.20	10.05	19.25	8.80	10.02	18.82	3.24	3.56	6.81	-1.22	-4.08	-5.30
3.9	-1.69	-2.13	-3.81	-3.10	-1.89	-4.99	-3.44	-0.57	-4.01	0.24	1.96	2.20	-1.97	-0.70	-2.67
3.a	6.33	7.31	13.64	5.68	4.72	10.39	5.73	2.93	8.66	-1.91	-1.27	-3.19	4.48	2.70	7.17
3.c	18.14	17.20	35.34	5.66	6.86	12.53	6.64	8.64	15.28	5.97	8.07	14.03	8.79	9.83	18.62
3.d	14.52	16.30	30.82	3.84	7.01	10.84	5.91	9.08	14.98	4.72	8.45	13.17	7.91	9.20	17.11
4.1	13.55	18.17	31.72	11.31	13.72	25.03	8.21	15.72	23.93	8.53	12.91	21.44	8.06	9.66	17.71
4.2	14.62	10.24	24.86	9.01	5.91	14.92	5.19	3.70	8.89	6.98	4.58	11.56	4.09	1.63	5.72

	Bangladesh			China			India			Indonesia			Japan		
Target	In-degree	Out-degree	Degree	In-degree	Out-degree	Degree	In-degree	Out-degree	Degree	In-degree	Out-degree	Degree	In-degree	Out-degree	Degree
4.3	5.61	6.43	12.04	3.24	5.04	8.28	3.17	3.50	6.67	4.22	2.75	6.97	3.16	4.16	7.32
4.4	9.94	11.84	21.77	4.68	5.61	10.29	6.90	8.69	15.60	6.97	8.39	15.36	5.18	6.75	11.93
4.5	10.01	6.28	16.29	9.30	7.98	17.28	8.50	8.56	17.06	9.91	7.39	17.31	8.62	7.66	16.28
4.6	2.62	10.21	12.83	3.75	9.94	13.68	3.87	9.95	13.82	5.69	14.17	19.86	3.34	7.41	10.74
4.7	5.10	7.57	12.67	5.54	3.26	8.79	4.80	4.24	9.04	5.96	6.30	12.27	2.41	1.67	4.08
4.a	4.52	13.96	18.48	4.04	9.06	13.10	2.64	9.75	12.39	1.03	7.38	8.42	2.50	7.42	9.92
4.c	22.01	13.18	35.19	11.09	2.99	14.08	10.41	6.81	17.22	9.90	4.68	14.58	11.14	8.62	19.76
5.1	9.06	11.03	20.08	9.76	9.46	19.22	14.66	13.82	28.47	13.47	11.20	24.66	8.49	8.10	16.59
5.2	-2.43	-3.28	-5.71	-8.74	-5.83	-14.57	-8.23	-4.86	-13.09	-3.09	-0.68	-3.76	6.09	2.52	8.61
5.3	8.99	4.64	13.63	-7.70	-2.06	-9.76	6.89	3.01	9.89	6.74	2.24	8.98	7.15	2.15	9.30
5.4	7.00	5.83	12.82	12.70	10.36	23.07	10.55	11.04	21.58	5.01	5.88	10.89	10.14	9.67	19.81
5.5	9.20	11.13	20.33	7.42	6.05	13.47	9.42	7.39	16.81	8.21	3.91	12.12	7.68	6.48	14.17
5.6	9.13	5.28	14.41	3.88	1.85	5.73	2.28	1.23	3.51	4.59	2.89	7.48	5.43	3.13	8.56
5.b	17.16	15.73	32.89	10.09	8.12	18.21	10.28	9.59	19.88	6.00	5.23	11.23	6.68	4.87	11.55
5.c	7.86	8.28	16.14	8.16	6.89	15.05	9.83	9.88	19.71	9.12	8.66	17.78	7.65	6.85	14.50
6.1	12.14	24.41	36.55	9.55	13.34	22.88	13.19	13.59	26.78	3.44	3.48	6.92	0.74	6.44	7.18
6.2	22.55	37.72	60.27	11.04	19.78	30.82	17.07	22.00	39.07	5.80	11.30	17.10	9.23	12.34	21.57
6.4	-11.88	-7.83	-19.71	-7.41	-5.48	-12.89	-9.02	-4.91	-13.93	-2.33	-3.78	-6.11	-0.46	0.38	-0.08
6.5	-6.01	-2.16	-8.18	-5.44	-6.53	-11.97	-4.91	-7.33	-12.24	-4.43	-3.92	-8.35	1.02	9.25	10.26
6.6	24.70	15.82	40.52	13.15	5.02	18.17	12.48	5.22	17.70	11.57	2.94	14.51	11.13	14.59	25.72
6.a	9.31	-6.24	3.07	1.97	-7.63	-5.66	5.39	-4.29	1.10	7.10	-0.35	6.76	5.81	2.57	8.38
7.1	20.19	21.92	42.11	11.89	11.40	23.29	14.60	18.10	32.70	9.58	9.26	18.84	6.37	5.61	11.98
7.3	1.30	13.36	14.66	2.85	5.83	8.68	3.82	11.73	15.54	2.65	4.54	7.20	-1.69	7.97	6.28
7.a	21.94	21.15	43.09	9.26	9.27	18.52	9.83	9.89	19.72	11.05	11.04	22.09	10.15	10.59	20.74
7.b	9.47	8.65	18.12	5.59	5.50	11.09	6.94	6.90	13.84	2.76	2.75	5.51	5.11	3.38	8.49
8.1	14.47	10.67	25.14	9.32	6.64	15.96	10.19	7.75	17.94	7.65	3.01	10.66	5.98	1.78	7.76
8.2	6.50	1.10	7.60	-7.25	-4.38	-11.62	10.01	6.39	16.39	-5.05	-1.31	-6.36	-0.65	3.27	2.63

	Bangladesh			China			India			Indonesia			Japan		
Target	In-degree	Out-degree	Degree	In-degree	Out-degree	Degree	In-degree	Out-degree	Degree	In-degree	Out-degree	Degree	In-degree	Out-degree	Degree
8.3	5.19	3.13	8.32	2.59	1.56	4.16	2.59	1.56	4.16	2.59	1.56	4.16	2.59	1.56	4.16
8.4	17.24	14.15	31.38	7.77	5.78	13.55	11.42	8.16	19.57	5.42	4.71	10.13	7.46	3.54	11.01
8.5	-3.78	1.64	-2.14	-10.37	-5.47	-15.83	-9.22	-4.47	-13.70	13.14	7.34	20.48	9.25	3.30	12.55
8.6	-1.41	0.63	-0.78	-4.60	-5.34	-9.95	-5.77	-6.43	-12.20	9.13	9.60	18.73	8.74	7.09	15.83
8.7	4.61	3.12	7.73	2.30	1.56	3.87	2.30	1.56	3.87	2.30	1.56	3.87	2.30	1.56	3.87
8.8	6.10	3.32	9.42	3.05	1.66	4.71	3.05	1.66	4.71	3.05	1.66	4.71	3.05	1.66	4.71
8.b	-1.86	1.95	0.09	-6.91	-2.49	-9.40	-6.25	-1.66	-7.91	10.47	5.32	15.80	8.00	2.01	10.01
9.1	17.80	29.36	47.16	10.79	15.67	26.46	12.11	19.67	31.78	5.15	10.79	15.94	12.87	13.88	26.76
9.2	6.21	2.96	9.17	-3.04	0.12	-2.92	6.46	1.25	7.71	-6.95	-3.06	-10.01	-0.62	-3.82	-4.44
9.4	-15.66	-12.75	-28.41	-9.84	-6.57	-16.40	-11.93	-10.87	-22.80	-5.85	-6.03	-11.88	0.06	-0.88	-0.82
9.5	9.38	4.14	13.53	6.48	1.97	8.44	6.18	3.02	9.20	0.27	5.19	5.46	4.65	3.65	8.30
9.a	12.26	12.80	25.06	1.35	3.83	5.18	5.43	6.74	12.16	8.96	10.69	19.65	7.51	6.68	14.19
9.c	13.47	9.71	23.19	8.76	5.28	14.03	9.57	6.67	16.24	6.66	3.74	10.39	7.33	1.97	9.30
10.1	11.51	9.37	20.88	-3.75	-3.19	-6.95	-16.05	-11.29	-27.34	-12.53	-10.75	-23.27	5.07	4.91	9.98
10.2	12.22	7.05	19.27	12.00	9.14	21.15	18.82	12.15	30.97	16.32	13.61	29.93	7.36	5.17	12.53
10.3	10.87	7.00	17.87	12.48	8.19	20.67	19.92	10.37	30.29	19.59	11.90	31.49	7.76	5.07	12.83
10.4	-6.87	-1.78	-8.64	18.28	13.00	31.27	20.63	14.31	34.94	6.46	5.05	11.50	11.98	9.83	21.82
10.7	3.62	0.13	3.75	10.85	6.14	17.00	13.21	5.34	18.56	-7.00	-3.70	-10.70	-1.55	-0.36	-1.90
10.b	5.51	11.82	17.33	-4.57	4.17	-0.40	2.23	7.06	9.29	0.12	5.26	5.38	4.22	6.51	10.73
11.1	19.29	14.72	34.02	13.81	11.02	24.83	12.23	11.62	23.84	6.10	5.36	11.45	7.63	7.49	15.12
11.2	16.31	15.82	32.13	8.11	10.78	18.89	11.47	14.48	25.95	-1.93	-1.23	-3.17	9.10	12.08	21.18
11.5	10.21	10.07	20.29	-0.88	-0.29	-1.18	-3.12	-2.31	-5.43	-0.15	0.65	0.49	-1.31	-0.86	-2.17
11.6	-5.85	-3.95	-9.81	-3.86	-2.26	-6.12	-5.64	-4.50	-10.14	-2.26	0.28	-1.98	-2.16	-0.54	-2.70
12.3	2.15	2.12	4.27	-7.34	-7.30	-14.64	6.21	6.13	12.34	-5.19	-5.06	-10.25	-0.90	0.40	-0.51
12.4	25.15	23.89	49.03	14.03	14.08	28.11	17.24	16.91	34.15	7.06	6.26	13.32	10.04	13.90	23.94

	Bangladesh			China			India			Indonesia			Japan		
Target	In-degree	Out-degree	Degree	In-degree	Out-degree	Degree	In-degree	Out-degree	Degree	In-degree	Out-degree	Degree	In-degree	Out-degree	Degree
12.5	7.14	8.87	16.01	5.42	3.40	8.81	7.78	9.08	16.85	4.53	3.90	8.44	3.79	7.02	10.81
12.a	8.89	7.69	16.58	4.61	3.57	8.18	4.68	2.57	7.25	2.38	4.12	6.50	3.71	3.43	7.14
13.1	10.67	11.47	22.14	-0.83	-1.05	-1.89	-3.20	-2.83	-6.04	0.34	1.24	1.57	-3.33	-1.81	-5.13
13.2	9.38	6.41	15.79	4.69	3.20	7.89	7.79	7.93	15.72	7.30	7.81	15.11	3.07	2.58	5.65
13.3	18.34	15.38	33.73	9.17	7.69	16.86	13.39	12.40	25.79	11.07	10.66	21.73	3.06	2.31	5.37
13.a	7.63	6.49	14.12	3.81	3.24	7.06	6.40	5.55	11.95	6.32	5.49	11.82	2.81	3.11	5.92
13.b	12.57	9.78	22.35	6.28	4.89	11.18	12.68	12.18	24.86	13.22	12.45	25.66	4.02	4.20	8.22
14.1	15.56	20.84	36.39	6.63	9.65	16.28	8.67	12.08	20.75	2.92	6.10	9.02	8.01	10.64	18.65
14.2	17.48	15.79	33.27	6.48	6.47	12.95	4.35	3.94	8.29	4.54	4.37	8.91	9.40	5.93	15.34
14.3	5.96	7.83	13.79	2.98	3.92	6.90	3.99	5.18	9.17	3.81	5.27	9.08	2.45	3.18	5.63
14.4	7.07	8.43	15.50	3.99	4.99	8.98	2.02	1.02	3.05	2.00	3.00	5.00	2.13	1.14	3.28
14.5	4.02	10.66	14.67	1.02	5.02	6.04	1.42	5.82	7.24	1.20	3.39	4.58	4.60	10.12	14.72
14.6	6.44	8.43	14.88	3.00	4.99	7.98	1.03	1.02	2.06	3.00	3.00	6.00	3.13	1.14	4.27
14.7	10.87	10.98	21.85	5.62	5.81	11.43	-1.10	-1.53	-2.62	2.04	4.01	6.05	4.11	3.13	7.25
14.a	7.17	6.96	14.14	3.69	3.65	7.34	2.52	2.68	5.21	3.00	2.90	5.90	3.50	3.44	6.94
15.1	1.00	-7.09	-6.10	-4.90	-9.28	-14.18	-5.69	-3.69	-9.38	-3.22	-7.88	-11.10	8.23	9.31	17.55
15.2	7.89	4.30	12.19	2.36	1.55	3.91	5.62	5.38	10.99	3.86	3.29	7.15	3.02	0.45	3.48
15.3	-1.23	-1.53	-2.76	6.74	5.76	12.49	6.88	5.86	12.74	-7.21	-6.22	-13.43	5.68	3.13	8.81
15.5	17.64	14.66	32.30	8.62	6.84	15.46	7.35	5.51	12.86	7.45	7.54	14.99	8.22	4.60	12.81
15.7	11.97	6.00	17.97	6.00	3.00	9.00	5.97	3.00	8.97	5.99	3.00	8.99	4.14	3.00	7.14
15.a	15.63	18.39	34.03	7.06	9.02	16.08	8.28	9.42	17.70	7.57	9.20	16.78	12.55	11.80	24.35
15.b	14.28	18.65	32.93	6.08	9.02	15.10	7.70	9.42	17.12	6.76	9.19	15.95	12.99	10.61	23.60
15.c	15.89	9.91	25.80	8.00	5.00	13.00	5.98	3.00	8.98	7.99	5.00	12.99	6.14	5.00	11.14
16.1	0.58	-2.30	-1.71	3.01	9.38	12.39	2.52	7.21	9.73	1.58	1.99	3.57	3.57	7.65	11.23
16.2	3.55	0.86	4.42	4.74	4.85	9.60	3.22	4.93	8.15	2.00	3.25	5.25	5.59	7.01	12.61

	Bangladesh			China			India			Indonesia			Japan		
Target	In-degree	Out-degree	Degree	In-degree	Out-degree	Degree	In-degree	Out-degree	Degree	In-degree	Out-degree	Degree	In-degree	Out-degree	Degree
16.5	2.00	2.62	4.62	1.00	0.54	1.54	1.00	-0.27	0.73	1.00	0.19	1.19	1.00	-0.60	0.40
16.6	4.36	1.17	5.53	9.24	10.84	20.08	-8.02	-9.81	-17.83	-9.78	-9.86	-19.65	-10.50	-9.42	-19.91
16.7	10.77	9.41	20.19	7.07	2.86	9.93	7.75	5.10	12.85	7.67	7.16	14.83	5.87	5.47	11.34
16.10	2.60	6.46	9.06	1.97	6.00	7.97	0.03	4.09	4.13	0.02	2.88	2.89	0.01	4.62	4.63
17.1	-0.74	1.04	0.31	0.71	-0.53	0.17	-0.33	2.02	1.69	-2.13	1.87	-0.26	-0.90	4.70	3.81
17.2	18.35	19.20	37.55	8.82	9.19	18.00	9.20	9.96	19.16	10.22	11.02	21.24	9.29	10.99	20.28
17.2	20.00	21.34	41.34	10.00	11.94	21.94	10.00	11.57	21.56	10.00	11.28	21.28	10.00	11.15	21.15
17.6	6.40	6.88	13.28	2.20	3.10	5.31	3.15	3.82	6.96	4.68	3.83	8.50	2.16	2.85	5.01

About IGES

The Institute for Global Environmental Strategies (IGES), established in March 1998 under an initiative of the Japanese government, is an international research institute conducting solution-oriented and innovative policy research for realising sustainable development both in the Asia-Pacific region and globally. IGES research focuses on climate change and energy, sustainable consumption and production, natural resource management, strategic and quantitative analysis, and sustainable governance.

Contact

Dr. Xin Zhou
Principal Policy Researcher and Research Leader
Strategic and Quantitative Analysis Centre
Institute for Global Environmental Strategies (IGES)
2108-11 Kamiyamaguchi, Hayama, Kanagawa, 240-0115 Japan
Tel. + 81-46-855-3863
E-mail: zhou@iges.or.jp
URL: http://www.iges.or.jp

June 2017

IGES Publication Code RR1602

ISBN978-4-88788-199-0