sessions 13-14
Land Expectation Value
Forest Valuation
Cost of Conservation

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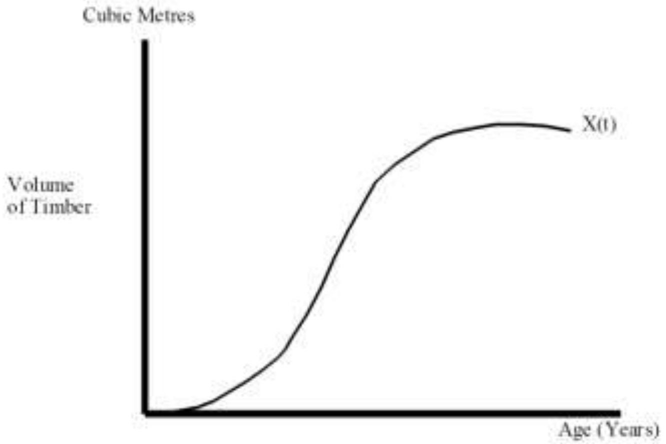
1. Land Expectation Value

- A forest has the potential to produce a wide range of goods and services (lumber, wood pulp, recreation, forage for livestock, habitat for wildlife, flood prevention, reduction of soil erosion and a source of biodiversity)
- Forestry economics help determine a pattern of forest use which maximizes the present value of forest rent
  - The annual forest rent is the total annual value of the flows of the various goods and services produced by the forest
- The analysis of the values of alternative uses of the forest is based on a **bioeconomic** model.
  - The biological component of the model describes the growth of the volume of timber over time on a hectare of forest land
  - The economic component of the model places rupee values on the output of forested land
- The net value of the timber growing on an area of forest land is termed the stumpage value - the value of the timber "on the stump“
  - This is the sale value of the timber less the cutting and transportation costs
- The cutting cycle which maximizes the present value of stumpage is the optimal rotation

1. Land Expectation Value

- The bioeconomic model is a biological production function combined with an economic model of production and cost
  - The biological production function describes the relationship between time and the quantity of timber growing on a hectare of forest land
- The volume of timber on a hectare of forest land is assumed to be an increasing function of the age of the stand
  - Since there is a limit to the quantity of biomass supported by a hectare of forest land, the instantaneous growth rate of the volume of timber decrease after some point in time

Figure 1: Volume of Timber on a Stand in Relation To the Age of the Trees



1. Land Expectation Value

- Stumpage value of timber at time t, S = P(t) * X(t) – C(t), where

P(t) = Sale price of timber per unit

X(t) = Quantity of timber sold

C(t) = Extraction costs

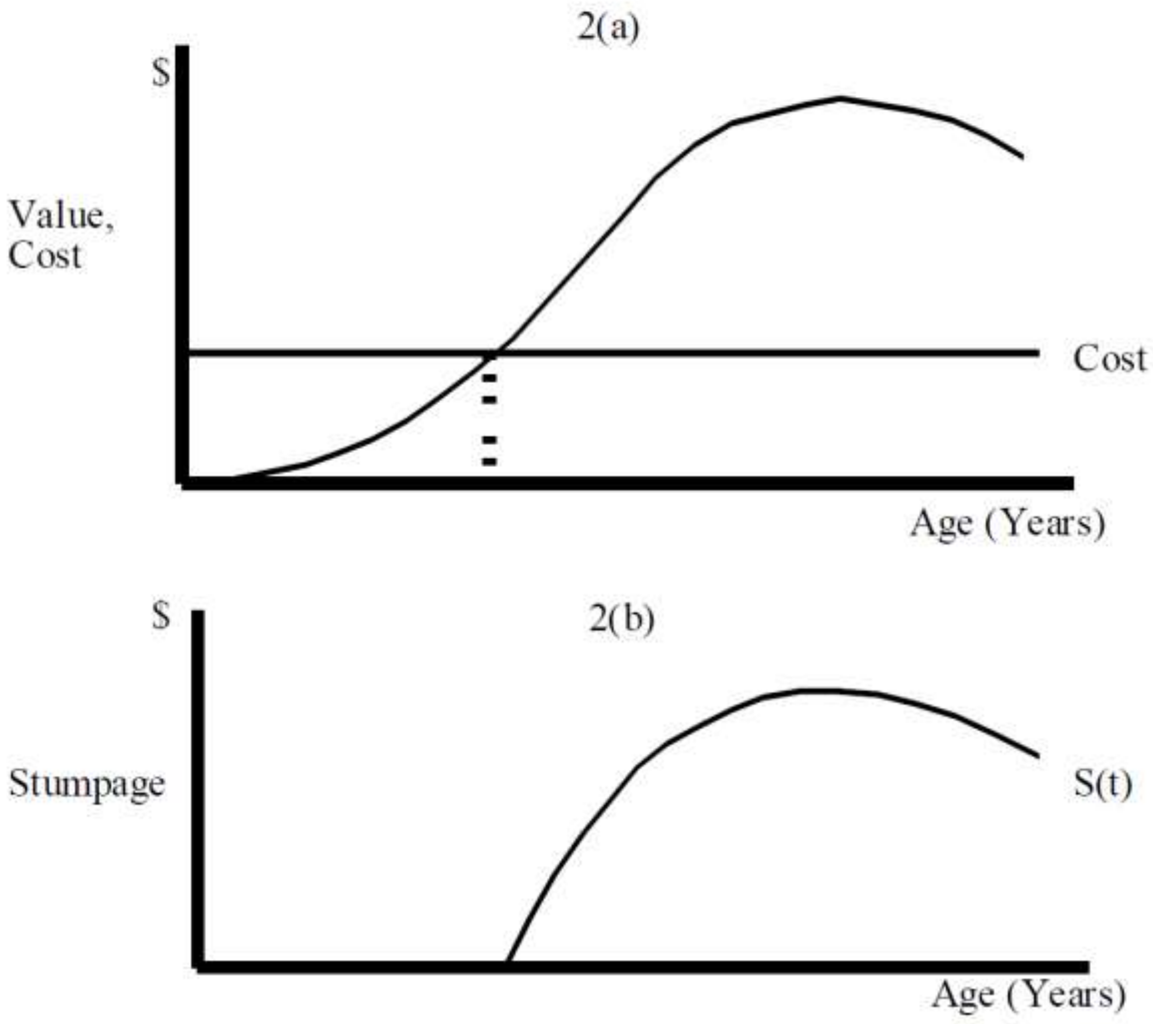
- Optimal rotation is the age at which the trees are cut to maximize the value of the land in commercial timber production
- Present value of the stumpage,

$$V = \frac{S}{[1 + r]^t}$$

- Where, S = Net value in year "t" = All future revenues in year "t" – All future costs in year "t", t = rotation period, and r = interest rate in decimal

1. Land Expectation Value

Figure 2: Value of Timber and Harvesting Cost in Relation to Stand Age



As age of stand increases, price increases; number of trees, felling costs, and other extraction costs may decrease, and often, increases. This implies S(t) increases as age of the stand increases. If only the current stand is harvested:

Efficiency requires that MC = MB; Now, MB of letting the stand grow for extra period of time = d S(t)/dt ;

MC = foregone interest which can be earned by cutting down the stand, selling the timber, and placing the proceeds in the bank = r * S(t), where r = rate of interest offered by the bank;

dS(t) /dt > r*S(t);

As long as the rate of growth of the value of timber exceeds r, leave the capital in the forest.

Economic efficiency implies that we cut the trees when the rate of growth of value of timber is equal to r [Fisher's rule].

1. Land Expectation Value…

- In the case of multiple harvest every “t” years, there is a perpetual cycle of cutting, re-growth, cutting, …
- Here, we assume
  - Stumpage value, S, is constant for all rotations
  - Biological and economic conditions remain constant, with nil forest risks
- The present value of such a perpetual cycle, starting with bare forest land, cutting, and replanting every “t” years, is

$$V = \frac{S}{[1+r]^{t}} + \frac{S}{[1+r]^{2t}} + \frac{S}{[1+r]^{3t}} + \cdots$$

1. Land Expectation Value …

- This simplifies to the Land Expectation Value (LEV) identity

$$V = \frac{S}{[1 + r]^t - 1}$$

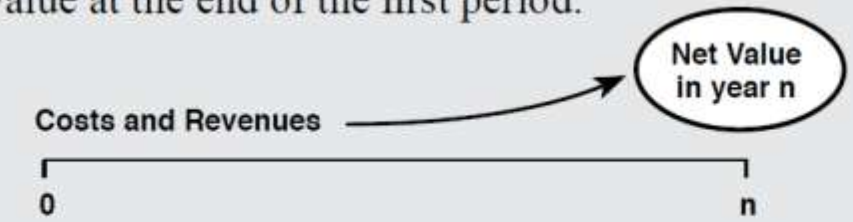
- LEV,
  - Estimates the value of bare land used for growing timber in a perpetual cycle
  - Considers all revenues and costs involved with timber production perpetually (for even aged and uneven aged management)
  - Is also known as the Faustmann's formula

1. Land Expectation Value…

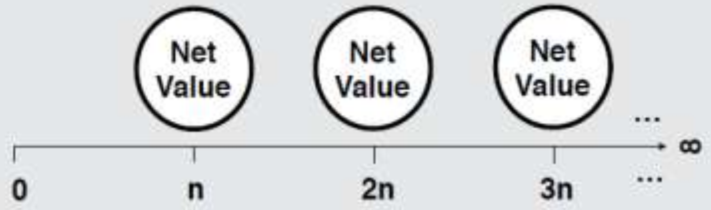
To calculate LEV:

1) Determine all of the costs and revenues associated with the first rotation of timber (the first cutting cycle if uneven-aged management is used). These values should include initial costs of planting, site preparation, etc., as well as all subsequent costs and revenues. Land cost should not be included, however. In calculating LEV you're estimating the value of land for growing timber.

2) Place the first rotation's (or cutting cycle's) costs and revenues on a time-line and, using the necessary compound interest formulas, compound all of them to the end of the rotation (or cutting cycle). Subtract the costs from the revenues to obtain a net value at the end of the first period.



3) Assuming a perpetual series of identical n-year rotations (or cutting cycles), the "net value" for the land's first period can be expected every n years forever…



1. Land Expectation Value…

Problem 1

Consider a teak plantation to be harvested in 30 years. The costs include rs. 120 per acre for site preparation and rs. 38 per acre for teak seedlings and planting which are incurred at the beginning. The annual management cost is rs. 5 per acre, to be incurred every year.

Revenues include rs. 500 per acre from the mid rotation thinning at age 16 and rs. 2,800 per acre for the final harvest.

The forest manager who is planning to invest in this teak plantation has other investment options which can yield her 6 % per annum.

Calculate the LEV and interpret your results.

1. Land Expectation Value…

Let C be the cost incurred every year; we need to find the future value at year n = C + C(1+R) + … + C (1+R)^(n-1) , where R is the rate of interest… (1)

S = a + ar + ar^2 + …. Ar^n-1 = a (1-r^n) / (1-r); … (2)

Substituting a = C, and r = (1+R), future value of costs C incurred every year =

C[(1+r)^n -1]/R.

FV = 5[(1+0.06)^30 -1]/0.06 = 395.29;

Hence the net value in year 30 = 2800+1130.45-(689.22+218.25+395.29) = 2627.29

LEV = 2727.29/ [(1+0.06^30)-1] = **553.95.**

Given the costs, revenues, and the opportunity cost (=6%), the interpretation is that the utmost a forest manager would be willing to pay for bare land that could be used for a 30-year teak plantation invetsment is rs. 553.95 per acre.

1. Land Expectation Value…

Problem 1 Solution; LEV = S(t)/[(1+r)^t -1]= net value in year t/ [(1+r)^t -1];

Net value = All future revenues – All future costs;

Future revenues:

Final harvest value of teak at year 30 = rs. 2800 per acre

The revenue from thinning at year 16 must be compounded into the future to compute FV at year 30 = 500(1+0.06)^14 = rs. 1,130.45

FV of site preparation cost at year 30 = 120 (1+0.06)^30 = rs. 689.22

FV of seedlings and planting costs at year 30 = 38(1+0.06)^30 = rs. 218.25

FV of annual management costs at year 30 @ rs. 5 every year:

2. Forest Valuation – Types of Forest Value

- Total Economic Value is the sum of direct and indirect use, and non-use values

Use Values			Non-Use Values
1. Direct Use	2. Indirect Use	3. Option	4. Existence
Wood products (timber, fibre, fuel)	Watershed protection	Future direct and indirect uses	Biodiversity (wildlife)
Non-wood products (food, medicine, genetic material)	Nutrient cycling		Culture, heritage
Educational, recreational & cultural uses	Air pollution reduction		Intrinsic worth
Human habitat	Micro-climatic regulation		Bequest value
Amenities (landscape)	Carbon storage		

2. Forest Valuation…

- Direct use values are usually reflected in market prices
- Indirect use values may be reflected in the prices of certain goods and services which depend heavily on the underlying environmental benefit
- Non-use values are rarely reflected in market prices or decision-making
- Public agencies make efforts to provide non-timber benefits (restrict felling in virgin forests and steep slopes to prevent floods and ensure water quality)
- But these efforts are limited in scope as forest managers, public and private, are not benefitted for providing such benefits
- Even where forest benefits are partly traded, they escape notice
  - In India for example, rural populations consume and sell vine and edible fruit, but this is rarely evaluated by forest authorities
  - Similarly, in the developed world, entry fees to forest recreational areas are much less than the true willingness to pay of visitors
- **Hence, there is more focus on direct uses, and benefits**

2. Forest Valuation…

- Two of the most important reasons for market failure in forestry are the prevalence of "public goods" and "externalities".
  - Public goods: Forests produce public goods [carbon sequestration, aesthetic scenery, and conservation]
  - Externalities: uncompensated costs or benefits arising from economic activity
    - *An example* is the decline in availability of game or NTFP due to logging. Unless the logging company pays compensation to hunters / gatherers for their loss of livelihood, the full economic cost of extracting timber will not have been paid
- Other reasons include
  - lack of information about their contribution to economic welfare
  - Distortions in prices arising from public policy and regulations (incentives not tied to clean goods production)
  - lack of clear or secure property rights over forest lands

2. Forest Valuation… Methods

1. Using market prices

- This method relies on market prices
  - Many forest goods from forests are traded, either in local markets or internationally (timber, pulp, fuel, food, medicine, livestock, meat and fish)
  - In this near "efficient" market, forest products would be priced at their marginal value product and reflect the full opportunity costs of resource use
- Example: Peters et al.(1989) use this method to value the edible fruit and latex extracted from the forests of Peru (at US$ 422 per ha)
- Assuming that this amount can be obtained in perpetuity, and a discount rate of 5%, the authors compute the NPV of the forest for sustainable fruit and latex production at US$6,330 per ha
- Pricing labor inputs in rural areas of developing countries can be problematic, due to thin labor markets and seasonal changes in work opportunities
- Estimating the amount of time involved in harvesting can also be difficult, due to the complementarity between harvesting NTFPs and other activities

2. Forest Valuation… Methods

2. The Travel Price Method (TCM)

- Here, we assume that consumers value the experience of a particular forest site at no less than the cost of getting there, which includes
  - direct transport costs
  - foregone earnings
- This survey-based method has been used in rich and developing economies to estimate environmental benefits in wildlife reserves, trekking areas and beaches
- Three steps are involved
  1. Survey of a sample of tourists to determine socioeconomic data and costs
  2. Manipulate the data to derive a demand curve
  3. Determine willingness to pay for what the site has to offer
- Example: In Costa Rica, Tobias and Mendelsohn (1991) estimate the eco-tourism value to domestic users of the Monteverde Cloud Forest Biological Reserve at about $100,000 per year

2. Forest Valuation… Methods

3. The Hedonic Pricing Method

- This method isolates the specific influence of an environmental amenity or risk on the market price of a good or service
- A constraint is that private property markets are thin, uncompetitive and poorly documented
- In forest-adjacent tracts, formal title to land may be missing and, and the land in question may be an open access resource
- Example: Garrod & Willis (1992) estimate the negative impact of pollution, and the presence of waste disposal facilities, on the market prices of residential property in USA

2. Forest Valuation… Methods

4.5 HOUSING PRICES AND AIR POLLUTION

For a sample of 506 communities in the Boston area, we estimate a model relating median housing price (*price*) in the community to various community characteristics: *nox* is the amount of nitrogen oxide in the air, in parts per million; *dist* is a weighted distance of the community from five employment centers, in miles; *rooms* is the average number of rooms in houses in the community; and *stratio* is the average student-teacher ratio of schools in the community. The population model is

$$\log(price) = \beta_0 + \beta_1 \log(nox) + \beta_2 \log(dist) + \beta_3 rooms + \beta_4 stratio + u.$$

Using the data in HPRICE2.RAW, the estimated model is

$$\widehat{\log(price)} = \underset{(0.32)}{11.08} - \underset{(.117)}{.954} \log(nox) - \underset{(.043)}{.134} \log(dist) + \underset{(.019)}{.255}\, rooms - \underset{(.006)}{.052}\, stratio$$

$$n = 506,\ R^2 = .581.$$

2. Forest Valuation… Methods

4. Substitute Goods Approach

- The basic premise of this method is that if the two goods are perfect substitutes then their economic values should be close
- As an example, fuel wood consumed by forest communities may be proxied by the price of fuel wood sold in other areas, or its substitute (charcoal)
- Examples:
  - Adger et al. (1995) and Gunatilake et al. (1993) use this approach to estimate the value of NTFPs in Mexico and Sri Lanka, respectively
  - Chopra (1993) uses the approach for valuing fuel wood, in a study of deciduous forests in India.

2. Forest Valuation… Methods

5. The Production Function Method

- This method estimates the ecological value of forests, through their contribution to market activities
- The approach has been used extensively to estimate the impact of deforestation on productivity in agriculture, fisheries, and on human health
- Good information on the physical relationship between the environmental resource and the economic activity it supports is required
- Example: Hodgson and Dixon (1988), estimate the value of coastal ecosystems in Philippines by quantifying the damage due to coastal logging, and sedimentation on tourism and marine fisheries

2. Forest Valuation… Methods

6. The Contingent Valuation Method

- Here, information on the value of an environmental benefit is obtained by asking consumers about their willingness to pay (WTP) for it or, alternatively, their willingness to accept (WTA) cash compensation for losing the benefit
- Valuations produced are "contingent" because value estimates are derived from a hypothetical situation that is presented by the researcher to the respondent
- The two main variants are
  - Open-ended, where respondents indicate their bids freely
  - Dichotomous choice formats, where respondents must choose from pre-set alternatives
- Example: Smith et al. (1997) use this method to assess Peruvian farmers' WTA compensation for adopting alternative land use practices which store more carbon (as a mitigation strategy for global warming), and farmers' WTP for carbon storage function of forests
  - WTP = $91 per household; WTA = $108 per household
- Through CVM, the cost of maintaining forest services, such as carbon storage, in terms of farmers' WTA compensation for adopting sound land use practices were computed

2. Forest Valuation… Methods

7. The Replacement Cost Method

- This method generates a value for the benefits of an environmental service by estimating the cost of replacing the benefits with an alternative service
- The least cost option among possible technologies is used to avoid over-estimation of the environmental benefit
- Example 1: Where road construction in upland forest areas leads to increased runoff and sedimentation, Chopra (1993) use information on the costs of dredging and flood control as a rough estimate of the non-market benefit of watershed protection
- Example 2: Niskanen (1998) estimate the value of soil nutrients lost due to increased erosion associated with logging and deforestation in terms of the cost of manufactured fertilizer needed to replace the eroded nutrients

2. Forest Valuation…some conclusions

- Valuation studies suggest that
  - The general public prefers forested landscapes composed of mixed species and varying ages
  - For recreational purposes (e.g. trekking) the public generally prefers mature forests with little undergrowth, high canopies and relatively few stems, to younger, denser stands
  - Both preferences are not in tune with industrial forestry, and so, private firms will tend to under-supply older and more diverse forest landscapes

2. Forest Valuation…(i) Economic Value of Forests in HP

(Verma, M. (2003). Economic valuation of forests in Himachal Pradesh, India, IIED conference paper

Total geographical forest area of H.P. : 36,986 Km^2				
Area under tree cover & Scrub Forest : 14,346 Km^2				
Goods/services from Forests (1)	Physical value (2)	Monetary value (Rs. Crores) (3)	Rs. Per ha. Value of goods/services in terms of total geo. Area of forests (4)	Rs. Per ha. Value of goods/services in terms of area under tree cover and scrub forest (5)
Total growing stock	10.25 crores m^3	40860	1.10 lakhs	2.85
Economic Value of Direct and Indirect Benefits				
I. Direct Benefits				
A. Direct Consumptive benefits				
1.Salvage	3.50 lakhs m^3	32.00	0.08 thousand	0.22 thousand
2.Timber for right holders	1.06 lakhs m^3	60.00	0.16 thousand	0.42 thousand
3. Fuelwood	27.60 lakh tons	276.00	0.75 thousand	1.92 thousand
4.Fodder	92.0 lakh tons	690.00	1.86 thousand	4.81 thousand
5.Minor forest produce	1161.56 tons	25.00	0.067 thousand	0.17 thousand
Total Direct consumptive benefits		1083.00	3 thousand	7 thousand
B. Direct Non Consumptive Benefits				
6.Ecotourism*	66.56 lakh - Tourists	6657	18 thousand	46 thousand
Total Direct Benefits(A+B)		7740	21 thousand	53 thousand

2. Forest Valuation…Economic Value of Forests in HP

II. Indirect Benefits

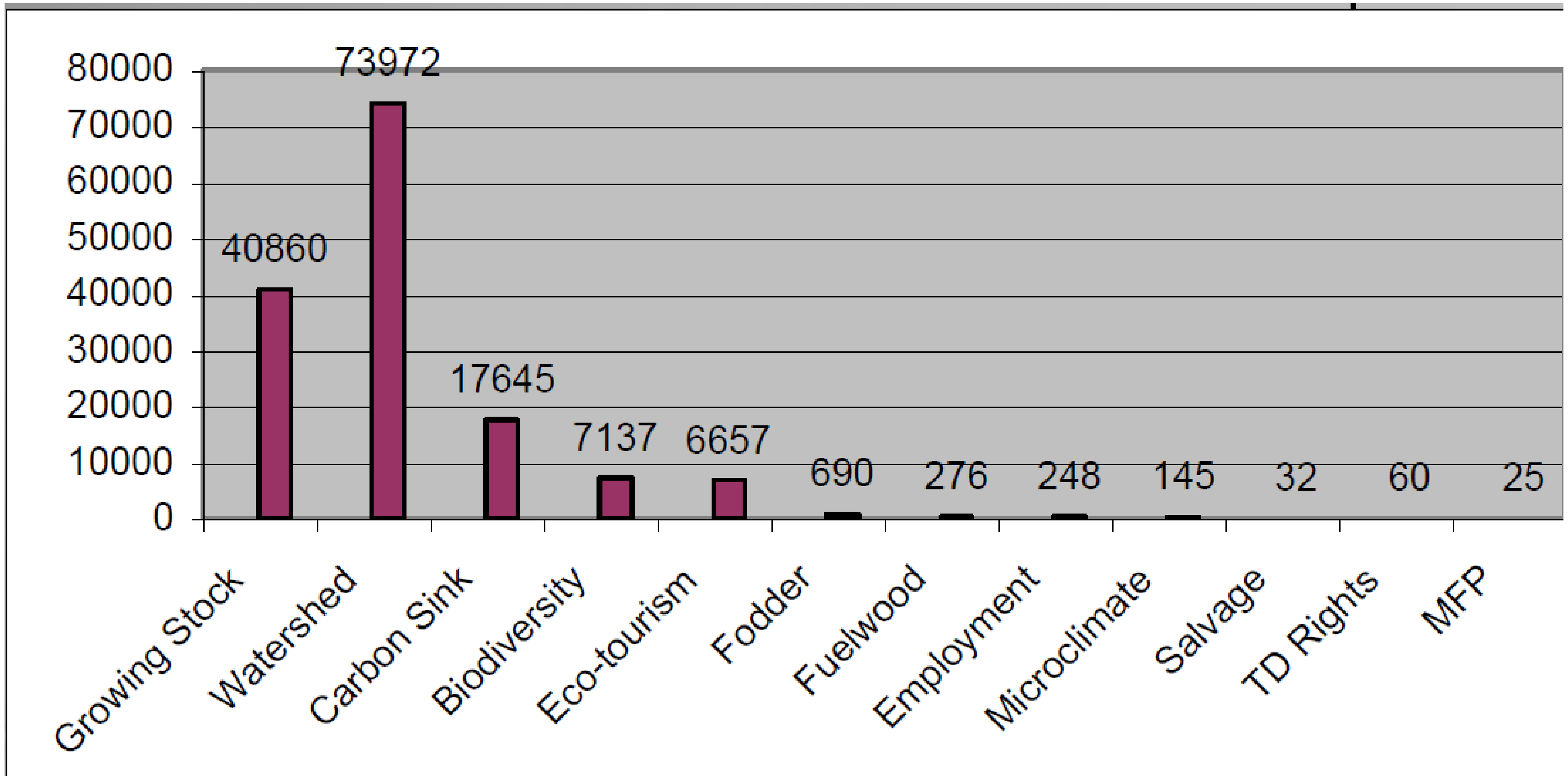
7.Watershed*	6.77crore m3 - Growing stock in river Basin Forest Circle and 36986 km2 - entire forest area	73972	2.0 lakh	5.16 lakhs
8.Microclimatic factors	969018 Households	145	0.39 thousand	1 thousand
9.Carbon Sink*	14346 km2 - cover and scrub forest	17645	4.7 thousand	1.23 lakhs
10.Biodiversity*/ Endangered Species	8966- Total no. of species found in Himanchal Pradesh & 125 - Endangered species	7137	20 thousand	49 thousand
11.Employment Generation	48.40 Man days	25	0.06 thousand	1.7 thousand
Total Indirect Benefits (7+11)		98924	2.68 lakhs	6.90 lakhs
Total Economic Value(I+II)		106664	2.89 lakhs	7.43 lakhs

2. Forest Valuation…

1. Value of Growing Stock 2. Total Economic Value of Forests 3. Total Expenditure incurred in forest (Annual Budget) 4. Revenue realised by forests	Rs. 40860 Crore Rs. 106664Crore Rs. 109 Crore Rs. 41 Crore
II. Contribution of Forsts to the GSDP	
5. Total GSDP	Rs. 9258 Crores
6. Forestry & Logging	Rs. 487
7. Forestry as % of GSDP	5.26%
8. TEV of forests of HP (as per current estimate)	Rs. 106664 Crores
9. Corrected GSDP	Rs. 115434 Crores
10. Forestry as % of corrected GSDP	92.40 %

2. Forest Valuation…(i) Economic Value of Forests in HP

(Verma, M. (2003). Economic valuation of forests in Himachal Pradesh, India, IIED conference paper



2. Forest Valuation: (ii) Value of NTFP in Tamil nadu

- Describes the role of NTFPs in the subsistence economy of Tamil Nadu State, India, including a case study of NTFP extraction from the Kadavakurichi Forest Reserve.
- For all products, the total estimated value extracted was Rs 1.9 million per year, or about Rs 2,090 (US$70) per hectare per year
- Empirical data
  - A forestry survey of 324 villages conducted in Tamil Nadu, including the number of "head-loaders" (men, women and children) entering the forest daily and the quantity (in tonnes) of product removed annually (fuelwood, small timber and fodder)
  - A case study carried out under a social forestry project managed by the Palni Hills Conservation Council (PHCC), detailing forest product extraction by local villagers, i.e. fuel wood, fodder, honey and other products (medicinal plants, small game, green manure)
  - "Footpath" surveys in which 43 entry paths into the FR were monitored over a seven week period to determine the number of trips made, the quantity of each product extracted and other variables (age and sex of collector, intended end use)
  - An inventory of vegetation in the reserve, and their uses

2. Forest Valuation: Value of NTFP in Tamil nadu

- Market prices were used to estimate direct use values
- NTFP extraction is expressed in term of the average (per headloader) and total (for the entire Forest Reserve) value per annum

Ref: Appasamy, P.P. 1993. “Role of Non-Timber Forest Products in a Subsistence Economy: The Case of a Joint Forestry Project in India” in *Economic Botany, 47(3): 258-267.*

2. Forest Valuation: (iii) Value of Tropical Forests in India

Type of assessment & main findings: The paper presents a financial CBA of non-timber benefits per hectare for tropical moist (37% of total forest area) and tropical dry (28.6%) deciduous forests in India. The sum of direct and indirect use values is estimated to fall between US$220 and $357 per hectare per year.

Empirical data: Secondary data on monetary values for fuelwood, fodder and other forest products, soil conservation, nutrient cycling, tourism and recreation are used, drawn from a range of studies carried out in India and elsewhere.

Details of CBA: The analysis includes direct and indirect use values, option and existence values, and is undertaken from an economic perspective. A 12% discount rate over a 30 year time horizon is used to convert annual returns into net present values (NPV).

2. Forest Valuation…

Ref: Chopra, K. 1993. "The Value of Non-Timber Forest Products: An Estimation for Tropical Deciduous Forests in India" in *Economic Botany, 47(3):251-257*

Item	Valuation technique
Fuelwood	1. Substitute good approach - price of soft coke. 2. Labour inputs - cost of time spent in collection.
Fodder	PFA - market value of fertiliser and milk output from cattle feeding on established pasture and scrubland.
Other forest products (*sal* and *bidi* leaves, *tassan* cocoons, dyes and lacquer)	Labour inputs (as above).
Soil conservation benefits	1. Replacement cost approach - cost of fertiliser required to restore nutrients lost due to soil erosion. 2. Restoration cost technique - cost of dredging accumulations of silt downstream.
Nutrient cycling function	Experimental data on litter fall in different kinds of forest.
Tourism and recreational values	Based on aggregate expenditure data from the national accounts.

2. Forest Valuation… (iv) The Borivli NP, Mumbai

Ref: Hadker, N., Sharma, S., David, S. and T.R. Muraleedharan. 1997. "Willingness-to-pay for Borivli National Park: evidence from a Contingent Valuation" in *Ecological Economics 21(2): 105-122.*

Type of assessment & main findings: CVM is used to assess willingness to pay (WTP) of residents of Bombay (Mumbai) for conservation of the Borivli National Protected Area, which covers a fifth of the metropolitan area and is increasingly threatened by encroachment and deforestation. Average household WTP is estimated at US$0.23 per month, or about US$31.6 million in aggregate present value terms, which far exceeds the current budget of US$520,000 to maintain the area.

Empirical data: Primary data were collected through a four-part survey administered to about 500 people. Information collected included:

- socio-economic data including age, gender, income, education, occupation, membership of environmental groups, etc.;
- environmental interests, i.e. whether respondents consider themselves "pro-environment", "pragmatic" or "pro-development";
- maximum WTP for the introduction of a management plan which will ensure protection of the area, as well as the preferred payment vehicle; and
- respondents' willingness to volunteer time to help protect the area.

2. Forest Valuation… (iv) The Borivli NP, Mumbai

Ref: Hadker, N., Sharma, S., David, S. and T.R. Muraleedharan. 1997. “Willingness-to-pay for Borivli National Park: evidence from a Contingent Valuation” in *Ecological Economics 21(2): 105-122.*

Socio-economic groups affected: WTP results were analysed with respect to respondents' age, gender, income, environmental interest, etc. Key determinants of "true" WTP include income, years of schooling, occupation, expressed preference for environmental activities, membership of an environmental group and frequency of visits to the site. Most variables affect WTP as expected, eg. higher income is associated with increased WTP. Interestingly, businessmen express higher average WTP than professionals, even though businessmen are generally less educated than professionals and WTP increases with education.

Example 1: The travel cost method

You have been commissioned to estimate the demand curve for admission to the Corbett National Park. To do this, you spend a day surveying visitors to the park. Before doing this, you divide the area around the park into 10 zones, with the distance from the park approximately constant within a zone. You ask each person you interview where they come from.

Based on that information, and figures on annual attendance at the park, you are able to calculate the annual number of visitors from each zone. Data is shown in table (next slide).

Admission to the park is Rs. 150 per person. The transportation costs, including time costs, are Rs. 0.5 per person per kilometer in each direction. Ignore the value of time in the park.

- Calculate the demand curve for visits to the National Park, showing visits as a function of the entry price
- How many visitors would you expect there to be if the management raised the admission fee to Rs. 200?

Example 1 …

Zone	Distance from park (km)	Zonal population	Number of visitors
1	10	5000	500
2	20	10000	900
3	30	25000	2000
4	40	10000	700
5	50	100000	6000
6	60	500000	25000
7	70	200000	8000
8	80	50000	1500
9	90	100000	2000
10	100	100000	1000

Example 1…

Zone	Distance (km)	Population	Visitors	Visitors (%)	Admission Fee	Travel Cost	Total Cost
1	10	5,000	500	10	150	10	160
2	20	10,000	900	9	150	20	170
3	30	25,000	2,000	8	150	30	180
4	40	10,000	700	7	150	40	190
5	50	100,000	6,000	6	150	50	200
6	60	500,000	25,000	5	150	60	210
7	70	200,000	8,000	4	150	70	220
8	80	50,000	1,500	3	150	80	230
9	90	100,000	2,000	2	150	90	240
10	100	100,000	1,000	1	150	100	250
		1,100,000	47,600				

Example 1…

A. To find the demand function, assign TC, on the y axis and visitor % on the x axis; As discussed, we select (2,240) and (1, 250) as (x1,y1) and (x2,y2); We need to find the slope m and the intercept c for this equation y=mx+c;

- m= y2-y1/(x2-x1) = (250-240) /(1-2) = -10, indicating the slope is negative and the curve slopes downward; Plug (1,250) and m= -10, in y= mx+c, to obtain c = 260; So, the demand curve for visitors to corbett is :

TC = -10 (visitor%) + 260…. The demand curve, or visitor% = 26-0.1(TC), where TC = total cost.

B.

Example 1…

- Visitor% = 26-0.1 (TC) = 26-0.1(210) = 5
- Thus, a rs. 50 increase in admission fee results in only 2600 visitors to corbett, down from the earlier 47,600 visitors. This drop in visitation is due to the hike in admission fee, given the data and the context of the problem.

Example 1…

Zone	Distance (km)	Travel Cost	Admission Fee	Total Cost	Visitors (%)	Population	Visitors
1	10	10	200	210	5	5,000	250
2	20	20	200	220	4	10,000	400
3	30	30	200	230	3	25,000	750
4	40	40	200	240	2	10,000	200
5	40	50	200	250	1	100,000	1,000
6	50	60	200	260	0	500,000	0
7	60	70	200	270	0	200,000	0
8	70	80	200	280	0	50,000	0
9	80	90	200	290	0	100,000	0
10	100	100	200	300	0	100,000	0
						1,100,000	2,600

3. Cost of Conservation

McCarthy, D, P. (2012). Financial costs of meeting global biodiversity conservation targets: current spending and unmet needs, *Science, 338.*

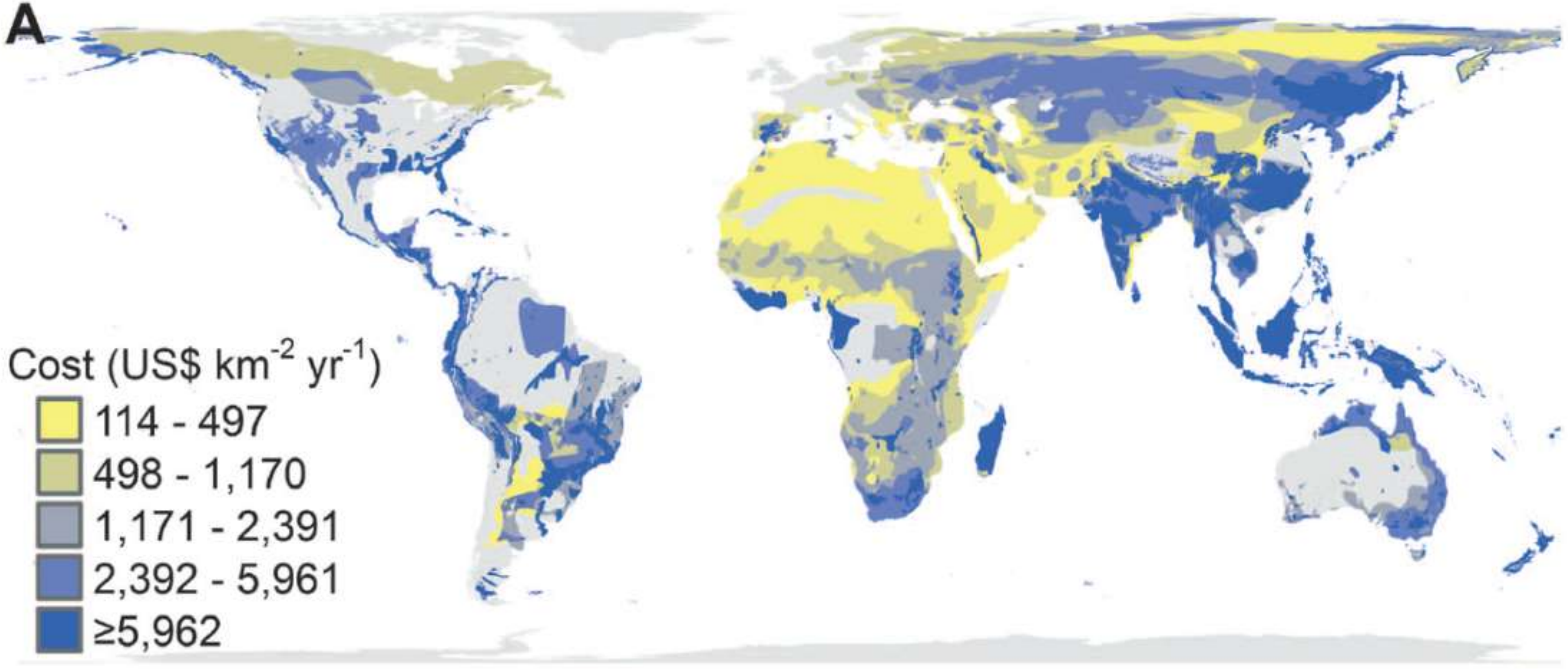
- Under the Convention on Biological Diversity (CBD), governments have agreed to meet 20 conservation targets by 2020, of which costs for two are analyzed:
    1. Lowering the extinction risk for 211 avian species by one category on the Red List of the International Union for the Conservation of Nature
    2. Expanding protected areas to cover 17% of terrestrial and inland water areas, and 10% of coastal and marine areas
- The cost for (1) is estimated at U.S. $0.875 to $1.23 billion annually over the next decade, of which 12% is currently funded
    - Incorporating threatened non avian species increases this total to $3.41 to $ 4.76 billion annually
- The cost for (2), which includes 11,731 Important Bird Area (IBA) is estimated at $76.1 billion annually (< 20% of consumers' spend on soft drinks globally!)
- Only 28% of IBAs are completely covered by existing protected areas, 23% are partially protected, and **49% are entirely unprotected**
- The cost estimate for (1) is a function of breeding distribution extent, degree of forest dependence, mean Gross Domestic Product per sq. km of breeding range states, and mean Purchasing Power Parity of breeding range states

3. Cost of Conservation …

McCarthy, D, P. (2012). Financial costs of meeting global biodiversity conservation targets: current spending and unmet needs, *Science, 338.*

- 20% of the estimated costs are for species-specific actions such as captive breeding, while the rest are for actions (like site protection) that will probably benefit other species whose distributions overlap
- These annual costs are a fraction of the value of nature's ecosystem services (pollination of crops, carbon sinks), which are estimated between $ 2- 6 trillion
- Conservation costs per species appear to be lower for other taxa (except mammals), because they have smaller distributions on average than birds
- Studies show that annual conservation costs for birds are 4.20 times larger than for other taxa
- Threatened birds make up 7.65% of all threatened species on the IUCN Red List
- Such investments does not guarantee success, as multiple factors influence conservation
  - Furthermore, many species will require continued funding beyond 2020, due to more climate change threats

Costs of Conservation …



End of session

Thanks