國立臺北大學自然資源與環境管理研究所 113 學年度第二學期『資源管理與環境系統分析』

課程講義(01):環境系統、模式與量化指標 Environmental Systems, Modeling, and Indicators

- THIS COURSE: A GENERIC INTRODUCTION
 - Business Analytics, Operations Research, Environmental Systems Analysis
 - ⇒ Descriptive, Predictive, and Prescriptive Analytics => Chats with AI and Refs
 - ⇒ Environmental Informatics => Geographic Information Systems
 - ⇒ Life Cycle Assessment, Material Flow Analysis, and Industrial Ecology



- \Box Content \Rightarrow Systems Analysis Models and Applications Concerning the *Environment*
 - ⇒ Systems vs. Systems Analysis
 - ⇒ Systems Analysis vs. Operations Research (Operational Research)
 - ⇒ Systems Analysis vs. System Simulation => Systems Thinking and System Dynamics
 - ⇒ Programming vs. Planning => Simulation and Optimization
 - ⇒ Conceptual models => Mathematical models (Analytical and Numerical) => Simulation/Optimization models => Visualization
- □ Mathematical Models (Quantitative Models)
 - ⇒ Classification: Prescriptive vs. Descriptive; Deterministic vs. Stochastic
 - ⇒ Solution Techniques: Symbolic/Graphical Interpretation; Analytical vs. Numerical
 - ⇒ Algorithms, Numerical Methods => Linearity, Convexity, and Complexity
- □ Computer Applications
 - ⇒ Command Line Interface vs. Graphical User Interface (GUI)
 - ⇒ <u>Imperative Programming</u> vs. Object Oriented Programming
 - ⇒ Commercial Packages vs. GNU General Public License; Open Source & Open Data
 - ⇒ Cloud Computation and Cloud Storage => AI Chatbot (e.g., ChatGPT, DeepSeek)

• SOFTWARE TO BE COVERED

- D Microsoft Office Applications: Excel, Visio, and Project
- \square <u>R</u> and <u>RStudio</u>: a free software environment for statistical computing and graphics.
- □ <u>EULER Math Toolbox</u>: A powerful math program combining numerical and symbolic tools (using the computer algebra system <u>Maxima</u>) in one free and open source package.
- □ <u>GNU Octave</u>: Scientific Programming Language
- Depuise the provided and a provided
- □ <u>Super Decisions</u>: Decision support software that implements the AHP and ANP.
- □ <u>FreeMind</u> / <u>Freeplane:</u> free mind mapping software.
- □ <u>Vensim (Vensim from Ventana Systems)</u>: "Vensim is used for developing, analyzing, and packaging

high quality dynamic feedback models."

- ENVIRONMENTAL SYSTEMS ANALYSIS: MODELING AND DECISION MAKING
 - □ Environmental Systems and Environmental Modeling
 - ⇒ A system is composed of interrelated components, connected together in order to facilitate information, matter and energy flows.
 - ➡ Modeling can be defined as the process of application of fundamental knowledge or experience to simulate or describe the performance of a real system to achieve certain goals.
 - ⇒ Physical modeling, Empirical modeling, and Mathematical modeling
 - ⇒ Environmental Systems: Ecological/Biological, Chemical (Engineering) and Socio-Economical Phenomena/Processes
 - \Rightarrow Environmental Modeling => *e.g.*, Streeter-Phelps Equation of Oxygen Sag Curve
 - □ Environmental Systems Analysis and Environmental Informatics (Environmatics)
 - ⇒ Environmental Systems Analysis: Applications of system approaches to dealing with problems/issues of environmental modeling and decision making
 - ⇒ Environmental Informatics is a part of applied Informatics and supports methods and procedures of information technologies that contribute to environmental data analysis and environmental protection.
 - ⇒ Environmental Data: Cross section, Time series, Spatial data, Panel data.
 - □ Environmental Systems Analysis and <u>Systems Analysis for Sustainable Engineering</u> ⇒ Systems analysis and sustainable management strategies
 - ⇒ Economic valuation, instruments, and project selection => Statistical forecasting models
 - ⇒Linear, nonlinear, integer, and dynamic programming models => Multicriteria decision analyses
 - \Rightarrow System dynamics models and simulation analyses =>System thinking

• INDICATOR, INDEX AND METRIC SYSTEM

□ Metric System: Performance, Benchmarking, Indicator, and Index

- ⇒ Index, Sub-indices, and Indicators
- ⇒ UN Sustainable Development Goals => Goal, Target, Indicator
- □ OECD <u>Handbook on Constructing Composite Indicators: Methodology and User Guide</u>
 - \Rightarrow The construction of composite indicators:
 - 1. Theoretical framework
 - 2. Data selection
 - 3. Imputation of missing data
 - 4. Multivariate analysis
 - 5. Normalisation

- 6. Weighting and aggregation7. Robustness and sensitivity
- 8. Back to the real data
- 9. Links to other variables
- 10. Presentation and Visualisation
- ⇒ OECD/JRC Handbook on constructing composite indicators Putting theory into practice (Michela Nardo & Michaela Sai - PowerPoint PPT Presentation)
- □ Examples of Index Systems
 - ⇒ Environmental Indices: PSI vs. AQI; RPI vs. WQI => CTSI
 - ⇒ Yale University: 2024 Environmental Performance Index
 - ⇒ World Economic Forum (WEF) <u>The Global Risks Report</u>
 - ⇒ IEA Global Energy and Climate Model => Net Zero Emissions by 2050 Scenario (NZE)
- Homework Assignment #1 (Reading Assignments)

請閱讀 OECD (2008) Handbook on Constructing Composite Indicators,以進一步了解 複合性指標之建構步驟,並嘗試操作 Normalization and Visualization。