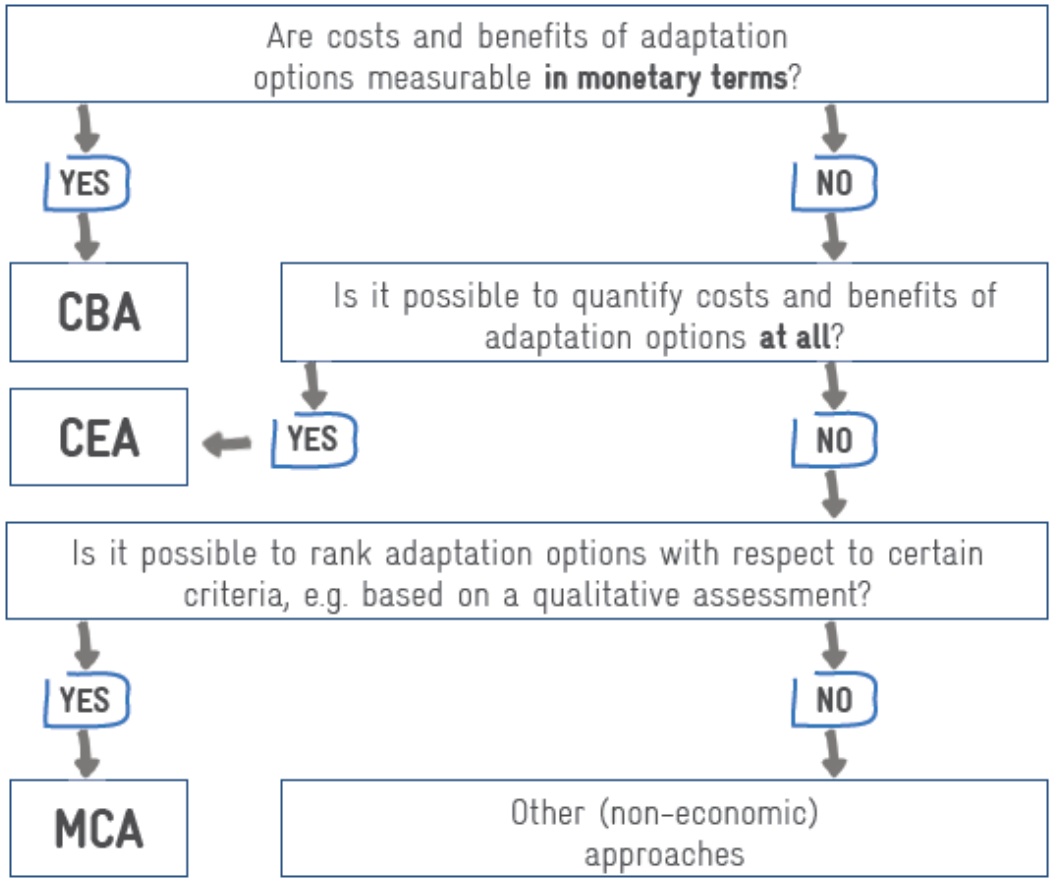
Appraisal Methods of Adaptation Measures (CBA-CEA)

OUTLINE

- **CEA & CBA –** ***goals, process, strengths and weaknesses***
- **Valuation**
- **Discount rate**
- **Sensitivity analysis**
- **Examples**



Economic tools for ranking and prioritizing adaptation options

WHICH ONE TO USE?

Cost Effectiveness Analysis: What is it?

CEA produces ranking in terms of costs of different options that achieve the same objective

The main aim is finding the least costly option

Cost Effectiveness Analysis Strengths and Weaknesses

Strengths	Weaknesses
- Benefits expressed in physical terms = no monetary valuation of benefits	- Optimizes to a single metric, which can be difficult to pick. Less applicable for cross-sectoral complex risks
- Increases applicability to non-market sectors	- The focus on a single metric omits important risks, and does not capture all costs and benefits (attributes) for option appraisal
- Relatively simple approach easy to understand	- Tends to work best with technical options, and can therefore omit or give lower priority to capacity building and soft (non-technical) measures
- Frequently used for CCM = approach widely recognised by policy makers	- Does not lend itself to the consideration of uncertainty and adaptive management
- Can assess different policy targets and how to achieve these at least cost - how to achieve greatest benefits for available resources - cost implications of progressively more ambitious policies	

Cost Effectiveness Analysis: How do we do it?

MAIN STEPS:

1. Agree on the adaptation objective and identify the potential adaptation options
2. Establish a baseline
3. Quantify and aggregate various costs (@PV)
4. Determine Effectiveness
5. Compare the cost-effectiveness of the different options

Cost Effectiveness Analysis *Example*

Two forms of ratio can be expressed:

- **Cost-Effectiveness Ratio: dividing costs of an alternative by the measure of effectiveness**
- **Incremental Cost-Effectiveness Ratio: dividing effectiveness measured by costs of alternative (*f*)**

Using these ratios the researcher can compare two project alternatives as follows:

Where,
C*i* = Costs of alternative *i*
C*j* = Costs of alternative *j*
E*i* = Effectiveness units of alternative *i*
E*j* = Effectiveness units of alternative *j*

$$CE_{ij} = \frac{C_i - C_j}{E_i - E_j}$$

Scheme	Cost (£)	E (lives saved per annum)	C/E	ΔC	ΔE	ΔC/ΔE
A	9,000	5	1,800	-	-	-
B	15,000	8	1,875	6,000	3	2,000
C	20,000	11	1,818	5,000	3	1,667
D	30,000	12	2,500	10,000	1	10,000

Cost Benefit Analysis: What is it?

Method of choice in most Gov economic appraisal

Portney: “it is an attempt to identify and express in dollar terms all of the effects of proposed government policies or projects”

It is a useful tool to assess the social welfare impacts of a project or policy

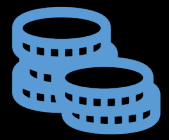
Many economists favor using it when assessing a project – though it still raises concerns in many quarters and can be difficult to get right

Cost Benefit Analysis: *How do we do it?*

Add up costs and add up benefits; if net benefits are positive do the project!

Simple, right?

Not quite! Issue of measurement of costs and benefits



Often times, costs simpler – tend to be one-off and are market transactions e.g. one time cost of constructing a dam

Benefits can be trickier e.g. what is the value of cleaner air after an land use policy is implemented?

Cost Benefit Analysis: *How do we do it?*

#2

1. **Identify adaptation objective and potential adaptation options**

2. **Establish a baseline and project pipeline to determine costs and benefits and compare the two situations**

3. **Quantify and aggregate direct and indirect costs over specific time periods**

4. **Quantify and aggregate benefits over specific time periods**

5. **Compare the aggregated costs and benefits (@PV)**

NB: benefits and costs need to be discounted to calculate their present value

NPV > 0
BCR > 1
IRR1 > IRR2

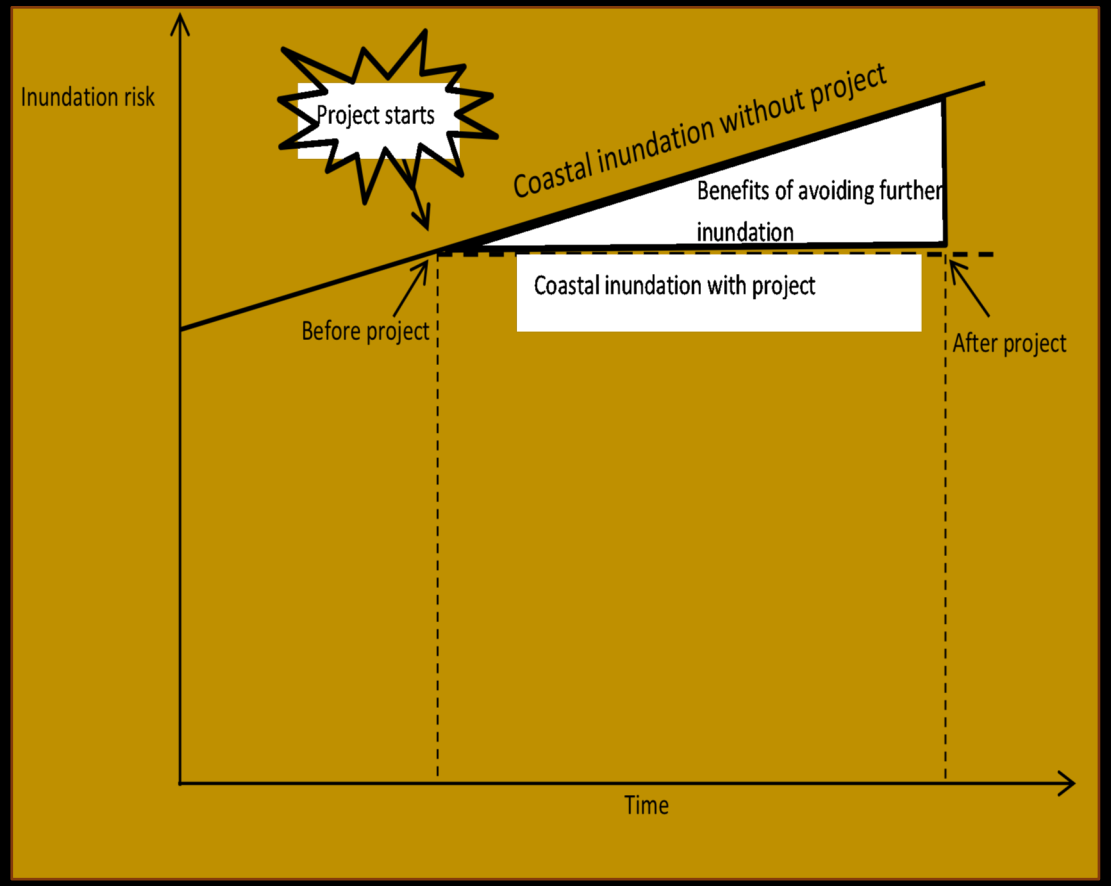
Cost Benefit Analysis: *How do we do it?*

#2 – cont'd

1. **Identify adaptation objective and potential adaptation options**
2. **Establish a baseline and project pipeline to determine costs and benefits and compare the two situations**

"With and without" analysis

- **Different from "before and after"**
- **Allows costs & benefits resulting from a proj to be identified**



Cost Benefit Analysis: *How do we do it?*

#2 – cont'd

With & Without Project

Lagoon Dredging Project

Present situation	Without lagoon dredging	With lagoon dredging and accompanying ban on beach mining
Beach mining of coastal aggregates (household mining estimated at 77,000 m^3 per year and Ministry of Public Works and utilities (MPWU) estimated at 6,500 m^3 per year) **Importation of aggregate material from overseas estimated at 5,000 m^3 per year**	Total beach mining increases at 5 per cent per year for next 10 years Importation of aggregate material increases at 7 per cent per year for next 10 years	Reduced reliance on coastal mining and importation of aggregate: Provision of 46,000 m^3 of aggregate per annum, expected to offset 75 per cent of imported aggregates and all aggreates mined by MPWU from the coast. The remainder of the 46,000 m^3 is intended to offset an equivalent quantity mined by communities Beach mining for large boulders and remaining aggregate needs (21,000 m^3 estimated) continues
Coastal erosion exacerbated by mining of beach flats, leading to increased risk of inundation, and damage to infrastructure, agriculture and public health	Coastal erosion continues with resulting ongoing harm to infrastructure, agriculture and public health Expenditure on protective works (e.g. sea walls) increases by Aus$7,500 per year	Expenditure on protective works remain at the same level Reduced damage costs in infrastructure and agriculture Reduced public health losses Possible impacts on fisheries?
Coastal mining supplementing incomes to numerous families, and sole or primary source of income for many	Continues at same level	Negative impacts on livelihoods of some community members
Low compliance with regulations restricting coastal mining (illegal mining in vulnerable areas, low payment of mining royalties)	Continues	Increased compliance from some sectors of the community but Likely on-going noncompliance from some families reliant on beach mining as primary source of income Possible social unrest due to negative perceptions by community of lagoon dredging (negative impact of livelihoods, environmental impacts etc.)

Cost Benefit Analysis: *How do we do it?*

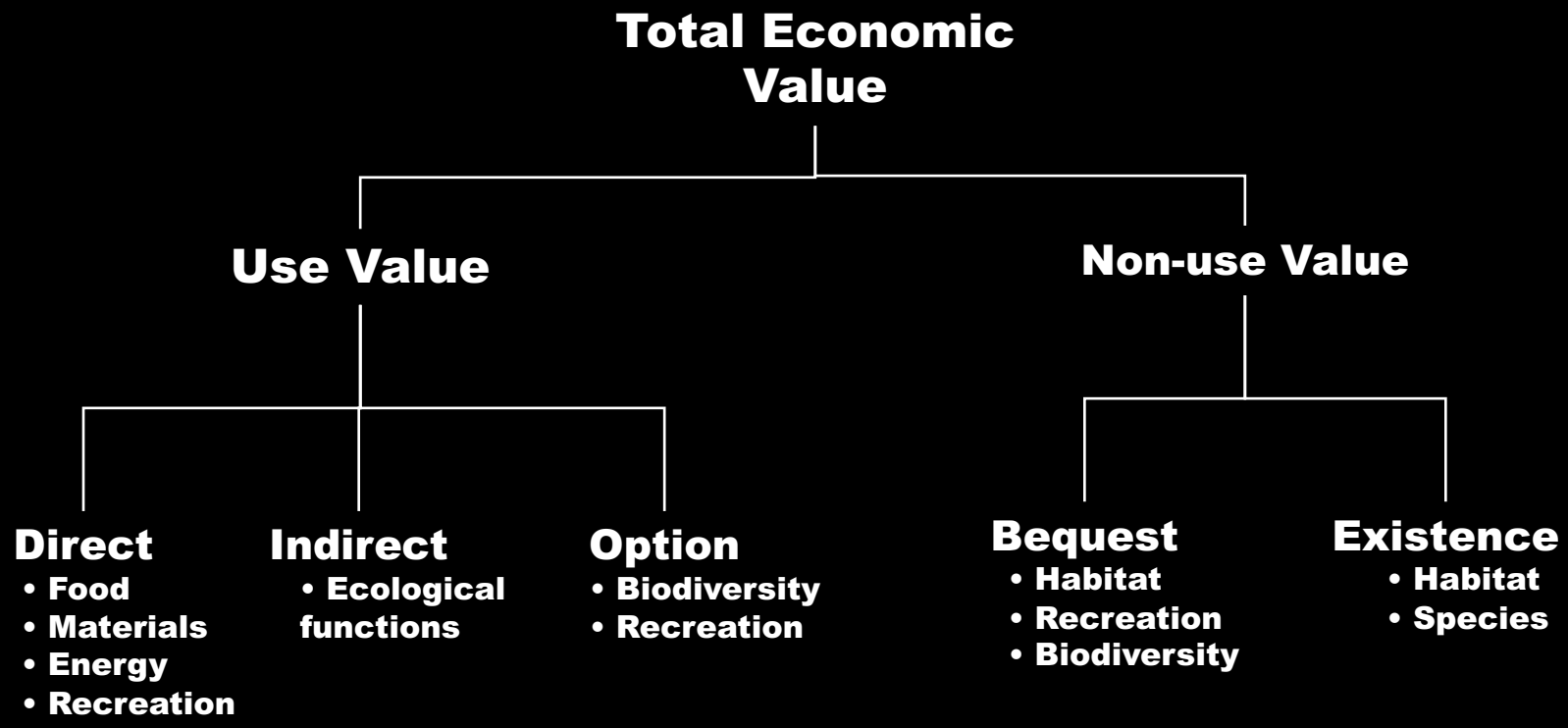
#3

Methodological points:

- **Need to turn to valuation techniques**
- **Need to be cognizant of timing of costs and benefits – costs and benefits are usually accrued over time**
- **Need to understand distribution of net present value**
- **Need to identify factors that drive results (*sensibility*)**

Valuing Costs and Benefits

Must engage in full valuation – not just market valuation of costs and benefits



Valuing Costs and Benefits

Strategy to get valuation is based on:

1. **Existing literature – plenty exist but lucky if in same context and period of time**

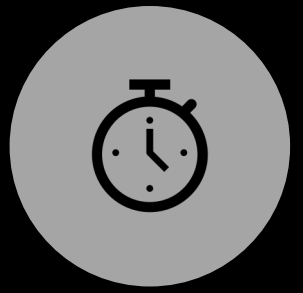
2. **Conduct own study – variety of methods including:**
   - **For adaptions: Impact Evaluation**
   - **More generally:**

	Revealed Preference	Stated Preference
Explicit prices/markets	•Market prices (IE)	•Contingent valuation
	•Simulated markets	
Implicit prices/markets	•Travel cost	•Contingent ranking
	•Hedonic property values	
	•Hedonic wage	
	•Avoidance expenditures	
	•Derived demand for options	

Note: for adaptations that save lives, we use value of a statistical life (VSL) to add benefits of deaths averted

Discounting: What is it?

Many times we want to assess value of events in the future e.g. costs and benefits that occur in the future



Projects span time – activities occur over many months/years

How do we think about activities that have value but occur at times other than the present?

Idea: reduce all future values to a common present value

Discounting: Why is it?

- Why? Because: ***money today is worth more than money tomorrow***

- We need to convert future values into a present value
- To do this we discount the future back to the present

- The ***discount rate*** is a product of society's time value of money (composed of the pure rate of time preference and the goods discount rate)

Discounting: *How do we do it?*

Use this formula to convert all future values to present values:

$$PV = FV_t/(1 + r)^t$$

Where PV is present value, FV is future value, r is the discount rate and t is time.

Need to define number of relevant periods

NB: GCF projects have chosen r = 10%

Sensitivity Analysis

Tests the robustness of the results of a model or system in the presence of uncertainty

Increases understanding of the relationships between input and output variables in a system or model

- **What if key parameters are shifted by some percentage?**
- **How sure are we about the quality of our input?**
- **And O&M?**
- **How about the benefits?**

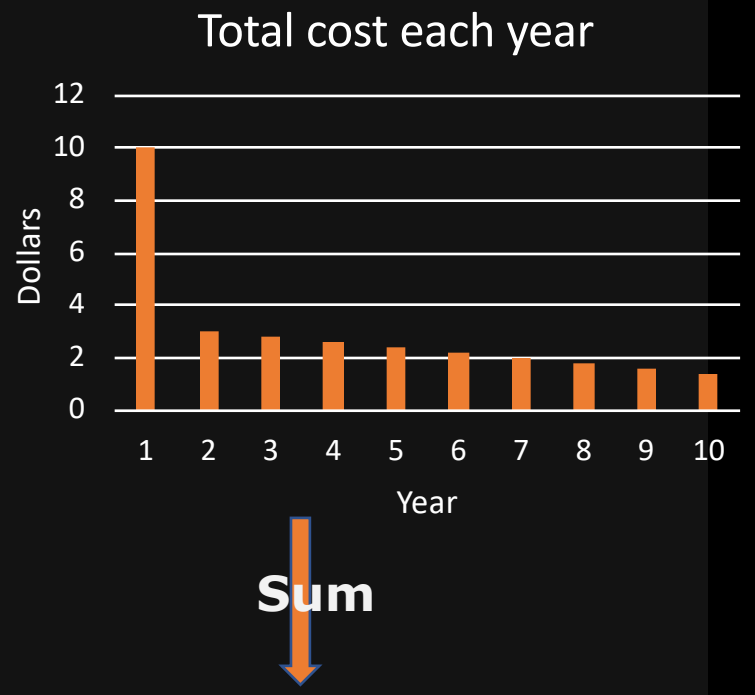
How to Choose

- Decision making – go/no-go
- If selecting from a suite of projects pick one with highest NPV – BCR (>1)
- If deciding on single project proceed if NPV is positive (or Economic Internal Rate of Return is greater than assumed discount rate)
- Is risk acceptable? Range of NPV values acceptable?
- Add: Sensitivity to specific parameters – are we confident in our ability to control those inputs?

How to Choose #2

Benefit Cost Ratio

“For every dollar spent, how much is returned in benefits?”



Sum

Sum

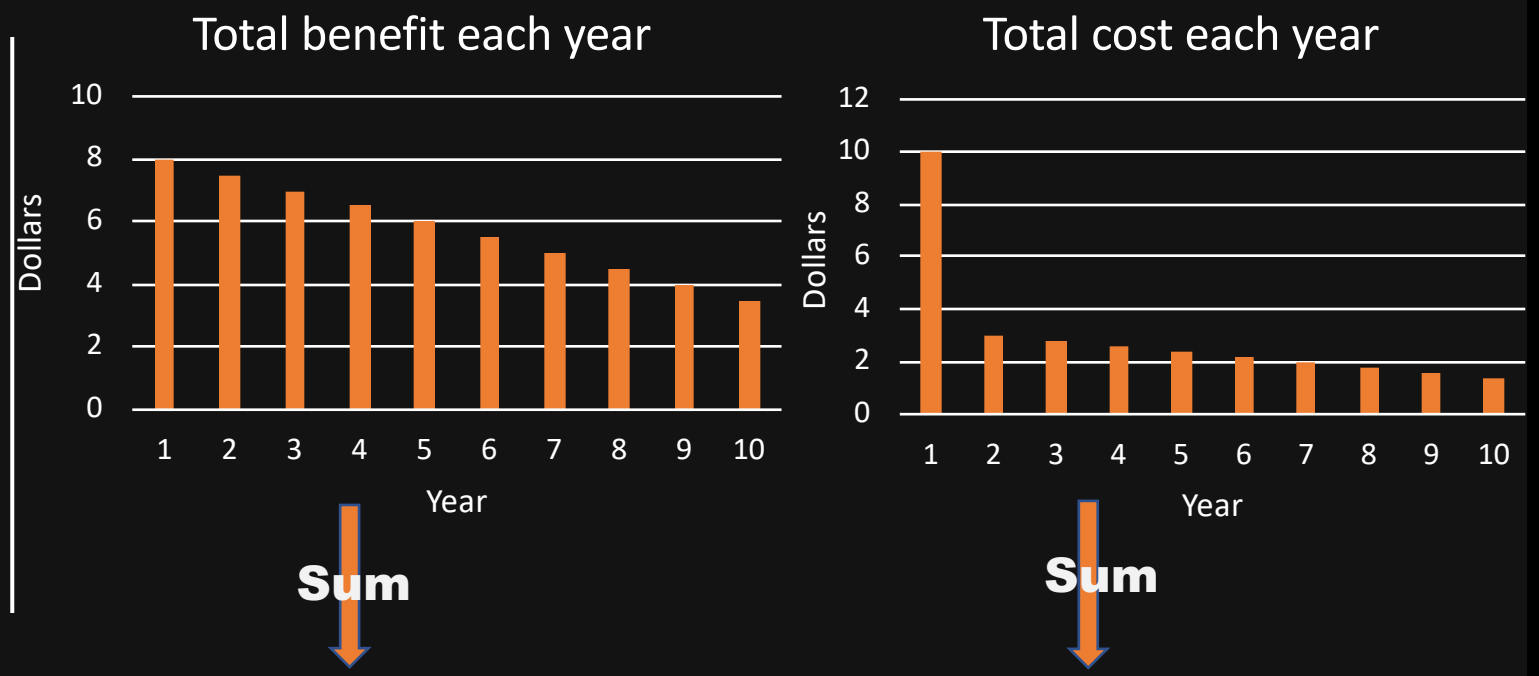
Total overall benefit of option ÷ **Total overall cost of option**

= **Benefit cost ratio**

Net Present Value

“what is the overall impact of this option?”

How to Choose #3



Total overall benefit of option — **Total overall cost of option**

= **Net Present Value**

Irrigation as Adaptation to Climate Change

Climate change affects temperature and precipitation among other climate phenomena

Changes in the hydrological cycle will be some of the most obvious changes that will affect agriculture

Irrigation systems are a way to adapt to changes in the hydrologic cycle (especially changes in the quantity and timing of precipitation)

"The prices of staple foods are at near historic lows, and stockpiles are adequate. This is a situation that would be inconceivable without the last half-century's *investments in irrigation*... Irrigation is the *largest recipient of public agricultural investment* in the developing world"

(World Bank (1995))

CBA – a practical example – Bhutan

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CBA – EXERCISE

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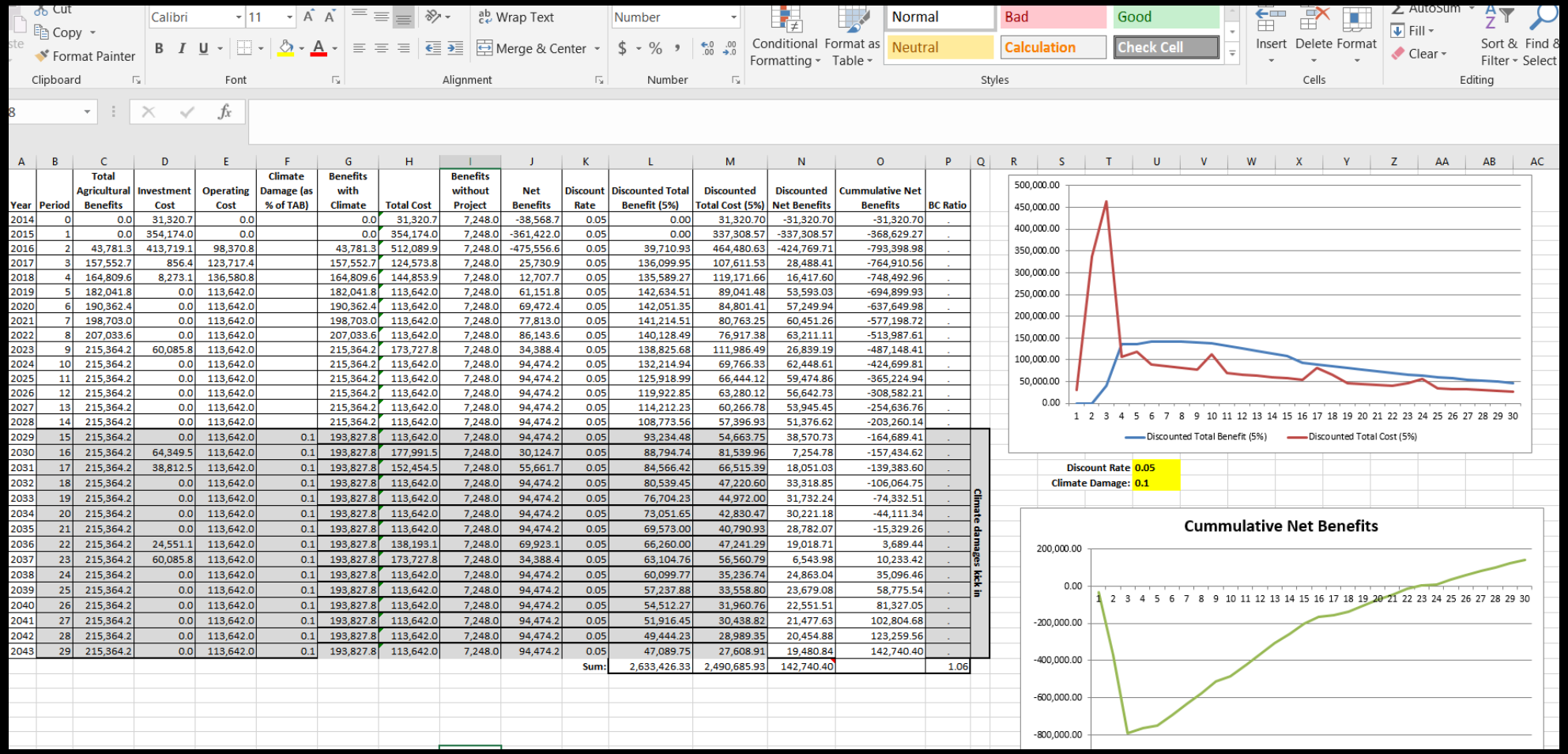

Year	Period	Total Agricultural Benefits	Investment Cost	Operating Cost	Climate Damage (as % of TAB)	Benefits with Climate	Total Cost	Benefits without Project	Net Benefits	Discount Rate	Discounted Total Benefit (5%)	Discounted Total Cost (5%)	Discounted Net Benefits	Cummulative Net Benefits	BC Ratio
2014	0	0.0	31,320.7	0.0		0.0	31,320.7	7,248.0	-38,568.7	0.05	0.00	31,320.70	-31,320.70	-31,320.70	.
2015	1	0.0	354,174.0	0.0		0.0	354,174.0	7,248.0	-361,422.0	0.05	0.00	337,308.57	-337,308.57	-368,629.27	.
2016	2	43,781.3	413,719.1	98,370.8		43,781.3	512,089.9	7,248.0	-475,556.6	0.05	39,710.93	464,480.63	-424,769.71	-793,398.98	.
2017	3	157,552.7	856.4	123,717.4		157,552.7	124,573.8	7,248.0	25,730.9	0.05	136,099.95	107,611.53	28,488.41	-764,910.56	.
2018	4	164,809.6	8,273.1	136,580.8		164,809.6	144,853.9	7,248.0	12,707.7	0.05	135,589.27	119,171.66	16,417.60	-748,492.96	.
2019	5	182,041.8	0.0	113,642.0		182,041.8	113,642.0	7,248.0	61,151.8	0.05	142,634.51	89,041.48	53,593.03	-694,899.93	.
2020	6	190,362.4	0.0	113,642.0		190,362.4	113,642.0	7,248.0	69,472.4	0.05	142,051.35	84,801.41	57,249.94	-637,649.98	.
2021	7	198,703.0	0.0	113,642.0		198,703.0	113,642.0	7,248.0	77,813.0	0.05	141,214.51	80,763.25	60,451.26	-577,198.72	.
2022	8	207,033.6	0.0	113,642.0		207,033.6	113,642.0	7,248.0	86,143.6	0.05	140,128.49	76,917.38	63,211.11	-513,987.61	.
2023	9	215,364.2	60,085.8	113,642.0		215,364.2	173,727.8	7,248.0	34,388.4	0.05	138,825.68	111,986.49	26,839.19	-487,148.41	.
2024	10	215,364.2	0.0	113,642.0		215,364.2	113,642.0	7,248.0	94,474.2	0.05	132,214.94	69,766.33	62,448.61	-424,699.81	.
2025	11	215,364.2	0.0	113,642.0		215,364.2	113,642.0	7,248.0	94,474.2	0.05	125,918.99	66,444.12	59,474.86	-365,224.94	.
2026	12	215,364.2	0.0	113,642.0		215,364.2	113,642.0	7,248.0	94,474.2	0.05	119,922.85	63,280.12	56,642.73	-308,582.21	.
2027	13	215,364.2	0.0	113,642.0		215,364.2	113,642.0	7,248.0	94,474.2	0.05	114,212.23	60,266.78	53,945.45	-254,636.76	.
2028	14	215,364.2	0.0	113,642.0		215,364.2	113,642.0	7,248.0	94,474.2	0.05	108,773.56	57,396.93	51,376.62	-203,260.14	.
2029	15	215,364.2	0.0	113,642.0	0.1	193,827.8	113,642.0	7,248.0	94,474.2	0.05	93,234.48	54,663.75	38,570.73	-164,689.41	.
2030	16	215,364.2	64,349.5	113,642.0	0.1	193,827.8	177,991.5	7,248.0	30,124.7	0.05	88,794.74	81,539.96	7,254.78	-157,434.62	.
2031	17	215,364.2	38,812.5	113,642.0	0.1	193,827.8	152,454.5	7,248.0	55,661.7	0.05	84,566.42	66,515.39	18,051.03	-139,383.60	.
2032	18	215,364.2	0.0	113,642.0	0.1	193,827.8	113,642.0	7,248.0	94,474.2	0.05	80,539.45	47,220.60	33,318.85	-106,064.75	.
2033	19	215,364.2	0.0	113,642.0	0.1	193,827.8	113,642.0	7,248.0	94,474.2	0.05	76,704.23	44,972.00	31,732.24	-74,332.51	.
2034	20	215,364.2	0.0	113,642.0	0.1	193,827.8	113,642.0	7,248.0	94,474.2	0.05	73,051.65	42,830.47	30,221.18	-44,111.34	.
2035	21	215,364.2	0.0	113,642.0	0.1	193,827.8	113,642.0	7,248.0	94,474.2	0.05	69,573.00	40,790.93	28,782.07	-15,329.26	.
2036	22	215,364.2	24,551.1	113,642.0	0.1	193,827.8	138,193.1	7,248.0	69,923.1	0.05	66,260.00	47,241.29	19,018.71	3,689.44	.
2037	23	215,364.2	60,085.8	113,642.0	0.1	193,827.8	173,727.8	7,248.0	34,388.4	0.05	63,104.76	56,560.79	6,543.98	10,233.42	.
2038	24	215,364.2	0.0	113,642.0	0.1	193,827.8	113,642.0	7,248.0	94,474.2	0.05	60,099.77	35,236.74	24,863.04	35,096.46	.
2039	25	215,364.2	0.0	113,642.0	0.1	193,827.8	113,642.0	7,248.0	94,474.2	0.05	57,237.88	33,558.80	23,679.08	58,775.54	.
2040	26	215,364.2	0.0	113,642.0	0.1	193,827.8	113,642.0	7,248.0	94,474.2	0.05	54,512.27	31,960.76	22,551.51	81,327.05	.
2041	27	215,364.2	0.0	113,642.0	0.1	193,827.8	113,642.0	7,248.0	94,474.2	0.05	51,916.45	30,438.82	21,477.63	102,804.68	.
2042	28	215,364.2	0.0	113,642.0	0.1	193,827.8	113,642.0	7,248.0	94,474.2	0.05	49,444.23	28,989.35	20,454.88	123,259.56	.
2043	29	215,364.2	0.0	113,642.0	0.1	193,827.8	113,642.0	7,248.0	94,474.2	0.05	47,089.75	27,608.91	19,480.84	142,740.40	.
										Sum:	2,633,426.33	2,490,685.93	142,740.40		1.06

Climate damages kick in

Discount Rate 0.05
Climate Damage: 0.1

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