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

課程講義(16-17)：多目標規劃與多評準決策分析
Multiobjective Programming and Multi-Criteria Decision Making

• MULTIOBJECTIVE PROGRAMMING

- □ Conflicting between Objectives (Goals) => Trade-off among objectives
- □ Non-dominance, Non-inferiority, "Efficiency," or "Pareto Optimality"
- □ Terminology
  - ⇨ Decision Space vs. Objective Space
  - ⇨ Tradeoff 抵換 vs. Pay-off 償付
  - ⇨ Noninferior Solution or "Best-Compromise Solution"非劣解
- □ Categories of MOP Solution Methods
  - ⇨ Information Flow: Bottom-Up or Top-Down
  - ⇨ Techniques that Incorporate Preferences
- □ Generating Techniques: Evaluating Alternatives, Decision Support
  - ⇨ Weighting method, Constraint method
  - ⇨ Multiobjective simplex method, and others
- □ Number of Decision Makers

$$\text{Maximize } \mathbf{Z}(x_1, x_2) = [Z_1(x_1, x_2), Z_2(x_1, x_2)]$$

where

$$Z_1(x_1, x_2) = 5x_1 - 2x_2$$
$$Z_2(x_1, x_2) = -x_1 + 4x_2$$

$$\text{s.t.} \quad -x_1 + x_2 \le 3, \quad x_1 + x_2 \le 8$$
$$x_1 \le 6, \qquad x_2 \le 4$$

• INTRODUCTION TO MULTICRITERIA DECISION MAKING

- □ Multiattribute Decision Making: Multiple criteria decision making (MCDM) refers to making decisions in the presence of multiple, usually conflicting, criteria. https://pdfs.semanticscholar.org/ecf0/ed8c805c366c435ad4d9d188ea7d4b71df2e.pdf
- □ Main Features of MCDM
  - ⇨ Multiple attributes/criteria often form a hierarchy
  - ⇨ Conflict among criteria.
  - ⇨ Uncertainty
  - ⇨ Hybrid nature
  - ⇨ Large Scale
  - ⇨ Assessment may not be conclusive
- □ MCDM Solutions
  - ⇨ Ideal solution
  - ⇨ Satisfying solutions
  - ⇨ Non dominated solutions
  - ⇨ Preferred solutions
- □ MADM Methods (Malczewski, J.,1999. *GIS and Multicriteria Decision Analysis*. Wiley, N.Y.)

- ⇨ Scoring (Weighted Sum)
- ⇨ Multiattribute Value (MAVT)
- ⇨ Multiattribute Utility (MAUT)
- ⇨ Analytic Hierarchy Process (AHP)
- ⇨ Ideal Point (TOPSIS)
- ⇨ Concordance (ELECTRE)
- ⇨ Ordered Weighted Averaging (Fuzzy TOPSIS?)

- DECISION ANALYSIS AND MULTI-CRITERIA DECISION ANALYSIS METHODS
  - □ Decision Tree; Laplace, Maximin, Minimax, Hurwicz, Minimax Regret
  - □ Weighted Sum and Weighted Product
  - □ ELECTRE (ELimination Et Choix Traduisant la Réalité)
  - □ TOPSIS (Technique for Order Preference by Similarity to Ideal Solution)
  - □ The Example Problem

	1.Criterion	**2.Criterion**	**3.Criterion**	**4.Criterion**
1.Alternative	0.120	0.129	0.119	0.456
2.Alternative	0.065	0.185	0.064	0.071
3.Alternative	0.569	0.068	0.484	0.170
4.Alternative	0.200	0.067	0.223	0.100
5.Alternative	0.045	0.551	0.109	0.203
Weights	0.137	0.347	0.065	0.452

- THE ANALYTIC HIERARCHY PROCESS (AHP)
  - □ Top Objective, Criteria, Sub-Criteria, Sub...-Criteria, Alternatives
  - □ Complete Hierarchy and Partial Hierarchy
  - □ Mathematical Fundamentals: Properties a Positive Reciprocal Matrix
  - □ Priority (Weighting) Vectors and Eigenvector
  - □ Inconsistency Index and Eigenvalues
    - ⇨ The Maximum Eigenvalue and Random Index
    - ⇨ Consistency Index or Consistency Ratio
  - □ Variations of AHP: Fuzzy AHP and Grey AHP (Preference Programming)
  - □ Analytical Network Process