# ENVIRONMENTAL VALUATION: MOTIVATION, METHODS, APPLICATION AND CAVEATS

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# WHY VALUE?
# (modified version of Pagiola et al, p.5)

| WHY | APPROACHES | HOW |
|---|---|---|
| To understand the contribution of ecosystems to society | Determining the total value of the current flow of net benefits | ➢Identify all mutually-compatible services provided; measure the quantity of each service provided; multiply by the value of each service<br>➢Relate results to macro-economic and development concerns. |
| To assess whether the intervention is economically worthwhile | Determining the net benefits of an intervention that alters ecosystem conditions | ➢Measure how the quantity of each service would *change* as a result of the intervention, as compared to their quantity without the intervention; multiply by the marginal value of each service |
| To identify winners and losers, for equity and practical reasons | Identify relevant stakeholder groups; determine specific services used & values | ➢Disaggregate data into sectors, income groups, special groupings; overlay maps with economic activity, location of stakeholders and damage sites |
| Traditional markets (commodities, financial, credit, labor) which do not account for ES adequately need to be supplemented to encourage good behavior. | Determine how much it costs to supply the ES; estimate the benefits from ES (demand side) | ➢Identify groups that receive large benefit flows, from which funds could be extracted using various mechanisms; identifying potential financing sources for conservation.<br>➢Design appropriate instruments for implementing the "users pay" and/or "polluters pay" principles. |

## Millenium Ecosystem Assessment: Ecosystem services typology

- **Provisioning**
  - Goods produced or provided by ecosystems

- **Regulating**
  - Benefits obtained from regulation of ecosystem processes

- **Cultural**
  - Non-material benefits from ecosystems

Photo credits (left to right, top to bottom): Purdue University, WomenAid.org, LSUP, NASA, unknown, CEH Wallingford, unknown, W. Reid, Staffan Widstrand

# Provisioning Services

## Goods produced or provided by ecosystems

- Food
  - Crops
  - Livestock
  - Capture Fisheries
  - Aquaculture
  - Wild Foods
- Fiber
  - Timber
  - Cotton, hemp, silk
  - Wood Fuel
- Genetic resources
- Biochemicals
- Freshwater
- Recreation and Ecotourism

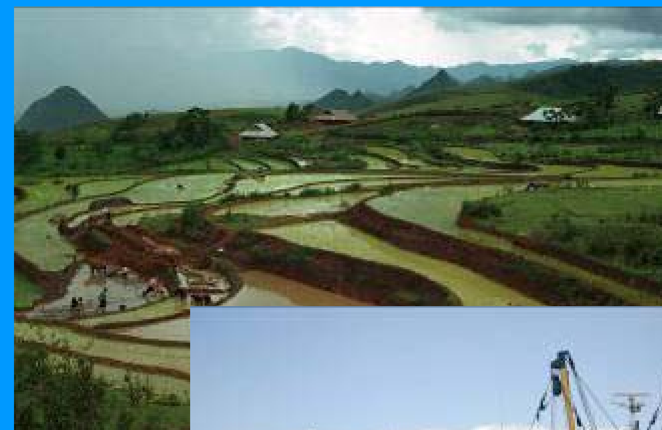
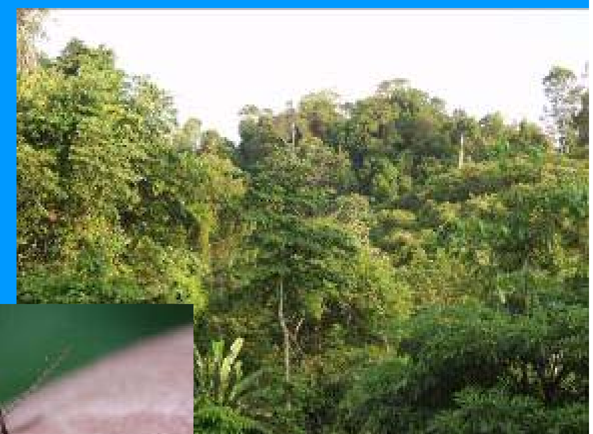


Photo credit (top): Tran Thi Hoa (World Bank),

# Regulating Services

**Benefits obtained from regulation of ecosystem processes**

- Air Quality regulation
- Climate regulation
  - Global ($CO_2$ sequestration)
  - Regional and local
- Erosion regulation
- Water purification
- Disease regulation
- Pest regulation
- Pollination
- Natural Hazard regulation
- Habitat



# Cultural Services

**Non-material benefits obtained from ecosystems**

- Spiritual and Religious Values
- Knowledge Systems
- Educational values
- Inspiration
- Aesthetic Values
- Social Relations
- Sense of Place

Photo credits ( top to bottom): W. Reid, Mary Frost, Staffan Widstrand, unknown.

# Some Typology Equivalence

Ecosystem services

- Provisioning
  - === Environmental goods
  - === Natural Resource-based commodities
- Regulating
  - === Environmental Services
  - === Ecological Services
- Cultural
  - === Environmental Services
  - === (Human) Ecological Services

# Techniques of Environmental Valuation

**Revealed Preference Methods : actual behavior**

- indicates preferences and implies willingness to pay
    1. Production function approach
    2. Surrogate market approach
    3. Travel Cost Method (TCM)
    4. Hedonic Pricing (HP)
    5. Avertive/coping expenditures

**Cost-based Approaches**

1. Replacement Costs
2. Mitigative Expenditures
3. Potential Avertive expenditures

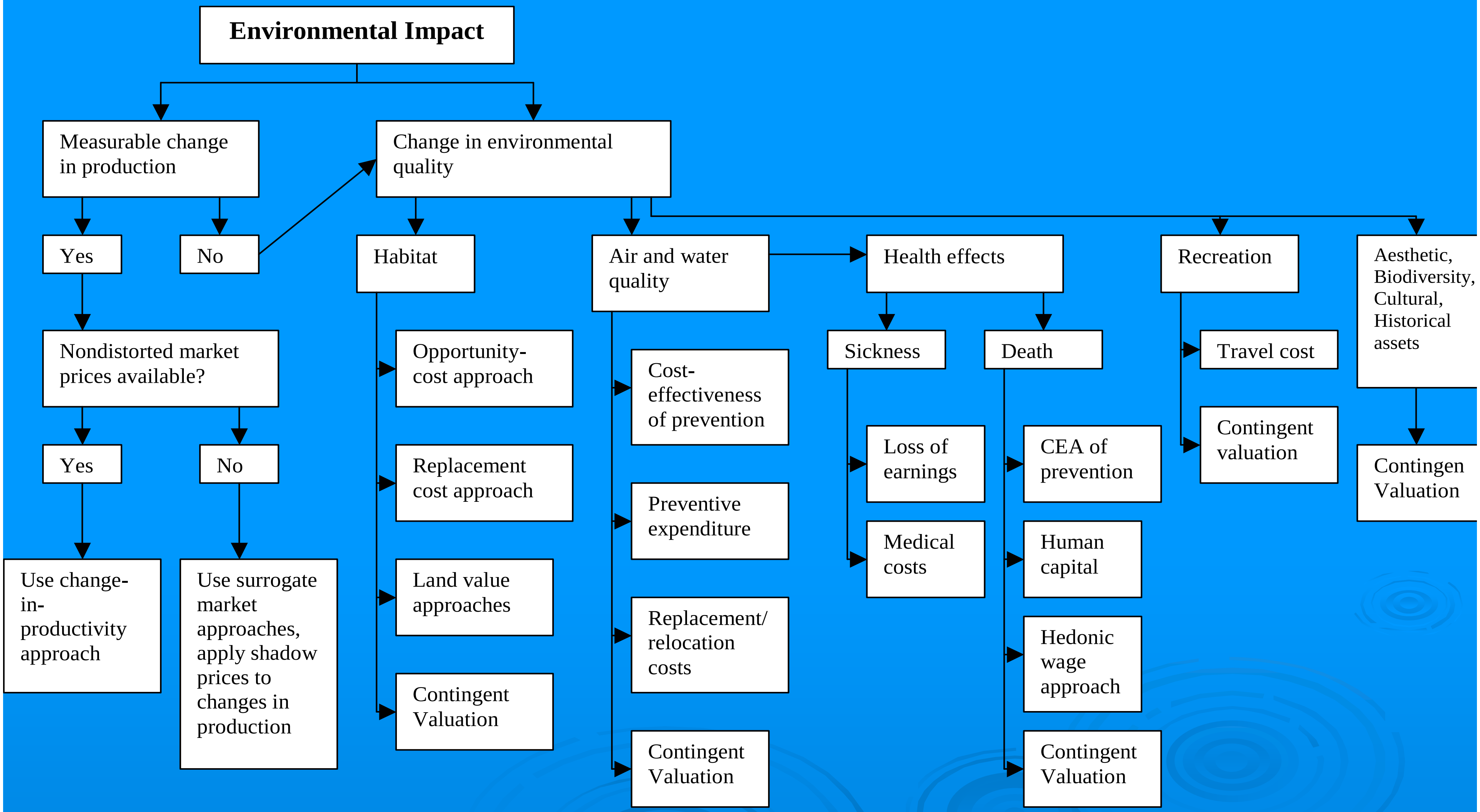
**Stated Preference Approaches**

1. Contingent Valuation Method (CVM)
2. Cojoint Analysis (not in this presentation)
3. Choice Experiments (not in this presentation)

**Benefits Transfer Method (BTM)**

- adapt relationships, impacts, values from other sites

# Selecting the appropriate valuation technique – a flow chart




**From J. Dixon**

# PRODUCTION FUNCTION APPROACH

- Environmental impacts on production/productivity

- Requirements:
  - Knowledge of impact pathways
  - Use market prices of inputs and outputs: NET VALUES
- Examples:
  - Land use interactions, aquatic sectors interactions
  - Production = f (Environmental quality, Labor, Machinery, Natural Resource Base, etc)
  - Damage = Decline in Production X Net Value

# Applications of Change in Productivity approach

- Natural resource sector – changes in crop production, forestry, fisheries, aquifers, others
- Human Health – another form of change in productivity
- Ecosystems – harder to measure but possible. E.g. watersheds, coral reefs, mangroves, others

# Production function: Agriculture and water quality

$$Q_i = Q_i(x_{i1}..x_{iJ}, W_i) \text{ for all i}$$

$$C_i = C_x X_J + c_w W_i \text{ for all i}$$

$$P_i = P_i(Q_i)$$

where:

$Q_i$ = the output of the $i^{th}$ crop

$W_i$ = water input for the $i^{th}$ crop

$x_J$ = vector of $x_1,\ldots x_j$ = other variable inputs; j = i,...J

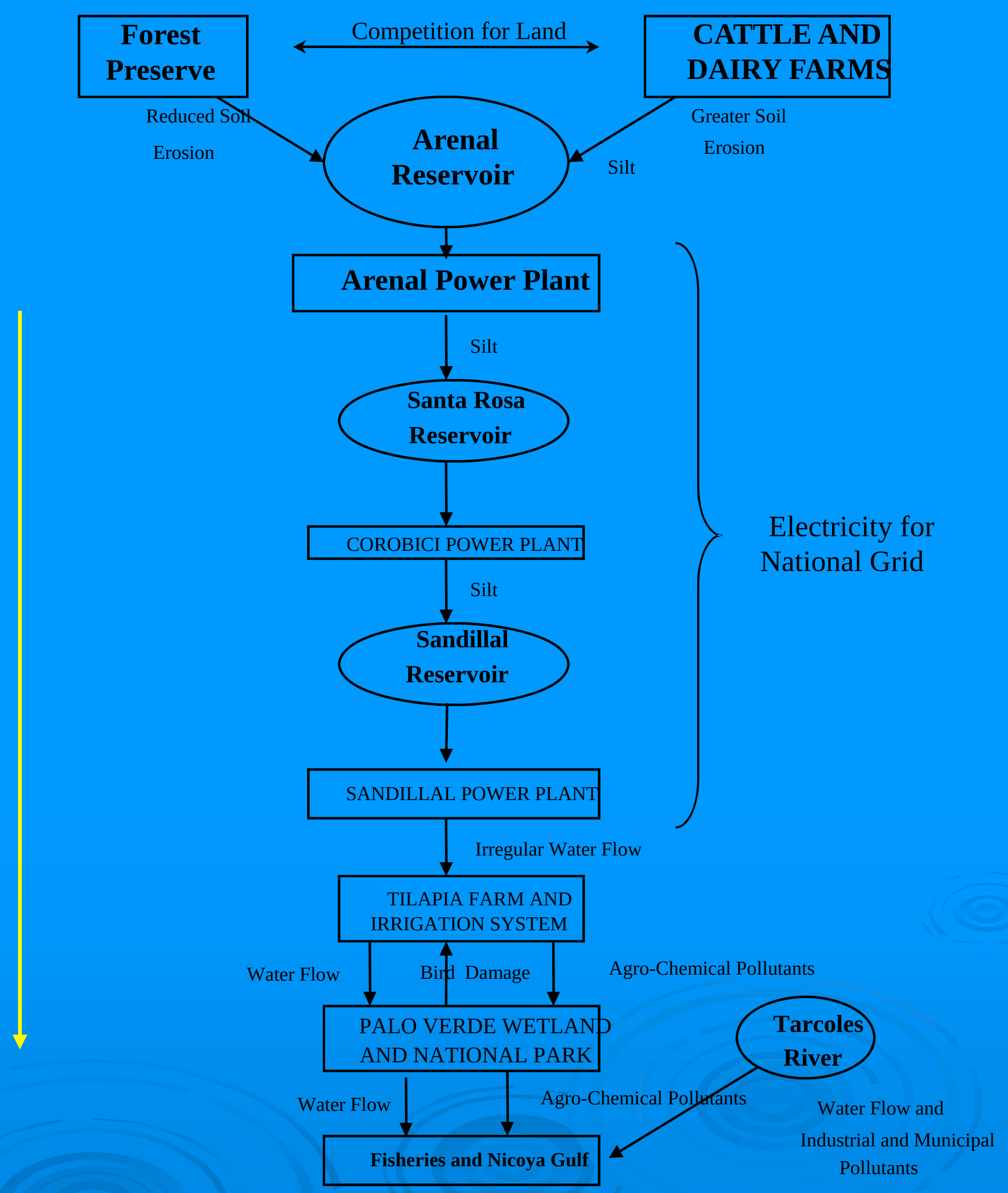
$P_i$ = market price of $Q_I$

$C_x$ = vector of $c_{xi},\ldots c_{xJ}$, strictly positive input prices

# The Arenal-Tempisque Watershed

(from J. Dixon)

A Flowchart of the Watershed – the bio-physical systems



# Show estimated impacts from interactions through a Payoff Matrix

- The diagonal elements are the different users/ sectors in the watershed and show their net return from their activity without taking externalities into account
- The off-diagonal elements represent externalities – either those that affect others downstream (below the diagonal) or that affect the sector's net benefits (elements on the same row)
- A social welfare measure is found in the final column (realized benefit) and final row (net benefit)

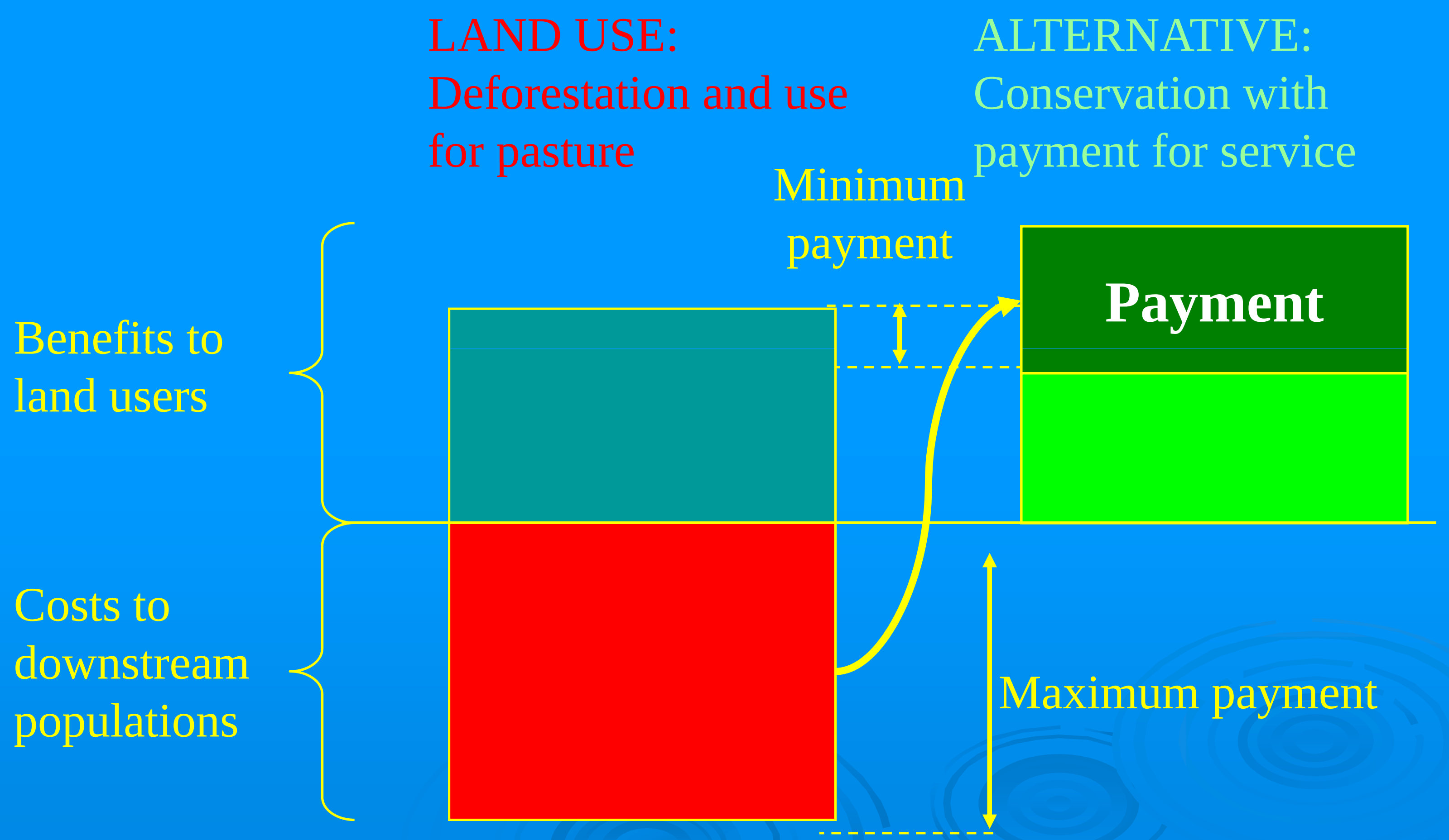
# Example 1a. Baseline Payoff Matrix –Unresponsive Costa Rica Hydroelectric Power Manager (in present value, million dollars)

| | Forest Reserves | Dairy/Cattle Farms | ICE | Irrigated Farms | Wetland | Fishermen | Realized Benefit |
|---|---|---|---|---|---|---|---|
| Forest Reserves | Maximize forest area (39.7) | | | | | | (39.7) |
| Dairy Cattle Farms | - | Maximize dairy & cattle income (38) | | | | | (38.0) |
| ICE | - | Siltation of reservoirs (-703.1) | Optimize electricity production (1,821.6) | | | | (1,118.5) |
| Irrigated Farms | - | - | - | Maximize crop income (195) | Bird damage to crops (-20.1) | | (174.9) |
| Wetland | - | - | - | Agro-chemical pollution and soil runoff (-51.6) | Maximize conservation (70.7) | | (19.1) |
| Fishermen | - | - | - | Agro-chemical pollution and soil runoff (-111.6) | Reduced Agro-chemical and soil runoff (16.9) | Maximize fish income (121.2) | (26.5) |
| Net Benefit | (39.7) | (-665.1) | (1,821.6) | (31.8) | (67.5) | (121.2) | (1,416.7) |

**Valuation as a basis for watershed protection payments by downstream, irrigated farmers to upstream pasturalists**

How much are downstream beneficiaries likely to pay?

How much are pasturalists likely to accept?




Source: S Pagiola

# Example 1b. Payoff Matrix-2
# Responsive Costa Rica Hydroelectric Power Manager
# (in present value, million dollars)

| | Forest Reserves | Dairy/Cattle Farms | ICE | Irrigated Farms | Wetland | Fishermen | Realized Benefit |
|---|---|---|---|---|---|---|---|
| Forest Reserves | Maximize forest area (39.7) | | | | | | (39.7) |
| Dairy Cattle Farms | - | Maximize dairy & cattle income (38) | | | | | (38.0) |
| ICE | - | Siltation of reservoirs (-5.4) | Optimize electricity production (1,821.6) | | | | (1,816.2) |
| Irrigated Farms | - | - | - | Maximize crop income (195) | Bird damage to crops (-20.1) | | (174.9) |
| Wetland | - | - | - | Agro-chemical pollution and soil runoff (-51.6) | Maximize conservation (70.7) | | (19.1) |
| Fishermen | - | - | - | Agro-chemical pollution and soil runoff (-111.6) | Reduced Agro-chemical and soil runoff (16.9) | Maximize fish income (121.2) | (26.5) |
| Net Benefit | (39.7) | (32.6) | (1,821.6) | (31.8) | (67.5) | (121.2) | (2,114.4) |

# Example 2: Valuing impacts on various sectors that rely on fisheries and aquatic ecosystems (from H. Cesar, 1996)

**Total Net Benefits and Losses Due to Threats to Indonesian Coral Reefs**

**( Present value; 10% discount rate; 25 yr. Time-span; in U.S. $1000; per km$^2$ )**

| | Net Benefits to Individuals | Net Losses to Society | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Function/Threat | Total Net Benefits | Fishery | Coastal Protection | Tourism | Food Security | Biodiversity | Others | Total Net Losses (quantifiable) |
| Poison Fishing | 33.3 | 40.2 | 0.0 | 2.6 - 435.6 | n.q. | n.q. | n.q. | 42.8 - 475.6 |
| Blast Fishing | 14.6 | 86.3 | 8.9 - 193.0 | 2.9 - 481.9 | n.q. | n.q. | n.q. | 98.1 - 761.2 |
| Coral Mining | 121.0 | 93.6 | 12.0 - 260.0 | 2.9 - 481.9 | n.q. | n.q. | > 67.0 | 175.5 - 902.5 |
| Sediment - logging | 98.0 | 81.0 | - | 192.0 | n.q. | n.q. | n.q. | 273.0 |
| Sediment - urban | ? | ? | ? | ? | ? | ? | ? | ? |
| Overfishing | 38.5 | 108.9 | - | n.q. | n.q. | n.q. | n.q. | 108.9 |

*Source: Cesar (1996)*

# Household Production Function: Household Water Collection

$$Max\, U = U(Q, W)$$

$$s.t.\; W = W_p + W_c; W_c, W_p \geq 0$$

$$where\; W_c = \frac{L_w}{\alpha}$$

$$Y(L_0 - L_w, z) - P_w W_p = Q$$

where:

Q = good produced by the hh

W = total water demanded by hh

$L_0$ = total household labour

Lw= labour used in collecting water

Pw= price of vended water

Wc= quantity of water collected

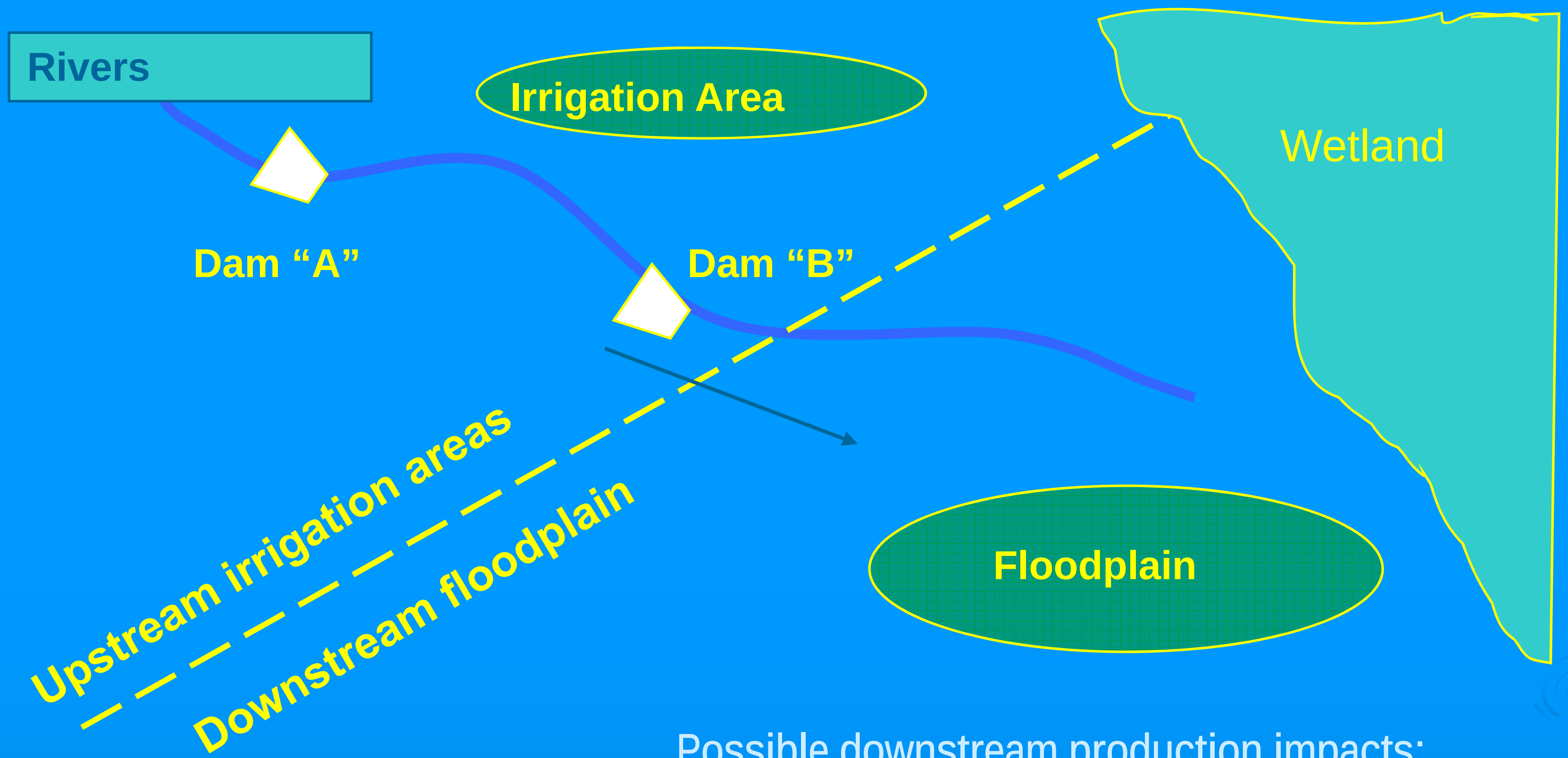
Wp= quantity of water purchased

Y = household income

z = household characteristics

$\alpha$ = time cost of collecting water

# Valuing water services




Possible downstream production impacts:

- Domestic water use
- Irrigated agriculture

## Example 3. Welfare impacts from changes in domestic water consumption patterns due to changes in environmental good (from G. Acharya)

| Household Type | Welfare Loss (consumer surplus) | Percentage of Monthly income |
|---|---|---|
| Purchasing only households | 2.86 | 6.9 |
| Collecting only households | 12.09 | 12 |
| Purchasing and Collecting | 19.93 | 4.2 |
| All households | 11.62 | 7.7 |

# HEALTH IMPACTS

- Impacts on morbidity (illness) and mortality (death)
- Change in water quality affects health
  - Use dose response functions
  - Changes in cost of illness
  - Changes in lifetime earnings (human capital approach)
  - Change in risk of death (Value of Statistical Life, or VSL)
- Constraints:
  - Scientific basis and knowledge on impact pathways
  - Confounding factors and attribution of impacts
- Thus, do:
  - Careful analysis
  - Discern direction of likely bias: over-estimates or under-estimates
- Caution: VSL does not estimate the (immeasurable) value of life itself, but attempts to estimate willingness to pay to lower the risk of dying

# Valuing Environmental Health Effects
(source: M. L. Cropper)

Damage Function Approach:

- Value of number of cases of illness/death avoided = Number of Cases Avoided * Value per Case
- Value per Case Avoided should reflect individual's willingness to pay (WTP) to avoid illness or risk of death
- Human Capital/Cost of Illness Approach, which focuses on lost productivity, medical costs, generally serves as a lower bound to WTP

## Valuing Risks to Life: What Is to Be Valued?

- Epidemiologic studies predict number of deaths avoided
- Treat these as equivalent to reducing risk of death for each person in the exposed population
- Risk reduction per person = (Number of deaths avoided)/(Size of exposed population)

# Key Concepts

- Concept of a Statistical Life
  - Reducing risk of death by 1 in 10,000 for each of 10,000 people saves one **statistical life**

- Value of a Statistical Life
  - If each of the 10,000 people is willing to pay $500 for the 1 in 10,000 risk reduction
  - the **Value of a Statistical Life** is = 10,000 x $500 = $5,000,000

## How to Measure WTP for a Reduction in Risk of Death?

- Labor Market Studies
  - Use compensating wage differentials to value risks of death
- Contingent Valuation Studies
  - Ask people directly what they would pay for a change in risk of death
- Averting Behavior Studies
  - Use data on seatbelt use, purchase of smoke detectors, switch to low-tar cigarettes, **boiling water**

# Empirical Estimates of Value of a Statistical Life (VSL)

- Value of Statistical Life estimates range between $ 1 - 10 million (1990 USD); USEPA’s preferred estimate is $4.8M (1990 USD)
- Problems**:**
  - **A**verage age of worker is 40—older than average age of person whose life is extended by an environmental program
  - Estimates of VSL from Averting Behavior Studies almost one order of magnitude lower than in Labor Market Studies

# Valuing Reductions in Morbidity

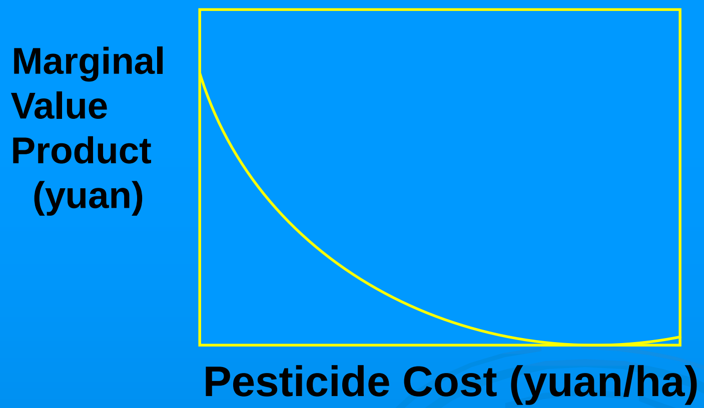
- Private WTP for a reduction in risk of illness should reflect:
  - Value of lost work time
  - Value of lost leisure time
  - Value of expenditures to ameliorate illness
  - Value of expenditures to avoid illness
  - Discomfort (pain) of illness
    - Value to Society of the Risk Reduction = Individual's WTP plus reduction in costs borne by society
    - Cost of Illness = Value of lost work time + Value of medical expenditures

# Example 4.
# Appropriate pesticide use given productivity and health effects, China

Source: J. Huang, F. Qiao, L. Zhang and S. Rozelle (2001). Farm Pesticides, Rice Production, and the Environment. EEPSEA Research Report 2001-RR3.

**ZHEIJING PROVINCE, CHINA**

| Pesticide Use/Farm | Health Cost (Yuan) |
|---|---|
| Less than 9 kg | 9 |
| Between 9-15 kg | 24 |
| Over 15 kg | 33 |




**CONCLUSION: The optimum level of pesticide use is less than half of current levels in Zheijing**

## Example 5
## Health Benefits from Ganges Action Plan (GAP)
## (Source: Markandiya)

- Surveys conducted of affected populations, comparing populations close to river with control groups, before and after GAP.
- Benefits measured in terms of :
  - Changes in user income due to changes in working days
  - Savings in cost of treatment of raw water for public supply due to GAP.

# **Example 5, results:** Health Benefits From Reduced Loss of Working Days, Ganges River, India (Source: Markandiya)

| Town | Average No of Working Days Saved Yearly Family | Regular Users of Ganga in Town (No of Families) | Individual Daily Income (Rs.) | Total Value (Rs. Mn.) |
|---|---|---|---|---|
| Haridwar | 6.09 | 41,300 | 64 | 16.00 |
| Kanpur | 3.42 | 15,560 | 35 | 1.86 |
| Patna | 6.58 | 22,480 | 88 | 12.94 |
| Chandannagar | 6.44 | 5,690 | 38 | 1.37 |
| Nabadwip | 7.37 | 4,760 | 65 | 2.28 |
| Titagarh | 2.61 | 4,920 | 31 | 0.39 |

# CHANGES IN PRODUCTIVITY (cont'd)

- **Challenges/concerns**
  - **confounding factors and attribution of impacts, specially for water pollution**
  - **distortions due to market imperfections (single buyer, single seller, uneven information) result in distorted prices**

- **Examples:**
  - **water pricing that does not follow marginal cost pricing; price control on water tariffs**
  - **apparent water shortage may be attributed to lower supply when in fact it is also caused by higher demand**
  - **improvement in water quality may be caused by decline in pollution loads because of the disincentive effect of pollution charges (micro-conditions) and slower economic growth (macro conditions)**

- **Thus do:**
  - **Estimate shadow prices (correcting for distortions)**
  - **Careful analysis; do range of estimates, simulations**
  - **Discern direction of likely bias: over-estimates or under-estimates**
  - **If pressed for time and resources, use Benefits Transfers Method carefully**

# REPLACEMENT, RESTORATION COSTS

- Cost of alternative means of generating the environmental good or service
  - Cost of replacing the service
  - Cost of replacing the input for production
  - Cost of replacing the consumed good
  - Always look at least cost option

# REPLACEMENT, RESTORATION COSTS: an exercise

- Cite alternatives to the following and what constitute costs of providing them:
  - loss of buffer functions of wetlands:
  - loss of filter functions of wetlands:
  - reduced supply of adequate water
    - For household use
    - For habitat
    - For recreation
  - loss of coral reefs

# REPLACEMENT, RESTORATION COSTS

- Applications:
  - Cost Effectivenss Analysis  or CEA (alternative ways of achieving a pre-determined target)
  - The Cost side of Benefits-Costs analysis of a Mitigation Plan
  - The  Benefit side (avoided costs) of a Preventive Action
- Constraints:
  - Substitute may not be perfect
  - Often-times more expensive to do
  - Co-benefits from the lost environmental service may be higher than what alternatives could provide

# TRAVEL COST METHOD

- Construct demand curve based on actual travel costs incurred by recreationists.
  - Gather data on travel expenses
  - Gather data on time of travel from origin to destination, convert this to money terms using wages

# The Zonal Travel Cost Model: an illustration (from D. Whittington)

<u>Assumption</u>: visitors will react to changes in travel cost incurred to visit a recreational site in the same manner that they would react to changes in admission fees to enter the recreational site if admission fees were charged.

Assume that the populations of A, B, and C are the same with respect to income, education, etc. so that the only thing that is different and affects their demand to visit the park is distance.

$\Rightarrow$ People in community A would behave the same as people in community B if they were to move 500 miles closer to the park

(i.e. 800 miles $\rightarrow$ 300 miles)

# The Zonal Travel Cost Model: An Illustration

| Area | Population | Distance to Park | No. of Visits as % of Pop. | Cost per visit (US$) |
|---|---|---|---|---|
| A | 10,000 | 100 miles | 50% | $20 |
| B | 20,000 | 300 miles | 15% | $40 |
| C | 30,000 | 800 miles | 5% | $100 |

# The Zonal Travel Cost Model: An illustration

Consider community A (pop. = 10,000)

\$1 increase in travel costs $\Rightarrow$ 2% reduction in visits

\$2 increase in travel costs $\Rightarrow$ 3% reduction in visits

2% of 10,000 $\Rightarrow$ - 200 visits

3% of 10,000 $\Rightarrow$ - 300 visits

# The Zonal Travel Cost Model

$$T_{ij} / Pop_i = \beta_0 - \beta_1 TC_{ij} - \beta_2 Time_{ij} + \beta_3 Sub_{ik} + \beta_4 Inc_i + \beta_5 Qual_j$$

where

$T_{ij}$ = number of trips (visits) from origin i to site j

$Pop_i$ = population of origin i

$TC_{ij}$ = monetary travel costs from origin i to visit site j

$Time_{ij}$ = travel time from origin i to visit site j

$Sub_{ik}$ = a measure of the cost of visiting substitute site k from origin i

$Inc_i$ = average income of households in origin i

$Qual_j$ = recreation quality at site j

# The Zonal Travel Cost Model - Questions

1. How do you select the zones? Extent of the market?
2. Choice of functional form?
3. Should you use perceived or actual travel cost?
4. Does the travel journey itself have value?
5. Is residential location exogenous with respect to the site?
6. How should you handle multiple-purpose trips?
7. What do you want to measure? Total benefits of visits? or the benefits of an environmental quality improvement?

# The Travel Cost Model
# – Implementation Issues

1. Unit of observation: individuals vs. zones
   (Participant surveys vs. population sampling)
2. Measurement of travel costs (e.g., round-trip mileage, average number of users per vehicle)
3. Value of time spent traveling
4. What’s a “visit’? Length of time spent at the site?
5. Measurement of the quality of the experience at a site
6. Many people may make no visits; other people may go often.

# The Zonal Travel Cost Model - Concerns

- Need large number of recreationists to include in survey and may be costly
- More complicated for multiple destinations
- For single destinations, there may be other reasons for traveling to the site.

# HEDONIC PRICING METHOD

- Estimate impacts of environmental quality on land values,  on labor market
- Price of land =

  f (environmental quality, location, etc)

  - Discern change in price due to change in environmental quality

# Example 6.
# Hedonic Pricing:
# The Zandvlei Wetland
# Capetown

(from J. Dixon)

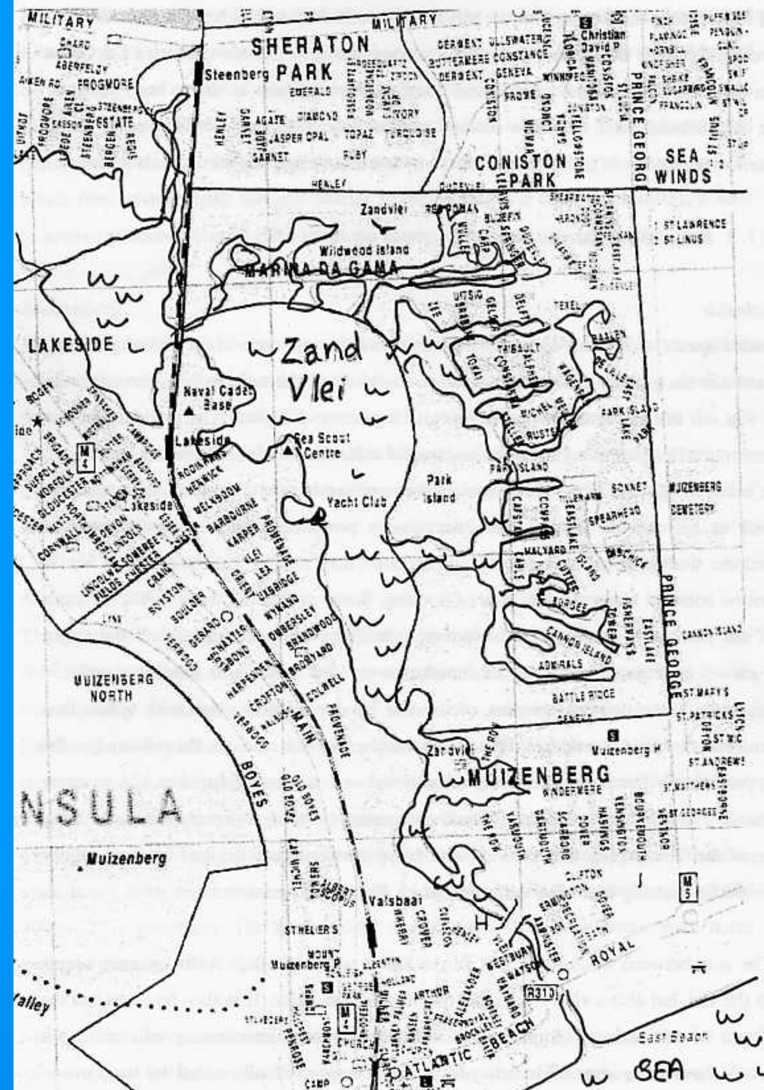



Figure 1 The residential areas surrounding Zandvlei

Source: Map Studio, 1999

# Valuation Approaches applied

- Expert opinion – estate agents (*aka* real estate agents) were interviewed to determine their expert opinion of the determinants of home prices, especially with respect to access to the Zandvlei (could be considered a type of "stated preference" measure of hedonic values)
- A traditional Property Value hedonic study was also carried out on four separate neighborhoods around the Zandvlei (a "revealed preference" measure of hedonic values)
- In most cases water views/ proximity added value, except where security (burglary) was an issue

# Expert Opinion results (estate agents)

- Prime Zandvlei shore locations commanded a premium of 7% to 12% (view plus recreational values) – a premium of R30,000 to R150,000 per house
- Next few roads back had a “recreational access” premium of about 3% (for both premia see van Zyl/ Leiman paper, Table 1).
- Some areas near public barbecue facilities and undeveloped reed beds may sell for a slight discount due to security/ nuisance concerns
- Total Zandvlei premium (capitalized value) of some R90,000,000 (or about US$10 million)

# Hedonic Property Analysis results

- Based on sales data over past 4 years; results extrapolated to housing stock in area
- Premium per house for water frontage about R130,000 per house (about US$13,000) (see van Zyl/ Leiman paper Tables 2 and 3)
- Very similar to estate agents results for Marina da Gama – Hedonic approach value of R77 million vs Expert opinion R88 million – is this an expected or unexpected result.

# Hedonic Pricing Method: Concerns

- If actors are not aware of environmental links, value will not be reflected in the price.
- Data intensive
- Complicated statistical analysis

# CONTINGENT VALUATION METHOD (CVM)

- Ask users their Willingness to Pay (WTP)

  for ES to continue to be provided at different levels

  - non-use values: existence and bequest
- Concerns
  - Need large number of survey respondents who understand the service and the scenarios
  - Need sophisticated estimation techniques
- When to implement?
  - Situations when the ES is perceived to be large and viewed as important by many

**Example 7. Ganges (India) River:**
**User & Non-User Benefits,**
**options analysis of Ganga Action Plan (GAP)**
**(Source: A. Markandiya)**

| Mean WTP Rp/HH 1995-96 Prices | | | | |
|---|---|---|---|---|
| Water Quality | Bathing Quality | 1995 Quality Wi/GAP | 1985 Quality Wi/GAP | 1995 Quality Wo/GAP |
| Non-users | 558 | 193 | 101 | 98 |
| Users | 582 | 167 | 93 | 71 |

# Example 8. Costa Rica Studies:
# % of respondents willing to pay fee
# Point price elasticities of demand

**Table 5:**

Percentage of respondents that would pay and earmarking fee for conservation and congestion

| % of respondents that… | Cancún | Contoy | Cozumel | Puerto Morelos |
|---|---|---|---|---|
| Would pay more if fee is earmarked for conservation. | 29.4% | 12.1% | 2.57% | 41.45% |
| Would pay more if fee would ensure less congestion at the site. | 13.9% | 10.7% | 1.67% | 38.94% |

Source: National Institute of Ecology (2001), "Marine protected natural areas in Mexico survey", Environmental Economics and Policy Research, Mexico

**Table 7:**
**Point price elasticities of demand**
**(at the 20 pesos level)**

| Area | High | | Low | |
|---|---|---|---|---|
| | Foreign | Mexican | Foreign | Mexican |
| Cancún | -0.29 | -0.33 | -0.23 | -0.26 |
| Contoy | -0.67 | -0.41 | -0.98 | -0.72 |

## Example 9
## FULL COST PRICING MAY NOT ALWAYS BE ANTI-POOR
## Insights from Households' Willingness to pay (WTP) for the Improved Water Services, Kathmandu, NEPAL
## (source: D. Whittington)

1. For households who currently have a
   NWSC connection, mean WTP = US$13.77/mo.
2. For *poor* households who currently
   have a NWSC connection, mean WTP = US$11.40/mo.
3. For households currently *without*
   a NWSC connection, mean WTP
   *for a private connection* = US$12.00/mo.
4. For households currently *without* a
   NWSC connection, mean WTP
   *for a shared connection* = US$3.20/mo.

# Valuation as a basis for water pricing

**Demand Side Approach**

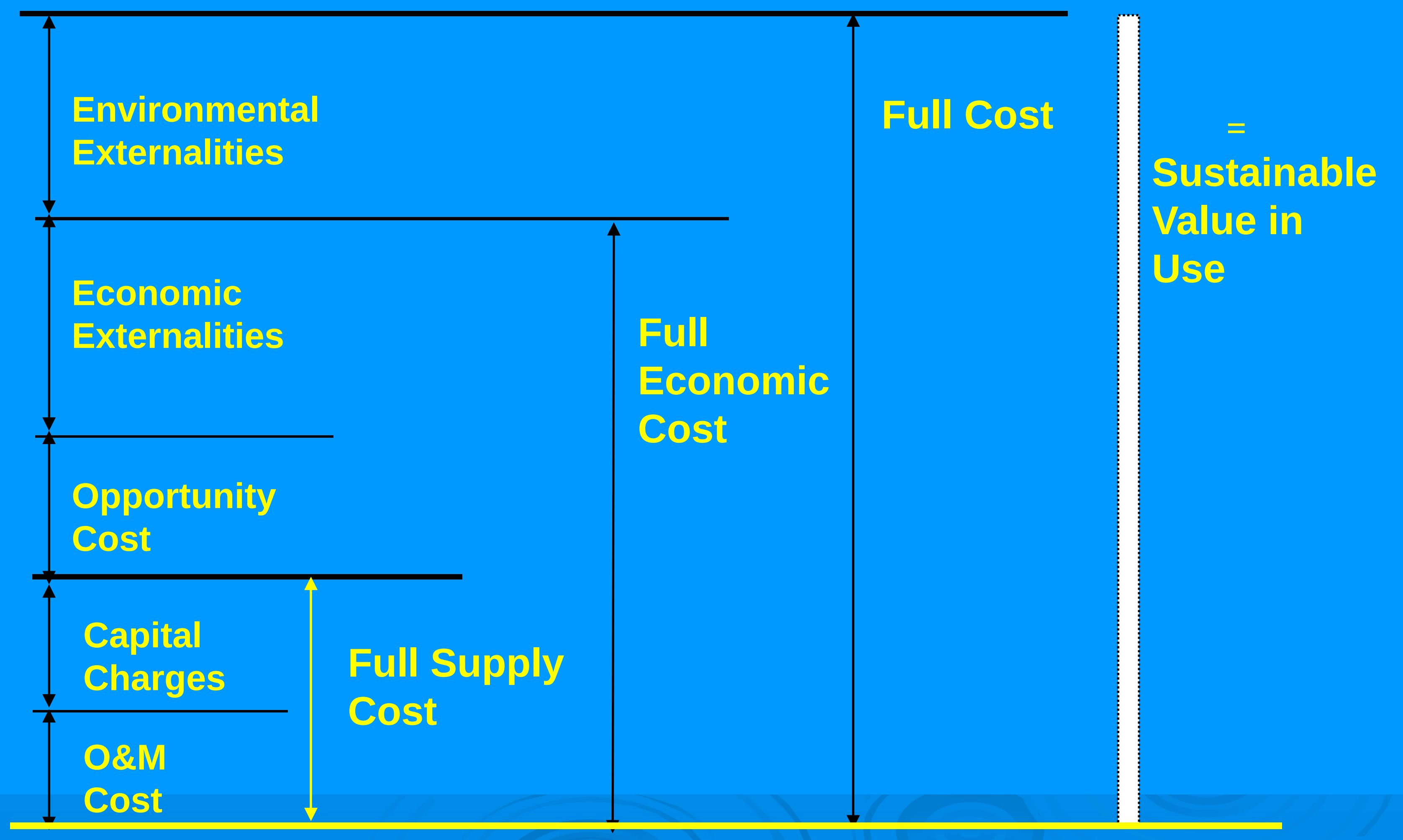
- discern real value of water
- all types of uses

**Supply-Side Approach**

- hydrological and engineering aspects
- and financial costs
- economic costs
- environmental costs

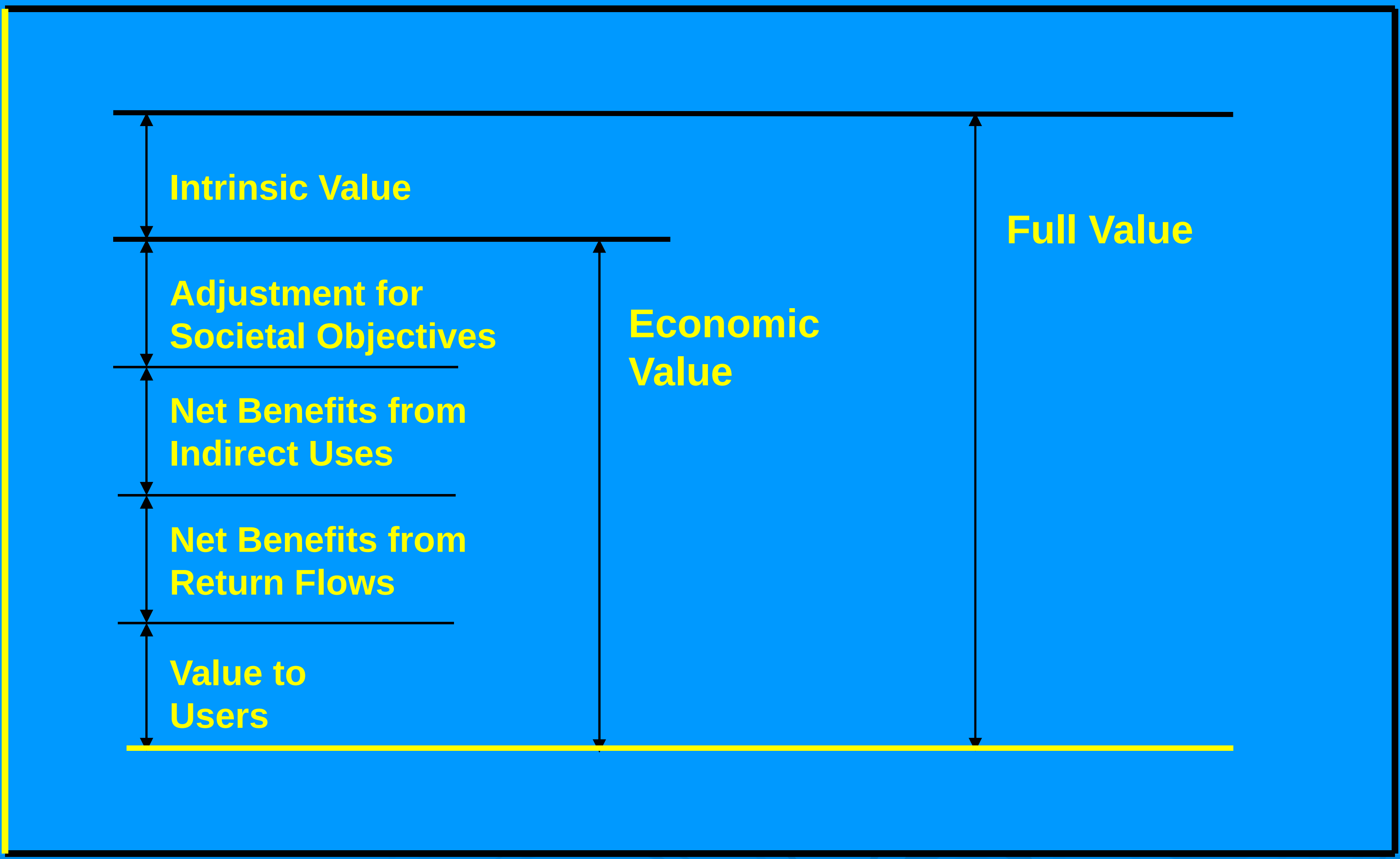
**IDEAL SITUATION: DO BOTH**

# General Principles for Cost of Water




From Rogers et al (1997)

# General Principles for Value-in-Use of Water




From Rogers et al (1997)

# Example 10

**Costs and Values for Urban Water Supply in Phuket, Thailand**

(per cu.m.) from Rogers et.al. 1997

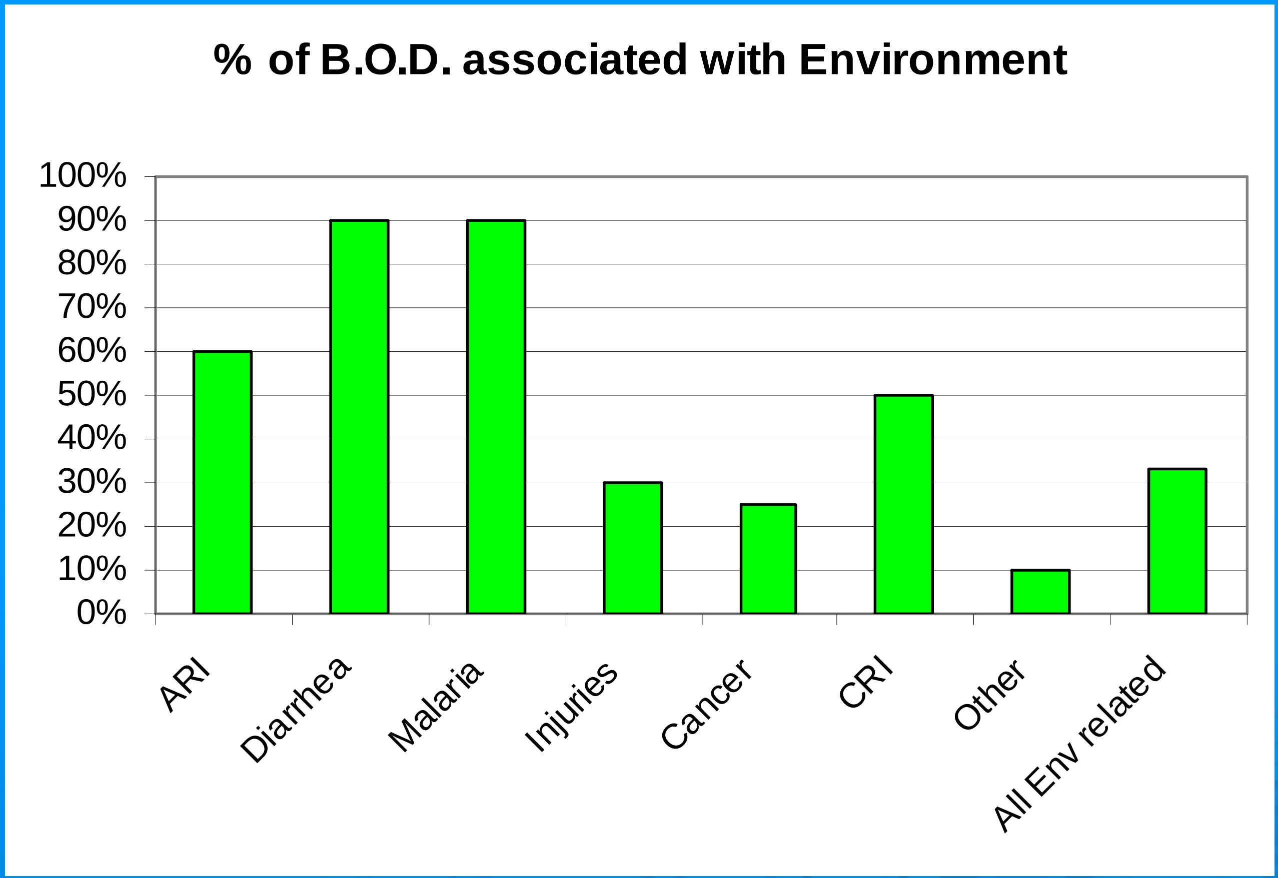
| | | | |
|---|---|---|---|
| | Value in Use = $1.30 | | |
| Environmental | | | |
| Externalities = $0.50 | | | |
| Economic Externalities (n.a.) | | | |
| Opportunity Cost = 0 | | Full | Full |
| | | Economic | Cost |
| Capital Charges = $0.24 | Full | Costs | =$1.08 |
| | Supply | =$0.58 | |
| | Costs = | | |
| O&M Costs = $0.34 | $0.58 | | |

# CVM: concerns

- Hypothetical approach and possible biases:
  - Instrument bias
  - Interviewer bias
  - Strategic behavior
  - Respondent bias
- Controversy over whether respondents would really pay the actual amounts that they state in interviews.
- Most controversial but the only way to estimate non-use values

# Environment and poverty: Environmental factors play major part in some of the biggest killers of the poor

(source: WDR and K Hamilton)



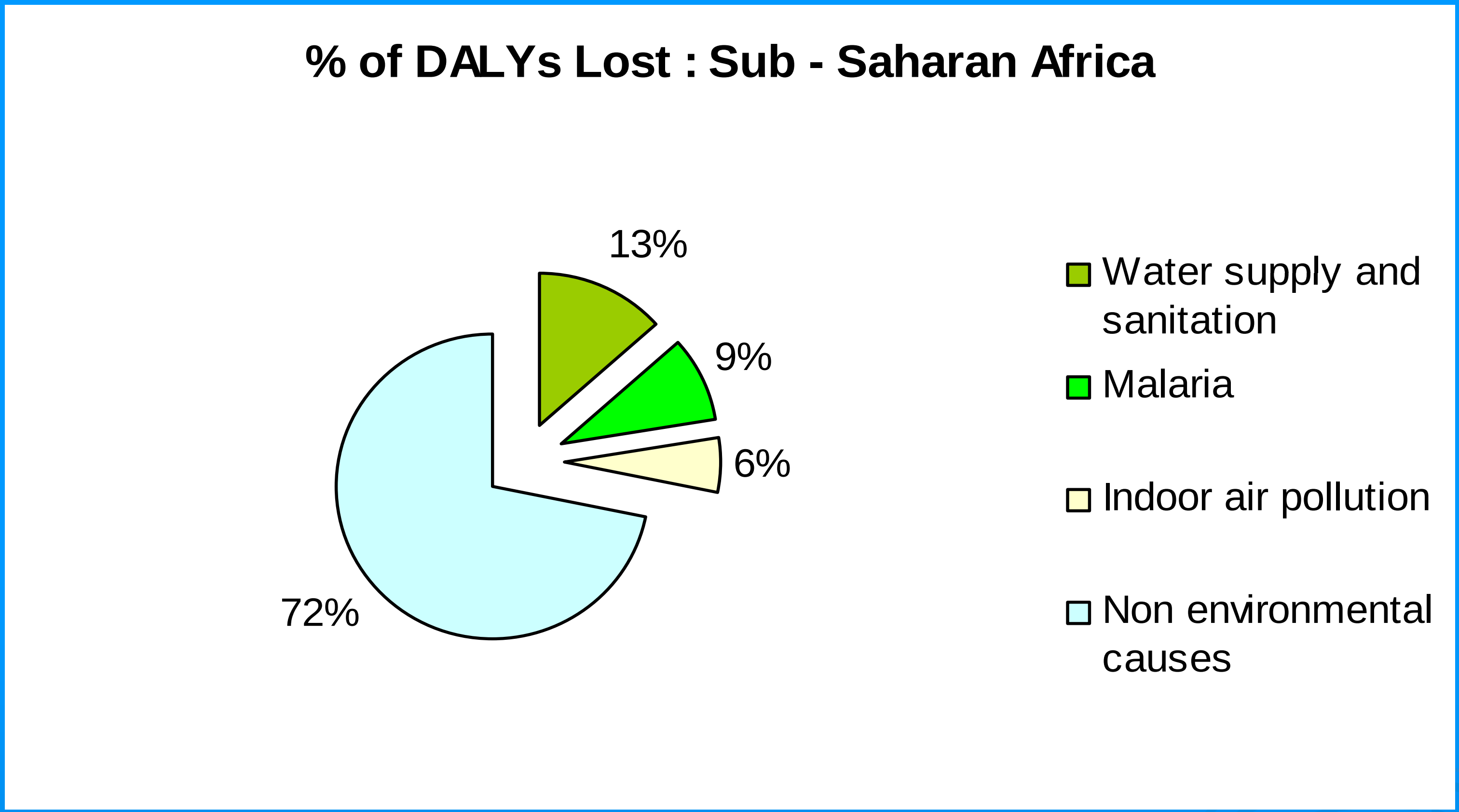
# How Is Burden of Disease Measured?

**Disability-adjusted Life Years Associated with a Risk Factor =**

- Lost life years due to premature death +
- Lost life years due to disability (illness and injury) multiplied by a severity factor

- YLL + YLD = DALY

# 30% of illness and death in Sub-Saharan Africa relates to environmental factors



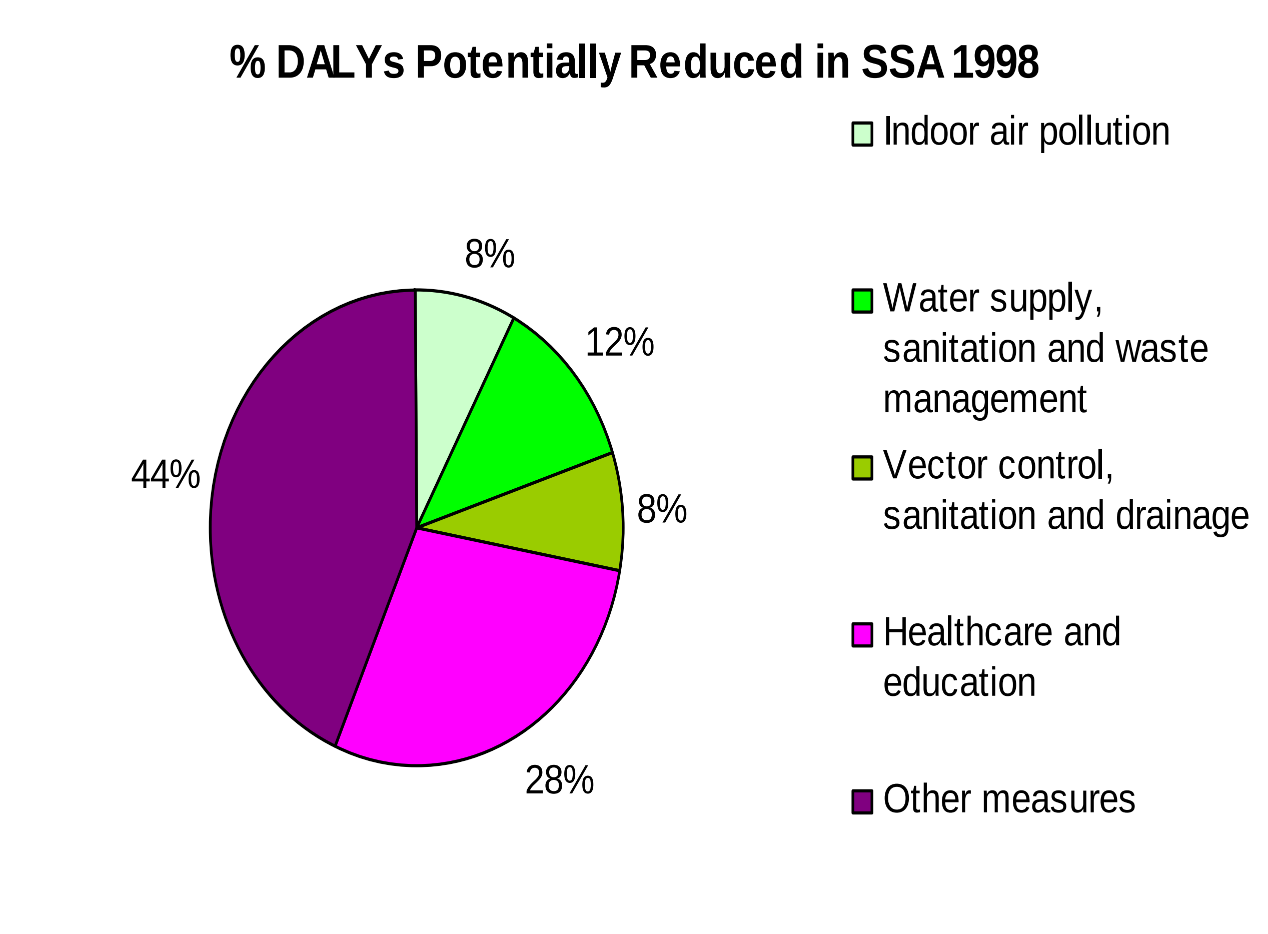

Source : Murray and Lopez, 1996. Data mostly pre-date the effects of AIDS

# Developing regions: range and prevalence of environmental disease

| Environmental health group | Percent of total DALYs in each country group | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | AFR | India | China | Asia & Pacific | LAC | FSE | All developing | High income |
| Water supply & sanitation | 13 | 11 | 4.5 | 10 | 7 | 2 | 9 | 1.5 |
| | | | | | | | | |
| Malaria | 9 | 0.5 | 0 | 1.5 | 0 | 0 | 3 | 0 |
| | | | | | | | | |
| Indoor air pollution | 5.5 | 6 | 9.5 | 4 | 0.5 | 0 | 5 | 0 |
| | | | | | | | | |
| Urban air pollution | 1 | 2 | 5 | 2 | 3 | 3 | 2 | 1 |
| | | | | | | | | |
| Agro-industrial waste | 1 | 1 | 1.5 | 1.5 | 2 | 2 | 1 | 2.5 |
| | | | | | | | | |
| All causes | 29.5 | 20.5 | 20.5 | 19 | 12.5 | 7 | 21 | 5 |

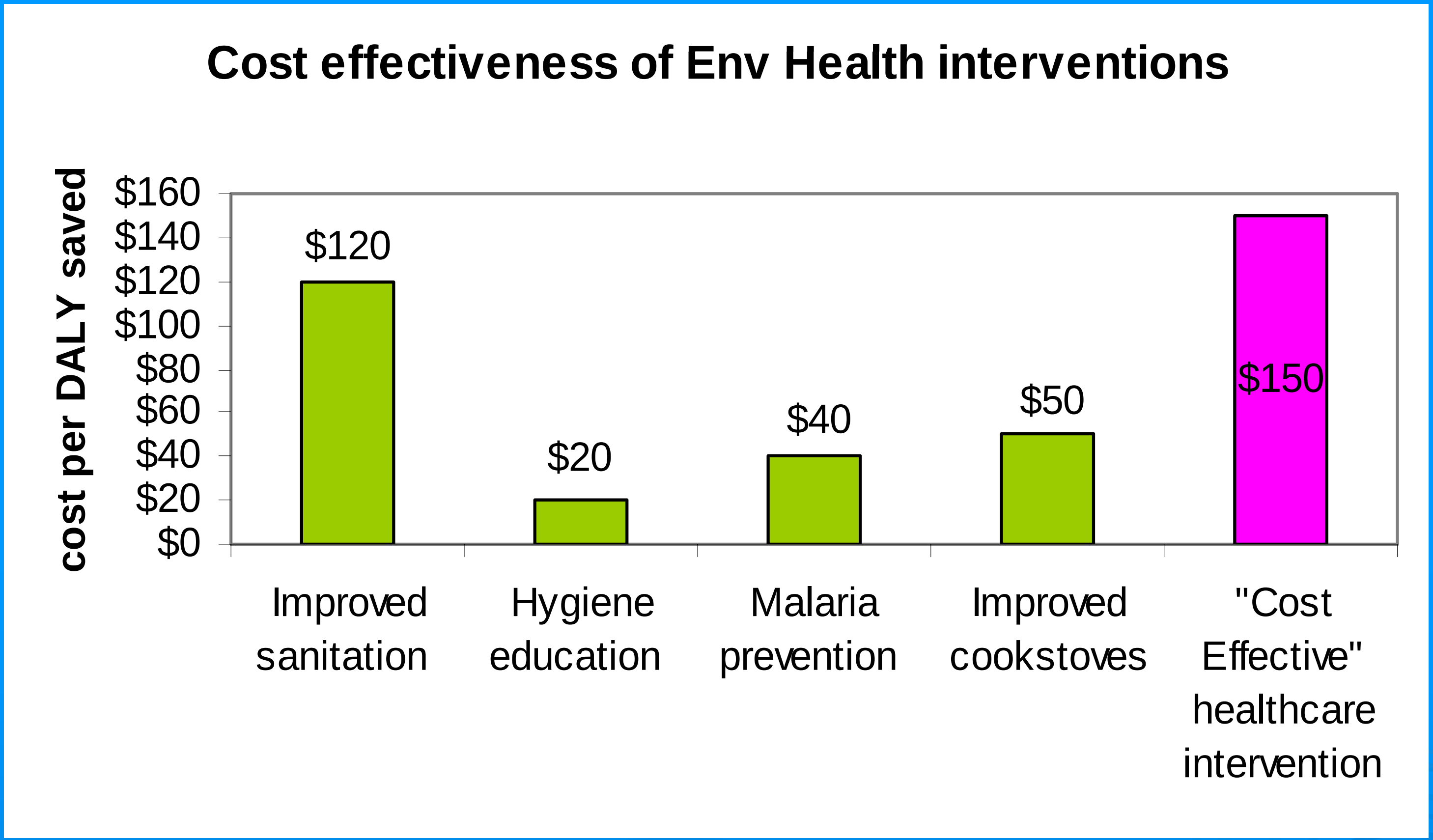
Source: Murray and Lopez 1996, Smith 1998, World Bank staff

# Environmental health and healthcare interventions can have equal impacts




- Improved environment can reduce burden of disease by 23-29% in SSA
- Healthcare interventions aimed at same can reduce a further 23-28%

# Environmental health interventions can be highly cost-effective




Note : estimates vary widely, depending on circumstances. These are considered high estimates. Estimate for healthcare comes from WDR 1993

# Interventions to improve environmental health require multisectoral approach

- Infrastructure -- e.g. water supply, water storage, latrines, improved drainage
- Private goods -- e.g. cookstoves, ventilation in houses, bednets, water filters
- Behaviour change -- e.g. hygiene practices, handwashing

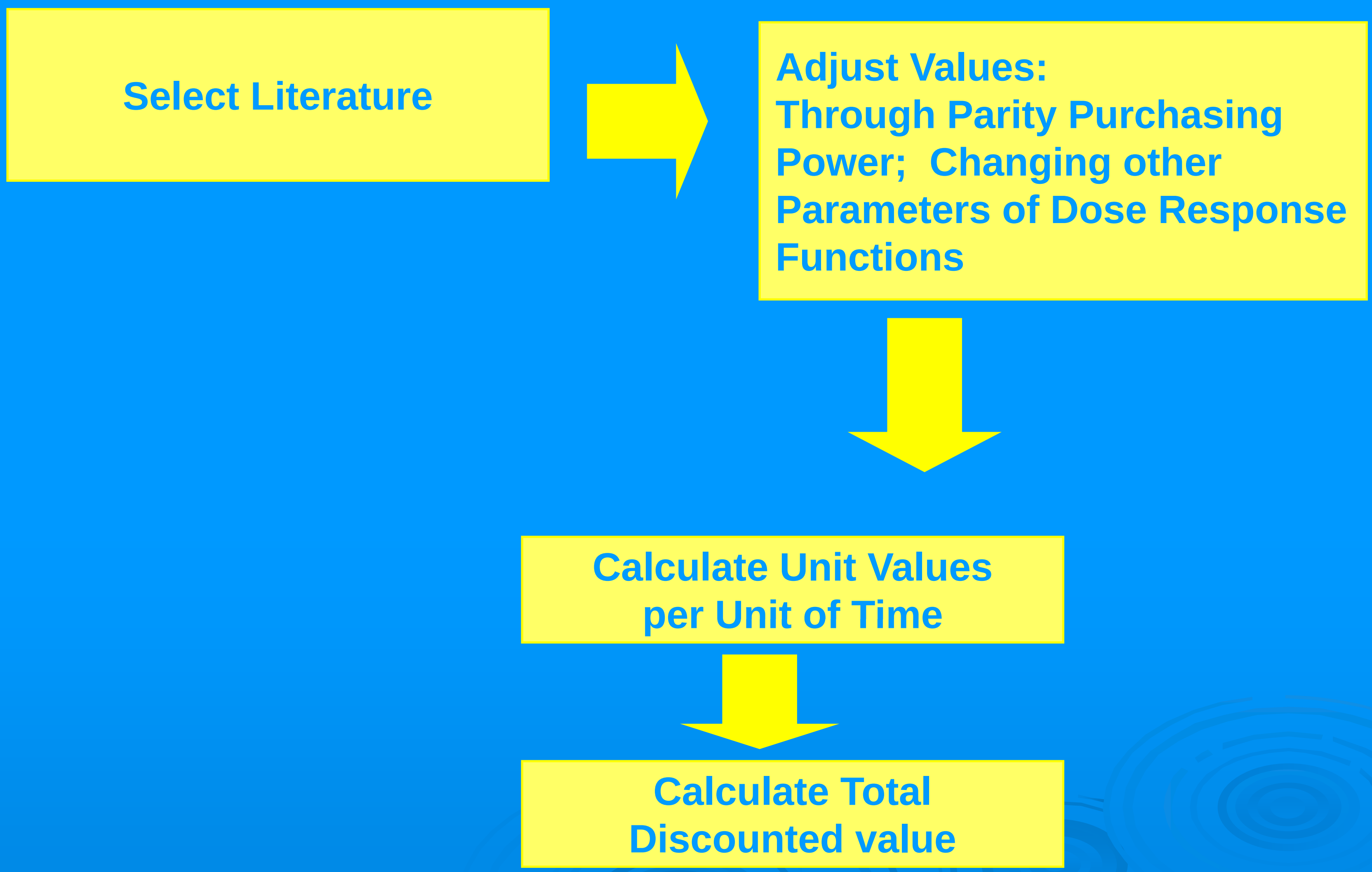
# Interventions have public and private character

- Combination of private willingness to pay with public benefit
  - e.g. household latrine is a private good and households often willing to pay for it
  - latrine coverage in community is important determinant of health outcomes whether a particular household has a latrine or not

# Conclusion : Environmental conditions have a major impact on public health

- Environmental conditions contribute to a large part of the burden of disease
- The impacts are preventable by technically simple interventions (eg drinking water)
- The interventions are cost effective relative to other options
- The public health benefits are achieved only through multi-sectoral actions, which are hard to implement in practice

# Benefits Transfer Method



# BENEFITS TRANSFER METHOD (BTM)

- Used as a rapid approach, may be a first approximation of values
- Borrow/transfer  from other studies  environmental values of similar ecosystems' comparable uses
- Adapt to local situation ( adjust for local prices, socio-economic profile)
- Easier to do for health impacts
- Extrapolation an be done only for sites with similar gross characteristics
- Compare with values in meta-analysis as a reality check
- Applied widely in many initiatives

## Some Advantages of Valuing Environmental Impacts During Economic Analyses and/or Environmental Management Options

- ***Provides a more complete picture of an action's true worth - recognizes both environmental benefits and costs***

- ***Encourages more careful and systematic consideration of the environmental consequences***

- ***Produces clear and defensible arguments for accepting or rejecting a project, a policy decision, or a resource management strategy***

# The Advantages of Valuing Environmental Impacts During Economic Analyses

- *Addresses the concerns of developing countries, donors, and NGOs on all aspects.*
- *Promotes consistency in evaluation across project categories and countries*
- *Eliminates investment bias towards projects that promote resource overuse and/or degradation*
- *Demonstrates key principles and methodologies that can be adopted in formulating environmental policies*
- *Allows comparisons and rankings of different projects competing for scarce resources*

# The Requirements of Valuing Environmental Impacts During Economic Analyses

- ***Resource and environmental economists, ecologists, engineers, sociologists and specialists work together.***
- ***Iteration of various analyses to allow for options for mitigation to be considered.***
- ***Analysis is built into the decision-making as early as possible.***

# Wisdom is knowing what you don't know:
## The Limits of Economic Analysis

Areas where economic analysis of the environment is often weak include the following:

- Large, non-incremental impacts
- Uncertainty
- Irreversible impacts
- The value of genetic material
- Preferences of future generations (and projects with long time horizons)