A paper presented at the 16th International Conference on Sustainable Development at the United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP) Bangkok, Thailand, 2022.

Comparative analysis of ASEAN countries using Sustainability Window and Doughnut Economy models

Luukkanen, Jyrki, Kaivo-oja [1], Jari and Vehmas [2], Jarmo [3]
[1,2,3] Finland Futures Research Centre, University of Turku
Åkerlundinkatu 2 A, 33100 Tampere, Finland
Corresponding authors: jyrki.luukkanen@utu.fi, jari.kaivo-oja@utu.fi, jarmo.vehmas@utu.fi

OIDA International Journal of Sustainable Development, Ontario International Development Agency, Canada.
ISSN 1923-6654 (print) ISSN 1923-6662 (online) www.oidaijsd.com
Also available at http://www.ssrn.com/link/OIDA-Intl-Journal-Sustainable-Dev.html

Abstract: The role of economic growth has been central in the discussion about sustainability. Economic growth has been linked to the social development of societies, to the improvement in welfare and to poverty alleviation. Economic growth has also been seen as a driver of climate change and environmental destruction. Also, the problems related to equity and internal and international inequality are often linked to economic growth.

The Sustainability Window (SuWi) -analysis is a novel method that can be used to analyse the sustainability of development simultaneously in environmental, economic and social dimensions. SuWi is used for analysing sustainability using different indicators in order to provide information on the maximum and minimum economic development to maintain the development within sustainability boundaries. The maximum economic development is determined using environmental criteria, not to exceed sustainable environmental stress, and the minimum economic development using social criteria, to guarantee sustainable social development. The Sustainability Window method can be used for comparative analysis because it is possible to use different indicators and different time periods which makes the comparative analysis of different dimensions easy. This novel method makes it also possible to analyse the dynamics of sustainability and changes over time.

Sustainability Window analysis can be used for analysing both weak and strong sustainability. Weak sustainability means that the intensity of environmental stress, measured with different indicators, should not increase. Strong sustainability means that environmental stress per se should not increase.

Sustainability Window analysis can be used for constructing the Doughnut Economy model for the analysed countries. In the Doughnut Economy model, the SuWi results are organised in a radial diagram to illustrate the possible area for sustainable economic development in relation to environmental and social development. The outer boundary of economic development indicates the maximum economic development not to exceed the environmental boundaries. The inner boundary illustrates the minimum economic development to fulfil the social development needs. The doughnut area between the outer and inner boundaries forms the sustainable development space.

This study provides a comparative Doughnut Model analysis based on SuWi analyses of eight ASEAN countries within the time frame of 2006-2016. The data used for the sustainability analysis in the study is taken from the Sustainable Society Index (SSI) database and UN SDGs data, which provide comprehensive data sets for key dimensions of sustainability.

This study reveals key challenges and successful cases of sustainable development in eight ASEAN -countries. The results of the analyses illustrate the problematic areas of development and the successful areas in each ASEAN country. The countries perform differently in different areas having both successful and problematic areas where further policy efforts are needed. The results of the SuWi analysis can be used as a basis for developing balanced sustainability strategies in the ASEAN countries. The research results of the comparative analyses can be used for learning processes in the planning of sustainability policies in the different ASEAN countries.

Keywords: ASEAN; Doughnut economy; sustainable development; Sustainability Window; sustainability transitions

Introduction

The definition of sustainable development is often taken from the classical publication of the Brundtland Commission 'Our Common Future' [1]: "Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs". The practical meaning and measuring of sustainable development are however complex because the concept is multidimensional and multidisciplinary disclosing the incommensurate aspects of development processes. There exist several methods developed for measuring some aspects of sustainability, but often the problem is the linking of different dimensions of development in the same methodological framework. This article presents a novel tool for sustainability analysis which integrates the analysis process in a multidimensional framework developed by the research team at Finland Futures Research Centre. The Sustainability Window (SuWi) tool combines all three dimensions of sustainable development (social, environmental and economic) in a single coherent analysis framework. The results of the Sustainability Window analyses can be used for the quantitative construction of a Doughnut Model for the countries. The Doughnut Model illustrates the sustainability area of development indicating the maximum economic development not to exceed the environmental limit of sustainability and the minimum economic development to fulfil the social development needs.

In this article, we present the SuWi method and its use for Doughnut Model construction and illustrate them with a comparative analysis of eight ASEAN (Association of Southeast Asian Nations) countries.

Materials and Methods

The Sustainability Window (SuWi) approach can be used as a tool for transdisciplinary sustainability analysis because it provides a simultaneous assessment of different dimensions of sustainability in a single framework. The SuWi analysis can be used to visualize key transition paths for providing a multifaceted perspective for planners, decision-makers and stakeholders in the planning process (see [2], [3], [4], [5]). The analyses can be utilised for governance purposes for transition management (see [5], [6], [7]). With the SuWi method, both transition scenarios and realistic backcasting scenarios can be constructed, because the transition paths and associated backcasting targets can be identified (see [8], [9]). Furthermore, reflective evaluations of sustainable development can be developed by using the Sustainability Window approach (see [10], [11], [12]).

The main data source for this analysis is the Sustainable Society Index (SSI) of [13]. The SSI integrates indicators of Human Wellbeing, Environmental Wellbeing and Economic Wellbeing based on the definition of sustainable development elaborated by the Brundtland report. The period of the analysis is from 2006 to 2016, the period for which continuous data in the SSI database is available.

In addition, we have also used the World Bank database for the indicator of 'Social inclusion', the CPIA database (Country Policy and Institutional Analysis) in order to explicitly include this green growth dimension in the analysis [14]. World Bank data is also used for the 'Forest rent' indicator [15]. The social inclusion indicator is, however not available for all ASEAN countries. It was used in the analysis only for Cambodia, Laos and the Philippines.

The SSI database does not have data for Brunei and Singapore and that is why they are omitted from this analysis. Other eight ASEAN countries are included with full datasets.

For the SuWi analyses, we have indexed the indicators from the SSI database and the World Bank database to have the value 1 for the base year 2006 of the analysis.

Sustainability Window analysis is based on the one hand on the idea that certain economic development is needed in order to guarantee the sustainability of social development. This can mean for instance that the level of education, access to healthcare or nutrition level of the population is maintained or rather improved with economic growth. In the SuWi analysis, social development sets the lower limit of sustainable economic development – certain economic development is needed in order not to deteriorate social wellbeing.

On the other hand, it is assumed that economic development may cause environmental deterioration such as increased use of energy and increased emissions of CO_2, increased use of natural resources, etc. These environmental considerations set the upper limit for economic growth – the state of the environment should not get worse. The lower limit, set by social development and social wellbeing, and the upper limit, set by environmental considerations, define the boundaries for sustainable economic development – the Sustainability Window.

The SuWi method provides information on the maximum and minimum economic development that is required to maintain the direction of social and environmental development towards more sustainable targets in accordance with the original Brundtland approach of sustainability [1]. In this sense, the approach is linked to the discussion of the

Doughnut Economy [16] which sees the environmental limits (planetary boundaries) as an environmental ceiling of resource use, limiting economic development and the social foundation of resource use. Thus, the SuWi method can be used for the quantitative assessment of the Doughnut Economy. According to Kate Raworth [16] "The environmental ceiling consists of nine planetary boundaries beyond which lie unacceptable environmental degradation and potential tipping points in Earth systems. The twelve dimensions of the social foundation are derived from internationally agreed minimum social standards, as identified by the world's governments in the Sustainable Development Goals in 2015. Between social and planetary boundaries lies an environmentally safe and socially just space in which humanity can thrive." The SuWi analysis provides quantitative information on these boundaries and economic development about them. The method provides a visual interpretation of the Doughnut and indicates where the problematic unsustainable development areas exist.

The impact of economic development on social and environmental wellbeing does not, however, remain stable over time but depends on several factors such as technology, policy programmes, priorities in spending and investments etc. The SuWi approach takes these changes into account and defines the lower and higher limit of economic development accordingly. The SuWi analysis provides a dynamic view of sustainable development taking into account the time-variant nature of all development.

A simple illustration of the SuWi analysis is provided in Figure 1 using Cambodian data. The indicators used for the analysis are Healthy life years as the social indicator, Greenhouse Gas emission intensity (GHG/GDP) as the environmental indicator and GDP as the economic indicator. The indexed data in the base year of analysis, 2006, has values 1 (point A in Fig1) and the developments of the social and environmental indicators (on the y-axis) are plotted against GDP (on the x-axis) and shown in Fig. 1.

Healthy life years increase from point A to point B until 2016. In 2006 line r1 (going via A) describes the 'Healthy life year productivity of GDP', while in 2016 line r2 (going via B) describes the reduced productivity. With this productivity (determined by r2, ceteris paribus) the GDP should reach the level indicated by point D in order not to reduce the Healthy life years. This indicates the minimum economic growth level (GDP_{min}) to reach sustainable social development with the productivity determined by r2 when we use the chosen indicators. GDP_{min} determines the lower boundary of the Sustainability Window.

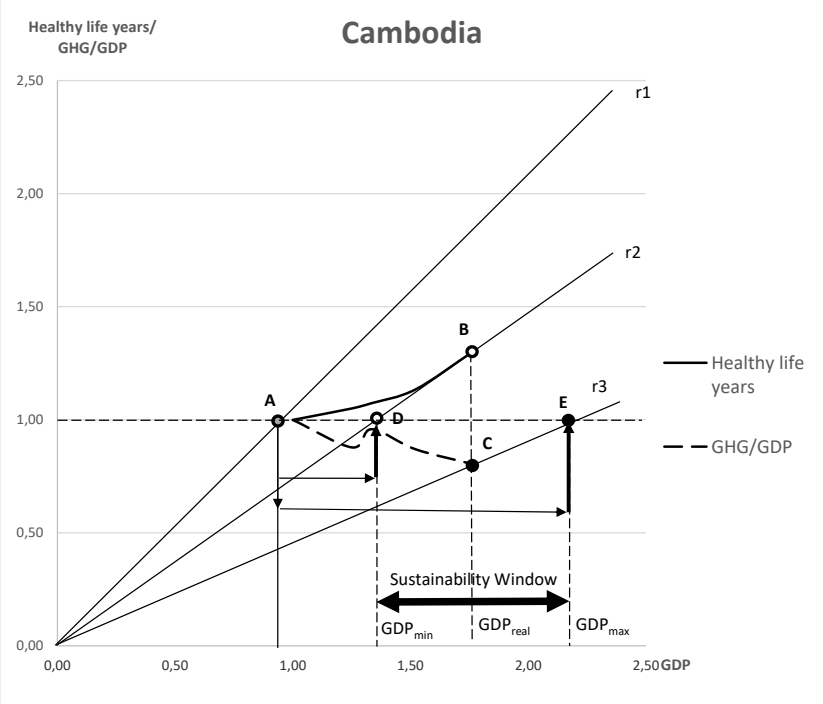

Figure 1. Sustainability Window analysis for Cambodia using Healthy Life Years as a Social Indicator, Greenhouse gas emissions intensity (GHG/GDP) as an Environmental Indicator and GDP as an Economic Indicator. The base year of analysis is 2006 and the data is shown up to 2016.

The Greenhouse gas emission intensity (GHG/GDP) decreases from the base year level (point A) to the level determined by point C in the year 2016. This determines the GHG intensity productivity of GDP indicated by line r3 in the figure. This productivity line r3 determines (ceteris paribus) the maximum economic growth, point E, in order not to increase the environmental impact. Thus, point E determines the GDP_{max} or the upper boundary for Sustainability Window in the environmental dimension. The SuWi for this example is determined by GDP_{min} and GDP_{max} as shown in Figure 1. In this example, the real GDP growth (GDP_{real}) is within the SuWi.

This SuWi example indicates the Weak Sustainability Window because the indicator for the environmental dimension refers to the intensity value, not the absolute value of the environmental dimension. More discussion of the weak and strong sustainability window can be seen in [12], [17], [18], [19], [20], [21], [22], [23].

If the GDP_{min} is larger than GDP_{max} the SuWi does not exist. In this type of case environmental sustainability restricts economic development so much that social sustainability cannot be reached or, put in another way, social sustainability requires so large economic growth that environmental sustainability cannot be reached. The existence of both the Strong and the Weak SuWi analyses have been carried out for the ASEAN countries in this article. In addition, we have analysed whether the real GDP growth is within the SuWi.

Figure 2 shows an example of SuWi analysis for Cambodia using both Strong and Weak Sustainability. In this case, the real GDP is within the Weak Sustainability Window (SuWi) but not in the Strong Sustainability Window (SuWi).

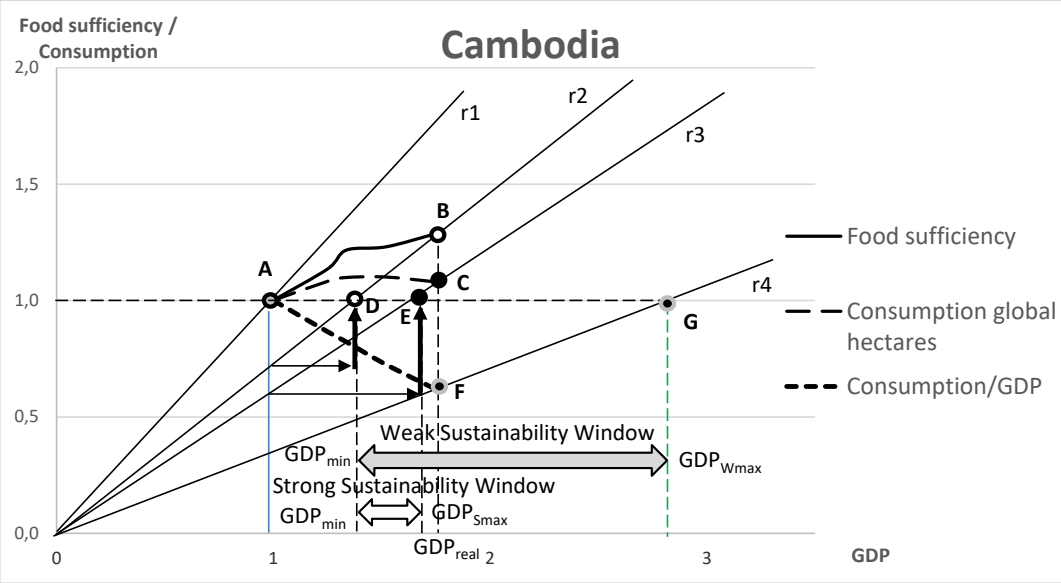

Figure 2. Weak and Strong Sustainability Window for Cambodia using 'Food Sufficiency' as a Social indicator and 'Consumption of global hectares' as an Environmental indicator for Strong SuWi (GDP_{min} - GDP_{Smax}) and 'Consumption of global hectares'/GDP as an Environmental indicator for Weak SuWi (GDP_{min} - GDP_{Wmax}), and GDP as an Economic indicator. The base year is 2006 and the final year is 2016.

In this analysis, we have used the so-called relative measure of sustainability. We are not referring to the absolute level of sustainability because it is difficult to determine in many cases. The absolute level of for instance sustainable biodiversity is difficult to determine as well as the absolute level of socially sustainable education. The relative measure of sustainability means that we look at changes from the selected base year value and analyse whether the changes are towards a more sustainable state or not. It is possible to use also absolute targets (like CO_2 emissions per capita) in the SuWi analysis

The dynamic changes in the Sustainability Window for different years can be analysed using the developed methodology. Figure 3 shows an example of the analysis for Laos using Social inclusion as a social indicator and GHG intensity as the environmental indicator (weak sustainability). In this case, the real GDP growth has been within the SuWi during the period of analysis from 2006 to 2014. During this time period, the real GDP growth has been

high enough to fulfil the social sustainability criterion and has not exceeded the weak environmental sustainability level.

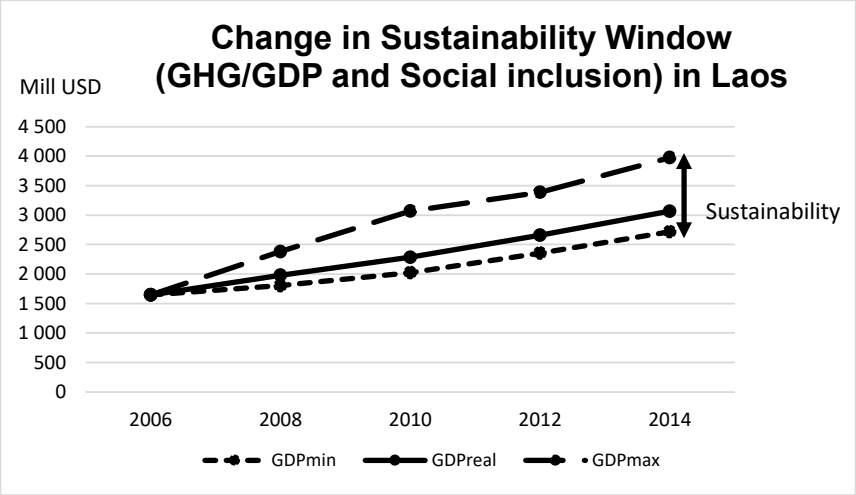

Figure 3. The Dynamic changes in Sustainability Window for Laos for the years 2006-2014 using 'Social Inclusion' as a Social Indicator and 'GHG intensity' (GHG/GDP) as the Environmental Indicator.

More detailed analyses of Cambodian and Lao development are carried out in [23],[24].

Results and Discussion

The economic dimension was measured in the analysis using GDP as the indicator. For the environmental dimension, several indicators were used in order to have a wider perspective of the sustainability of the development. For the environmental dimension, weak sustainability was used as a basis of the analysis for the Doughnut Model because most of the countries could not reduce the originally low-level environmental burden. The use of weak sustainability analysis is based on the idea that the strong criterion e.g. related to GHG emissions may be too demanding for LDC countries with a very low level of emissions per capita. A requirement that the CO_2 emissions for instance in Laos should not increase in the future could be seen as too restrictive from the point of view of the right to develop.

For social sustainability, we have used nine indicators to have a wide perspective in this dimension and to be able to include a variety of development paths. Table 1 shows the indicators used in the analysis.

Table 1. Indicators used in the SuWi analysis and Doughnut Model for ASEAN countries.

Economic	Environmental	Abbreviation	Social	Abbreviation
GDP	Biodiversity, Forest area	Forest, For	Sufficient food	Food
	Biodiversity, Protected area	Conservation, Conser	Sufficient to drink	Drink
	Renewable water resources	Water	Education	Edu
	Consumption of global hectares	Consu	Healthy life years	HLY
	Energy intensity	Intens	Gender equality	Gend
	CO_2 emissions	CO2	Income distribution	Inc
	Renewable energy	Ren energy	Employment	Emp
	Organic farming	Organic	Social inclusion	Soc inc
	Safe sanitation	Sanitation	Human development	HDI

For the comparative analysis of the eight ASEAN countries, we have used all the possible combinations of the indicators of Table 1 for all the years where the data was available (2006 as the base year, and 2008, 2010, 2012, 2014 and 2016 for the analysis).

We have also compared the dynamics and the trends of the Sustainability Window for different countries. Some illustrative figures of the sustainability trends are presented in the following figures.

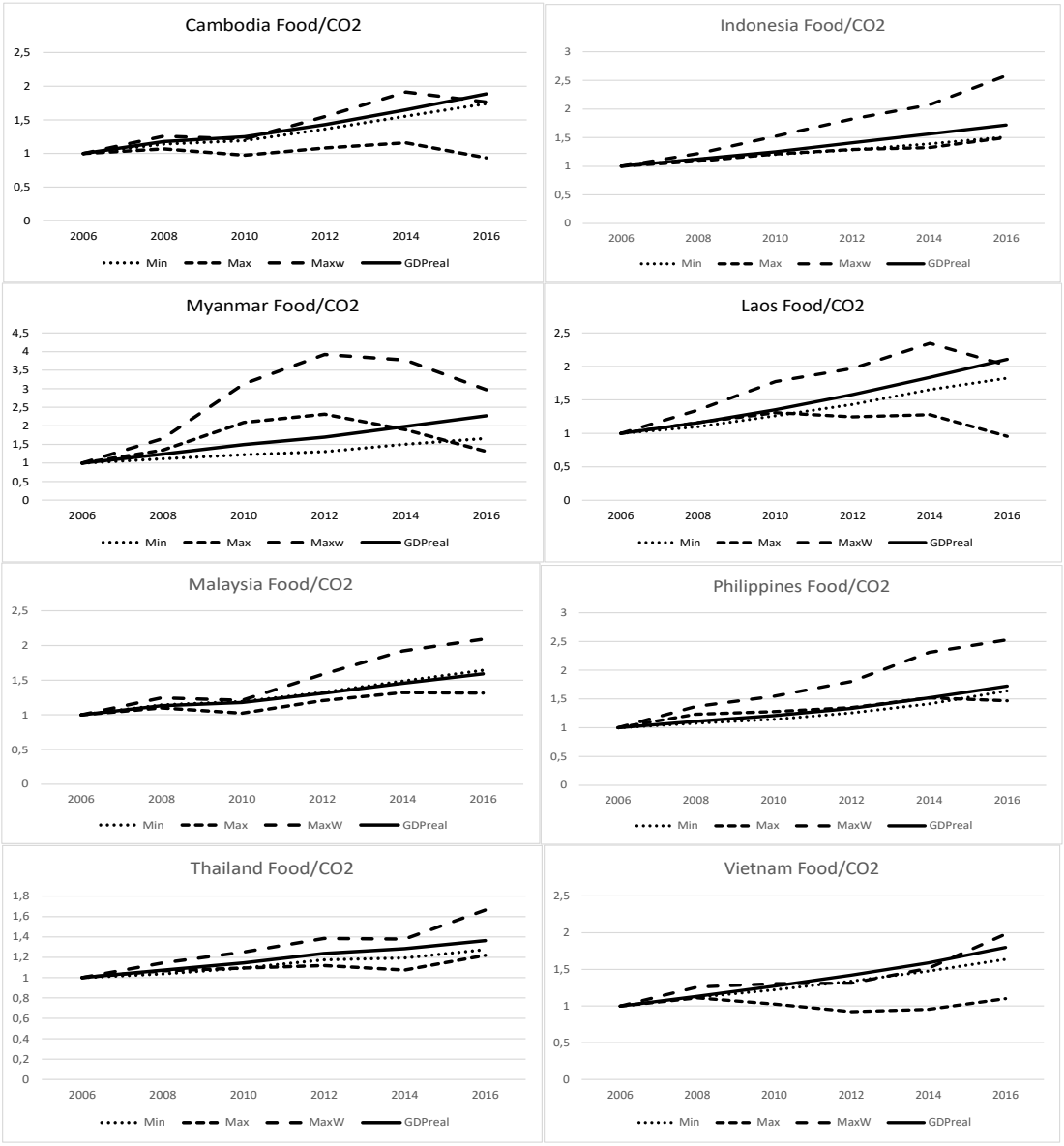

Figure 4. Trends of the Sustainability Window for the different ASEAN countries using 'Sufficient Food' as the Social Indicator (Min) 'CO_2 Emissions' as the Environmental Indicator (Strong Sustainability, Max), 'CO_2 Emission Intensity' as Environmental Indicator (Weak Sustainability, MaxW) and GDP (GDPreal)as the Economic Indicator.

The figures illustrate the trends of Sustainability Window for different ASEAN countries as an example of 'Sufficient food' and 'CO_2' analysis. In the figures, the minimum level of GDP (social dimension, Min), the maximum level of GDP (environmental dimension, Max), the maximum level of GDP in weak sustainability sense (MaxW), and real GDP (GDPreal) levels are presented for the years 2006-2016.

It can be seen in the trend figures that strong sustainability in regard to CO_2 emissions is problematic for the ASEAN countries. Only Myanmar and the Philippines have existing strong SuWi up to 2014 and the real GDP is within this SuWi. The requirement for strong sustainability in regard to CO_2 emissions is not always fair for countries with very low initial emission levels (see e.g. [22]). For all countries except Indonesia, the weak SuWi exists for the whole

analysis period. The real GDP growth is however outside the weak SuWi in Cambodia, Laos and the Philippines in 2016 and in Vietnam for 2010-2014.

The results of the SuWi analysis organised in Dougnut Models for the eight ASEAN countries are presented next. A simplified example of the Doughnut Model for Cambodia is presented in Figure 5. In this figure, we have used only six environmental indicators (CO_2 emissions, Global consumption hectares, Energy use, Safe sanitation, Biodiversity measured with forest area and Biodiversity measured with protected area) and only three social indicators (Healthy life years, Social inclusion, Sufficient food) to simplify the figure. The Sustainability Window is constructed for the different possible pairs of social and environmental indicators (Healthy life years vs. CO_2 emissions, Social inclusion vs. CO_2 emissions, etc.) and the results of the SuWi analyses are organised in a radial chart shown in Fig. 5. In this figure the minimum sustainable economic development, determined by social sustainability, is marked with an inner blue line for the different indicators. The maximum sustainable economic development is illustrated with the outer blue line of the green area determined by environmental sustainability. The area between these two lines, marked with green colour, illustrates the sustainability Doughnut for development. The red line shows the real economic development for the analysis period. We can see that real economic development is within the sustainable area in relation to some indicators but it seems to be too high in relation to CO_2 emissions. Real economic development seems to fulfil the social development criteria in relation to all the indicators used in this model.

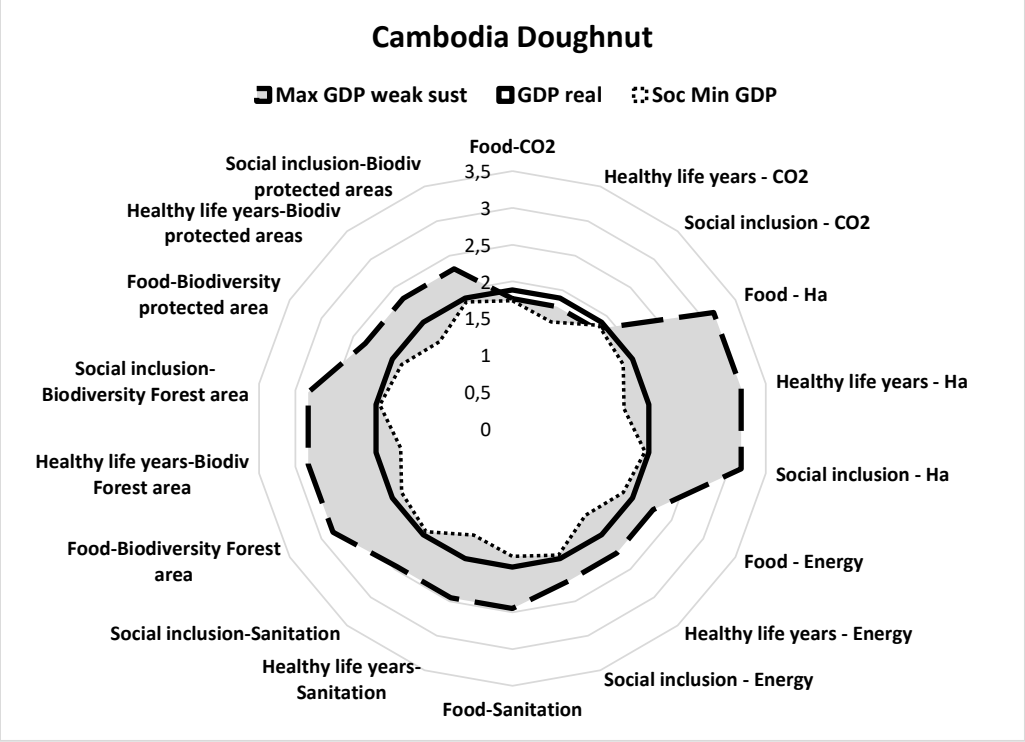

Figure 5. Doughnut Economy model for Cambodia concerning selected indicators of social and environmental development for the analysis of weak sustainability. The inner dotted line indicates the minimum economic development to secure social sustainability, the outer dashed line defines the maximum environmentally sustainable economic development, the grey area illustrates the sustainable development space and the continuous black line shows the real economic development during the research period.

Next, the Doughnut models for eight ASEAN countries are illustrated using the nine social and nine environmental indicators shown in Table 1.

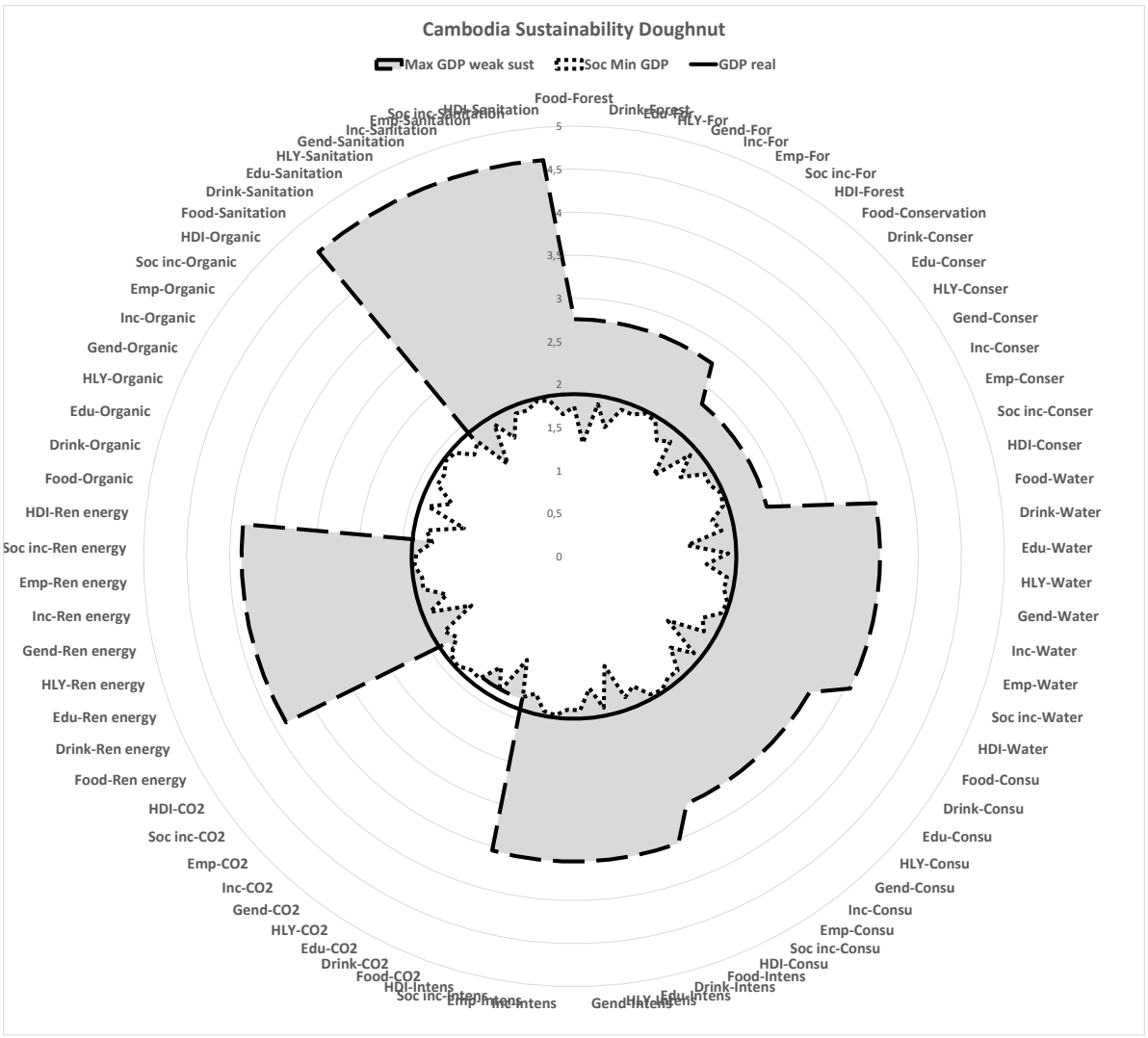

Figure 6. Doughnut Model for changes from 2006 to 2016 in Cambodia using the Indicators of Table 1.

The Doughnut model for Cambodia concerning the changes in environmental performance (shown with the dashed outer line) indicates that the changes in the fields of sanitation, renewable energy, energy intensity, consumption of global hectares, renewable water, forest conservation and forest area are within the weak sustainability. In these areas, the real GDP growth (shown with a continuous line) has been below the ceiling determined by weak environmental sustainability. The problem areas are organic farming and CO_2 emissions. In these areas, economic growth has caused the environmental burden to exceed the limits of weak sustainability.

The social sustainability limit is shown with the inner dotted line in the figure. It seems that the economic development in Cambodia, indicated by the continuous line, has been fast enough to improve the social sustainability measured by the chosen indicators. Economic development has been close to the sustainability limit in the fields of employment production and social inclusion, where the target of improved social development has not been easy to achieve with the real GDP growth level and the related improvement in social welfare productivity.

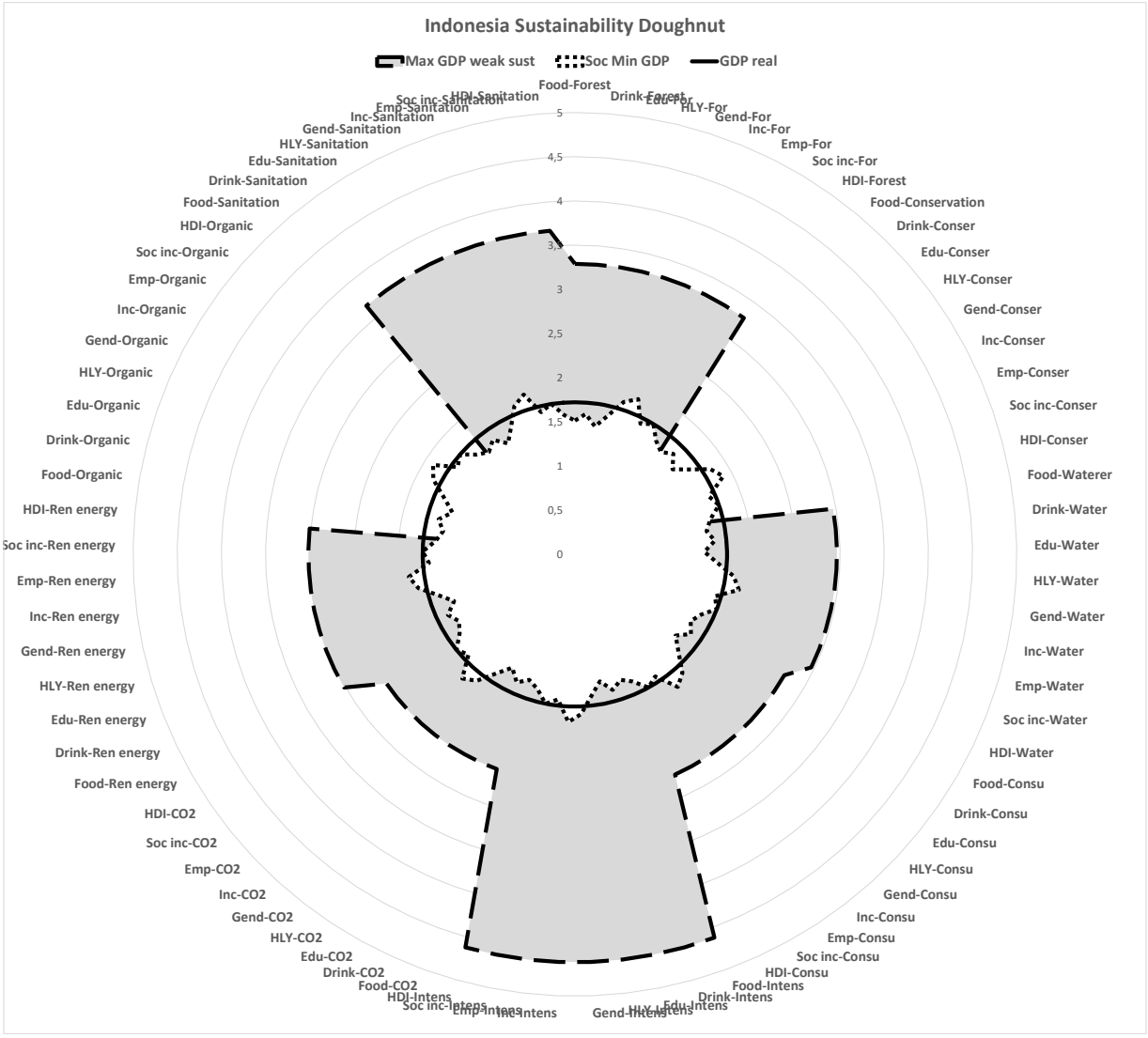

Figure 7. Doughnut Model for changes from 2006 to 2016 in Indonesia using the Indicators of Table 1.

The Doughnut model for Indonesia shows that the economic development has not caused environmental changes to exceed the weak sustainability limit in the areas of sanitation, renewable energy, CO_2 emissions, energy intensity, consumption of global hectares, renewable water and forest area. In the fields of organic farming and forest conservation economic development has, however, caused the system to exceed the limits of weak sustainability.

The economic growth has been fast enough in Indonesia to improve social development in most of the measured areas. There are problems, however with gender equality and income distribution where the changes have not reached the sustainable level.

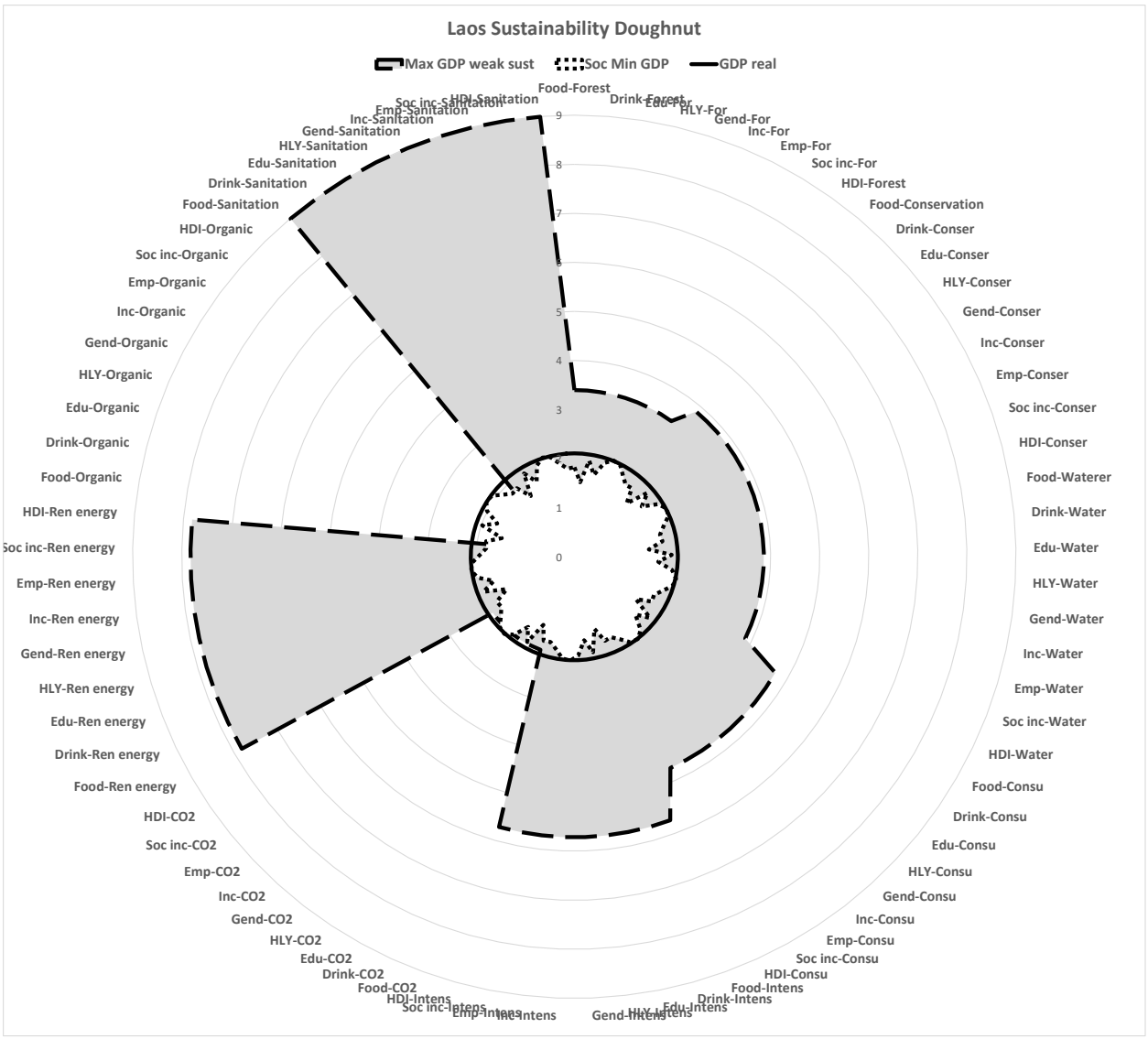

Figure 8. Doughnut Model for changes from 2006 to 2016 in Laos using the Indicators of Table 1.

In Laos, the problematic areas for sustainable environmental development have been organic farming and CO_2 emissions. In these areas, economic growth has caused the system to exceed the weak sustainability level. In other environmental areas, economic development has been within weak sustainability limits. In the field of social development, income distribution has not developed sufficiently to reach the sustainability target. Gender equality is also close to the limit, but it is still on the sustainable side of the border.

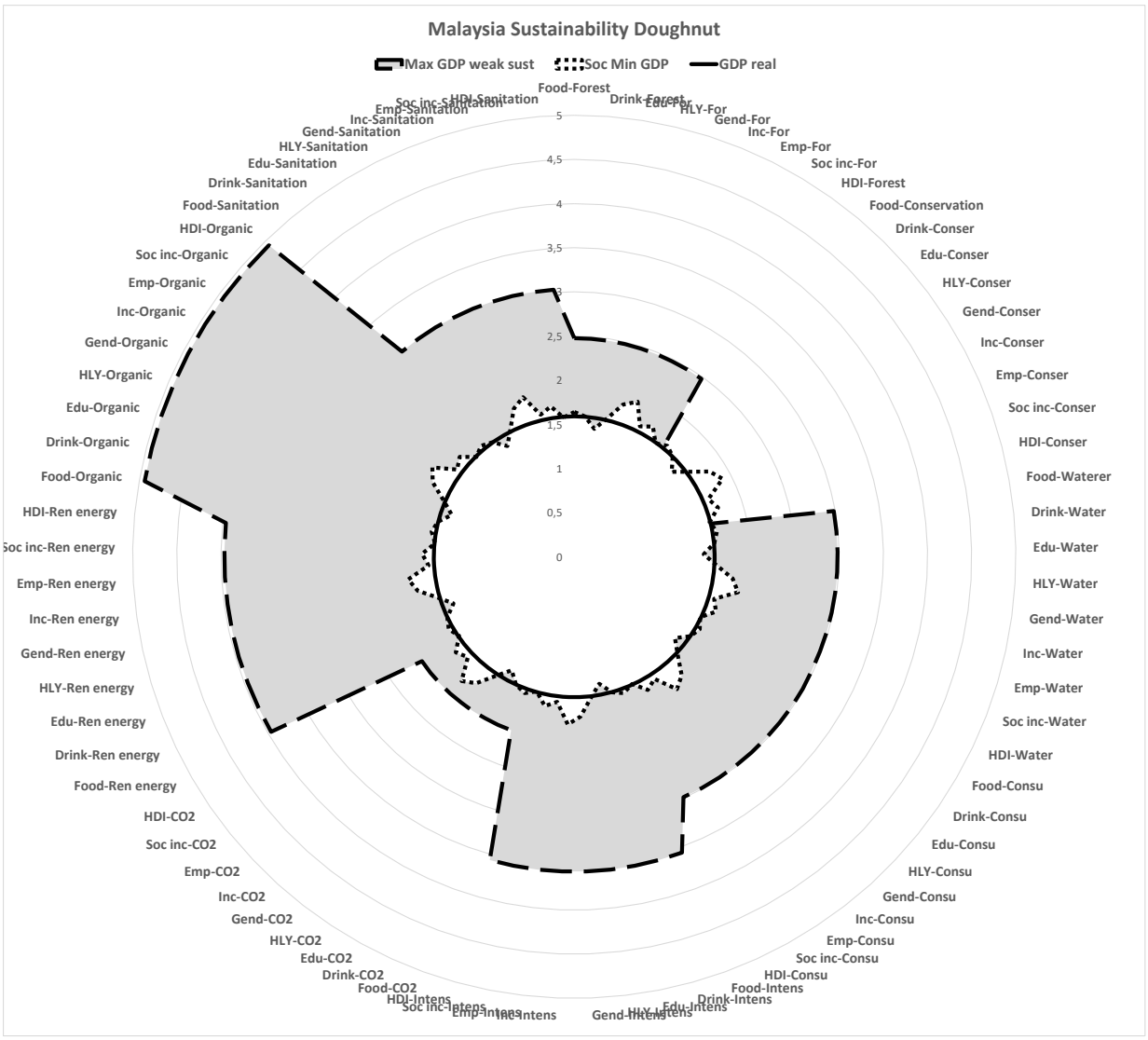

Figure 9. Doughnut Model for changes from 2006 to 2016 in Malaysia using the Indicators of Table 1.

In Malaysia, the development has been within the limits of weak environmental sustainability except in the area of forest conservation. Social development in Malaysia has, however, not reached the sustainable level in the fields of sufficient food, sufficient drink, healthy life years, gender equality, income distribution, employment and social inclusion.

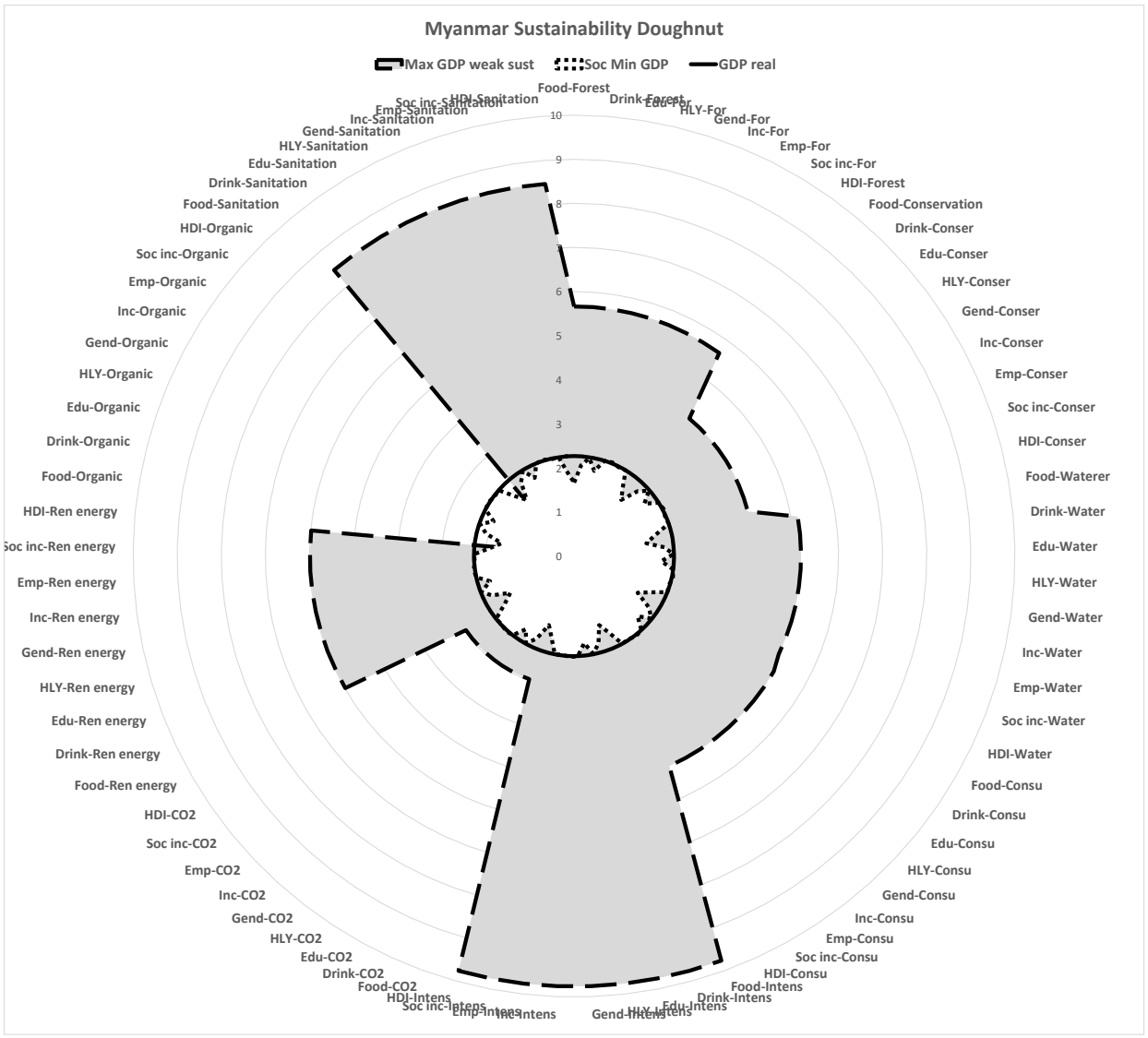

Figure 10. Doughnut Model for changes from 2006 to 2016 in Myanmar using the indicators of Table 1.

In Myanmar, environmental development has reached weak sustainability targets in other areas except organic farming. Social development in Myanmar has reached the sustainability level, measured with the selected indicators, during the analysed period.

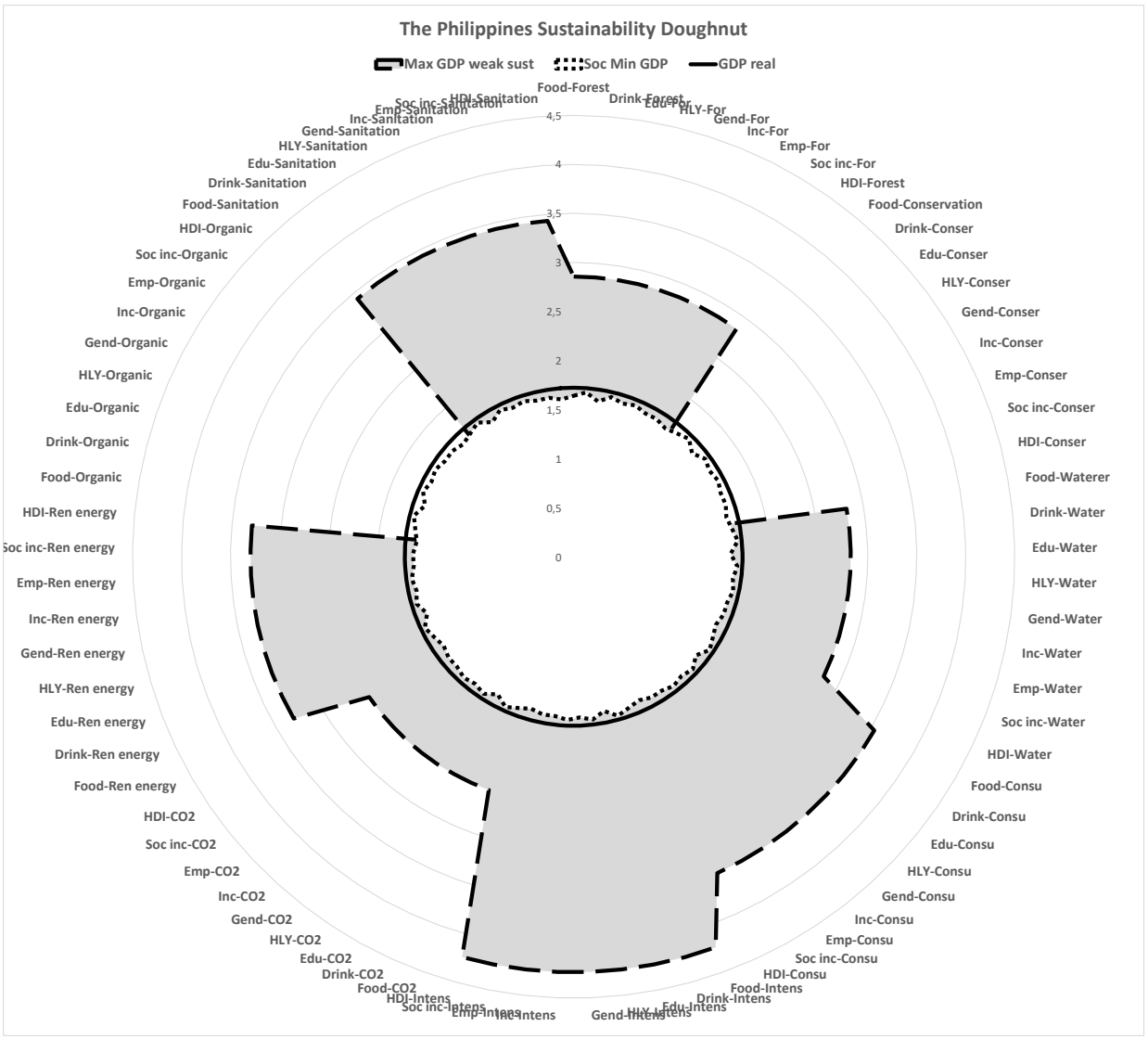

Figure 11. Doughnut Model for changes from 2006 to 2016 in The Philippines using the Indicators of Table 1.

In the Philippines, the environmental changes have been within the weak sustainability limits for other areas except for organic farming and forest conservation. Social development in the Philippines has also been towards a more sustainable state when measured with the selected indicators.

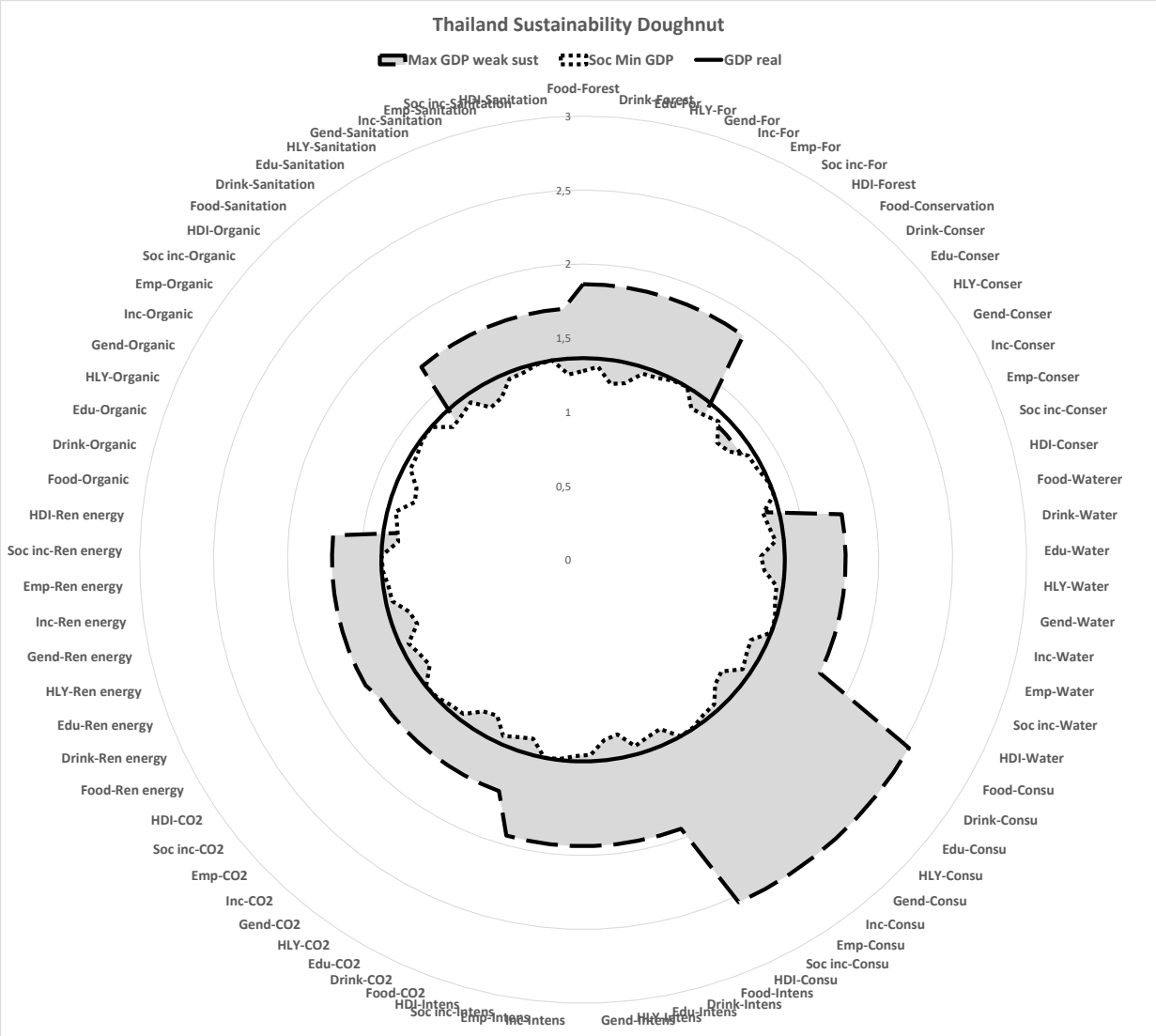

Figure 12. Doughnut Model for changes from 2006 to 2016 in Thailand using the Indicators of Table 1.

In Thailand, environmental development has been within the weak sustainability limits for other sectors except for organic farming and forest conservation. Social development has taken place towards a more sustainable direction during the research period when it is measured with the selected indicators.

Figure 13. Doughnut Model for changes from 2006 to 2016 in Vietnam using the Indicators of Table 1.

In Vietnam, environmental development has been within the limits of weak sustainability in other areas except for organic farming and forest conservation. Social development has not reached sustainability in the fields of gender equality, income distribution and employment.

If we look at strong sustainability the picture looks quite different. Strong sustainability means that the absolute environmental stress does not increase while weak sustainability was analysing the changes in environmental stress intensity of GDP (environmental stress/GDP). Figure 14 shows the case of the strong sustainability Doughnut model for Vietnam.

Figure 14. Doughnut Model for Strong Sustainability for changes from 2006 to 2016 in Vietnam using the Indicators of Table 1.

In the case of strong environmental sustainability in Vietnam, economic growth has caused a reduction in forest area and forest conservation area, an increase in consumption of global hectares, in energy use, in CO_2 emissions and a decrease in organic farming. The development has been sustainable only in sanitation, renewable energy and energy intensity. Social sustainability is calculated in the same way as in the weak environmental sustainability case.

Conclusions

Sustainability Window analysis provides an easy to use tool for comparative analysis of different countries integrating the different dimensions of sustainability in the same analytical framework. The results of the SuWi analysis are easy to interpret and it is easy to make comparisons based on the analyses.

The SuWi approach provides an interesting method for dynamic analysis of development. It can illustrate the trends and their changes and can be used for sustainability policy planning. The method does not provide direct recommendations for policy making but shows the areas of development, where problems and sustainability challenges exist. This makes it a useful tool for pre-planning analysis of sustainability transitions.

The Doughnut Model of sustainable development, based on the SuWi analyses, provides a new visual tool for analysing sustainability and its changes. It illustrates the environmental limits of economic growth and, at the same time, the needed economic development in order to fulfil the social development objectives.

The quality and availability of data have a significant impact on the results of SuWi and Doughnut Model and the comparative analyses between different countries depends on the reliability of data in these countries. Sustainability Window and Doughnut Model are not able to analyse the reasons and drivers behind certain development trends. These methods illustrate the development paths and trends but other methods, such as decomposition analysis or cross-impact analysis, are needed to analyse the drivers behind the changes.

One of the main aspects of the SuWi method and Doughnut Model is to integrate the different dimensions of development, social, economic and environmental, in the same methodological framework and to provide a quantitative approach for dealing with the complex sustainability issue.

Often in the policy formulations in ASEAN countries, uniform sustainability policy strategies are outlined, but this study reveals that the problems of sustainability are country-specific in different ASEAN countries. This study indicates that country-specific sustainability policy formulations are needed.

This research can be seen as a demonstration of the SuWi method and the Doughnut model for explorative benchmarking analysis of the sustainability transition. As normally in benchmarking studies there are possibilities for learning from good results of sustainability policies in different dimensions of sustainability. The study reveals that, on the one hand, every ASEAN country has some areas where improved sustainability policies are needed. On the other hand, there are countries, which are performing well in some fields of sustainability.

Acknowledgements

The authors want to thank the Academy of Finland for funding the “Cuban energy transformation Integration of Renewable intermittent sources in the power system (IRIS)” project, decision n:o 320229.

References

[1] Our Common Future. Report of the World Commission on Environment and Development (1987), Oxford University Press, Oxford.
[2] Komiyama, H. & K. Takeuchi, K. (2006) Sustainability science. Building a new discipline. Sustainability Science, 1, pp. 1–6.
[3] Kajikawa, Y. (2008) Research core and framework of sustainability science. Sustainability Science 3, pp. 215-239.
[4] Brandt, P., Ernst, A., Gralla, F., Luederitz, C., Lang, D.J., Newig, J., Reinert, F., Abson, D.J., Von Wehrden, H. (2013) A review of transdisciplinary research in sustainability science, Ecological Economics 92 (2013), pp. 1–15.
[5] Geels, F. & Schot, J. The Dynamics of Transitions: A Socio-Technical Perspective pp 11-104, in Grin,J., Rotmans, J. & Schot, J. (eds) (2016) Transitions to Sustainable Development. New directions in the Study of Long Term Transformative Change. Routledge, London.
[6] Loorbach, D. (2002) Transition Management: Governance for Sustainability. Berlin: International Dimensions of Human Change.
[7] Kemp, R. & Parto, S. (2005) Governance for sustainable development: moving from theory to practice. International Journal of Sustainable Development, Vol. 8, Nos. 1/2, 2005, pp. 12–30.
[8] Schoenaker, N., Hoekstra, R. & Smits, P. (2015) Comparison of Measurement Systems for Sustainable Development at the National Level. Sustainable Development 23, pp. 285-300.
[9] Sondeijker, S. Geurts, J., Rotmans, J. and Tukker, A. (2006) Imagining sustainability: The added value of transition scenarios in transition management. Foresight 8 (5), pp. 15–30.
[10] Voss, J-P., Bauknecht, D. & Kemp, R. (eds.). (2006) Reflexive Governance for Sustainable Development. Cheltenham: Edward Elgar.
[11] Quental, N., Lourenço, J., & da Silva, F. (2011) Sustainability: characteristics and scientific roots. Environment, Development and Sustainability 13, pp. 257-276.
[12] Luukkanen, J., Kaivo-oja, J., Vehmas, J., Panula-Ontto, J. and Häyhä, L. (2015) Dynamic sustainability. Sustainability Window analysis of Chinese poverty-environment nexus development. Sustainability. 2015, 7(11), 14488-14500; doi:10.3390/su71114488
[13] van de Kerk, G. & Manuel, A. (2014) SSI-2014, Sustainable Society Index 2014. Sustainable Society Foundation, The Hague, The Netherlands.
[14] World Bank Group (2016a) CPIA database (http://www.worldbank.org/ida) accessed on 16.8.2019.

[15] World Bank (2016b) A Guide to Valuing Natural Resources Wealth. Policy and Economics Team – Environment Department, World Bank. http://siteresources.worldbank.org/INTEEI/1105643-1116228574659/21003722/NaturalWealth_EstMethods.pdf Accessed on 17.9.2019.
[16] Raworth, K. (2017) Doughnut Economics: Seven Ways to think like a 21st-Century Economist. White River Junction, Vermont: Chelsea GreenPublishing.
[17] Neumayer, E. (2013) Weak vs Strong Sustainability. Exploring the Limits of Two Opposing Paradigms. Edvar Elgar Publishing Limited, Cheltenham, UK.
[18] Kaivo-oja, J., Luukkanen, J. and Malaska, P. (2001) Sustainability Evaluation Frameworks and Alternative Analytical Scenarios of National Economies. Population and Environment. A Journal of Interdisciplinary Studies. Vol. 23, No. 2, pp. 193-215.
[19] Vehmas, Jarmo & Luukkanen, Jyrki & Kaivo-oja, Jari (2007) Linking Analyses and Environmental Kuznets Curves for Material Flows in the European Union 1980-2000. Journal of Cleaner Production 15 (17), pp. 1662-1673.
[20] Kaivo-oja, J., Vehmas, J. and Luukkanen, J. (2014a) A Note: De-growth Debate and New Scientific Analysis of Economic Growth. Journal of Environmental Protection. Special Issue Environmental Management Vol.05 No.15 (2014).
[21] Kaivo-oja, J., Panula-Ontto, J., Luukkanen, J. and Vehmas, J. (2014b) Relationships of the dimensions of sustainability as measured by the Sustainable Society Index framework. International Journal of Sustainable Development & World Ecology. Volume 21, Issue 1, January 2014, pages 39-44.
[22] Luukkanen, J., Vehmas, J., Kinnunen, V., Kuntsi-Reunanen, E. & Kaivo-oja, J. (2005) Converging CO2 Emission to Equal per Capita Levels. Mission Possible? FFRC-Publications 2/2005. Finland Futures Research Centre, Turku School of Economics and Business Administration. Turku. 139 p.
[23] Luukkanen, J., Kaivo-oja, J., Vähäkari, N., O'Mahony, T., Korkeakoski, M., Panula-Ontto, J., Vehmas, J. and Nguyen Quoc, A (2018) Resource efficiency and green economic sustainability transition. evaluation of green growth productivity gap and governance challenges in Cambodia. Sustainable Development. 2018;1–9. https://doi.org/10.1002/sd.190
[24] Luukkanen, J., Kaivo-oja, J., Vähäkari, N., O'Mahony, T., Korkeakoski, M., Panula-Ontto, J.1, Phonhalath, K., Nanthavong, K., Reincke, K., Vehmas, J, Hogarth, N.J. (2019) Green economic development in Lao PDR: a Sustainability Window analysis of Green Growth Productivity and the Efficiency Gap. Journal of Cleaner Production 211 (2019) 818-829. https://doi.org/10.1016/j.jclepro.2018.11.149