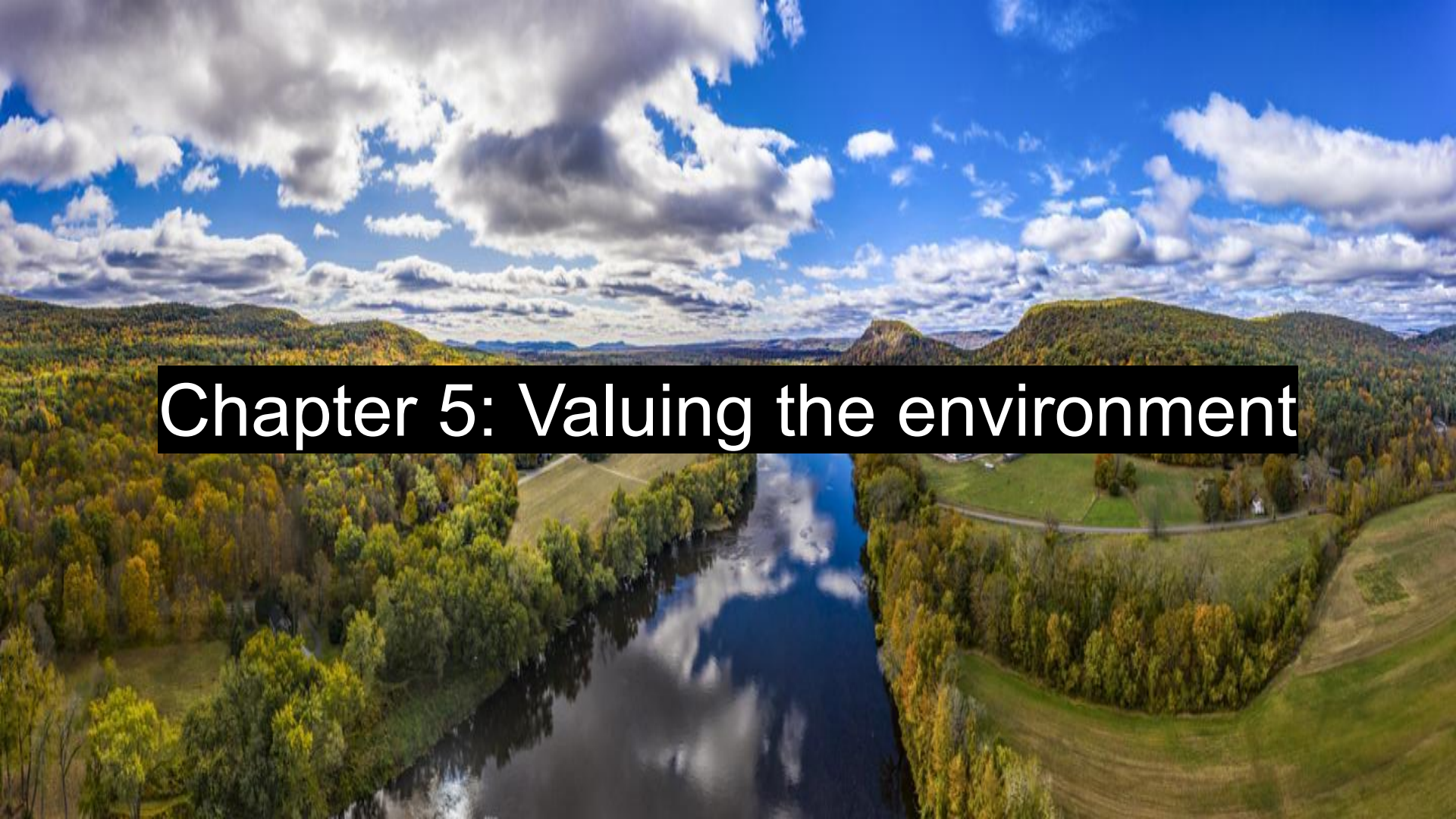
Environment economics and policies

EC 506



Chapter 5: Valuing the environment

Focuses

- *What are the different types of economic values?*
- *What techniques do economists use to estimate the value of the environment and natural resources in monetary terms?*
- *Does a monetary valuation of the environment provide a good basis for policy decisions?*

Values from market and non-market transactions

Flood protection dam

Coastal wetlands
preventing storm surges

Values from market and non-market transactions

Painting purchase

Feeling fresh after Sundarban trip

Values from market and non-market transactions

Values from market and non-market transactions

Air purifier purchase

Community tree planting

Values from market and non-market transactions

In standard economic theory, nature has value only because humans ascribe some value to it.

According to this viewpoint, species do not have an inherent right to exist. Instead, their “worth” derives from any values placed on their existence by humans.

According to **traditional environmental economics**, the economic value that people obtain from a specific resource is defined as their maximum willingness to pay (WTP) for it. Also, willingness to accept (WTA) the minimum amount of money people would accept as compensation for an action that reduces their well-being.

Ecological economists with an ecocentric worldview are more likely to suggest that natural values derive from ecosystem functioning and should not be based solely on human economic values.

It is certainly possible to go beyond market value to take into account environmental and social factors.

Would you be willing to pay (WTP) for clean water?

Recreational swimming

Recreational fishing

Recreational boating

Would you be willing to accept (WTA) compensation for

Housing

Solar installation

Road network

Use and non-use values

Use values are **tangible benefits** that can be physically observed. Use values are further classified into direct-use value and indirect-use value.

Direct-use value is obtained when we make a deliberate decision to use a natural resource. These values may derive from the **financial benefits** that we obtain by extracting or harvesting a resource, such as the profits from drilling for oil or harvesting trees. They may also derive from the **well-being** that we obtain by physically interacting with a natural environment, such as fishing or going for a hike.

Indirect-use values are tangible benefits obtained from nature, but **without any effort on our part**. Also referred to as ecosystem services, they include flood prevention, the mitigation of soil erosion, pollution assimilation, and pollination by bees.

Use and non-use values

Nonuse values are derived from the intangible well-being benefits that we obtain from the environment. While these benefits are psychological in nature, they are nonetheless “economic” as long as people are willing to pay for them. There are **three types of nonuse values.**

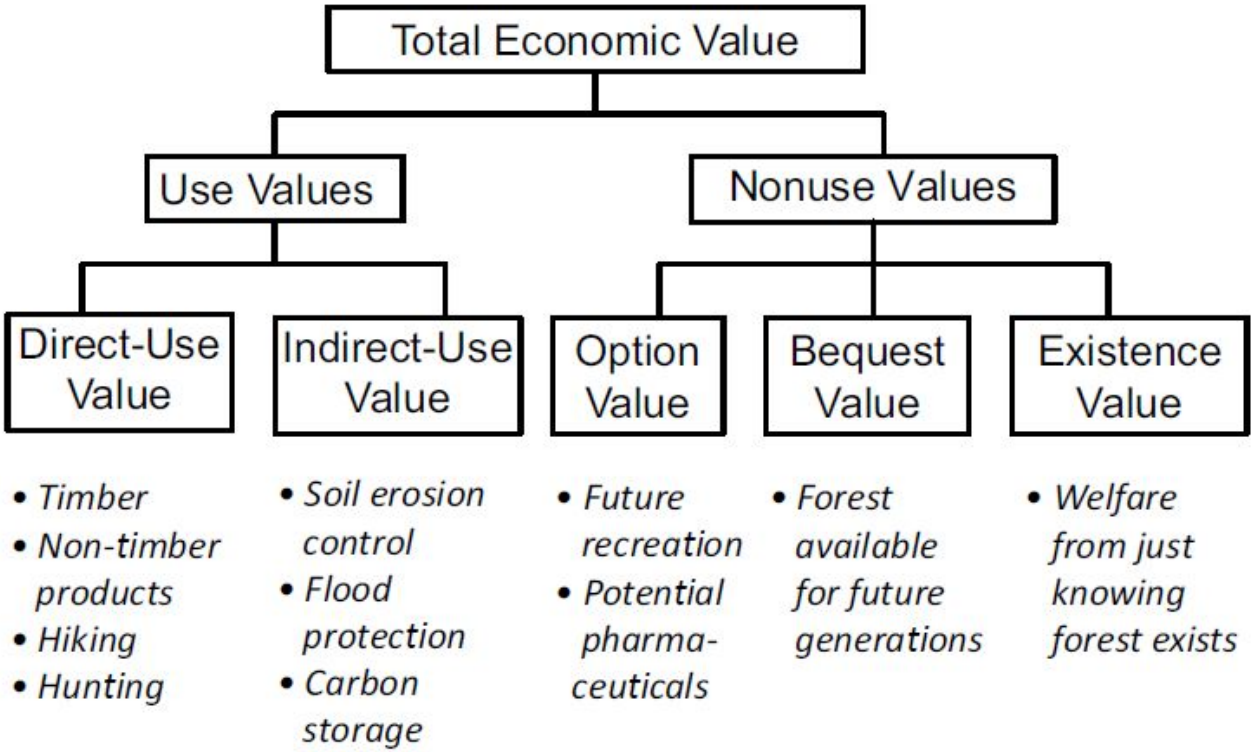
First, there is **option value**, or the amount that people are willing to pay to preserve a resource because they may wish to use it in the future. Example: someone’s willingness to pay to ensure the protection of the Arctic National Wildlife Refuge in Alaska, which provides habitat for wildlife, because he or she might visit it in the future.

Second type of nonuse value is **bequest value**, or the value that one places on a resource because he or she wishes it to be available for future generations. For example, one might wish to have the Arctic National Wildlife Refuge preserved so that his or her children will be able to visit it.

Finally, there is **existence value**, the benefit that an individual obtains from simply knowing that a natural resource exists, assuming that he or she will never physically use or visit the resource, and separate from any bequest value.

Use and non-use values

Values of a forest



Valuation techniques

Environmental valuation techniques into five basic categories:

1. Market Valuation
2. Cost of Illness Method
3. Replacement Cost Methods
4. Stated Preference Methods
5. Revealed Preference Methods

Valuation techniques

1. Market Valuation

Many environmental goods, such as forests, fish stocks, minerals, and groundwater, can be sold in existing markets. By estimating consumer and producer surplus, economists can calculate the benefits of these resources as market commodities—a type of direct-use value.

Valuation techniques

2. Cost of Illness Method

The cost of illness is an approach for valuing the negative impacts of pollution by estimating the cost of treating illnesses caused by the pollutant.

This method monetizes the direct and indirect costs associated with illnesses attributed to environmental factors. The direct costs include medical costs, such as office visits and medication, paid by individuals and insurers, and lost wages due to illness. Indirect costs include decreases in human capital, such as when a child misses a significant number of school days due to illness and falls behind other students. Other indirect costs include the well-being losses from pain and suffering, as well as decreases in economic productivity due to the physical or mental effects of an illness.

Valuation techniques

3. Replacement Cost Methods

An approach to measuring environmental damages that estimates the costs necessary to restore or replace the resource, such as applying fertilizer to restore soil fertility.

This method can be used to estimate the indirect-use value of ecosystem services, considers the costs of actions that provide human-made substitutes for lost ecosystem services. For example, a community could construct a water treatment plant to make up for the lost water purification benefits from a forest habitat. The natural pollination of plants by bees could, to some extent, be done by hand or machine. If we can estimate the costs of these substitute actions, in terms of construction and labor costs, these can be considered an approximation of society’s WTP for these ecosystem services.

Valuation techniques

4. Stated Preference Methods (Contingent Valuation Method)

A hypothetical situation for the use of an environmental resource is described and the interviewees are asked, contingent on the existence of the situation described to them, how much they would be willing to pay for the use and/or non-use services of the resource, such as recreation or existence.

The most commonly used stated preference method is the Contingent Valuation Method (CVM). CVM uses surveys to ask people directly how much they would be willing to pay for a change in the quality or quantity of an environmental resource.

The resulting sample mean (or median) WTP is then multiplied by the relevant population to estimate total WTP. CVM is, in principle, a relatively simple method, although state-of-the-art applications have become quite complex.

One of the main advantages of CVM, like other stated preference methods, is that it is capable of estimating both use and non-use values and it can be applied to almost any situation.

Valuation techniques

4. Stated Preference Methods (Contingent Valuation Method)

CVM is susceptible to a number of response biases. These include:

- **hypothetical market bias:** where responses are affected by the fact that it is a hypothetical and not a real market choice, and individuals may overstate their true preferences for an environmental good, or, where they simply want to please the interviewer – “yeah-saying”;
- **strategic bias:** where respondents believe that their survey response bids could be used to determine actual charges or expenditures they may understate or overstate their true WTP;
- **design bias:** the way in which the information is presented to the respondents can influence the individuals’ responses, especially concerning the specification of the payment vehicle, raising the question of how far preferences can be considered exogenous to the elicitation process; and,
- **part-whole bias:** individuals have been found to offer the same WTP for one component of an environmental asset, say, recreational fishing in one river, as they would for fishing in the entire river system.

Valuation techniques

4. Stated Preference Methods (Contingent Valuation Method)

Open-ended. Perhaps the simplest form of CV question is the open-ended format, in which a respondent is directly asked to state a maximum WTP for a desirable scenario.

Payment card. The respondent is presented with numerous potential WTP amounts and picks the one that most closely represents her or his maximum WTP.

Single-bounded. The respondent is given a single WTP amount and asked whether he or she would be willing to pay this amount for the scenario being presented. The WTP amount is not the same for all respondents—a range is used to provide variation and more precisely estimate average WTP. If the question is phrased as a vote on a hypothetical ballot issue, it is called a referendum format.

Double-bounded. A limitation of the single-bounded format is that we only know whether a respondent's WTP is above or below a certain amount. In a double-bounded question, the initial WTP amount is followed by a second question with a different WTP amount, This format provides more precise information about someone's WTP.

Multiple-bounded. Even more precise information can be obtained using the multiple-bounded format, which asks respondents to indicate whether they would be willing to pay several different amounts.

Contingent valuation method example: Payment card

Options	No. of hh	Sample WTP/hh ($)	Total WTP ($)	Project cost ($)	Net benefit ($)	Net benefit/$cost
Option 1: improve river quality to a level suitable for recreational boating	200	12.5	2500	2000	500	0.25
Option 2: improve river quality to a level suitable for recreational fishing	200	17.5	3500	3250	250	0.08
Option 3: improve river quality to a level suitable for swimming	200	25	5000	4250	750	0.18

If you rank the options in terms of: (a) **maximum aggregate net benefit, you will rank as option 3 > option 1 > option 2** and in terms of (b) **maximum net benefit per $ invested, you will rank as option 1 > option 3 > option 2**. Option 2 always comes in last.

Contingent valuation method: design examples

Open-Ended Format:
What is the maximum amount you would be willing to pay annually, as a tax surcharge, to fund a wetlands protection program?

Payment Card Format:
Which of the amounts below most closely indicates your maximum willingness to pay annually, as a tax surcharge, for a wetlands protection program? Please circle your answer.

$5	$40	$80	$200	$750
$10	$50	$100	$300	$1000
$20	$60	$125	$400	$1500
$30	$75	$150	$500	$2000

Single-Bounded Format:
Would you be willing to pay $75 annually, as a tax surcharge, to fund a wetlands protection program?

Yes
No
Unsure

Double-Bounded Format:
Would you be willing to pay $75 annually, as a tax surcharge, to fund a wetlands protection program?

- If respondent answers "Yes," then ask: "Would you be willing to pay $150?"
- If respondent answers "No," then ask: "Would you be willing to pay $40?"

Multiple-Bounded Format:
For each dollar amount below, indicate whether you would be willing to pay that amount annually, as a tax surcharge, to fund a wetlands protection program?

$5	Yes	No	Unsure
$10	Yes	No	Unsure
$25	Yes	No	Unsure
$50	Yes	No	Unsure
$75	Yes	No	Unsure
$100	Yes	No	Unsure
$200	Yes	No	Unsure
$300	Yes	No	Unsure
$500	Yes	No	Unsure
$1000	Yes	No	Unsure

Valuation techniques

5. Revealed Preference Methods (Travel Cost Models)

Travel cost models (TCMs) can be used to estimate the use value of natural recreation sites, such as national parks, beaches, and wilderness areas. Visitors to recreation sites typically must pay various trip costs such as gas and other vehicle costs (if they drive), other transportation costs such as airfares and public transportation, entrance fees, lodging, food, and so on.

TCMs use statistical analysis to determine people's willingness to pay to visit a natural resource such as a national park or river; a demand curve for the resource is obtained by analyzing the relationship between visitation choices and travel costs.

The key insight of TCMs is to note that the cost to travel to a park or other recreation site varies for different visitors primarily based on their distance from it.

Those who live nearby face relatively low travel costs, while those who travel from far away must pay higher travel costs to visit the site. This effectively provides us with variation in the "price" that different visitors must pay in order to visit a particular site. We can use this variation to estimate a full demand curve and thus obtain an estimate of consumer surplus.

Valuation techniques

5. Revealed Preference Methods (Travel Cost Models)

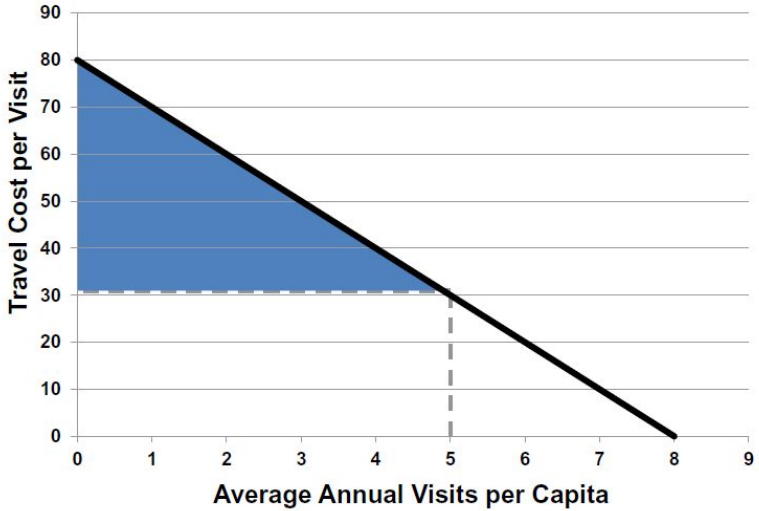
Suppose that for a particular zone, the average cost to visit the site is $30.

Consumer surplus as the area below the demand curve and above the cost of a visit—the shaded area in the figure.

Consumer surplus is a triangle with a base of 5 visits and a height of $50.

So, consumer surplus (CS) for 5 trips is: CS = ½ × 5 × 50 = $125

The consumer surplus for an individual trip would be $25 ($125 divided by 5).



Valuation techniques

5. Revealed Preference Methods (Travel Cost Models)

Advantages

- The method is based on actual behavior—what people actually do—rather than stated willingness to pay—what people say they would do in a hypothetical situation.
- The method is relatively inexpensive to apply.
- On-site surveys provide opportunities for large sample sizes, as visitors tend to be interested in participating.
- The results are relatively easy to interpret and explain.

Limitations

- TCM cannot be used to value non-use or passive use values.
- There are complications when valuing a trip with multiple destinations or purposes. A problem arises about the appropriate allocation of costs among multipurpose journeys.
- Visits to certain sites could be seasonal and therefore the survey results could be biased unless it is conducted over a long period.
- There is no consensus as to how time should be accounted for in TCM.

Valuation techniques

5. Revealed Preference Methods (Hedonic pricing)

We can use the behaviour of consumers as revealed in other related markets to infer their preferences for the good in question. **The underlying proposition is that an individual's utility for a good or service is derived from the attributes of the good or service in question, and that it is possible to distinguish the value of each attribute.**

For example, if the quality of an environmental resource, such as air or water, is considered an important attribute entering our choice of house, **variations in air or water quality should directly affect relative house prices.** For instance, the value to the resident of property frontage on a waterway could be affected by the quality of the water. If we compare house prices in polluted vs. non-polluted situations, with controls for price differences attributable to other factors, we should be able to measure the dollar value of differences (and changes) in water quality. **When all other effects have been accounted for, any difference in property price is attributed to the differential water quality. This is called the Hedonic Pricing Method (HPM).**

Valuation techniques

5. Revealed Preference Methods (Hedonic pricing)

In which area, will house prices be higher?

Valuation techniques

5. Revealed Preference Methods (Hedonic pricing)

To apply the HPM in this instance, data on house prices are gathered to estimate a model that explains variations in house price in terms of a whole set of attributes, one of which is the environmental attribute in question. For example, observed house price can be modeled as a function of house and site characteristics, neighbourhood characteristics, and water quality characteristics. This is the hedonic price function which can be expressed as:

$$P_h = P\,(S_i, N_j, Q_k)$$

where, P_h = house price
S_i = site characteristics
N_j = neighbourhood characteristics
Q_k = environmental quality characteristics
and, i = 1…m; j =1…n; and k = 1…1

Firstly, calculate an implicit “price” or value for the environmental attribute in terms of its marginal influence on house prices. Secondly, estimate a demand curve for the environmental attribute, using the environmental price and quantity information obtained from the first stage and allowing for socio-economic differences among the sampled house buyers so as to isolate the effect of water quality from other factors, such as income, which affect house prices.

Valuation techniques

5. Revealed Preference Methods (Hedonic pricing)

The main advantages of the HPM are:

- HPM is relatively straightforward and uncontroversial to apply, because it is based on actual market prices and fairly easily measured data.
- Property markets are relatively efficient in responding to information, so can be good indications of value.
- Property records are typically very reliable.
- Data on property sales and characteristics are generally readily available through many sources.
- If data are readily available, it can be relatively inexpensive to apply.

The main disadvantages of the HPM are:

- It requires a relatively high degree of statistical knowledge and skill to use.
- It generally relies on the assumption that the price of the house is given by the sum of the values of its individual attributes, implying a linear relationship among attributes.
- It assumes that there is a continuous range of product choices containing all possible combinations of attributes available to each house buyer.

Valuation techniques

5. Revealed Preference Methods (Defensive Expenditure Method)

The defensive expenditures approach collects data on actual expenditures to obtain a lower-bound WTP for environmental quality changes. The most common application of the defensive expenditures approach is to drinking water quality, when households with concerns about their drinking water quality may purchase bottled water, install a home water purification system, or obtain their drinking water from another source. Exposure to air pollutants can be reduced by purchasing home air purifiers.**This is a pollution valuation methodology based on the expenditures households take to avoid or mitigate their exposure to a pollutant.**

The remise is that if a household is observed paying, say, $20 per month for bottled water in response to concerns about the quality of their tap water, then their WTP for an improvement in drinking water quality is at least $20 per month.

Limitations:

- it provides only a lower-bound estimate to WTP. A household may be willing to spend much more than it actually is spending to improve the quality of its drinking water, but this approach does not allow us to estimate its maximum WTP.
- individuals who take actions to reduce their exposure to environmental harms may also be taking such actions for other reasons.

Gold: Ioannis pavlos evangelidis, GREECE

Traditional stilt fishermen try their luck with the changing tide at sunset in Koggala, Sri Lanka. It showcases the water movement in contrast to the stillness of the fishermen. Traditional, artisanal fishing methods like these, used for subsistence do not pose significant threats to the ocean's natural resources and on the contrary makes local communities stakeholders to the ocean's health.

See No Evil

Orangutans exploited by the tourism industry, Thailand, 2023. Credit: Aaron Gekoski, Winner in the "Humanity versus Nature" category and Environmental Photographer of the Year 2024