Introduction to Economics of Natural Resources - ENR

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Efficiency (1)

- Resources are used so that there are no missed opportunities
  - ***Technical or physical efficiency***:
    - one electricity plan produces more electricity given the same input
  - Suppose two power plants use the **same amount of coal** (e.g., 100 tons):
    - **Plant A** produces **500 MWh** of electricity.
    - **Plant B** produces **600 MWh** of electricity.
  - Plant B is **technically more efficient** because it produces **more electricity with the same input.**
  - If we choose Plant A instead of Plant B, we are **missing an opportunity** to produce an additional 100 MWh of electricity using the same resources.

Efficiency (2)

- Resources are used so that there are no missed opportunities
  - ***Allocative efficiency***:
    - one pollutant input produces more electricity, but the pollution costs more than compensate for the higher productivity
  - Suppose there are two ways to produce electricity:

Plant A (coal)
- Produces **600 MWh**
- Private production cost: **€50,000**
- Pollution damage (health + environmental costs): **€30,000**
- **Total social cost: €80,000**

Plant B (natural gas or renewables)
- Produces **550 MWh**
- Private production cost: **€60,000**
- Pollution damage (health + environmental costs): **€5,000**
- **Total social cost: €65,000**

Efficiency (3)

- Although **Plant A produces more electricity**, its pollution causes large external costs.
  When we include those costs, Plant B has the **lower total social cost**.

- If society chooses Plant A just because it produces more electricity, resources are **not allocatively efficient**, because the extra electricity is worth less than the environmental damage it creates.

- Allocative efficiency means choosing the option where **social benefits exceed social costs**, so no better alternative is left unused.

Optimality (1)

- Two essential elements
  - A group of people:
    - the relevant society
  - Some objectives regarding the relevant society
    - e.g. max welfare
  - Efficiency is a necessary but not a sufficient condition for optimality
    - There might be several efficient allocations, but only one maximizes the outcome pursued by the society
  - Constraints should be taken into account!

Optimality (2)

- **Two Essential Elements**
  - **Relevant society:** Citizens of a country (today and future generations)
  - **Objective:** Maximize social welfare (economic benefits − environmental damages)
- **Constraint:** Limited forest area (10,000 hectares)
- The government must decide how to use the forest:
  - **Intensive logging**
  - **Sustainable logging**
  - **Full conservation (national park)**

Optimality (3)

- **Step 1 – Efficiency**
  - All 10,000 hectares are used in every option.
    No land is left idle.
  - All three allocations are **efficient** (no wasted resource).

- But efficiency is not enough.

Optimality (4)

- **Step 2 – Compare Social Welfare**

- **Option A: Intensive logging**
  - Timber profits: **€50 million**
  - Environmental damage (biodiversity loss, CO_2, flooding): **€35 million**
  - **Net welfare: €15 million**

- **Option B: Sustainable logging**
  - Timber profits: **€35 million**
  - Environmental damage: **€10 million**
  - **Net welfare: €25 million**

- **Option C: Full conservation**
  - Tourism + ecosystem services: **€20 million**
  - Environmental damage: **€0**
  - **Net welfare: €20 million**

Optimality (5)

- **Step 3 – Conclusion**

- All options are **efficient** (full use of land).
- But only **sustainable logging** maximizes net social welfare (€25 million).
- Therefore, it is the **optimal allocation**.

- **Key Message**
  - Efficiency is necessary (no unused forest).
  - But multiple efficient allocations exist.
  - Optimality requires choosing the one that **maximizes welfare**, taking into account environmental costs and constraints.

Sustainability (1)

- Optimality constrained to the well being of future generations

- **Example: Groundwater Extraction**
  - **Relevant society:**
    - Current residents
    - Future residents
  - **Objective:**
    - Maximize social welfare
  - **Constraint (sustainability condition):**
    - Future generations must have access to sufficient groundwater.