

國立臺北大學自然資源與環境管理研究所  
108 學年度第二學期『清潔生產與工業生態』

課程進度(07)：永續性指標與評估工具  
Sustainability Indicators, Metrics, and Assessment Tools

● DEFINITION OF SUSTAINABILITY

□ Defining Sustainability

- ⇒ Sustaining the current state of welfare, closely related to environment: resources depletion, waste handling, recycling, and preservation of biodiversity
- ⇒ “Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs”
- ⇒ The Triple Bottom Line (TBL): Environmental, Social, and Economic metrics
- ⇒ Sustainability is the possibility that humans and other forms of life will flourish on the planet forever
- ⇒ Sustainability  $\sim (AP/I) = 1/T \Rightarrow$  Ratio of human quality of life to environmental impact (\*)

□ The Triple P: People, Planet, Profit/Prosperity

- ⇒ “People”, the social consequences of its actions
- ⇒ “Planet”, the ecological consequences
- ⇒ “Profit”, the economic profitability of companies (being the source of “Prosperity”)
- ⇒ From this “Triple P” perspective, an organization that considers a strategy of sustainability must find a balance between economic goals and goals with regard to the social and ecological environment.

□ Four context levels: Planet-Society-Business-Engineer (Jonker and Harmsen, 2012)

● SUSTAINABILITY INDICATORS

□ Indicator vs. Index

- ⇒ In context of economics, an indicator is a measure, such as unemployment rate, which can be used to predict economic trends; while an index is a single number calculated from an array of prices or of quantities.

□ SMART (Reddy et al., 2019)

- ⇒ Specific, Measurable, Actionable/Achievable, Relevant, Timely
- ⇒ MRV (GHG Emission Inventory): Measurable, Reportable, Verifiable
- ⇒ Fundamental Principles for Effective Disclosure (TCFD): 7 Principles (\*)

□ UN Sustainability Indicators ([UNDESA, 2007](#))

□ EU's Indicator System of Sustainable Development ([EC, 2009](#))

□ Taiwan's Indicator of Sustainable Development

- ⇒ 聯合國於 1996 年發表第 1 版永續發展指標系統...後續...分別於 2002 年及 2007 年發表第 2 版及第 3 版永續發展指標系統...第 2 版指標架構與聯合國第 3 版指標架構同為「面向」、「議題」、「指標」之三層次
- ⇒ 面向：環境、國土資源、生物多樣性、生產、生活、科技、城鄉文化、健康、治理、參與
- ⇒ 「國家永續發展指標系統評量」 $\Rightarrow$  107 年永續發展指標系統評量結果報告（第二版系統）
- ⇒ 『永續台灣向前指』

□ Sustainable Development Indicators for Organizations (?)

□ Sustainability Indicators for Engineering projects: The Triple Bottom Line Indicators

**Poverty**

- Unemployment rate
- Poverty index
- Population living below poverty line

**Population Stability**

- Population growth rate trend
- Population density

**Human Health**

- Average life expectancy
- Access to safe drinking water
- Access to basic Sanitation
- Infant mortality rate

**Living Conditions**

- Urban population growth rate
- Floor area per capita
- Housing cost

**Coastal Protection**

- Population growth
- Fisheries yield
- Algae index

**Agricultural Conditions**

- Pesticide use rate
- Fertilizer use rate
- Arable land per capita
- Irrigation % of arable land

**Ecosystem Stability**

- Threatened species
- Annual rainfall

**Atmospheric Impacts**

- Greenhouse gas emissions
- Sulfur oxide emissions
- Nitrogen oxides emissions
- Ozone depleting emissions

**Generation**

- Municipal waste
- Hazardous waste
- Radioactive waste
- Land occupied by waste

**Consumption**












- Forest area change
- Annual energy consumption
- Mineral reserves
- Fossil fuel reserves
- Material intensity
- Groundwater reserves

**Economic Growth**

- GNP
- National debt/GNP
- Average income
- Capital imports
- Foreign investment

**Accessibility**

- Telephone lines per capita
- Information access


SDI theme	Headline indicator	EU-27 evaluation of change
Socioeconomic development	Growth of GDP per capita	
Climate change and energy	Greenhouse gas emissions*	
	Consumption of renewables	
Sustainable transport	Energy consumption of transport relative to GDP	
Sustainable consumption and production	Resource productivity	
Natural resources	Abundance of common birds**	
	Conservation of fish stocks***	
Public health	Healthy life years****	
Social inclusion	Risk of poverty****	
Demographic changes	Employment rate of older workers	
Global partnership	Official development assistance*****	
Good governance	[No headline indicator]	:


\* EU-15    \*\* Based on 19 Member States    \*\*\* In North East Atlantic    \*\*\*\* EU-25, from 2005    \*\*\*\*\* From 2005

**LEGEND:**

 clearly favourable change/on target path

 moderately unfavourable change/far from target path

 no or moderately favourable change/close to target path

 clearly unfavourable change/moving away from target path

:

contextual indicator or insufficient data

**Environmental sustainability indicators:**

- Greenhouse gases and other air emissions
- Contributions to climate change
- Use of fresh water resources
- Impacts to soil
- Utilization of raw natural resources
- Impacts to surface water or groundwater
- Use of recycled/repurposed materials
- Overall waste generation
- Diversion of waste materials from or to landfill facilities.

**Economic sustainability indicators:**

- Direct and indirect job creation within the community
- Direct and indirect investment within the community
- Facilitation of government grants for the project and community as a whole
- Long-term tax and revenue generation within the enhanced community
- Degree of highest and best use (HBU) achieved by the engineered project.

**Social sustainability indicators:**

- Enhancement of community aesthetics
- Enhancement of quality-of-life features (e.g. improved transportation opportunities or recreational facilities)
  - Public participation in decision-making
  - Educational and job training opportunities
  - Interaction between community groups
  - Emotional ownership of the community in an engineering project
  - Improved physical and mental health and well-being of members of the community
  - Enhanced social opportunities for members of the community
  - Strengthening or enhancement of existing community institutions (e.g. recreational organizations, charitable foundations, and houses of worship).

**● SUSTAINABILITY METRICS**

- Positive vs. Negative Indicators/Indices
- Physical Units
  - ⇒ Energy: kWh, KLOE...
  - ⇒ Pollutants: concentration vs. 'total emission'
- Monetary Values.
- 'Human Dimensions'
  - ⇒ Qualitative measures
  - ⇒ Preference
  - ⇒ Interval measures

## □ Environmental Impact Categories

- *Global climate change impact category* – carbon dioxide (CO<sub>2</sub>) equivalents
- *Acidification impact category* – sulfur dioxide (SO<sub>2</sub>) equivalents
- *Eutrophication impact category* – nitrogen (N) equivalents
- *Ozone depletion impact category* – trichlorofluoromethane (CFC-11) equivalents
- *Photochemical smog formation impact category* – ozone (O<sub>3</sub>) equivalents
- *Human health particulate matter impact category* – fine particulate matter (PM<sub>2.5</sub>) equivalents
- *Human health cancer impact category* – comparative toxicity unit cancer equivalents
- *Human health noncancer impact category* – comparative toxicity unit noncancer equivalents
- *Eco-toxicity impact category* – comparative toxicity unit eco-toxicity equivalents.

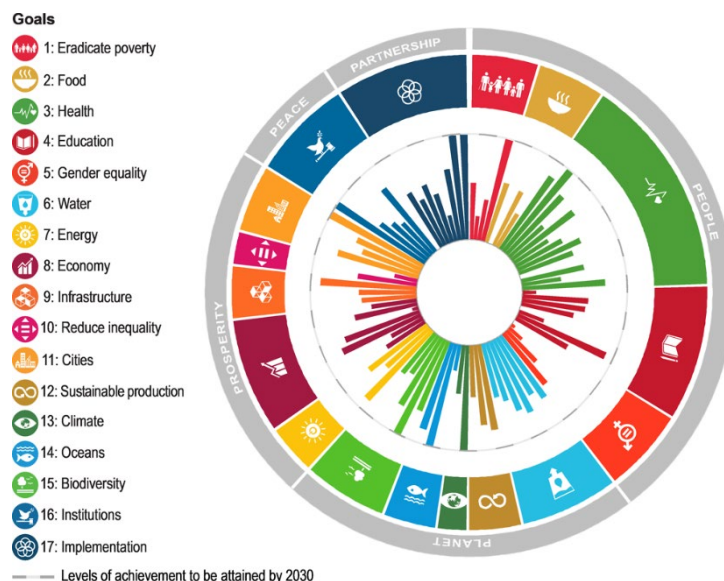
## □ Steps for constructing a composite indicator ([OECD, 2008](#))

1. Developing a theoretical framework
2. Selecting variables
3. Imputation of missing data
4. Multivariate analysis
5. Normalisation of data
6. Weighting and aggregation
7. Robustness and sensitivity
8. Back to the details
9. Links to other variables
10. Presentation and dissemination

## ● SUSTAINABLE DEVELOPMENT GOALS

### □ UN Sustainable Development Goals

- ⇒ The 17 goals
- ⇒ 169 targets, 247 indicators (231 unique indicators)
- ⇒ UN SDG Report: <https://www.un.org/sustainabledevelopment/progress-report/>
- ⇒ [Measuring Distance to the SDG Targets 2019: An Assessment of Where OECD Countries Stand](#)



### □ Taiwan Sustainable Development Goals

- ⇒ The 18<sup>th</sup> Goal
- ⇒ 143 項具體目標(targets)與 336 項對應指標(indicators)

## ● HOMEWORK ASSIGNMENT #3 (Due 2020/04/21):

請蒐集、整理相關指標或指數，繪圖並探討台灣地區之經濟發展與環境保護是否出現「脫鉤現象」？經濟發展相關指數建議可考量人均 GDP，環境保護建議可考量每人每日垃圾清運量或空氣品質良好日數百分比。

# 聯合國 SDGs 與台灣永續發展目標之比較

	聯合國永續發展目標	Target	Indicator	台灣永續發展目標	具體目標數	對應指標數
1	消除貧窮	7	12	強化弱勢群體社會經濟安全照顧服務	6	25
2	零飢餓	8	14	確保糧食安全，消除飢餓，促進永續農業	8	24
3	優良之健康與福祉	13	26	確保及促進各年齡層健康生活與福祉	11	39
4	優質教育	10	11	確保全面、公平及高品質教育，提倡終身學習	9	30
5	性別平等	9	15	實現性別平等及所有女性之賦權	6	13
6	潔淨用水及衛生設施	8	11	確保環境品質及永續管理環境資源	11	29
7	可負擔之清潔能源	5	6	確保人人都能享有可負擔、穩定、永續且現代的能源	3	5
8	合宜之工作與經濟成長	12	17	促進包容且永續的經濟成長，提升勞動生產力，確保全民享有優質就業機會	13	34
9	工業、創新與基礎建設	8	12	建構民眾可負擔、安全、對環境友善，且具韌性及可永續發展的運輸	5	10
10	縮小不平等	10	11	減少國內及國家間不平等	7	15
11	永續城鄉	10	15	建構具包容、安全、韌性及永續特質的城市與鄉村	12	28
12	負責任之消費與生產	11	13	促進綠色經濟，確保永續消費及生產模式	10	29
13	氣候行動	6	9	完備調適行動以因應氣候變遷及其影響	3	5
14	水棲生物	10	10	保育及永續利用海洋生態系，並防止海洋環境的劣化	8	14
15	陸棲生物	12	14	保育及永續利用陸域生態系，以確保生物多樣性，並防止土地劣化	9	13
16	健全之和平與正義制度	12	23	促進和平多元的社會，確保司法平等，建立具公信力且廣納民意的體系	7	10
17	永續發展全球夥伴關係	19	25	建立多元夥伴關係，協力促進永續願景	10	13
18	-	-	-	逐步達成環境基本法所訂非核家園目標	5	-
	17項	169	244	18項	143	336