Doctoral course
Climate Economics for Engineers

Valuation methods (1)

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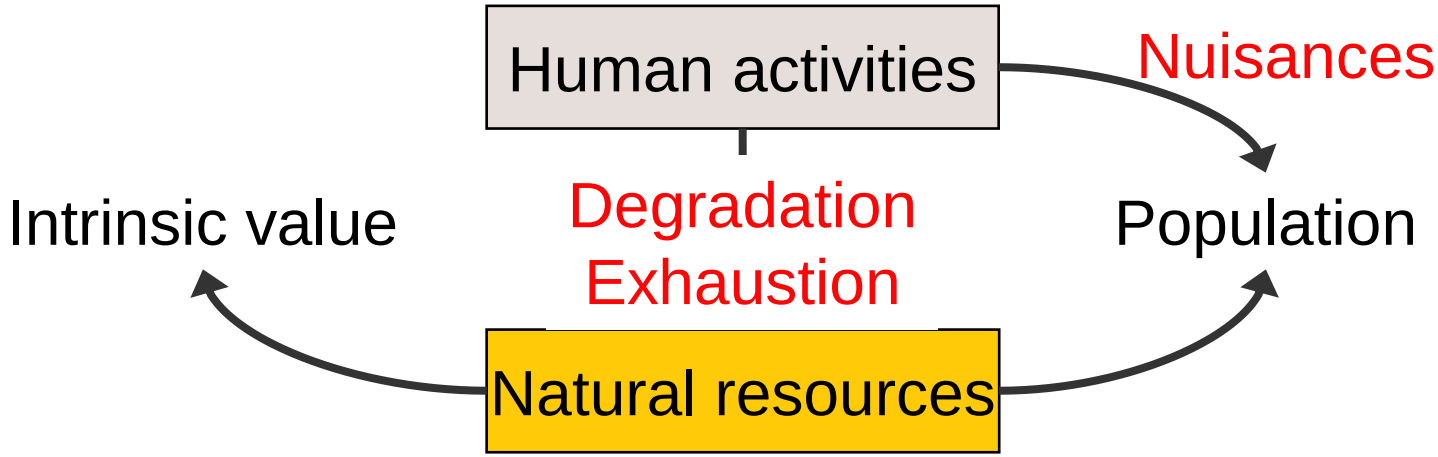
PRINCIPLES OF IMPACTS AND VALUES

Environmental & human impacts and resources

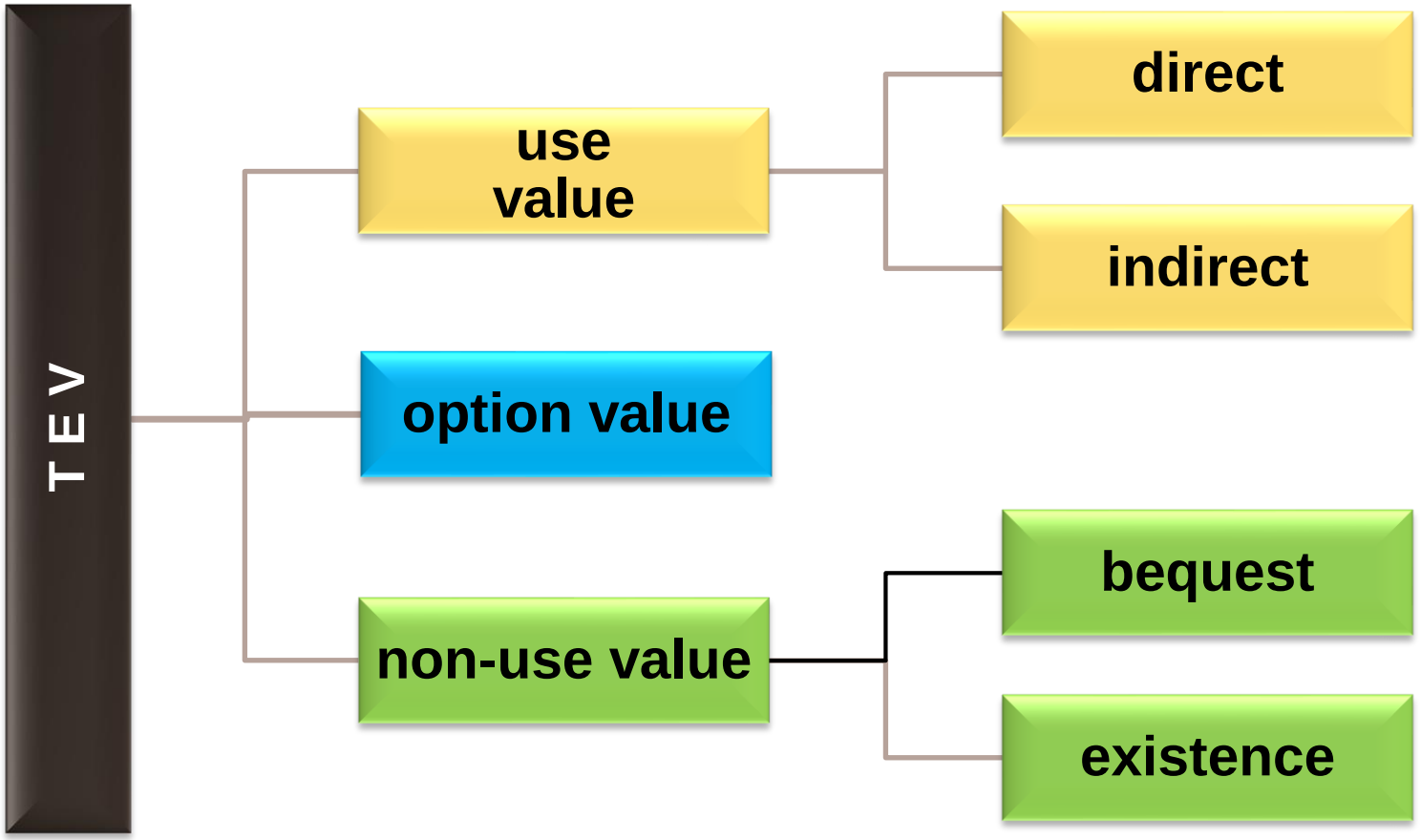
- **Value** of natural resources: air, water, plants, animals, landscapes, minerals
- **Cost** of environmental & human impacts:
  - Degradation of natural resources
  - Health risks for populations
  - Nuisances for populations
  - Impacts on productivity (indirect effects)



Why is someone willing to pay to preserve, e.g., a forest ?

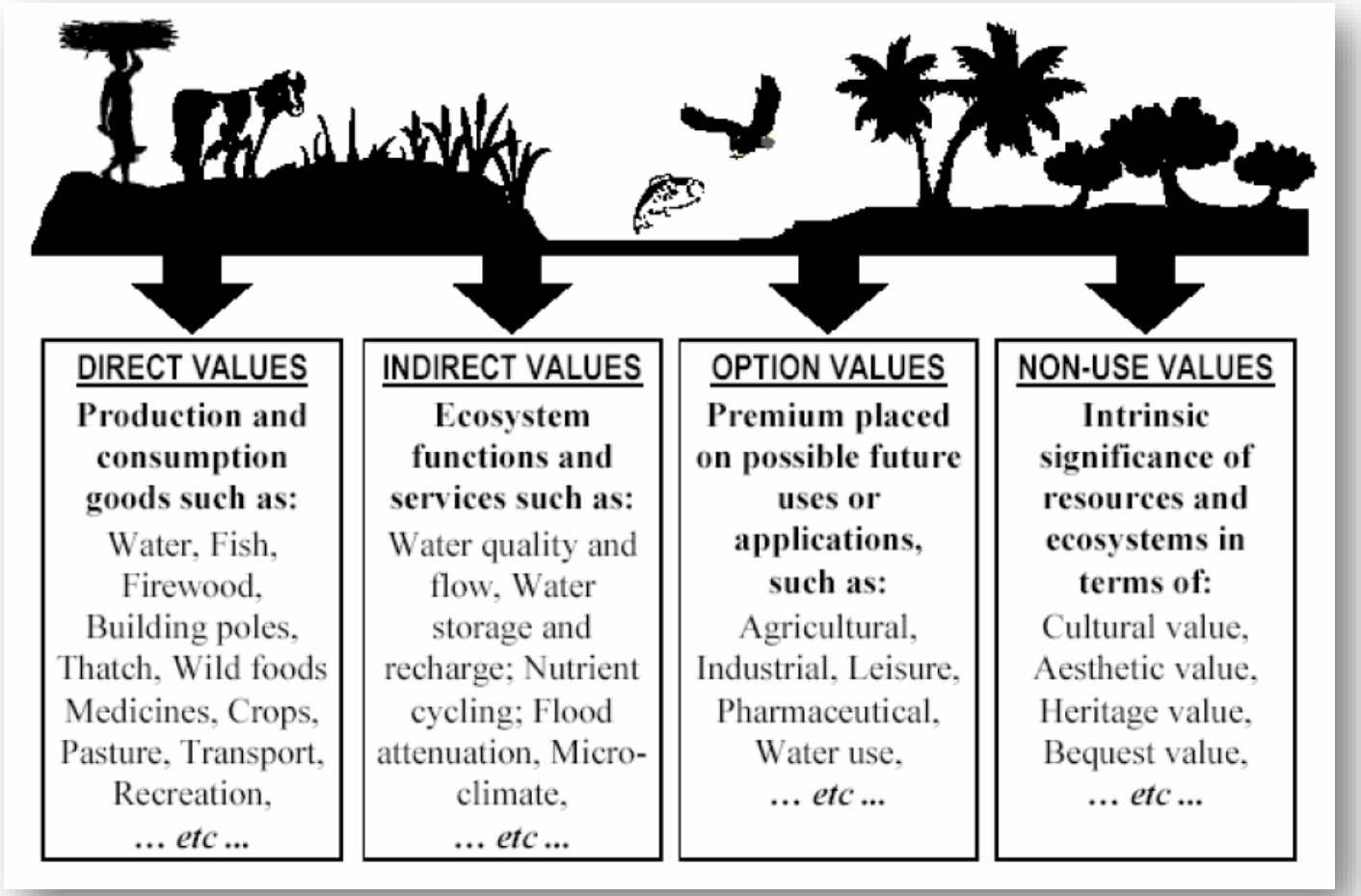
- She can use the forest (walks, mushrooms, branches, or just looking at it): **direct consumption use value**
- She can exploit the forest (logging): **production use value**
- The forest provides services she would otherwise have to pay for (eco-system services): **indirect production value**
- She might benefit from the plants and animals in the forest in the future (biodiversity): **option value**
- She might be happy to know that the forest exists: **existence value**, a part of **non-use value**
- She might also take into account the value of the forest to **other people** and **future generations**, another part of **non-use value**

Classification proposed in many textbooks



Source : Soguel N. (1994), *Evaluation monétaire des atteintes à l'environnement : une étude hédoniste et contingente sur l'impact des transports.* Neuchâtel: EDES-Editions de la Division économique et sociale, p.6.

TEV of Wetlands



Source : Emerton L. (2005), *Values and Rewards: Counting and Capturing Ecosystem Water Service for Sustainable Development*, IUCN Water, Nature and Economics Technical Paper N.1, Cambridge (UK): IUCN-The World Conservation Union. P.4

Different components of value

- Some benefits from natural resources are easier to measure than others
- Ideally, the easier to measure benefits are sufficient to justify protection
- E.g.: the value of the blue whale is certainly greater than the commodities derived from it, but if those commodities justify limiting whaling until a stable population is restored, that makes the proof easier (Spence, 1974)

FIRST DISTINCTION BETWEEN ASSESSMENT METHODS

First distinction

Not based on individual preferences	**Based on individual preferences**
Damage function	Stated (expressed) preferences
Production function	Revealed preferences

DAMAGE FUNCTION METHOD

Principles

1. Impact: measure physical or health relation between some environmental attribute (e.g. pollution) and some damage (e.g. sickness, damage to buildings, lost crop)
2. Cost: apply unit price to working days lost, cleaning up, lost crop

Not individual avoidance expenditure, because that would be a revealed preferences approach

Example (1)

Costs of traffic congestion, 2014:

- Light vehicles (cars + light trucks) lost 27.85 million hours/year in traffic jams and heavy vehicles (heavy trucks + buses) 1.09 million hours
- Estimate: 1h lost = 41.6 CHF for light vehicles, 80.8 CHF for heavy vehicles
- Source: SN 641 822a (Zeitkosten Personenverkehr), SN 641 823 (Zeitkosten Güterverkehr) and SN 641 827 (Betriebskosten von Strassenfahrzeugen)
- Cost = 27.85×41.6 + 1.09×80.8 = 1245 MCHF
- Add costs for congestion related accidents, additional fuel use and air pollution

Mario Keller (MK Consulting) u. Philipp Wüthrich (Infras), "Neuberechnung Staukosten Schweiz", Schlussbericht zH des Bundesamtes für Raumentwicklung, Juni 2016

Example (2)

Impacts of road-traffic related air pollution on buildings (2010):

- Inventory of effects on building facades: additional cleaning costs, additional renovation costs, shortened life-expectancy
- Identification and measurement of immissions: PM10 dirties inside rooms, darkens facades and corrodes materials
- Distinction by source of PM10, type of agglomeration, type of facade and building use
- Data: surfaces affected (m^2) and costs per m^2
- E.g. cleaning costs: 166 million m^2 of windows and glass and metal facades, of which 11.4 million m^2 are exposed to PM10 and commercially cleaned; additional cleaning: 1/year at 5.25 CHF/m^2 cleaning costs; total cost = 11.4 x 5.25 = 59.9 million CHF

Ecoplan/Infras, "Externe Effekte des Verkehrs 2010. Monetarisierung von Umwelt-, Unfall- und Gesundheitseffekten", Schlussbericht zH des Bundesamtes für Raumentwicklung, 14.06.2014

Example (3)

Infras, "Health Costs due to Road Traffic-related Air Pollution Attributable Cases", 1999

- Study on health costs due to road traffic-related air pollution:
- Sickness: number of working days lost × value of a working day (productivity)
- Death:
  - Numbers of working years lost × median yearly income (9.5 × 20,600=195,700 € in CH1996)
  - Immaterial costs: based on court rulings on compensation for deadly accidents (134,800 €)

It can be too restrictive

Le Temps
Lundi 6 septembre 2010

Temps fort

Santé: bientôt des indemnités à 7 chiffres?

- Une famille réclame 17 millions de francs aux HUG après une opération qui a mal tourné
- Les médecins craignent une américanisation du système judiciaire

Swiss courts only grant compensation for lost income and additional costs

Limits of this method

- Often based on actual clean up and reparation, even when it is only partial
- Victims are often assumed to be perfectly passive: no self protection, no change in activity (e.g. replacing crops)
- Prices are assumed to be unaffected

PRODUCTION FUNCTION METHOD

Beach front exercise

Suppose that climate change elevates the ocean level, so that coastal areas disappear under water. Assume that in Palm Beach (Florida), beach front property sells at 1000$/$m^2$ and that this price declines by 20% for every 100m distance from the coast. Suppose also that the higher ocean level swallows the first 100m stretch. What is the lost land value (without buildings)?

Example: valuation of ecosystem services

- Ecosystems provide services that would be lost if they were destroyed. What value?
  - Damage cost avoided: lost service could imply damage; e.g. drying up wetlands could cause flooding
  - Replacement cost: cost of making similar wetlands that provide the same services
  - Substitution cost: cost of providing the same service, e.g. with dams
- Such estimates provide a minimum value as they retain only the service value of ecosystems, i.e. they reduce ecosystems to the services they provide
- Is substitution or replacement of the ecosystem really possible?

Example: valuation of ecosystem services

Exercise:

What is the value a mountain forest protecting a village from avalanches? Use this information:

	Annual	Cumul. (5%)
Estimated damage due to avalanches	1.0	20
Est. cost of temp. protection and replanting	0.8	16
Cost of avalanche barriers	0.5	10
WTP of population for safety from avalanches	1.5	30

Solution: what is the least-cost option for producing the protection service?

Impact on agricultural output and land value

Estimation of impact of global warming on agricultural land values:

- Estimate an econometric land value function by regressing the average price of agricultural land in US counties on soil characteristics, temperature and precipitations
- Allow for changes in crops
- Simulate a uniform increase of temperatures by 5°F and precipitations by 8%
- Some northern counties will have higher land values, most southern counties will have lower land values
- Global effect is slightly positive, thanks to gains on the irrigated western and southern lands (sunbelt)

Mendelsohn, Robert, William Nordhaus et Daigee Shaw (1994) "The impact of global warming on agriculture: A Ricardian analysis", *American Economic Review* 84(4)

Shifting crops

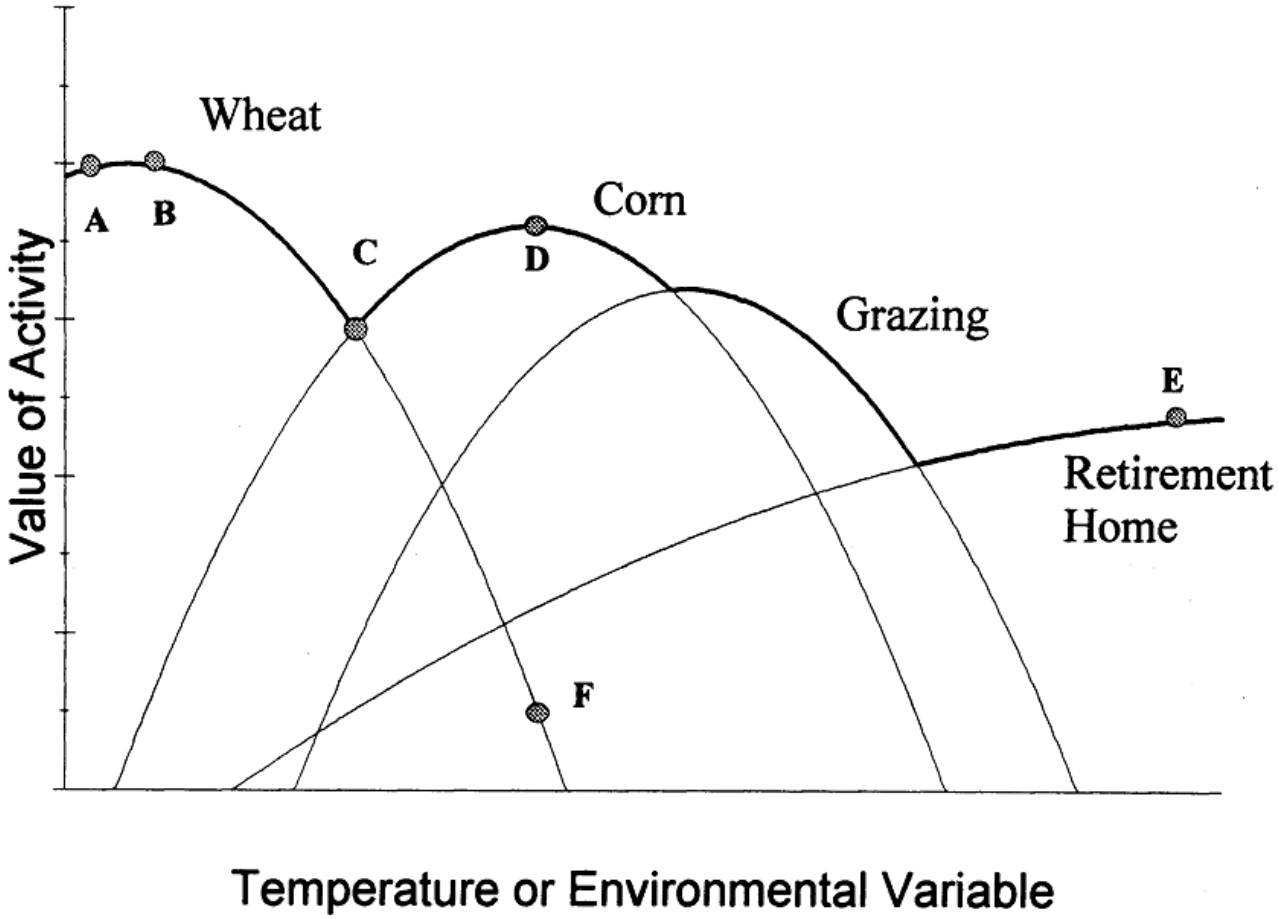


FIGURE 1. BIAS IN PRODUCTION-FUNCTION STUDIES

Mendelsohn, Robert, William Nordhaus et Daigee Shaw (1994)

Winners and losers

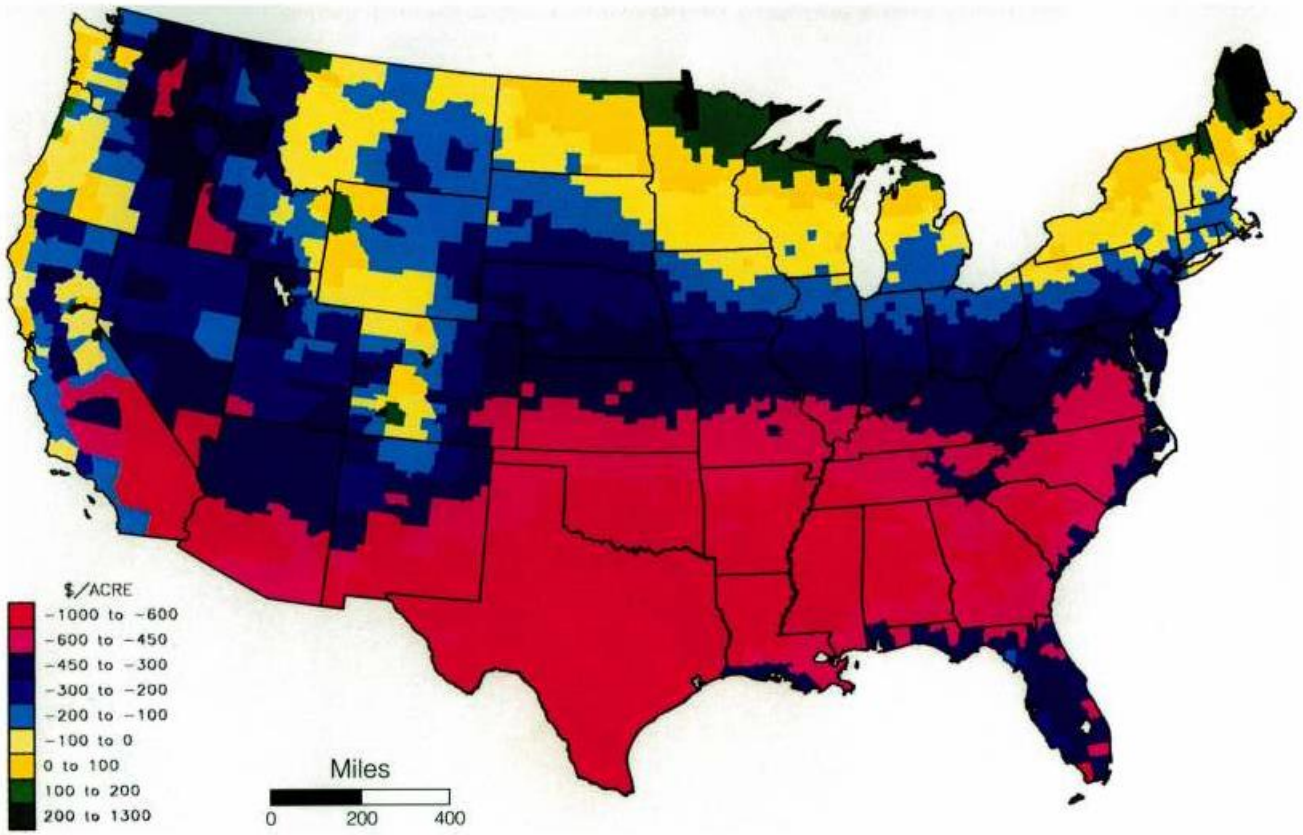


FIGURE 4. CHANGE IN FARM VALUE FROM GLOBAL WARMING: CROPLAND WEIGHTS
Note: The map shows the change in terms of dollars per acre for a 5°F uniform warming and an 8-percent increase in precipitation, 1982 prices.

Mendelsohn, Robert, William Nordhaus et Daigee Shaw (1994)

Principles of production function method (1)

- Augment a production function with environmental factors; when environmental factors change:
  - by how much is output reduced?
  - or by how much must other inputs be increased to maintain production?

Output Q = f(K,L,M,E,P,T)

K = capital, L = labour, M = intermediate goods, E = energy,
P = precipitations, T = temperature

Principles of production function method (2)

- Consider all alternatives
- Take the change in prices triggered by the change in production into account (output loss is partly offset for producers by price increase)
- The error from omitting this market effects is of second order for total damage, but the allocation of gains or losses between producers and users (consumers) is wrong