



Report on Local Evaluation and Prospect of Sustainable Development Goals in China:

—Based on Provincial Data from 2004 to 2017

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TUSDG Introduction

Housed in the School of Public Policy and Management in Tsinghua University, the Institute for Sustainable Development Goals of Tsinghua University (TUSDG) was founded on May 14, 2017. It aims to establish a leading platform to conduct interdisciplinary research and collaborate with global partners to address challenges in implementing UN Sustainable Development Goals (SDGs). By integrating theoretical learning and practical experience in the field, TUSDG strives to cultivate a new generation of talent who is dedicated to the implementation of SDGs and the improvement of global governance. In addition, TUSDG will make every effort at creating a high-end open platform in the research field of SDGs, attracting world-class experts and scholars to engage in teaching and research activities. Finally, TUSDG aspires to become a leading think tank in China on SDG-related policies through cooperative partnerships with relevant government agencies.





WWF Introduction

World Wide Fund for Nature is one of the world's largest and most respected independent organizations dedicated to the conservation of nature. Since the first office was founded in Switzerland in 1961, WWF has grown into a global network active in more than 100 countries with almost five million supporters. WWF's Mission is to stop the degradation of the planet's natural environment and to build a future in which humans live in harmony with nature.



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Abstract

Sustainable development has become essential in today's human society. In September 2015, United Nations Sustainable Development Summit adopted Transforming our World: The 2030 Agenda for Sustainable Development (the 2030 Agenda), which was jointly agreed by the 193 member states of the United Nations. This agenda is another guiding document on the global development process following the United Nations Millennium Declaration. The 2030 Agenda contains 17 Sustainable Development Goals (SDGs), 169 Targets and 232 Indicators¹, which spans the economic, social and environmental dimensions and provides a new road map and weather vane for global development. However, in view of the fuzziness of the Goals and indicators, the complexity and magnitude of the indicator framework and the difficulty of access to data, the monitoring of SDGs mainly stays at the global and national level, and regional monitoring is still facing challenges. In particular, the evaluation work that follows the framework of SDGs and pays attention to regional disparities has always been inadequate.

In order to promote the localization of SDGs, the China's regional Sustainable Development Goals are measured, monitored and prospected in this report on the basis of the original SDG framework and China's provincial economic and social statistics from 2004 to 2017. Drawing on the World Competitiveness Index of the International Institute for Management Development (IMD), the report constructs an indicator system of China's provincial Sustainable Development Goals, which covers 74 indicators under the framework of 14 Goals from 2005 to 2016, calculates China's Provincial Sustainable Development Goal Index (CPSDGI) which includes one Total SDG Index and fourteen SDG Indices (SDG1 Index to SDG17 Index) and reveals the regional progress of Goal 15 (Life on Land) for 2004-2017. Based on the composite index and quantitative analysis, this report evaluates the current situation of China's provincial Sustainable Development Goals, diagnoses the development gaps between SDGs and among regions, and provides relevant policy recommendations.

Through the monitoring of China's provincial Sustainable Development Goals, the findings of the report are as follows: First, from the perspective of the analysis under the framework of 14 Goals from 2005 to 2016, the development between the provincial SDGs is unbalanced, and there are long-term development weaknesses in each province; the imbalance in the development of public services among provinces is more prominent compared with that in economic development; unlike the development gap among provinces, the disparity between three belts (the East, the Middle and the West of China) shortens with time; the provincial development gap in gender equality remains unchanged, while the gap in economic equality among three belts keeps narrowing; among all the SDGs, the development of SDG9 are the most unbalanced. Second, the analysis of Goal 15 (Life on Land) from 2004 to 2017 indicates the differences of the provincial natural endowments in China. To begin with, the difference in life on land among provinces have gradually reduced in the past 20 years, which has something to do with the regional ecological input. Despite that all provinces attached importance to the improvement of terrestrial ecosystems, ecological output indicators still show a strong positive spatial agglomeration phenomenon due to the insurmountable difference in natural endowments; in the long run, the difference in natural endowments of provinces is not going to disappear but every province's development of Goal 15 (Life on Land) can be vertically and effectively influenced by sustainable ecological input.

Based on the research results, the policy suggestions have been put forward: First, in order to boost the SDG localization and make the 2030 Agenda further serve China's high-quality development, it is suggested that more localized SDG indicators should be incorporated into China's development goal system of the 14th Five-Year Plan in accordance with China's national conditions and development priorities. In view of China's current unbalanced development, the design of the index system should fully take into account the difference in China's regional development. Emphasis should be placed on the classified monitoring of Goals 13 (Climate Action) and 14 (Life Below Water), as well as on the vertical comparison of Goal 15 (Life on Land) and international communication and cooperation. SDGs and the index system should be measurable, implementable, statistical, monitorable, evaluable, assessable, summarizable and communicable. Second, efforts should be made to strengthen domestic policy support and mechanism building, and take a multi-pronged approach to advance the local sustainable development agenda. At the policy level, the 17 SDGs and their targets and indicators should be strengthened to link up with relevant policies in the 14th Five-Year Plan and China's national conditions, so as to form an effective policy system led by central policies and supported by special and local policies. In conjunction with this, an incentive mechanism should be established for local governments to implement the 2030 Agenda. Third, social participation and international cooperation should be encouraged for experience sharing with the world, which should not only give full play to the think-tank role of universities and scientific research institutes to realize cross-disciplinary and cross-regional cooperation, but also strengthen the convergence between SDGs and domestic and international development plans. Special attention should be paid to the use of internationally comprehensible words to share China's experience.

The report is of great significance for China to achieve SDGs in the future. It can provide data support and evaluation methods of SDGs for China's central and local decision-making departments. Besides, the research results can also offer policy reference to the compilation of China's 14th Five-Year Plan and the realization of the 2030 Agenda at the national and local levels. Following this way, China's experience can be shared with countries around the world to bolster international exchange.

¹According to the 51st Statistical Commission in March 2020, the final indicator framework includes 231 unique indicators.



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Action), Goal 14 (Life Below Water), Goal 15 (Life on Land), Goal 16 (Peace, Justice and Strong Institutions) and Goal 17 (Partnerships for the Goals). In terms of content, the SDGs span the dimensions of economy, society and environment, and it is a huge indicator framework with 17 first-level Goals and 169 second-level targets. As of March 2017, the structure of SDGs was identified by the United Nations Inter-Agency and Expert Group on Sustainable Development Goal Indicators (IAEG-SDGs) and the United Nations Statistical Commission as 17 Goals, 169 targets and 232 indicators. In order to facilitate monitoring, IAEG-SDGs classifies all indicators into three tiers. In Tier 1, indicator is conceptually clear, has an internationally established methodology and standards are available, and data are regularly produced by countries for at least 50 percent of countries and of the population in every region where the indicator is relevant; in Tier 2, indicator is conceptually clear, has an internationally established methodology and standards are available, but data are not regularly produced by countries; in Tier 3, no internationally established methodology or standards are yet available for the indicator, but methodology/standards are being (or will be) developed or tested. As of December 11, 2019, the updated tier classification contains 116 Tier I indicators, 92 Tier II indicators, 20 Tier III indicators and 4 indicators that have multiple tiers (different components of the indicator are classified into different tiers).

Compared with MDGs, SDGs has been adjusted in its object, goal, negotiation process and implementation approach. SDGs mainly contain the economic, social and environmental goals, with the characteristics of universality, relevance, comprehensiveness, participation and inclusiveness. In terms of objects, MDGs are generally goals for developing countries, while SDGs are applicable for all countries, and each country can adjust according to its own situation. Regarding goals, MDGs are 8 separate goals, while SDGs consist of 17 Goals and 169 Targets, which integrates the economic, social and environmental dimensions of sustainable development and are interrelated. In the process of consultation, MDGs are the coordination product of the United Nations Secretariat, while SDGs are the fruit of UN member states through three years of negotiations, in which stakeholders have participated in the discussions, and each country could formulate and implement SDG policies according to its own situation. On the implementation side, MDGs mainly focus on North-South funding, but related reports and follow-up reviews are insufficient; SDGs instead have a relatively good global architecture for monitoring, follow-up and review with the market access, technology transfer, capacity development and policy support. SDGs have made corresponding improvements from the experiences and lessons of MDGs, but how to implement the 2030 Agenda and achieve all 17 SDGs is no small issue. SDGs have numerous targets and indicators, some of which are still controversial. Additionally, there are gaps in funds, facilities and technology in the implementation of SDGs. How to collect the data needed by SDG indicators and track and monitor the implementation of the indicators in time is also a big challenge.

1. Background of the 2030 Agenda

Sustainable development has become essential in today's human society. On the basis of summarizing the implementation of the Millennium Development Goals (MDGs) from 2000 to 2015, world leaders adopted Transforming our World: The 2030 Agenda for Sustainable Development at the United Nations Sustainable Development Summit in September 2015, with 17 Sustainable Development Goals (SDGs) covered. The 2030 Agenda and the 17 SDGs reaching at the United Nations through intergovernmental consultations aimed at guiding the global development process by 2030 and providing a new road map and weather vane for development.

The 17 SDGs covering multiple dimensions mainly refer to Goal 1 (No Poverty), Goal 2 (Zero Hunger), Goal 3 (Good Health and Well-being), Goal 4 (Quality Education), Goal 5 (Gender Equality), Goal 6 (Clean Water and Sanitation), Goal 7 (Affordable and Clean Energy), Goal 8 (Decent Work and Economic Growth), Goal 9 (Industry, Innovation and Infrastructure), Goal 10 (Reduced Inequality), Goal 11 (Sustainable Cities and Communities), Goal 12 (Responsible Consumption and Production), Goal 13 (Climate



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2. Purpose and Significance

Regional monitoring that follows the original framework of SDGs is relatively rare. The 2030 Agenda covers 17 interrelated Goals, 169 targets and 232 indicators, but in view of the fuzziness of its indicators, the complexity and magnitude of the indicator framework and the difficulty of obtaining data, the current monitoring of SDGs is basically at the global and national level, and regional monitoring within countries is still facing challenges. Assessments that follow the framework of SDGs are also rare. In the monitoring framework, most studies still rely on the traditional path of sustainable development evaluation, namely the Domain based Framework, which draws the framework according to the main sustainable directions (economic, social, environmental, etc.) (Yang Ling et al., 2007), and then carries on the exponential fitting. Therefore, it is necessary to monitor the regional SDGs on the basis of following the original framework.

Regional monitoring should focus more on regional disparities than on regional rankings or the realization of target values set by certain standard. From the existing research, on the one hand, the implementation of SDGs is essentially a political behavior at the national level, not at the regional level, where there lacks data to correspond to the huge indicator framework of SDGs. On the other hand, the rankings of target performance at the national level can urge countries to take responsibility for the implementation of SDGs; but at the regional level, the rankings are no more suitable for liability supervision, at the same time, if the target value is in accordance with the international standard rather than the national standard, it will be meaningless at the local level. Therefore, monitoring at the national level should pay more attention to ranking and target values, as the alignment of rankings and target values is directly related to the achievement of SDGs; monitoring at the regional level ought to pay more attention to regional disparities, since it is also in line with the spirit of SDGs.

It is essential to further consider the SDG implementation progress of China's provinces. As the largest developing country, China has a vast territory, a large population and obvious regional differences. To fully implement China's SDGs, there is need to further consider the implementation at the regional level. As the highest level of local government in China, the provincial government plays a coordinating role in the relationship between the central and local governments, which enables the central policies to be implemented in cities, counties and even townships. On the basis of following the original framework of 17 SDGs, this report calculates China's Provincial Sustainable Development Goal Index, explores the localized measurement and monitoring of SDGs, and reveals the regional sustainable development differences and inter-provincial disparities in China from 2004 to 2017. Specifically, this report includes regional SDG monitoring under the framework of 14 goals from 2005 to 2016 and that under Goal 15 from 2004 to 2017.

The report is of great significance for China to achieve SDGs in the future. It can provide data support and evaluation methods of SDGs for China's central and local decision-making departments. Besides, the research results can also offer policy reference to the compilation of China's 14th Five-Year Plan and the realization of the 2030 Agenda at the national and local levels. Following this way, China's experience can be shared with countries around the world to bolster international exchange.



3. China's Implementation of the 2030 Agenda during the 13th Five-Year Plan Period

As a major and responsible country, China attaches great importance to the 2030 Agenda and the SDGs. The 2030 Agenda is considered to be highly compatible with the purposes and spirit of ecological civilization, the Belt and Road Initiative and South-South cooperation. To this end, China has adopted a raft of related policy documents, and has actively implemented work at the national, regional and international levels.

3.1 National Level

As the largest developing country in the world, China has always pursued development as its top priority and put ecological environment protection in a prominent position. During the 13th Five-Year Plan period, China has taken realizing sustainable development and promoting the construction of ecological civilization as its fundamental national policy. In order to implement the 2030 Agenda, the Chinese government has taken a series of actions in the areas of top-level design, strategic docking, mechanism guarantee, international exchanges and South-South cooperation, on which China has made positive progress. China has established a domestic coordination mechanism to implement the 2030 Agenda, which is led by the Ministry of Foreign Affairs of the People's Republic of China and based on the cooperation of 43 government departments. "Actively implementing the 2030 Agenda for Sustainable Development" has been incorporated into Chapter 53 (Assume International Responsibilities and Obligations) in the 13th Five-Year Plan for Economic and Social Development of the People's Republic of China. China combines the implementation of the 2030 Agenda, the 13th Five-Year Plan and the national medium

- and long-term development strategy, guided by the vision of innovative, coordinated, green, open and inclusive development. The 13th Five-Year Plan also clearly proposes to promote green development that enriches the country and benefits the people, provide more high-quality ecological products for the people, develop eco-friendly growth model and ways of life, and continue the Beautiful China initiative. During the 13th Five-year Plan period, China has established four types of performance targets: economic development target (4 indicators), innovation-driven target (4 indicators), people's well-being target (7 indicators) and resources and environment target (10 indicators). Among them, 12 are anticipated indicators and 13 are obligatory indicators. There are 15 Sustainable Development Goals (except SDG5 and SDG10) as well as their targets and indicators in the 2030 Agenda can be linked with the 25 indicators of the 13th Five-Year Plan.

The Chinese government has launched a host of initiatives from the aspects of top-level design, strategic docking and mechanism guarantee, and incorporated the 2030 Agenda into the 13th Five-Year Plan and the country's medium - and long-term overall development plan. For example, in the economic field, the Chinese government has formulated Outline of the National Strategy of Innovation-Driven Development and Outline of National Agricultural Sustainable Development (2015-2030). In the social field, The Decision on Winning the Battle Against Poverty and the Outline of Health China have been issued. In the field of environment, China National Biodiversity Conservation Strategy and Action Plan (2015-2030) and National plan of Tackling Climate Change (2014-2020)

have been prepared. Furthermore, China has also formulated a raft of relevant policies that can be linked with the SDGs and their targets. For example, for Goal 1, the 13th Five-Year Plan has taken poverty alleviation as an important development goal. For Goal 2 (Zero Hunger), China implements Outline of National Agricultural Sustainable Development (2015-2030) (target 2.4). For Goal 5 (Gender Equality), China adopts the Outline for the Development of Chinese Women, the Outline for the Development of Chinese Children (target 5.1), and enforces Marriage Law of the Peoples Republic of China (target 5.3), the Law of the People's Republic of China on the Protection of Rights and Interests of Women, Law of the People's Republic of China on the Protection of Minors, the Anti-Domestic Violence Law of the People's Republic of China (target 5.c). For Goal 6 (Clean Water and Sanitation), China formulates the Action Plan for Water Pollution Prevention and Control (target 6.3). For Goal 8 (Decent Work and Economic Growth), China implements Made in China 2025 strategy (target 8.2), 10-Year Framework of Programmes on Sustainable Consumption and Production Patterns (10YFP) (target 8.4), Employment Promotion Law of the People's Republic of China (target 8.5), National Plan of Anti-Trafficking Action (2013-2020) (target 8.7) and the Plan for Promoting the Development of Financial Inclusion (2016-2020) (target 8.10). For Goal 9 (Industry, Innovation and Infrastructure), China adopts Made in China 2025 (target 9.2), the Plan for Promoting the Development of Financial Inclusion (2016-2020) and Outline of the National Strategy of Innovation-Driven Development (target 9.5). For Goal 11 (Sustainable Cities and Communities), China enforces Law of the People's Republic of China on the Protection of Cultural Relics, Intangible cultural heritage law of the People's Republic of China, Regulations on Scenic and Historic Areas, Regulation on Museums (target 11.4), Emergency Response Law of the People's Republic of China, Regulations on the Prevention and Control of Geological Hazards, Meteorology Law of the People's Republic of China, Law of the People's Republic of China on Road Traffic Safety (target 11.5). For Goal 13 (Climate Action), China implements Work Plan for Controlling Greenhouse Gas Emissions during the 13th Five-Year Plan (target 13.2). For Goal 14 (Life Below Water), China implements Regulations on the Administration of Fishery Fishing License (target 14.6). For Goal 15 (Life on Land), China enforces Law of the People's Republic of China on the Protection of Wildlife and improves List of Wildlife under Special State Protection (target 15.7). For Goal 16 (Peace, Justice and Strong Institutions), China implements Outline for children development (2011-2020), Outline for children development (2021-2030), and enforces Law of the Protection of Minors (target 16.2), Regulations on Household Registration and Law of the People's Republic of China on Resident Identity Cards (target 16.9).

China has adopted a raft of policies and reports related to the 2030 Agenda, which provide policy guidance for the implementation of the 2030 Agenda and SDGs. In March 2016, China issued the 13th Five-Year Plan for Economic and Social Development of the People's Republic of China and regards the active implementation of the 2030 Agenda as its own international responsibility and obligation. In April 2016, China adopted China's Position Paper on the Implementation of the 2030 Agenda for Sustainable Development. In September 2016, the G20 Summit held in Hangzhou promoted G20 Action Plan on the 2030 Agenda for Sustainable Development. In October 2016, China formulated

China's National Plan on Implementation of the 2030 Agenda for Sustainable Development, proposing specific plans and actions. In December 2016, China issued China's Construction Plan on National Innovation Demonstration Zone of Implementation of the 2030 Agenda for Sustainable Development. In August 2017, China published China's Progress Report on Implementation of the 2030 Agenda for Sustainable Development, which assessed the progress of China's sustainable development. In September 2019, China released China's Progress Report on Implementation of the 2030 Agenda for Sustainable Development 2019, revealing how SDGs were achieved in cases like poverty alleviation, innovation-driven development, ecological civilization construction, rural revitalization, and co-building of the Belt and Road Initiative.

3.2 Local Level

In accordance with the overall national strategy and the achievements of the UN Development Summit, China's local governments have actively pushed ahead with many tasks related to SDGs, actively promoting local ecological civilization construction and sustainable economic and social development. First, the establishment of ecological civilization pilot zone is an innovative measure for provincial units to practice sustainable development. In August 2016, the General office of CCCPC and General Office of the State Council of the People's Republic of China published Opinions on Establishing a Unified and Standardized National Ecological Civilization Pilot Zone and the Implementation Plan for the National Ecological Civilization Pilot Zone (Fujian). In October 2017, China adopted The Implementation Plan for the National Ecological Civilization Pilot Zone (Jiangxi) and The Implementation Plan for the National Ecological Civilization Pilot Zone (Guizhou). In May 2019, The Implementation Plan for the National Ecological Civilization Pilot Zone (Hainan) was released. In general, the ecological civilization pilot zone has laid the foundation for implementing the comprehensive experiment of ecological civilization system reform and improving the ecological civilization system.

Second, a number of Innovation Demonstration Zones for Implementation of Sustainable Development Goals have been set up, which indicates that China's local governments are actively carrying out the demonstration work of implementing the 2030 Agenda. In December 2016, the State Council of the People's Republic of China issued China's Construction Plan on National Innovation Demonstration Zone of Implementation of the 2030 Agenda for Sustainable Development. In March 2018, Guilin in Guangxi province, Shenzhen in Guangdong province and Taiyuan in Shanxi province became the first National Innovation Demonstration Zones for Implementation of SDGs. To implement the Construction plan, Guilin, Guangxi has tried to exert the demonstration effect of sustainable development in the multi-ethnic and ecologically fragile areas of the Middle and the West of China; Shenzhen, Guangdong has strived to take on the demonstration effect of sustainable development of super large cities. Taiyuan, Shanxi has made it the mission to explore the demonstration effect of economic transformation of resource-based regions. In May 2019, Chenzhou in Hunan province, Lincang in Yunnan province and Chengde in Hebei province became the second batch of National Innovation Demonstration Zones. With the theme of sustainable use of water resources and green development, Chenzhou, Hunan carried out

themed activities on sustainable use of water resources and green development to enhance water safety; Lincang, Yunnan demonstrates how innovation-driven development can be realized in a multi-ethnic underdeveloped areas; Chengde, Hebei aims to build lucid waters and lush mountains with the theme of sustainable development of water conservation function areas in urban agglomerations.

Third, some municipal local units in China have launched a host of initiatives with their own characteristics on the implementation of the 2030 Agenda. In July 2018, Guiyang in Guizhou province held the forum on Synergy between the 2030 Agenda for Sustainable Development and the Green “Belt and Road”. For the first time at home and abroad, Deqing in Zhejiang province used geographic information to quantitatively evaluate and comprehensively analyze the sustainable development of a county, and issued Progress Report on the Implementation of the 2030 Agenda for Sustainable Development of Deqing (2017). In 2019, Deqing won the “Geospatial World Excellence Awards” at the 2019 World Geospatial Forum. In August 2019, Shenzhen was approved to build a frontier demonstration zone for socialism with Chinese characteristics, striving to become a highland of quality development, a model for the rule of law and urban civilization, a benchmark for citizens’ well-being, and a pioneer of sustainable development. In November 2019, Ningbo in Zhejiang Province held the “Ningbo forum 2017 (Local Implementation of the 2030 Agenda for Sustainable Development landscapes for community revival)”.

3.3 International Level

China combines the 2030 Agenda with the Belt and Road Initiative strategy to promote the sustainable development process of countries along the routes. Through the United Nations and other international platforms, China has made substantive commitments and expressions to the environment, society, peace and security, and international cooperation. At the G20 summit, China actively promoted the 2030 Agenda as the core agenda. China actively implements the relevant international treaties. Specifically Speaking, for Goal 3 (Good Health and Well-being), China implemented World Health Organization Framework Convention on Tobacco Control (WHO FCTC) (target 3.a). For Goal 14 (Life Below Water), China supports the implementation Guidelines on the Transfer of Marine Technology (target 14.a) of the Intergovernmental Oceanographic Commission’s Criteria and United Nations Convention on the Law of the Sea (target 14.c). For Goal 15 (Life on Land), China participates in the United Nations Convention to Combat Desertification (UNCCD) (target 15.3) and Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) (target 15.c). For Goal 17 (Partnerships for the Goals), China pushes for the implementation of the Addis Ababa Action Agenda (target 17.2), the Agreement on Trade Facilitation (target 17.11), and the formulation of the G20 Action Plan on the 2030 Agenda for Sustainable Development (target 17.14).





4. Research Background

4.1 Researches on SDGs

It has been more than 30 years since the concept of sustainable development was formally put forward, and the international evaluation indicators of sustainable development have also evolved for a long time. After the birth of the Sustainable Development Goals, many researches has been done on the implementation and monitoring of SDGs. Specifically Speaking, researches related to goal implementation mainly concentrate on opportunities and challenges in goal implementation (Xue & Weng, 2017), policy innovation (Sun, 2017; Zhu & Zhang, 2020), implementation mechanism (Zhu & Chen, 2019), implementation progress (Zhou et al., 2019), national development patterns (Guan & Xue, 2019) and so on. The researches on goal monitoring includes evaluation framework (Zhu et al. 2018), country monitoring (Lu et al., 2019; McArthur & Rasmussen, 2019), regional monitoring (Xu et al, 2020) and so on. In addition to scholars, many global or national research institutions have also published relevant research results. For example, the United Nations has released the Sustainable Development Goal Report 2016, 2017, 2018 and 2019; the Institute for Global Environmental Strategies (IGES) of Japan has released Sustainable Development Goals Interlinkages and Network Analysis: A practical tool for SDG integration and policy coherence; Chinese academy of Environmental Planning (CAEP) and World Wide Fund for Nature (WWF) jointly released China SDGs Indicators and Progress Assessment Report 2018; China Center for International Economic Exchange, Earth Institute of Columbia University and the Ali Research jointly released Evaluation Report on the Sustainable

Development of China (2018).

However, there is still a large research gap in the measurement and monitoring of SDGs. Due to the fuzziness of its indicators, the complexity and magnitude of the indicator framework and the difficulty of obtaining data, the current monitoring of SDGs is basically at the global and national level, and regional monitoring within countries is still facing challenges. Assessments that follow the framework of SDGs are also rare. In the monitoring framework, most studies still rely on the traditional path of sustainable development evaluation, namely the Domain based Framework, which draws the framework according to the main sustainable directions (economic, social, environmental, etc.) (Yang Ling et al., 2007). Therefore, it is necessary to monitor the regional SDGs on the basis of respecting the original framework.

4.2 Measurement of SDGs

Measurement of SDGs refer to definition of the dimensions of Goals and the specific values of indicators, which is important for understanding the connotation of SDGs. According to the existing literature, the main challenge of measurement is the vagueness and imprecision of Goals and indicators.

First, the indicator framework of SDGs is facing challenges in professional measurement. For example, in the field of urban public health, the SDG indicators is facing the challenge of the New Urban agenda (NUA) put forward by the United Nations Human Settlements Programme (UN-Habitat). Giles-Corti et al. (2019) have pointed out that these two health action frameworks are inconsistent in measurement. SDG indicators assess more outcome than comprehensive and integrated policy intervention, while NUA tends to incorporate intervention indicators and exclude

outcome indicators. Considering the importance of specific policy interventions for achieving healthy and sustainable city, the results-oriented framework of SDGs has certain limitations.

Second, some of the definitions of Goals and targets are probably controversial. Around Goal 6 (Clean Water and Sanitation), the World Health Organization (WHO) and the United Nations Children's Fund (UNICEF) have discussed how to understand the accessibility of health services from a human rights perspective through Joint Monitoring Programme, and proposed a set of norms to measure this right (Gine-Garriga et al., 2017). Weststrate et al. (2019) also have pointed out the limitation of SDG6's only including quantitative indicators. As for Goal 7 (Cheap and Clean Energy), it also has been challenged by the concept of "common but differentiated responsibilities" as well as the principle of global distribution (Munro et al., 2017). In addition, it has been indicated that Goal 8 (Decent Work and Economic Growth) is lack of attention to the field of social reproduction (Rai et al., 2019). In terms of specific indicators, a study has found after distinguishing the indicators in detail that indicator 6.4.2 mainly deals with water resource pressure and it is not comprehensive enough in terms of the following 7 dimensions: whether to distinguish between gross water consumption and net water consumption, whether to consider ecological and environmental water demand, whether to consider the uneven distribution of time and space, whether to consider the interaction of renewable surface water and groundwater resources, whether to consider alternative water and whether to consider the water storage in reservoir, water recycling and aquifer recharge. (Vanham et al., 2018).

4.3 Monitoring of SDGs

The monitoring of SDGs refers to collecting high-quality indicator data and evaluating their completion progress. The existing studies about the monitoring of SDGs focus on data management, goal monitoring, national monitoring and regional monitoring. Data management concentrates on the source, supply and quality of data; Goal monitoring mainly describes the progress of different Goals in the world or among different countries. National and regional monitoring focus on the overall progress of SDGs in a country or regions within a country.

(1) Data Management

The source, supply and quality of indicator data has effect on the monitoring of SDGs. Due to the complexity and magnitude of the indicator framework, the difficulty of obtaining data has become the main challenge to evaluate SDGs. Taking Goal 11 (Sustainable Cities and Communities) for example. As the world's first Urban Sustainable Development Goal (USDG) and a policy tool, Goal 11 has been pointed out to face some difficulties in indicator data collection. These difficulties manifested in the poor availability of standardized, open and comparable data, the lack of data collection agencies, and the complexity of the localization are the main factors hindering the performance of this target framework (Klopp and Petretta, 2017). Moreover, a study has also argued that Nigeria's domestic data management system is one of the obstacles to achieving SDGs (Maduekwe et al, 2018).

(2) Goal Monitoring

Different goals have different completion progress among countries, which have been carefully evaluated by some studies.

Nhamo et al. (2019) were more concerned about Goal 6 (Clean Water and Sanitation). They believed that although Goal 6 has already been proposed, it has not yet begun to be implemented in many countries. After monitoring the achievement of the goals in 53 African countries during 2000-2015 by using the composite index analysis, this study found that African countries were at different stages of achieving Goal 6. With some countries showing a downward trend in the composite index between 2000 and 2015, it may be difficult for Africa to achieve the SDGs by 2030. Chaudhary et al. (2018) focused on food-related goals, stating that they are the core of at least 12 Goals. They quantified the performance of food systems in 156 countries through 25 sustainability indicators in 7 domains (nutrition, environment, food affordability and availability, sociocultural well-being, resilience, food safety and waste), and conducted the first global analysis of food systems. The research showed that there is significant difference in food performance among countries under different food improvement strategies. High-income countries score higher on most indicators, but lower on environmental, food waste and health-sensitive nutrient-intake indicators. At the same time, this study also found that the transition from animal food to plant food can improve the scores of most countries.

(3) National Monitoring

The SDGs are political goals at the global level, and their original intention is to achieve better sustainable development in countries. Therefore, researchers and institutions are also very concerned about the national monitoring of SDGs.

Relevant studies have shown the progress of different countries' achieving SDGs by exploring their overall performance. Lu et al. (2019) systematically reviewed China's progress and achievements in different SDGs (regional disparity, urban-rural gap, social inequality and the impact of land on the sea) after 40 years of reform and opening-up. By analyzing long-term data, this study indicated that China's economic growth has been decoupled from major pollutant since 2015, but it is still highly related to CO2 emissions. At the same time, China has made progress in health care provision, poverty alleviation and gender equality in education, but there still lies regional and urban-rural income gap. McArthur and Rasmussen (2019) classified 169 specific targets and summed up 78 targets that can be quantitatively monitored, 70 of which were systematically tested with Canadian data. Based on the concept of "no one left behind" and the principle of considering the risk of life and basic needs, this study found that only 18 indicators in Canada will be successfully achieved; 7 indicators have been at least half but not fully achieved; 33 indicators have not even reached half of the implementation; another 12 indicators have shown stagnation or retreating. In addition, this study also pointed out that about 54,000 Canadians lives at stake and millions of people are lagging behind in poverty eradication, education promotion, reduction of spousal violence, and access to water and sanitation.

There are also many monitoring results in practice, which can be divided into two categories. The first one is the national progress report, which is represented by the SDG Index and Dashboards Report published by the Sustainable Development Solutions Network (SDSN). This report began to monitor OECD countries and gradually covered 157 countries, revealing the weakness of national



development by SDG index and dashboards. OECD countries also have their own progress reports. For instance, Chinese academy of Environmental Planning (CAEP) and World Wide Fund for Nature (WWF) also have released China SDGs Indicators and Progress Assessment Report 2018, which focuses on China's localized indicator list, so as to provide information on the progress of indicators at the national level. The other is the national evaluation report. Representative evaluation techniques and frameworks are the score table designed by Oversea Development Institute (ODI) and the Country Development Diagnostics Framework designed by The World Bank. The former mainly focuses on national and intercontinental data for long-term prediction of 2030, while the latter mainly focuses on national data for horizontal comparison among countries. Besides, UNDP regularly publishes progress assessment reports of the Asia-Pacific region based on national data.

(4) Regional Monitoring

Regional monitoring targets different regions within a country. In the past few years, studies have tried to monitor the implementation process of SDGs on different regional scales accurately, but these studies are always restricted due to lack of data. Consequently, there are still few regional monitoring results so far.

Representative results include Evaluation Report on the Sustainable Development of China(2018) jointly released by China Center for International Economic Exchange, Earth Institute of Columbia University and the Ali Research, the first urban SDG progress report, New York City's Implementation of the 2030 Agenda for Sustainable Development, and The U.S. Cities Sustainable Development Goals Index 2017 and The U.S. Cities Sustainable Development Goals Index 2018 released by the Sustainable Development Solutions Network (SDSN). However, the monitoring of various regions in China and New York city failed to follow the original framework of 17 SDGs except SDSN. China's regional monitoring framework (Evaluation Report on the Sustainable Development of China) is constructed with five dimensions which are economic development, social livelihood, resources and environment, consumption and emission and environmental governance, while the monitoring framework of New York City only focuses on SDG6, SDG7, SDG11, SDG12 and SDG15. Although the above simplified monitoring works have advantages in data acquisition and methodology, their connections with the original framework are significantly weakened.

There is only one study by Xu et al. (2020) has evaluated the implementation of China's provincial Sustainable Development Goals based on the original framework of 17 SDGs. However, there are some shortcomings in this study, such as including more inter-provincial incomparable indicators (SDG13, SDG14, SDG15), paying too much attention to ranking and target values, and the restricted traditional perspective of regional disparity.

Therefore, this report argued that it is still necessary to do further detailed researches on the selection of SDG evaluation framework, the innovation of SDG monitoring methodology, and the revelation of inter-provincial regional disparity.



5. Establishing the Framework of Provincial SDG Indicators of China

5.1 Evaluation Framework

The Sustainable Development Goals cover such new fields as climate change, economic inequality, innovation, sustainable consumption, peace and justice. To fully embody all the dimensions of sustainable development, this report establishes a two-tier evaluation framework (hereafter referred to as the indicator system) that follows the original structure of the 17 SDGs, and develops an indicator framework of China's provincial Sustainable Development Goals that corresponds to the 232 indicators from the 2030 Agenda.

To ensure comparability among regions, the indicator system, with only 14 Goals selected from the 2030 Agenda, does not take into consideration the Goals related to climate actions and

marine resources, so it excludes Goal 13 (Take urgent action to combat climate change and its impacts) and Goal 14 (Conserve and sustainably use the oceans, seas and marine resources for sustainable development). Focusing on climate change, SDG13 is not suitable for inter-provincial comparisons, since climate change usually occurs on a larger scale so that defining its impacts on a certain province is technically difficult; meanwhile, not all provinces are faced with impact of climate change, and geographically speaking, most provinces do not encounter large-scale phenomena of climate change. SDG14 focuses on marine resources and underwater organisms, which exists mostly in a few eastern provinces, so it is also unsuitable for large-scale horizontal comparison among provinces. Though provincial statistics are available for Goal 15 (Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss), there exists large endowment gaps between provinces, so it is inappropriate to conduct monitoring and

evaluation through the method of composite index analysis. If SDG15 is put together with other Goals to fit a composite index, the resulted difference will largely depend on the difference in SDG15 per se. To objectively reflect provincial performances over SDG15, this report monitors it independently.

Consequently, this report selected Goal 1 (End poverty in all its forms everywhere), Goal 2 (End hunger, achieve food security and improved nutrition and promote sustainable agriculture), Goal 3 (Ensure healthy lives and promote well-being for all at all ages), Goal 4 (Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all), Goal 5 (Achieve gender equality and empower all women and girls), Goal 6 (Ensure availability and sustainable management of water and sanitation for all), Goal 7 (Ensure access to affordable, reliable, sustainable and modern energy for all), Goal 8 (Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all), Goal 9 (Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation), Goal 10 (Reduce inequality within and among countries), Goal 11 (Make cities and human settlements inclusive, safe, resilient and sustainable), Goal 12 (Ensure sustainable consumption and production patterns), 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) and Goal 17 (Strengthen the means of implementation and revitalize the Global Partnership for Sustainable Development) serve as the first-tier evaluation framework for the study.

At the same time, according to UN's Transforming our World: The 2030 Agenda for Sustainable Development, China's National Plan on Implementation of the 2030 Agenda for Sustainable Development and the economic and social development requirements by China's 13th Five-year Plan, and concerning the connotation of the selected Goals as well as the data availability of 232 indicators, this report develops the second tier of the indicator system as follows.

Goal 1 (No Poverty) should at least include three dimensions, eradication of extreme poverty, accessibility of basic services and participation in social protection. Goal 2 (Zero Hunger) should contain the target of children's nutrition level. Goal 3 (Good Health and Well-being) should at least consider three dimensions, infectious disease control, reproductive health level and possession of medical resource. Goal 4 (Quality Education) should take educational resource input and education quality into consideration. Goal 5 (Gender Equality) should at least be concerned with the target of gender equality in education. Goal 6 (Clean Water and Sanitation) should at least consider three targets, accessibility of domestic water, clean environment management and utilization of water resources. Goal 7 (Affordable and Clean Energy) should at least cover the targets of energy utilization rate and energy possession. Goal 8 (Decent Work and Economic Growth) should at

least include the targets of economic development and employment sufficiency. Goal 9 (Industry, Innovation and Infrastructure) should at least consider three targets, infrastructure density, innovation capacity and secondary sector development. Goal 10 (Reduced Inequalities) should at least be concerned with disparity between urban and rural areas and regional disparity. Goal 11 (Sustainable Cities and Communities) should at least cover two targets, namely, environment of public space, and accidental casualties. Goal 12 (Responsible Consumption and Production) should at least include the targets of the improvement in the Three Wastes treatment and the improvement in cutting emission. Goal 16 (Peace, Justice and Strong Institutions) should center around possession of judicial resources and occurrence of legal cases. Goal 17 (Partnership for the Goals) should take fiscal capacity into account.

5.2 Principles for Selecting SDG Indicators

To ensure the scientific selection of indicators of the SDG Indicator System, this report follows three principles of data: availability, comparability and applicability, which play critically important roles in determining the final indicator system.

(1) The availability of data: indicators should be quantifiable, having generally recognized methods of evaluation and calculation across the country, which means sound basis of regular statistics. Quantitative statistics released on a regular basis help acquire, compare and use the data. Therefore, availability has at least two shades of meaning, quantifiability and regular release.

(2) The comparability of data: indicators can be divided into absolute indicators and relative indicators. As the economic and social development, demographic characteristics and resource endowments vary from place to place, the absolute indicators are hardly comparable. This report, therefore, employs relative indicators and compare them at provincial level under certain weights.

(3) The applicability of data: indicators shall correspond to UN's Transforming our World: The 2030 Agenda for Sustainable Development, China's National Plan on Implementation of the 2030 Agenda for Sustainable Development as well as the economic and social development requirements by China's 13th Five-year Plan.

5.3 Indicator System

Following UN's Transforming our World: The 2030 Agenda for Sustainable Development, China's National Plan on Implementation of the 2030 Agenda for Sustainable Development, the indicator system in this report reflects the requirements of the 2030 Agenda, and the economic and social development requirements in China's 13th Five-year Plan. Guided by the principles of availability, comparability and applicability of data, the indicator system is as follows.

Table 1 Provincial SDG indicator system of China (2005-2016) ^②

| SDGs | Targets | Indicators | Corresponding Indicators from 2030 Agenda | Correlation | Sources | |
|---|------------------------------------|---|--|-------------|---|--|
| 1 NO POVERTY  | Eradication of Extreme Poverty | Percentage of population living on minimum subsistence allowances | 1.1.1 | Negative | China Civil Affairs' Statistical Yearbook | |
| | Accessibility of Basic Services | Proportion of government spending on public services | 1.a.2 | Positive | China Statistical Yearbook | |
| | | Education expenditure per capita | 1.4.1 | Positive | | |
| | Participation in Social Protection | Participation rate of old-age insurance | Participation rate of health insurance | 1.3.1 | Positive | China Health and Family Planning Statistical Yearbook, China Civil Affairs' Statistical Yearbook |
| | | | Participation rate of health insurance | 1.3.1 | Positive | |
| | | | Participation rate of unemployment insurance | 1.3.1 | Positive | |
| 2 ZERO HUNGER  | Children's Nutrition Level | Percentage of undernourished children | 2.1.1 | Negative | China Health and Family Planning Statistical Yearbook | |
| | | | | | | |
| 3 GOOD HEALTH AND WELL-BEING  | Infectious Disease Control | Tuberculosis incidence | 3.3.2 | Negative | National Bureau of Statistics of China | |
| | | Malaria incidence | 3.3.3 | Negative | | |
| | | Viral hepatitis incidence | 3.3.4 | Negative | | |
| | Reproductive Health Level | Maternal mortality rate at birth | 3.1.1 | Negative | | |
| | | Infant mortality rate at birth | 3.2.1 | Negative | | |
| | Possession of Medical Resources | Number of health workers per 10,000 inhabitants | 3.c.1 | Positive | | |
| Number of beds in medical establishments per 10,000 inhabitants | | New Indicator | Positive | | | |
| 4 QUALITY EDUCATION  | Educational Resource Input | Student-teacher ratio of primary education | 4.c.1 | Negative | National Bureau of Statistics of China, Educational Statistics Yearbook of China, jg.com.cn, The 3rd through the 6th Population Census of PRC | |
| | | Student-teacher ratio in middle schools | | Negative | | |
| | | Student-teacher ratio in high schools | | Negative | | |
| | | Student-teacher ratio in secondary vocational schools | 4.3.1 | Negative | | |
| | | Student-teacher ratio of higher education | | Negative | | |
| | Education quality | Retention rate of compulsory education | 4.1.1 | Positive | | |
| | | Retention rate of preschool education | 4.2.2 | Positive | | |
| | | Average years of schooling | New Indicator | Positive | | |
| Illiteracy rate | 4.6.1 | Negative | | | | |
| 5 GENDER EQUALITY  | Gender Equality in Education | Disparity of illiteracy rate by sex | 5.6.2 | Negative | National Bureau of Statistics of China | |
| | | Proportion of non-schooled population by sex | | Negative | | |
| 6 CLEAN WATER AND SANITATION  | Accessibility of Domestic Water | Water availability in urban areas | 6.1.1 | Positive | National Bureau of Statistics of China, China Statistical Yearbook on Environment | |
| | | Proportion of inhabitants with access to running water in rural areas | | Positive | China Social Statistical Yearbook | |
| | Clean Environment Management | Decontaminated and clean toilet coverage | 6.2.1 | Positive | National Bureau of Statistics of China, China Statistical Yearbook on Environment | |
| | | Proportion of wastewater safely treated in urban areas | 6.3.1 | Positive | | |
| | Utilization of Water Resources | Proportion of decontaminated household waste | New Indicator | Positive | | |
| | | Water consumption per unit of GDP | 6.4.1 | Negative | | |
| Water resource per capita | 6.4.2; 6.5.1 | Positive | | | | |
| 7 AFFORDABLE AND CLEAN ENERGY  | Energy Utilization Rate | Energy consumption per unit of GDP | 7.3.1 | Negative | National Bureau of Statistics of China, China Energy Statistical Yearbook | |
| | | Decrease in energy consumption per unit of GDP | | Positive | | |
| | Energy Possession | Proportion of population with access to natural gas in urban areas | 7.1.2 | Positive | National Bureau of Statistics of China | |

^② The official SDG indicator framework of the United Nations is to be refined annually. This study is based on the original version that was agreed upon at the 48th session of the United Nations Statistical Commission held in March 2017.

| SDGs | Targets | Indicators | Corresponding Indicators from 2030 Agenda | Correlation | Sources | | | |
|---|---|--|---|--|--|---|----------|---|
| 8 DECENT WORK AND ECONOMIC GROWTH  | Economic Development | GDP per capita | 8.1.1 | Positive | National Bureau of Statistics of China | | | |
| | | GDP per employed person | 8.2.1 | Positive | Wind Database, qianzhan.com, National Bureau of Statistics of China | | | |
| | | Composite contribution of tourism to GDP | 8.9.1 | Positive | The Yearbook of China Tourism Statistics, National Bureau of Statistics of China | | | |
| | Employment Sufficiency | Registered urban unemployment rate | 8.5.2 | Negative | National Bureau of Statistics of China | | | |
| 9 INDUSTRY, INNOVATION AND INFRASTRUCTURE  | Infrastructure Density | Road density | 9.1.1; 9.1.2 | Positive | National Bureau of Statistics of China, National Administrative Division Information Inquiry Platform of China | | | |
| | | Railway density | | Positive | | | | |
| | | Drainage density | Positive | | | | | |
| | | Water supply pipe density | Positive | | | | | |
| | | Internet coverage | 9.c.1 | Positive | | | | |
| | Innovation Capacity | Industrial companies' expenditure in R&D as percentage of GDP | 9.5.1 | Positive | National Bureau of Statistics of China | | | |
| | | R&D personnel (in full-time equivalent) per 10,000 inhabitants | 9.5.2 | Positive | China Statistical Yearbook on Science and Technology, National Bureau of Statistics of China | | | |
| | Secondary Sector Development | Proportion of invention patent holders per 10,000 inhabitants | New Indicator | Positive | National Bureau of Statistics of China | | | |
| Industrial added value as percentage of GDP | | 9.2.1 | Positive | China Industrial Economy Statistical Yearbook, Wind Database, qianzhan.com | | | | |
| Percentage of manufacturing employment in total employment | 9.2.2 | Positive | | | | | | |
| 10 REDUCED INEQUALITIES  | Disparity between Urban and Rural Areas | Urban-rural disparity in personal disposable income | 10.1.1 | Negative | National Bureau of Statistics of China | | | |
| | | Urban-rural consumption disparity | New Indicator | Negative | | | | |
| | Regional Disparity | Coefficient of variation of GDP per capita in a province | New Indicator | New Indicator | Negative | Wind Database, qianzhan.com | | |
| | | | | | | | | |
| 11 SUSTAINABLE CITIES AND COMMUNITIES  | Environment of Public Space | Greenery coverage rate of the built-up areas | 11.7.1 | Positive | National Bureau of Statistics of China | | | |
| | | Population density | 11.3.1 | Negative | | | | |
| | | Disposal and utilization rate of hazardous industrial wastes | 11.6.1 | Positive | China Statistical Yearbook on Environment | | | |
| | | Mean levels of PM2.5 in cities | 11.6.2 | Negative | Chinese Research Data Services Platform | | | |
| | Accidental Casualties | Number of deaths from traffic accidents per 10,000 population | 11.5.1; 11.5.2 | Negative | China Statistical Yearbook, China Civil Affair's Statistical Yearbook | | | |
| | | | | | | Number of deaths from fire accidents per 10,000 population | Negative | Fire and Rescue Department (Ministry of Emergency Management of China), China Civil Affair's Statistical Yearbook |
| | | | | | | Number of deaths from natural disasters per 10,000 population | Negative | China Social Statistical Yearbook, China Civil Affair's Statistical Yearbook |
| Proportion of economic loss from natural disasters | China Social Statistical Yearbook, China Statistical Yearbook | | | | | | | |
| | | | | | | | | |
| 12 RESPONSIBLE CONSUMPTION AND PRODUCTION  | Improvement in the Three Wastes Treatment | Composite utilization rate of industrial solid waste | 12.4.2; 12.5.1 | Positive | China Statistical Yearbook of the Tertiary Industry, qianzhan.com | | | |
| | | Emissions per unit of industrial added value | 12.2.1; 12.4.1 | Negative | National Bureau of Statistics of China | | | |
| | | Effluent treatment rate | | Negative | | | | |
| | Ammonia and nitrogen emissions per unit of GDP | Negative | | | | | | |
| | Improvement in Cutting Emissions | Chemical oxygen demand emissions per unit of GDP | Negative | China Emission Accounts and Datasets | | | | |
| | | SO ₂ emissions per unit of GDP | Negative | | | | | |
| CO ₂ emissions per unit of GDP | | Negative | | | | | | |
| 16 PEACE, JUSTICE AND STRONG INSTITUTIONS  | Possession of Judicial Resources | Number of lawyers per 10,000 population | New Indicator | Positive | China Social Statistical Yearbook, National Bureau of Statistics of China | | | |
| | Occurrence of Legal Cases | Administrative litigation incidence | 16.10.1 | Negative | Website of the Ministry of Justice of PRC, National Bureau of Statistics of China | | | |
| | | Incidence of corruption | 16.5.1; 16.5.2 | Negative | jg.com.cn, National Bureau of Statistics of China | | | |
| | 17 PARTNERSHIPS FOR THE GOALS  | Fiscal Capacity | Fiscal revenue as percentage of GDP | 17.1.1 | Positive | National Bureau of Statistics of China | | |
| Fiscal self-reliance rate | | | Positive | | | | | |
| Tax revenue as percentage of total fiscal revenue | | | 17.1.2 | Positive | | | | |



6. Research Methods and Data Processing

6.1 Data Collection

Our research draws information from two sets of data collected. One includes the data obtained for 14 selected SDGs from 2005 to 2016, the other includes data obtained for Goal 15 from 2004 to 2017. Given limited data availability, the former set from 2005 to 2016 does not include Tibet (30 provinces). The latter includes Tibet (31 provinces).

These statistical data are drawn from China Civil Affairs' Statistical Yearbooks, China Statistical Yearbooks, China Health and Family Planning Statistical Yearbooks, China Labor Statistical Yearbooks, the Chinese Research Data Service Platform (CNRDS), China Social Statistical Yearbooks, the National Bureau of Statistics of China, China Education Statistical Yearbooks, China Environment Statistical Yearbooks, China Energy Statistical Yearbooks, China Industry Statistical Yearbooks, qianzhan.com, jg.com.cn, the Wind Database, The Yearbooks of China Tourism Statistics, the National administrative division information inquiry platform, China Statistical Yearbooks on Science and Technology, China Industrial Economy Statistical Yearbooks, the Fire and Rescue Department Ministry of Emergency Management, China Statistical Yearbooks of the Tertiary Industry, China Emission Accounts and Datasets, the Ministry of Justice, the National Bureau of Statistics, National People's Congress Economic Forum. Other data used are obtained by calculation.

Given the availability, comparability and continuity of relevant data, our research does not include and consider data from Hong Kong, Macao and Taiwan.

6.2 Data Processing

The raw data obtained from the aforementioned sources differed in their units, magnitudes, and possess both positive and negative correlations with the object under study. Thus, these raw data are not comparable and needs to be cleaned. Data cleansing follows three steps. First, the raw data are standardized into a standard normal distribution (z-distribution). After standardization, the dataset will follow a z-distribution where indicator mean equals to zero, and indicator standard variance becomes 1. The formula used is as followed:

$$X_{ij}^s = \frac{X_{ij} - \bar{X}_i}{Std(X_i)}$$

X_{ij} is province j 's i^{th} indicator

\bar{X}_i is the i^{th} indicator mean of all provinces








$Std(X_i)$ is the standard deviation of i^{th} indicator of all provinces

X_{ij}^s is the z-score of province j 's i^{th} indicator

Next, we tested the normal assumption of every X_{ij}^s . We also calculated the 95% confidence interval, and replaced extreme values outside the [-1.96,1.96] interval with critical values at 95% level.

Lastly, the raw scores possess both positive and negative correlation. That is to say, larger scores of positively-correlated

Table 2 Provincial SDG indicators and weight allocation (2005-2016)

| SDGs | Targets | Indicators | Correlation | Weights |
|---|------------------------------------|---|-------------|---------|
| 1 NO POVERTY  | Eradication of Extreme Poverty | Percentage of population living on minimum subsistence allowances | Negative | 0.33 |
| | Accessibility of Basic Services | Proportion of government spending on public services | Positive | 0.11 |
| | | Education expenditure per capita | Positive | 0.11 |
| | | Proportion of population provided with family health services | Positive | 0.11 |
| | Participation in Social Protection | Participation rate of old-age insurance | Positive | 0.11 |
| | | Participation rate of health insurance | Positive | 0.11 |
| | | Participation rate of unemployment insurance | Positive | 0.11 |
| 2 ZERO HUNGER  | Children's Nutrition Level | Percentage of undernourished children | Negative | 1 |
| 3 GOOD HEALTH AND WELL-BEING  | Infectious Disease Control | Tuberculosis incidence | Negative | 0.11 |
| | | Malaria incidence | Negative | 0.11 |
| | | Viral hepatitis incidence | Negative | 0.11 |
| | Reproductive Health Level | Maternal mortality rate at birth | Negative | 0.17 |
| | | Infant mortality rate at birth | Negative | 0.17 |
| | Possession of Medical Resources | Number of health workers per 10,000 inhabitants | Positive | 0.17 |
| | | Number of beds in medical establishments per 10,000 inhabitants | Positive | 0.17 |
| 4 QUALITY EDUCATION  | Educational Resource Input | Student-teacher ratio of primary education | Negative | 0.10 |
| | | Student-teacher ratio in middle schools | Negative | 0.10 |
| | | Student-teacher ratio in high schools | Negative | 0.10 |
| | | Student-teacher ratio in secondary vocational schools | Negative | 0.10 |
| | | Student-teacher ratio of higher education | Negative | 0.10 |
| | Education quality | Retention rate of compulsory education | Positive | 0.13 |
| | | Retention rate of preschool education | Positive | 0.13 |
| | | Average years of schooling | Positive | 0.13 |
| | | Illiteracy rate | Negative | 0.13 |
| 5 GENDER EQUALITY  | Gender Equality in Education | Disparity of illiteracy rate by sex | Negative | 0.50 |
| | | Proportion of non-schooled population by sex | Negative | 0.50 |
| 6 CLEAN WATER AND SANITATION  | Accessibility of Domestic Water | Water availability in urban areas | Positive | 0.17 |
| | | Proportion of inhabitants with access to running water in rural areas | Positive | 0.17 |
| | Clean Environment Management | Decontaminated and clean toilet coverage | Positive | 0.11 |
| | | Proportion of wastewater safely treated in urban areas | Positive | 0.11 |
| | | Proportion of decontaminated household waste | Positive | 0.11 |
| | Utilization of Water Resources | Water consumption per unit of GDP | Negative | 0.17 |
| Water resource per capita | | Positive | 0.17 | |
| 7 AFFORDABLE AND CLEAN ENERGY  | Energy Utilization Rate | Energy consumption per unit of GDP | Negative | 0.25 |
| | | Decrease in energy consumption per unit of GDP | Positive | 0.25 |
| | Energy Possession | Proportion of population with access to natural gas in urban areas | Positive | 0.50 |

| SDGs | Targets | Indicators | Correlation | Weights |
|---|---|--|-------------|---------|
| 8 DECENT WORK AND ECONOMIC GROWTH  | Economic Development | GDP per capita | Positive | 0.17 |
| | | GDP per employed person | Positive | 0.17 |
| | | Composite contribution of tourism to GDP | Positive | 0.17 |
| | Employment Sufficiency | Registered urban unemployment rate | Negative | 0.50 |
| 9 INDUSTRY, INNOVATION AND INFRASTRUCTURE  | Infrastructure Density | Road density | Positive | 0.07 |
| | | Railway density | Positive | 0.07 |
| | | Drainage density | Positive | 0.07 |
| | | Water supply pipe density | Positive | 0.07 |
| | | Internet coverage | Positive | 0.07 |
| | Innovation Capacity | Industrial companies' expenditure in R&D as percentage of GDP | Positive | 0.11 |
| | | R&D personnel (in full-time equivalent) per 10,000 inhabitants | Positive | 0.11 |
| | | Proportion of invention patent holders per 10,000 inhabitants | Positive | 0.11 |
| | Secondary Sector Development | Industrial added value as percentage of GDP | Positive | 0.17 |
| Percentage of manufacturing employment in total employment | | Positive | 0.17 | |
| 10 REDUCED INEQUALITIES  | Disparity between Urban and Rural Areas | Urban-rural disparity in personal disposable income | Negative | 0.25 |
| | | Urban-rural consumption disparity | Negative | 0.25 |
| | Regional Disparity | Coefficient of variation of GDP per capita in a province | Negative | 0.50 |
| 11 SUSTAINABLE CITIES AND COMMUNITIES  | Environment of Public Space | Greenery coverage rate of the built-up areas | Positive | 0.13 |
| | | Population density | Negative | 0.13 |
| | | Disposal and utilization rate of hazardous industrial wastes | Positive | 0.13 |
| | | Mean levels of PM2.5 in cities | Negative | 0.13 |
| | Accidental Casualties | Number of deaths from traffic accidents per 10,000 population | Negative | 0.13 |
| | | Number of deaths from fire accidents per 10,000 population | Negative | 0.13 |
| | | Number of deaths from natural disasters per 10,000 population | Negative | 0.13 |
| | | Proportion of economic loss from natural disasters | Negative | 0.13 |
| 12 RESPONSIBLE CONSUMPTION AND PRODUCTION  | Improvement in the Three Wastes Treatment | Composite utilization rate of industrial solid waste | Positive | 0.17 |
| | | Emissions per unit of industrial added value | Negative | 0.17 |
| | | Effluent treatment rate | Negative | 0.17 |
| | Improvement in Cutting Emissions | Ammonia and nitrogen emissions per unit of GDP | Negative | 0.13 |
| | | Chemical oxygen demand emissions per unit of GDP | Negative | 0.13 |
| | | SO ₂ emissions per unit of GDP | Negative | 0.13 |
| | | CO ₂ emissions per unit of GDP | Negative | 0.13 |
| 16 PEACE, JUSTICE AND STRONG INSTITUTIONS  | Possession of Judicial Resources | Number of lawyers per 10,000 population | Positive | 0.50 |
| | Occurrence of Legal Cases | Administrative litigation incidence | Negative | 0.25 |
| | | Incidence of corruption | Negative | 0.25 |
| 17 PARTNERSHIPS FOR THE GOALS  | Fiscal Capacity | Fiscal revenue as percentage of GDP | Positive | 0.33 |
| | | Fiscal self-reliance rate | Positive | 0.33 |
| | | Tax revenue as percentage of total fiscal revenue | Positive | 0.33 |

indicators suggest favorable conditions to development whereas larger scores of negatively-correlated indicators suggest the opposite.

Hence, we multiplied scores of those negatively-correlated indicators by “-1” to make all scores positively-correlated to development.

6.3 Data Weighting

Assume that all 14 goals are equally significant in economic and social development. This research assigns equal weight to each goal and different weights to each target/indicator within each goal. The allocation is as followed:

6.4 Data Calculation

We observe zeros after standardizing the data set into z-distribution. Hence, we conclude that the measuring of geometric average is not suitable in this design. Thus, we adopted arithmetic mean method for calculations of all three level indicators. Based on the arithmetic average method and the weights of each development goal, we calculate the z-score of each SDG. With these z-scores, this research uses max-min standardization to project the scores of each development goal onto an interval of [0,1]. We used the formula as followed:

$$D_d^* = \frac{D_d - \min(D_d)}{\max(D_d) - \min(D_d)}$$

D_d^* is the score after standardization for province j 's d^{th} development goal
 $\min(D_d)$ is the minimum z-score for province j 's d^{th} development goal
 $\max(D_d)$ is the maximum z-score for province j 's d^{th} development goal

Lastly, to better present the results, this report converted the scores into a scale of 60-100, (60 being the worst, and 100 being the best) with the following formula:

$$S_{dj} = 60 + D_d^* * 40$$

S_{dj} is the score (in 100) for j^{th} province and its d^{th} development goal



7. Results

This report aims to evaluate the current situation and development disparity of Sustainable Development Goals among China's provinces, as well as the development gaps between different Goals in the same province. Disparities in development point to a structural problem, indicating that development, as a type of welfare, is distributed unevenly. Such disparities with most academic focuses usually include urban-rural disparity, disparities among regions of different sizes, or the disparity of a certain development index between groups of people. In this report, we use "individual" to refer to a certain urban or rural area, region of a certain size as well as a certain group of people. Hence, we refer to the abovementioned types of disparities as "disparity between individuals".^③ This report further provides another perspective to look into disparity, which is disparity in level between different

development indices of a same individual. Finally, considering the time variable, the study fully examines the balances of development goals from both the horizontal (regional disparity) and vertical perspectives (disparity between SDG Index scores of a same region). The key findings are as follows.

7.1 Unbalanced Performance over Development Goals and Long-term Weaknesses of Each Province

The SDG composite index and dashboard are important analytical tools for evaluating national SDG performance. These tools make the most of available national data for the 17 Goals, present real-time gaps in achieving SDGs for each country, and help decision makers identify priorities like dealing with weaknesses that call for improvement in early SDGs actions. According to the data structure of provincial-level SDG indicator system, this report also forms the index dashboard through clustering analysis.^④ The dashboard shows the disparities in SDG Index rankings between

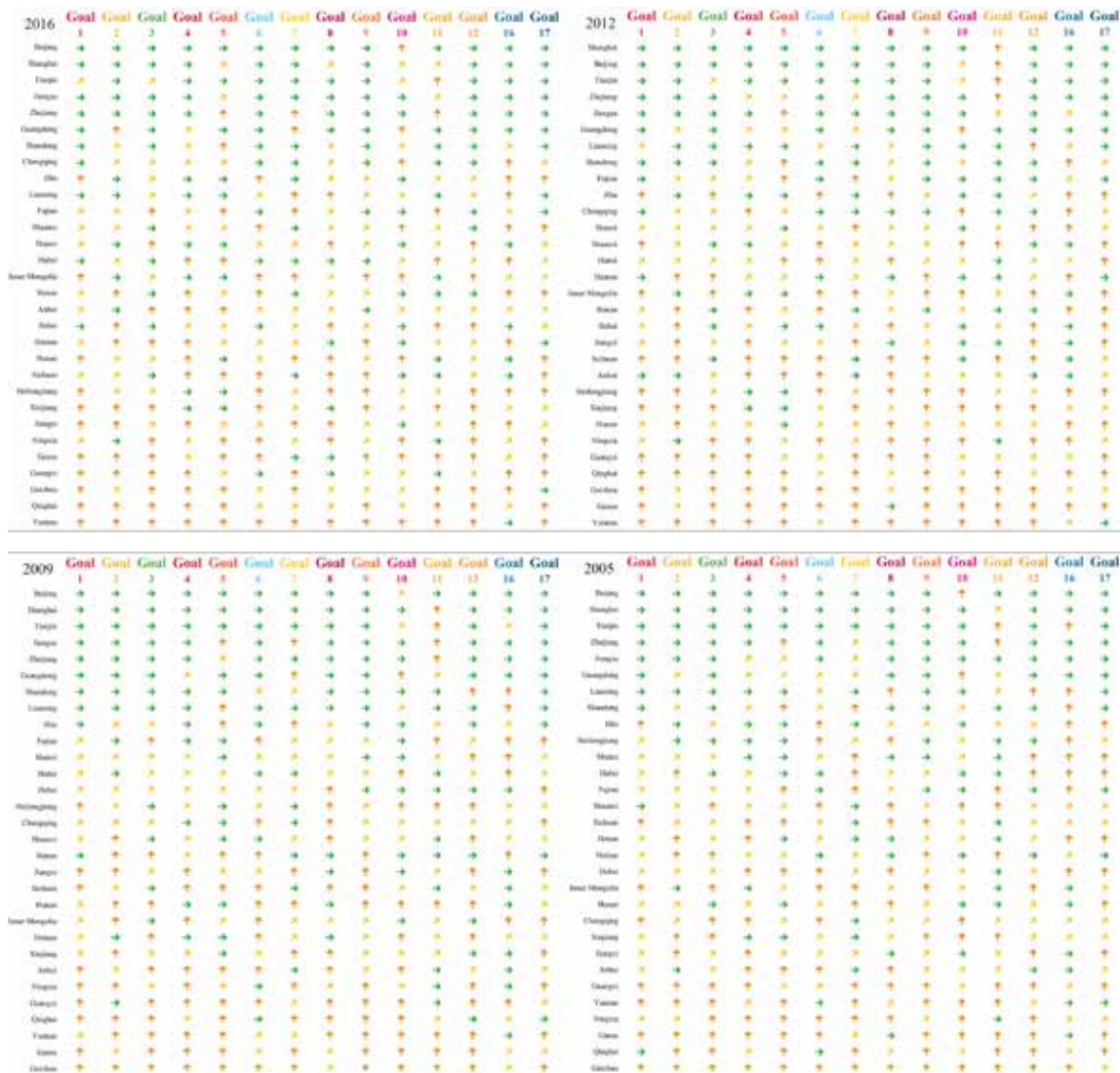


Fig.1 Provincial SDG Index dashboard (2005-2016)

^③ Examples are urban-rural disparity, regional disparity, income disparity, etc.

^④ This report analyzes, through natural breakpoint cluster analysis, the ranking of each province in 14 SDGs.

different development goals of the same province, based on which we could identify comparative weaknesses of each province.

The dashboard in Figure 1 reveals the changes in provincial SDG Indices in the years of 2005, 2009, 2012 and 2016. Through clustering analysis, we examined each province’s rankings in all the 14 Goals. The development levels of Goals are divided into three categories marked by arrows in three colors: advanced (green), moderate (yellow) and weak (orange). Counting the number of orange arrows, therefore, helps identify each province’s weaknesses.

As demonstrated by the dashboard, the inconsistent rankings of each province in the 14 different SDGs suggest that each province has its unique strengths and weaknesses in SDG performances. To be specific, from 2005, provinces and economic belts (the East, the Middle and the West of China) all have had relatively undesirable performances, which has not changed much till 2016. In March 2018, Guilin in Guangxi, Shenzhen in Guangdong and Taiyuan in Shanxi became China’s first batch of National Innovation Demonstration Zones for Implementation of SDGs. Take these three provinces as examples to interpret rankings in the dashboard, Guangxi has relatively more weaknesses in sustainable

development, the long-standing ones being around Goal 1 (No Poverty), Goal 2 (Zero Hunger), Goal 3 (Good Health and Well-being), Goal 4 (Quality Education), Goal 7 (Affordable and Clean Energy), Goal 8 (Decent Work and Economic Growth) and Goal 9 (Industry, Innovation and Infrastructure). Guangdong’s only weakness lies in Goal 10 (Reduced Inequalities). Shanxi’s long-existing weaknesses consist in Goal 12 (Responsible Consumption and Production) and Goal 16 (Peace, Justice and Strong Institutions). Additionally, in view of disparities between China’s three economic belts, the East has fewest weaknesses, the Middle relatively more, and the West the most. Such disparity changes little from 2005 to 2016.

7.2 Outstanding Imbalance in Public Services Development Compared with Economic Development

Our study calculates 14 Theil indices of the selected 14 SDGs. These indices measure the weighted average deviation of each province from the national “entropy”. A Theil index becomes zero when each province is equally represented in the nation for a certain SDG. Figure 2 demonstrates the changes in Theil index of the SDG indices. The formulae of Theil index (Wen, 2005) is in the appendix.

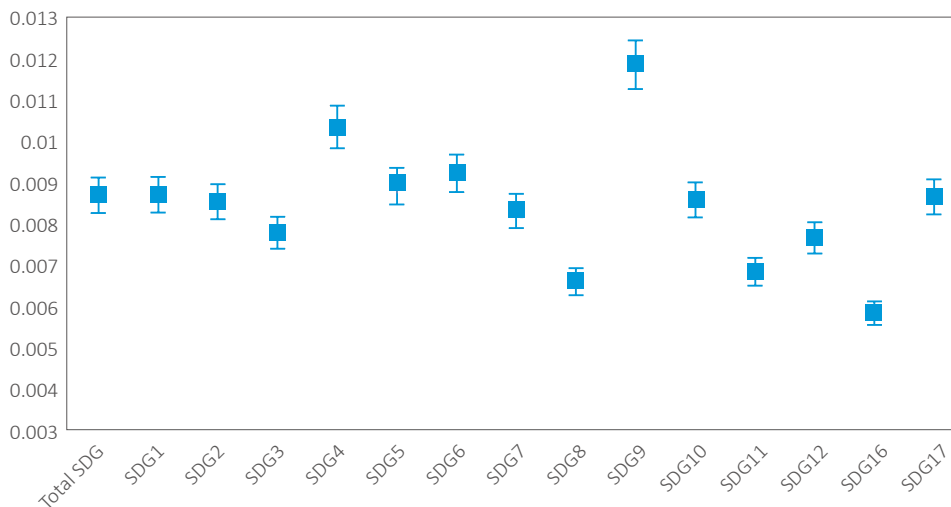


Fig.2 Theil indices of SDG Indices (2016)

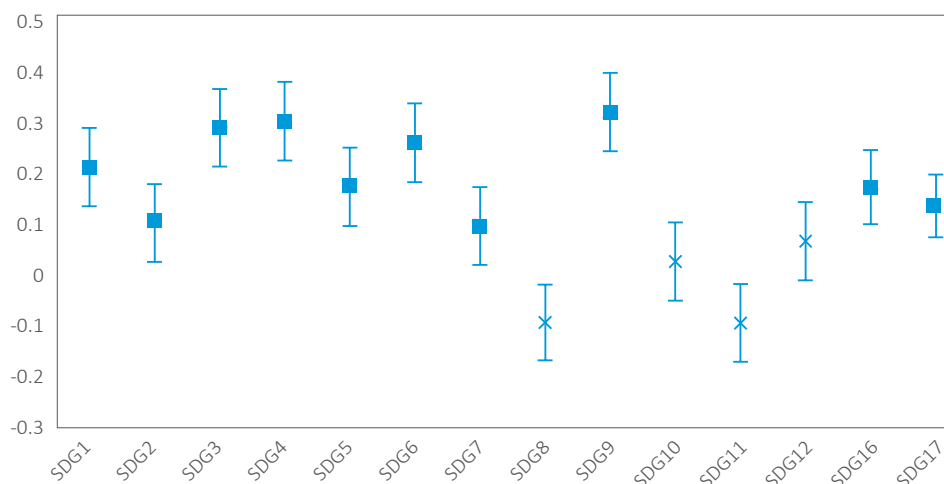


Fig.3 Spatial autocorrelation analysis of the SDG Indices (2016)

The analysis of spatial autocorrelation^⑥ aims to find out possible spillover effect among neighboring provinces. In other words, geographic location has certain effects on data distribution. Moran's I^⑦ is a commonly used index for measuring spatial autocorrelation. We have attached the formulae used in this report in the appendix. To reveal the spatial differences, we calculated Moran's I using 2016 data as presented in figure 3. Here, "■" indicates a significant correlation and "x" indicates an insignificant one. A positive number suggests positive correlation, whereas a negative number suggests negative correlation.

With the calculated Theil indices at hand, we also applied OLS linear regression^⑧ to establish a time series variation of the Theil

index for all 14 SDGs during the period of 2005-2016 as shown in figure 4. One of the advantage of the Theil index lies in ability to identify the share of inequality attributable to both the inter-group and intra-group components. Our research splits provinces into three belts (the East, the Middle and the West of China). Using OLS linear regression, we can trace the time series variation of the inter-belt Theil index for 14 SDGs from 2005 to 2016, as shown in figure 5.

According to figure 2, figure 3 and figure 4, inter-provincial inequality level varies for different SDGs. From the 2016 data, we observe that some SDGs demonstrate more inter-provincial imbalances. Development of SDGs which reflect economic and institutional development such as Goal 16 (Peace, Justice,

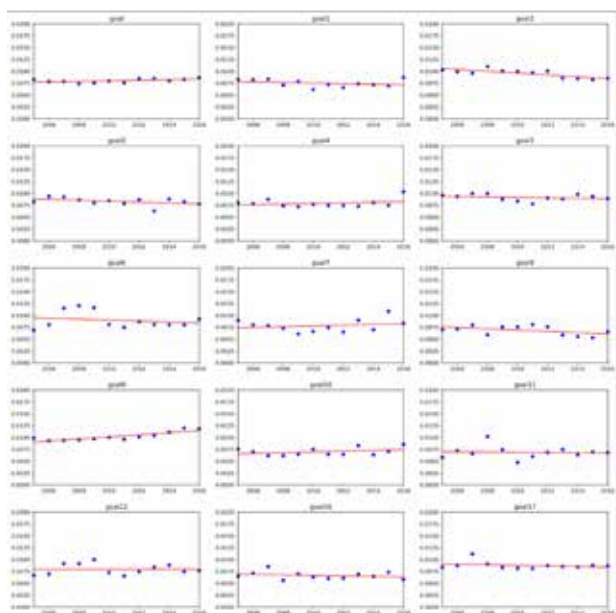


Fig.4 Changes in Theil indices

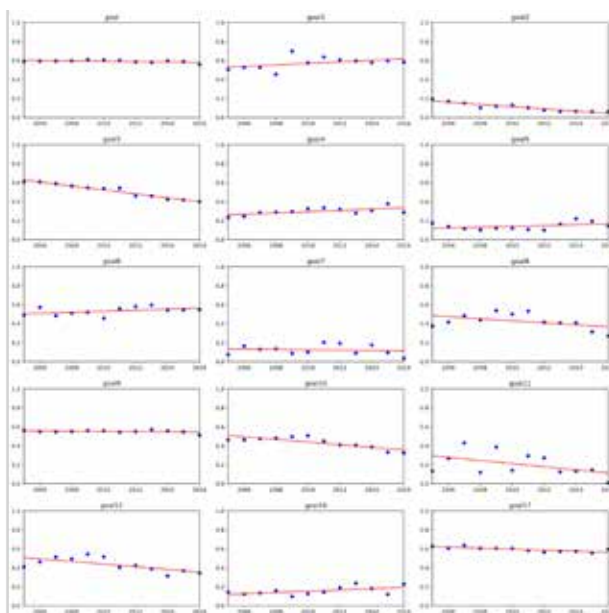


Fig.5 Inter-group contributions

⑥ Spatial autocorrelation is used to study whether and how data obtained in a certain geographic region are related to the data obtained in other geographic regions. Commonly seen examples of such studies include mutual influences of pollution in neighboring provinces, and housing prices in the same school district.

⑦ Moran's I is a commonly used index to measure spatial autocorrelation. In our research, Moran's I demonstrates whether and to what extent there exists spatial correlations between neighboring provinces.

⑧ We can use the Ordinary Least Square (OLS) linear regression model to detect any linear trend for the datasets.

and Strong Institutions), Goal 8 (Decent Work and Economic Growth) and Goal 11 (Sustainable Cities and Communities) are more balanced among provinces. Meanwhile, SDGs that reflect development in public services, such as Goal 4 (Quality Education), Goal 6 (Clean Water and Sanitation), Goal 9 (Industry, Innovation, and Infrastructure) demonstrate most inequality among province. Besides, between 2005 and 2016, the inter-provincial gap in Goal 4 (Quality Education) remains virtually constant; and the gap in Goal 6 (Clean Water and Sanitation) slightly narrowed. However, the inter-provincial gap in Goal 9 (Industry, Innovation, and Infrastructure) has a widening trend.

Besides, we observe large inter-provincial gaps coupled with relatively strong positive clustering effects in Goal 4 (Quality Education), Goal 6 (Clean Water and Sanitation), and Goal 9 (Industry, Innovation, and Infrastructure). We found that provinces with high SDG indices scores for these three goals tend to cluster in the same geographic area and the provinces that do not perform well are also close to each other. Therefore, comparing to the imbalances in economic development, there is a greater imbalance in development of public service. More specifically, the regional gaps in development of public services are large with relatively prominent clustering effect, and there is no evidence showing any trend of narrowing gaps over time.

7.3 No Significant Improvement in Provincial Disparity while Belt Gaps Narrowed

As shown in Figures 4 and 5, from a vertical comparison, disparities in SDG Index scores between provinces have not been reduced significantly from 2005 to 2016. Also, combined with the Theil index, the inter-provincial disparities in scores of the 14 SDGs over the same period are calculated. It is found that, disparities among provinces in Goal 7 (Affordable and Clean Energy) and Goal 9 (Industry, Innovation and Infrastructure) are widening over time, while other Goals present few significant changes. However, after decomposing the Theil index of inter-provincial disparities into disparities inside and between the three belts, this report found that, among most development goals, disparities between belts accounted for less than 50% of the total inter-provincial disparities, and its contribution for the total difference is still obviously shrinking. Specifically, these Goals with downward trend include Goal 2 (Zero Hunger), Goal 3 (Good Health and Well-being), Goal 7 (Affordable and Clean Energy), Goal 8 (Decent Work and Economic Growth), Goal 10 (Reduced Inequalities), Goal 11 (Sustainable Cities and Communities) and Goal 12 (Responsible Consumption and Production).

On the other hand, Goals where the contribution of disparities between belts to provincial disparities makes up over 50% merely include Goal 1 (No Poverty), Goal 6 (Clean Water and Sanitation), Goal 9 (Industry, Innovation and Infrastructure), Goal 17 (Partnership for the Goals), but for the changes of the contribution, SDG17 has shown a significant downward trend, and SDG1, SDG6 and

SDG9 have also shown varying degrees of decline in recent years. In addition, Goal 3 (Good Health and Well-being) has changed the most, whose contribution from disparities between belts to inter-provincial disparities declined from around 60% to around 40% in 2005-2016. It can thus be concluded that the provincial disparities in China have not been effectively alleviated, but the gap between the three economic belts has been narrowed. For another point, concerning the contribution of disparities between belts to provincial disparities, and the future development trend, the three major economic belts may no longer be a powerful factor to explain the uneven development in China.

7.4 Provincial Gaps Unchanged over Gender Equality Improvement, but Narrowed in Economic Equality Enhancement

As suggested by Figure 4 and Figure 5, it is relatively easier to narrow the gaps between provinces in promoting economic equality, and more difficult for gender equality. Intra-generational equity, of which Goal 5 (Gender Equality) and Goal 10 (Reduced Inequalities) are main components, is one of the concepts attached greatest importance in the SDGs. SDG5 points to different levels among provinces of promoting gender equality in education. SDG10 mainly refers to economic equality represented by the urban-rural gap and the disparity of GDP per capita in prefecture-level cities. This study believes that, chronologically speaking, inter-provincial disparities of any development goal are expected to narrow rather than expanding. SDG5 and SDG10, however, are inconsistent with expectation. It is found that inter-provincial disparities over the two equality issues have shown no sign of significant improvement, but disparities between the three economic belts have, firstly in economic equality, witnessed breakthrough: despite stagnant progress in narrowing the inter-provincial gaps in improving gender and economic equality, and the unchanged disparity between belts in gender equality, the gaps between belts over economic equality enhancement has presented a significant narrowing trend in accordance with the expected direction.

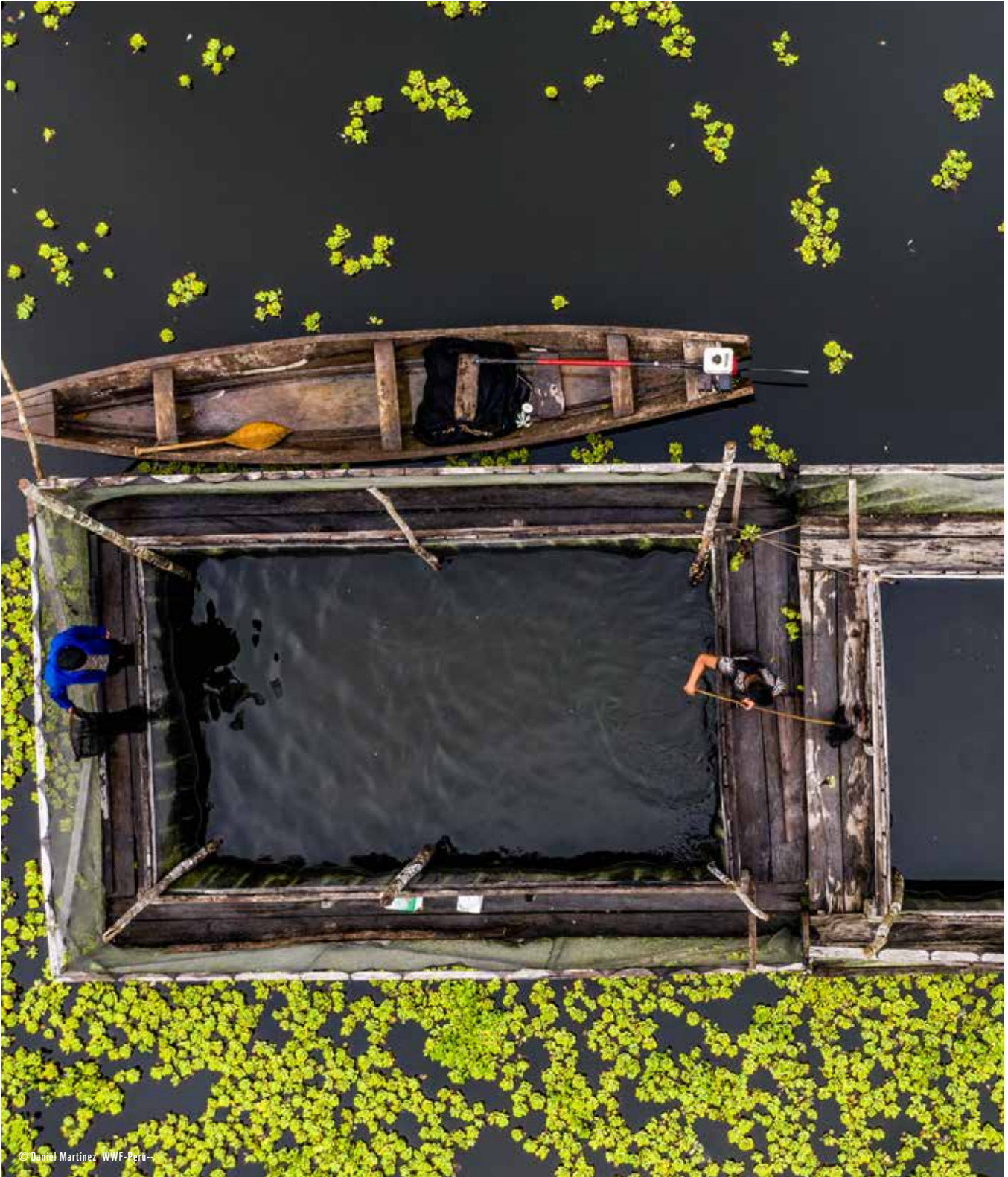
7.5 The Most Unevenly Developed Goal: Industry, Innovation and Infrastructure.

According to figures above, Goal 9 (Industry, Innovation and Infrastructure) presents not only a significant inter-provincial disparity and a strong positive spatial correlation effect, but also an expanding trend of those. There are also no signs of narrowing between three economic belts. If we look from four angles that measure the matter of imbalance of SDG performance (the inter-provincial disparity, changes in disparity between provinces over time, the spatial correlation effect, and changes in disparity between belts over time), SDG 9 is the only one in the 14 Goals that displays inconsistency with expectation in all these four aspects. Goals on the opposite, namely those with better performance at all four angles include Goal 8 (Decent Work and Economic Growth) and Goal 11 (Sustainable Cities and Communities) demonstrate relatively balanced performances and no obvious clustering effects

among all the provinces. Meanwhile, the inter-provincial disparity is suggesting a slightly narrowing trend whereas the inter-belt disparity is demonstrating an obvious narrowing trend

To sum up, through the monitoring of Sustainable Development Goals in China, and from the perspective of uneven development, we can at least come down to these conclusions: uneven development exists among different development goals, and each province has long-term weaknesses; the imbalance in economic

development has been effectively alleviated over 2005-2016; but the imbalance in the development of public services is not only more prominent, but also more difficult to be solved between provinces; as for equality issues, gaps over economic equality enhancement are easier to be narrowed than those over gender equality; among the selected 14 SDGs, Goal 9 (Industry, Innovation and Infrastructure) is faced with most uneven development, and should be given enough attention in terms of both time and space.



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8. Research Design and Evaluation for SDG15


Given the complex geographic conditions in China, inter-provincial variation in natural endowment inevitably demonstrates largest gaps. Hence, SDG15 would have contributed most variations should it be added into the aforementioned calculations together with other 14 Goals. Thus, SDG15 should be separately considered and assessed to avoid biases. The assessment for SDG15 adopted similar approaches to previous assessments.

8.1 Adapted Indicators for SDG15

SDG15 aims to conserve, restore and promote the sustainable use of terrestrial ecosystem; to sustainably manage forests, combat desertification, halt and reverse land degradation, and to halt biodiversity loss. Reconciling the SDGs and plans in the 2030 Agenda, and taking into account the availability and measurability of local statistics in China, we propose to study the

following indicators. They are: 15.1.1 (Forest area as a proportion of total land area); 15.2.1 (Progress towards sustainable forest management); 15.4.1 (Coverage by protected areas of important sites for mountain biodiversity); and 15.a.1 (Official development assistance and public expenditure on conservation and sustainable use of biodiversity and ecosystems). The adapted indicators in China include Forestry investment as a proportion of regional GDP, Forest area as a proportion of total land area, total extension of forest area, Number of nature reserves, Number of state-level nature reserves, and Nature reserve area as a proportion of the administrative area. Details and sources of these indicators are as suggested in table 3.

Table 3 Goal 15 (Life on Land) adapted indicators (2004–2017)

| Goals | Targets | Adapted Indicators | Corresponding Indicators from 2030 Agenda | Correlation | Source | |
|---|---------|--|---|-------------|--|----------|
|  | 15.a | Forestry investment as a proportion of regional GDP (A) | 15.a.1 | Positive | Chinese Research Data Services (CNRDS) | |
| | 15.1 | Forest area as a proportion of total land area (B) | 15.1.1 | Positive | | |
| | 15.2 | Total extension of forest area (C) | 15.2.1 | Positive | | |
| | 15.4 | Number of nature reserves (D) | | 15.4.1 | | Positive |
| | | Number of state-level nature reserves (E) | | | | Positive |
| | | Nature reserve area as a proportion of the administrative area (F) | | | | Positive |
| | | Positive | | | | |

8.2 SDG15 Research Methodology and Evaluation

Given the vast differences in natural endowment among provinces, indicators in SDG15 cannot be compared horizontally. Hence, we adopt a different framework to spot performance differences among provinces for SDG15.

First, the research identified three key questions for evaluating SDG15 performances. One, have there been significant changes in biodiversity in respective provinces over time? Two, have any clusters of provinces been observed in terms biodiversity? Three, have the resources put into the ecological development by each province yielded effective and expected outputs? Based on these

fundamental questions, the research used Theil index and Gini coefficient to measure changes of regional differences in SDG15 performances from 2004 to 2017. Next, the research adopted spatial auto-correlation model to test the existence of possible spillover effects, and detected changes in spatial clustering over time. Last, we used panel model to examine the correlation between resource input and ecosystem improvement for every province (demonstrates significant influences of Forestry investment as a proportion of regional GDP on Forest area as a proportion of total land area and on forestry stock).

8.3 Regional Performance Differences of SDG 15

Table 4 Theil index and Gini coefficient of SDG15 indicators

| Year | Theil's index of A | Gini Coefficient of A | Theil's index of B | Gini Coefficient of B | Theil's index of C | Gini Coefficient of C | Theil's index of D | Gini Coefficient of D | Theil's index of E s | Gini Coefficient of E | Theil's index: of F | Gini Coefficient of F |
|------|--------------------|-----------------------|--------------------|-----------------------|--------------------|-----------------------|--------------------|-----------------------|----------------------|-----------------------|---------------------|-----------------------|
| 2004 | 0.39 | 0.48 | 0.22 | 0.37 | 0.40 | 0.49 | 0.33 | 0.45 | 0.15 | 0.30 | 0.22 | 0.36 |
| 2005 | 0.39 | 0.48 | 0.22 | 0.37 | 0.35 | 0.45 | 0.34 | 0.45 | 0.15 | 0.30 | 0.22 | 0.36 |
| 2006 | 0.38 | 0.48 | 0.22 | 0.37 | 0.42 | 0.50 | 0.33 | 0.45 | 0.15 | 0.30 | 0.22 | 0.37 |
| 2007 | 0.39 | 0.48 | 0.22 | 0.37 | 0.46 | 0.51 | 0.34 | 0.45 | 0.15 | 0.30 | 0.22 | 0.36 |
| 2008 | 0.37 | 0.47 | 0.22 | 0.37 | 0.50 | 0.54 | 0.36 | 0.46 | 0.15 | 0.30 | 0.22 | 0.36 |
| 2009 | 0.49 | 0.52 | 0.17 | 0.32 | 0.45 | 0.52 | 0.36 | 0.46 | 0.16 | 0.31 | 0.24 | 0.37 |
| 2010 | 0.58 | 0.56 | 0.17 | 0.32 | 0.35 | 0.44 | 0.36 | 0.46 | 0.16 | 0.31 | 0.23 | 0.36 |
| 2011 | 0.43 | 0.48 | 0.17 | 0.32 | 0.34 | 0.44 | 0.36 | 0.46 | 0.16 | 0.32 | 0.23 | 0.37 |
| 2012 | 0.43 | 0.47 | 0.17 | 0.32 | 0.36 | 0.46 | 0.35 | 0.46 | 0.17 | 0.33 | 0.23 | 0.36 |
| 2013 | 0.44 | 0.46 | 0.17 | 0.32 | 0.31 | 0.42 | 0.36 | 0.46 | 0.19 | 0.34 | 0.23 | 0.36 |
| 2014 | 0.51 | 0.49 | 0.17 | 0.32 | 0.29 | 0.41 | 0.36 | 0.46 | 0.19 | 0.34 | NA | NA |
| 2015 | 0.50 | 0.49 | 0.17 | 0.32 | 0.27 | 0.39 | 0.35 | 0.46 | 0.19 | 0.34 | NA | NA |
| 2016 | 0.47 | 0.49 | 0.17 | 0.32 | 0.32 | 0.43 | 0.35 | 0.46 | NA | NA | 0.24 | 0.37 |
| 2017 | 0.46 | 0.48 | 0.17 | 0.32 | 0.32 | 0.44 | 0.35 | 0.46 | NA | NA | 0.24 | 0.37 |

Table 4 shows changes in Theil's indices and Gini coefficients of the six adapted indicators. (Forestry investment as a proportion of regional GDP, Forest area as a proportion of total land area, Total extension of forest area, Number of nature reserves, Number of state-level nature reserves, and Nature reserve area as a proportion of the administrative area) Figure 6, uses line charts to further demonstrate the changes in trend in Theil's index.

According to table 4 and figure 6, Adapted indicators that require more natural endowments such as Numbers of nature reserves, Number of state-level nature reserves and Nature reserve area as a proportion of the administrative area did not demonstrate clear variations in provincial differences over time from 2004 to 2017. In other words, in the past ten over years, changes in such natural-endowments-heavy adapted indicators are more related to

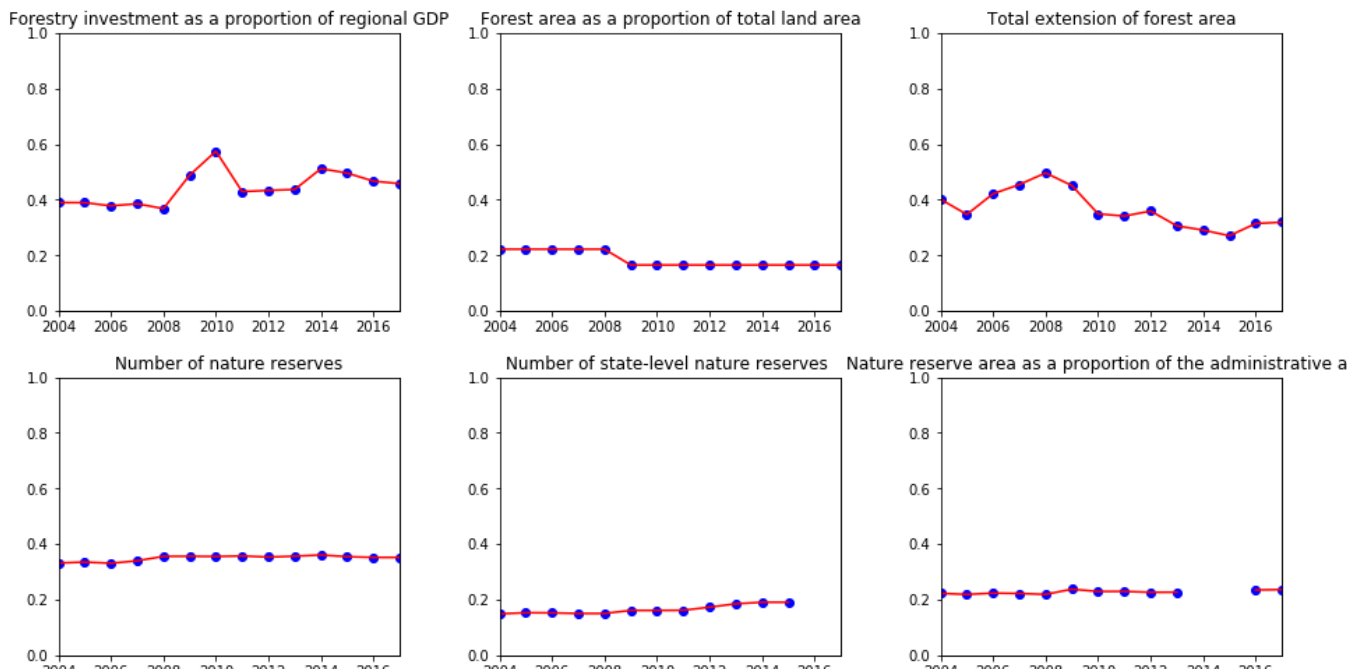


Fig.6 SDG15: Changes in Theil index

provincial differences instead of time differences.

Observing input and output related adapted indicators, the “Forestry investment as a proportion of regional GDP” indicator demonstrates a slight upward trend. The regional differences in “Total extension of forest area” showed a downward trend.

One possible explanation is that, in terms of capital investment, various localities have made different targeted investments based on their own endowments. (As shown in Figure 7, the proportion of forestry investment in Guangxi, Tibet, and Fujian has increased

rapidly over time.) Whereas for investment on forestry expansion, facing similar environmental protection urges from the central government, all provinces are actively working to improve their environment. Finally, in terms of the output target of SDG15, the provincial gap in “Forest area as a proportion of total land area” is narrowing. According to Figure 8, we can also find that the reason for narrowing provincial gaps in forest coverage is the simultaneous ecological improvements across all provinces, instead of forestry degradation in previously ecologically superior provinces.



Fig.7 Time series of Forestry investment as a proportion of regional GDP

Figure 8 demonstrates increases in forest areas across all 31 provinces in China. With regard to progresses in SDG15 (Life on Land), only some of the provinces including Qinghai, Tibet, Inner Mongolia, Jilin, Tianjin, Shandong, Xinjiang and Heilongjiang fell short. Also, given the simultaneous increases in both the proportion

of forestry investment and proportion of forest area, it is worth evaluating whether the fiscal investment causes the improvement in general. This possible causal relation will be examined in section 5 of this Chapter.



Fig.8 Time series of Forest area as a proportion of total land area for each province

8.4 Spatial Clustering of SDG 15

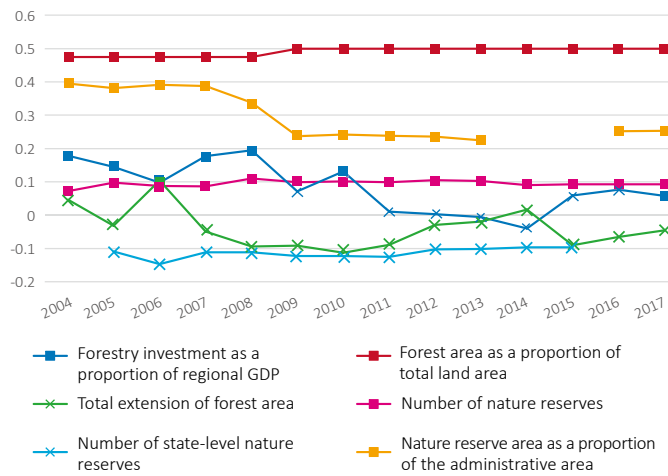


Fig.9 SDG15: adapted indicators' spatial auto-correlation

Figure 9 shows the spatial autocorrelation (both spillover effects and clustering) of following indicators including Forestry investment as a proportion of regional GDP, Forest area as a proportion of total land area, Total extension of forest area, Number of nature reserves, Number of state-level nature reserves, and Nature reserve area as a proportion of the administrative area. Here, “■” indicates a significant correlation and “x” indicates an insignificant one. A positive number suggests positive correlation, whereas a negative number suggests negative correlation.

From figure 9, we observe a change in spatial autocorrelation for the Forestry investment as a proportion of regional GDP indicator from positive spatial clustering to non-clustering. Meanwhile, adapted indicators including Forest area as the proportion of total land area, Number of nature reserves, and Nature reserve area as a proportion of the administrative area demonstrate relatively strong spatial clustering over time. We also observe almost no clustering for adapted indicators such as Total extension of forest area and Number of state-level nature reserves.

Hence, it is evident that the ecological input indicators (Forestry investment as a proportion of total regional GDP and Total extension of forest area) in various provinces have not experienced a strong spatial “spillover” effect, which means that the ecological investment efforts in various provinces are relatively equal. On the other hand, due to the constraints of natural endowments, such output indicator as Forest area as a proportion of total land area still endures a strong positive spatial clustering until 2017.

Finally, provinces with different advantages in natural endowments demonstrate gaps in performances in nature reserve-related indicators. Hence, the examination of these indicators similarly demonstrate relatively strong positive spatial clustering.

8.5 Effectiveness of Forestry Investment in Improving Life on Land

Table 5 Correlation between resource input and ecosystem improvement

| | Forest area as a proportion of total land area | Forest area as a proportion of total land area | Forestry stock | Forestry stock |
|--|--|--|-------------------------|--------------------------|
| | Fixed effect | Random effect | Fixed effect | Random effect |
| Forestry investment as a proportion of regional GDP | 223.8*** (57.43) | 224.3*** (57.92) | 20.26*** (4.829) | 19.13*** (4.715) |
| Total extension of forest area | 0.0104** (0.00347) | 0.00917** (0.00342) | 0.00241** (0.000713) | 0.00251*** (0.000733) |
| Number of nature reserves | 0.00421 (0.0146) | 0.0237 (0.0129) | -0.000821 (0.00254) | 0.0000856 (0.00230) |
| Number of state-level nature reserves | 0.609*** (0.130) | 0.577*** (0.121) | 0.112*** (0.0215) | 0.115*** (0.0224) |
| Area of nature reserves | 0.000819 (0.00614) | -0.00587 (0.00385) | -0.00213 (0.00136) | -0.00107 (0.00109) |
| Area of state-level nature reserves | -0.00161 (0.00797) | 0.00280 (0.00443) | 0.00513* (0.00243) | 0.00478* (0.00193) |
| Nature reserve area as a proportion of the administrative area | -0.563* (0.219) | -0.598** (0.191) | -0.0152 (0.0116) | -0.0257 (0.0153) |
| _cons | 25.57*** (3.128) | 26.71*** (3.457) | 2.450*** (0.659) | 2.016** (0.729) |
| Provincial effects | Control | Control | Control | Control |
| N | 309 | 309 | 309 | 309 |

Notes: * p < 0.05, ** p < 0.01, *** p < 0.001

Based on the above calculations, we conclude that the proportion of forestry investment changes in the same direction as the proportion of forest area.

The research used both fixed and random effect models to test the effect of forestry investment on the improvement of ecological output (Forest area as a proportion of total land area). We only controlled the provincial differences on the consideration that the dependent variable is more influenced by natural endowments of each province and less so by time. After controlling both manmade and natural influences, Forestry investments as a proportion of total regional GDP demonstrates a much more positive effect on the increases in Forest area as a proportion of total land area. This is also proven in the robustness check of forestry stocks. Also, the Total extension of forest area and the Number of state-level nature reserves demonstrate significant positive impacts on Forest area as a proportion of total land area and on forestry stock. Therefore, it is fair to conclude that properly increasing the proportion of forestry investment and the total extension of forest area can significantly improve the quality of life on land.

8.6 Summary

Although different provinces in China are possess vastly different natural endowments, their differences in SDG15 performance are narrowing. This narrowed gaps are primarily due to consistent efforts put in by each province over the past 20 years. However, although emphasis have been made on improving living conditions of life on land across all provinces, the endowment-related indicators still demonstrate relatively strong positive spatial clustering until 2017. In the long run, differences in natural endowments are unlikely to disappear. Instead, consistent efforts and continuous channeling of financial and other resources are the only ways to improve the quality of life on land.



9. Policy Recommendations

9.1 To Incorporate More Localized SDG Indicators into China's 14th Five-Year Plan

To promote quality development in China, the 2030 Agenda can be incorporated into the 14th Five-Year Plan based on China's domestic development experience, national conditions and development priorities. In this process, it is also necessary to measure, screen, revise, localize, classify, grade and quantify the SDGs and indicators to establish a system in line with China's national conditions.

Secondly, it is worth noting that disparities still exist in development levels between provinces and in performances between development goals of a same province, which, therefore, should be taken into consideration while localizing the 2030 Agenda. Special attention should be paid to huge development gaps between provinces including the uneven development of public services, the existing regional gaps in gender equality and the disparities in industry, innovation and infrastructure. Therefore,

in the next stage of China's development and reform, more importance should be attached to achieving SDGs around public services, equality, industry, innovation and infrastructure so that development gaps can be narrowed between provinces and goals with the purpose of comprehensive development.

Equally important is the classified monitoring of indicators, vertical comparisons and regional integration of some indicators. In view of the trans-regional and transnational characteristics of climate, marine resources and life below water, as well as their dynamics and geographical particularities, it is of critical importance to monitor Goal 13 (Climate Action) and Goal 14 (Life Below Water) at the national level and promote communication and cooperation at the international level. Besides, priorities of monitoring the goals should be distinguished at the local level in accordance with local development reality. For example, the monitoring standard for Goal 14 (Life Below Water) shall vary between coastal provinces and freshwater-rich provinces in order to strengthen monitoring and information exchange. In addition, there is still much room for implementation at the national and regional levels in terms of vertical comparison of SDGs. From the perspective of exploring the

constraints of target change, vertical comparison is more important than horizontal comparison, and is easier to help evaluated subjects find the “SDG accelerators” fit for themselves, especially for goals like Goal 15 (Life on Land) that are more relevant to natural endowment.

Finally, SDGs and the indicator system should be measurable, implementable, statistically available, monitorable, evaluable, examinable, able to be summarized and communicable. For national and local governments, the next key task of SDG monitoring is to figure out how to use multivariate statistics and other methods to identify key indicators that can be used for local government monitoring. In terms of the research methods of SDGs, the existing dimensionality reduction methods of indicators mostly focus on the logic of correlation analysis, so the screening of the key indicators can be more integrated into more approaches such as Social Network Analysis and Machine Learning. Additional efforts should be put to the collection, collation and utilization of data related to the implementation and monitoring of SDGs in a top-down approach. On the basis of monitoring, localities should strengthen the use of evaluation methods by setting up evaluation frameworks, issuing evaluation reports and conveying feedback to policy makers, and making corresponding adjustments for further implementation. More to mention, the government can set up institutions related to SDGs to facilitate research, exchange and cooperation at home and abroad, and to publish regular reports on the implementation progress and achievements of relevant SDGs, so as to provide policy and research reference of China’s 2030 Agenda for domestic and international institutions.

9.2 To Strengthen Domestic Policy Support and Mechanism Building, and Take a Multi-Pronged Approach to Promote the Local Sustainable Development Agenda

With respect to policymaking, the 17 SDGs, together with their targets and indicators, should be linked up with relevant policies and future plans which are based on China’s national conditions, so as to form an effective policy system with central guiding policies and local supportive policies. With respect to building mechanisms, the “central-local” government linkage mechanisms and interdepartmental coordination mechanisms should be established.

Incentive mechanism for local governments to implement the 2030 Agenda should also be established. First of all, sustainable development issues such as the localization of SDGs and the construction of “ecological civilization” can be included in the assessment of local governments; secondly, based on local differences and characteristics, it is feasible to expand the scope and level of constructing the National Innovation Demonstration Zones for implementation of SDGs. During the 14th Five-Year Plan period, the number of demonstration zones can grow to about 30 throughout the country. Thirdly, an online national information-sharing platform can be set up to share excellent and innovative local-level implementation methods, plans, mechanisms and cases of the 2030 Agenda, so as to encourage local governments to promote the agenda in an orderly and effective manner.

9.3 To Encourage Social Participation and International Cooperation, and Share Experience with the World

In the upcoming 14th Five-Year Plan period, we should give full play to the role of universities and scientific research institutes in promoting the 2030 Agenda. Joint expert consultation teams across regions, disciplines, and industries should be formed to conduct comprehensive and comparative studies on SDGs at global, international, national and local levels, so as to track the implementation and provide expert advice. The participation of international and regional organizations, domestic and foreign NGOs and the private sector should be encouraged to fully use their advantages in promoting the 2030 Agenda. International exchanges, communication and cooperation on SDGs should be strengthened, especially over issues with global, cross-regional and transnational characteristics, such as Goal 13 (Climate Action), Goal 14 (Life Below Water) and Goal 15 (Life on Land). The establishment of effective mechanisms of financing, communication, technology transfer, talents and laws should be speeded up to strengthen international and regional cooperation. It is of great significance to use narratives that are universally comprehensible and internationally acceptable, to exchange and share China’s experience with the world. By integrating the 2030 Agenda and SDGs into the construction of “the National Ecological Civilization Pilot Zone”, “National Innovation Demonstration Zones for Implementation of SDGs” and “the Shenzhen Demonstration Pilot Zone for Socialism with Chinese Characteristics”, the high-quality development experience can be displayed and exchanged. The platforms of international and regional organizations should be made good use of to share our experience in implementing SDGs for other countries in the world.

10. Appendix and Schedule





Appendix 1: The 2030 Agenda and review of China's 13th Five-Year Plan

| Policy background | Content and action | |
|---|---|---|
| The 2030 Agenda | <ul style="list-style-type: none"> Transforming our World: The 2030 Agenda for Sustainable Development (The 2030 Agenda) with 17 Year-2030 Sustainable Development Goals (SDGs) covered are global issues reached in the United Nations Sustainable Development Summit, aimed at providing guidance for the development of countries and international development cooperation after 2015. The 17 SDGs cover multiple dimensions, which are Goal 1 (No Poverty), Goal 2 (Zero Hunger), Goal 3 (Good Health and Well-being), Goal 4 (Quality Education), Goal 5 (Gender Equality), Goal 6 (Clean Water and Sanitation), Goal 7 (Affordable and Clean Energy), Goal 8 (Decent Work and Economic Growth), Goal 9 (Industry, Innovation and Infrastructure), Goal 10 (Reduced Inequality), Goal 11 (Sustainable Cities and Communities), Goal 12 (Responsible Consumption and Production), Goal 13 (Climate Action), Goal 14 (Life Below Water), Goal 15 (Life on Land), Goal 16 (Peace, Justice and Strong Institutions) and Goal 17 (Partnerships for the Goals). | |
| Policy documents of the 13th Five-Year Plan related to the 2030 Agenda | <ul style="list-style-type: none"> In March 2016, the 13th Five-Year Plan for Economic and Social Development of the People's Republic of China was published, which included 'Actively implementing the 2030 Agenda for Sustainable Development' in the Chapter 53 (Assume International Responsibilities and Obligations). In April 2016, China adopted China's Position Paper on the Implementation of the 2030 Agenda for Sustainable Development. In September 2016, the G20 Summit held in Hangzhou promoted G20 Action Plan on the 2030 Agenda for Sustainable Development. In October 2016, China formulated China's National Plan on Implementation of the 2030 Agenda for Sustainable Development, proposing specific plans and actions. In December 2016, China issued China's Construction Plan on National Innovation Demonstration Zone of Implementation of the 2030 Agenda for Sustainable Development. In August 2017, China published China's Progress Report on Implementation of the 2030 Agenda for Sustainable Development, which assessed the progress of China's sustainable development. In September 2019, China released China's Progress Report on Implementation of the 2030 Agenda for Sustainable Development 2019, revealing how SDGs were achieved in cases like poverty alleviation, innovation-driven development, ecological civilization construction, rural revitalization, and co-building of the Belt and Road Initiative. | |
| System Construction of the 13th Five-Year Plan related to the 2030 Agenda | <ul style="list-style-type: none"> During the 13th Five-Year Plan period, China has established a domestic coordination mechanism to implement the 2030 Agenda, which is led by the Ministry of Foreign Affairs of the People's Republic of China and based on the cooperation of 43 government departments. In March 2017, Center for International Knowledge on Development (CIKD) was officially approved to be established, providing a platform for China and other countries in the world to study and exchange development theories and practices related to the 2030 Agenda. Municipal governments of provinces and autonomous regions integrate the 2030 Agenda and Sustainable Development Goals into work to promote local economic and social development in accordance with the country's overall strategy. | |
| Chinese actions of the 13th Five-Year Plan related to the 2030 Agenda | <ul style="list-style-type: none"> According China's National Plan on Implementation of the 2030 Agenda for Sustainable Development, China has proposed plans and actions for all 17 SDGs and 169 targets. China's Progress Report on Implementation of the 2030 Agenda for Sustainable Development reviews China's policies and actions to implement the 17 SDGs and looks forward to future work. | |
| International actions of the 13th Five-Year Plan related to the 2030 Agenda | <ul style="list-style-type: none"> During the 13th Five-Year Plan period, China actively advocated the 2030 Agenda and SDGs in international platforms such as the United Nations and the G20 meeting, combined the 2030 Agenda with the Belt and Road Initiative strategy to promote the sustainable development process of countries along the routes. | |
| Policy documents corresponding to the 2030 Agenda and its targets *According to China's National Plan on Implementation of the 2030 Agenda for Sustainable Development | China formulated and implemented *10 SDGs and 20 targets | <ul style="list-style-type: none"> For Goal 2 (Zero Hunger), China implements Outline of National Agricultural Sustainable Development (2015-2030) (target 2.4). For Goal 5 (Gender Equality), China adopts the Outline for the Development of Chinese Women, the Outline for the Development of Chinese Children (target 5.1), Marriage Law of the Peoples Republic of China (target 5.3), the Law of the People's Republic of China on the Protection of Rights and Interests of Women, Law of the People's Republic of China on the Protection of Minors, the Anti-Domestic Violence Law of the People's Republic of China (target 5.c). For Goal 6 (Clean Water and Sanitation), China formulates the Action Plan for Water Pollution Prevention and Control (target 6.3). For Goal 8 (Decent Work and Economic Growth), China implements Made in China 2025 strategy (target 8.2), 10-Year Framework of Programmes on Sustainable Consumption and Production Patterns (10YFP) (target 8.4), Employment Promotion Law of the People's Republic of China (target 8.5), National Plan of Anti-Trafficking Action (2013-2020) (target 8.7) and the Plan for Promoting the Development of Financial Inclusion (2016-2020) (target 8.10). For Goal 9 (Industry, Innovation and Infrastructure), China adopts Made in China 2025 (target 9.2), the Plan for Promoting the Development of Financial Inclusion (2016-2020) and Outline of the National Strategy of Innovation-Driven Development (target 9.5). For Goal 11 (Sustainable Cities and Communities), China enforces Law of the People's Republic of China on the Protection of Cultural Relics, Intangible cultural heritage law of the People's Republic of China, Regulations on Scenic and Historic Areas, Regulation on Museums (target 11.4), Emergency Response Law of the People's Republic of China, Regulations on the Prevention and Control of Geological Hazards, Meteorology Law of the People's Republic of China, Law of the People's Republic of China on Road Traffic Safety (target 11.5). For Goal 13 (Climate Action), China implements Work Plan for Controlling Greenhouse Gas Emissions during the 13th Five-Year Plan (target 13.2). For Goal 14 (Life Below Water), China implements Regulations on the Administration of Fishery Fishing License (target 14.6). For Goal 15 (Life on Land), China enforces Law of the People's Republic of China on the Protection of Wildlife and improves List of Wildlife under Special State Protection (target 15.7). For Goal 16 (Peace, Justice and Strong Institutions), China implements Outline for children development (2011-2020), completed Outline for children development (2021-2030), and enforces Law of the Protection of Minors (target 16.2), Regulations on Household Registration and Law of the People's Republic of China on Resident Identity Cards (target 16.9). |
| | International promotion of *4 SDGs and 8 targets | <ul style="list-style-type: none"> For Goal 3 (Good Health and Well-being), China implemented World Health Organization Framework Convention on Tobacco Control (WHO FCTC) (target 3.a). For Goal 14 (Life Below Water), China supports the implementation Guidelines on the Transfer of Marine Technology (target 14.a) of the Intergovernmental Oceanographic Commission's Criteria and United Nations Convention on the Law of the Sea (target 14.c). For Goal 15 (Life on Land), China participates in the United Nations Convention to Combat Desertification (UNCCD) (target 15.3) and Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) (target 15.c). For Goal 17 (Partnerships for the Goals), China pushes for the implementation of the Addis Ababa Action Agenda (target 17.2), the implementation of the Agreement on Trade Facilitation (target 17.11), and the formulation of the G20 Action Plan on the 2030 Agenda for Sustainable Development (target 17.14). |

Appendix 2: SDGs connected to the economic and social development indicators of the 13th Five-Year Plan

| Indicator | Economic development | | | | Innovation driven | | | | People's well-being | | | | | | | Resources and Environment | | | | |
|-----------|----------------------|---|---|---|-------------------|---|---|---|---------------------|---|---|---|---|---|---|---------------------------|---|----|--------|--|
| | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | Number | |
| Goal | | | | | | | | | | | | | | | | | | | | |
| SDG1 | | | | | | √ | √ | √ | | | | | | | | | | | 4 | |
| SDG2 | | | | | | | √ | | | | | | | | | | | | 2 | |
| SDG3 | | | | | | | | | | | | | | | √ | √ | √ | √ | 4 | |
| SDG4 | | | | | | | √ | | √ | | | | | | | | | | 2 | |
| SDG5 | | | | | | | | | | | | | | | | | | | 0 | |
| SDG6 | | | | | | | | | | | | | | | | √ | √ | √ | 3 | |
| SDG7 | | | | | | | | | | | | | | | | | √ | | 2 | |
| SDG8 | √ | √ | | √ | | | | √ | √ | | | | | | | | | | 6 | |
| SDG9 | | | | | | | | | | | | | | | | | √ | √ | 6 | |
| SDG10 | | | | | | | | | | | | | | | | | | | 0 | |
| SDG11 | | | √ | | | | | | | | | | √ | | | √ | | | 5 | |
| SDG12 | | | | √ | | | | √ | √ | | | | | | | √ | √ | | 5 | |
| SDG13 | | | | | | | | | | | | | | | | | | √ | 3 | |
| SDG14 | | | | | | | | | | | | | | | | | | √ | 1 | |
| SDG15 | | | | | | | | | | | | | | | | | √ | | 1 | |
| SDG16 | | | | | | | | | | | | | | | | | | √ | 1 | |
| SDG17 | √ | | | | | | | | | √ | √ | | | | | | | | 4 | |
| Number | 2 | 1 | 1 | 2 | 1 | 2 | 3 | 3 | 1 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 5 | |
| | | | | | | | | | | | | | | | | | | | 3 | |
| | | | | | | | | | | | | | | | | | | | 5 | |

Appendix 3: Provincial SDG indicator system of China (2005-2016)

| SDGs | Targets | Indicators | Corresponding Indicators from 2030 Agenda | Correlation | |
|---|--|---|---|---|----------|
| 1 NO POVERTY  | Eradication of Extreme Poverty | Percentage of population living on minimum subsistence allowances | 1.1.1 Proportion of population below the international poverty line, by sex, age, employment status and geographical location (urban/rural). 1.3.1 Proportion of population covered by social protection floors/systems, by sex, distinguishing children, unemployed persons, older persons, persons with disabilities, pregnant women, newborns, work-injury victims and the poor and the vulnerable | Negative | |
| | Accessibility of Basic Services | Proportion of government spending on public services | 1.a.2 Proportion of total government spending on essential services (education, health and social protection) | Positive | |
| | | Education expenditure per capita | | Positive | |
| | | Proportion of population provided with family health services | 1.4.1 Proportion of population living in households with access to basic services | Positive | |
| | Participation in Social Protection | Participation rate of old-age insurance | 1.3.1 Proportion of population covered by social protection floors/systems, by sex, distinguishing children, unemployed persons, older persons, persons with disabilities, pregnant women, newborns, work-injury victims and the poor and the vulnerable | Positive | |
| | | Participation rate of health insurance | | Positive | |
| | | Participation rate of unemployment insurance | | Positive | |
| | 2 ZERO HUNGER  | Children's Nutrition Level | Percentage of undernourished children | 2.1.1 Prevalence of undernourishment | Negative |
| | 3 GOOD HEALTH AND WELL-BEING  | Infectious Disease Control | Tuberculosis incidence | 3.3.2 Tuberculosis incidence per 100,000 population | Negative |
| | | | Malaria incidence | 3.3.3 Malaria incidence per 1,000 population | Negative |
| Viral hepatitis incidence | | | 3.3.4 Hepatitis B incidence per 100,000 population | Negative | |
| Reproductive Health Level | | Maternal mortality rate at birth | 3.1.1 Maternal mortality ratio | Negative | |
| | | Infant mortality rate at birth | 3.2.1 Under-five mortality rate. 3.2.2 Neonatal mortality rate | Negative | |
| Possession of Medical Resources | | 3.2.2 Neonatal mortality rate | 3.c.1 Health worker density and distribution | Positive | |
| | Number of beds in medical establishments per 10,000 inhabitants | New Indicator | Positive | | |
| 4 QUALITY EDUCATION  | Educational Resource Input | Student-teacher ratio of primary education | 4.c.1 Proportion of teachers in: (a) pre-primary; (b) primary; (c) lower secondary; and (d) upper secondary education who have received at least the minimum organized teacher training (e.g. pedagogical training) pre-service or in-service required for teaching at the relevant level in a given country | Negative | |
| | | Student-teacher ratio in middle schools | | Negative | |
| | | Student-teacher ratio in high schools | | Negative | |
| | | Student-teacher ratio in secondary vocational schools | 4.3.1 Participation rate of youth and adults in formal and non-formal education and training in the previous 12 months, by sex | Negative | |
| | | Student-teacher ratio of higher education | | Negative | |
| | Education quality | Retention rate of compulsory education | 4.1.1 Proportion of children and young people: (a) in grades 2/3; (b) at the end of primary; and (c) at the end of lower secondary achieving at least a minimum proficiency level in (i) reading and (ii) mathematics, by sex | Positive | |
| | | Retention rate of preschool education | 4.2.2 Participation rate in organized learning (one year before the official primary entry age), by sex | Positive | |
| | | Average years of schooling | New Indicator | Positive | |
| | | Illiteracy rate | 4.6.1 Proportion of population in a given age group achieving at least a fixed level of proficiency in functional (a) literacy and (b) numeracy skills, by sex | Negative | |

| SDGs | Targets | Indicators | Corresponding Indicators from 2030 Agenda | Correlation |
|---|--|--|---|-------------|
| 5 GENDER EQUALITY  | Gender Equality in Education | Disparity of illiteracy rate by sex | 5.6.2 Number of countries with laws and regulations that guarantee full and equal access to women and men aged 15 years and older to sexual and reproductive health care, information and education | Negative |
| | | Proportion of non-schooled population by sex | | Negative |
| 6 CLEAN WATER AND SANITATION  | Accessibility of Domestic Water | Water availability in urban areas | 6.1.1 Proportion of population using safely managed drinking water services | Positive |
| | | Proportion of inhabitants with access to running water in rural areas | | Positive |
| | Clean Environment Management | Decontaminated and clean toilet coverage | 6.2.1 Proportion of population using safely managed sanitation services, including a hand-washing facility with soap and water | Positive |
| | | Proportion of wastewater safely treated in urban areas | 6.3.1 Proportion of wastewater safely treated | Positive |
| | | Proportion of decontaminated household waste | New Indicator | Positive |
| | Utilization of Water Resources | Water consumption per unit of GDP | 6.4.1 Change in water-use efficiency over time | Negative |
| Water resource per capita | | 6.4.2 Level of water stress: freshwater withdrawal as a proportion of available freshwater resources | Positive | |
| 7 AFFORDABLE AND CLEAN ENERGY  | Energy Utilization Rate | Energy consumption per unit of GDP | 7.3.1 Energy intensity measured in terms of primary energy and GDP | Negative |
| | | Decrease in energy consumption per unit of GDP | | Positive |
| | Energy Possession | Proportion of population with access to natural gas in urban areas | 7.1.2 Proportion of population with primary reliance on clean fuels and technology | Positive |
| 8 DECENT WORK AND ECONOMIC GROWTH  | Economic Development | GDP per capita | 8.1.1 Annual growth rate of real GDP per capita | Positive |
| | | GDP per employed person | 8.2.1 Annual growth rate of real GDP per employed person | Positive |
| | | Composite contribution of tourism to GDP | 8.9.1 Tourism direct GDP as a proportion of total GDP and in growth rate | Positive |
| | Employment Sufficiency | Registered urban unemployment rate | 8.5.2 Unemployment rate, by sex, age and persons with disabilities | Negative |
| 9 INDUSTRY, INNOVATION AND INFRASTRUCTURE  | Infrastructure Density | Road density | 9.1.1 Proportion of the rural population who live within 2 km of an all-season road. 9.1.2 Passenger and freight volumes, by mode of transport | Positive |
| | | Railway density | | Positive |
| | | Drainage density | | Positive |
| | | Water supply pipe density | | Positive |
| | Innovation Capacity | Internet coverage | 9.c.1 Proportion of population covered by a mobile network, by technology | Positive |
| | | Industrial companies' expenditure in R&D as percentage of GDP | 9.5.1 Research and development expenditure as a proportion of GDP | Positive |
| | | R&D personnel (in full-time equivalent) per 10,000 inhabitants | 9.5.2 Researchers (in full-time equivalent) per million inhabitants | Positive |
| | Secondary Sector Development | Proportion of invention patent holders per 10,000 inhabitants | New Indicator | Positive |
| Industrial added value as percentage of GDP | | 9.2.1 Manufacturing value added as a proportion of GDP and per capita | Positive | |
| | Percentage of manufacturing employment in total employment | 9.2.2 Manufacturing employment as a proportion of total employment | Positive | |

| SDGs | Targets | Indicators | Corresponding Indicators from 2030 Agenda | Correlation | |
|---|---|---|--|--|----------|
| 10 REDUCED INEQUALITIES  | Disparity between Urban and Rural Areas | Urban-rural disparity in personal disposable income | 10.1.1 Growth rates of household expenditure or income per capita among the bottom 40 per cent of the population and the total population | Negative | |
| | | Urban-rural consumption disparity | New Indicator | Negative | |
| | Regional Disparity | Coefficient of variation of GDP per capita in a province | New Indicator | Negative | |
| 11 SUSTAINABLE CITIES AND COMMUNITIES  | Environment of Public Space | Greenery coverage rate of the built-up areas | 11.7.1 Average share of the built-up area of cities that is open space for public use for all, by sex, age and persons with disabilities | Positive | |
| | | Population density | 11.3.1 Ratio of land consumption rate to population growth rate | Negative | |
| | | Disposal and utilization rate of hazardous industrial wastes | 11.5.2 Direct economic loss in relation to global GDP, damage to critical infrastructure and number of disruptions to basic services, attributed to disasters | Positive | |
| | | Mean levels of PM2.5 in cities | 11.6.1 Proportion of urban solid waste regularly collected and with adequate final discharge out of total urban solid waste generated, by cities | Negative | |
| | Accidental Casualties | Number of deaths from traffic accidents per 10,000 population | 11.5.1 Number of deaths, missing persons and directly affected persons attributed to disasters per 100,000 population 11.5.2 Direct economic loss in relation to global GDP, damage to critical infrastructure and number of disruptions to basic services, attributed to disasters | Negative | |
| | | Number of deaths from fire accidents per 10,000 population | | Negative | |
| | | Number of deaths from natural disasters per 10,000 population | | Negative | |
| | | Proportion of economic loss from natural disasters | | Negative | |
| | 12 RESPONSIBLE CONSUMPTION AND PRODUCTION  | Improvement in the Three Wastes Treatment | Composite utilization rate of industrial solid waste | 12.4.2 Hazardous waste generated per capita and proportion of hazardous waste treated, by type of treatment 12.5.1 National recycling rate, tons of material recycled | Positive |
| | | | Emissions per unit of industrial added value | | Negative |
| Effluent treatment rate | | | 12.2.1 Material footprint, material footprint per capita, and material footprint per GDP. | Negative | |
| Improvement in Cutting Emissions | | Ammonia and nitrogen emissions per unit of GDP | 12.4.1 Number of parties to international multilateral environmental agreements on hazardous waste, and other chemicals that meet their commitments and obligations in transmitting information as required by each relevant agreement | Negative | |
| | | Chemical oxygen demand emissions per unit of GDP | | Negative | |
| | | SO ₂ emissions per unit of GDP | | Negative | |
| | | CO ₂ emissions per unit of GDP | | Negative | |
| 16 PEACE, JUSTICE AND STRONG INSTITUTIONS  | Possession of Judicial Resources | Number of lawyers per 10,000 population | New Indicator | Positive | |
| | Occurrence of Legal Cases | Administrative litigation incidence | 16.10.1 Number of verified cases of killing, kidnapping, enforced disappearance, arbitrary detention and torture of journalists, associated media personnel, trade unionists and human rights advocates in the previous 12 months | Negative | |
| | | Incidence of corruption | 16.5.1 Proportion of persons who had at least one contact with a public official and who paid a bribe to a public official, or were asked for a bribe by those public officials, during the previous 12 months. 16.5.2 Proportion of businesses that had at least one contact with a public official and that paid a bribe to a public official, or were asked for a bribe by those public officials during the previous 12 months | Negative | |
| 17 PARTNERSHIPS FOR THE GOALS  | Fiscal Capacity | Fiscal revenue as percentage of GDP | 17.1.1 Total government revenue as a proportion of GDP, by source | Positive | |
| | | Fiscal self-reliance rate | | Positive | |
| | | Tax revenue as percentage of total fiscal revenue | 17.1.2 Proportion of domestic budget funded by domestic taxes | Positive | |

Table 1 Theil index of Total SDG Index score (2005-2016)

| Year | Theil index | Intra-group contribution | | Inter-group contribution | | The East Contribution | | The Middle contribution | | The West contribution | |
|------|-------------|--------------------------|------------|--------------------------|------------|-----------------------|------------|-------------------------|------------|-----------------------|------------|
| | | Theil index | Proportion | Theil index | Proportion | Theil index | Proportion | Theil index | Proportion | Theil index | Proportion |
| 2005 | 0.0082908 | 0.003396 | 40.96% | 0.0048950 | 59.04% | 0.0022861 | 27.57% | 0.0002027 | 2.44% | 0.0009070 | 10.94% |
| 2006 | 0.0078188 | 0.003167 | 40.51% | 0.0046516 | 59.49% | 0.0019573 | 25.03% | 0.0001590 | 2.03% | 0.0010509 | 13.44% |
| 2007 | 0.0078400 | 0.003172 | 40.46% | 0.0046682 | 59.54% | 0.0020617 | 26.30% | 0.0001820 | 2.32% | 0.0009281 | 11.84% |
| 2008 | 0.0073660 | 0.002974 | 40.37% | 0.0043921 | 59.63% | 0.0019247 | 26.13% | 0.0001290 | 1.75% | 0.0009202 | 12.49% |
| 2009 | 0.0075564 | 0.002951 | 39.05% | 0.0046056 | 60.95% | 0.0018060 | 23.90% | 0.0001456 | 1.93% | 0.0009991 | 13.22% |
| 2010 | 0.0079098 | 0.003107 | 39.28% | 0.0048028 | 60.72% | 0.0017887 | 22.61% | 0.0001554 | 1.96% | 0.0011628 | 14.70% |
| 2011 | 0.0075735 | 0.003016 | 39.83% | 0.0045573 | 60.17% | 0.0017173 | 22.68% | 0.0001616 | 2.13% | 0.0011373 | 15.02% |
| 2012 | 0.0084712 | 0.003513 | 41.47% | 0.0049579 | 58.53% | 0.0019053 | 22.49% | 0.0002057 | 2.43% | 0.0014023 | 16.55% |
| 2013 | 0.0084863 | 0.003553 | 41.87% | 0.0049332 | 58.13% | 0.0021114 | 24.88% | 0.0001575 | 1.86% | 0.0012843 | 15.13% |
| 2014 | 0.0080111 | 0.00323 | 40.32% | 0.0047807 | 59.68% | 0.0019227 | 24.00% | 0.0001982 | 2.47% | 0.0011096 | 13.85% |
| 2015 | 0.0082889 | 0.003398 | 41.00% | 0.0048909 | 59.00% | 0.0019505 | 23.53% | 0.0002673 | 3.22% | 0.0011804 | 14.24% |
| 2016 | 0.0086890 | 0.003844 | 44.24% | 0.0048446 | 55.76% | 0.0021303 | 24.52% | 0.0002628 | 3.02% | 0.0014513 | 16.70% |

Table 2 Theil Index of SDG1 Index score (2005-2016)

| Year | Theil index | Intra-group contribution | | Inter-group contribution | | The East Contribution | | The Middle contribution | | The West contribution | |
|------|-------------|--------------------------|------------|--------------------------|------------|-----------------------|------------|-------------------------|------------|-----------------------|------------|
| | | Theil index | Proportion | Theil index | Proportion | Theil index | Proportion | Theil index | Proportion | Theil index | Proportion |
| 2005 | 0.0083029 | 0.0041035 | 49.42% | 0.0041995 | 50.58% | 0.0028263 | 34.04% | 0.0001315 | 1.58% | 0.0011458 | 13.80% |
| 2006 | 0.0082217 | 0.0038729 | 47.11% | 0.0043488 | 52.89% | 0.0026997 | 32.84% | 0.0001231 | 1.50% | 0.0010500 | 12.77% |
| 2007 | 0.0083674 | 0.0039512 | 47.22% | 0.0044161 | 52.78% | 0.0028865 | 34.50% | 0.0001183 | 1.41% | 0.0009464 | 11.31% |
| 2008 | 0.0070691 | 0.0038470 | 54.42% | 0.0032221 | 45.58% | 0.0017396 | 24.61% | 0.0000448 | 0.63% | 0.0020626 | 29.18% |
| 2009 | 0.0078391 | 0.0023509 | 29.99% | 0.0054882 | 70.01% | 0.0016328 | 20.83% | 0.0001153 | 1.47% | 0.0006029 | 7.69% |
| 2010 | 0.0061649 | 0.0026117 | 42.36% | 0.0035532 | 57.64% | 0.0014368 | 23.31% | 0.0000491 | 0.80% | 0.0011258 | 18.26% |
| 2011 | 0.0072605 | 0.0026305 | 36.23% | 0.0046300 | 63.77% | 0.0014504 | 19.98% | 0.0001084 | 1.49% | 0.0010718 | 14.76% |
| 2012 | 0.0065909 | 0.0025976 | 39.41% | 0.0039934 | 60.59% | 0.0012861 | 19.51% | 0.0002197 | 3.33% | 0.0010918 | 16.56% |
| 2013 | 0.0073753 | 0.0029774 | 40.37% | 0.0043978 | 59.63% | 0.0014436 | 19.57% | 0.0001543 | 2.09% | 0.0013795 | 18.70% |
| 2014 | 0.0071975 | 0.0030432 | 42.28% | 0.0041543 | 57.72% | 0.0013400 | 18.62% | 0.0001302 | 1.81% | 0.0015730 | 21.85% |
| 2015 | 0.0069306 | 0.0027914 | 40.28% | 0.0041392 | 59.72% | 0.0011513 | 16.61% | 0.0001931 | 2.79% | 0.0014470 | 20.88% |
| 2016 | 0.0086999 | 0.0036293 | 41.72% | 0.0050706 | 58.28% | 0.0013281 | 15.27% | 0.0004375 | 5.03% | 0.0018638 | 21.42% |

Table 3 Theil Index of SDG2 Index score (2005-2016)

| Year | Theil index | Intra-group contribution | | Inter-group contribution | | The East Contribution | | The Middle contribution | | The West contribution | |
|------|-------------|--------------------------|------------|--------------------------|------------|-----------------------|------------|-------------------------|------------|-----------------------|------------|
| | | Theil index | Proportion | Theil index | Proportion | Theil index | Proportion | Theil index | Proportion | Theil index | Proportion |
| 2005 | 0.0103182 | 0.0083123 | 80.56% | 0.0020059 | 19.44% | 0.0031036 | 30.08% | 0.0012775 | 12.38% | 0.0039312 | 38.10% |
| 2006 | 0.0099079 | 0.0082358 | 83.12% | 0.0016721 | 16.88% | 0.0032403 | 32.70% | 0.0011412 | 11.52% | 0.0038543 | 38.90% |
| 2007 | 0.0096314 | 0.0081720 | 84.85% | 0.0014594 | 15.15% | 0.0031503 | 32.71% | 0.0006607 | 6.86% | 0.0043611 | 45.28% |
| 2008 | 0.0110412 | 0.0098994 | 89.66% | 0.0011417 | 10.34% | 0.0037582 | 34.04% | 0.0021874 | 19.81% | 0.0039539 | 35.81% |
| 2009 | 0.0100509 | 0.0088586 | 88.14% | 0.0011923 | 11.86% | 0.0035555 | 35.37% | 0.0009911 | 9.86% | 0.0043121 | 42.90% |
| 2010 | 0.0099900 | 0.0086826 | 86.91% | 0.0013074 | 13.09% | 0.0036380 | 36.42% | 0.0011427 | 11.44% | 0.0039019 | 39.06% |
| 2011 | 0.0097592 | 0.0087531 | 89.69% | 0.0010061 | 10.31% | 0.0041702 | 42.73% | 0.0013197 | 13.52% | 0.0032632 | 33.44% |
| 2012 | 0.0100468 | 0.0092669 | 92.24% | 0.0007799 | 7.76% | 0.0041615 | 41.42% | 0.0013052 | 12.99% | 0.0038002 | 37.82% |
| 2013 | 0.0085294 | 0.0079946 | 93.73% | 0.0005348 | 6.27% | 0.0038354 | 44.97% | 0.0015444 | 18.11% | 0.0026149 | 30.66% |
| 2014 | 0.0084898 | 0.0079291 | 93.40% | 0.0005607 | 6.60% | 0.0036887 | 43.45% | 0.0014165 | 16.68% | 0.0028238 | 33.26% |
| 2015 | 0.0082346 | 0.0077280 | 93.85% | 0.0005066 | 6.15% | 0.0037733 | 45.82% | 0.0015154 | 18.40% | 0.0024393 | 29.62% |
| 2016 | 0.0085294 | 0.0079946 | 93.73% | 0.0005348 | 6.27% | 0.0038354 | 44.97% | 0.0015444 | 18.11% | 0.0026149 | 30.66% |

Table 4 Theil Index of SDG3 Index score (2005-2016)

| Year | Theil index | Intra-group contribution | | Inter-group contribution | | The East Contribution | | The Middle contribution | | The West contribution | |
|------|-------------|--------------------------|------------|--------------------------|------------|-----------------------|------------|-------------------------|------------|-----------------------|------------|
| | | Theil index | Proportion | Theil index | Proportion | Theil index | Proportion | Theil index | Proportion | Theil index | Proportion |
| 2005 | 0.0082507 | 0.0032359 | 39.22% | 0.0050148 | 60.78% | 0.0019604 | 23.76% | 0.0001058 | 1.28% | 0.001170 | 14.18% |
| 2006 | 0.0093945 | 0.0036841 | 39.22% | 0.0057103 | 60.78% | 0.0020967 | 22.32% | 0.0000691 | 0.74% | 0.001518 | 16.16% |
| 2007 | 0.0092642 | 0.0038080 | 41.10% | 0.0054562 | 58.90% | 0.0018673 | 20.16% | 0.0000767 | 0.83% | 0.001864 | 20.12% |
| 2008 | 0.0086328 | 0.0037544 | 43.49% | 0.0048785 | 56.51% | 0.0016874 | 19.55% | 0.0000687 | 0.80% | 0.001998 | 23.15% |
| 2009 | 0.0079547 | 0.0036078 | 45.35% | 0.0043469 | 54.65% | 0.0016151 | 20.30% | 0.0000989 | 1.24% | 0.001894 | 23.81% |
| 2010 | 0.0084621 | 0.0039022 | 46.11% | 0.0045598 | 53.89% | 0.0015334 | 18.12% | 0.0002186 | 2.58% | 0.002150 | 25.41% |
| 2011 | 0.0078180 | 0.0035713 | 45.68% | 0.0042467 | 54.32% | 0.0013567 | 17.35% | 0.0001598 | 2.04% | 0.002055 | 26.28% |
| 2012 | 0.0086893 | 0.0046871 | 53.94% | 0.0040022 | 46.06% | 0.0019034 | 21.91% | 0.0002103 | 2.42% | 0.002573 | 29.61% |
| 2013 | 0.0063231 | 0.0034193 | 54.08% | 0.0029038 | 45.92% | 0.0012273 | 19.41% | 0.0003344 | 5.29% | 0.001858 | 29.38% |
| 2014 | 0.0087814 | 0.0050593 | 57.61% | 0.0037221 | 42.39% | 0.0019716 | 22.45% | 0.0004787 | 5.45% | 0.002609 | 29.71% |
| 2015 | 0.0082694 | 0.0048282 | 58.39% | 0.0034412 | 41.61% | 0.0016530 | 19.99% | 0.0003595 | 4.35% | 0.002816 | 34.05% |
| 2016 | 0.0077726 | 0.0046551 | 59.89% | 0.0031175 | 40.11% | 0.0016866 | 21.70% | 0.0002723 | 3.50% | 0.002696 | 34.69% |

Table 5 Theil Index of SDG4 Index score (2005-2016)

| Year | Theil index | Intra-group contribution | | Inter-group contribution | | The East Contribution | | The Middle contribution | | The West contribution | |
|------|-------------|--------------------------|------------|--------------------------|------------|-----------------------|------------|-------------------------|------------|-----------------------|------------|
| | | Theil index | Proportion | Theil index | Proportion | Theil index | Proportion | Theil index | Proportion | Theil index | Proportion |
| 2005 | 0.0079970 | 0.0061193 | 76.52% | 0.0018777 | 23.48% | 0.0021653 | 27.08% | 0.0022821 | 28.54% | 0.0016719 | 20.91% |
| 2006 | 0.0078208 | 0.0059192 | 75.69% | 0.0019016 | 24.31% | 0.0022898 | 29.28% | 0.0020356 | 26.03% | 0.0015937 | 20.38% |
| 2007 | 0.0087422 | 0.0062640 | 71.65% | 0.0024782 | 28.35% | 0.0022742 | 26.01% | 0.0023157 | 26.49% | 0.0016741 | 19.15% |
| 2008 | 0.0073730 | 0.0052432 | 71.11% | 0.0021298 | 28.89% | 0.0019513 | 26.47% | 0.0016883 | 22.90% | 0.0016035 | 21.75% |
| 2009 | 0.0071983 | 0.0050821 | 70.60% | 0.0021162 | 29.40% | 0.0018304 | 25.43% | 0.0014021 | 19.48% | 0.0018495 | 25.69% |
| 2010 | 0.0076711 | 0.0051691 | 67.38% | 0.0025020 | 32.62% | 0.0017078 | 22.26% | 0.0018536 | 24.16% | 0.0016077 | 20.96% |
| 2011 | 0.0074425 | 0.0049471 | 66.47% | 0.0024954 | 33.53% | 0.0017041 | 22.90% | 0.0014349 | 19.28% | 0.0018081 | 24.29% |
| 2012 | 0.0074324 | 0.0050715 | 68.23% | 0.0023609 | 31.77% | 0.0015976 | 21.50% | 0.0012918 | 17.38% | 0.0021821 | 29.36% |
| 2013 | 0.0072971 | 0.0052614 | 72.10% | 0.0020357 | 27.90% | 0.0020824 | 28.54% | 0.0011360 | 15.57% | 0.0020430 | 28.00% |
| 2014 | 0.0080395 | 0.0055761 | 69.36% | 0.0024633 | 30.64% | 0.0022470 | 27.95% | 0.0012602 | 15.67% | 0.0020690 | 25.74% |
| 2015 | 0.0074810 | 0.0046614 | 62.31% | 0.0028196 | 37.69% | 0.0017920 | 23.95% | 0.0011536 | 15.42% | 0.0017158 | 22.94% |
| 2016 | 0.0103489 | 0.0073832 | 71.34% | 0.0029657 | 28.66% | 0.0022909 | 22.14% | 0.0025388 | 24.53% | 0.0025534 | 24.67% |

Table 6 Theil Index of SDG5 Index score (2005-2016)

| Year | Theil index | Intra-group contribution | | Inter-group contribution | | The East Contribution | | The Middle contribution | | The West contribution | |
|------|-------------|--------------------------|------------|--------------------------|------------|-----------------------|------------|-------------------------|------------|-----------------------|------------|
| | | Theil index | Proportion | Theil index | Proportion | Theil index | Proportion | Theil index | Proportion | Theil index | Proportion |
| 2005 | 0.0095601 | 0.0079240 | 82.89% | 0.0016361 | 17.11% | 0.0021707 | 22.71% | 0.0018173 | 19.01% | 0.0039360 | 41.17% |
| 2006 | 0.0093330 | 0.0080557 | 86.31% | 0.0012773 | 13.69% | 0.0019059 | 20.42% | 0.0019598 | 21.00% | 0.0041899 | 44.89% |
| 2007 | 0.0099725 | 0.0088246 | 88.49% | 0.0011479 | 11.51% | 0.0022943 | 23.01% | 0.0021519 | 21.58% | 0.0043784 | 43.91% |
| 2008 | 0.0099353 | 0.0089297 | 89.88% | 0.0010056 | 10.12% | 0.0029579 | 29.77% | 0.0017026 | 17.14% | 0.0042691 | 42.97% |
| 2009 | 0.0087349 | 0.0076758 | 87.88% | 0.0010591 | 12.12% | 0.0016670 | 19.08% | 0.0017248 | 19.75% | 0.0042841 | 49.05% |
| 2010 | 0.0083651 | 0.0073620 | 88.01% | 0.0010031 | 11.99% | 0.0015947 | 19.06% | 0.0018775 | 22.44% | 0.0038898 | 46.50% |
| 2011 | 0.0077666 | 0.0069412 | 89.37% | 0.0008255 | 10.63% | 0.0015317 | 19.72% | 0.0020644 | 26.58% | 0.0033450 | 43.07% |
| 2012 | 0.0090496 | 0.0081497 | 90.06% | 0.0009000 | 9.94% | 0.0017387 | 19.21% | 0.0027450 | 30.33% | 0.0036660 | 40.51% |
| 2013 | 0.0088329 | 0.0073918 | 83.69% | 0.0014410 | 16.31% | 0.0027973 | 31.67% | 0.0014683 | 16.62% | 0.0031262 | 35.39% |
| 2014 | 0.0097941 | 0.0076309 | 77.91% | 0.0021632 | 22.09% | 0.0026670 | 27.23% | 0.0012926 | 13.20% | 0.0036713 | 37.48% |
| 2015 | 0.0093531 | 0.0075434 | 80.65% | 0.0018097 | 19.35% | 0.0023143 | 24.74% | 0.0010247 | 10.96% | 0.0042045 | 44.95% |
| 2016 | 0.0089077 | 0.0076037 | 85.36% | 0.0013040 | 14.64% | 0.0026975 | 30.28% | 0.0014101 | 15.83% | 0.0034961 | 39.25% |

Table 7 Theil Index of SDG6 Index score (2005-2016)

| Year | Theil index | Intra-group contribution | | Inter-group contribution | | The East Contribution | | The Middle contribution | | The West contribution | |
|------|-------------|--------------------------|------------|--------------------------|------------|-----------------------|------------|-------------------------|------------|-----------------------|------------|
| | | Theil index | Proportion | Theil index | Proportion | Theil index | Proportion | Theil index | Proportion | Theil index | Proportion |
| 2005 | 0.0069021 | 0.0035135 | 50.90% | 0.0033887 | 49.10% | 0.0012714 | 18.42% | 0.0002008 | 2.91% | 0.0020412 | 29.57% |
| 2006 | 0.0080608 | 0.0034423 | 42.70% | 0.0046184 | 57.30% | 0.0017173 | 21.30% | 0.0004128 | 5.12% | 0.0013122 | 16.28% |
| 2007 | 0.0115466 | 0.0059721 | 51.72% | 0.0055745 | 48.28% | 0.0023894 | 20.69% | 0.0005599 | 4.85% | 0.0030228 | 26.18% |
| 2008 | 0.0120411 | 0.0059024 | 49.02% | 0.0061387 | 50.98% | 0.0021223 | 17.63% | 0.0008309 | 6.90% | 0.0029492 | 24.49% |
| 2009 | 0.0116314 | 0.0055770 | 47.95% | 0.0060544 | 52.05% | 0.0021983 | 18.90% | 0.0009684 | 8.33% | 0.0024104 | 20.72% |
| 2010 | 0.0080899 | 0.0043837 | 54.19% | 0.0037062 | 45.81% | 0.0014821 | 18.32% | 0.0012636 | 15.62% | 0.0016380 | 20.25% |
| 2011 | 0.0074561 | 0.0032977 | 44.23% | 0.0041584 | 55.77% | 0.0006591 | 8.84% | 0.0011249 | 15.09% | 0.0015137 | 20.30% |
| 2012 | 0.0087103 | 0.0036550 | 41.96% | 0.0050553 | 58.04% | 0.0007675 | 8.81% | 0.0012853 | 14.76% | 0.0016023 | 18.40% |
| 2013 | 0.0080825 | 0.0032679 | 40.43% | 0.0048146 | 59.57% | 0.0006034 | 7.47% | 0.0010517 | 13.01% | 0.0016128 | 19.95% |
| 2014 | 0.0080421 | 0.0036650 | 45.57% | 0.0043771 | 54.43% | 0.0009497 | 11.81% | 0.0013801 | 17.16% | 0.0013352 | 16.60% |
| 2015 | 0.0080375 | 0.0036515 | 45.43% | 0.0043859 | 54.57% | 0.0009730 | 12.11% | 0.0013710 | 17.06% | 0.0013076 | 16.27% |
| 2016 | 0.0092210 | 0.0041634 | 45.15% | 0.0050575 | 54.85% | 0.0010656 | 11.56% | 0.0014938 | 16.20% | 0.0016040 | 17.40% |

Table 8 Theil Index of SDG7 Index score (2005-2016)

| Year | Theil index | Intra-group contribution | | Inter-group contribution | | The East Contribution | | The Middle contribution | | The West contribution | |
|------|-------------|--------------------------|------------|--------------------------|------------|-----------------------|------------|-------------------------|------------|-----------------------|------------|
| | | Theil index | Proportion | Theil index | Proportion | Theil index | Proportion | Theil index | Proportion | Theil index | Proportion |
| 2005 | 0.0089625 | 0.0082964 | 92.57% | 0.0006660 | 7.43% | 0.0045787 | 51.09% | 0.0013826 | 15.43% | 0.0023351 | 26.05% |
| 2006 | 0.0080281 | 0.0067123 | 83.61% | 0.0013158 | 16.39% | 0.0032522 | 40.51% | 0.0007677 | 9.56% | 0.0026924 | 33.54% |
| 2007 | 0.0077880 | 0.0067753 | 87.00% | 0.0010127 | 13.00% | 0.0041708 | 53.55% | 0.0001707 | 2.19% | 0.0024339 | 31.25% |
| 2008 | 0.0073204 | 0.0063360 | 86.55% | 0.0009843 | 13.45% | 0.0041504 | 56.70% | 0.0001896 | 2.59% | 0.0019960 | 27.27% |
| 2009 | 0.0061303 | 0.0055982 | 91.32% | 0.0005320 | 8.68% | 0.0027333 | 44.59% | 0.0003566 | 5.82% | 0.0025083 | 40.92% |
| 2010 | 0.0066098 | 0.0059528 | 90.06% | 0.0006571 | 9.94% | 0.0018587 | 28.12% | 0.0005752 | 8.70% | 0.0035188 | 53.24% |
| 2011 | 0.0074197 | 0.0059158 | 79.73% | 0.0015039 | 20.27% | 0.0030850 | 41.58% | 0.0002465 | 3.32% | 0.0025844 | 34.83% |
| 2012 | 0.0065136 | 0.0052479 | 80.57% | 0.0012657 | 19.43% | 0.0020109 | 30.87% | 0.0001915 | 2.94% | 0.0030456 | 46.76% |
| 2013 | 0.0089882 | 0.0081770 | 90.98% | 0.0008112 | 9.02% | 0.0036906 | 41.06% | 0.0007389 | 8.22% | 0.0037475 | 41.69% |
| 2014 | 0.0069808 | 0.0057557 | 82.45% | 0.0012252 | 17.55% | 0.0036617 | 52.45% | 0.0004291 | 6.15% | 0.0016649 | 23.85% |
| 2015 | 0.0108817 | 0.0098621 | 90.63% | 0.0010196 | 9.37% | 0.0052327 | 48.09% | 0.0014351 | 13.19% | 0.0031943 | 29.35% |
| 2016 | 0.0083027 | 0.0080030 | 96.39% | 0.0002997 | 3.61% | 0.0037381 | 45.02% | 0.0007215 | 8.69% | 0.0035435 | 42.68% |

Table 9 Theil Index of SDG8 Index score (2005-2016)

| Year | Theil index | Intra-group contribution | | Inter-group contribution | | The East Contribution | | The Middle contribution | | The West contribution | |
|------|-------------|--------------------------|------------|--------------------------|------------|-----------------------|------------|-------------------------|------------|-----------------------|------------|
| | | Theil index | Proportion | Theil index | Proportion | Theil index | Proportion | Theil index | Proportion | Theil index | Proportion |
| 2005 | 0.0070142 | 0.0044069 | 62.83% | 0.0026073 | 37.17% | 0.0031507 | 44.92% | 0.0008224 | 11.73% | 0.0004338 | 6.18% |
| 2006 | 0.0071331 | 0.0041587 | 58.30% | 0.0029744 | 41.70% | 0.0030465 | 42.71% | 0.0007967 | 11.17% | 0.0003154 | 4.42% |
| 2007 | 0.0079931 | 0.0041305 | 51.68% | 0.0038626 | 48.32% | 0.0028722 | 35.93% | 0.0008614 | 10.78% | 0.0003969 | 4.97% |
| 2008 | 0.0059109 | 0.0033072 | 55.95% | 0.0026037 | 44.05% | 0.0021189 | 35.85% | 0.0005362 | 9.07% | 0.0006521 | 11.03% |
| 2009 | 0.0075375 | 0.0034764 | 46.12% | 0.0040611 | 53.88% | 0.0025909 | 34.37% | 0.0003616 | 4.80% | 0.0005239 | 6.95% |
| 2010 | 0.0075766 | 0.0037858 | 49.97% | 0.0037908 | 50.03% | 0.0025106 | 33.14% | 0.0004784 | 6.31% | 0.0007969 | 10.52% |
| 2011 | 0.0080970 | 0.0037801 | 46.68% | 0.0043169 | 53.32% | 0.0024834 | 30.67% | 0.0004617 | 5.70% | 0.0008350 | 10.31% |
| 2012 | 0.0075850 | 0.0044352 | 58.47% | 0.0031498 | 41.53% | 0.0029418 | 38.78% | 0.0006371 | 8.40% | 0.0008563 | 11.29% |
| 2013 | 0.0058846 | 0.0034819 | 59.17% | 0.0024027 | 40.83% | 0.0020903 | 35.52% | 0.0006380 | 10.84% | 0.0007537 | 12.81% |
| 2014 | 0.0055362 | 0.0032722 | 59.10% | 0.0022641 | 40.90% | 0.0018278 | 33.01% | 0.0005918 | 10.69% | 0.0008526 | 15.40% |
| 2015 | 0.0053146 | 0.0036477 | 68.64% | 0.0016669 | 31.36% | 0.0019231 | 36.19% | 0.0008596 | 16.17% | 0.0008650 | 16.28% |
| 2016 | 0.0065814 | 0.0047974 | 72.89% | 0.0017840 | 27.11% | 0.0028580 | 43.43% | 0.0009497 | 14.43% | 0.0009897 | 15.04% |

Table 10 Theil Index of SDG9 Index score (2005-2016)

| Year | Theil index | Intra-group contribution | | Inter-group contribution | | The East Contribution | | The Middle contribution | | The West contribution | |
|------|-------------|--------------------------|------------|--------------------------|------------|-----------------------|------------|-------------------------|------------|-----------------------|------------|
| | | Theil index | Proportion | Theil index | Proportion | Theil index | Proportion | Theil index | Proportion | Theil index | Proportion |
| 2005 | 0.0098995 | 0.0043657 | 44.10% | 0.0055338 | 55.90% | 0.0036934 | 37.31% | 0.0003065 | 3.10% | 0.0003658 | 3.70% |
| 2006 | 0.0093260 | 0.0042138 | 45.18% | 0.0051122 | 54.82% | 0.0035044 | 37.58% | 0.0002626 | 2.82% | 0.0004467 | 4.79% |
| 2007 | 0.0094048 | 0.0042609 | 45.31% | 0.0051439 | 54.69% | 0.0035380 | 37.62% | 0.0002289 | 2.43% | 0.0004940 | 5.25% |
| 2008 | 0.0094998 | 0.0042723 | 44.97% | 0.0052275 | 55.03% | 0.0035772 | 37.66% | 0.0001925 | 2.03% | 0.0005025 | 5.29% |
| 2009 | 0.0096955 | 0.0042750 | 44.09% | 0.0054205 | 55.91% | 0.0035614 | 36.73% | 0.0001485 | 1.53% | 0.0005651 | 5.83% |
| 2010 | 0.0100086 | 0.0044363 | 44.32% | 0.0055723 | 55.68% | 0.0035819 | 35.79% | 0.0002018 | 2.02% | 0.0006526 | 6.52% |
| 2011 | 0.0095939 | 0.0043726 | 45.58% | 0.0052214 | 54.42% | 0.0035004 | 36.49% | 0.0001787 | 1.86% | 0.0006934 | 7.23% |
| 2012 | 0.0100849 | 0.0045438 | 45.06% | 0.0055411 | 54.94% | 0.0035854 | 35.55% | 0.0002173 | 2.15% | 0.0007412 | 7.35% |
| 2013 | 0.0104194 | 0.0044832 | 43.03% | 0.0059362 | 56.97% | 0.0034883 | 33.48% | 0.0002727 | 2.62% | 0.0007223 | 6.93% |
| 2014 | 0.0111342 | 0.0049333 | 44.31% | 0.0062009 | 55.69% | 0.0036665 | 32.93% | 0.0004001 | 3.59% | 0.0008667 | 7.78% |
| 2015 | 0.0120036 | 0.0054429 | 45.34% | 0.0065608 | 54.66% | 0.0038458 | 32.04% | 0.0005645 | 4.70% | 0.0010327 | 8.60% |
| 2016 | 0.0118670 | 0.0057871 | 48.77% | 0.0060799 | 51.23% | 0.0039707 | 33.46% | 0.0007214 | 6.08% | 0.0010950 | 9.23% |

Table 11 Theil Index of SDG10 Index score (2005-2016)

| Year | Theil index | Intra-group contribution | | Inter-group contribution | | The East Contribution | | The Middle contribution | | The West contribution | |
|------|-------------|--------------------------|------------|--------------------------|------------|-----------------------|------------|-------------------------|------------|-----------------------|------------|
| | | Theil index | Proportion | Theil index | Proportion | Theil index | Proportion | Theil index | Proportion | Theil index | Proportion |
| 2005 | 0.0075355 | 0.0040572 | 53.84% | 0.0034783 | 46.16% | 0.0015410 | 20.45% | 0.0004154 | 5.51% | 0.0021008 | 27.88% |
| 2006 | 0.0070096 | 0.0037717 | 53.81% | 0.0032380 | 46.19% | 0.0013787 | 19.67% | 0.0005549 | 7.92% | 0.0018380 | 26.22% |
| 2007 | 0.0061641 | 0.0032530 | 52.77% | 0.0029111 | 47.23% | 0.0012046 | 19.54% | 0.0003994 | 6.48% | 0.0016490 | 26.75% |
| 2008 | 0.0061673 | 0.0031969 | 51.84% | 0.0029704 | 48.16% | 0.0013775 | 22.34% | 0.0004104 | 6.65% | 0.0014090 | 22.85% |
| 2009 | 0.0064496 | 0.0032486 | 50.37% | 0.0032010 | 49.63% | 0.0014882 | 23.07% | 0.0004834 | 7.50% | 0.0012769 | 19.80% |
| 2010 | 0.0075401 | 0.0037280 | 49.44% | 0.0038120 | 50.56% | 0.0015628 | 20.73% | 0.0006895 | 9.14% | 0.0014758 | 19.57% |
| 2011 | 0.0064365 | 0.0035480 | 55.12% | 0.0028885 | 44.88% | 0.0012928 | 20.09% | 0.0007571 | 11.76% | 0.0014981 | 23.27% |
| 2012 | 0.0064327 | 0.0038040 | 59.14% | 0.0026287 | 40.87% | 0.0014075 | 21.88% | 0.0007413 | 11.52% | 0.0016551 | 25.73% |
| 2013 | 0.0083286 | 0.0049488 | 59.42% | 0.0033798 | 40.58% | 0.0024125 | 28.97% | 0.0010163 | 12.20% | 0.0015200 | 18.25% |
| 2014 | 0.0063568 | 0.0038915 | 61.22% | 0.0024653 | 38.78% | 0.0016737 | 26.33% | 0.0009022 | 14.19% | 0.0013156 | 20.70% |
| 2015 | 0.0070325 | 0.0047053 | 66.91% | 0.0023272 | 33.09% | 0.0025951 | 36.90% | 0.0007220 | 10.27% | 0.0013882 | 19.74% |
| 2016 | 0.0085716 | 0.0058013 | 67.68% | 0.0027704 | 32.32% | 0.0036203 | 42.24% | 0.0006951 | 8.11% | 0.0014858 | 17.33% |

Table 12 Theil Index of SDG11 Index score (2005-2016)

| Year | Theil index | Intra-group contribution | | Inter-group contribution | | The East Contribution | | The Middle contribution | | The West contribution | |
|------|-------------|--------------------------|------------|--------------------------|------------|-----------------------|------------|-------------------------|------------|-----------------------|------------|
| | | Theil index | Proportion | Theil index | Proportion | Theil index | Proportion | Theil index | Proportion | Theil index | Proportion |
| 2005 | 0.0058142 | 0.0050487 | 86.83% | 0.0007655 | 13.17% | 0.0017799 | 30.61% | 0.0004255 | 7.32% | 0.0028432 | 48.90% |
| 2006 | 0.0072058 | 0.0052761 | 73.22% | 0.0019296 | 26.78% | 0.0031780 | 44.10% | 0.0007357 | 10.21% | 0.0013624 | 18.91% |
| 2007 | 0.0065919 | 0.0037617 | 57.07% | 0.0028302 | 42.93% | 0.0014966 | 22.70% | 0.0006965 | 10.57% | 0.0015686 | 23.80% |
| 2008 | 0.0102300 | 0.0090008 | 87.98% | 0.0012292 | 12.02% | 0.0036999 | 36.17% | 0.0017652 | 17.26% | 0.0035357 | 34.56% |
| 2009 | 0.0074519 | 0.0045765 | 61.41% | 0.0028754 | 38.59% | 0.0012200 | 16.37% | 0.0003616 | 4.85% | 0.0029949 | 40.19% |
| 2010 | 0.0047288 | 0.0040672 | 86.01% | 0.0006616 | 13.99% | 0.0010564 | 22.34% | 0.0001720 | 3.64% | 0.0028387 | 60.03% |
| 2011 | 0.0060223 | 0.0042593 | 70.73% | 0.0017630 | 29.27% | 0.0010934 | 18.16% | 0.0000733 | 1.22% | 0.0030926 | 51.35% |
| 2012 | 0.0068491 | 0.0049794 | 72.70% | 0.0018698 | 27.30% | 0.0013257 | 19.36% | 0.0001102 | 1.61% | 0.0035435 | 51.74% |
| 2013 | 0.0074756 | 0.0065482 | 87.59% | 0.0009274 | 12.41% | 0.0016460 | 22.02% | 0.0009034 | 12.08% | 0.0039987 | 53.49% |
| 2014 | 0.0063513 | 0.0055138 | 86.81% | 0.0008376 | 13.19% | 0.0019899 | 31.33% | 0.0001827 | 2.88% | 0.0033412 | 52.61% |
| 2015 | 0.0069533 | 0.0059537 | 85.62% | 0.0009997 | 14.38% | 0.0018966 | 27.28% | 0.0001728 | 2.49% | 0.0038843 | 55.86% |
| 2016 | 0.0068219 | 0.0067702 | 99.24% | 0.0000518 | 0.76% | 0.0019316 | 28.31% | 0.0007396 | 10.84% | 0.0040990 | 60.09% |

Table 13 Theil Index of SDG12 Index score (2005-2016)

| Year | Theil index | Intra-group contribution | | Inter-group contribution | | The East Contribution | | The Middle contribution | | The West contribution | |
|------|-------------|--------------------------|------------|--------------------------|------------|-----------------------|------------|-------------------------|------------|-----------------------|------------|
| | | Theil index | Proportion | Theil index | Proportion | Theil index | Proportion | Theil index | Proportion | Theil index | Proportion |
| 2005 | 0.0066430 | 0.0039145 | 58.93% | 0.0027285 | 41.07% | 0.0010500 | 15.81% | 0.0006936 | 10.44% | 0.0021709 | 32.68% |
| 2006 | 0.0069312 | 0.0037366 | 53.91% | 0.0031946 | 46.09% | 0.0010503 | 15.15% | 0.0005788 | 8.35% | 0.0021075 | 30.41% |
| 2007 | 0.0091381 | 0.0044447 | 48.64% | 0.0046934 | 51.36% | 0.0015660 | 17.14% | 0.0012539 | 13.72% | 0.0016248 | 17.78% |
| 2008 | 0.0091278 | 0.0046069 | 50.47% | 0.0045209 | 49.53% | 0.0015928 | 17.45% | 0.0008578 | 9.40% | 0.0021562 | 23.62% |
| 2009 | 0.0099970 | 0.0045690 | 45.70% | 0.0054279 | 54.30% | 0.0013019 | 13.02% | 0.0010322 | 10.33% | 0.0022350 | 22.36% |
| 2010 | 0.0072659 | 0.0035100 | 48.31% | 0.0037559 | 51.69% | 0.0012271 | 16.89% | 0.0006075 | 8.36% | 0.0016754 | 23.06% |
| 2011 | 0.0065357 | 0.0038916 | 59.54% | 0.0026441 | 40.46% | 0.0019365 | 29.63% | 0.0002605 | 3.99% | 0.0016947 | 25.93% |
| 2012 | 0.0074484 | 0.0042947 | 57.66% | 0.0031537 | 42.34% | 0.0021409 | 28.74% | 0.0002985 | 4.01% | 0.0018553 | 24.91% |
| 2013 | 0.0083918 | 0.0051356 | 61.20% | 0.0032562 | 38.80% | 0.0025776 | 30.72% | 0.0006061 | 7.22% | 0.0019519 | 23.26% |
| 2014 | 0.0088413 | 0.0060670 | 68.62% | 0.0027742 | 31.38% | 0.0032899 | 37.21% | 0.0007636 | 8.64% | 0.0020136 | 22.77% |
| 2015 | 0.0074310 | 0.0046839 | 63.03% | 0.0027471 | 36.97% | 0.0019065 | 25.66% | 0.0007333 | 9.87% | 0.0020442 | 27.51% |
| 2016 | 0.0076501 | 0.0050083 | 65.47% | 0.0026417 | 34.53% | 0.0015983 | 20.89% | 0.0011873 | 15.52% | 0.0022227 | 29.05% |

Table 14 Theil Index of SDG16 Index score (2005-2016)

| Year | Theil index | Intra-group contribution | | Inter-group contribution | | The East Contribution | | The Middle contribution | | The West contribution | |
|------|-------------|--------------------------|------------|--------------------------|------------|-----------------------|------------|-------------------------|------------|-----------------------|------------|
| | | Theil index | Proportion | Theil index | Proportion | Theil index | Proportion | Theil index | Proportion | Theil index | Proportion |
| 2005 | 0.0064596 | 0.0055244 | 85.52% | 0.0009352 | 14.48% | 0.0032610 | 50.48% | 0.0018254 | 28.26% | 0.0004380 | 6.78% |
| 2006 | 0.0071102 | 0.0062431 | 87.81% | 0.0008671 | 12.19% | 0.0038422 | 54.04% | 0.0016063 | 22.59% | 0.0007947 | 11.18% |
| 2007 | 0.0085241 | 0.0073809 | 86.59% | 0.0011432 | 13.41% | 0.0045033 | 52.83% | 0.0012924 | 15.16% | 0.0015853 | 18.60% |
| 2008 | 0.0056089 | 0.0047247 | 84.23% | 0.0008843 | 15.77% | 0.0028717 | 51.20% | 0.0013528 | 24.12% | 0.0005001 | 8.92% |
| 2009 | 0.0069904 | 0.0063060 | 90.21% | 0.0006844 | 9.79% | 0.0044262 | 63.32% | 0.0007695 | 11.01% | 0.0011104 | 15.88% |
| 2010 | 0.0062738 | 0.0054795 | 87.34% | 0.0007943 | 12.66% | 0.0035668 | 56.85% | 0.0012372 | 19.72% | 0.0006755 | 10.77% |
| 2011 | 0.0060199 | 0.0051536 | 85.61% | 0.0008664 | 14.39% | 0.0038227 | 63.50% | 0.0006652 | 11.05% | 0.0006657 | 11.06% |
| 2012 | 0.0060557 | 0.0049020 | 80.95% | 0.0011538 | 19.05% | 0.0033376 | 55.12% | 0.0005509 | 9.10% | 0.0010135 | 16.74% |
| 2013 | 0.0069099 | 0.0052680 | 76.24% | 0.0016419 | 23.76% | 0.0038139 | 55.19% | 0.0006219 | 9.00% | 0.0008323 | 12.04% |
| 2014 | 0.0064424 | 0.0052768 | 81.91% | 0.0011656 | 18.09% | 0.0037860 | 58.77% | 0.0009672 | 15.01% | 0.0005236 | 8.13% |
| 2015 | 0.0073466 | 0.0064688 | 88.05% | 0.0008778 | 11.95% | 0.0023727 | 32.30% | 0.0008473 | 11.53% | 0.0032488 | 44.22% |
| 2016 | 0.0058128 | 0.0044816 | 77.10% | 0.0013313 | 22.90% | 0.0030653 | 52.73% | 0.0007602 | 13.08% | 0.0006560 | 11.29% |

Table 15 Theil Index of SDG17 Index score (2005-2016)

| Year | Theil index | Intra-group contribution | | Inter-group contribution | | The East Contribution | | The Middle contribution | | The West contribution | |
|------|-------------|--------------------------|------------|--------------------------|------------|-----------------------|------------|-------------------------|------------|-----------------------|------------|
| | | Theil index | Proportion | Theil index | Proportion | Theil index | Proportion | Theil index | Proportion | Theil index | Proportion |
| 2005 | 0.0083763 | 0.0031171 | 37.21% | 0.0052591 | 62.79% | 0.0025432 | 30.36% | 0.0001158 | 1.38% | 0.0004581 | 5.47% |
| 2006 | 0.0087292 | 0.0034473 | 39.49% | 0.0052819 | 60.51% | 0.0024607 | 28.19% | 0.0004119 | 4.72% | 0.0005747 | 6.58% |
| 2007 | 0.0111728 | 0.0040332 | 36.10% | 0.0071396 | 63.90% | 0.0031592 | 28.28% | 0.0003571 | 3.20% | 0.0005169 | 4.63% |
| 2008 | 0.0090523 | 0.0035787 | 39.53% | 0.0054737 | 60.47% | 0.0024847 | 27.45% | 0.0004398 | 4.86% | 0.0006541 | 7.23% |
| 2009 | 0.0083412 | 0.0032882 | 39.42% | 0.0050531 | 60.58% | 0.0023278 | 27.91% | 0.0003766 | 4.51% | 0.0005837 | 7.00% |
| 2010 | 0.0081546 | 0.0032391 | 39.72% | 0.0049155 | 60.28% | 0.0021677 | 26.58% | 0.0003171 | 3.89% | 0.0007544 | 9.25% |
| 2011 | 0.0081172 | 0.0034131 | 42.05% | 0.0047041 | 57.95% | 0.0023219 | 28.61% | 0.0003407 | 4.20% | 0.0007505 | 9.25% |
| 2012 | 0.0087088 | 0.0038114 | 43.76% | 0.0048974 | 56.24% | 0.0026786 | 30.76% | 0.0004227 | 4.85% | 0.0007101 | 8.15% |
| 2013 | 0.0085245 | 0.0036546 | 42.87% | 0.0048700 | 57.13% | 0.0026157 | 30.68% | 0.0004253 | 4.99% | 0.0006136 | 7.20% |
| 2014 | 0.0084264 | 0.0035970 | 42.69% | 0.0048293 | 57.31% | 0.0027108 | 32.17% | 0.0004370 | 5.19% | 0.0004492 | 5.33% |
| 2015 | 0.0087784 | 0.0038965 | 44.39% | 0.0048819 | 55.61% | 0.0030498 | 34.74% | 0.0004352 | 4.96% | 0.0004115 | 4.69% |
| 2016 | 0.0086484 | 0.0034935 | 40.40% | 0.0051549 | 59.61% | 0.0026831 | 31.02% | 0.0004415 | 5.11% | 0.0003689 | 4.27% |

Table 16 Changes in provincial development weaknesses (2005-2016)

| Provinces | 2005 | 2009 | 2012 | 2016 |
|-------------------|--|---|--|--|
| the East | | | | |
| Beijing | G10 | — | G11 | G10 |
| Tianjin | G11 | G11 | G11 | G11 |
| Hebei | G2, 7, 12, 16, 17 | G8, 17 | G2, 8, 12, 17 | G2, 8, 11, 12 |
| Liaoning | G8, 12, 16 | G5, 16 | G12 | G7, 8, 16 |
| Shanghai | — | G11 | G11 | — |
| Jiangsu | — | G5, 7, 11 | G5 | — |
| Zhejiang | G5, 11 | G11 | G11 | G5, 7, 11 |
| Fujian | G5, 7, 11, 16 | G3, 6, 11, 16, 17 | G5, 7 | G3, 5, 7, 11 |
| Shandong | G5, 7, 16 | G12, 16 | G5, 16 | G5 |
| Guangdong | G10 | G7, 10 | G10 | G2, 7, 10 |
| Hainan | G2, 3, 9, 11 | G3, 6, 10, 12 | G2, 3, 9, 16 | G2, 3, 4, 9, 16 |
| the Middle | | | | |
| Shanxi | G7, 12, 16, 17 | G12, 16 | G7, 12, 16 | G3, 8, 12 |
| Inner Mongolia | G1, 3, 6, 7, 9, 12 | G2, 4, 6, 16, 17 | G1, 3, 6, 7, 9, 10, 16, 17 | G1, 6, 7, 9, 10, 12 |
| Jilin | G1, 6, 16, 17 | G5, 7 | G1, 3, 6, 8, 16, 17 | G1, 6, 16, 17 |
| Heilongjiang | G6, 8, 16 | G1, 8, 10, 11, 12 | G1, 2, 6, 8, 9, 10, 16, 17 | G1, 6, 8, 9, 12, 16, 17 |
| Anhui | G4, 5, 6, 8 | G1, 3, 4, 5, 6, 8, 10 | G4, 5, 6, 8 | G3, 4, 5 |
| Jiangxi | G2, 4, 12, 17 | G1, 2, 4, 7, 9, 12, 17 | G2, 4, 7, 12, 17 | G1, 2, 4, 7, 8, 12, 16 |
| Henan | G2, 4, 16, 17 | G2, 3, 5, 6, 9, 16 | G2, 4, 6, 16, 17 | G2, 4, 6, 16, 17 |
| Hube | G4, 5, 6, 8, 16, 17 | G10, 16 | G5, 6, 8, 17 | G4, 5, 11, 16 |
| Hunan | G7, 8, 17 | G2, 3, 6, 7, 9, 10, 11, 12 | G2, 8, 16, 17 | G1, 4, 7, 8, 10, 17 |
| Guangxi | G1, 2, 3, 4, 7, 8, 9, 11, 12, 17 | G1, 3, 4, 5, 6, 8, 9, 10, 12, 16 | G1, 2, 3, 4, 7, 8, 9, 17 | G1, 2, 3, 4, 7, 16, 17 |
| the West | | | | |
| Sichuan | G1, 4, 5, 8, 9 | G1, 4, 5, 6, 8, 9 | G1, 2, 4, 5, 6, 8, 9, 11, 12 | G4, 5, 6, 8, 9, 17 |
| Guizhou | G1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 16 | G1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 17 | G1, 3, 4, 5, 6, 7, 9, 10, 11, 12 | G1, 3, 4, 5, 7, 11, 12, 16 |
| Yunnan | G1, 2, 3, 5, 7, 9, 10, 11 | G2, 3, 4, 5, 8, 9, 10, 11, 12, 17 | G1, 2, 3, 4, 5, 7, 8, 9, 10, 11, 12 | G1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 17 |
| Chongqing | G1, 3, 4, 6, 10 | G6, 8, 17 | G4, 10, 16 | G10, 16 |
| Shaanxi | G3, 6, 8, 10, 11 | G2, 8, 12 | G1, 6, 10, 11, 17 | G6, 10, 16, 17 |
| Gansu | G1, 2, 3, 4, 5, 6, 9, 10, 12, 17 | G1, 3, 4, 5, 7, 9, 10, 11, 12 | G1, 3, 4, 5, 6, 7, 9, 10, 11, 12, 16, 17 | G1, 2, 3, 5, 6, 9, 10, 11, 12, 17 |
| Qinghai | G2, 3, 5, 7, 9, 11, 12, 17 | G1, 2, 3, 5, 7, 8, 9, 10 | G1, 2, 3, 4, 5, 7, 9, 11, 16, 17 | G1, 2, 3, 4, 5, 9, 11, 12, 17 |
| Ningxia | G3, 4, 5, 6, 7, 8, 10, 12 | G1, 2, 4, 7, 9, 12, 17 | G3, 4, 6, 8, 9, 10, 12, 16 | G3, 5, 6, 8, 10, 12, 17 |
| Xinjiang | G2, 3, 9, 10, 11 | G2, 7, 8, 17 | G1, 2, 3, 7, 9, 10, 11, 12 | G1, 2, 3, 6, 9, 11, 12 |

Note: considering the availability, comparability and continuity of the data, the report does not analyze data from Hong Kong, Macao and Taiwan. Due to data consistency, we only analyzed data of goal 15 in Tibet.

The East :

Beijing: Goal 10 (Reduced Inequality) is one of the few development weaknesses in Beijing. Although it has improved from 2005 to 2016, it has been in a state of deficiency.

Tianjin: Goal 11 (Sustainable Cities and Communities) is the only weakness of Tianjin in all four years, indicating that it needs to be strengthened in terms of urban sustainability.

Hebei: The continuing weaknesses lie in Goal 2 (Zero Hunger), Goal 8 (Decent Work and Economic Growth), Goal 12 (Responsible Consumption and Production) and Goal 17 (Partnerships for the Goals).

Liaoning: Goal 8 (Decent Work and Economic Growth) and Goal 16 (Peace, Justice and Strong Institutions) are outstanding weaknesses.

Shanghai: Shanghai has very few weaknesses, with only Goal 11 (Sustainable Cities and Communities), and it has developed from weak level to moderate level in 2016.

Jiangsu: Goal 5 (Gender Equality) is a prominent weakness.

Zhejiang: There are fewer weaknesses, and Goal 11 (Sustainable Cities and Communities) is a prominent weakness.

Fujian: The continuing weaknesses are Goal 5 (Gender Equality), Goal 7 (Affordable and Clean Energy) and Goal 11 (Sustainable Cities and Communities).

Shandong: The continuing weaknesses lie in Goal 5 (Gender Equality) and Goal 16 (Peace, Justice and Strong Institutions).

Guangdong: There are fewer weaknesses, and Goal 10 (Reduced Inequality) is a prominent weakness.

Hainan: The continuing weaknesses are Goal 2 (Zero Hunger), Goal 3 (Good Health and Well-being) and Goal 9 (Industry, Innovation and Infrastructure).

The middle:

Shanxi: The continuing weaknesses are Goal 12 (Responsible Consumption and Production) and Goal 16 (Peace, Justice and Strong Institutions).

Inner Mongolia: The continuing weaknesses are Goal 1 (No Poverty), Goal 6 (Clean Water and Sanitation), Goal 7 (Affordable and Clean Energy) and Goal 9 (Industry,

Innovation and Infrastructure). The less prominent but frequent weaknesses are Goal 16 (Peace, Justice and Strong Institutions) and Goal 17 (Partnerships for the Goals).

Jilin: The continuing weaknesses are Goal 1 (No Poverty), Goal 6 (Clean Water and Sanitation), Goal 7 (Affordable and Clean Energy) and Goal 9 (Industry, Innovation and Infrastructure). The less prominent but frequent weaknesses are Goal 16 (Peace, Justice and Strong Institutions) and Goal 17 (Partnerships for the Goals).

Heilongjiang: The development weaknesses have increased year after year, and the continuing weaknesses are Goal 1 (No Poverty), Goal 6 (Clean Water and Sanitation), Goal 8 (Decent Work and Economic Growth), and Goal 16 (Peace, Justice and Strong Institutions).

Anhui: The continuing weaknesses are Goal 4 (Quality Education), Goal 5 (Gender Equality), Goal 6 (Clean Water and Sanitation) and Goal 8 (Decent Work and Economic Growth).

Jiangxi: The continuing weaknesses are Goal 2 (Zero Hunger), Goal 4 (Quality Education), Goal 7 (Affordable and Clean Energy), Goal 12 (Responsible Consumption and Production) and Goal 17 (Partnerships for the Goals).

Henan: The continuing weaknesses are Goal 2 (Zero Hunger), Goal 4 (Quality Education), Goal 16 (Peace, Justice and Strong Institutions) and Goal 17 (Partnerships for the Goals).

Hubei: The persistent weaknesses are Goal 5 (Gender Equality) and Goal 16 (Peace, Justice and Strong Institutions).

Hunan: The weaknesses tend to rise first and then decline, with Goal 7 (Affordable and Clean Energy), Goal 8 (Decent Work and Economic Growth) and Goal 17 (Partnerships for the Goals).

Guangxi: There are many weaknesses in the development of Guangxi, and the long-standing ones are Goal 1 (No Poverty), Goal 2 (Zero Hunger), Goal 3 (Good Health and Well-being), Goal 4 (Quality Education), Goal 7 (Affordable and Clean Energy), Goal 8 (Decent Work and Economic Growth) and Goal 9 (Industry, Innovation and Infrastructure).

The West:

Sichuan: The continuing weaknesses are Goal 1 (No Poverty), Goal 4 (Quality Education), Goal 5 (Gender Equality), Goal 6 (Clean Water and Sanitation), Goal 8 (Decent Work and Economic Growth), Goal 9 (Industry, Innovation and Infrastructure).

Guizhou: There are many weaknesses in sustainable development, and most of the 14 Goals are in weak level or moderate level. Weaknesses include Goal 1 (No Poverty), Goal 3 (Good Health and Well-being), Goal 4 (Quality Education), Goal 5 (Gender Equality), Goal 6 (Clean Water and Sanitation), Goal 7 (Affordable and Clean Energy), Goal 9 (Industry, Innovation and Infrastructure), Goal 10 (Reduced Inequality), Goal 11 (Sustainable Cities and Communities), Goal 12 (Responsible Consumption and Production). There is still a big gap in sustainable development between Guizhou Province and other provinces.

Yunnan: Similar to Guizhou province, there are many weaknesses in sustainable development, and most of the 14 Goals are in weak level or moderate level. Weaknesses include Goal 1 (No Poverty), Goal 2 (Zero Hunger), Goal 3 (Good Health and Well-being), Goal 4 (Quality Education), Goal 5 (Gender Equality), Goal 7 (Affordable and Clean Energy), Goal 8 (Decent Work and Economic Growth), Goal 9 (Industry, Innovation and Infrastructure), Goal 10 (Reduced Inequality), Goal 11 (Sustainable Cities and Communities).

Chongqing: There are weaknesses in Goal 10 (Reduced Inequality) and Goal 16 (Peace, Justice and Strong Institutions) in 2016.

Shaanxi: The continuing weaknesses are Goal 6 (Clean Water and Sanitation) and Goal 10 (Reduced Inequality).

Gansu: There are many weaknesses in sustainable development, and most of the 14 Goals are in weak level or moderate level. Weaknesses include Goal 1 (No Poverty), Goal 3 (Good Health and Well-being), Goal 4 (Quality Education), Goal 5 (Gender Equality), Goal 6 (Clean Water and Sanitation), Goal 7 (Affordable and Clean Energy), Goal 10 (Reduced Inequality), Goal 11 (Sustainable Cities and Communities), Goal 12 (Responsible Consumption and Production).

Qinghai: The continuing weaknesses are Goal 1 (No Poverty), Goal

2 (Zero Hunger), Goal 3 (Good Health and Well-being), Goal 5 (Gender Equality), Goal 7 (Affordable and Clean Energy) and Goal 11 (Sustainable Cities and Communities).

Ningxia: There are many weaknesses in development, and the continuing weaknesses are Goal 3 (Good Health and Well-being), Goal 4 (Quality Education), Goal 5 (Gender Equality), Goal 6 (Clean Water and Sanitation), Goal 8 (Decent Work and Economic Growth), Goal 12 (Responsible Consumption and Production).

Xinjiang: The continuing weaknesses are Goal 2 (Zero Hunger), Goal 3 (Good Health and Well-being), Goal 9 (Industry, Innovation and Infrastructure) and Goal 11 (Sustainable Cities and Communities)

Table 17: Theil index

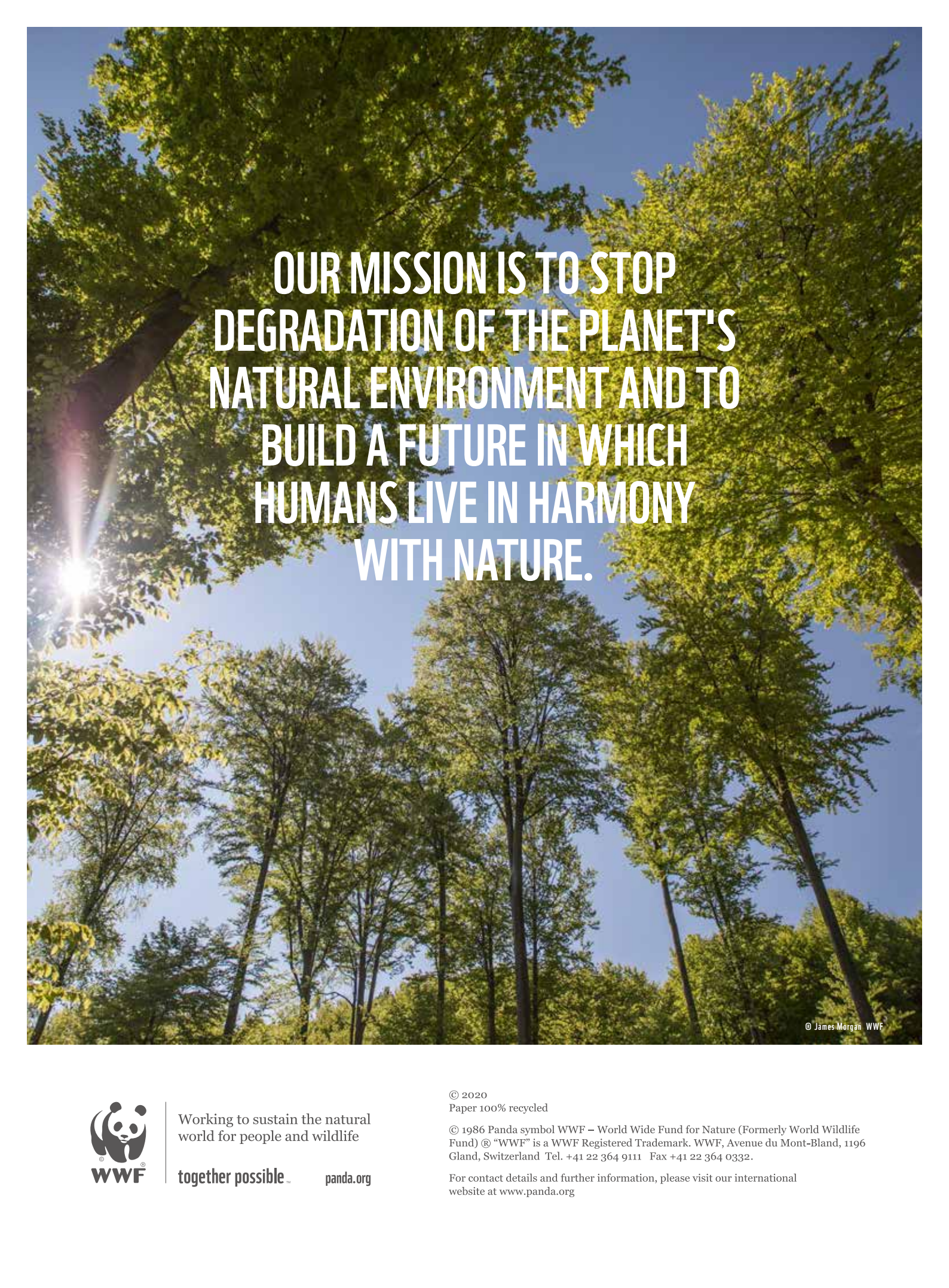
| Difference decomposition | Notes |
|--|---|
| Theil index | $T_i = \frac{U_i}{\sum_{i=1}^n U_i}$ $J = \sum_{i=1}^n T_i L_n(nT_i)$ <p> U_i is the SDG Index score for i^{th} province T_i is the SDG Index score for i^{th} province as a proportion to the national score n is the total number of provinces J is the Theil index at the national-level </p> |
| Theil Indices of the East, Middle and West China | $T_d = \sum_d T_i$ $T_z = \sum_z T_i$ $T_x = \sum_x T_i$ $J_d = \sum_{i=1}^{n_d} \frac{T_i}{T_d} \text{Ln} \left(n \frac{T_i}{T_d} \right)$ $J_z = \sum_{i=1}^{n_z} \frac{T_i}{T_z} \text{Ln} \left(n \frac{T_i}{T_z} \right)$ $J_x = \sum_{i=1}^{n_x} \frac{T_i}{T_x} \text{Ln} \left(n \frac{T_i}{T_x} \right)$ <p> T_d, T_z, T_x represent the regional SDG Index scores as proportions of the national score for East, Middle and West China respectively n_d, n_z, n_x represent the numbers of provinces in the East, Middle and West China respectively J_d, J_z, J_x represent the Theil Indices of the East, Middle and West China respectively </p> |
| Intra-regional differences | $J_r = T_d J_d + T_z J_z + T_x J_x$ |
| Inter-regional differences | $J_j = T_d \text{Ln} \left(T_d \frac{n}{n_d} \right) + T_z \text{Ln} \left(T_z \frac{n}{n_z} \right) + T_x \text{Ln} \left(T_x \frac{n}{n_x} \right)$ |
| Total differences | $J_{\text{sum}} = J_r + J_j$ |

Table 18 Moran's I

| Moran's I | Notes |
|---|---|
| <p>Spatial autocorrelation describes a systematic spatial variation based on geographic locations.</p> <p>Spatial autocorrelation assesses whether the proposed model is clustering, discrete or random.</p> <p>The assessment is conducted through calculating Moran's I, z-scores and p-values.</p> <p>The spatial autocorrelation index used in this research is drawn from Global Moran's I package from ArcGIS.</p> <p>Where Moran's I can be calculated as:</p> $I = \frac{n}{S_0} \frac{\sum_{i=1}^n \sum_{j=1}^n W_{ij} Z_i Z_j}{\sum_{i=1}^n Z_i^2}$ | <p>Where:</p> $E[I] = -1/(n-1)$ $V[I] = E[I^2] - E[I]^2$ <p>Z_i is the difference between element i and \bar{z}</p> <p>W_{ij} is the spatial weight between element i and j</p> <p>n equals to the total number of elements</p> <p>S_0 is the aggregated sum of all spatial weights</p> $S_0 = \sum_{i=1}^n \sum_{j=1}^n W_{ij}$ <p>Z_i is calculated as:</p> $Z_i = \frac{I - E[I]}{\sqrt{V[I]}}$ <p>Assuming standardized weights, Moran's I falls between -1.0 to 1.0.</p> <p>Moran's I > 0 suggests positive spatial correlation. The larger the value, the more evident the spatial correlation. Moran's I < 0 suggests negative spatial correlation. The smaller the value, the greater the spatial difference. Otherwise when Moran's I = 0, there is random spatial relation.</p> <p>The p-value and z-score are used to assess the significance of Moran's I.</p> |

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