

### ECON/FRE 374 – Problem Set 4

Instructions: a) Your grade on this problem set will be determined by *randomly* grading a single problem from the set below. It is thus important to do each question carefully as any one problem could determine your grade. b) Problem sets are to be handed in at the beginning of class. Please do not upload your problem sets in webct. c) Any problem set received after the time it is due will not be graded. d) Please label and mark all graphs clearly.

Questions (each question is potentially worth 10 points):

#### Question 1

Construction is now under way in China on what will be the world's largest hydroelectric dam. When it is completed in 2009, Three Gorges Dam will stretch more than one mile across the Yangtze River and soar 600 feet above the valley floor. It will be the largest concrete dam in the world, and will produce 18,000 megawatts of electrical energy, nudging Brazil's Itaipu Dam to second place. When finished, Three Gorges Dam will generate one-ninth of China's power.

**List 5 costs and 4 benefits from the construction of this dam.**

Answer

What are some of the costs associated with a dam?

- cost of site selection.
- cost of designing and building the dam.
- the cost of buying the land and/or moving people out of the way.
- the cost of property damage and lives lost if dam fails.
- the cost associated with downstream erosion.
- cost of maintenance of dam facilities.
- cost of net decreased discharge downstream.
- loss of recreational sites
- cultural and social values of communities (burial sites, sacred spaces etc)

Benefits associated with a dam:

- the power generated
- property losses prevented from flooding
- saved lives by prevention of the flooding.
- water supply benefits
- recreational value of dams
- carbon dioxide and other pollutant credits gained by not having to produce energy with fossil fuels.

Question 2

Sulfur Dioxide (SO<sub>2</sub>) is produced by power plants and industries that burn fossil fuels that contain sulfur, such as coal and oil, and by the phosphate industry through its production of sulfuric acid. Sulfur dioxide is irritating to the lungs and can result in a higher incidence of respiratory disease. It is also responsible for acid rain formation. The traditional management was by having tall flue gas stacks to disperse the emissions by dilution. This however transported the problem to other regions in the form of acid rain. Acid rain has been shown to have adverse impacts on forests, freshwaters and soils, killing off insect and aquatic life.

In the Philippines, energy generation emits approximately 81mt of SO<sub>2</sub> annually. There are two options to address this problem, to install a flue gas desulfurization facility or to switch to a higher grade fuel with relatively lower sulphur content.

You are to recommend to the Department of Environment which option is cheaper per unit of SO<sub>2</sub> removed, in other words, which option is cost effective.

Control Technology	Capital Cost	Removal Efficiency	Cost (US\$)	units
Flue Gas Desulfurization	US\$ 13M 30 yrs life	90%	1,500.00	\$/Mt SO <sub>2</sub>
Switching to 2% sulfur fuel		40%	10.00	\$/mt fuel consumed
Fuel consumption		14 million	mt fuel	
Average Emissions per year		81,112.52	mt	
Energy output		4.30	million MWH	

Source: Corpuz, Catherine Frances. 1999. Pollution Tax For Controlling Emissions From The Manufacturing And Power Generation Sectors: Metro Manila. Published by the Economy and Environment Program for South East Asia. Publication 1999-08

Note while calculating the capital cost, use straight line depreciation, in other words, assume that the capital cost is evenly distributed over the 30 year life.

Capital cost	a	13,000,000	\$
Service life	b	30	yrs
Abatement cost (SOx)	c	1,500.00	\$/mt/yr
Emissions	d	81,112.52	mt/yr
Abatement cost (MWH)	j	100,000.00	\$/MWH
Energy output (MWH)	h	4,300,000	MWH
Energy output (million MWH)	h'	4.30	million MWH

**Option 1 Using direct abatement cost, fixed cost straightline depreciation**

Fixed cost (a/b)/(0.9*d)	e	5.94	\$/yr
Variable cost	c	1,500	
<b>\$/mt/yr abated total (e + c)</b>		<b>1,505.94</b>	

**Option 2 Switching to 2% sulphur fuel**

Fuel consumption	r	1,400,000	mt
Cost of switching	s	10	\$/mt fuel
Abatement cost (r*s)	t	14,000,000	
\$/mt/yr abated (t/(0.4*d))	q	431.50	
<b>**Effective \$/mt/yr abated (q*3)</b>		<b>1294.50</b>	

**Issues of choosing Option 1**

- high efficiency removal rate
  - high capitalization
- maintain
- fixed technology, once adopted the industry is stuck with it for the next 30 yrs

**Issues of choosing Option 2**

- low removal efficiency rate
- no capitalization required
- no staff issues to deal with
- easy to adopt a new technology that could prove to be a better option than what is currently available

### Question 3

In the past half-century, over half the world's mangroves - estimated to have covered 22 million hectares (54,340,000 acres) of tropical and subtropical coastlines in the middle of the last century - have been lost to development, oil exploration, pollution, inland irrigation, and especially shrimp aquaculture. Mangrove ecosystems in Sri Lanka provide important ecological benefits such as storm surge buffers, protection against shoreline erosion, absorption of pollutants, support of diverse biodiversity and water conservation. As well, these ecosystems provide benefits to communities including building materials, food, fishing and medicine and fuel sources. However, mangrove ecosystems prove to be ideal site for ecologically harsh shrimp aquaculture. Shrimp aquaculture is responsible for 40-50% of Sri Lankan aquaculture exports. Thus, pressure to develop mangrove forests into shrimp ponds is extremely high. A study determined an estimate of the total economic value for the Rekawa Lagoon mangrove ecosystem, the site of a proposed 32 ha shrimp aquaculture project.

Estimated Total Economic Values  
Rekawa Mangrove Ecosystem (\$US, 1998)  
(250 ha lagoon and 200 ha forest)

Mangrove Benefits	Value (US\$/ha/year)	Valuation Method
Forestry Net Benefits (at Subsistence Level)	24.00	Used actual amount of harvested wood multiplied by shadow value ("price for inland wood sold by licensed concessionaires")
Lagoon Fishery Net Benefits (at subsistence level)	268.00	Used the fish market value and amount of fish secured.
Coastal Fishery Net Benefits	493.00	Used fish secured, market value and net human effort.
Erosion Control and Buffer Against Damage From Storms	300.00	Used replacement cost analysis. The cost of alternate buffers for storm/erosion control (sea walls, revetments or groynes) is estimated.
Existence, Bequest and Option Values to Local Community	2.60	Contingent valuation method (CVM). Using open-ended format respondents are asked their willingness to pay for a hypothetical mangrove/lagoon ecosystem protection fund.
Total Value	1, 088.00	

Source: Gunawardena, M. and J.S. Rowan, "Economic Valuation of a Mangrove Ecosystem Threatened by Shrimp Aquaculture in Sri Lanka", Environmental Management 36, no. 4 535-550 , 2005

Item	US\$	unit
Average production	7178	kg/ha/yr
Area for pond conversion	32	ha
Pond Development cost	5,500	/ha
Operational Cost	4.56	/kg
Price	8.65	/kg

Source: Bith-Hong Linga, Ping Sun Leung and Yung C. Shang. 1999. Comparing Asian shrimp farming: the domestic resource cost approach. *Aquaculture*. Volume 175, Issues 1-2, 30 April 1999, Pages 31-48.

Given the above information about the Sri Lanka Shrimp Industry financial structure, complete the following table: **Show computation tables**. Assume that investment year as period 0. Compute for 10 periods.

	r=5%	r=8%
<b>Private</b>		
Net Present Value	7,078,235.00	6,127,831.00
B/C ratio	1.86	1.85
<b>Social</b>		
Net Present Value	6,809,395.00	5,894,212.00
B/C ratio	1.80	1.79

Average production	a	7,178.00	kg/ha/yr
Area	b	32.00	ha
Pond Development cost	c	5,500.00	ha
Cost	d	4.56	/kg
Fixed Cost	e	0.76	/kg
Variable	f	3.80	/kg
Price	g	8.65	/kg
External cost	h	1,088.00	ha/yr

Total revenue  $(a * g) * b$  1,986,870.40 Benefits  
Pond development cost  $(b * c)$  176,000.00 Investment cost at year 0

Cost per year  
Fixed cost  $(e * a) * b$  174,568.96  
Variable cost  $(f * a) * b$  872,844.80  
Total cost per year 1,047,413.76 1

Environmental cost  $(b * h)$  34,816.00 2

Total social cost  $(1 + 2)$  1,082,229.76

Undiscounted Cash flow

Period	Benefit	Cost	Net Benefits	External cost	Total Social Cost	Net Social Benefits
0	-	176,000	(176,000)	-	176,000	(176,000)
1	1,986,870	1,047,414	939,457	34,816	1,082,230	904,641
2	1,986,870	1,047,414	939,457	34,816	1,082,230	904,641
3	1,986,870	1,047,414	939,457	34,816	1,082,230	904,641
4	1,986,870	1,047,414	939,457	34,816	1,082,230	904,641
5	1,986,870	1,047,414	939,457	34,816	1,082,230	904,641
6	1,986,870	1,047,414	939,457	34,816	1,082,230	904,641
7	1,986,870	1,047,414	939,457	34,816	1,082,230	904,641
8	1,986,870	1,047,414	939,457	34,816	1,082,230	904,641
9	1,986,870	1,047,414	939,457	34,816	1,082,230	904,641
10	1,986,870	1,047,414	939,457	34,816	1,082,230	904,641

Discounted Table at 5%

Period	Benefit	Cost	Net Benefits	External cost	Total Social Cost	Net Social Benefits
0	-	176,000	(176,000)	-	176,000	(176,000)
1	1,892,258	997,537	894,721	33,158	1,030,695	861,563
2	1,802,150	950,035	852,115	31,579	981,614	820,536
3	1,716,333	904,795	811,538	30,075	934,871	781,463
4	1,634,603	861,710	772,893	28,643	890,353	744,250
5	1,556,765	820,676	736,089	27,279	847,955	708,810
6	1,482,633	781,596	701,037	25,980	807,577	675,057
7	1,412,032	744,377	667,654	24,743	769,120	642,911
8	1,344,792	708,931	635,861	23,565	732,496	612,296
9	1,280,754	675,172	605,582	22,443	697,615	583,139
10	1,219,766	643,021	576,745	21,374	664,395	555,371

Discounted Table at 8%

Period	Benefit	Cost	Net Benefits	External cost	Total Social Cost	Net Social Benefits
0	-	176,000	(176,000)	-	176,000	(176,000)
1	1,839,695	969,828	869,867	32,237	1,002,065	837,630
2	1,703,421	897,988	805,433	29,849	927,838	775,584
3	1,577,242	831,471	745,771	27,638	859,109	718,133
4	1,460,409	769,880	690,529	25,591	795,471	664,938
5	1,352,231	712,852	639,378	23,695	736,547	615,683
6	1,252,065	660,048	592,017	21,940	681,988	570,077
7	1,159,320	611,156	548,164	20,315	631,471	527,849
8	1,073,444	565,885	507,559	18,810	584,695	488,749
9	993,930	523,968	469,962	17,417	541,384	452,546
10	920,305	485,155	435,150	16,127	501,282	419,024